Value Added per Employee and Factor Content of India's Foreign Trade: A Study in I-O Framework

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Abstract

While determining the factor content of a country's foreign trade, human capital component requires to be properly accounted for. This requires that while calculating labour requirement, one should separate out the skilled labour component (ie, differentiation between skilled and unskilled) from the total labour requirements and be clubbed with the physical capital requirement while calculating capital intensity. If we assume that wage value is highly correlated with labour skills , value added per employee may be taken to reflect inputs of human as well as physical capital. When value added per employee method is used to calculate capital intensity one may expect that along with physical capital 'human capital' component is automatically captured in the estimation process. Besides, the usual reliance on more infrequent and sometimes unreliable statistics of stocks of physical capital not of good quality as a measure of capital intensity may be avoided by using this alternative notion of factor intensity. This paper tries to improve the robustness of the results related to the above by using domestic Input-Output matrix for projection on the one hand and using 'Value Added per Employee' as a measure of relative capital intensity on the other. Using the Input Output matrices for the years 1989-90, 1993-94, 1998-99, 2003-04, 2006-07 , 2007-08 and 2013-14 the results obtained suggest that India exports labour intensive goods and imports capital intensive goods and like the pre reform period, Hecksher-Ohlin theorem holds good for India in post reform periods also. As far as sectoral study is concerned, we observe that , Hecksher-Ohlin theorem survives comfortably for manufacture in India in 2013-14 when it is looked from the view point of direct factor content of trade. On the other hand, evaluating from the view point of direct and indirect factor content of trade. trade pattern of agriculture,and community services support Hecksher-Ohlin theorem. The other sectors like trade and hotels, transport, finance and insurance do not support the Hecksher-Ohlin theorem neither from direct factor content nor from direct and indirect factor content of trade point of view.

I Introduction :

Varying factor* endowments in different countries, as Hecksher-Ohlin Theorem asserts, is the most important single factor in determining comparative cost differences leading to international trade. This coupled with the fact of different commodities using different factor proportions will lead to a pattern of trade where 'each country tends to export commodities which use relatively large amounts of abundant factors'.

Based on certain assumptions, the Hecksher-Ohlin theorem has been put to empirical verification by quite a few researchers including Leontief himself in various countries in fifties, sixties and also a few in recent decades. So far, the most controversial of such attempts is that of Leontief himself who aimed to analyze the structural basis of American Foreign Trade (1956). Leontief put to test with the help of Input – Output model commonly held notion that U.S possesses a comparative advantage in the production of commodities which require large quantities of capital and relatively small amount of labour for their manufacture as suggested by Hecksher-Ohlin Model. It is well known that the Input-output method has the unique advantage of enabling us determining not only the direct but also the indirect input requirements (induced by some exogenous demand)

The factual finding of Leontief caused a great deal of puzzle as it implied some notion contrary to general expectation that the U.S exports goods which require relatively more labour than those required by her competitive import replacements. The later studies of Leontief related to the pattern of trade between the Rest of the World and Japan, U.S, West Germany and Canada also did not support the theorem(1953, 1956).

But the studies by Totemoto and Ichumura (1959) related to Japan, Stolper, Roskamp (1961) related to East Germany and Bharadwaj (1962) , Sengupta(1989) related to India supported the theorem. These observations, certainly , stimulated some more studies incorporating some new approaches towards measuring capital intensity in determining the precise factor content of a country's trade.

Leontief's results apparently contradicting with that of Hecksher-Ohlin theorem induced quite a few researchers to examine the above conflict from various angles.

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*Here 'Factor' means primary inputs like labour and capital only. Material and fuel inputs generally as they are absorbed in production are not termed as factors in the standard economic literature.

Leontief himself suggested that though there is some scope of substitutability of capital for labour in America, the productivity of American labour is still higher than that of other countries due to the fact that American labour is possibly endowed with richer human capital . Leontief observed (1956) and later Bharadwaj & Bhagabati (1968) subscribed to the same observation that U.S seemed labour abundant because the U.S labour was on the average three times as efficient as foreign labour and so Hecksher-Ohlin theorem seems valid for U.S also .

