Assessing structural coherence with factor proportions of tradable sectors in Indian economy

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Abstract

Structural transformation supports higher output growth if it reflects the endowment fundamentals of the economy. Since the industrial structure is expected to align with factor-intensive sectors, structural coherence with factor proportions becomes an important consideration for industrial policy design. In the past, measurement of factor proportion (intensity) has been restricted to direct use within the sector ignoring the crucial fact that factors are also embedded in upstream supplies. Therefore, an underestimation of the factor proportions across sectors of the economy cannot be ruled out if evaluated using direct factor contents only. It is important to account for the indirect requirement for factors of production. Capital, in particular, is expected to be used intensely in the tradable sectors due to their relative importance in output, exports and investment. However, tradables are often studied in isolation of their interaction with the non-tradables. The use of Semi Input-Output (SIO) model permits to address both the above mentioned shortcomings.

This paper has two objectives for studying the tradables using an SIO approach using the KLEMS data from the RBI. First, to provide an improved estimate of factor proportions from the additional accounting for interlinkages with the non-tradables. Second, to study the structural coherence with factor proportions. The absence of a clear pattern between the structure of output and factor proportions points to market failures preventing movement of labour and capital to the most desirable sectors, thus constraining growth. Major exporting tradables are not the most labour-intensive sectors, indicating a mis-match vis-a-vis the proportions. The output and exports are not concentrated among the most capital-intensive tradables. The concentration of FDI into sectors with high relative use of capital, in a labour

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rich economy, leaves not a very encouraging situation for employment generation. From a policy perspective, the results suggest that under the present orientation of factor proportions, FDI is unlikely to be the solution to employment generation problems with the existing skill set. With increased capital proportion of even the labour-intensive sectors, a different type of labour supply is needed which is better trained and also mobile across sectors.

Keywords: Factor proportions; Tradables; Capital-to-Labour ratio; Semi-Input-Output; Linkages; India.

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1. Introduction

There is growing interest in multi-sector analysis on the issues of aggregate growth and relative growth of different sectors of the economy. The presence of secular trends in different metrics of aggregate growth does not necessarily rule out disparate trends at a disaggregate level. Despite the dominance of specific sectors in defining the trend, the production linkages of some non-prominent sectors can have implications at the aggregate level. In other words, the apparently less significant sectors of the economy can influence through their multiplier effects based on the intensity of their production linkages with the rest of the economy. The size of this multiplier depends on the influence of the sector on other sectors through its supply and use relations.

Embedding these inter-sectoral relations in a multi-sector framework can have implications through an inclusive accounting of the effect of use of intermediate inputs. For instance, the network effect of the production linkages will account for the effect of inputs such as material and factors of production e.g. labour and capital. Discounting the interactive effects can result in incorrect assessment. At the same time, it is argued that with changing factor abundance e.g. capital accumulation, the industrial structure shifts to factor-intensive industries (Che, 2012). This structural transformation supports higher output growth if the industrial structure reflects the endowment fundamentals of the economy. Thus, the presence of structural coherence, assessed by the degree to which the composition of output (or any other structural indicator) is aligned with factor proportions, has a growth enhancing effect on aggregate output of the economy.

Therefore, structural coherence becomes an important consideration for industrial policy design. Further, if the industrial structure exhibits dynamism, this is also likely to impact structural coherence, calling for a reassessment. A hitherto structural coherence is no guarantee of its continuation in future. This is more relevant in the developing country context due to their relatively fast changing patterns of production, demand and technology. For instance, in India, the opening up of the economy registered a liberal investment regime through easier access to foreign investment. Foreign Direct Investment (FDI), which is understood to be capital-intensive in nature due to a developed country base, is likely to have altered (relative) factor proportions of the a priori labour endowed Indian economy. At the

same time, the existing domestic capital-intensive industries also picked up on their technology upgradation drive to stay competitive, further contributing to intensification of the proportion of capital-use relative to labour. Therefore, it is highly likely that a lot more sectors exhibit high capital-to-labour ratios when compared to a national benchmark figure. At the same time, the conventional labour-intensive sectors such as textiles have also witnessed a gradual technology upgradation through use modern spinning machinery which has a worker displacing effect hinting on a general increasing proportion of capital-use even in the not so capital-intensive sectors (ILO, 2018; Rathee, 2016). Capital incentives through one-time capital subsidies and reduced credit rates have contributed to higher capital proportions in the industry (Gulhane and Turukmane, 2017).[1]

Therefore, it makes sense to re-estimate India's factor proportions (also referred as factor intensity or factor coefficient) for a recent time period and assess for their structural coherence. An assessment based only on the direct factor proportion, as is done in many existing studies, results in an underestimation. This leaves scope for improvement. It is required to take into account the interactions of different linkages into the production process. With the common expectation of FDI to be market seeking – both domestic market as well as global market through the host countries' trade partners – our work maintains focus on tradable sectors of the economy. The tradable sectors are more probable to capital expansion in new and existing firms, through either of the two channels of investment viz. domestic and foreign. Thus, we are motivated to investigate the factor proportions vis-a-vis the existing structure of the economy as represented by the sector-wise distribution of output, export and FDI. We make a novel attempt to analyse factor proportions in tradable sectors of the economy for the available year of 2013-14 as published by Singh and Saluja (2018, 2016). By making use of the Semi-Input Output (SIO) modelling of Tinbergen (1967), we are able to account for the direct and indirect factor proportions in the economy which, in turn, provides a general equilibrium sense to the analysis. The analysis in the paper contributes in three key ways through:

1. Revisiting factor proportions by including the indirect factor usage through accounting for the linkage effect of tradables with non-tradables consumed as intermediates;

2. Generating and using a national benchmark of factor proportions for capital and labour to assess the sector-wise use of factors;

[1] Technology Upgradation Fund Scheme (TUFS) and Amended Technology Upgradation Fund Scheme for

3. Comparing the structures of total output, exports and foreign investment with factor proportions, across the tradable sectors of the economy.

2. Literature on measuring factor proportions

Structure of the economy is often assessed from the relative significance of sectors in output, employment, value added or investment. For instance, a broad structure of the economy is assessed through a composition into the three aggregate sectors of agriculture, manufacturing and services. A structural change is realised through compositional changes in output (or another indicator) at a disaggregate level and underlies even the balanced growth path where growth rates of output, capital-output ratio, returns to capital and factory income shares are maintained (Cuadrao, Long and Poschke, 2016)**.** However, a disaggregated structure of the economy determines the real attractiveness of sectors due to the resource allocation reflected therein.

Emphasising the significance of factor allocations for an economy, Romalis (2004) opines that factor proportions are determining considerations for the production and trade structure. According to the Romalis' doctrine, countries indulge in commodities which increasingly use abundant factors. Studies on factor contributions of trade emphasise on influence of factor proportions on the commodity pattern of international trade by finding export performance to be dependent on skill intensities (Keesing, 1966) and trade balances to be related with factor intensities (Baldwin, 1971).

The growth models attribute economic expansion from structural change to either of the two – demand (Keynesian standpoint) or technology (Solow approach). The demand channel works through high income elasticity for goods and service. With increasing incomes, the demand for non-necessary goods increases thus shifting the resources out from the low demand elasticity sectors of the economy. On the other hand, technological viewpoint of structural change is effective through the difference (or divergence) in sectoral rate of growth of productivity (Ngai and Pissarides, 2007) or through the sectoral differences in factor proportions (capital intensity of output) (Daron and Guerrieri, 2008). Additionally, Cuadrao, Long and Poschke (2016) show that changes in capital-labour ratio lead to reallocation of factors of production, resulting in sectoral changes in production, ultimately reflected as a structural change in the economy.

