AN INTERTEMPORAL COMPARISON OF THE STRUCTURE OF THE SRI LANKAN ECONOMY FROM 1986 TO 2000

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ABSTRACT

This paper analyses the structure of the Sri Lankan economy using three Input-Output Tables of 1986, 1994 and 2000 in the Extended Input-Output Framework. The structure of the economy is seen to evolve into a mix that contains traditional sectors like Tea, Rubber and Coconut along with manufacturing sectors like other Manufactured Products and Chemical & Chemical Products as also services like Construction and Trade Transport & Other Services. The export-oriented Textile and Garment sectors have a weak level of integration with the rest of the economy. Most of the sectors with high values of Ordinary Income Multipliers or Total Income Multipliers belong to either agriculture- related activities or service-related activities in the economy. Over the entire time-span 1986 to2000, the strongly import-intensive production sectors of the Sri Lankan Economy have been the Petroleum Industry, Textiles Footwear & Leather Products, Other Manufactured Products, Garments, Basic Metals, and Machinery & Equipment Manufacturing, together with the plantation sectors of Tea, Coconut and Rubber. The overall spread of export-dependence on the various sectors of the Sri Lankan Economy is seen to increase over time.

Key-words: Structure, Extended Input-Output Framework, Import Intensity, Income Multipliers, Export Dependence.

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1. INTRODUCTION

Following Leontief (1941), an economy can be conceptualized to comprise numerous sectors such as Agriculture, Light Manufacturing including Consumer Goods, Basic Metals like Iron, Heavy Industries such as Steel and Coal, Mining and Quarrying Industries, Services like Banking & Finance or Shipping, Machinery Manufacturing and Exports, to name a few. Each of these sectors engages in transactions with the other sectors of the economy. These interactions lead to the final outcomes in the economy in the form of production, exchange and consumption. From these final outcomes we assess the level of performance of the economy in terms of employment, value addition leading to income generation or final output known as the Gross Domestic Product, import requirements, export performance and so on. In the ultimate analysis, the performance of the economy depends largely on the interconnections between the various sectors of the economy as also those with the rest of the world. Therefore, the economist has to look into the detailed inter-sector transactions that occur in the economy in order to identify the inter-industry linkages and assess whether the different sectors are well -enough coordinated to lead the economy to the desired state of equilibrium. For example, if we want to look into the reasons behind low overall growth in a hypothetical oil -exporting

economy, we would do well to make a detailed study of the linkages with the oil sector and the other sectors of that economy. To cite a case in point, Matallah and Proops (1992) have shown that a major reason for low overall growth of the Algerian economy is that the oil-exporting sector is not well connected or coordinated with the rest of the economy.

Sri Lanka has traveled a long way since its independence in 1948 until date in its pursuit of economic growth, experiencing shifting paradigms in terms of economic policy orientation as also recurring conflicts arising out of ethnic divides and economic constraints that have created vicissitudes in its run up to a developed mature economy. The question arises whether the economy has been reasonably diversified over time to generate well-balanced growth that permeates throughout the economy. This calls for a clear picture of how the inter-sector linkages have developed and changed in the Sri Lankan economy over the last three decades, i.e. from the 1980-s to the 2000-s, with the help of a suitable model. This paper is organized into five sections. Section 2 discusses the Extended Input-Output model. Sections 3 and 4 present the Data-Base and some measures of interconnectedness of the Sri Lankan economy respectively. Finally, Section 5 summarizes and concludes the paper. We now discuss the model for the analysis of linkages and multipliers in the Sri Lankan economy.

2. THE MODEL

The Extended Input-Output Structure (Adamos & Gowdy, 1990 and Gowdy, 1991) of an economy can be theoretically depicted by the following compact schematic representation:

The adjective 'Extended' is because this structure can accommodate the traditional demand-driven Leontief framework as also a later extension in the form of a supply-driven framework developed by Ghosh (1958, 1974). The notations of the Input-Output Model are defined as follows:

X = square matrix (n x n) of inter-sector transactions in the economy;

f = column-vector (n x 1) of final demands;

x = column-vector (n x 1) of gross outputs in the economy;

v′ = row-vector (1 x n) of value addition in the different sectors

e = column-vector (n x 1) at the unit level.

The traditional Leontief structure is read as **x = Xe + f,** which shows that gross output of each sector is the sum of intermediate sales to other sectors and final use. On the other hand, an alternative way of accounting for the gross output of each sector is to add up the intermediate purchases of that sector with the value added in the sector. This is the Ghosh Structure, given by **x′ = e′X + v′**. Both the interpretations are useful for analyzing the structure of an economy. At a more fundamental level, the equivalence of the two alternative forms of representation is reflected by the fact that the total final demand **e′f** must equal the total value added **v′e**. The Extended Leontief Framework is very helpful in making inter-temporal comparisons of the structure of an economy. It can be used to compute various measures of linkages and multipliers for different years. Comparison

and analysis of the results gives a picture of the structural changes in an economy over successive time-periods.

We define $\langle \mathbf{x} \rangle^{-1}$ as the inverse of the diagonal matrix of gross sector -outputs in the economy. From the Leontief framework, we have

$$\mathbf{x} = \mathbf{Xe} + \mathbf{f}$$

$$= \mathbf{X}\langle \mathbf{x} \rangle^{-1} \mathbf{x} + \mathbf{f}$$

$$= \mathbf{A}\,\mathbf{x} + \mathbf{f}$$

$$\Rightarrow \quad \mathbf{x} = (\mathbf{I}-\mathbf{A})^{-1} \mathbf{f} \ldots\ldots \textbf{(i)}$$

$$\Rightarrow \quad \mathbf{x} = \mathbf{L}\,\mathbf{f}$$

$$\Rightarrow \quad \Delta\mathbf{x} = \mathbf{L}\,\Delta\mathbf{f}$$

The matrix $\mathbf{(I-A)}^{-1} = \mathbf{L} = [\mathbf{L_{ij}}]$ is called the Leontief Inverse**.** It forms the basis for some of the most important measures of interconnectedness among the different sectors of an economy. The element $\mathbf{L_{ij}}$ {(i,j) = 1,2,….,n}shows the change in the gross output of the i^{th} sector due to a unit change in the final demand for the output of the j^{th} sector.

