The Changing Structure of Indian Agriculture during the Post-Reform Period: A Study in the IO Framework

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Introduction:

An economy may be divided into a number of sectors according to the type of output produced. Three major sectors namely, primary (agriculture), secondary (manufacturing), and tertiary (transport and services) sectors are distinguished. The structure of an economy may then be defined by shares of these sectors in total output, total employment, total trade ,total inter industry inputs used in the production etc. . Over time the structure of an economy surely changes as the economic activities expand. Obviously economic development is characterized by structural changes. Structural shifts and changing shares of different sectors in macro aggregates like total output and inter-industry input uses go hand in hand. From the development experiences of the developed economies it has been observed that there is a definite relationship between economic development and structural changes of an economy (Kuznet). As the economy is on the development path, the structure of the economy shifts away from agriculture to industry and then from industry to services.

The process of agricultural production gets transformed with the spread of mechanization and modernization: agriculture becomes more modernized as traditional inputs are substituted by modern inputs like fertilizers, pesticides and bio-technologically engineered seeds and becomes more mechanized as agricultural implements like tractor, harvester, and pumps for irrigation are used in place of ploughs driven by bullocks, hand-lifted water for irrigation. As a consequence, the crop pattern as well as the cropping intensity in agriculture undergoes substantial changes.

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Agricultural productivity and production both rise. Side by side transformation of agriculture brings about changes in its demand for manufacturing outputs as inputs like fertilizer, pesticides, petroleum products, machineries and implements. The input supplying industries in turn get stimulated to produce more to meet the increasing demand for their products.

***Purpose of the study*:**

Indian economy has also undergone structural changes during the plan period (since 1950) and the economy has now put itself on the high growth path. Structural changes of the economy are manifest in the spheres of agriculture, industries and services (Pal 1988). Earlier studies include Hazari (1970) and Pal (1981, 1988) for the over all economy, Mukhopadhaya and Chakraborty (1999) for the energy sector and Bhowmik, (2004) for the service sector. But no such study has yet been performed for India's agriculture sector during the period of ongoing reforms. The present study attempts to examine in the IO framework the changing relative importance of agriculture in terms of input use and output distribution patterns. More specifically, the changing significance (importance) of agriculture during the period of ongoing reform is evaluated in terms of macro indices like linkage dispersion indices, relative linkage indices, and index of significance.

To analyze the changing input structure of India's agriculture we have considered 3×3and 11×11aggregated IO tables of India for two time points, 1993-1994 and 2006-2007. The time points fall in the period of ongoing reforms. In the 3×3 table sectors are agriculture, industry and services. The11×11 table contains 11 sectors. Out of eleven sectors considered in the analysis, sector 1 is agriculture (aggregated) .The remaining 8 sectors are: 2. agro-industry 1(food and beverages), 3.agro-industry II, 4.modern inputs like fertilizer ,5.pesticides, 6.agricultural implements, 7.petroleum and chemicals , 8.electricity , 9. all other manufacturing ,10. transport and 11.services.The IO tables are in current prices and aggregated from the detailed tables

prepared by Central Statistical Organisation, India. Estimates of the output –distribution structures based on the distribution co-efficient matrix remain invariant with price deflation, but those of the input structures based on input –co-efficient matrix expectedly vary with price deflation. The latter estimates are hence to be taken with such limitations.

Our sector classification and aggregation is purposive. Since our interest lies in examining the changing interrelationship of agriculture with industry and services, the industry sector is purposefully divided into 8 sub-sectors and the service sector is divided into transport and service sub-sectors. The changing dependence of agriculture on industrial outputs and inputs as well as the changing importance of agriculture to different sectors as input supplier will be evaluated using the IO Tables.

First Section (section 1) presents the mathematical digression of the IO model. Section 2 provides the estimation and analysis. Section 3 contains concluding remarks.

Section 1: Methodology: IO Analysis

Section 1.1: Description of the IO model.

The IO model describes the inter-dependence among the different producing industries of the economy. Thus it becomes a tool to measure the structural interdependence of an economy and to determine the extent and degree of inter-linkages among industries.

There are two approaches to the I-O models. The Input-Use approach is due to Leontief (1941) and the Output-distribution approach is due to Ghosh (1958) which was subsequently modified by Pal (1981 ,1988).

1.2 Input – Use Approach

Define $a_{ij} = X_{ij} / x_j$: amount of output x_i used by industry j to produce output x_j; it is taken as fixed.

We write the balance equation for output i :

$x_i = a_{i1}\, x_1 + a_{i2}\, x_2 + \ldots.. + a_{ii}\, x_i + \ldots + a_{in}\, x_n + C_i + E_i - M_i$ … (1)

i = 1, 2, …., n

In matrix notation

$x = Ax + D$ … (1a)

where $x = (x_j)$ an n-column vector of gross output.

$A = (a_{ij})$: an nxn input coefficient matrix.

$= X(x)^{-1}$; x = diag $(x_1, \ldots, x_n)$,.

$X = (X_{ij})$: nxn transaction matrix

$D = (C_j + E_j + IV - M_j)$: an n column vector of final demand net of competitive imports (M_j),

E_j: foreign demand (export), C_j: domestic demand, IV : inventory

Equation (1a) can be solved for the vector of gross output:

$x = (I - A)^{-1} D.$ … (2),

$(I - A)^{-1} = B^{-1}$, which is called the Leontief inverse.

1.3 Output Distribution Approach

This was first developed by Prof. A Ghosh (1958) which has been subsequently extended by researchers like Pal (1981, 1988, and 2005), Dizenbacher (1997), Osterhaven (1998) and others. The following model is due to Pal (1981,1988)

Define $\hat{a}_{ij} = X_{ij} / z_i$ where $z_i = x_i + M_i + Inv$, $Inv < 0$ . . . (3)

We can write total output expenditure balance equations as

$$x_j = \sum_{i=1}^{n} X_{ij} + v_j \qquad \ldots (4)$$

$j = 1, \ldots, n.$,

where v_j is the value added of sector j.

Substituting (3) in (4) we can write the balance equations as

$$x_j = \sum_{i=1}^{n} \hat{a}_{ij} z_i + v_j \quad \text{j = 1, 2, …., n.}$$

In vector – matrix form

$$x = \hat{A}'z + V$$

where $\hat{A}$ is nxn output distribution coefficient matrix and

V is n-column vector of value added.

Thus $x = (I - \hat{A}')^{-1}(\hat{A}'M + V)$ … (5)

Here, $\hat{B}^{-1} = (I - \hat{A}')^{-1}$ … (6)

which is called the output inverse matrix and which always exists. Ghosh (1958) has defined

$\hat{a}_{ij} = \frac{X_{ij}}{x_i}$ so that $\hat{A} = (\hat{a}_{ij})$ and $\hat{B}^{-1} = (I - \hat{A}')^{-1}$ which may not exist, and even if exists, may not be positive so long as imports are competitive and inventory is negative (Pal 1988,2005)

1.4 Linkage Indices: Measurement of interrelatedness

The matrices of the inter-industry coefficients embody structural interdependence of the system. The measures- input and distribution linkages- have been extensively used for the analysis of both types of interdependent relationships between/among economic sectors(Rasmussen 1956; Hirschman 1958; McGilvray 1977; Jones 1976;Pal 1981,1988; Dietzenbacher 1997etc).