Relative factor price is noted as a determinant of the factor allocations and the resulting sector-wise factor proportions within the economy.[2] For instance, distorted factor price markets result in cheaper capital increasing its relative use. If a given sector has high substitution elasticity between capital and labour, it is likely to use more capital and less labour, thus rebalancing factor proportions. Cuadrao, Long and Poschke (2016) argue that changes in sectoral factor proportions and factor income shares coincide with structural change.

Often the reasons for unsatisfactory growth and low employment are linked to adoption of capital-intensive techniques of production which have low potential for labour absorption. Mason and Sakong (1971) note a higher capital intensity of the manufacturing in developing countries as compared to developed countries indicating that developing economies employ more capital per worker than the advanced counterparts. This has been attributed to a range of possible reasons, among which factor market price distortion is a key argument leading to the capital-using bias in the production. Other plausible explanations include product market price distortions encouraging the capital-intensive production, technological inflexibilities, and underutilised capital. Also, the lack of technological know-how can lead to capital deepening before reaping the ultimate benefits from employing capital-intensive technologies (Burton, 1955).

Recognising that factor intensity is determined not only at the last stage of production, Riedel (1974) uses Input-Output (IO) framework to additionally account for factor requirements at each intermediate stage, measuring factor proportions through the labour-output ratio.[3] Although direct factor requirements are relevant for allocations across production and trade flows, total factor intensities are relevant for net trade balance of factors in the traded products (Baldwin, 1971). Likewise, Hamilton and Sevensson (1983) also mandate to consider total factor intensities of traded goods to account for direct factor inputs in producing the non-traded goods which are in turn used in production of the traded goods of an economy.

Indirect requirements for factors of production are also emphasised by others (Aladdin and Tisdell, 1988). Ignoring their effect, it has been argued, tends to underestimate the factor requirements particularly of industries with high proportionate consumption of intermediate

[2] Relative price effect, relative marginal product effect, and factor rebalancing effect jointly influence factor allocations in response to capital accumulations and technical change (ibid).

[3] The phrases factor proportion and factor intensity are used interchangeably.

products. Significant differences between the factor intensity of upstream industries in comparison to the using industry also introduce a bias in the estimates of factor content.

A strand of literature also shows differential productivity levels between tradables and non-tradables. In their recent work, Mano and Castillo (2015) show a generally low productivity among the Asian tradable sectors in China and India, compared with the European and other OECD countries. The authors also note less heterogeneity in the productivity levels of non-traded sectors. Over time, India is observed to have recorded an increase in productivity of both sectors, although productivity in traded sectors has increased over time, a negative differential between traded and non-traded sectors is noted for India.

Models of relative factor endowments continue to play an important role in studies of international trade and also specialisation (Harrigan and Zakrajsek, 2000). Taking into account the traditional trade theory some economists like Che (2012) have analysed the relationship between structural coherence and economic growth. Structural coherence is the extent to which the industrial structure of a country optimally reflects the factor endowment fundamentals of that country. Che opines that structural coherence (incoherence) supports higher (lower) economic growth. Relating the industrial structure to economic growth, the analysis by Che provides evidence for select 11 countries. For instance, the US is observed to have registered extraordinary economic growth during the period of improvement in its structural coherence. Other countries with improvement in structural coherence include Germany. However, Japan, Italy and Denmark are identified for lower levels of structural coherence. The lack of responsiveness of industrial structure to the changing factor proportions is attributed to structural rigidities. Despite a generally increasing capital endowment across countries, although with varying degrees, the insensitive industrial structure of countries with declining structural coherence is on account of their 'sticky' nature, in turn constraining an upward movement in the capital intensity of industries. The empirical analysis by the author further estimates decreasing structural incoherence to be growth supporting through a 0.8 percent point increase in annual GDP growth. Effectively, this accounts for a quarter of the growth differential between countries with high and low coherence in their structures. A positive relationship between structural coherence and economic growth of the country is noted. This implies that the higher is the coherence between the capital endowment of the country and the industrial structure of the country, the higher will be the growth of output. So, countries that have structural incoherence will have slower growth in the long run.

In many ways, India is an interesting case for analysis. Despite being the fastest growing economy it has not made a breakthrough in manufacturing. It has liberalized on many fronts including foreign investment and exchange rate, but has not gained through increased employment opportunities or through skill upgradation. Increasing use of capital in the Indian economy is attributed to labour market rigidities (Gupta et al, 2009), supply side bottlenecks (Sen, 2008) and the rising ratio of wage-to-rental price of capital (w/r ratio) (Sen and Das, 2015). Each of these effects causes substitution in favour of machines (i.e. capital). More specifically with regard to the w/r ratio, the negative correlation (exceeding 0.60) with the labour intensity in most labour-intensive industries provides an indication of increase in relative use of capital even in the labour intensive sectors. Thus, costlier labour due to higher w/r ratio induces shifts away to capital-intensive techniques, as reflected in the higher factor proportion (K-to-L ratio). This study computes the relative factor use across sectors and evaluates them vis-à-vis structure of the economy.

3. Model formulation – Semi-Input-Output Model

The expansion of output to meet final demand of a given sector entails factor requirements that are estimated based on the factor proportion of the corresponding sector. However, measurement of factor requirements based on the direct factor proportion makes the assessment partial in nature due to exclusion of the interactive effects with other sectors of the economy. An approach to expand the scope of measurement is to include the indirect effects so that the factor requirements, both explicit and implicit, of the additional activity are known. While the direct factor requirements are measured proportionate to the capacity expansion of the sector, the indirect effects account for factor usage in the sectors which supply output for intermediate use in the given sector. The IO model proposed by Leontief is equipped to capture the interactive effects of intermediates and using sectors. However, Tinbergen (1967) argues for a distinction criterion among sectors of the economy to facilitate development planning in phases. He emphasises that national sectors (which cannot be traded or are subject to other domestic considerations) must be expanded in accordance with domestic demand; while stating that factor returns are more determining in the case of expansion in international (i.e. tradable) sectors (Tinbergen, 1967). He proposes a formulation of the IO, referred to as the Semi-Input-Output (SIO) Method. By virtue of the distinction between tradable and non-tradable sectors, the SIO is considered to be more focussed on tradables while also maintaining the spirit of a general equilibrium analysis

through inclusion of indirect quantities of multiple orders. We introduce details of the SIO method as follows.

The conventional I-O model represents interactions among the *m* sectors through a system of linear equations corresponding to each sector of the economy. The domestic output of a given sector can be disposed of as intermediate use, final demand and traded. Generally, the trade components are subsumed in aggregate final demand. However, given our specific focus on tradables, we show the trade component distinct from other components of final demand viz., private final consumption, government final consumption, gross fixed capital formation and change in inventories, for a given year. Intermediate use is represented through a matrix of intersectoral transactions while the sector-wise output (X_i), final demand (D_i) and trade (B_i) are represented through column vectors as shown in Equation (1).[4]

$$\begin{bmatrix} x_1 \\ \vdots \\ x_m \end{bmatrix} = \begin{bmatrix} x_{1,1} & \cdots & x_{1,m} \\ \vdots & \ddots & \vdots \\ x_{m,1} & \cdots & x_{m,m} \end{bmatrix} \begin{bmatrix} x_1 \\ \vdots \\ x_m \end{bmatrix} + \begin{bmatrix} d_1 \\ \vdots \\ d_m \end{bmatrix} + \begin{bmatrix} b_1 \\ \vdots \\ b_m \end{bmatrix} \dots\dots (1)$$

where x_i, d_i and b_i denote the output, domestic final demand and net trade and for the i^{th} sector of the economy, i=1,....,m. The Equation (1) can be compactly written as follows:

$$X = AX + D + B \dots\dots (2)$$

$$\text{Or, } X = AX + D + (X - M) \dots\dots (3)$$

where the column vectors X, D, and B represent output, final demand and net trade. The intersectoral flows are given by the square matrix A of dimension *m*.