In a similar way, from the Ghosh framework, we have

$$\mathbf{x}' = \mathbf{e}'\mathbf{X} + \mathbf{v}'$$

$$= \mathbf{x}'\langle \mathbf{x} \rangle^{-1} \mathbf{X} + \mathbf{v}'$$

$$= \mathbf{x}'\mathbf{B} + \mathbf{v}'$$

$$\Rightarrow \quad \mathbf{x}' = \mathbf{v}'\,(\mathbf{I}-\mathbf{B})^{-1} \ldots\ldots\ldots \textbf{(ii)}$$

$$\Rightarrow \quad \mathbf{x}' = \mathbf{v}'\mathbf{G}$$

$$\Rightarrow \quad \Delta\mathbf{x}' = \Delta\mathbf{v}'\,\mathbf{G}$$

The matrix $\mathbf{(I-B)^{-1} = G = [G_{ij}]}$ is called the Ghosh Inverse. It too forms the basis for some important measures of inter-relatedness among the different sectors of an economy. The element $\mathbf{G_{ij}}$ {(i,j) = 1,2,….,n}shows the change in the gross output of the i^{th} sector due to a unit change in the value added for the output of the j^{th} sector. The Leontief and Ghosh solutions given by equations (i) and (ii) derived above form the basis for the inter-temporal structural analysis of Sri Lanka. Before proceeding with the measures of interconnectedness and their corresponding empirical results, we present the data base for our investigations.

3. DATA BASE

Sri Lanka's Input-Output Tables of 1986, 1994 and 2000 have been used for the empirical analysis. The Input Output Tables of 1986 and 2000 have been sourced from The Ministry of Planning, Colombo, Sri Lanka while the Institute for Policy Studies has published the Input-Output Table of 2000, Colombo, Sri Lanka in 2004. In order to make inter-temporal comparisons meaningful, the tables have been converted into the common base-year price of 2000[1], as per standard norms. Further, to facilitate inter-temporal comparisons, each table has been aggregated into nineteen (19) sectors using a suitable Aggregation Scheme, which is presented in Table 1 in the Appendix.

4. MEASURES OF INTERCONNECTEDNESS

Sequel to the pioneering works of Chenery and Watanabe (1958), several Measures of Interconnectedness exist in the Input Output framework. Unlike the case of countries like

[1] This point is elaborated upon in the end-note to the paper.

USA, Canada, Japan etc., (Blair, P.& Wyckoff, A. 1980 and Gowdy, J.M. 1991), very little empirical research (Bhowmik, R. & Chakraborty, D., 1995) has been done on the Structural Analysis of the developing economy of Sri Lanka. In this section we develop and quantify some widely used measures of interconnectedness, namely

1. Backward Linkages:
2. Output Multipliers
3. 'Key-Sector' Identification by Backward Linkages and Output Multipliers
4. Ghosh Forward Linkages
5. 'Key-Sector' Identification by Backward and Forward Linkages
6. Income Multipliers
7. Modified Income Multipliers
8. Import Intensity Multipliers
9. Modified Import Intensity Multipliers
10. Index of Dependence on Components of Final Demand

For any sector, if the measure of any linkage or multiplier exceeds the overall average of that linkage or multiplier, then we say that the sector is 'STRONG' in that linkage or multiplier.

4.1 **Backward Linkages**

The Backward Linkage of a sector shows the effects of a change in the final demand of that sector on the rest of the economy. It is defined as $\mathbf{[e'(I-A)^{-1}]}$, where $\mathbf{e'}$ is the unit row-vector. The j^{th} column-sum of the Leontief Inverse gives the Backward Linkage of the j^{th} sector with the rest of the economy.

The Backward Linkages of the various sectors in 1986 are as follows. In this year, the six sectors with strong backward linkages were, Petroleum Industry (17), Milling (7), Electricity, Water & Gas (18), Construction (16), Other Manufactured Products (13), Food Beverages & Tobacco (10), in descending order.

For the year 1994, the sectors with strong backwardly-linked sectors in 1994 were Tea(1), Rubber(2), Construction(16), Milling(7), Electricity, Water & Gas(18), Other Manufactured Products(13), Non-Metallic Products(12), Food, Beverages & Tobacco(10), Textiles, Footwear & Leather Products (8), and Chemical & Chemical Products(11).

From the computations of Backward Linkages for 2000 , we find that the Rubber sector shows the highest Backward Linkage. In this year, the strong backwardly -linked sectors were Rubber(2), Tea(1), Milling(7), Co nstruction(16), Non-Metallic Products(12), Trade, Transport & Other Services (19) and Textiles, Footwear & Leather Products(8),. This set of sectors is very similar but not identical to that of the year 1994. Table 2 in the Appendix summarizes the informa tion on the sectors with strong backward linkages that we have gathered so far.

There is a great deal of similarity as also some difference between the sectors with strong backward linkages in 1986 and 1994. Except for the Petroleum Industry (17), all the sectors showing strong Backward Linkages in 1986 also show strong Backward Linkages

in 1994. These sectors are Milling(7), Food, Beverages & Tobacco(10), Other Manufactured Products(13), Construction (16), and Electricity, Water & Gas(18). In addition, Tea(1), Rubber(2), Textiles, Footwear & Leather Products(8), Chemical & Chemical Products(11) and Non-Metallic Products(12) also feature in 1994. Coming to the year 2000, we see that two out of the six strongly backward -linked sectors of 1986 feature in the year 2000 too. These are Milling (7) and Construction (16). There is a sort of continuity in the structure of the economy as it evolves from 1994 to 2000. Both the years 1994 and 2000 include Tea(1), Rubber(2), Milling(7), Textiles, Footwear & Leather Products(8) and Non-Metallic Products(12) as sectors with strong Backward linkages. In addition there is the upcoming Trade, Transport & Other Services Sector (19) in the year 2000 as another sector with strong Backward Linkages.

The general equilibrium nature of an economy is portrayed in the Leontief structure by the fact that each sector of the economy draws inputs from all the sectors and at the same time, provides inputs to all the sectors. The discussion on Backward Linkages focuses on the first part where a sector draws inputs from the entire economy. This leads one to the question of Forward Linkages, which measures the degree to which a sector caters to the entire economy by supplying inputs. In the Leontief Framework, Rasmussen Forward Linkages are defined as the Row Totals of the Leontief Inverse Matrix. This measure is also known as the Output Multiplier.