1.4a. Direct Linkage Structure:

A and $\hat{A}$ are direct coefficient matrices. These display, by their elements, the direct sector-wide linkages. The columns of A give the structures of direct input linkages. The rows of matrix $\hat{A}$ display the structures of direct distribution linkages. We discuss the **simple indices** below.

Total input and distribution linkages are exhibited by the columns and rows of B and $\hat{B}$ respectively.

Direct Economy Wide Input Linkage (DEIL) for sector j is

$$u_j = \frac{\sum_{i=1}^{n} X_{ij}}{x_j} \qquad \ldots (7)$$

Similarly, the Direct Economy Wide Distribution Linkage (DEDL) for sector i

$$w_i = \frac{\sum_{j=1}^{n} X_{ij}}{z_i} \qquad \ldots (8)$$

u_j*'s* and w_i*'s* are the column sums and the row sums of A and $\hat{A}$ respectively. u_j is the total inter industry inputs required by sector j for one unit of its production. $0 \leq u_j \leq 1$. w_i is the total inter industry deliveries by sector i per unit of its total supply.

$0 \leq w_i \leq 1$.

u_j*'s* and w_i*'s* are not pure numbers but expressed in terms of the units of measurement of their basic variables. To make the indices comparable across sectors and over time, u_j*'s* and w_i*'s* are standardised with respect to their respective over-all values i.e. u_{od} and $w_{od..}$

$$u_j^* = \frac{u_j}{u_{od}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

$$w_i^* = \frac{w_i}{w_{od}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

$u_j^* > 1$ indicates the above average input dependence of sector j and $w_i^* > 1$ implies the above average importance of sector i .

One may be interested in knowing the characteristics of the linkage structures. For this purpose, consider the average linkage.

Input $\bar{u}_j = n^{-1} u_j$ … (11)

Distribution $\bar{w}_i = n^{-1} w_i$ … (12)

The indices are based on the assumption that linkages are evenly distributed over many sectors. Dominance of the linkages by one or many sectors can be taken into account by using the dispersion index (i.e., coefficient of variation)

Input $\sigma_{u_j}^* = [(n-1)^{-1} \sum_{i=1}^{n} (a_{ij} - \bar{u}_j)^2]^{\frac{1}{2}} / \bar{u}_j$, j = 1……n … (13)

Distribution $\sigma_{w_i}^* = [(n-1)^{-1} \sum_{j=1}^{n} (\hat{a}_{ij} - \bar{w}_i)^2]^{\frac{1}{2}} / \bar{w}_i$, i = 1……n … (14)

$$0 \leq \sigma_{ui}^* , \sigma_{wi}^* \leq \sqrt{n}$$

The dispersion indices would exhibit the nature of scatteredness of the links: whether the linkage is predominantly due to one or two sectors or is evenly dispersed among the sectors (Pal 1988).

The upper boundaries of above indices are influenced by n (the number of sectors) : higher the number of sectors, higher is the value of upper boundary and this makes these dispersion indices incomparable for different levels of aggregation. These indices need to be normalized .

The dispersion indices are normalized by √n .

Input: $\sigma_{uj}^{**} = \frac{\sigma_{uj}^{*}}{\sqrt{n}}$ ..(15)

Output $\sigma_{wi}^{**} = \frac{\sigma_{wi}^{*}}{\sqrt{n}}$ …….(16)

Obviously $0 \leq \sigma_{ui}^{**}, \sigma_{wi}^{**} \leq 1$.

1.4b Total Linkage Structures

The matrices B and $\hat{B}$ are used to obtain measures of total linkage .

The (i, j) element of B, b_{ij} indicates the amount of total (direct plus indirect) change in the output of sector i required to support one unit change in final demand for the output of sector j.

The (i, j) element of $\hat{B}$ represents the amount of total (direct plus indirect) change in the output of sector j brought about by one unit change in the value – added in sector i.

Therefore, column sums of B represent the measure of total economy wide input linkage (TEIL) for individual sectors. The row sums of $\hat{B}$ are used to measure total economic wide distribution linkage (TEDL).

The TEIL and TEDL for sector j and i are

$$U_j = \sum_{i=1}^{n} b_{ij} \qquad \forall j = 1,.....n \qquad \ldots (17)$$

$$W_i = \sum_{j=1}^{n} \hat{b}_{ij} \qquad \forall i = 1,.....,n \qquad \ldots (18)$$

The dispersion indices (i.e., coefficient of variation) for the total linkage structures are

$$\sigma^*_{U_j} = [(n-1)^{-1} \sum_{i=1}^{n} (b_{ij} - \bar{U}_j)^2]^{\frac{1}{2}} / \bar{U}_j \qquad \forall j = 1,...,n \qquad \ldots (19)$$

$$\sigma^*_{w_i} = [(n-1)^{-1} \sum_{j=1}^{n} (\hat{b}_{ij} - \bar{W}_i)^2]^{\frac{1}{2}} / \bar{W}_i \qquad \forall i = 1,...,n \qquad \ldots (20)$$

σ^{**}_{Uj} and σ^{**}_{Wi} are analogously defined as in (15) and (16).

*1.5 **Relative Linkage indices**: Measurement of intra-sector vis-à-vis inter –sector relatedness*

In the IO structure, one particular sector may be conceived of consisting of several sub-sectors . A sector is related with other sectors / industries of the economy for supplying and receiving of intermediate inputs. We have already said that distribution (input) linkages provide information about the sector's importance (dependence) to (on) the system relative to other sectors of the economy. But these linkages fail to capture the sector's link with itself including its sub-sectors (intra-sector) in relation to its link with the system as a whole (inter- sector). This is captured by the concept of **Relative Linkage Index** (developed by **Pal** 1981) defined as the total intra-sector transaction of the sector including its sub-sector in relation to its inter-sector transactions. This index is particularly useful in sector planning because a sector may have strong intra- sector linkage (input as well as output) but very weak sector-wide and economy –wide linkages.

In an n×n input –output system where x_j = gross output vector and total supply vector $z_i = x_i + M_i + Inv$

Supposing sector K is formed by n_K sectors (sub) of the system represented in the IO table, where sub-sectors are denoted by ***i***=1,2,…….., n_K. Then the direct Relative input index (RL) for sub-sector 'i' within the sector 'K' is defined as follows:

$$\text{RL (input)}\ r_i = \frac{\sum_{j\in K}^{nk} Xij/xi}{\sum_{j=1}^{n} Xij/xi} = \frac{pi}{ui} \quad \text{..... .(21)}$$

And direct Relative output distribution index

$$\text{RL (distribution)}\ s_i = \frac{\sum_{j\in K}^{nk} Xij/zi}{\sum_{j=1}^{n} Xij/zi} = \frac{qi}{wi} \quad \text{..... (22)}$$

$0 \le r_i, s_i \le 1 \Rightarrow$ $r_{i,}$, s_i =0 ,if the sector is completely dependent on the system that sector does not purchase (sell) intermediate inputs from(to) its parent sector including itself and $r_{i,}$,s_i =1 if the sector is completely independent of the system i.e. it receives (supplies) intermediate inputs solely from (to) its parent sector.

