A Study on Intersectoral Linkages in Indian Economy

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Abstract

The study was undertaken to estimate the inter-sectoral linkages among the economic sectors of the Indian economy using Rasmussen method (1956).The data source of this study was the input output table consisting of 130 sectors for the year 2007-08 prepared by Central Statistical Office (CSO) of the Government of India and published in 2012. For the purpose of analysis, the Input Output Table was further consolidated into 56 sectors. The key sectors were identified using Hirschman (1958) criteria to identify influential sectors of the economy having substantial spill-over effects on the rest of the economy. The results appear to be in support of policy initiatives for providing ample opportunities for the expansion of manufacturing sector and more so the service sector to achieve the growth rate envisaged in the 12th plan document.

Keywords : **input output analysis, backward linkage, forward linkage, key sector, India**

JEL Classification : C67, D57, O11

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The importance of specific sectors for the rest of the economy can be illustrated with simple share in value added, share in employment, growth, export performance or a similar indicator. A shared aspect of these indicators is that they inspect each activity individually without investigating the relations with other activities. This paper tried to identify activities within the Indian economy which have significant impact on other activities. Thus, the inter-sectoral linkages are explored and activities having the strongest impact on the rest of the economy are considered as key sectors. The study of sectoral linkages helps government to design growth enhancing policies for sectors with large spillover effects and also help in understanding the structure of an economy (Cai & Leung, 2004). Thus, the best way to calculate inter-sectoral linkages is with the help of input output table.

The study of inter-sectoral linkages holds special significance in case of India since the growth process in India has not followed the conventional development path as suggested in the findings of Clark (1957), Kuznets (1966), and Chenery and Taylor (1968), This means that as development takes place, manufacturing sector expands before the service sector. Instead, there has been shift in output towards the service sector, thereby, leading to its substantial expansion in comparison to manufacturing. This shift in composition is likely to cause changes in demand and supply linkages among various sectors. Thus, a proper understanding of sectoral linkages is important for designing long run strategies. Thus, the study attempted the quantitative analysis of sectoral dependence in terms of linkage effects by utilizing the input output table 2007 [1] (published in 2012) by CSO for 130 sectors. This was further consolidated to 56 sectors and fulfilled the purpose of identification of key industries and influential sectors. Key industries were identified on the basis of Hirschman (1958) criteria and since then numerous modifications have been undertaken.

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[1] The Input Output Table 2007-08 is the most recent I-O model constructed on the principles of System of National Accounts (SNA) suggested by UN.

Review of Literature

Input output analysis became the fundamental means for studying inter-sectoral linkages when after 1941, W. Leontief introduced Input-Output (I-O) tables for the American economy. Consequently, I-O tables began to be used quite early. Rasmussens (1958) and Chenery and Watanabe (1958) used these for establishing the linkage between the sectors in an economy. Various studies were undertaken in India to quantify the extent to which services, manufacturing, and agriculture have spill-over effects on each other. Hirschman (1958) developed the idea of inter-industry linkages in this I/O framework and provided the link between linkages and economic development. The two inducement mechanisms that may generate economic activities in developing countries are backward and forward linkage effects. Backward linkages represent the dependence of some industries on others supplying their inputs while forward linkages identify the amount of output supplied forward by some industries to others in the I/O chain.

Three different approaches are found in measurement of linkages, which are Chenery and Watanabe (1958), Yotopoulos and Nugent (1976), and Rasmussen (1958). Chenery and Watanabe (1958) proposed to use the column and row sums of technical coefficients matrix to measure the direct backward and forward linkages respectively while Rasmussens (1958) measured backward linkages as the column sum of the Leontief inverse matrix,$(-1\ A)^{-1}$.The criteria for identification of priority sectors was given by Hirschman (1958) and since then numerous modifications have been undertaken to establish key sectors and their use on different economies can be found in studies by Hazari (1970), Jones (1970), Schultz (1977), Hewings (1982), and Dietzenbacher (1992).

Various studies in India have been carried to study inter-sectoral linkages by Hansda (2001) ; Sastry, Singh, Bhattacharya, and Unnikrishnan (2003) ; Bhardwaj and Chaddha (1991) ; Dhawan and Saxena (1992) ; Munjal (2007) ; Mitra and Schmid (2008) ; Saikia (2011) ; Bhattacharya and Rajeev (2014) ; and Kumar and Das (2015) analyzed the sources of industrial growth in India from a multi-sectoral perspective followed by highlighting inter industry linkages in the economy during the period 1973-74 through 1984-85. Dhawan and Saxena (1992) used Leontief demand driven model for measuring backward linkages and Ghosh (1958) supply driven model to estimate forward linkage. Hansda (2001) used Rasmussens indices to measure inter-sectoral dependence and index of vertical integration to measure the multiplying effect of each activity on the gross output of the rest of the economy. The comprehensive study of the inter-sectoral linkages in the Indian economy for the period 1950-51 to 2000-01 was carried out by Bathla (2003). Munjal (2007) calculated the column multiplier (*backward linkage*) and row multiplier (*forward linkage*) and used his product to derive multiplier product matrix. The findings of Mitra and Schmid (2008) based on state level data showed that services like transport, trade and banking are indeed important for manufacturing growth. These services together with electricity are actually part of the infrastructure which facilitated production in manufacturing sector.