Given our focus on the factor proportion of the tradable sectors, which are likely to receive more foreign investments than the non-tradables, we rearrange the *m* sectors so that the *t* tradables are placed above the *n* non-tradables of the economy (t+n=m). Thus, the elements of the matrices in Equation (1) are ordered as shown in Equation (4).

$$\begin{bmatrix} x_1 \\ \vdots \\ x_t \\ x_{t+1} \\ \vdots \\ x_{t+n} \end{bmatrix} = \left[\begin{array}{ccc:ccc} x_{1,1} & \cdots & x_{1,t} & x_{1,t+1} & \cdots & x_{1,n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ x_{t,1} & & x_{t,t} & x_{t,t+1} & & x_{t,n} \\ \hdashline x_{t+1,1} & & x_{t+1,t} & x_{t+1,t+1} & & x_{t+1,n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ x_{t+n,1} & \cdots & x_{t+n,t} & x_{t+n,t+1} & \cdots & x_{t+n,t+n} \end{array}\right] \begin{bmatrix} x_1 \\ \vdots \\ x_t \\ x_{t+1} \\ \vdots \\ x_{t+n} \end{bmatrix} + \begin{bmatrix} d_1 \\ \vdots \\ d_t \\ d_{t+1} \\ \vdots \\ d_{t+n} \end{bmatrix} + \begin{bmatrix} b_1 \\ \vdots \\ b_t \\ b_{t+1} \\ \vdots \\ b_{t+n} \end{bmatrix} \dots\dots (4)$$

[4] The variable X traditionally denotes output. Here in addition, we use variable D denoting demand and variable B to denote balance of trade.

In effect, we have partitioned the system of *m* equation into two segments, one each for tradables and non-tradable sectors as shown in Equation (5).

$$\begin{bmatrix} X_t \\ X_n \end{bmatrix} = \begin{bmatrix} A_{t,t} & A_{t,n} \\ A_{n,t} & A_{n,n} \end{bmatrix} \begin{bmatrix} X_t \\ X_n \end{bmatrix} + \begin{bmatrix} D_t \\ D_n \end{bmatrix} + \begin{bmatrix} B_t \\ B_n \end{bmatrix} \dots\dots (5)$$

The intersectoral interactions and the components of final demand and trade can now be expressed as:

$$X_t = A_{t,t}X_t + A_{t,n}X_n + D_t + B_t \dots\dots (6)$$

and

$$X_n = A_{n,t}X_t + A_{n,n}X_n + D_n + B_n \dots\dots (7)$$

According to Equation (6), the output of a tradable sector is dependent upon its intermediate use within tradables, intermediate use by non-tradables, its final demand and traded components which can be re-arranged as shown in Equation (8).

$$X_t = \underbrace{A_{t,t}X_t}_{interactive\ effect\ of\ intermediate\ tradables\ on\ tradables} + \underbrace{D_t + B_t}_{final\ demand\ effects\ of\ expansion\ in\ tradables} + \underbrace{A_{t,n}X_n}_{interactive\ effect\ of\ intermediate\ non-tradables\ on\ tradables} \dots\dots (8)$$

In estimating the interactive effects of tradables on non-tradables ($A_{t,n}$), through the intermediate input use of the former in the production of latter, the final demand and trade components of the tradable sector will not have a contribution and are therefore dropped from the specification. Thus, without any loss of generality Equation (8) can be rewritten as:

$$X_t = A_{t,t}X_t + A_{t,n}X_n \dots\dots (9)$$

Equation (9) is reformulated to express the complementary effect of expansion in the non-tradables on the tradables ($A_{t,n}$) through the interaction with the total requirement coefficient matrix of the tradables given by $(I\text{-}A_{t,t})^{-1}$.Thus, we express the indirect effects as:

$$X_t = (I - A_{t,t})^{-1}A_{t,n}X_n \dots\dots (10)$$

Further, the interactive effect of output expansion of X_n due to interaction with non-tradables and tradables is expressed in Equation (7) above. Since we are attempting to account for the effect of expansion in tradables on non-tradables, essentially through the interdependencies

due to input requirements, the term D_n becomes irrelevant for consideration. Also, $B_n=\varphi$ given the non-tradable nature of the input under consideration as the sector cannot be traded. Thus, Equation (7) can be simplified as follows:

$$X_n = A_{n,t}X_t + A_{n,n}X_n \dots\dots (11)$$

Equation (11) can be transformed to provide an expression for the interactive effect of non-tradable as follows:

$$X_n = (I - A_{n,n})^{-1}A_{n,t}X_t \dots\dots (12)$$

Substituting the expression in Equation (12) into the Equation (10), we get:

$$X_t = (I - A_{t,t})^{-1}A_{t,n}(I - A_{n,n})^{-1}A_{n,t}X_t \dots\dots (13)$$

The output vector $X_{t,}$ on the extreme right of the expression takes the value of an identity vector since we are interested in assessing the effects for a unit of expansion. Thus, the right hand side of Equation (13) represents the complementarity effect of non-tradable in increasing the output of a tradable sector, through inclusion of the interactive effects among the non-tradables and the tradables. It follows that the interaction of indirect expansion in output with the direct factor proportions of tradables, F_t^k, provides the factors required indirectly by a tradable sector on account of use of a non-tradable.[5] Thus, expanded factor proportions for tradables, $\tilde{F}_t^k$, are expressed as sum of the direct and indirect proportions as shown in Equation (14).[5]

$$\tilde{F}_t^k = F_t^k + F_t^k(I - A_{t,t})^{-1}A_{t,n}(I - A_{n,n})^{-1}A_{n,t}X_t \dots\dots (14)$$

where the vectors F_t^k and $\tilde{F}_t^k$ represent the direct and expanded factor coefficients,

and the subscript *t* represents tradable sector, *k* represents factors of production (labour, capital).

4. Measurement of factor proportions and assessment of structural coherence

Labour and Capital are two key factors of production studied here. A third factor of production refers to the use of land. The former two factors of production are considered mobile across sectors in comparison to land. Computing sector-wise land-to-output ratio requires information on land stock for each of the sectors of analysis. However, there exist

[5] Note the use of word expanded factor proportions. This signifies the increase upon accounting for the interlinkages with the non-tradable used as an intermediate input. For clarification, it may be mentioned here that the total requirement coefficients, as referred in the conventional Leontief I-O modelling, are inclusive of the linkage effects of both tradables and non-tradables, making it difficult to distinguish the effect.

data limitations. Therefore, land is excluded for analysis due to constraints on availability of comparable information from within the KLEMS database.[6]

Our approach to measurement of factor proportions is based on factor intensity. Factor intensity (also referred as factor ratio or factor coefficient) is the amount of a productive factor used in one unit of output.

While labour use can be directly assessed from the labour income share in sector output, the measurement of capital use is not straightforward. The use of capital refers to capital deployed in the economic activity and is challenged with measurement difficulties due to issues related to depreciation and obsolescence, which are difficult to integrate in IO data. As information on capital use is not explicitly reported in an IO framework, the same is approximated through the income share of capital. Since capital use is related to profitability of capital (i.e. returns to capital, or the profit), which in turns determines the income share of capital, the former can be proxied by the latter.[7] The use of capital income (in absolute form or as a share) provides a way to integrate capital use into the IO framework in a manner compatible to labour income. By the above definition, factor proportions are ratios.