4.2. **Output Multipliers**

The Output Multipliers of a sector measure the effect of a unit change in the final demand of all sectors on the various individual sectors of the economy. It is defined as **[(I-A)** $^{-1}$ **e]**, where **e** is the unit column-vector. The i th row-sum of the Leontief Inverse gives the Output Multiplier of that sector.

In 1986, the sectors with strong Output Multipliers were Trade, Transport & Other Services(19) and Paddy(4). The corresponding results for the year 1994 reveal that the sectors with strong Output Multipliers were Trade Transport & Other Services(19), Rubber(2), Other Manufactured Products(13) and Chemical & Chem ical Products(11) . From the computations of Output Multiplier for 2000 , we find that that if there is a unit increase in the final demand for all the sectors in 2000, then that would create a total increase of 3.3639 units in the gross production in the Trade, Transport & Other Services(19) sector. This is the sector with the highest Output Multiplier in the year 2000. Other sectors in diminishing order of Output Multiplier are also shown in this table. Of these the relatively higher-order backward-linked sectors are Construction(16), Tea(1), Paddy(4), Rubber(2) and Electricity, Water & Gas (18) in descending order. The information gathered so far on Output Multipliers is summarized in Table 3 of the Appendix.

The Trade Transport & Other Services(19) sec tor features in all three years as the unique sector with the highest Output Multiplier in all the three years. The Paddy(4) sector features twice, in 1986 and in 2000. Similarly, Rubber(19) is included in 1994 as also

2000. The year 1994 shows Other Manuf actured Products(13) and Chemical & Chemical Products(11) as two additional sectors with strong Output Multipliers. Construction(16), Tea(1), and Electricity, Gas & Water(18) sectors also exhibit strong Output Multipliers in the year 2000.

Primary products feature in this group for each of the three years. In 1986 there was Paddy(4) , in 1994 there was Rubber(2) while in 2000, both these sectors show up as representatives of the Primary Sectors. So the Strong Output -Multiplier group is characterized by the predominance of some service-sectors as also primary-sectors although the secondary-sector is not altogether absent. On the whole, during the time period 1986 to 2000, the number of sectors with strong Output Multipliers have increased due to the addition of new sectors like Construction(16) and Electricity, Water & Gas(18) on the one hand and Tea(1) and Rubber(2) on the other.

The Output Multipliers and Backward Linkage measures are two different dimensions of the degree of interconnectedness of any sec tor with the entire economy. The economist is also interested in developing a measure of the overall degree of interconnectedness of any sector with the entire economy. Together, the Backward Linkage and the Output Multiplier of a sector provide a picture of this overall integration of any sector with the entire economy. We now turn to the identification of the Key -Sectors based on Output Multipliers and Backward Linkages.

4.3 **'Key-Sectors' based on Backward Linkages & Output Multipliers**

Identification of the 'Key Sectors' of the economy helps to pin-point those areas where the overall linkage is highest. These sectors may be viewed as the nodal points of the economy that are transmit the effects of their own expansion and growth to the entire economy in a relatively strong manner. In this section, we define a key-sector as one that exhibits both strong Output Multipliers as also strong backward linkages. Table 4 in the Appendix lists the Key-Sectors for each of the three Input-Output Tables of 1986, 1994 and 2000 for the Sri Lankan Economy.

As per our model, none of the sectors qualifies as a Key-sector in the year 1986. Over a period of six years, the structure of the economy is seen to evolve into a mix that contains both traditional sectors like Rubber(2) and Manufacturing sectors like other Manufactured Products(13) and Chemical & Chemical Products(11). However, in the year 2000 we find two Primary Sectors Tea(1) and Rubber(2) along with another two Service Sectors Construction(16) and Trade Transport & Other Services(19) as the Key Sectors of the economy. Thus, the economy is not well-diversified. This is corroborated by the fact that certain crucial sectors like Machinery & Equipment Manufacturing, Basic Metals & Rolling are not present as strong or Key Sectors for any of the three Input-Output Tables available during the period 1986 to2000. Essentially, it may be viewed as a combination Plantation and Service Oriented economy even in the year 2000. Another important observation is that although the country's export basket is getting more and more heavily weighed toward the Textiles & Garments sector, these sectors are not

included in the list of Strong or Key-Sectors of the economy, indicating that they have a weak level of integration with the rest of the economy.

The Leontief System generates fixed coefficients of production that create the links between the various sectors of he economy. The production structure is given by each column of the [**A]** matrix defined in the process of developing equat ion (3.2.1) above. Forward linkages of any sector however, are more appropriately conceptualized as what the sector gives to the entire economy. The Ghosh structure is based on the matrix **[B]** of allocation coefficients defined in the process of developing the equation (3.2.2) above. As such, it is expected to provide a more appropriate measure of Forward Linkages, which we now discuss.

4.4 **Ghosh Forward Linkages**

The measure of Forward Linkages obtained from the Ghosh Structure is called the Ghosh Forward Linkage, as distinct from the Rasmussen Forward Linkage that are today more widely called the Output Multipliers. The i^{th} row-sum of the Ghosh inverse matrix denoted by $\mathbf{(I-B)^{-1}}$ or **G** shows the effect of a unit level of value addition in the i^{th} sector on the gross outputs of all the sectors of the economy. Hence, it may be interpreted as a measure of the degree to which the i^{th} sector gives its output to all the sectors of the economy. This concept of the i^{th} row-sum of the Ghosh inverse matrix $\mathbf{(I-B)^{-1}}$ or **G** is therefore used as a measure of Forward Linkage. Table 5 of the Appendix summarizes the sectors with strong Ghosh Forward Linkages.

Four sectors of the economy show strong Ghosh forward linkages for all the three Input Output tables of 1986, 1994 and 2000. They are the Petroleum Industry (17), Electricity Water & Gas (18), Non-Metallic Products (12) and the Paddy (4) sector. The Trade Transport & Other Services (19) sector shows strong Ghosh forward linkages in 1986 as well as 1994. The Rubber(1) sector shows strong Ghosh forward linkage in 1994 as also in 2000. Other than these, there is the Mining & Quarrying Sector (6) that shows strong Ghosh forward linkage in 1986 and 2000, the Chemical & Chemical Products (11) and Other Manufactured Products (13) that show strong Ghosh forward linkage in 1994, and the Tea(1), Basic Metals (15) and Construction (16) sectors that show strong Ghosh Forward Linkage in 2000.