Saikia (2011) showed that there has not been any significant interdependence between agriculture and service sectors but there is strong interdependence between industry and service sectors and it has improved in the post-reform period. Ashwani and Vashisht (2012) used input output tables for the years 2003-04 and 2006-07 and identified high linked sectors of the Indian economy. Comparison of the two input output tables revealed that the classification of the sectors based on linkages indices value remained more or less changed. Recently, by using import-adjusted domestically produced input based matrix for the latest year 2007-08. Bhattacharya, and Rajeev (2014) identified key sectors critical for the rapid growth of Indian economy. Kumar and Das (2015) studied the linkage analysis of various sectors which policy makers should consider while planning for allocating resources to 'Make in India'. They identified such sector and found that some of the industries having strong linkages have not been considered for 'Make in India'.

Research Objectives

The purpose of the study was to measure the inter-sectoral linkages and interdependence among sectors in the

Indian economy as well as to identify the most influential sectors in the economy. This study mainly describes the uses of linkage measures and their analytical findings for planning and policy research.

Research Methodology

The present study primarily uses Input Output table of Indian economy for the year 2007-08 as it is the latest input output table prepared by CSO of the Government of India and published in 2012. The next I-O table for the year 2012-13 would be made available in public domain by CSO in 2017.The table originally gives input output flow for 130 sectors of the Indian economy but for measuring inter-linkages, this 130 x 130 input output table has been consolidated into a 56 x 56 input output table. Two important linkage measures namely, forward and backward have always attracted discussion on their methods of measurement [2]. On the basis of suggestions of Cai and Leung (2004) for model choice, we used Leontief (1936) demand driven model and Ghosh (1958) supply driven model for this paper.

(1) Basic Input Output Model : The analysis of input output table introduced by Leontief (1936) identifies the interdependence of production and consumption in an economy. An input output model is a system of linear equations and thus, can be presented in the form of linear equation . The inter-sectoral flows are expressed in monetary terms for a particular year where the flows represent intermediate goods and services.

$$Xi = \sum a_{ij} X_j + F_i \ , i = 1,2,3,.....n \qquad (1)$$

where, X_i is the total output of sector i, F_i is the final demand having five components, namely, private final consumption expenditure (PFCE), government final consumption expenditure (GFCE), change in stock (CIS), exports (EXP), and imports(IMP). In equation 1, a_{ij} is the technical coefficient which shows input requirement of sector i in sector j and is obtained by ($a_{ij} = (X_{ij} / X_j)$.

In matrix notation equation (1) can be written as :

$$X = (I\text{-}A)^{-1} * F \qquad (2)$$

where, $(I\text{-}A)^{-1}$ is known as Leontief Inverse or matrix multiplier. It gives both direct and indirect requirements of inputs. Therefore, after calculating input output coefficient matrix *'A'* and final demand vector *'F',* value of output of any sector can be determined.

On the other hand for Ghosh (1958) supply driven model we consider the following equation :

$$X_j = \sum b_{ij} X_i + V_j \qquad (3)$$

where, X_j is total input for sector j, V_j is the primary input (or the value added) of the same sector, and b_{ij} is the output coefficient of sector j to sector i and is obtained by $b_{ij} = (X_{ij}/X_i)$. The same expression can be reorganized in matrix form :

$$X' = (I\text{-}B)^{-1} * V \qquad (4)$$

where, $(I\text{-}B)^{-1}$ is called Ghosh inverse (Ghosh, 1958).

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[2] See Cai & Leung (2004) ; Jones (1970) ; Hewings (1982).

(2) Analytical Method of Backward and Forward Linkage : Different approaches are found in measurement of linkages. Chenery and Watanabe (1958) proposed to use column and row sums of technical coefficients matrix (A) and allocation coefficient matrix (B) to measure the backward and forward linkages respectively. Backward linkage of the sector measures the inducement to production in other sectors which is absorbed as an input to the former. On the other hand forward linkage of a sector measures the extent to which the sector provides inputs for utilization by other sectors.