The declining tendencies of the indices indicate the increasing interrelatedness of a particular sector with other sectors or the economy as a whole.

1.6 Index of Significance: Method of Withdrawal

In the Previous sections linkages indices (absolute and relative) are discussed in the context of measuring sectoral inter-relatedness(examining the nature of input and distribution patterns of the sectors). Linkage indices do not meaningfully reveal the nature and the degree of significance of a sector in the economy. How is the system affected if a particular sector does not supply and/

or purchase inter-industry inputs? How is the sector important in the system? **The index of significance** is developed in this context to account for these issues.

We are interested in analyzing the changing relative importance (significance) of agriculture in the context of different sectors in the economy. For this we need a macro index which is formulated using the principle of withdrawal. The importance of a sector is best judged in terms of its absence from the system. In the system there are many sectors interrelated to each other. If suddenly one sector is withdrawn from the system or added to the system, the system becomes in some way or other affected and this can be evaluated in terms of some chosen economic variables like output, input use or value added.

We now discuss algebraically the Method of Withdrawal which was primarily due to Strassert (1968) and Cella (1984). The method is commonly known as Method of Extraction.

The basic idea of the Hypothetical Extraction Method (HEM) is to elicit the role of a particular sector or a cluster of sectors by eliminating it or its cluster from the system. To estimate the importance of a sector i to the economy the i^{th} row and the i^{th} column are suppressed from the input –co-efficient matrix **A** and then output is calculated using the equation (2). The difference between the total output of the economy before and after withdrawal $(\sum x_i - \sum x_{Ei})$[1] measures the importance of sector i to the economy. The size of the gap is indicative of the degree of importance of the extracted sector. If the gap is positive (negative) and substantially large in magnitude, the importance of the sector to the economy is considerably high (low).

HEM, however, underestimates the level of total linkage and the role of input and distribution linkages is not identified.

1: Alternatively it is defined as $(\sum x_i - \sum x_{Ei}) / (\sum x)$ which is unit free and ranges from 0 to 1.

Cella (1984) has proposed a modified version of Extraction Method. He has estimated total linkage and then decomposed it into input and distribution linkages. He has considered the actual pattern of output and compared with a hypothetical situation, where other things being equal, sector j does not sell or buy any intermediate input from/to all other sectors in the system. The difference in total output before and after extraction indicates the total linkage effect of industry j.

The *method of Cella's hypothetical withdrawal* may be viewed from 3 different angles on the basis of mode of withdrawal.

Case I. **Complete withdrawal** of sector 1,say, in the sense that it does neither supply to nor receive anything from the system.

Case II. **Partial withdrawal** of sector 1 from the distribution side by suppressing its role as supplier of intermediate inputs to other sectors.

Case III. **Partial withdrawal** of sector 1 from the input side: Sector 1 does not buy any intermediate inputs from the system.

Output gaps are measured in each case and the relative importance of the sector is then judged as before. Particularly, whether the sector is relatively more important as input supplier or input purchaser is evaluated by this method.

In our analysis there are two co-efficient matrices: A which corresponds to input use and $\hat{A}$ which corresponds to output distribution. Correspondingly, we have B and $\hat{B}$. These matrices are used in the computation of the relative importance of the sector.

For the case of **n** industries:

$$A=\begin{bmatrix} a_{11} & a_{12} & ... & a_{1n} \\ . & . & & . \\ . & . & & . \\ a_{n1} & a_{n2} & ... & a_{nn} \end{bmatrix} \qquad \text{…….(23)}$$

and $$\hat{A}=\begin{bmatrix} \hat{a_{11}} & \hat{a}_{12} & ... & \hat{a_{1n}} \\ . & .. & & . \\ . & .. & & . \\ \hat{a_{n1}} & \hat{a_{n2}} & ... & \hat{a_{nn}} \end{bmatrix} \qquad \text{……(24)}$$

$$x = (I - A)^{-1} D \qquad \text{……..(25)}$$

$$= B.D$$

$$\begin{bmatrix} x_1 \\ x_2 \\ . \\ . \\ x_n \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} & . & . & b_{1n} \\ . & . & & & . \\ . & . & & & . \\ . & . & & & . \\ b_{n1} & b_{n2} & . & . & b_{nn} \end{bmatrix} \begin{bmatrix} d_1 \\ d_2 \\ . \\ . \\ d_n \end{bmatrix} \text{……..(26)}$$

Therefore $x_1=b_{11}.d_1+b_{12}d_2+ \cdots\cdots\cdots\cdots+b_{1n}\, d_n$

: : : :

$\boldsymbol{x}_n=b_{n1}d_1+b_{n2}d_2+\cdots\cdots\cdots\cdots+b_{nn}d_n$

Consider final demand at unit level for each sector

Then $x_1=b_{11}+b_{12}+ \cdots\cdots\cdots\cdots+b_{1n}$

: : : :

$x_n=b_{n1}+b_{n2}+\cdots\cdots\cdots\cdots+b_{nn}$

and $\sum x_i=\sum\sum b_{ij}$…….....(27)

= sum of all b's,which gives the total output in the economy when final demand is 1 unit for each sector's output and sectors are fully interrelated to each other both ways.

Case I. Complete withdrawal of sector 1 from the system: Sector 1 is completely withdrawn from the system in the sense that it does not receive or sell any intermediate inputs from/to other sectors in the economy.

$$\text{Then} \quad \tilde{A} = \begin{bmatrix} a_{11} & 0 & \dots & 0 \\ 0 & a_{22} & \dots & a_{2n} \\ . & . & & . \\ 0 & a_{n2} & \dots & a_{nn} \end{bmatrix} \qquad \dots\dots\dots\dots\dots\dots(28)$$

$$(I - \tilde{A})^{-1} = \begin{bmatrix} \tilde{b}_{11} & 0 & \dots & 0 \\ 0 & \tilde{b}_{22} & \dots & \tilde{b}_{2n} \\ . & . & & . \\ 0 & \tilde{b}_{n2} & \dots & \tilde{b}_{nn} \end{bmatrix} \qquad \dots\dots\dots\dots(29)$$

$$\therefore \quad \tilde{x} = (I - \tilde{A})^{-1} D$$

$$= \tilde{B} \cdot D \qquad . \quad \dots\dots\dots\dots\dots \quad (30)$$

Thus $\tilde{x}_1 = \tilde{b}_{11} . d_1 < x_1$

$$\tilde{x}_2 = \tilde{b}_{22} . d_2 + \tilde{b}_{23} . d_3 + \dots\dots\dots\dots\dots + \tilde{b}_{2n} d_n . \qquad < x_2$$

$$\tilde{x}_n = = \tilde{b}_{n2} . b_{n2} . d_2 + \tilde{b}_{n3} . d_3 + \dots\dots\dots\dots\dots + \tilde{b}_{nn} d_n . \quad < x_n .$$

$$\therefore \quad \therefore \sum_{i=1}^{n} \tilde{x}_i = \sum_i \sum_j \tilde{b}_{ij} \quad \text{which is} \qquad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(31)$$

total output in the economy in the case of complete absence of agriculture's inter industry linkage (agriculture is self-contained).