4.5 **Key Sectors by Backward & Ghosh Forward Linkages**

We now present the alternative set of Key Sectors identified by Ghosh Forward and Leontief Backward Linkages in Table 6 in the Appendix. Under this alternative classification scheme, the Key-Sectors of the economy in 1986 are the Petroleum Industry (17) and Electricity, Water & Gas(18) sectors. In 1994 Rubber (2), Other Manufactured Products(13), Electricity Water & Gas(18), Non-Metallic Products(12) and Chemical & Chemical Products(11) sectors qualify as Key sectors with strong Leontief Backward and Ghosh Forward Linkages. The Rubber (2) and Non-Metallic Products(12) sectors feature as key sectors once again in the year 2000. Other sectors with similar with strong Leontief Backward and Ghosh Forward Linkages in 2000 are Tea (1) and Construction(16).

On comparing the two sets of Key Sectors obtained by the two different methods of classification, we find that there are some similarities between them. The Rubber (2) sector, Other Manufactured Products (13) and the Chemical & Chemical Products (11) sectors feature as key sectors in 1994 under both the methods of classification. It will be recalled that the Rubber (2), Tea(1) and Construction(16) sectors were key sectors in 2000 even under the earlier scheme of classification by Backward Linkages and Output Multipliers. Although the sets of Key Sectors are not identical under the two methods of classification, we retain the basic conclusion that the structure of the economy is seen to evolve into a mix that contains both traditional sectors like Rubber (2) and Tea (1) along with services like Construction (16) and a manufacturing sector, namely, Non-Metallic products(12).

4.6 **Income Multipliers**

The Income Multiplier of a sector calculates the income generated or value-added by all sectors of the economy taken together when there is a unit increase in the final demand for that particular sector. It is defined as $\mathbf{[\upsilon' (I-A)^{-1}]}$ where $\boldsymbol{\upsilon}$ is the vector of value-addition coefficients.

There is a lot in common between the sectors with strong Income Multipliers in 1986 and 1994. Both these years include Mining & Quarrying(6), Coconut(3), Trade Transport & Other Services(19), Other Agriculture(5), Paddy(4), Non-Metallic Products(12) and Electricity, Water & Gas(18) as sectors with strong or above-average Income Multipliers

in descending order. Tea(1), Rubber(2), Milling(7) and Construction(16) also appear in the list for 1994.

The Input-Output Table of 2000 shows strong Income Multipliers for Non-Metallic Products(12), Mining & Quarrying(6), Trade Transport & Other Services(19), Electricity Water & Gas(18), Coconut(3), Tea(1), Construction(16), Rubber(2),Other Agriculture(5), Paddy(4), and Food Beverages and Tobacco(10) sectors, in descending order. Once again, we find some similarities between the sectors with strong Income Multipliers in 1994 and 2000.

It may be noted that among the sectors with strong income multiplier s in the year 2000, Non-Metallic Products (12), Mining & Quarrying (6), Trade Transport & Other Services (19), Electricity Water & Gas (18), Coconut (3), Other Agriculture (5) and Paddy (4) also qualified in the list for 1994 and 1986. The Tea (1), Rubber (2), and Construction (16) sectors show strong Income Multipliers in both the years 2000 and 1994 but not in 1986. The Milling (7) sector shows strong Income Multiplier in 1994 alone.

An interesting feature is that while Petroleum Industry (17) and Chem ical & Chemical Products (11) show high Income Multipliers in 1986, these two sectors are absent in the list when we consider the later years 1994 or 2000. Instead Food Beverages and Tobacco (10) gets included in the year 2000. Hence there is a definite s tructural change in the economy as far as Income Multipliers are concerned. The r esults are summarized in Table 7 in the Appendix.

4.7 **Modified Income Multipliers (MIM)**

The concept of income Multipliers relates the total value addition generated in the economy with a unit increase in the final demand of a particular sector. Sometimes we may be interested to know the effects of economy-wide total value addition per unit of value added in a particular industry. This measure is called the Modified Income Multiplier. It is defined as $\mathbf{[\upsilon'(I-A)^{-1} <\upsilon>^{-1}]}$ where $<\upsilon'>^{-1}$ is the inverse of the diagonal matrix of value-addition coefficients. We compute these multipliers by dividing the ordinary Income Multipliers by their respective value-addition coefficients. The Modified-Income-Multipliers (MIM) computed for the three years 1986, 1994 and 2000 show that while there is a similarity between the sets for 1986 and 1994, the set for 2000 is somewhat different. The Milling sector (7) is the only sector with above-average Modified Income Multipliers in all three years. These results are summarized in Table 8 of the Appendix.

4.8 **Total Income Multipliers**

The ordinary and Modified Income Multipliers discussed are in the nature of production-income multipliers. These are basically dependent on the production technology of the Input-Output system. Following Keynes, we know that when the income in the economy rises, it induces consumption expenditure which in turn leads to further expansion of output and income. The Total Income Multiplier is the sum of the ordinary production-income multiplier and induced consumption-income multipliers. We measure the Total Income Multipliers by the expression $\mathbf{\upsilon'[I-(A + a\upsilon')]^{-1}}$, instead of the ordinary or standard expression $\mathbf{\upsilon'[I-A]^{-1}}$. Both the measures consist of pre-multiplying an inverse

matrix with the row vector of value-addition coefficients **v'.** The vector of value-addition coefficients used in the two measures is identical. The difference between ordinary and total income multipliers arises due to the different inverse matrices used in the two measures. While the ordinary or modified income multipliers are based on the Leontief inverse $(I-A)^{-1}$, the total income multiplier considers an inverse matrix $\mathbf{[I-(A + a\upsilon')]^{-1}}$, based on an additional matrix $\mathbf{a\upsilon'}$. Total private consumption in the economy is conceptualized to arise out of total household income or value added. The vector of Private Final Consumption Expenditure deflated by total household income gives us the column vector **'a'** which is like an additional household-production-coefficient vector**.** The matrix $\mathbf{a\upsilon'}$ therefore distributes the consumption-led additional income generation coefficients across the various sectors of the economy. Now by adding the standard technology matrix **A** and the matrix $\mathbf{a\upsilon'}$, we obtain the new coefficient matrix $\mathbf{(A + a\upsilon')}$. We do a Leontief type of inverse operation on this augmented coefficient matrix to obtain the new inverse matrix $\mathbf{[I-(A + a\upsilon')]^{-1}}$. The Total Income Multipliers are obtained by pre-multiplying this matrix by the value-addition coefficients **v'** to arrive at the expression $\mathbf{\upsilon'[I-(A + a\upsilon')]^{-1}}$. The Total Income Multipliers are much larger than the ordinary Income Multipliers. Table 9 of the Appendix shows the sectors with high Total income Multipliers in the three years 1986, 1994 and 2000.