Thus, the backward and forward linkages are straight forward and represent respectively, the sum of the column elements and sum of the row elements of the matrices 'A' and 'B', respectively. Thus, for backward linkage, the output to the total value of production in each sector is,

$$BL_j = \sum X_{ij} / X_j = \sum_i a_{ij} \qquad (5)$$

where, X_{ij} represents the number of units of commodity i used in production of X_j units of commodity j. The values of a_{ij} are obtained from technical coefficient matrix A. In the other words, X_{ij} is the ij^{th} element of the flow matrix and X_j is the gross output of sector j. Correspondingly, 'forward' linkage for any i^{th} sector (FL_i) is defined as the ratio of inter industry demand to total demand :

$$FL_i = \sum X_{ij} / X_i = \sum_j b_{ij} \qquad (6)$$

The above indices only measure direct impacts and they do not account for the indirect effects for which we need total linkage measure. Thus, for obtaining indirect effects Rasmussen (1958) measure of backward and forward linkage indices has been used.

To facilitate inter-industry comparison Rasmussen's measure of backward linkage can be made by constructing an index of backward linkage as follows;

$$Uj = (1/N) \sum_i A_{ij} / (1/N^2) \sum_{j=1}^{N} A_{ij} \qquad (7)$$

where, the numerator represents the average of direct and indirect needs to meet the increases of final demand by one unit from sector j products, whereas the denominator refers to average total needs in an economy to meet the increase of final demand by one unit. This means that the aggregation of increased final demand in all sectors is one unit.

The inter-industry comparison of forward linkage can be made by constructing an index of backward linkage as follows:

$$Ui = (1/N) \sum_i B_{ij} / (1/N^2) \sum_{i=1}^{N} B_{ij} \qquad (8)$$

where, the numerator refers to average of the total of row which belongs to i sector in inverse Leontief matrix output, which measures the total impact on sector i, when the final demand grows for all sectors by one unit, the increase in investment in sector i motivates the production of sectors which used the products of this sector. Whereas the denominator states the average of averages for all the sectors.

Analysis and Results

(1) Measures of Backward Linkage Indices : Rasmussens's (1958) backward and forward linkages indices are estimated from input output table 2007-08 using formulae given in equations (7) and (8), respectively. The values of total direct and indirect backward linkage and forward linkage measure with their corresponding ranking are

given in Table 1. It was observed from Table 1, that the agriculture sector including other crops, forestry, and fishing have very low ranking with respect to backward and forward linkages which may be attributed to lack of public investment and modern farm technology. Obviously, these sectors have very low input dependence as compared to other sectors of the economy. Most of the services are characterized by sectors having both low backward and forward linkages and this might be due to the very high labour components in its production of output.

Whereas, the highest ranking sector by forward linkage is crude petroleum followed by natural gas. The agriculture sector has low forward linkage since a major part of it goes to final demand as private final consumption expenditure whereas agro processing sectors induce strong backward linkages and medium weak forward linkages. The sectors having high backward linkage are concentrated in manufacturing since it utilizes input from both agriculture and services. But key manufacturing sectors including fertilizer, iron, and steel

Table 1. Rasmussens's Backward Linkage *(Uj)* and Forward Linkage *(Ui)* for I- O Table 2007- 08 (with 56 Sectors)