In the noted exercise of Bharadwaj and Bhagwati (1968) , we see a very stimulating attempt to split capital intensity of various Indian industries into physical and human capital components and the apparent contradiction between the Hecksher-Ohlin Theorem and Leontief's original empirical studies can be resolved if these results are adjusted by accommodating human capital in the capital intensity calculation and the Hecksher-Ohlin Theorem seems to survive comfortably. The first exercise of Bharadwaj(1962) on factor content of Indian trade was carried out on unadjusted data (human capital was not taken into consideration) The actual pattern of Indian trade observed in this study seemed to support the Hecksher-Ohlin theorem. The second exercise of Bharadwaj jointly with Bhagawati was carried out with an intention to test the validity of Hecksher-Ohlin Theorem in the context of Indian economy incorporating revised notion of capital (adjusted for human capital) It was suggested that the skilled labour be separated from unskilled labour and the differential wage rates are to be treated as returns to human capital. Their results despite the adjustment for human capital did support the Hecksher-Ohlin theorem .

The analytically interesting explanation for this contradictions perhaps is the one that runs in terms of the concept of Factor Intensity Reversal introduced by Minhas (1963) (and suitably linked with Hecksher-Ohlin theorem). Minhas in his outstanding exercise(1963) tried to show that the strong factor intensity assumption implicit in the Hecksher-Ohlin theorem does not hold if factor intensities are reversible empirically within the observable price range. The CES production function fitted by him to international data showed elasticities of substitution both significantly different from unity and zero and also from one another. This implies that factor intensity reversals took place within observable price ratios. However, serious doubts have been raised on the validity of these observations on both statistical and analytical grounds.

In this connection it should be mentioned that the earlier works for India , by and large, are based on the   Input-Output tables prepared by the planning commission. Unfortunately Planning Commission's tables are mostly derived from projection from previous tables(not based on actual

survey) In the empirical work of Bharadwaj and Bhagawati (1968), in the absence of any availability of imported input matrix, factor requirements have been calculated on the basis of total input matrix only(Domestic + Import). So, to this extent, imported inputs are proxied by domestic inputs. Hence, factor requirement calculation is to some extent erroneous because calculation of domestic factor requirement needs to be based on domestic input-output matrix only. It needs to be noted that no exercise published till date relating to testify the validity of Hechsher-Ohlin theorem seems to have been based on domestic matrix.

Now, in this paper, an attempt has been made to understand and study the trade pattern of India in relation to its factor endowment in pre and post reform periods. The study covers six period points of Indian economy namely 1989-90, 1993-94 , 1998-99 and 2003-04 , 2006-07 , 2007-08 and 2013-14.

So, the purpose of this paper is four fold.

First, to utilize the domestic input output matrices for India for the years 1989-90, 1993-94 ,1998-99 and 2003-04 (except for 2006-07, 2007-08 and 213-14) made available by CSO for getting a more correct projection of domestic output requirement and hence the capital and labour requirement for a certain export and import vector as a component of final demand. So by the above we may expect some improvement in the quality of projection of the consequences of liberalisation of import compared to projection obtained in the exercises done by others.

Second, as the data base of our study incorporates information related to more recent periods it has been possible to capture the impact of liberalization in the truer sense as it is expected that as more and more time passes consequences of relaxation of controls will be manifested in greater and greater degrees. In this respect, results of our study possibly appear more robust.

Third, 'Value Added Per Employee' as a measure of capital intensity proposed by Lary (1968) is used here to calculate the factor content of Indian Trade. The concept of 'Value Added Per Employee' as a measure of capital intensity has some unique advantages which would be discussed later on.