In 1986, the sectors with high total income multipliers and those with high ordinary income multipliers are identical. When we look at the year 1994, we find that some of the sectors that show high ordinary income multipliers do not have high Total income multipliers. The same is true for 2000. An important observation can be made to sum up

our discussion of the different types of income multipliers in Sri Lanka. It is that most of the sectors with high values of the Ordinary or Total Income Multipliers belong to either agriculture- related activities or service-related activities in the economy.

4.9 **Import-Intensity Multipliers**

The Sri Lankan Economy has long been following a relatively li beralized trade policy compared to many developing countries. An open economy has the flexibility to import what it requires, but it must keep in mind that it has to export in order to import. In this section we analyze the import-content of the economy's production-structure.

Imports are of two types – final goods and services and intermediates. Intermediate imports are included in the structure of production of an economy because such imports are exclusively meant to produce the various sector-wise gross outputs. Imports of final goods and services form parts of various components of domestic final demand.

Imported intermediate inputs are used in differing intensities along with other inputs in the production processes of the various sectors of the ec onomy. In this section we identify those sectors of the economy that are relatively more import-intensive by computing the total amounts of direct and indirect imported intermediate inputs that are required by the entire economy due to a unit-level increase in the final demand for the net output of each different sector.

Let us denote the elements of the Leontief Inverse by $(I-A)^{-1}$ by L_{ij}. An increase in the final demand of the j^{th} sector by one unit leads to a series of expansion in the gross - outputs of the various sectors. These increments are measured by the column vector $[L_{1j}\ L_{2j} \ldots L_{nj}]'$. For each component of this column vector there will an import requirement given by the corresponding elements of the row vector of imported intermediate input requirements of the economy, $[m_1\ m_2 \ldots m_n]$. So the total direct and indirect imported intermediate input requirement of sector j is given by $\sum_{i=1}^{n} m_i L_{ij}$. Applying the same procedure for all the different sectors of the economy, we obtain the Impor t-Intensity Multiplier $m'(I-A)^{-1}$.We identify the sectors that have above -average Import-Intensity Multipliers as sectors that have strong Import -Intensity. Over the entire time -span 1986 to2000, the strongly import -intensive production sectors of the Sri Lankan Economy have been:

- **Petroleum Industry (17)**
- **Textiles, Footwear & Leather Products(8)**
- **Other Manufactured Products(13)**
- **Garments(9)**
- **Basic Metals(15), and**
- **Machinery & Equipment Manufacturing(14)**

Apart from these, the year 1986 includes the Construct ion(16) sector. The Milling sector features in both 1986 and 2000 while the Chemical & Chemical Products(11) sector is included in 1994 and 2000 as strongly import -intensive sectors.

The imported intermediate input requirements represent the component of an economy's total foreign-exchange requirement that is not much amenable to change, at least in the near future. In this sense, these form the lower bound on the foreign -exchange requirements of an economy.

4.10 **Modified Import-Intensity Multipliers**

The rationale behind this measure of interconnectedness is the same as that for Modified -Income-Multipliers. We define Modified-Import-Intensity-Multipliers as **$[\mathbf{m}'(\mathbf{I}-\mathbf{A})^{-1}\langle\mathbf{m}\rangle^{-1}]$** where **$\langle\mathbf{m}\rangle^{-1}$** is the inverse of the diagonal matrix of imported -intermediate-input coefficients. This gives us a measure of the total direct and indirect imported intermediate input requirements in the entire economy arising out of a unit -level increase in the imported intermediate input expenditure in each sector. Summarizing the results we find that there are five (5) common sectors that have strong Modified -Import-Intensity-Multipliers in 1994 as also in 2000.These are:

- **Tea(1)**
- **Coconut(3)**
- **Rubber(2)**
- **Trade, Transport & Other Services(19) and**
- **Construction(16).**

It may be noted that the plantation sectors of Tea(1), Coconut(3) and Rubber(2) are essentially export-oriented in nature. However, the import content in the production structures of these sectors are high.

The Non-Metallic Products(12) sector features in 1986 as also in the year 2000. Strong sectors unique to 1994 and 2000 respectively are Mining & Quarrying(6) and Other Agriculture(5).

4.11 **Dependence on Components of Final Demand**

The Leontief System is demand-driven. The gross outputs of the various sectors are produced in order that the resulting net-output caters to the final demands for the outputs of the various sectors of the economy. Main components of final demand are Private Final Consumption Expenditure, Gross Domestic Capital Formation, Government Final Consumption Expenditure and Exports. Accordingly, the sector-wise gross outputs can be split-up into four main components to calculate the proportions of the gross sector-wise outputs that go for satisfying the four main components of final demand. For each column-vector component of final demand, we may calculate and find out the vector of gross outputs of all the sectors of the economy. The ratio of each element in this vector to the total gross output of the corresponding sector, gives us an index of dependence of that sector on the particular component of final demand considered. We can then segregate and identify the sectors that are mainly driven by the various components of final –demand. So we can pin-point which sectors are most sensitive to changes in Private Final Consumption Expenditure, Gross Domestic Capital Formation, Government Final Consumption Expenditure and Exports respectively.

We define the index of dependence on the four components of final demand by the expression $\mathbf{(I-A)^{-1}\,[h_1\ h_2\ h_3\ h_4]\langle x\rangle^{-1}}$ where $\mathbf{h_1}$ is the first component-vector of final demand and so on. The common sectors that are most sensitive to Private Final Consumption Expenditure in each of the years 1986, 1994 and 2000 are

- **Paddy(4)**
- **Coconut(3)**
- **Other Agriculture(5)**
- **Milling(7)**
- **Food, Beverages & Tobacco(10)**
- **Chemicals & Chemical Products (11)**
- **Petroleum Industry (17), and**
- **Electricity Water & Gas (18).**

Textiles Footwear & Leather Products(8), Non-Metal Products (12), Basic Metals (15) and Trade Transport & Other Services(19) also show high dependence on private consumption in 1986. Two of these sectors, namely Textiles Footwear & Leather Products(8) and Trade Transport & Other Services(19) also show high dependence on private consumption in 1994.