S.No.	SECTORS	*BLj*	*FLi*	*BLj + Fli*	*Uj*	*Ui*	*Uj + Ui*	Rank *	Rank^
1	Crops	0.3676	0.5074	0.8750	0.8145	0.7118	1.5263	39	43
2	Animal husbandry	0.3882	0.3632	0.7514	0.791	0.6339	1.4249	43	47
3	Forestry and logging	0.1459	0.5536	0.6995	0.6217	0.7295	1.3512	46	48
4	Fishing	0.1461	0.2069	0.3529	0.6302	0.5082	1.1384	52	52
5	Coal and lignite	0.2762	1.3850	1.6612	0.7513	1.9965	2.7478	8	7
6	Natural gas	0.1729	2.1542	2.3271	0.6609	2.6228	3.2837	3	3
7	Crude petroleum	0.2847	6.5661	6.8508	0.7806	6.4664	7.2470	1	1
8	Iron ore	0.1505	0.4957	0.6462	0.6293	0.8813	1.5106	48	44
9	Other minerals	0.1563	1.4605	1.6168	0.6317	1.6363	2.2680	10	10
10	Sugar	0.9422	0.3274	1.2696	1.2137	0.5972	1.8109	26	33
11	Food products excluding sugar	0.8806	0.3018	1.1824	1.2406	0.5907	1.8313	28	29
12	Beverages	0.7561	0.1672	0.9232	1.2432	0.5063	1.7495	36	37
13	Tobacco products	0.4742	0.1056	0.5798	0.8867	0.4276	1.3143	49	49
14	Textiles	0.7514	0.3287	1.0801	1.2278	0.5882	1.816	33	31
15	Furniture and fixtures-wooden	0.6026	0.2335	0.8361	0.9764	0.5615	1.5379	41	41
16	Wood and wood products	0.6172	0.7699	1.3871	0.9446	0.8484	1.7930	23	34
17	Paper, paper products & newsprint	0.7352	0.9061	1.6413	1.2061	1.1373	2.3434	9	9
18	Printing and publishing	0.7051	0.4666	1.1717	1.2413	0.7475	1.9888	30	24
19	Leather and leather products	0.7238	0.4152	1.139	1.1653	0.6500	1.8153	31	32
20	Plastic and rubber products	0.0732	0.0565	0.1297	0.5467	0.4230	0.9697	54	54
21	Petroleum products	0.8188	0.6134	1.4322	1.1436	0.9007	2.0443	18	22
22	Coal tar products	0.6263	1.2661	1.8924	1.0258	1.2013	2.2271	6	13
23	Inorganic heavy chemicals	0.7808	1.0976	1.8784	1.3527	1.5965	2.9492	7	5
24	Organic heavy chemicals	0.7750	1.1732	1.9482	1.2931	1.4927	2.7858	5	6
25	Fertilizers	0.9161	1.2600	2.1761	1.5677	1.6677	3.2354	4	4
26	Pesticides	0.7330	0.8690	1.6020	1.3088	1.3309	2.6397	12	8
27	Paints, varnishes, and lacquers	0.6274	0.7819	1.4093	1.1559	0.8647	2.0206	20	23

28	Drugs and other chemicals	0.7177	0.6950	1.4127	1.2586	0.9285	2.1871	19	18
29	Cement	0.6598	0.9471	1.6069	1.017	0.8224	1.8394	11	28
30	Non-metallic mineral products	0.6429	0.825	1.4679	1.1238	0.8164	1.9402	14	26
31	Iron & steel industries and foundries	0.7273	0.8444	1.5717	1.1963	1.0181	2.2144	13	14
32	Non-ferrous basic metals	0.7985	1.5661	2.3646	1.2705	2.0793	3.3498	2	2
33	Metal products except machinery &transport	0.7343	0.7187	1.4530	1.2665	0.9407	2.2072	16	15
34	Tractors and agricultural implements	0.6983	0.1701	0.8684	1.2810	0.5003	1.7813	40	36
35	Industrial machinery(F & T)	0.7778	0.5609	1.3387	1.3932	0.8098	2.2030	24	16
36	Other machinery	0.7397	0.5638	1.3035	1.3285	0.9295	2.2580	25	11
37	Electrical, electronic machines & appliances	0.7734	0.6162	1.3896	1.3476	0.8908	2.2384	22	12
38	Transport equipment	0.7963	0.4015	1.1978	1.4032	0.6858	2.0890	27	20
39	Miscellaneous manufacturing industries	0.7353	0.4432	1.1785	1.2617	0.6969	1.9586	29	25
40	Construction	0.6176	0.0814	0.6990	1.0983	0.4395	1.5378	47	42
41	Electricity	0.5894	0.8561	1.4455	1.0390	1.1570	2.1960	17	17
42	Water supply	0.4216	0.3072	0.7288	0.9026	0.5808	1.4834	45	45
43	Railway transport services	0.3919	0.5669	0.9588	0.926	0.9209	1.8469	35	27
44	Other transport services	0.5559	0.4732	1.0291	1.0432	0.7427	1.7859	34	35
45	Storage and warehousing	0.4091	0.9870	1.3961	0.9004	1.2373	2.1377	21	19
46	Communication	0.2373	0.5778	0.8151	0.7535	0.8596	1.6131	42	38
47	Trade	0.1921	0.5466	0.7387	0.6618	0.7860	1.4478	44	46
48	Hotels and restaurants	0.6680	0.4507	1.1187	1.1063	0.7195	1.8258	32	30
49	Banking	0.1601	0.7314	0.8915	0.619	0.9551	1.5741	38	40
50	Insurance	0.2294	0.6683	0.8977	0.7032	0.8889	1.5921	37	39
51	Ownership of dwellings	0.0460	0	0.0460	0.5207	0.3816	0.9023	55	55
52	Education and research	0.1022	0.056	0.1582	0.5702	0.4272	0.9974	53	53
53	Medical and health	0.3678	0.0444	0.4122	0.8876	0.4112	1.2988	51	50
54	Business services	0.4693	0.9872	1.4565	0.9399	1.1448	2.0847	15	21
55	Other services	0.2491	0.2279	0.4770	0.7022	0.5613	1.2635	50	51
56	Public administration	0	0	0	0.4737	0.3816	0.8553	56	56

Note: * indicates total direct linkages and ^ indicates total direct plus indirect linkages.