Fourth, to carry out the comparison of indirect factor content implicit in the composite export and that in the composite import replacements in somewhat unconventional fashion. The total factor content of Indian export in a hypothetical pre trade situation would be compared with the total factor content of the same bill of goods in the actual post trade situation. The indirect factor content of an

average unit of export in the actual post trade situation will have to accommodate for intermediate imported inputs. Here the hypothetical pre trade situation is considered as proxy for a situation of import substitution and the post trade situation is generally considered as a situation of import leakage. Then the comparison of factor content of an average unit of export in the pre trade and the post trade situation can be taken as equivalent to the comparison of factor content of export and import replacements.

Now, the paper has been organized as follows:

In Section-I after highlighting the purpose of the paper, section -II discusses the case for using 'Value Added per Employee' as a measure of factor intensity , originally proposed by Lary(1968). In Section-III the unconventional method of assessing the factor content of trade which is somewhat similar to that used by Mogilany and Simpson(1968) in analyzing the pattern of factor content in trade is reviewed. Section-IV contains a discussion on the data base of the present exercise for analyzing the factor content of actual Indian trade pattern for the years 1989-90, 1993-94, 1998-99 , 2003-04 , 2006-07 , 2007-08 an 2013-14. The significant findings are presented in section-V. Section-VI deals with the limitation of the study along with the concluding remarks.

II Rationale of Taking 'Value Added Per Employee' as a Measure of Relative Capital Intensity :

According to 'Value Added per Employee' as a measure of relative capital intensity, industries with a high value added per employee are regarded as relatively capital intensive and industries with a low value added per employee are regarded as relatively labour intensive. While this measure of capital intensity has its own limitations, Lary's tests on US data suggest that value added per employee is a reasonably good measure of relative capital intensity.

If we assume that wage value is highly correlated with labour skills , value added per employee may be taken to reflect inputs of human as well as physical capital. The usual reliance on more infrequent and sometimes unreliable statistics of stocks of physical capital not of good quality as a measure of capital intensity may be avoided by using this alternative notion of factor intensity. It is worthy of mention that Lary has tested the validity of this approach by breaking down the value added per employee into its wage component and the rest and significant correlations have been found across industries between the first component and measures of skill and between the second and stocks of physical capital. Value added per employee being a flow concept rather than a stock figure, it fits

5

better with the notion of factor inputs into production. Apart from this, the problems associated with the conventional measurement of physical capital are due to the fact that the available data on capital assets include equipment and buildings acquired at various times in the past and evaluated at different price levels, varying depreciation practices and changing tax laws.

III   The Methodological Framework :

Leontief open static input-output model appears undoubtedly the most useful basic tool for analyzing the factor content of Indian trade. Total output from each industry equals total inter-industrial demand plus the final demand. So, we have the balance relations as follows:

$$X_i = \sum_{j=i}^{m} X_{ij} + D_i \ldots\ldots(1)$$

where X_i = Output of the ith sector(in value terms), D_i = Final Demand in the ith sector (in value terms) and X_{ij} = input flow from i^{th} sector to j^{th} sector.

Assuming a production function with fixed coefficients , we can write

$$X_{ij} = a_{ij}.X_j \ldots\ldots\ldots(2) \quad \text{where } a_{ij} = X_{ij}/X_j$$

By substituting (2) in (1) , gross output or sales of sector i can be expressed as :

$$X_i = \sum_{j=i}^{m} a_{ij}.X_j + D_i \ldots\ldots(3)$$

Therefore, $X = AX + D$ where $X = (X_i)$, $A = (a_{ij})$ and $D = (D_i)$

Or, $D = X - AX = IX - AX = (I - A)X$

Or, $X = (I - A)^{-1}D \ldots\ldots\ldots(4)$

In the equation (4) if D is prescribed from outside, the required gross output levels X's get determined. For our present purpose it is not the entire Final Demand but the export and import part of the final demand that are relevant.