Clearly $\therefore \sum_{i=1}^{n} \tilde{x}_i < \sum x_i$

The difference between the actual output and the output in this hypothetical case i.e. $x_i - \tilde{x}_i$ indicates the significance of sector 1 in the respect of the economy's total output and sectoral

outputs when the agricultural sector as both input supplier and receiver of intermediate input is suppressed.

Case II. Partial withdrawal of sector 1 from the distribution side: Sector 1 has no role to play as input supplier to other sectors though it has input linkage with other domestic sectors in the economy. This situation may occur if the entire output is used for final consumption.

Here $$A'' = \begin{bmatrix} a_{11} & 0 & . & 0 \\ a_{21} & . & . & a_{2n} \\ . & . & . & . \\ a_{n1} & . & . & a_{nn} \end{bmatrix} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (32)$$

$$\therefore \quad x'' = (I - A'')^{-1} D$$

$$= B''.D \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (33)$$

Hence, $$\sum_{i=1}^{n} x_i'' = \sum_i \sum_j b_{ij}'' \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (34)$$

$\sum x_i''$ is the total output of the economy in the absence of agriculture as input supplier when demand is 1 unit for each sector (d_i=1) . Therefore ($\sum x_i$ - $\sum x_i''$) is the difference between total output before and after withdrawal of agricultural inputs. This difference will reveal the impact of agricultural inputs on total output as well as on specific sector to be particular.

Case III. Partial withdrawal of sector 1 as the inter-industry input purchaser: this kind of hypothetical withdrawal implies that agriculture has no input dependence on other sectors of the economy; it is wholly dependent upon primary inputs (excepting its own output as input).

Hence , input coefficient matrix becomes

$$A''' = \begin{bmatrix} a_{11} & a_{12} & . & a_{1n} \\ 0 & . & . & a_{2n} \\ . & . & . & . \\ 0 & . & . & a_{nn} \end{bmatrix} \text{.....(.35)}$$

$$\therefore x''' = (\mathrm{I} - A''')^{-1}.\mathrm{D}$$

$$= B'''.\mathrm{D} \qquad \text{.....(36)}$$

Total output : $\sum_{i=1}^{n} x_i''' = \sum_i \sum_j b_{ij}'''$ ..... (37)

Thus the difference in total outputs of the economy with both input and distribution linkages and without either input or distribution linkages indicates the extent of relative importance does agriculture will have as intermediate input user and /or intermediate input supplier .

The above exercise is operationally useful in explaining which linkage (input or distribution) of sector 1 is relatively more powerful in terms of impact it exerts on total output produced in the economy at the micro and macro level.

So far we have discussed the method of evaluating particular sector's importance to the economy by way of withdrawing that sector from the system. Similar exercises can be performed to examine the impact on a sector (say sector 1) if one specific sector is withdrawn with no linkages at all.

Agriculture is supposed to be modernized as the economy develops in the sense of increasingly using commercial **fertilizer**, **pesticides, agricultural implements, petroleum products and energy**. We are particularly interested in examining whether agriculture is actually increasingly mechanized. To examine this aspect we have used this method of withdrawal with respect to different sectors mentioned above.

To investigate the impact a sector (say sector 4) on sector1, we have withdrawn sector 4 from the system by replacing the 4^{th} row and 4^{th} column by zeroes in the off diagonal positions. This has been done to examine the impact on sector 1 or on overall economy if sector 4 has neither distribution nor input linkages at all.

Therefore $x_i - x_{i(4)}$ would show what would be the change in output of i if sector i was not to buy inputs from sector 4 directly or indirectly and not to sell inputs to this sector as well.

Section 2: Estimates and Analysis

During 1993-94 to 2006-2007, there has been a structural shift away from agriculture in favor of industry and then in favor of service sector .Shift from agriculture to industry has been the most common pattern of structural change that all the developed countries have experienced. Structural shift has been associated with economic development. The structural changes are measured in terms of a set of macro variables like gross output, total inter-industry input purchase and gross value added. The role of these macro variables in the structural transformation, however, differs, we have already said, from economy to economy and from time to time. It may so happen that depending on some socio-economic conditions and govt policy measures role of some variables are emphasized more than others. It is the point of interest to identify the sector which plays the pivotal role in the structural transformation of India's economy.

Section 2.1: Relative Shares: 3×3 Aggregative Analysis

A. Gross Output:

During 1993-94, the share of agriculture sector in total output was 21.51%. The share has declined to 12.7% during 2006-2007. Manufacturing sector's contribution to total output has substantially increased to 51.3% in 2006-2007 from 43.17%in 1993-94.The contribution of

service sector has also increased marginally from 35.32% to 36.17% during 1993-94 to 2006-2007.

Sectoral share of agriculture in total output declined annually at the rate of 3.97%. On the other hand, shares of manufacturing sector and service sector grew annually at an average rate of 1.31% and 0.18% respectively (Table 1).

It thus follows that manufacturing is still the dominant sector in terms of the sectoral share in total output followed by service and agriculture. Rising sectoral share of manufacturing in total output suggests that India is still in the middle range of economic development.

B. Inter –Industry input purchase share:

In the Input-Output framework inter-industry input use indicates the amount of output a particular sector purchases as intermediate inputs from other sector in the economy to produce its own output (at unit level of operation , it indicates amount of input is required). It actually signifies the dependence of a particular sector on other sectors of the economy for inputs.

The sum total of inter–industry input purchases by all sectors gives the total inter-industry purchases of the economy. In national income accounting such sum has, in fact, no entity because of the fact that it becomes embodied in the gross output. But in the IO analysis it has special significance in the sense that the degree of interrelatedness of the sectors is revealed by it. Sectorally , the share of a particular sector in total inter industry input purchases of the economy reflects the relative dependence(or importance) of the sector on(to)the economy.

The inter-industry purchase share of the agricultural sector was 11.40%in 1993-94 and 6.97%in 2006-2007. The share has declined annually on an average rate of 3.71%.Industrial sector's share in total inter industry input purchase has increased significantly from 64.37%to 72.22% during 1993-94 to 2006-2007, the annual rate of growth being 0.89 on an average. But service sector's share in total inter-industry input purchase has declined from 24.23% to 20.8%during 1993-2006, registering a negative annual growth of 1.17%.

Thus it can be concluded that shares of agriculture and service sector in total inter-industry input purchase have declined over time, the fall in agriculture sector's share being the highest.

C. Gross Value Added:

In the I-O framework gross value added (GVA) is the difference between the total output produced and the inter-industry input uses in the I-O framework. GVA shows the amount of value added to the system by a particular sector(In the neo-classical sense total output is equal to the total payment to factors of production in the gross sense) .Gross value added is necessarily the contribution of primary inputs like labour and land to gross output.

Analysis of sectoral share in total gross value added in the economy shows that share of agriculture (in total GVA) has declined from 30.38%to 18.93% with an annual retrogression rate of 3.57%.during the period. The sectoral shares of industry and services in total gross value added have however increased from 24.58% to 28.22% and from 45.05% to 52.85% respectively during the period.

In terms of GVA it is observed that service sector's share in total GVA has been at the top for both the years considered. And value added to the system was least by the agriculture sector.

Thus in terms of sectoral shares in total output, total inter industry input purchases and total GVA there is a definite shift away from agriculture in favor of industry, though not always in favor of services.