Source: Author's estimation by using I-O table for 2007-08 in CSO (2012).

industry are manufactured principally for intermediate supplies and hence, have higher ranking by forward linkages than that of backward linkages. Manufacturing industries such as tobacco, furniture and fixture, wood and wood products, plastic and rubber products have low forward linkage since their contribution towards final demand is more than intermediate demand in the economy. In the service sector electricity, storage and warehousing, and business services have higher ranking in forward linkage in contrast to low forward linkage in sectors like construction, other transport, hotels, and restaurants. Health and education services have low backward and forward linkages because they are very labour intensive in production and supply all their output to final consumers.

(2) Interpretation of Backward and Forward Linkage Indices : Now, both backward and forward linkages are used to identify key sectors. According to Hirschman, ideally the priority sectors in which investment is to be

concentrated are those with high values of backward and forward linkage effects (that is Ui >1and Uj >1).The next desirable group of sectors in order of priority are those with strong backward linkages (Uj >1) but weak forward linkage (Ui <1).This is because according to Hirschman (1958) the pressures of backward linkage are more powerful than those of forward linkages especially in developing countries. The next group of sectors in order of ranking, are those with low backward (Uj <1) and high forward linkage (Ui >1).

(i) Priority Sector 1 - *Ui* >1 and *Uj* >1 : Results from Table 2 reveal that the priority sectors namely, paper, paper products, newsprint, coal tar products, inorganic heavy chemicals, organic heavy chemicals, fertilizers, pesticides, iron & steel industries and foundries, non-ferrous basic metals comprised of 16.1% of the total number of sectors in 2007-08. Among nine key sectors identified, seven sectors except paper products, newsprint and electricity have relatively higher forward linkage than backward linkage and by looking at the sectoral shares in components of final demand [3] and intermediate demand, it has been found that key sectors accounted for only 15% of the intermediate use (IUSE), less than 1% for both private final consumption expenditure (PFCE) and government final consumption expenditure (GFCE), 10% in exports (EXP) and relatively large share of 25% in imports (IMP). The sectors which have the largest contribution for intermediate use are the same as those having highest share in GFCF which includes, iron, and steel industry, non-ferrous, thus having maximum spill-over effects on the rest of the economy. It is seen that paper, paper prods, and inorganic heavy chemicals are sectors with both high forward and backward linkages which are in conformity with the findings of Bhattacharya and Rajeev (2014) while sectors of inorganic heavy chemicals, organic heavy chemicals and iron & steel industries are in conformity with the findings of Ashwini and Vashisht (2012).

Table 2. Key Sectors with *Uj* >1 and *Ui* >1 in Indian Economy for 2007-08

			Backward linkage	Forward linkage	% Share in total of each indicator							Share (%)^	
S.No	I-O Code	Sector Name	*Uj*	*Ui*	IUSE	PFCE	GFCE	GFCF	CIS	EXP	IMP	TIU	TFU
1	17	Paper, paper prods. & newsprint	1.2061	1.1373	0.91	0.21	0.71	0.00	1.02	0.16	0.70	91	9
2	64	Coal tar products	1.0258	1.2013	0.44	0.00	0.00	0.00	0.20	0.03	0.44	127	-27
3	65	Inorganic heavy chemicals	1.3527	1.5965	1.08	0.00	0.00	0.00	1.33	0.34	0.92	110	-10
4	66	Organic heavy chemicals	1.2931	1.4927	1.07	0.00	0.02	0.00	0.59	2.46	2.65	117	-17
5	67	Fertilizers	1.5677	1.6677	1.26	0.00	0.00	0.00	2.16	0.01	1.48	126	-26
6	68	Pesticides	1.3088	1.3309	0.23	0.00	0.00	0.00	0.23	0.21	0.07	87	13
7	77-79	Iron & steel industries and foundries	1.1963	1.0181	6.19	0.00	0.00	2.10	13.86	3.72	3.82	84	16
8	80	Non-ferrous basic metals	1.2705	2.0793	2.36	0.00	0.00	1.85	1.85	1.68	7.40	157	-57
9	107	Electricity	1.0390	1.1570	2.36	0.00	0.00	1.85	1.85	1.68	7.40	86	14

Source: Author's calculation from input output table 2007-08, CSO, Note: ^ indicate percent share of total intermediate use(TIU) and total final use (TFU) in total output.