Now, if $X_{ij}(m)$ = Imported input of ith sector to j^{th} sector and if $X_{ij}(t)$ = total supply of input of ith sector to j^{th} sector, then we can estimate $X_{ij}(d)$ which indicates domestically produced input of ith sector to j^{th} sector and is given by

$$X_{ij}(d) = X_{ij}(t) - X_{ij}(m) \ldots\ldots\ldots\ldots(5)$$

we are now in a position to obtain the total (direct and induced) domestic output requirement X_E to meet the export basket, E which can be expressed as

$$X_E = (I-A_d)^{-1} E \ldots\ldots\ldots\ldots\ldots.(6) \text{ where } A_d = (a_{ij}(d)).$$

Similarly, $X_M = (I-A_d)^{-1}M$ ......(7) where X_M=Gross output requirement (direct plus induced) to meet the import replacement(domestically) vector M.

We, now, discuss the methodology related to the determination of factor content of export.

a) Using the criterion of 'Value Added Per Employee', as proposed by Lary(1968) and as already referred to, direct factor content of export is given by the scalar

V^E = V.E……………………..(8) where E is a column vector of sectoral export proportions representing an average unit of export and V is a row vector of value added per employee. V^E is then simply a weighted mean of value added per employee, the weights being the sectoral export proportions. Similarly, the factor content of competitive imports is given by

V^M = V.M ………………………(9) where M is a vector of import proportions.

Here we can consider two possible situations.

Situation-1 : $V^E > V^M$

The above situation may be characterized as a situation when an average unit of a country's export is relatively more capital intensive than an average unit of import replacements.

Situation-2 : $V^E < V^M$

This situation can be interpreted as a situation where an average unit of a country's export is relatively less capital intensive than an average unit of import replacements.

Now the procedure for calculation of total factor content is as follows:

Considering 'A' as the current Technical Matrix (combining the domestic and the imported input) in case of no trade and consequent absence of any intermediate imports, it may be taken to approximate to the domestic 'pre-trade' technical matrix as it is assumed that domestic inputs are

substitutes for imported inputs. So vector $\mathbf{X} = \mathbf{(I-A)^{-1}E}$ indicates the direct and indirect output requirement induced by a unitary increase in export in sector $\mathbf{i}$. Hence total capital content of an average unit of exports as suggested by Lary can be calculated by pre- multiplying the normalized $\mathbf{X}$ by the vector of value added per employee as follows:

$\mathbf{T_k = V^{*.} \; \overline{X}}$ ....(10)

Where $\mathbf{T_k}$ = Total capital content of an average unit of exports

$\mathbf{V^*}$ = Row **vector** of value added per employee

$\overline{\mathbf{X}}$ = Normalised $\mathbf{X}$ (The elements of this vector $\overline{\mathbf{X}}$ is obtained by dividing corresponding element of $\mathbf{X}$ by the sum of the elements of the vector $\mathbf{X}$).

Similarly, we define $\mathbf{X^* = (\;I-A_d)^{-1}\;E}$ as the vector of sectoral outputs to satisfy an average unit of exports in the situation when opening up of trade allows import leakage in the intermediate inputs. $\mathbf{E}$ = Column vector of Sectoral export proportions.

So, $\mathbf{T_k^* = V^*.\;\overline{X}^*}$ ....(11) will indicate total capital content of an average unit of export when opening up of trade allows import leakage in the intermediate inputs. Here, $\overline{\mathbf{X}}^*$ = Vector of normalized $\mathbf{X^*}$.

Now, we are in a position to compare the relative capital intensity of exports vis-à-vis capital intensity of imports substituted for the intermediate inputs and in this context we make the crucial assumption that the country concerned is relatively labour abundant and capital scarce .

We may have the two possible situations as follows :

Situation 1:

If it happens that $\mathbf{T_k > T_k^*}$, then it would mean that an average unit of the concerned country's export is relatively less capital intensive. In this case, the country concerned imports capital intensive goods and skilled labour from Rest of the World and exports labour intensive goods and the Hecksher-Ohlin proposition holds good.

