Macro contribution

Of a micro level Company

A study through Input-Output framework

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Abstract

In the context of the globalization of the Indian economy, it is necessary to examine the dependence of an individual micro-level company on the macro economy and its constituent sectors. We have taken up the study of a diversified private engineering and construction company to analyze the structure of its business, using input-output framework. The operational impact of the company and its dependence on the economy are evaluated, using three different types of linkages: Hirshman's backward and forward linkages, and the residentiary linkages conceptualized by Shri Prakash. An attempt has been made to experiment with a single company's partial model in the general equilibrium framework. The results of the study are expected to reflect the operational paradigm shift that Indian companies have effected in the globalised Indian economy. The results highlight the role and importance of use of advanced technology by such firms to the national economy.

Background

For three decades after independence, India so consistently averaged GDP growth of 3.5 per cent per year that it came to be called the Hindu rate. Then, in the 1980s, India graduated to the range of 5 to 6 %, growth rate though erratically. Economic reforms followed, and growth exceeded 7 per cent for three years in the mid-1990s. Indian economy has steered clear of its erstwhile unimpressive annual rate of growth of 3 to 3.5% and per capita income of 2% and entered a new phase in the global economic scene, although after the acceptance of the Pay Commission award, GDP growth slid back to 5-6 %.

With the advent and maturity of Information Technology sector as well as the evolution and development of other knowledge-based service sectors, India is certainly poised for a respectable position in the world economic order in the years to come. It is the emergence of the above sectors and globalization of the Indian economy that have changed the business scenario in India. With the induction of several MNCs, some of which may in their home countries even be bigger than the size of the Indian economy, the role and importance of individual companies, irrespective of whether it is a public, private, Indian, foreign multinational, or joint venture company, have changed. It is in this context that we are examining the dependence of an individual company on the macro economy and its constituent sectors / industries on the one hand, and the impact of the operations of the company on the economy on the other.

While examining the recent changes in the economy, it is noted that the Indian economy fared well with an estimated GDP growth of around 7% during the fiscal 2003-04 as compared to 4.4% in the previous year. Construction activity, which accounts for over 5% of the country's GDP, registered a growth of 6.5% during 2003-04. The growth in domestic manufacturing sector increased to 7.2% during the year from 6% in the previous year. The capital goods sector grew by 11.9% during the year. As commodity prices revived across the globe, cement, steel and metal industries recorded significant improvement in performance. *These are the goods the company under study deals in. Naturally, it belongs to the fastest growing sector of the economy.*

In the pre-globalization scenario, many industries depended on Government and public sector units for their operational existence and growth. Government's purchase policies, focusing on economizing, and hence, cutting purchases under compulsion to cut costs, adversely impacted the level and scope of business of the companies, which have been conventionally depending substantially on the government / public sector customers. The company we have chosen for study, is dealing mostly with heavy and basic industrial goods, which were earlier under the commanding heights of Public Sector. Under such circumstances, a private sector firm has to change its market strategy in order to survive, *and one such strategic option would have been to seek international business.* If the company is able to perform well in the *competitive international market, the chances are that it will be able to strengthen its position even within the country which, in turn, could impact the economy. Conversely, if a company is strong within the country, it will also have the strength to face international competition both in India and abroad. These are the thesis and counter thesis.*

Operational impact of a micro level company on macro economy

We have taken up the study of a diversified private engineering and construction company. The structure of its business is analyzed, using Input-Output framework, which provides an approach to develop a computable general equilibrium model. *The operational impact of the company and its dependence on the economy are proposed to be evaluated through three different types of linkages* – Hirshmanian backward and forward linkages as well as the residentiary linkages that have been conceptualized by S.Prakash (1986, 1992). It is further proposed to estimate the patterns and magnitudes of the linkages by two alternative methods: the method developed by Rasmussen and the model developed by S.Prakash (1992). As compared to backward and forward linkages, the residentiary linkage as conceptualized and operationalised by S.Prakash has

been found to be much more important in Indian economy so far as the information technology based sectors are concerned (Artha Vijnana, 2000).

This has been attempted in order to find the interface between *micro company* level and *macro economy* level operations in the economy. *Macro* here refers to sectors, each of which comprises of several industries or group of activities which, in turn comprise of companies. The analysis is expected to help *estimate the dependence of the company on the national economy and also evaluate its impact on the economy.* It will help estimate the role and importance of the company to the national economy. The results of the study may also reflect the operational paradigm shift that Indian companies have effected in the globalised Indian economy.