(ii) Priority Sectors 2 - (*Uj* > 1) and (*Ui* <1) : This category represents a very high proportion of all sectors as in developing countries the linkages based on demand pressures (B.L) are more predominant than those based on supply pressures (F.L). Table 3 shows that sugar, food products excluding sugar, beverages, textiles, printing and publishing, leather and leather products, petroleum products, paints, varnishes and lacquers, drugs and other

[3] Final demand has five components private final consumption expenditure (PFCE) , government final consumption expenditure (GFCE), change in stock (CIS), exports (EXP),and imports(IMP).

Table 3. Sectors with High Backward Linkage Indices in Indian Economy for 2007-08

			Backward linkage	Forward linkage	% Share in total of each indicator							Share (%)	
S.No	I-O Code	Sector name	*Uj*	*Ui*	IUSE	PFCE	GFCE	GFCF	CIS	EXP	IMP	TIU	TFU
1	38-39	Sugar	1.2137	0.5972	0.29	0.81	0.00	0.00	1.54	0.36	0.00	33	67
2	40-43	Food products excluding sugar	1.2406	0.5907	1.67	6.16	0.67	0.00	4.23	2.10	0.98	30	70
3	44	Beverages	1.2432	0.5063	0.11	0.95	0.05	0.00	0.57	0.02	0.03	17	83
4	46-54	Textiles	1.2278	0.5882	2.36	5.65	1.09	0.23	6.25	7.51	1.02	33	67
5	58	Printing and publishing	1.2413	0.7475	0.33	0.48	1.25	0.00	0.53	0.07	0.23	47	53
6	59-60	Leather and leather products	1.1653	0.6500	0.32	0.57	0.00	0.00	0.68	0.74	0.16	42	58
7	63	Petroleum products	1.1436	0.9007	5.23	3.60	1.54	0.00	12.17	7.33	3.57	61	39
8	69	Paints, varnishes and lacquers	1.1559	0.8647	0.41	0.06	0.00	0.00	1.55	0.33	0.24	78	22
9	70-73	Drugs and other chemicals	1.2586	0.9285	2.57	1.35	1.12	0.00	5.86	2.83	2.31	70	30
10	75	Cement	1.0170	0.8224	1.08	0.00	0.00	0.00	1.08	0.05	0.02	95	5
11	74-76	Non-metallic mineral products	1.1238	0.8164	1.47	0.24	0.00	0.23	2.16	0.45	0.36	82	18
12	81-82	Metal products except machinery and transport	1.2665	0.9407	2.07	0.32	0.11	1.70	1.34	0.80	0.56	72	28
13	83	Tractors and agri. implements	1.2810	0.5003	0.10	0.00	0.00	1.37	0.26	0.14	0.03	17	83
14	84	Industrial machinery	1.3932	0.8098	0.21	0.00	0.00	0.90	2.87	0.20	1.22	56	44
15	85-87	Other machinery	1.3285	0.9295	2.52	0.31	0.14	7.74	8.97	2.10	6.25	56	44
16	88-94	Electrical, Electronic Machines & Appliances	1.3476	0.8908	2.62	0.82	1.61	7.88	1.83	2.10	7.94	62	38
17	95-100	Transport Equipment	1.4032	0.6858	1.77	1.35	1.60	6.93	-5.06	2.37	2.69	40	60
18	101-105	Miscellaneous manufacturing industries	1.2617	0.6969	1.85	1.02	0.14	5.43	27.00	3.44	8.15	44	56
19	106	Construction	1.0983	0.4395	4.46	0.12	2.39	56.02	0.00	0.59	0.23	20	80
20	110-113	Other transport services	1.0432	0.7427	0.83	0.69	0.55	0.29	0.00	0.56	0.00	47	53
21	117	Hotels and restaurants	1.1063	0.7195	2.17	4.62	0.84	0.00	0.00	0.00	0.00	45	55

Source: Author's calculation from input output table 2007-08,CSO. Note: ^ indicates percent share of total intermediate use (TIU) and total final use (TFU) in total output.

chemicals, cement, non-metallic mineral products, metal products except machinery & transport, tractors and agricultural implements, industrial machinery, other machinery, electrical, electronic machines & appliances, transport equipment, miscellaneous manufacturing industries, construction, and other transport services .The number of sectors in priority II category was 37.5% of the total number of sectors in 2007-08. It is seen that petroleum products, non-metallic mineral products, metal products except machinery & transport are sectors with high forward linkages. This is in conformity with the findings of Bhattachrya and Rajeev (2014). Food products, textiles and paints, varnishes, lacquers and transport equipment are forward linkage sectors which is in conformity with the findings of Ashwani and Vashisht (2012) and Kumar and Das (2015).