The KLEMS (capital, labour, energy, materials, services) database provides the shares of labour and capital income in value added for each sector of the economy (Das et al, 2018). Using the given shares, the total value added as in the economy-wide Input-Output Transaction Table (IOTT), is apportioned into labour and capital incomes. The values are used in the overall cost structure of the column to compute the direct factor coefficients for a given sector. The expression F_t^k is used to denote the direct factor coefficient of a factor k (labour, capital) at the tradable sector, t. The expanded factor proportion, $\tilde{F}_t^k$ is computed from the expression in Equation (14), separately for each value of k, viz. labour and capital.

Thus, factor proportions, as defined in this paper, refer to the amount of a factor used in a unit production. Accordingly, a sector is noted to have high factor proportion (i.e. factor intensity) if its factor proportion exceeds the average benchmark.

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[6] In fact, land is often excluded even in interregional study of large economies, e.g. the US. For instance, Horiba and Kirikpatrick (1981) consider capital, human capital and renewable and non-renewable resources while excluding land in their analysis of factor proportions across the three broad regions and on sub-regions of the US economy. This is in contrast to the use of land related information, although at an aggregate level only, as used in some studies on factor proportions that are based on cross country analysis. However, even industry-level panel studies, e.g. Che (2012), choose to stay silent on land as a factor of production.

[7] In fact, the empirical findings in Che (2012) using a measure of capital intensity based on the capital income share are found consistent with the results based on capital stock as a measure of capital intensity. This supports the use of capital income share to measure capital intensity.

The possibility of uniform factor prices across sectors requires clarification due to its restrictive implications. Most factor proportion studies assume uniform factor prices. Since, the present study uses KLEMS database, the reflection upon the actual factor market conditions are as good as the data used. The KLEMS database makes use of data on employment and earnings by education categories and over industries to compute a composite labour quality index (Das et al, 2015). This is likely to reflect upon the differential returns to labour across sectors. Further, on the income share of factors, the database uses a combination of sources among National Account Statistics (NAS), Annual Survey of Industries (ASI) and National Sample Survey Office (NSSO), as required. More specifically, the labour income share of GVA, is obtained as product of workforce and GVA per worker as sourced from various rounds of NSSO (CSO, 2012, and Das et al, 2015) thus indicating differential labour prices across sectors. Thus, the factor prices are not necessarily uniform cross sectors.

Structure of the tradable economy is represented through sector-wise composition of output, exports and FDI. The composition of output is representative of the overall economic structure. Export composition of tradables represents external demand as an important driver of the economy. Similarly, the FDI distribution of tradable sectors shows the structure of foreign investment which is relatively capital-intensive. To infer the presence (absence) of structural coherence, the most significant sectors contributing at least two-third of the structural indicator (output, exports, FDI) are identified. Within these, each sector is observed for its factor proportion, separately for labour and capital. Structural coherence is confirmed if the significant sectors are also the ones which exhibit factor proportions above the corresponding benchmark figure.

5. Data sources and time frame

The secondary data used for analysis is compiled from multiple sources. We make use of the latest IO table for the Indian economy available from published sources. The Central Statistics Office (CSO) is the nodal agency for compiling and providing the I-O Tables. While the IO Transaction Tables are available for up to 2007-2008, the CSO provides only the Supply and Use Tables (SUTs) for the later periods. Although the SUTs are asymmetric due to differences in the number of commodities and industries, the data available in SUTs is more granular for flows between commodities and industries. However, the SIO analysis requires a symmetric and balanced matrix of commodity transactions in the form of a matrix

of flows across commodities. Thus, we require an IOTT for the purpose of analysis. We make use of the IOTT for the available year of 2013-2014 which is based on SUTs available from the CSO (Singh and Saluja 2016).[8] The IOTT provides commodity flows across 130 sectors of the economy including the broad categories of agriculture and allied comprising 20 sectors, mining comprising of 11 sectors, manufacturing constituting 68 sectors, and services comprising 25 sectors.

The KLEMS database of the Reserve Bank of India (RBI) is used for working of the sector-wise factor proportions. The database provides productivity indicators for 27 economy-wide sectors which are in turn mapped to 130 sectors of the CSO I-O scheme of sectors. Without losing any information we retain each of the 27 sectors for our analysis. This ensures compatibility between the IOTT and the factor proportions based on KLEMS database.

Data on sector-wise FDI is sourced from the Department for Promotion of Industry and Internal Trade (DPIIT).[9]

6. Sector scheme of analysis

The 27 KLEMS sectors are classified into a subset of eighteen (18) tradable sectors and nine non-tradable sectors (Table 1). The classification is designed keeping in mind that output of tradable sectors is exportable (as commodity or service) and tradables are more likely recipients of capital investment, particularly FDI. This facilitates our objective to study factor proportions of the tradable sectors in the Indian economy. The tradable nature of manufacturing, agriculture, mining, financial services and business services is by virtue of their exposure to international competition through channels of trade and investment (in select cases). Education is considered tradable in view of the element of foreign fee-paying students considered as exports of education services. The education sector also includes training and online courses which have an international element. In contrast, non-tradables include non-market services such as public administration (inclusive of social security schemes) and health & social sector (largely driven by social concerns schemes). The electricity, gas and water supply is considered non-tradable owing to the predominantly domestic generation driven by domestic demand. Transport and storage is classified as non-tradable as most sub-sectors such as road transport; postal, courier and delivery services; and

[8] Although an SUT is available for 2015-16, the corresponding IO is not available from a published source. The preparation of an IOTT from an SUT requires a considerable amount of dedicated resources in terms of manpower and time. In view of the constraints on availability of resources, a published IOTT for 2013-14 is used to address the research enquiry in the paper.

[9] The erstwhile Department of Industrial Policy and Promotion (DIIP) was renamed to DPIIT after including internal trade under its mandate.

warehousing and storage services are not marked with significant international competition. The construction sector is another non-tradable sector due to its domestically driven demand. The post and telecommunication sector uses large amounts of domestic fixed capital investment which is not subject to foreign competition; hence the sector is considered non-tradable for analysis. Similarly, hotels and restaurant; and trade are classified as non-tradable due to the largely domestic demand. Accordingly, the IOTT is aggregated from 130 sectors to 27 sectors of the database.

Table 1: Sector scheme of analysis

Sector description*	Tradable (T)/ Non-Tradable (N)
Agriculture, hunting, forestry and fishing	T
Mining and quarrying	T
Food products, beverages and tobacco	T
Textiles, textile products, leather and footwear	T
Wood and products of wood	T
Pulp, paper, paper products, printing and publishing	T
Coke, refined petroleum products and nuclear fuel	T
Chemicals and chemical products	T
Rubber and plastic products	T
Other non-metallic mineral products	T
Basic metals and fabricated metal products	T
Machinery, nec.	T
Electrical and optical equipment	T
Transport equipment	T
Manufacturing, nec; recycling	T
Electricity, gas and water supply	N
Construction	N
Trade	N
Hotels and restaurants	N
Transport and storage	N
Post and telecommunication	N
Financial services	T
Business service	T
Public administration and defense; compulsory social security	N
Education	T
Health and social work	N
Other services	N

*Description as used in RBI, KLEMS database.

Note: The table provides classification of the sectors into tradable and non-tradable sectors.

Source: Author's classification of tradable and non-tradable based on the tradability of the sector output.