Situation 2:

But if the result shows that $\mathbf{T_{k\;<}\;T_k^*}$, it will mean that an average unit of the concerned country's export is relatively more capital intensive .In this case, the country concerned imports

labour intensive goods and exports capital intensive goods and the Hecksher-Ohlin proposition seems not valid.

IV   Data Base of the Empirical Study :

For our empirical study of relative factor content of Indian trade (capital and labour requirements of exports and import replacements), Input-Output tables (Total inter-industry Transaction matrix) prepared and circulated by CSO for the years 1989-90, 1993-94 , 1998-99 , 2003-04, 2006-07 and 2007-08   provide major part of the information required for our purpose. We have also used the input-output table of 2013-14 prepared by Singh and Saluja and published by NCAER, New Delhi. The import matrices for the said years except 2006-07, 2007-08 and 2013-14 are also prepared by CSO but these are not circulated by them. We have collected the import matrices(not published or circulated) from C.S.O 's desk informally. The import matrices for the years 2006-07, 2007-08 and 2013-14 are projected from other import matrices. The matrices (Transaction and Import) as obtained from CSO for the years 1989-90,1993-94 and 1998-99 are of order 115*115 where as the Transaction and Import matrix for the year 2003-04, 2006-07, 2007-08 and 2013-14 are of order 130*130. All the matrices (115*115 and 130*130) are aggregated into 6*6 matrices by clubbing the similar sectors.

The employment data for the different sectors have been taken from the Economic Survey, various years published by Govt. of India and National Accounts Statistics of India-(1950-51 to 2002-03), Linked series with 1993-94 as the base year , published by EPW Research Foundation respectively as well as from NSS Employment and Unemployment Surveys, various rounds.

V Results of the Study :

On the assumption that 'Value Added per Employee' may be taken as a reasonably reliable index of relative capital intensity, estimates of the factor content of Indian exports and imports replacements are obtained as shown in Table-1.

Table-1: Direct Factor Content of Indian Exports and Imports Replacements

	Value Added per Employee (In Rs. Lakh)						
	1989-90	1993-94	1998-99	2003-04	2006-07	2007-08	2013-14
Export(V^E)	0.6809	0.1880	0.3083	2.1230	2.1430	1.9510	4.8500
Import Replacements(V^M)	1.3260	0.6428	1.5221	7.0501	6.5432	4.0865	5.0868

Source : Author's Own Calculation Based on the Equations-8 and 9

It is observed from table-1 that in the pre reform as well as post reform periods, $V^E < V^M$. That is the value added per employee for exports are less than the value added per employee for import

replacements. So, on the basis of the results shown in table-1, we may conclude that an average unit of Indian exports is relatively less capital intensive than a unit of import replacement. Not only for the pre-liberalization period, 1989-90, the result is confirmed by repetition of the exercise of the calculation for the post liberalization years -1993-94, 1998-99 , 2003-04, 2006-07 , 2007-08 and 2013-14 also.

The results of 2003-04, 2006-07 , 2007-08 and 2013-14   in respect of value added per employee seem little bit large as compared to those of previous years like 1989-90, 1993-94 and 1998-99. So, one may question the sensibility of the above results. But we feel that the observations of value added per employee themselves do not seem to suggest any direct implication. Rather, we should be more concerned with the comparative values of value added per employee for export and import replacements to obtain any conclusion relevant for testing Hecksher-Ohlin theorem. Though we have taken value added per employee as our guideline for determining relative capital intensity, we should note that the increase in the absolute value added per employee may result from various other factor like technological changes etc. So, too high value of value added per employee in those may be partly result of significantly improved technology and so on.

Now, we incorporate the implication of induced factor requirement in the calculation of capital intensity through Value Added per Employee.