High backward linkage sectors account for 37.5% of the total intermediate use, 29% in PFCE, 13% of GFCE with the highest share in capital formation of 89%. Backward oriented sectors have strong presence in trade with textiles having larger pie in total exports of 7.5% and miscellaneous manufacturing item of 8% in imports.

(iii) Priority Sector III - (*Uj* < 1) and (*Ui* >1) : The sectors having high forward linkages include, coal and lignite,

Table 4. Sectors with High Forward Linkage Indices in Indian Economy for 2007-08

			Backward linkage	Forward linkage	% share in total of each indicator							Share (%)^	
S.No	I-O Code	Sector Name	*Uj*	*Ui*	IUSE	PFCE	GFCE	GFCF	CIS	EXP	IMP	TIU	TFU
1	27	Coal and lignite	0.7513	1.9965	1.44	0.02	0.03	0.00	0.10	0.02	1.68	138	-38
2	28	Natural gas	0.6609	2.6228	0.68	0.00	0.09	0.00	0.03	0.03	1.52	215	-115
3	29	Crude petroleum	0.7806	6.4664	6.00	0.00	0.00	0.00	-0.02	0.45	20.52	657	-557
4	31-37	Other Minerals	0.6317	1.6363	0.90	0.00	0.00	0.00	-1.40	4.00	3.91	146	-46
5	114	Storage and warehousing	0.9004	1.2373	0.09	0.00	0.01	0.00	0.00	0.00	0.00	99	1
6	123	Business Services	0.9399	1.1448	1.58	0.17	1.42	0.32	0.00	8.03	7.43	99	1

Source: Author's calculation from input output table 2007-08,CSO. Note: ^ indicate percent share of Total intermediate use(TIU) and Total Final Use (TFU) in total output.

Table 5. Non - Key Sectors of Indian Economy for 2007-08 Having Low Backward and Forward Linkage Indices

			Backward linkage	Forward linkage	% share in total of each indicator							Share (%)^	
S.No	I-O Code	Non Key Sector	*Uj*	*Ui*	IUSE	PFCE	GFCE	GFCF	CIS	EXP	IMP	TIU	TFU
1	1-20	Crops	0.8145	0.7118	8.49	14.58	1.56	0.00	-2.73	2.26	1.13	51	49
2	21-24	Animal Husbandry	0.7910	0.6339	2.06	6.22	0.44	0.12	1.29	0.14	0.04	36	64
3	25	Forestry and logging	0.6217	0.7295	1.08	1.68	0.00	0.00	0.41	0.14	0.42	55	45
4	26	Fishing	0.6302	0.5082	0.19	1.19	0.00	0.00	0.05	0.40	0.02	21	79
5	30	Iron ore	0.6293	0.8813	0.23	0.00	0.00	0.00	0.06	1.24	0.01	50	50
6	45	Tobacco products	0.8867	0.4276	0.05	0.76	0.00	0.00	0.41	0.05	0.00	11	89
7	55	Furniture and fixtures-wooden	0.9764	0.5615	0.19	0.51	0.48	0.52	2.44	0.11	0.02	23	77
8	56	Wood and wood products	0.9446	0.8484	0.47	0.20	0.00	0.03	0.62	0.04	0.08	77	23
9	61-62	Plastic and rubber products	0.5467	0.4230	5.23	3.60	1.54	0.00	12.17	7.33	3.57	56	44
10	108	Water supply	0.9026	0.5808	0.10	0.10	1.69	0.00	0.00	0.00	0.00	31	69
11	109	Railway transport services	0.9260	0.9209	0.83	0.69	0.55	0.29	0.00	0.56	0.00	57	43
12	115	Communication	0.7535	0.8596	1.04	0.79	1.72	0.00	0.00	1.11	0.28	58	42
13	116	Trade	0.6618	0.7860	9.92	10.26	1.47	2.63	0.00	8.09	0.00	55	45
14	118	Banking	0.6190	0.9551	3.64	2.11	1.65	0.00	0.00	0.00	0.00	73	27
15	119	Insurance	0.7032	0.8889	0.83	0.61	0.38	0.00	0.00	0.64	0.34	67	33
16	120	Ownership of dwellings	0.5207	0.3816	0.00	9.17	0.00	0.00	0.00	0.00	0.00	0	100
17	121	Education and research	0.5702	0.4272	0.21	4.36	13.50	0.00	0.00	0.00	0.91	6	94
18	122	Medical and health	0.8876	0.4112	0.11	3.42	3.66	0.00	0.00	0.00	0.01	4	96
19	124-129	Other services	0.7022	0.5613	1.64	3.16	5.83	0.31	0.00	21.15	3.88	23	77
20	130	Public administration	0.4731	0.3816	0	0	46.85	0	0	0	0	0	100