D. Intra-Sector analysis:

So far we have performed the inter-sector analysis in terms of selected macro variables in the context of the overall economy. Let us now turn to the intra-sector analysis. It becomes important for better understanding of the changing structures of different sectors in the economy (Table 2).

Percentage distributions of sectoral gross output by inter -industry input purchase and GVA show that out of each Rs100 output produced, agriculture spent Rs 24.77 on inter industry

input purchase in 1993-94 which has increased to 28.58rupees in 2006-2007. It implies that inter –industry input purchase by the agriculture sector has increased and as a result the value added by this sector has declined. Industrial sector's inter –industry input purchase as a percentage of its total output increased from 69.68% to 73.55%. It is not surprising that industrial sector's input purchase from other sectors in the system is quite high as compared to other two sectors , because the nature of industrial output is such that its inter industry input use has to be high. On the other hand, service sector's inter -industry input as a percentage of its total output declined and gross value added increased.

So for agriculture and manufacturing sectors total inter –industry input purchase as a percentage of total output increased and GVA declined. For the economy as a whole total inter-industry input purchase increased and gross value added declined as percentage of the total output produced in the economy.

E. Direct and Total Linkages:

Manufacturing sector has displayed the highest input linkage in both the time points with an increase in input dependence on the rest of the economy as uj=0.821in 2006-2007 and uj=0.654 in 1993-1994 for this sector. Manufacturing has the highest degree of dependence on the system. Agriculture showed the least dependence on the system for inputs during the same period and also its input dependence has declined over the time period as u_j has declined from 0.281 to .204. Sectoral ranking of total linkages has coincided with that of direct input linkage (Table 3, and Table 4)

Highest value of w_i (distribution linkage) has gone to the service sector in both the years implying that service sector has the highest importance to the system from distributional aspect as it has sold as intermediate product above 48% of its total supply. But total distribution linkage of the manufacturing sector is the highest W_i (1.905) in 1993-94 but in 2006-2007 it declined (Table 5 and Table 6).This indicates the existence of considerable indirect linkages among the

sectors. Direct distribution linkage of agriculture was the lowest in both time points. Agriculture had occupied the lowest position with respect to direct and total distribution linkage. It implies that agriculture is least important to the economy so far as the supply of raw materials to other sectors is concerned. Most of the agricultural output is used as final good.

Dispersion indices show that in 1993-94 agriculture had the lowest input linkage dispersion index (0.280) as well as the lowest distribution dispersion index (0.342), while the manufacturing sector had the highest input and distribution linkage dispersion index implying its most skewed patterns of distribution and input linkages.

In 2006-07 manufacturing sector also showed the least skewness in the structure of inputs while **agriculture** had the highest skewness in input linkage in 2006-2007. But the scenario is reversed for skewness of distribution linkages as agriculture had the lowest and manufacturing sector had the highest dispersion index.

Section 2.2: 11×11 Disaggregate Analysis

So far we have presented a highly aggregated structural analysis in terms of 3×3 aggregative structure. Now we move to a disaggregated structure: where industry has been disaggregated into agro industries(sector 2 and 3), modern agricultural inputs producing sectors(sector 4-fertilizer , sector 5: pesticides, sector 6:agri implements), petroleum and chemical products(sector 7), energy (sector 8), other manufacturing (sector 9) Service sector has been disaggregated into transports(sector 10) and all other services(sector 11).This kind of disaggregated analysis is needed for better understanding of the changing structure interconnectedness of the agriculture sector with other sectors which are supposed to be important for modernized and mechanized agriculture .

A: ***Relative Shares***

Sectoral contribution of agriculture sector in total output has declined annually at an average rate of 3.97%during the period 1993-2006. Agriculture was ranked among the top three sectors after manufacturing and services in terms of sectoral share in total output. Manufacturing and service sectors were able to increase their sectoral shares during the period. There was substantial growth of the share of the petroleum sector in total output and also the highest (Table 7).

Manufacturing (sector 9) has turned out to be the most important sector in terms of **percentage share in total intermediate input uses** and its share has increased annually at the rate of 1.84%. The rank of the agricultural sector has slipped down from third to sixth position during the period as the negative growth of sectoral share in inter industry input purchase has been registered for Agriculture. Petroleum (sector 7) has improved its position as inter-industry input purchaser and the growth of its percentage share grew at the highest rate of 1.93%.

For **sectoral share in gross value added in the economy**, the picture is almost the same except the fact that the share of service sector has been the highest in both 1993-1994 and 2006-2007. To be specific, Agriculture sector's share in total gross value added has declined (-3.57%)

B: Intra-sector Analysis:

Agriculture sector used to purchase Rs. 24.77 worth of intermediate input out of Rs 100 worth of output from other sectors which has reportedly increased to Rs28.58 and so it may be said that inter- industry relatedness of agriculture is showing a rising trend (Table2.). We have already said that GVA is nothing but the contribution of input supplied by outside agents like labor and capital to total output of a sector. Agricultural production in India is still labor intensive and this fact is established by its substantially high share of GVA in total output (almost above 70%) though the share has declined over the period (Table 8).

C: Direct and Total Linkage Indices:

Fertilizer (sector 4) has come out to be the most important sector to the economy judged by its highest direct distribution linkage (Tables 9 and 10).Its direct input dependence on the economy has been the highest and consequently the sector has turned out to be the most dependent on the economy . Total output distribution linkage has a different story altogether though not surprising. Electricity has the highest importance to the system as a supplier of input during the period as its total distribution linkage is the highest (Tables 11and 12)

Agriculture and service sector being the most primary input oriented activities have low input and distribution linkages. These two sectors are relatively less dependent on the system. Except the service sector, direct input linkage of all the sectors including agriculture have increased during the period.

For Agricultural implements direct distribution linkage has declined though its total output distribution linkage increased in line with other sectors.

Section 2.3 Relative Linkages of Agricultural Sector: Disaggregated Analysis

The agricultural sector is now subdivided into 16 sub-sectors depending upon the number of different crops produced by this sector. These sub-sectors are: paddy, wheat, jowar, bajra maize, gram, pulses, sugarcane, groundnut, jute, cotton, tea, coffee, rubber, tobacco and other crops (includes oilseeds, fruits, vegetables and all other crops).

By definition the relative input linkage (RL_{input}) of the agricultural sector as a whole is the quotient of the total intra-sector input of the agriculture sector divided by its total inter sector inputs. Similarly, the output distribution linkage is defined. Estimates show that RL_{input} has increased during 1993-2006 for the agriculture sector as a whole implying increased input dependence on its parent sector rather than on the system. But $RL_{input}(r_i)$ for its sub-sectors moved differently(Table 13).

Among the set of 16 crops, paddy, cotton, wheat, pulses groundnut, tobacco have exhibited rising **RL(input).** This is indicative of the fact that these crops have become relatively more confined to the agriculture sector itself and also less modernized. All the remaining crops have shown declining **RL(input**) which displays growing interconnectedness with other sectors other than its parent sector for inputs .

For rubber and jute, RL(input) =0 which implies no input dependence on its parent sector or in other words, these two crops are fully dependent on other sectors for intermediate inputs.