7. Results and discussion

Sectors of the economy comprise tradable and non-tradable sectors. The tradable sectors include the goods and services which are exposed to international competition. Remaining sectors of the economy are classified as non-tradable which include utilities (such as power generation), public administration and construction activities among others. The importance of tradables for the economy is recognised through their greater contribution, compared with the contribution of non-tradables, in each of the key indicators of structure of the economy – total output, intermediate use into production activities, exports and foreign direct investment (FDI).[10] While output and intermediate use are more representative of the internal structure of the economy, the tradable and non-tradable distribution of exports is important to consider because external demand can be an important driver of the economy. Likewise, it is useful to assess the similar distribution for FDI. The FDI represents capital-inflows which are relatively tied to technology transfer, and plant and equipment; and are also more concentrated in the tradables in developing countries (Athukorala and Rajapatirana, 2003). The importance of tradables for the economy is recognised through their greater contribution relative to non-tradable sectors in each of the indicators. The composite shares of tradables accounts for 59.6%, 72.8%, 86.5% and 75.8% of total output, intermediate use, exports and FDI, respectively. However, while maintaining focus on tradable sectors of the economy, it is also necessary to take into account their interactive effects with the non-tradables given the roundaboutness of the production process where the tradables also depend on inputs from the non-tradables. The inclusion of this interaction, in estimating the factor proportions, is the mainstay of analysis in the present paper.

The sector-wise factor proportions for labour (L) and capital (K), as computed using the RBI KLEMS data, are provided Table 2. In order to assess the relative use of factors (L, K) among sectors, the necessary benchmark is computed as the average of all tradable sectors, and referred to as the group average. The average capital proportion (i.e. direct capital coefficient) of the group of tradables is computed as 0.228 while the average labour coefficient of the group is 0.163, indicating a relatively higher capital intensity of the output of the tradable sectors. Interestingly, the comparable group average of labour proportion for the non-tradables is nearly double at 0.318. This is essentially on account of the high direct labour

[10] Intermediate use into production activities refers to the proportion of total output used as intermediate consumption.

coefficient of almost all non-tradables viz. public administration; health & social work; activities of wholesale & retail trade, and hotels & restaurants. These activities are primarily service oriented and their labour use can be considered as an indication of labour opportunities in the service sector. By contrast, capital coefficients of non-tradables are noted comparable to those of the tradables at 0.221; indicating no significant difference in capital intensity of the two groups. The much higher labour intensity of non-tradables – both relative to the tradables, and also in comparison to capital intensity of the non-tradable group, highlights a strong dependence on labour inputs, and therefore strengthens the argument for inclusion of their interactive effects on the complimentary group viz. the tradables, in improving the estimates of labour intensity of tradables. At the same time, the accounting of capital intensity of non-tradable inputs into the tradable sectors also reflects upon the capital requirements of the economy in a more realistic manner. Keeping in mind the study focus on tradables, the sector-wise discussions in paper are confined to tradables.

Comparison against the group average of tradables is helpful to identify the sector as the one using a given factor more intensively. Only six sectors have labour proportions exceeding the benchmark of group average. These include agriculture and allied, wood products, manufacturing nec, financial services, business services and education ((refer column (4) of Table 2). Likewise, agriculture and allied, mining, non-metallic mineral products, financial services, business services and education are identified as the six capital-intensive sectors.

Table 2: Sector-wise direct factor coefficients

	Sector name	Direct factor coefficient F_t^k		whether Labour-intensive**	whether Capital-intensive***
		Labour	Capital		
		(1)	(2)	(4)	(5)
Tradables	Agriculture and allied	0.4174	0.3518	intensive	intensive
	Mining	0.1475	0.4210		intensive
	Processed food	0.0946	0.1431		
	Textile and leather	0.1402	0.1787		
	Wood products	0.1727	0.1924	intensive	
	Paper, printing and publishing	0.1442	0.1507		
	Coke and petroleum products	0.0070	0.1361		
	Chemical products	0.0691	0.2278		
	Rubber and plastics	0.0702	0.1547		
	Non-metallic mineral products	0.1147	0.2593		intensive
	Basic metal products	0.0586	0.1702		
	Machinery nec	0.0748	0.1428		
	Electrical equipment	0.1218	0.1962		
	Transport equipment	0.0931	0.2226		
	Manufacturing nec	0.1817	0.1143	intensive	
	Financial services	0.2478	0.5078	intensive	intensive
	Business services	0.2380	0.3086	intensive	intensive
	Education	0.5403	0.2307	intensive	intensive
Non-tradab	Electricity, gas and water	0.0976	0.1482		
	Construction	0.2744	0.0741		
	Trade	0.3313	0.3806		
	Hotels & restaurants	0.3091	0.2217		
	Transport & storage	0.2435	0.1984		
	Post & telecommunication	0.1633	0.2503		
	Public administration	0.6247	0.1226		
	Health & social work	0.4510	0.1926		
	Other services	0.3684	0.3978		

l e s					
	Tradabales (18 sector average)	**0.1630**	**0.2283**		
	Non-tradables (9 sector average)	**0.3181**	**0.2207**		

Notes: *Factor with greater use is Labour if Col (1)> Col (2); Capital otherwise.

** A sector is considered labour-intensive if it has a direct labour coefficient more than that for the average labour coefficient of the tradable sectors as a group

** A sector is considered capital-intensive if it has a direct labour coefficient more than that for the average capital coefficient of the tradable sectors as a group

Refer Table 1 for classification of sectors into tradable and non-tradable sectors

Source: Author computations.

Our computations of (total) factor proportions, using the SIO modelling in the paper, show that the expanded labour coefficient for the tradable group increases by 7% over the direct labour coefficient, while the increase is higher by 10% in case of the expanded capital coefficient of the group (Table 3). The higher capital (and also labour) coefficients are attributed to the use of three key non-tradable across all tradables. These are trade, utilities (electricity, gas and water supply), and transport & storage. Within the three predominant non-tradable inputs, the trade sector has notable high capital and labour proportions when compared with the electricity and transport & storage sectors, and also in comparison to the remaining non-tradable sectors (Table 4). Also, the relatively higher capital proportion, compared with that of labour, for two of the before mentioned three non-tradables, viz. trade and electricity, has contributed to greater expansion in capital proportions of the tradables. Therefore, their inclusion contributes to improved estimates of factor proportions, which, in turn, makes the assessment of factor requirements more realistic for policy and planning.

Table 3: Sector-wise expanded factor coefficients, Tradable sectors

Sector name	**Total factor coefficient** $\tilde{a}_{ij}$		**Factor with greater use***	**whether Labour-intensive****	**whether Capital-intensive*****
	Labour	Capital			
	(1)	(2)	(3)	(4)	(5)
Agriculture and allied	0.459	0.387	Labour	intensive	intensive
Mining	0.196	0.559	Capital	intensive	intensive
Processed food	0.096	0.146	Capital		
Textile and leather	0.142	0.181	Capital		
Wood products	0.174	0.194	Capital		
Paper, printing and publishing	0.152	0.159	Capital		
Coke and petroleum products	0.009	0.184	Capital		
Chemical products	0.075	0.247	Capital		
Rubber and plastics	0.073	0.160	Capital		
Non-metallic mineral products	0.118	0.268	Capital		intensive
Basic metal products	0.067	0.196	Capital		
Machinery nec	0.076	0.144	Capital		
Electrical equipment	0.130	0.209	Capital		
Transport equipment	0.099	0.236	Capital		
Manufacturing nec	0.187	0.118	Labour	intensive	
Financial services	0.279	0.571	Capital	intensive	intensive
Business services	0.263	0.342	Capital	intensive	intensive
Education	0.542	0.232	Labour	intensive	
Tradables (average)	0.174	0.252			
Increase over direct coefficient	7.0	10.3			

Notes: *Factor with greater use is Labour if Col (1)> Col (2); Capital otherwise.