Source: Author's calculation from input output table 2007-08,CSO. Note: ^ indicate percent share of total intermediate use (TIU) and total final use (TFU) in total output.

natural gas, crude petroleum, other minerals, storage and warehousing, and business services as can be seen from Table 4. The number of sectors in priority III category was 10.7% of the total number of sectors in 2007-08. The total contribution of these sectors in total intermediate demand is 11%. The sectoral shares in PFCE, GFCF are less than one percent with sectoral contribution in change in stocks (CIS). Among all the sectors crude petroleum has the highest share in intermediate demand and account significantly in imports. The striking feature about sectors with high forward linkage is that there is substantial sectoral contribution in imports. Business services is the only sector which has strong presence in trade. It is seen that natural gas, crude petroleum are sectors with high forward linkages which is in conformity with the finding of Ashwani and Vashisht (2012) and Das and Kumar (2015).

(iv) Priority Sector IV : Table 5 reveals that the number of sectors in category IV was 35.7% of the total number of sectors in 2007-08. These sectors include crops, animal husbandry, forestry and logging, fishing, iron ore, tobacco products, furniture and fixtures-wooden, wood and wood products, water supply, railway transport services, communication, education and research among others. The striking feature about non key sectors is that although these have low backward and forward linkages, their sectoral contribution to intermediate usage is highest which may be attributed to the presence of twenty sectors out of 56 in this category. In eleven out of seventeen service activities are included in non-key category showing low intermediate demand from other sectors including from itself. The major chunk of output of these sectors is used in domestic consumption with government sector cornering the maximum. This is due to the fact that the government is spending considerable amount on education and research, medical health, and other services. It is seen that iron ore, education and research sectors are non-key sectors of the Indian economy which is in conformity with the findings of Bhattacharya and Rajeev (2014), whereas, tobacco products, wood and wood products, water supply, communication, education and research are the non key sectors. This is in conformity with the findings of Ashwani and Vashisht (2012).

Conclusion and Policy Implications

The study assesses the inter-sectoral linkages and identifies key sectors by using the latest input output table of Indian economy for the year 2007-08 prepared by CSO. The study found that in most primary activities strong linkages are absent which gives indication of weak technological driven process in the sector. Agriculture possesses relatively weak backward and medium forward linkages, whereas agro processing industries induce strong backward linkages. Thus, this implies that modernization of agriculture sector through technology and research development is the need of the hour. The government can exploit full potential of the sector by promoting exports policies in the sector. Majority of the sectors having relatively high backward linkage are concentrated in manufacturing sector which is in conformity with the findings of existing literature (Ashwani & Vashisht, 2012 ; Kumar & Das, 2015). This is due to the fact that the sector buys its inputs from both agriculture and services sector. Thus, provision of basic infrastructural facilities in the sector by the government with the help of public private partnership will lead to overall pulling of growth in the economy.

The examination of inter-industry linkages also reveals that the backward linkages of services are inherently stronger than forward linkage. Thus, the inducement impact of services sectors could be limited. Railway transport, other transport services, hotels and restaurants, medical, and health have created greater backward linkages, while electricity, storage and warehousing, banking, insurance and business services have greater forward linkages. A cheaper and better supply of services will help to reduce production costs of sectors using it as input. As the services sector requires inputs from other sectors, the growth of other sectors is important in order to avoid supply constraints. Also the policy measures should be focused on generating demand in agriculture sector which will boost up manufacturing growth in conformity with the findings of Saikia (2011). The results from the

overall sectoral contribution of the sectors towards the final demand reveals that it has been found that key sectors accounted for only 15% of the intermediate use (IUSE), with high backward linkage sectors account for 37.5% of the total intermediate use. The sectoral shares in PFCE, GFCF are less than one percent with sectoral contribution in CIS for sectors with high forward linkages and finally, the major chunk of output non key sectors is used in domestic consumption with government sector cornering maximum.

Limitations of the Study and Areas of Further Research

The major limitations of the study is that it pertains to the year 2007-08 as the latest input output table 2007-08 was published by CSO in 2012. The next table would be made available in public domain by CSO in 2017. Thus, the results obtained from inter-sectoral analysis performed on single year input output table could be useful in case we have definite policy objectives. The high linked sectors for Indian economy were identified on the basis of high forward and backward linkages in terms of output generation. Thus, future studies could examine external backward and forward linkages in terms of output and employment generation by employing intercountry input output database such as World Input Output Database (Timmer, Dietzenbacher, Los, Stehrar, & de Vries, 2015). The input output analysis could also be extended to environmental input output analysis by using the data on CO_2 emissions or any other pollutant and subsequently examining the carbon emission forward and backward linkages for various economic sectors of the Indian economy.

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