Table-2: Direct and Indirect capital content of an average unit of Export (Rs. Lakhs)

	1989-90	1993-94	1998-99	2003-04	2006-07	2007-08	2013-14
Without import leakege(T_k)	0.7955	0.3095	0.5892	0.7259	0.7843	0.6953	7.1935
With import leakege(T_k*)	0.7869	0.3012	0.5727	0.6435	0.6523	0.5892	6.6709

Source : Author's Own Calculation Based on the Equations -10 and 11

Table-2 shows that estimated values of T_k and T_k* for the year 1989-90 are   0.7955 and 0.7869 respectively. The corresponding values for the years 1993-94, 1998-99 ,2003-04, 2006-07 ,2007-08 and 2013-14 are 0.3095 and .3012 , .5892 and .5727, .7259 and .6435, .7843 and .6523 , .6953 and .5892 , 7.1935 and 6.6709 respectively. The results for the years suggest that opportunity of trade reduces the domestic capital intensity of an average unit of exports. This is in agreement with the hypothesis that India imports capital intensive inputs from the rest of the world and exports relatively labour intensive commodities. When measure of factor inputs based on direct plus induced input requirement is considered, an average unit of exports is found less capital intensive than what is suggested by a measure based on direct factor inputs only.

Whatever is true for the whole economy, may not equally be true for the sectoral level. So, we have undertaken a sectoral level micro study to understand the factor content of different sectors and for this purpose , we consider the year 2013-14 for which the latest I-O table is available.

Table-3 shows the estimated values of 'Direct' capital content of an average unit of export (Rs. Lakhs) at sectoral level. It is observed from table-3 that $V^E < V^M$ holds good only for 'manufacture'. For this sector, the value added per employee for exports are less than the value added per employee for import replacements. For the other sectors like agriculture, Trade and hotels, transport, Finance and insurance and community service, the value added per employee for exports are more than the value added per employee for import replacements. Based on the   results presented in table-3, it is our conclusion that an average unit of Indian exports is relatively less capital intensive than a unit of import replacement for the sector   'manufacture' whereas Agriculture, Trade and Hotels, Transport, Finance and Insurance and Community Services are more capital intensive as compared to import replacements.

Table-3: Direct Factor Content of Indian Exports and Imports Replacements at Sectoral Level, 2013-14(Rs.Lakhs)

	Agriculture	Manufacture	Trade & Hotels	Transport	Finance & Insurance	Comm. service
Export(V^E)	0.4621	0.7036	0.1635	0.2155	1.0659	1.7870
Import Replacements(V^M)	0.3399	0.8464	0.0100	0.2143	0.8225	0.8303

Source : Author's Own Calculation Based on the Equations -10 and 11

Table-4 highlights the estimated values of 'Direct and Indirect' capital content of an average unit of export (Rs. Lakhs) at sectoral level. It is observed from the table that $(T_k) > (T_k^*)$ is achieved for the sectors like agriculture and community services. The results for these sectors suggest that opportunity of trade reduces the domestic capital intensity of an average unit of exports. But for the other sectors like manufacture, trade and hotels, transport and finance and insurance, it is interesting to note that opportunity of trade increases the domestic capital intensity of an average unit of exports.

Table-4: Direct and Indirect capital content of an average unit of export (Rs. Lakhs) at Sectoral Level

Source : Author's Own Calculation Based on the Equations -10 and 11

	Agriculture	Manufacture	Trade & Hotels	Transport	Finance & Insurance	Comm. service
Without import leakege(T_k)	0.7342	1.2954	0.2200	0.2768	1.2267	1.7647
With import leakege(T_k*)	0.6762	1.4826	0.2406	0.3523	1.3773	1.4303

VI Conclusion :

India is a labour abundant and capital scarce country and our results, using the concept of 'value added per employee' show that India exports relatively more labour intensive commodities and imports capital intensive commodities, both in the pre liberalization and post liberalization periods. So, Hecksher Ohlin theorem holds for the Indian economy both in the pre reform and post reform periods.