We now move on to the index of dependence on Gross Domestic Capital Formation. The Construction sector (16) is most sensitive to Gross Domestic Capital Formation in all the three Input-output Tables of 1986, 1994 and 2000. The Non-Metal Products (12), Machinery & Equipment Manufacturing (14) and Basic Metals (15) sectors also show

high degree of dependence on Gross Domestic Capital Formation in 1986 and 1994. Apart from these sectors, the Mining & Quarrying (6) sector shows high dependence on Gross Domestic Capital Formation in 1986 and 2000.

Next, we look at the dependence on Government Consumption Expenditures. An interesting feature of the Sri Lankan economy is that the relative importance of Government Consumption in the generation of sector-level outputs has been relatively low compared to the other components of Final Demand. Analyzing the sector-wise dependence on this component of final demand, we find that the Other Manufactured Products (13), Petroleum Industry (17) and Electricity Water & Gas (18) sectors are more dependent on Government Consumption than the other sectors, over the entire time-span 1986 to 2000. In addition, for each of the years 1986 and 2000, the Basic Metals (15) sector shows such relative dependence on Government Consumption. In the same manner, the Trade Transport & Other Services (19) sector is relatively dependent on Government Consumption in both the years 1994 and 2000. Other sectors that figure in the list for the year 2000 are Rubber (2), Paddy (4), Milling (7), Chemical & Chemical Products (11) and Non-Metallic Products (12).

Finally, we present the results of dependence of the various sectors on exports. The Tea (1), Rubber (2) and Garments (9) sectors are strongly export-dependent in the entire time period 1984 to 2000. The overall spread of export-dependence on the various sectors of the Sri Lankan Economy is seen to increase over time. In 1994 and 2000, the Mining & Quarrying (6) sector was also heavily dependent on exports. In addition, in the year 2000

the Textiles Footwear& Leather products (8) and the Machinery & Equipment Manufacturing (14) sectors are also strongly export-dependent. The results indicate that the export basket of Sri Lanka has become somewhat diversified over the time-period 1986 to 2000. In recent times, in addition to the spurt in exports in Textiles & Garments, the country has also been faring well in the exports of semi -manufactures.

5. SUMMARY AND CONCLUSIONS

The results of structural analysis of the Sri Lankan economy in this paper using the Input-Output Tables of 1986, 1994 and 2000 show that based on Backward Linkages and Output Multipliers, none of the sectors qualifies as a Key Sector in the year 1986. Over the next six years, the structure of the economy is seen to evolve into a mix that contains both traditional sectors like Rubber and Manufacturing sectors like other Manufactured Products and Chemical & Chemical Products. However, in the year 2000 we find two primary sectors, Tea and Rubber along with another two service sectors, Construction and Trade Transport & Other Services as the Key Sectors of the economy. Certain crucial sectors like Machinery & Equipment Manufacturing, Basic Metals & Rolling are not present as strong or key-sectors for any of the three Input-Output Tables available during the period 1986 to 2000. Thus, the economy is needs to be more diversified. Essentially, it may be viewed as a combination Plantation and Service Oriented economy even in the year 2000.

Another important observation is that although the country's export basket is getting more and more heavily weighed toward the Textiles & Garments sector, these sectors are

not included in the list of Strong or Key Sectors of the economy, indicating that they have a weak level of integration with the rest of the economy. Ghosh Forward and Leontief Backward Linkages also alternatively identify Key Sectors . Under this alternative classification scheme, the only Key-Sector of the economy in 1986 is the Non-Metallic Products sector. In 1994 Rubber , Other Manufactured Products, Electricity Water & Gas, Non-Metallic Products, Chemical & Chemical Products and Trade, Transport & Other Services sectors qualify as Key sectors with strong Leontief Backward and Ghosh Forward Linkages. The Rubber sector features as a key sector once again in the year 2000. Other sectors with similar with strong Leontief Backward and Ghosh Forward Linkages in 200 are Tea, Construction and Trade Transport & other Services.

On comparing the two sets of Key Sectors obtained by the two different methods of classification find that there are some similarities between them. The Rubber sector, Other Manufactured Products and the Chemical & Chemical Products sectors feature as key sectors in 1994 under both the methods of classification. The Rubber, Construction and the Trade Transport & Other Services sectors qualify as Key Sectors in 2000 even under the earlier scheme of classification by Backward Linkages and Output Multipliers. Although the sets of Key Sectors are not identical under the two methods of classification, we retain the basic conclusion that the structure of the economy is seen to evolve into a mix that contains both traditional sectors like rubber and Coconut as also services like Construction and Trade Transport & Other Services.

The important result that sums up the discussion of the different types of income multipliers in Sri Lanka is that most of the sectors with high ordinary or Total Income Multipliers belong to either agriculture- related activities or service-related activities in the economy. Over the entire time-span 1986 to2000, the strongly import-intensive production sectors of the Sri Lankan Economy have been the Petroleum Industry, Textiles, Footwear & Leather Products, Other Manufactured Products, Garments, Basic Metals, and Machinery & Equipment Manufacturing. The plantation sectors of Tea, Coconut and Rubber, which are essentially export-oriented in nature, are also characterized by high import content in their respective production structures.

The common sectors that are most sensitive to Private Final Consumption Expenditure in each of the years 1986, 1994 and 2000 are Paddy, Coconut, Other Agriculture, Milling, Food, Beverages & Tobacco, Chemicals & Chemical Products, Petroleum Industry and Electricity Water & Gas. Textiles Footwear & Leather Products, Non-Metal Products, Basic Metals and Trade Transport & Other Services also show high dependence on private consumption in 1986. Two of these sectors, namely Textiles Footwear & Leather Products and Trade Transport & Other Services also show high dependence on private consumption in 1994. The Construction sector is most sensitive to Gross Domestic Capital Formation in all the three Input-output Tables of 1986, 1994 and 2000. The Non-Metal Products, Machinery & Equipment Manufacturing and Basic Metals sectors also show high degree of dependence on Gross Domestic Capital Formation in 1986 and 1994. Apart from these sectors, the Mining & Quarrying sector shows high dependence on Gross Domestic Capital Formation in 1986 and 2000.