Relative distribution index for agriculture sector as a whole has increased during the period implying its feeble distribution linkage with other sectors of the economy excluding its parent sector. Paddy, jowar, maize, sugarcane, jute,and other crops are having increasing distribution linkage with other sectors of the economy as RLs (distri) for these crops have decreased during the period. Rubber deserves special mention as it has consistently maintained its perfect distribution linkage with other sectors of the economy (RL (distri)=0). Rubber and jute supply their entire outputs to other sectors of the economy and from the distribution aspect their role becomes important for agriculture as well as for the economy. Crops such as wheat, bajra, gram, cotton, etc have shown increasing RLs(distri) indicating their weak distribution linkage .

Rubber and jute have strong input as well as distribution linkage with the rest of the economy to their credit and hence proved to be important sectors for the economy.

Section 2.4: Index of Significance of Indian Agriculture

We have already discussed this method of withdrawal in section 1.6. Now in this section, we shall try to ascertain the importance of Indian agriculture as input supplier to other sectors of the economy, as input purchaser from the economy, and both as input supplier and input purchaser.

Estimate shows that overall interrelatedness of the economy in terms of gross output (when one unit final demand for each sector is assured) during the period 1993-2006 has risen from 25.05 to 27.50 units when all the sectors are actually interrelated in both ways (Table 14)

Sectoral analysis reveals that due to change in the sectoral linkages during the period, sectoral outputs (at unit level of demand for each sector) have responded differently: sectors like manufacturing (sector 9), petroleum (sector 7), services (sector 11) and agro processing industries (sector 2) have increased outputs while other sectors have decreased outputs. Furthermore, maximum positive response (rise) is noted for manufacturing sector and maximum negative response (decline) has been noted for electricity, gas etc (sector 8) and agriculture (sector1).

Estimates shows that, had the agriculture sector not been allowed to interact with other sectors in both ways (input and distribution), gross output in the economy would have been 25.85 units in 2006-2007. This indicates a decline in overall interrelatedness by (27.50-25.85)=1.85 unit. This decline would have been 1.84units in 1993-94.

The gross outputs of each sector would have declined in case of complete absence of inter sector linkages of agriculture. The decline in output of agriculture would have been the highest (.95 in 2006-2007 and 1.17 in 1993-94) in complete absence of supply and demand stimuli of the agriculture sector.

We now partially withdraw agriculture by completely ignoring its role as supplier of intermediate inputs and the result shows a reduction in overall gross output by 1.35units in 2006-2007 and by 1.54 units in 1993-1994, at unit level of demands. The above result also implies the declining importance of agriculture to the overall economy as a supplier of intermediate inputs measured in terms of reduction in gross output of the economy. Agricultural output also gets reduced in absence of demand stimulus as agriculture does not sell its output to the system. All the sectors have responded to the absence of agricultural inputs to some extent except agro

industry I (sector 2) and agro industry II (sector 3) because of the fact that these sectors have no or very negligible input linkage with agriculture.

Economy as a whole has also responded to the partial withdrawal of agriculture in terms of its input linkage: overall gross output decreases in both the periods. Sectoral outputs would have declined as well in absence of demand stimulus from the agricultural sector. **Maximum decline in gross output has been noticed for the manufacturing sector and the amount of decline has been increasing over time implying increasing interrelatedness of manufacturing with agriculture.** Same conclusion can be drawn for sector 7 i,e. petroleum as well.

One important finding is that agricultural output is not affected much in absence of its input links with other sectors implying that agriculture is still relatively self- contained and not mechanized to the extent desired. Also agriculture's input dependence on the system has declined over-time.

Another important finding is that **the distribution linkage is stronger than the input linkage for agriculture and for the economy as a whole and consequently ,agricultural output as well as overall gross output would have fallen more in absence of distribution linkage than in absence of input linkage.**

Section 2.5 Estimation of the Impact of Modern Inputs on Agricultural Output

As already discussed in section 1.4, a particular sector may be withdrawn from the system to observe its impact on the economy as well as on a specific sector. A similar exercise has been performed for Indian agriculture to estimate the impact of modern inputs on agricultural output and on over-all economy (Table15.).

Agriculture has responded to the absence of fertilizer, petroleum, electricity and agri implements as its output gets reduced in each case. The decline in agricultural outputs indicates the dependence of agriculture on these sectors for inputs.

Absence of petroleum & chemical product brings about the greatest impact on agricultural output in both the years. Agricultural implements such as tractors, pumps etc. and electricity have the least impact (among the four inputs considered here) on agricultural output because of the fact that these are being used in a very small scale.

Section 3: Concluding Remarks

India's agricultural sector has feeble structural linkages (both input use and output distribution) during the period of ongoing reforms .The input structure as well as the output distribution structure has changed. The relative importance of agriculture judged by the index of significance is observed to be on the wane. The analysis of linkage indices indicates that India's agriculture is not modernized and mechanized at the desired level. Agricultural planning requires to be formulated in such a away that agricultural interrelatedness with the other sectors of the economy rises.

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Table 1: Shares of Sectors in Total Output, Inter Industry Input Purchase(at purchaser's price) and Gross Value Added (%)

Year / Sectors	1993-94	2006-2007	Growth	1993-94	2006-2007	Growth	1993-94	2006-2007
Agriculture	21.51	12.70	(-3.97)	11.40	6.97	(-3.71)	30.38	18.93
Manufacturing	43.17	51.13	1.31	64.37	72.22	0.89	24.58	28.22
Services	35.32	36.17	0.18	24.23	20.81	1.17	45.05	52.85
Total	100 (150011372)	100 (790775898)		100 (70103671)	100 (411769593)		100 (79907700)	100 (379006305)

Note:Figs in () total values in lakhs of rupees

Table. 2 : Percentage Distribution of Sector's Gross Output by Inter Industry Input Purchase and Gross Value Added: India (during 1993-94 2006-2007)

Year / Sectors	1993-94	1993-94		2006-2007	2006-2007	
	T.input+NIT	GVA	Total	T.input+NIT	GVA	Total
Agriculture	24.77	75.23	100.00	28.58	71.42	100.00
manufacturing	69.68	30.32	100.00	73.55	26.45	100.00
Services	32.06	67.94	100.00	29.96	70.04	100.00
Total	46.73	53.27	100.00	52.07	47.93	100.00

Table3: Indices of Direct linkage:3×3 Aggregated structure , India(1993-1994)

Index / Sectors	u_j	w_i	u_j^*	w_i^*	σ_{uj}^*	σ_{wi}^*	σ_{uj}^{**}	σ_{wi}^{**}
Agriculture	0.281	0.315	0.229	0.257	0.484	0.593	0.280	0.342
Manufacturing	0.654	0.425	0.532	0.347	0.782	1.028	0.451	0.594
Services	0.293	0.485	0.239	0.396	0.692	0.721	0.400	0.416

Table. 4: Indices of Direct linkage:3×3 Aggregated structure , India(2006-2007)

Index / Sectors	u_j	w_i	u_j^*	w_i^*	σ_{uj}^*	σ_{wi}^*	σ_{uj}^{**}	σ_{wi}^{**}
Agriculture	0.204	0.394	0.155	0.301	1.102	0.504	0.636	**0.291**
Manufacturing	0.821	0.434	0.626	0.331	0.306	1.230	0.177	**0.710**
Services	**0.286**	**0.482**	**0.218**	**0.368**	**0.596**	**0.799**	**0.344**	**0.461**