As far as sectoral study is concerned, we observe that , Hecksher-Ohlin theorem survives comfortably for manufacture in India in 2013-14 when it is looked from the view point of direct factor content of trade. On the other hand, trade pattern of agriculture and community services support Hecksher-Ohlin theorem when evaluated from the view point of direct and indirect factor content of trade. The other sectors like trade and hotels, transport, finance and insurance do not support the Hecksher-Ohlin theorem neither from direct factor content nor from direct and indirect factor content of trade point of view.

Three important points need be noted here.

One is that the orthodox measure of total factor intensity developed by Leontief assumes that all intermediate inputs are domestically produced. No distinction has been made between the imported input and the domestic inputs as regards the direct factor requirement calculation for the inputs. As a result, the applicability of the total factor intensity so computed is required to be dependent on the validity of the implicit assumption that in respect of direct factor intensity imported intermediate inputs are equivalent to domestic inputs. This assumption seems, to some extent, unrealistic.

Another point is that the labour has been used here in its unadjusted form. Human capital component requires to be properly accounted for. This requires that while calculating labour requirement, we should separate out the skilled labour component (ie differentiation between skilled and unskilled) from the total labour requirements and be clubbed with the physical capital requirement while calculating capital intensity. In this connection, it should be mentioned that when

value added per employee method is used to calculate capital intensity one may expect that along with physical capital 'human capital' component is automatically captured in the estimation process.

The third point is that we should be careful to note that in the calculation of total factor requirement when we consider the post trade situation by incorporating the possibility of imported inputs our procedure of calculation does not take into consideration import in final demands. So when we talk of import replacement we restrict the meaning of 'import' to import in intermediate inputs only. Further our method of analysis does not have any room for considering the factor content in non competitive imports. Though for US it may be true that large changes in domestic factor prices would not lead to goods classified as non competitive imports being substituted by domestic production , it is doubtful whether the same borderline in the classification of non competitive and competing imports can be applicable for India.

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Appendix

Import Matrix Projection for 2007-08 from 2003-04 import matrix :

As the import matrix for 2007-08 is not available, we have projected it from the import matrix of 2003-04. We assume that total intermediate import for 2003-04 distributed among the sectors of 2007-08 in such a way that the pattern of distribution of sectoral import for 2007-08 originated from a sector and destined to different sector assumed unchanged as in 2003-04.

Let $IM_i^{2003\text{-}04}$ and $TM_i^{2003\text{-}04}$ be the sectoral intermediate import and sectoral total import(includes final demand import) for the year 2003-04. For 2007-08, we have sectoral total import ie, $TM_i^{2007\text{-}08}$. First, we like to find out sectoral intermediate import for 2007-08 ie, $IM_i^{2007\text{-}08}$. In order to do this, we find the ratio of sectoral intermediate import to sectoral total import for 2003-04 ie, $m_i = IM_i^{2003\text{-}04} / TM_i^{2003\text{-}04}$. Then, $TM^{2007\text{-}08} * m_i$ simply provide us the sectoral intermediate import, ie, $IM_i^{2007\text{-}08}$ for the year 2007-08.

Now we inflate the total intermediate import of 2003-04 and the rate of over all inflation is given by $I = \sum IM_i^{2007\text{-}08} / \sum IM_i^{2003\text{-}04}$.

We calculate the share of intermediate import for each sector in total intermediate import for 2003-04 and 2007-08 which is given by $p_i = IM_i^{2003\text{-}04} / \sum IM_i^{2003\text{-}04}$ and $q_i = IM_i^{2007\text{-}08} / \sum IM_i^{2007\text{-}08}$

We now estimate an adjustment factor for each sector i which is given by, $r_i = q_i/p_i * I$

Finally, the sectoral adjustment factor is multiplied by respective row of import matrix of 2003-04 to get the import matrix of 2007-08. In other words, We get,

M11 * r1   M12 * r1 ……………….M1n*r1

……………………………………………

Mm1 * rn   Mm2 *rn…………………Mmn.rn

This is our projected import matrix for 2007-08 (projected from the import matrix of 2003-04). The import matrix for 2013-14 has been projected from the import matrix of 2007-08 in the same way.

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