An interesting feature of the Sri Lankan economy is that the relative importance of Government Consumption in the generation of sector-level outputs has been relatively low compared to the other components of Final Demand. We find that the Other Manufactured Products, Petroleum Industry and Electricity Water & Gas sectors are more dependent on Government Consumption than the other sectors, over the entire time-span 1986 to 2000. In addition, for each of the years 1986 and 2000, the Basic Metals sector shows such relative dependence on Government Consumption. In the same manner, the Trade Transport & Other Services sector is relatively dependent on Government Consumption in both the years 1994 and 2000. Other sectors that figure in the list for the year 2000 are Rubber, Paddy, Milling, Chemical & Chemical Products and Non-Metallic Products.

The Tea, Rubber and Garments sectors are strongly export-dependent in the entire time period 1984 to 2000. The overall spread of export-dependence on the various sectors of the Sri Lankan Economy is seen to increase over time. In 1994 and 2000, the Mining & Quarrying sector was also heavily dependent on exports. In addition, in the year 2000 the Textiles Footwear & Leather products and the Machinery & Equipment Manufacturing sectors are also strongly export-dependent. The results indicate that the export basket of Sri Lanka has become somewhat diversified over the time-period 1986 to 2000. In recent times, in addition to the spurt in exports in Textiles & Garments, the country has also been faring well in the exports of semi-manufactures.

Endnote

1. However, there is also a case for computing the measures of interconnectedness at current prices. It cannot be that what constitutes the true structure of an economy at any point of time will be affected by changes in the price vector. Otherwise, we would have as many different structures as alternative price vectors. This point is put across using relatively simple algebra and transforming the Input-Output table of any year to the common base-year prices. Let the diagonal matrix of sector-wise price indices be denoted by <P>.The revised Input-Output Structure now becomes [<P>x = <P>A<P> $^{-1}$<P>x + <P>f]

   ⇨ [(I-<P>A<P> $^{-1}$)<P>x =<P>f]

   or, <P>x=L<P>f,

   where L is defined as (<P>[I-A]<P> $^{-1}$) $^{-1}$ = (<P> [I-A] $^{-1}$ <P> $^{-1}$). Hence we have [<P>x = (<P> [I-A] $^{-1}$ <P> $^{-1}$) <P>f =<P> (I-A) $^{-1}$ f] or [x = (I-A) $^{-1}$ f], as expected from the Leontief Structure outlined in the first paragraph. This could have been deduced straight away from the first paragraph but the intervening algebra serves to drive home an important point explained below. When we convert an Input-Output Table using base-year prices, the Leontief Inverse (I-A) $^{-1}$ changes to (<P> [I-A] $^{-1}$ <P> $^{-1}$). However, in the calculation of linkages and multipliers, we use the fact that [$\Delta x = (I-A)^{-1} \Delta f$] and Δ[<P>x]= (<P> [I-A] $^{-1}$ <P> $^{-1}$). Δ[<P>f]. Any row-sum of the Leontief Inverse (I-A) $^{-1}$ must therefore be replaced with the corresponding row-sum of (<P> [I-A] $^{-1}$ <P> $^{-1}$) after allowing for price changes in the final-demand vector f. Hence we must substitute [(I-A) $^{-1}$ e] with [(<P> [I-A] $^{-1}$ <P> $^{-1}$) <P>e], which effectively replaces Δx with Δ[<P>x]. Any difference between these two values is attributable sole to the price vector P, so that the real structure is effectively captured by (I-A) $^{-1}$. Otherwise, the relative rankings of the sectors would be affected due to the weights of the price index matrix <P>. When we are interested in the column-sums of the Leontief Inverse, the conversion of the Input-Output Table into a common base-year price throws up more tricky problems. Let the physical

quantities of the first column of a two-sector Leontief Inverse be given by $[L_{11} \quad L_{21}]'$. These elements denote the changes in the quantities of gross outputs of sectors 1 and 2 consequent upon a unit change in the final demand quantity of sector 1. But the valuation of the total change in both the sectors at market prices of the base-period will be given by $(P_1 L_{11} + P_2 L_{21})$ which will distort the true effect of the stimulus to the final demand vector. Therefore, an alternative approach, not considered in this paper, is to consider the respective Input-Output Tables at their current prices.

APPENDIX

Table 1 Aggregation Scheme

	1986	1994	2000
1.	Tea	• Tea Growing • Tea Processing	• Tea Growing • Tea Processing
2.	Rubber	• Rubber Growing • Rubber Processing	• Rubber Growing • Rubber Processing
3.	Coconut	• Coconut Growing • Coconut Fiber & Yarn	• Coconut & Toddy • Coconut Processing
4.	Paddy	• Paddy Growing	• Paddy
5.	Other Agriculture	• Livestock • Fishing • Logging & Firewood • Forestry • Other Agriculture	• Vegetables • Fruits • Highland Crops • Potatoes • Minor Export Crops • Betel & Areca nut • Miscellaneous Agricultural Products • Livestock • Plantation Development • Firewood • Forestry • Fisheries
6.	Mining & Quarrying	Mining & Quarrying	Mining & Quarrying
7.	Milling (Rice & Flour)	Milling (Rice & Flour)	Milling (Rice & Flour)
8.	Textiles	• Textiles • Leather & Leather Products	Textiles Footwear & Leather Products
9.	Garments	Garments	Garments

	1986	1994	2000
10.	Food, Beverages & Tobacco	• Dairy Products • Bread • Other Bakery Products • Confectionery • Beverages • Bottled Fruit • Alcoholic Beverages • Desiccated Coconut • Other Processed Food • Tobacco Manufacturing	• Food Beverages & Other • Tobacco
11.	• Chemicals & Chemical Products • Agrochemicals & Fertilizers	• Fertilizers & Agrochemicals • Chemicals & Chemical Products • Toilet Preparation • Pharmaceuticals • Oils & Fats	Chemicals & Fertilizers
12.	• Non-Metallic Products • Structural Clay	• Structural & Clay Products • Ceramic & Glass Products • Ceramic & Cement Products	Non-Metallic & Other Mineral Products
13.	• Other Manufactured Products • Other Manufactures	• Wood Products • Paper & Paper Products • Printing & Publishing • Rubber Prods • Other Manufactured Products	• Wood & Wood Prods • Paper & Paper Prods • Plastic & Rubber Prods