** A sector is considered labour-intensive if it has an expanded labour coefficient more than that for the average expanded labour coefficient of the tradable sectors as a group

** A sector is considered capital-intensive if it has an expanded capital coefficient more than that for the average expanded capital coefficient of the tradable sectors as a group

Source: Author computations.

Table 4: Use of non-tradable inputs into tradable sectors

	Agriculture and allied	Mining	Processed food	Textile and leather	Wood products	Paper, printing and publishing	Coke and petroleum products	Chemical products	Rubber and plastics	Non-metallic mineral products	Basic metal products	Machinery nec	Electrical equipment	Transport equipment	Manufacturing nec	Financial services	Business services	Education
Electricity, Gas and Water Supply	0.01006	0.07611	0.01121	0.00710	0.01541	0.03934	0.03145	0.01698	0.03439	0.00398	0.04501	0.07466	0.07032	0.01554	0.02027	0.08885	0.06784	0.02826
Construction	0.00878	0.01321	0.00096	0.00143	0.00043	0.00245	0.01004	0.00247	0.00281	0.00184	0.03008	0.04486	0.01864	0.01215	0.00338	0.00791	0.02091	0.01482
Trade	0.02944	0.00612	0.11636	0.06796	0.05181	0.05048	0.01474	0.04593	0.07115	0.08408	0.05284	0.05033	0.03911	0.05142	0.04100	0.00225	0.00639	0.00376
Hotels and Restaurants	0.00069	0.02456	0.00000	0.00000	0.00000	0.00000	0.00220	0.00029	0.00000	0.00000	0.00000	0.00001	0.00001	0.00000	0.00010	0.01577	0.01392	0.00606
Transport and Storage	0.00760	0.01245	0.01522	0.03312	0.01959	0.02596	0.01207	0.01350	0.02150	0.05622	0.02279	0.02125	0.01445	0.01630	0.02694	0.00813	0.01790	0.00691
Post and Telecommunication	0.00044	0.02403	0.00014	0.00069	0.00118	0.00100	0.00543	0.00093	0.00026	0.00026	0.00026	0.00055	0.00043	0.00018	0.00176	0.01047	0.03323	0.00956
Public Administration	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Health and Social Work	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00059	0.00000	0.00000
Other services	0.00030	0.10626	0.00000	0.00000	0.00000	0.00003	0.00068	0.00009	0.00000	0.00001	0.00000	0.00004	0.00003	0.00000	0.00037	0.00209	0.07708	0.00424
Total*	5.7%	26.3%	14.4%	11.0%	8.8%	11.9%	7.7%	8.0%	13.0%	14.6%	15.1%	19.2%	14.3%	9.6%	9.4%	13.6%	23.7%	7.4%

Notes: Values across a column show cost proportions of non-tradable inputs in a unit output of tradable sector under consideration

* Total refers to the combined input share (as a percentage of total inputs) of non-tradables in the cost structure of the tradable sector.

Source: Author computations.

The sector-wise expanded factor proportions (i.e. total factor coefficients) for all 18 tradable sectors are reported in Table 3. As expected from the previously stated argument, the inclusion of interlinkages with the non-tradable contributes to increasing the factor proportions of tradables. Nevertheless, no significant changes are observed through emergence of newer sectors as either being labour or capital-intensive, although minor exceptions are discussed as follows (refer Tables 2 and 3 for comparison based on the expanded factor coefficients). The mining sector emerges as a labour-intensive sector. At the same time, the wood product sector is now reported to have (expanded) factor proportions below the corresponding benchmark value of labour proportion. The fewer changes within the tradable group only underscore the importance of the sectors for employment generation – agriculture and allied, mining, manufacturing nec, financial services, business services and education. It is worthy of notice that services have predominance by virtue of the labour intensive nature of each of the two tradable services. It is intriguing to note that the capital-intensive sectors of the economy span beyond the conventional secondary manufacturing products such as non-metallic mineral products; to also include primary and tertiary sectors such as agriculture, mining, financial services and business services.

7.1 Assessment of structure of the economy vis-a-vis factor proportions

A comparison of factor proportions against the corresponding structure (distribution of output, exports and FDI) adds perspective to the findings by determining if the existing structure of the economy is in conformity to factor proportions. On the other hand, the lack of coherence can be a helpful pointer to the mis-match essentially pointing to the presence of bottlenecks in preventing efficient allocation of resources within the economy.

The output distribution shows high shares of agriculture, coke and petroleum products, basic metal products, processed food, business services, chemical products, and financial services, jointly accounting for more than two-thirds of tradable output (Table 5). Among these only three sectors viz. agriculture and allied; financial services, and business services, are identified as both labour and capital-intensive and thus be said to be producing in sync with the factor proportions of the overall tradable sectors (Tables 3 and 5). However, the remaining of the four sectors (with high output shares) are neither labour-intensive or capital-intensive. Thus, a clear pattern of relation between the output

of tradables and the corresponding factor usage is difficult to ascertain in terms of their labour proportions and capital proportions.

The structure of export is relatively more concentrated among fewer tradables. Exports of only five tradables account for more than two-third of the aggregate tradable exports. These include business service, coke and petroleum products, machinery nec, textile and leather and chemical products. Among these, exports of only business services and manufacturing nec is found to be coherent with factor proportions. As noted from Table 3, business services is noted for an above average labour proportion and capital proportion; while manufacturing nec uses labour more intensely than the group average. The export performance of the remaining three sectors is not synchronised with their factor proportions. Thus, the pattern of exports cannot be distinctly linked to factor usage.

The FDI in tradables exhibits an even more concentrated distribution with only four recipient tradeables accounting for two-thirds of the share. These include processed food, chemical products, financial service and transport equipment. Interestingly, only the financial service sector has a factor proportion higher than the group average. Since none of the remaining tradables are noted labour-intensive in an economy endowed with labour, the reasons for FDI receipts are possibly other than cheap and abundant labour. Since the prime motive of an investor is profit making, foreign investment, particularly FDI which is considered more stable than equity flows, is likely to arrive in sectors which provide higher returns whether through reaping economies of scale, benefitting from a vast domestic market, or reasons such as preferential access to third countries. In other words, sectors with high usage of a factor, which is '*relatively'* cheap, offering higher returns to investment are likely to drawn in FDI.

The affinity of FDI with sectors which are not necessarily labour-intensive is unexpected at the first instance though not difficult to comprehend. We attempt to explicate as follows. The import substituting industrialisation of the pre-reform period emphasised on domestic production (Luis, 1999). This has been helpful in encouraging indigenous manufacturing of capital-intensive industries. Later, the trade reforms of the 1990s targeted liberalisation of capital and intermediate goods through tariff reductions. The resulting decline in the price of capital goods, which continued through the 2000s, distorted prices in favour of capital-intensive manufacturing which encouraged substitution of capital for labour (Sen, 2014). The issue of high effective prices of hiring

labour in post reform period and evidently more likely to be impacting large sized firms, has also been investigated in Gupta et al (2008). Since it is the large sized organised manufacturing where much of the manufacturing FDI is oriented; the price differentials further encouraged foreign investment into sectors which had higher proportions of capital, a factor of production that registered decline in price relative to labour. The lack of interest in labour-intensive activities also perhaps has to do with the relatively low price of capital over time.