Table 5 : Indices of Total linkage: 3×3 Aggregated structure , India(1993-1994)

Index / Sectors	U_j	W_i	$U_j^*=U_j/U_{od}$	W_i^*	$\sigma_{uj}^{**}=\sigma^*/\sqrt{n}$ (n=3)	σ_{Wi}^{**}
Agriculture	1.487	1.539	0.276	0.300	0.699	0.662
Manufacturing	2.326	1.905	0.432	0.372	0.660	0.789
Services	1.568	1.680	0.291	0.328	0.673	0.595

Table 6 : Indices of Total linkage: 3×3 Aggregated structure , India (2006-2007)

Index / Sectors	U_j	W_i	$U_j^*=U_j/U_{od}$	W_i^*	$\sigma_{uj}^{**}=\sigma^*/\sqrt{n}$ (n=3)	σ_{Wi}^{**}
Agriculture	1.600	1.692	0.287	0.317	0.629	0.576
Manufacturing	2.262	1.776	0.051	0.333	0.725	0.856
Services	1.718	1.869	0.308	0.350	0.632	0.550

Table 7: Shares of Sectors in Total Output, Inter Industry Input Purchase (at purchasers price),and Gross Value Added (%)

	Total output	Total output	Annual growth (%)	II Input Purchase	II Input Purchase	Annual growth (%)	Gross Value Added	GrossValue Added	Annual growth (%)
Sectors	**1993-94**	**2006-2007**		**1993-94**	**2006-2007**		**1993-94**	**2006-2007**	
1	21.51	12.70	-3.97	11.40	6.97	-3.71	30.38	18.93	-3.57
2	4.17	4.36	0.35	6.95	7.16	0.24	1.73	1.32	-2.05
3	4.18	3.13	-2.21	6.51	4.44	-2.89	2.15	1.70	-1.78
4	0.71	0.60	-1.21	1.19	1.16	-0.19	0.28	0.00	-41.11
5	0.19	0.15	-1.75	0.32	0.20	-3.67	0.07	0.10	2.43
6	0.24	0.25	0.27	0.38	0.38	0.00	0.12	0.10	-0.84
7	5.42	7.99	3.03	9.11	11.68	1.93	2.18	3.98	4.72
8	3.65	2.44	-3.06	5.07	3.02	-3.92	2.40	1.81	-2.16
9	24.62	32.21	2.09	34.84	44.18	1.84	15.65	19.22	1.59
10	7.82	7.88	0.06	9.88	9.53	-0.28	6.00	6.09	0.11
11	27.50	28.29	0.22	14.35	11.28	-1.84	39.04	46.77	1.40
Total	100	100	0	100	100	0	100	100	0.00
	(150011372)	**(790775898)**		**(70103671)**	**(411769593)**		**(79907700)**	**(379006305)**	

Note: Figs in () total values in lakhs of rupees

Table 8 : Percentage Distribution of Sector's Gross Output by Inter Industry Input Purchase and Gross Value Added: India (during 1993-94 2006-2007)

	1993-1994	1993-1994		2006-2007	2006-2007	
Sectors	Total .input purchase	GVA	Total	Total .input purchase	GVA	Total
1	24.77	75.23	100	28.58	71.42	100
2	77.93	22.07	100	85.51	14.49	100
3	72.67	27.33	100	73.97	26.03	100
4	78.56	21.44	100	99.98	0.02	100
5	79.81	20.19	100	68.79	31.21	100
6	74.19	25.81	100	79.90	20.10	100
7	78.54	21.46	100	76.14	23.86	100
8	64.97	35.03	100	64.49	35.51	100
9	66.14	33.86	100	71.41	28.59	100
10	59.09	40.91	100	62.97	37.03	100
11	24.38	75.62	100	20.76	79.24	100
Total	**46.73**	**53.27**		**52.07**	**47.93**	

Note: Total Input Purchase Includes Net Indirect Tax(NIT)

Table. 9: Indices of Direct linkage:11×11 Aggregated structure , India(1993-1994)

Index / Sectors	u_j	w_i	uj^-	w_i^-	u_j*=uj/uod	w_i*	σ_j**=σj/√11	σ_i**
1.Agriculture	0.281	0.315	0.026	0.029	0.042	0.054	0.013	0.014
2 .Agro Industryl	0.749	0.117	0.068	0.011	0.113	0.020	0.037	0.006
3.Agro Industry II	0.697	0.298	0.063	0.027	0.105	0.051	0.021	0.017
4.Fertilizer	0.781	0.991	0.071	0.090	0.118	0.170	0.026	0.077
5.Pesticides	0.747	0.941	0.068	0.086	0.113	0.162	0.024	0.063
6Agri Implements	0.673	0.248	0.061	0.023	0.101	0.043	0.029	0.013
7.Petroleum	0.730	0.726	0.066	0.066	0.110	0.125	0.027	0.024
8.Electricity	0.622	0.874	0.057	0.079	0.094	0.150	0.026	0.025
9. Manufacturing	0.614	0.456	0.056	0.041	0.092	0.078	0.028	0.023
10.Transport	0.513	0.525	0.047	0.048	0.077	0.090	0.018	0.015
11.Services	0.231	0.337	0.021	0.031	0.035	0.058	0.009	0.011

Table. 10: Indices of Direct linkage:11×11 Aggregated structure , India(2006-2007)

Index / Sectors	u_j	w_i	uj^-	w_i^-	u_j*=uj/uod	w_i*	σ_j**=σj/√11	σ_i**
1.Agriculture	0.329	0.394	0.030	0.036	0.047	0.070	0.014	0.016
2 .Agro Industryl	0.831	0.208	0.076	0.019	0.117	0.037	0.034	0.012
3.Agro Industry II	0.724	0.242	0.066	0.022	0.102	0.043	0.021	0.018
4.Fertilizer	0.941	0.999	0.086	0.091	0.133	0.178	0.040	0.082
5.Pesticides	0.628	0.797	0.057	0.072	0.089	0.142	0.027	0.048
6.Agri Implements	0.726	0.113	0.066	0.010	0.103	0.020	0.047	0.008
7.Petroleum	0.702	0.749	0.064	0.068	0.099	0.133	0.035	0.025
8.Electricity	0.739	0.831	0.067	0.076	0.104	0.148	0.029	0.032
9. Manufacturing	0.668	0.454	0.061	0.041	0.094	0.081	0.036	0.027
10.Transport	0.582	0.487	0.053	0.044	0.082	0.087	0.023	0.016
11.Services	0.203	0.350	0.018	0.032	0.029	0.062	0.008	0.012

Table. 11. Indices of Total Linkage:11×11 Aggregated structure , India(1993-1994)