	1986	1994	2000
14.	• Machinery & Equipment Manufacturing • Light Engineering • Electrical Appliances • Transport Equipment • Other Machinery	• Light Engineering • Electrical Appliances • Transport Equipment • Machinery & Equipment	• Other Manufacturing (Machinery & Equipment)
15.	Basic Metals	Basic Metals & Rolling	• Basic Metal Prods • Fabricated Metal Prods
16.	Construction	Construction	Construction
17.	Petroleum	Petroleum & Coal Prods	Petroleum Industry
18.	Electricity	Electricity & Water	Electricity Gas Water
19.	Services	• Road Passenger Transport • Railway Transport • Trade & Other Transport • Banking • Insurance • Ownership & Dwellings • Communication • Hotels & Restaurants • Tourism • Other Services • Health Services • Education Services • Govt. Admin & Defense • NGO • Non Profit Government Institutions	• Wholesale & Retail Trade • Transport • Hotels & Restaurants • Tourist Ships Travel Agents • Post & Communications • Banking Insurance Real Estate • Ownership Of Dwellings • Pub Admin & Defense • Other Personal Services.

Table 2 Sectors with 'Strong' Backward Linkages

1986	1994	2000
Petroleum Industry(17)	Tea(1)	Rubber(2)
Milling(7)	Rubber(2)	Tea(1)
Electricity, Water & Gas(18)	Construction(16)	Milling(7)
Construction(16)	Milling(7)	Construction(16)
Other Manufactured Products(13)	Electricity, Water & Gas(18)	Non-Metallic Products(12)
Food, Beverages & Tobacco(10)	Other Manufactured Products(13)	Trade, Transport & Other Services(19)
	Non-Metallic Products(12)	Textiles, Footwear & Leather Products(8)
	Food, Beverages & Tobacco(10)	
	Textiles, Footwear & Leather Products(8)	
	Chemical & Chemical Products(11)	

Source : Results from the study.

Table 3 Sectors with 'Strong' Output Multipliers

1986	1994	2000
Trade, Transport & Other Services(19)	Trade, Transport & Other Services(19)	Trade, Transport & Other Services(19)
Paddy(4)	Rubber(2)	Construction(16)
	Other Manufactured Products(13)	Tea(1)
	Chemical & Chemical Products(11)	Paddy(4)
		Rubber(2)
		Electricity, Water & Gas(18)

Source : Results from the study.

Table 4 Key-Sectors by Backward Linkages & Output Multipliers

1986	1994	2000
N.A.	Rubber(2)	Tea(1)
N.A.	Other Manufactured Products(13)	Rubber(2)
N.A.	Chemical & Chemical Products(11)	Construction(16)
		Trade, Transport & Other Services(19)

Source: Results from the Study.

Table 5 Sectors With 'Strong' Ghosh Forward Linkages

1986	1994	2000
Petroleum Industry (17)	Rubber(2)	Rubber (2)
Electricity, Water & Gas(18)	Paddy (4)	Electricity, Water & Gas (18)
Non-Metallic Products(12)	Electricity, Water & Gas(18)	Paddy (4)
Mining & Quarrying (6)	Non-Metallic Products(12)	Mining & Quarrying (6)
Paddy (4)	Chemicals & Chemical Products (11)	Non-Metallic Products (12)
Trade Transport & Other Services(19)	Petroleum Industry(17)	Tea (1)
	Other Manufactured Products (13)	Petroleum Industry (17)
	Trade Transport & Other Services(19)	Basic Metals (15)
		Construction (16)
		Chemicals & Chemical Products (11)

Source: Results from the Study.

Table 6 'Key-Sectors' by Backward & Ghosh Forward Linkages

1986	1994	2000
Petroleum Industry(17)	Rubber(2)	Rubber (2)
Electricity, Water & Gas(18)	Other Manufactured Products (13)	Tea (1)
	Electricity, Water & Gas(18)	Construction(16)
	Non-Metallic Products(12)	Non-Metallic Products(12)
	Chemicals & Chemical Products (11)	

Source: Results from the Study.

Table 7 Sectors with 'Strong' Income Multipliers, 1986-2000

1986	1994	2000
Petroleum Industry(17)	Mining & Quarrying(6)	Non-Metallic Products(12)
Chemicals & Chemical Products(11)	Coconut(3)	Mining & Quarrying(6)
Coconut(3)	Rubber(2)	Trade Transport & Other Services(19)
Mining & Quarrying(6)	Trade Transport & Other Services(19)	Electricity, Water & Gas(18)
Other Agriculture(5)	Other Agriculture(5)	Coconut(3)
Paddy(4)	Paddy(4)	Tea(1)
Electricity, Water & Gas(18)	Milling(7)	Construction(16)
Trade Transport & Other Services(19)	Tea(1)	Rubber(2)
Non-Metallic Products(12)	Non-Metallic Products(12)	Other Agriculture(5)
	Construction(16)	Paddy (4)
	Electricity, Water & Gas(18)	Food Beverages & Tobacco(10)

Source: Results from the Study.

Table 8 Sectors with 'Strong' Modified Income Multipliers, 1986-2000

1986	1994	2000
Name & Sector No.	Name & Sector No.	Name & Sector No.
Milling (7)	Basic Metals (15)	Milling (7)
Other Manufactured Products(13)	Other Manufactured Products (13)	Petroleum (17)
Electricity, Water & Gas (18)	Milling (7)	Rubber(2)
Construction (16)	Textile, Footwear, Leather Products(8)	Tea (1)
Food Beverages And Tobacco(10)	Petroleum (17)	
Textile, Footwear, Leather Products (8)	Food Beverages And Tobacco (10)	
	Electricity, Water & Gas (18)	
	Tea (1)	

Source: Results from the Study.

Table 9 Sectors with high Total Income Multipliers, 1986-2000

1986	1994	2000
Petroleum products (17)	Mining & Quarrying (6)	Mining & Quarrying (6)
Chemicals & Chemical Products (11)	Coconut (3)	Electricity Water & Gas (18)
Coconut (3)	Rubber (2)	Paddy (4)
Mining & Quarrying (6)	Trade Transport & Other Services (19)	Other Agriculture (5)
Other Agriculture (5)	Other Agriculture (5)	Coconut (3)
Paddy (4)	Paddy (4)	Trade Transport & Other Services (19)
Electricity Water & Gas (18)	Milling (7)	
Trade Transport & Other Services (19)	Tea (1)	
Non-Metallic Products (12)		

Source: Results from the Study

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