At this juncture, it may be helpful to study the relative use of labour and capital in a sector. The sector-wise capital-to-labour (K-to-L) ratio, as reported in Table 5, shows an exceptionally high value for the coke and petroleum product sector and is an outlier. Although the coke and petroleum products sector is heavily dependent on material inputs (Sahu and Sharma, 2015), its capital-intensive nature is due to relative dependency on capital. The sector includes oil refining which is a capital-intensive activity due high costs associated with planning and designing. The capital costs of the sector are also related to location which in turn depend on land and construction costs. Also, the range of inputs to be processed and the spectrum of outputs to be produced, add to complexity of the refinery which has an escalating effect on the capital required. The high K-to-L ratio of the coke and petroleum products is due to low expanded coefficient of labour in comparison to capital (Table 3). Therefore, we exclude the K-to-L ratio sector to compute the benchmark K-to-L of the tradable group. The average K-to-L ratio of the tradables is found to be 1.74.

Table 5: Structure of tradable sector

Sector name	**Distribution (%)**			**K-to-L**	**whether above average***
	Output	Exports	FDI	(ratio)	
Agriculture and allied	17.9	6.6	1.1	0.84	below average
Mining	3.9	1.0	0.2	2.85	above average
Processed food	8.1	3.2	29.1	1.51	below average
Textile and leather	6.0	8.6	0.9	1.27	below average
Wood products	0.9	0.0	0.0	1.11	below average
Paper, printing and publishing	1.2	0.4	0.9	1.04	below average
Coke and petroleum products	12.4	14.2	0.7	19.55	above average
Chemical products	6.3	7.1	15.7	3.30	above average
Rubber and plastics	1.8	2.0	2.6	2.20	above average
Non-metallic mineral products	2.2	0.3	2.8	2.26	above average
Basic metal products	9.1	6.0	2.8	2.91	above average
Machinery nec	2.8	3.2	7.3	1.91	above average
Electrical equipment	2.3	3.2	3.1	1.61	below average
Transport equipment	4.5	5.2	10.4	2.39	above average
Manufacturing nec	4.0	10.6	3.1	0.63	below average
Financial services	6.1	2.4	11.6	2.05	above average
Business services	7.3	25.9	6.1	1.30	below average
Education	3.2	0.2	1.5	0.43	below average
Average (all 18 sectors)				2.73	
Average (excluding coke and petroleum products)				1.74	
No of top sectors with more than 2/3rd share**	7 (67.3)	5 (66.3)	4 (66.8)		

Note: * Qualifies whether the K-to-L ratio of the sector is above the average value of the ratio

** Figures within the parenthesis are the cumulative share.

Comparing the sector-wise ratios for each of the four dominant FDI oriented sectors of processed food, chemical products, financial service, transport equipment, we find that three of these have a K-to-L ratio exceeding the group average. The sector-wise distribution of FDI showing a concentration into high capital proportion sectors

indicates the capital-intensive nature of FDI despite the *a priori* labour endowments of India. Our observations on FDI concentration into the sectors with high capital proportions are broadly in sync with Sen (2008) who notes a small amount of FDI directed to labour-intensive sectors of the economy. Our findings on the concentration of FDI into sectors with high capital-use (relative to labour) are also in sync with the Balasubramanyam and Sapsford (2007) who clarify that the nature of FDI was more process oriented and therefore requires the availability of skilled manpower with tertiary levels of education in scientific and engineering fields. These factor requirements are spatially different from those of the labour-intensive sectors in the present structure of the economy. Another plausible explanation for the predominance of sectors with high K-to-L ratio in FDI distribution is due to the preferential choice of acquisition (whether initially or later) as a mode of investment in an already existing setup of private companies. This proposition is supported by Wei and Balasubramanyam (2015) who directly emphasise on the FDI draft of capital-intensive manufacturing not only due to the existing structural bias but also attribute it to the availability of managerial skills adept for capital-intensive technologies which require less supervision with the engagement of fewer but skilled workers. They rather show a cold-shoulder to the role of labour rigidities in driving FDI away from labour-intensive activities and toward capital-intensive sectors. Therefore, relating the FDI shares and sector-wise K-to-L ratio, some sectors with high capital proportions are observed to have received significant FDI.

8. Conclusions

The importance of structural coherence with factor proportions has been highlighted for economic growth in economic literature (Che, 2012). Therefore, a study of factor proportions is central to achieving long term and sustainable growth. The present paper evaluates factor proportions for the Indian economy over a latest period for which Input-Output Transaction Table the KLEMS data are available from a published source. The focus on tradables is due to their attractiveness for capital expansion in new and existing firms, through either of the two channels of investment viz. domestic and foreign. Hence they are more likely to register expansion in output, export and FDI. However, their interactive effects with the non-tradables are also accounted for in the analysis. The methodology followed provides a refinement over the existing estimates of factor proportions. The SIO approach adopted in the paper recognises that factor

proportion of a given commodity is not completely determined at the ultimate stage of production. It is also important to account for factor proportions at the intermediate stage. The separation of sectors into tradables and non-tradables allows for improved estimates through inclusion of the impact of expansion of tradables on non-tradables by exposing the latter to indirect competition, an issue unaddressed before in the existing studies on Indian economy. Although industry-specific studies provide information on the determinants of growth, the essential information is missed out if general equilibrium effects are ignored (Reeve, 2002). Since factor accumulation and the resultant change in relative factor use, has an impact on the production structure, understanding the industrial structure is useful in achieving optimum aggregate growth. Therefore, it is both necessary and important to utilise information in an economy-wide framework through intersectoral interactions. A follow-up of the present research can be extended in two directions to study the inter-temporal changes in structural coherence and to include the non-tradable as explicit sectors of analysis.

The analysis shows the absence of a clear pattern between the structure of output and factor proportions pointing to market failures which prevent movement of labour and capital to the most desirable sectors in terms of output significance. Output in the most labour-intensive tradables has not really taken off. Likewise, the major exporting tradables are not the most labour-intensive sectors, indicating a mis-match of export structure vis-a-vis the labour proportions. On the other hand, the output and exports are not concentrated in the most capital-intensive tradables either. However, the concentration of FDI into sectors, mostly with higher than average relative use of capital in a labour rich economy, leaves not a very promising situation for employment scenario. These findings are aligned with the earlier works of Balasubramanyam and Sapsford (2007) and Sen (2008) who noted the capital-intensive nature of Indian manufacturing and also the FDI orientation towards capital-intensive sectors. Despite India's a priori endowments of unskilled labour, the FDI significance of sectors with high K-to-L ratio explains the weak employment effects of FDI in the Indian economy.

For the development of an industrial structure, which is coherent with the factor use, it is important to facilitate movement of factors across sectors of the economy. The adjustment costs of capital mobility across sectors are generally understood to be relatively high as compared to adjustment costs from labour movements. The resistance to free movement of factors prevents the expected changes in structure of the economy.

The resulting lack or inadequacy in responsiveness of the structure of economy to the changing factor use hinders the optimal growth path at an aggregate level. Further, in view of the generally increasing use of capital over time, it becomes necessary to anticipate the implications on labour through improved compatibility and adaptability within a capital-intensive industrial setup.

From a policy perspective, the results suggest that with the present orientation of factor proportions, FDI is unlikely to be the solution to employment generation problems with the existing skill set. This only underscores the need to upgrade and diversify the existing skill base so as to improve employment outcomes in the economy. With higher relative use of capital in many sectors of the economy, a different type of labour supply is needed which is better trained, adaptive to capital-intensive environments while also being mobile across sectors. The need to support labour mobility becomes even more pressing in view of the fast and changing technological norms, such as the advancement in the fields of artificial intelligence and internet of things. Therefore, the scope for employment promotion through output or export expansion without the accompanying programmes for skill-upgradation and skill-development is likely to have a fairly limited effect.