Index / Sectors	Uj	Wi	Uj^{-}	Wi^{-}	Uj*	Wi*	σ_{uj}**	σ_{Wi}**
1	1.521	1.466	0.138	0.133	0.061	0.069	0.105	0.105
2	2.281	1.162	0.207	0.106	0.091	0.054	0.098	0.096
3	2.417	1.471	0.220	0.134	0.096	0.069	0.108	0.112
4	2.817	2.587	0.256	0.235	0.112	0.121	0.107	0.132
5	2.795	2.627	0.254	0.239	0.112	0.123	0.110	0.133
6	2.469	1.357	0.224	0.123	0.099	0.063	0.109	0.102
7	2.607	2.437	0.237	0.222	0.104	0.114	0.123	0.112
8	2.348	2.812	0.213	0.256	0.094	0.132	0.120	0.115
9	2.305	1.897	0.210	0.172	0.092	0.089	0.140	0.127
10	2.052	1.963	0.187	0.178	0.082	0.092	0.097	0.094
11	1.441	1.606	0.131	0.146	0.058	0.075	0.101	0.099

Table. 12. Indices of Total Linkage:11×11 Aggregated structure , India(2006-2007)

Index / Sectors	Uj	Wi	Uj^{-}	Wi^{-}	Uj*	Wi*	σ_{uj}**	σ_{Wi}**
1	1.693	1.608	0.154	0.146	0.062	0.075	0.105	0.106
2	2.603	1.308	0.237	0.119	0.095	0.061	0.105	0.103
3	2.597	1.349	0.236	0.123	0.094	0.063	0.110	0.112
4	3.449	2.710	0.314	0.246	0.125	0.126	0.125	0.135
5	2.518	2.516	0.229	0.229	0.092	0.117	0.115	0.120
6	2.694	1.182	0.245	0.107	0.098	0.055	0.118	0.091
7	2.774	2.550	0.252	0.232	0.101	0.119	0.140	0.116
8	2.843	2.825	0.258	0.257	0.103	0.131	0.132	0.129
9	2.582	1.904	0.235	0.173	0.094	0.089	0.165	0.136
10	2.352	1.900	0.214	0.173	0.086	0.088	0.104	0.098
11	1.398	1.632	0.127	0.148	0.051	0.076	0.101	0.099

Table13. Relative Linkage Indices : India

years / Sectors	1993-94	2006-07	1993-94	2006-07
	Input (r_i)	**input(r_i)**	**Distri (s_i)**	**Distri (s_i)**
Paddy	**0.400**	**0.426**	**0.811**	**0.766**
wheat	0.307	**0.476**	**0.644**	**0.711**
Jowar	0.075	0.044	0.452	0.224
bajra	0.096	0.051	0.292	0.487
Maize	0.150	0.097	0.351	0.183
Gram	**0.405**	0.395	0.443	**0.771**
Pulses	0.347	**0.529**	0.553	0.511
Sugarcane	0.333	0.317	0.130	0.107
Groundnut	0.314	0.412	0.133	0.202
Jute	0.210	**0.000**	0.050	**0.000**
Cotton	0.137	0.258	0.033	0.086
Tea	0.022	0.054	0.003	0.008
Coffee	0.005	0.014	0.007	0.033
Rubber	**0.000**	**0.000**	**0.000**	**0.000**
Tobacco	0.093	0.185	0.014	0.036
Other crops	0.271	0.231	0.074	0.072
Total	**0.230**	**0.247**	**0.133**	**0.187**

Table 14: Impact of Withdrawal of Agriculture on Gross output in the Economy (at unit level of demand for each sector) : India

		Case I		Case II				Case III			Case IV	
	2006-07	**1993-94**	**change**	**2006-07**	**1993-94**	**change**	**2006-07**	**1993-94**	**change**	**2006-07**	**1993-94**	**change**
Agriculture	2.14	2.34	-0.20	1.19	1.17	0.02	1.19	1.17	0.02	2.13	2.32	-0.19
Agro Inustry-I	1.24	1.10	**0.14**	1.23	1.09	0.14	1.24	1.10	0.14	1.23	1.09	0.14
Agro Inustry-II	1.31	1.39	-0.08	1.30	1.38	-0.08	1.31	1.39	-0.08	1.30	1.38	-0.08
Pesticides	1.23	1.27	-0.05	1.11	1.18	-0.07	1.18	1.23	-0.05	1.11	1.18	-0.07
Fertilizer	1.30	1.25	0.04	1.28	1.24	0.04	1.29	1.25	0.04	1.28	1.24	0.04
Agri Implements	1.02	1.15	-0.13	1.01	1.15	-0.13	1.01	1.15	-0.13	1.01	1.15	-0.13
Petroleum	4.09	3.00	**1.09**	3.93	2.92	1.00	4.02	2.96	1.06	3.93	2.92	1.00
Energy	1.96	2.23	-0.27	1.91	2.16	-0.25	1.94	2.19	-0.26	1.91	2.16	-0.25
Manufacturing	7.07	5.38	**1.70**	6.84	5.23	1.62	6.97	5.30	1.67	6.84	5.23	1.62
Transport	2.16	2.29	-0.14	2.06	2.20	-0.13	2.12	2.25	-0.13	2.06	2.20	-0.13
Services	3.98	3.64	**0.34**	3.79	3.49	0.30	3.89	3.57	0.33	3.79	3.49	0.30
Over all	**27.50**	**25.05**	2.45	**25.65**	**23.21**	2.45	**26.15**	**23.54**	2.60	**26.59**	**24.36**	2.24

Case I-Perfect Integration of Agriculture

Case II Complete withdrawal Of Agriculture (no input and distribution linkage)

Case III Partial withdrawal Of Agri (no Distribution Linkage)

Case IV Partial withdrawal Of Agri (no Input Linkage**)**

Table 15: Impact of Withdrawal of Selected Sectors on Sectoral Outputs

	2006-2007						1993-1994				
	Case I	**Case II**	**Case III**	**Case IV**	**Case V**		**Case I**	**Case II**	**Case III**	**Case IV**	**Case V**
Sectoral output		**No fertilizer**	**No petroleum**	**No eletricity**	**No agri implements**	Sectoral output		**No fertilizer**	**No petroleum**	**No eletricity**	**No agri implements**
x_1	2.14	2.10	2.04	2.11	2.11	x_1	2.34	2.29	2.12	2.29	2.31
x_2	1.24	1.23	1.21	1.23	1.24	x_2	1.10	1.10	1.09	1.10	1.10
x_3	1.31	1.30	1.29	1.31	1.31	x_3	1.39	1.37	1.34	1.38	1.38
x_4	1.23	1.11	1.22	1.22	1.22	x_4	1.27	1.14	1.26	1.27	1.27
x_5	1.30	1.29	1.29	1.30	1.30	x_5	1.25	1.25	1.25	1.25	1.25
x_6	1.02	1.02	1.01	1.02	1.01	x_6	1.15	1.15	1.15	1.15	1.14
x_7	4.09	3.23	1.28	3.73	3.96	x_7	3.00	2.59	1.25	2.85	2.88
x_8	1.96	1.87	1.76	1.39	1.89	x_8	2.23	2.09	1.98	1.27	2.12
x_9	7.07	6.10	4.47	6.14	6.06	x_9	5.38	4.66	4.02	4.51	4.73
x_{10}	2.16	1.96	1.85	1.98	2.07	x_{10}	2.29	2.10	1.98	2.04	2.18
x_{11}	3.98	3.59	3.28	3.55	3.65	x_{11}	3.64	3.31	3.02	3.25	3.36
$\sum x$	**27.50**	**24.82**	**20.71**	**24.97**	**25.81**	$\sum x$	**25.05**	**23.05**	**20.46**	**22.36**	**23.72**