References

Alauddin M and Tisdell C, 1988. The Use of Input-Output Analysis to determine the Appropriateness of Technology and Industries: Evidence from Bangladesh, Economic Development and Cultural Change, The University of Chicago Press, Vol. 36, No. 2, pp. 369-391.

Athukorala PC and Rajapatirana S, 2003. Capital Inflows and the Real Exchange Rate: A Comparative Study of Asia and Latin America, World Economy, Vol. 26, No. 4, pp 613–637.

Bahal G, Raissi M and Tulin V, 2018. Crowding-out or Crowding-in? Public and Private Investment in India, World Development, Vol 109, No. 2, p. 23

Balasubramanyam VN and Sapsford D. 2007, Does India Need a Lot More FDI?, Economic and Political Weekly, Vol. 42, No. 2, pp. 1549–1555.

Baldwin RE, 1971. Determinants of the Commodity Structure of U.S. Trade, The American Economic Review, American Economic Association, Vol. 61, No. 2, pp. 126–146.

Bruton HJ, 1963. Growth Models and Under developed Economies, Journal of Political Economy, Reprinted in The Economics of Underdevelopment, Agarwala and Singh (eds.) Oxford University Press

Central Statistics Office 2012, National Accounts Statistics, Sources and Methods, Ministry of Statistics and Programme Implementation Government of India

Che NX, 2012. Factor Endowment, Structural Coherence, and Economic Growth, IMF Working Paper, WP/12/165.

Cobbold T 2003, A Comparison of Gross Output and Value-Added Methods of Productivity Estimation, Productivity Commission Research Memorandum, Canberra.

Coondoo D, Neogi C and Ghosh B, 1993. Technology-intensive Industrialisation in LDCs: Experience of Indian Industries, Economic and Political Weekly, Vol. 28, No. 8/9, pp. 43-52.

Cuadrado FA, Long NV and Poschke M, 2017. Capital–labor substitution, structural change, and growth, Theoretical Economics, Vol 12, No. 2, pp. 1229–1266.

Daron A and Guerrieri V, 2008. Capital deepening and nonbalanced economic growth. Journal of Political Economy, Vol. 116, No. 2, pp. 467–498.

Das DK, Erumban AA, Aggarwal S and Das PC, 2015, Measuring Productivity at the Industry Level The INDIA KLEMS Database, Data Manual 2015

Das DK, Erumban AA, Aggarwal S and Das PC, 2018. Measuring Productivity at the Industry Level, The India KLEMS Database, Data Manual 2017, https://rbidocs.rbi.org.in/rdocs/.PDF

Gulhane S and Turukmane R, 2017. Effect of Make in India on Textile Sector", Journal of Textile Engineering & Fashion Technology, Vol. 3, No. 2, pp. 551–555.

Gupta P, Hasan R and Kumar U, 2008. What Constrains Indian Manufacturing?, ERD Working Paper Series No. 119, Asian Development Bank.

Hamilton C and Svensson LEO, 1983. Should Direct or Total Factor Intensities Be Used in Tests of the Factor Proportions Hypothesis?", WeltwirtschaftlichesArchiv, Vol. 119, No. 2, pp. 453–463.

Harrigan J, Zakrajšek E. Factor supplies and specialization in the world economy.https://www.nber.org/papers/w7848

Horiba Y and Kirkpatrick RC, 1981. Factor Endowments, Factor Proportions, and the Allocative Efficiency of U.S. Interregional Trade, The Review of Economics and Statistics , Vol. 63, No. 2, pp. 178–187.

International Labour Organisation 2018, Emerging Technologies and the Future of Work in India, Tandem Research, ILO Asia-Pacific Working Paper Series, June.

Karunaratne ND, 1996. A Semi Input-Output Analysis of Australian Comparative Advantage", Chapter 12 in Puttaswamaiah (ed.), Tinbergen and Modern Economics, Indus publishing company, pp 193–210.

Kathuria V, Raj SNR and Sen K, 2010. Organised versus Unorganised Manufacturing Performance in The Post-Reform Period, Economic and Political Weekly, Vol. 45, No. 2, pp. 55–64.

Keesing DB, 1966. Labor Skills and Comparative Advantage. American Economic Review, May (Papers and Proceedings), Vol. 56, No. 2, pp. 249–58.

Leamer EE, 1984. Sources of International Comparative Advantage: Theory and Evidence, Cambridge, Mass., MIT Press.

Leontief W, 1953. Domestic Production and Foreign Trade; The American Capital Position Re-Examined, Proceedings of the American Philosophical Society, Vol. 97, No. 4, pp. 332–349.

Luis S, 1999. Does Public Capital Crowd Out Private Capital? Evidence from India, Policy Research Working Paper, World Bank. Accessed at http://documents.worldbank.org/curated/en/652401468771639280/Does-public-capital-crowd-out-private-capital-evidence-from-India

Mano RC and Castillo M, 2015. The Level of Productivity in Traded and Non Traded Sectors for a Large Panel of Countries, IMF Working Paper WP/15/48.

Mason R H and Sakong Il, 1971. Level of Economic Development and Capital-Labor Ratios in Manufacturing, The Review of Economics and Statistics, Vol. 53, No. 2, pp. 176–178.

Ngai LR and Pissarides CA, 2007. Structural change in a multi-sector model of growth. American Economic Review, Vol. 97, No. 2, pp. 429–443.

Panagariya A, 2017. Indian Industry Not Investing in Job-Intensive Sectors, The Economic Times, 25 August.

Rashid ZA and Bashir MS, 2000. Factor Intensity of Trade: Malaysia's Labour Skills in Manufacturing Trade Flows, Paper presented at 14th International Conference on Input-Output Techniques, Montreal, 10-15 October.

Rathee H, 2016. Textile Sector in India & Scope for International Technology Transfer and Cooperation, Presentation Arvind Limited (India), 28 September. Accessed at http://knowledgeplatform.in/wp-content/uploads/2016/11/Textile_presentation.pdf

Reeve TA, 2002. Factor Endowments and Industrial Structure, Board of Governors of the Federal Reserve System, International Finance Discussion Papers, Number 731.

Riedel J, 1974. Factor Proportions, Linkages and the Open Developing Economy, ECONSTOR/Kiel Institute for the World Economy (IFW), Kiel Working Paper No. 20.

Romalis J, 2004. Factor Proportions and the Structure of Commodity Trade, The American Economic Review, March.

Sen K, 1956. Capital Output Ratios in Indian Industry, The Economic Weekly, March 3.

Sen K, 2008. Trade, FDI and Industrial Transformation in India, Paper prepared for Research Workshop 'Emerging trends and patterns of trade and investment in Asia', Ninth Global Development Network Conference, Brisbane, Australia.

Singh K and Saluja MR, 2016. Input-Output Table of India: 2013-14, NCAER Working Paper 111.

Singh K and Saluja MR, 2018. Input–Output Table for India 2013–2014: Based on the New Series of National Accounts Statistics and Supply and the Use Table. Margin—The Journal of Applied Economic Research, Vol 12, No. 2, pp. 197–223 .

Srivastava A, 2012. Heckscher Ohlin Vanek Theorem: An excess supply approach, MPRA Paper No. 38279.

Tinbergen J (1967), Development Planning, World University Library, Weidenfeld and nicolson, London.

Vanek J, 1968. The Factor Proportions Theory: The N-Factor Case. Kyklos, Vol. 21, No. 2, pp. 749–756.

Wei Y and Balasubramanyam VN, 2015. A Comparative Analysis of China and India's Manufacturing Sectors, Economics Working Paper Series 2015/003, Lancaster University Management School.