Methodology

Generally, Leontief Static Input – Output model has been used to derive estimates of backward / forward linkages. The estimation formulae used by scholars have been propounded by Rasmussen. S.Prakash developed an *additional concept of residentiary linkage and hypothesized that the linkage studies have to be undertaken in the context of growth.* But growth cannot be kept in focus either by neglecting the final demand component or by overlooking the capital requirements of growth, which the static framework in which linkages have been studied does. Prakash conceptualized residentiary linkages and related the same to the final demand vector net of investment. This has been devised to *capture the multiplier process of growth. Further, investment has been endogenized through capital matrix in the dynamic model of growth.* He has developed formulae for all three linkages, *which are totally different from Rasmussen's formulae in concept and measuring approach* to capture indirect effects through Leontiff Inverse, whereas the conventional approach has neglected both acceleration and multiplier effects on growth. Prakash model has been used by a researcher in the study of *Information technology based sectors* of Indian economy which has been published in Artha Vijnana (2000). The concepts and the model of linkages have earlier been empirically operationalised by Prakash (1992) with the help of data relating to Indian economy.

Linkages

The Hirschmanian theory (1957) of unbalanced growth combines the Rostowian concept of the leading/key sector of the economy with his own concepts of backward and forward linkages. The

concept of a) linkages, and b) key sectors have been operationalised empirically through Leontief's Static Input Output Model on the basis of input coefficient matrix. Extension of Leontief Model by Chenery and Watanbe (1958) facilitated empirical testing of the theory extensively in numerous national economies.

Prakash (1991) *highlighted the following limitations of these studies*: i) *Growth pertains to dynamic rather than static model* used in such studies. *Negligence of investment/ capital matrix* jeopardized the relevance of the findings of these studies, since static linkages were not only a gross *underestimate of the real linkage effect but these concealed more of growth effect than what these linkages revealed;* ii) the formulae used for estimating the linkages *focused only on intermediate demand, neglecting final demand, and hence*, *the multiplier process of growth*. Thus the final use vector and its two important constituents, consumption and investment were totally neglected; iii) use of the elements of *coefficients matrix to estimate indices of linkages captured only direct and neglected indirect effects. In several cases, indirect effects are even more important than the direct effects.* Prakash, therefore, propounded the use of i) *Leontief Inverse* in place of input coefficients' matrix to capture both direct and indirect effects; ii) *Leontief's Dynamic rather than Static Inverse* to capture *fully the impact of accelerator on growth*, and iii) formulated and operationalised the concept of *Residentiary Linkage* to *capture the multiplier effect on growth.*

A recent study of information technology based sectors of Indian economy, published in Artha Vijnana, 2000, has shown that Prakash's *method yields better estimates of linkage indices* than Rasmussen and other conventional methods. The study also demonstrates that *residentiary linkages*, propounded by Prakash, capture the *impact of information and knowledge* based sectors better.

Data Base and Adjustments

We have taken up the study of Larsen & Toubro, a diversified engineering and manufacturing company, for analyzing its impact on the Indian economy.

The Input Output Transactions (Commodity - Industry) Table, 1993-94 – Absorption Matrix (CSO Publication) has been adopted for the study. The table's 115 sectors were regrouped into 44 sectors to make it more *manageable and amenable* to the mathematical software package available.

Larsen & Toubro is a High-tech Manufacturing as well as Service Company, having high knowledge intensity. It is a multi-product and multi-technology company, and hence, its outputs

and inputs relate to more than one sector of the economy. This is a violation of an essential assumption of I-O analysis that there is one to one correspondence between the sectors of the economy and the number of products, since each sector/industry is assumed to produce only one single product. However, the violation is not unique or atypical; for example, many sectors relating to processing of agricultural output like wheat flour, paddy and oil milling are also multi-product industries.

L & T uses 25 major raw material inputs such as coal, iron and steel sheets, tubes and components, limestone, clay, soda ash and other inorganic chemicals, rubber, bakelite, nonferrous metals, electronic and electrical components, cables and switch gear equipment, etc. These inputs appear as output of 25 different sectors of the economy.

There are six major and twelve minor products among the output of the company that are being manufactured by it. The major products include miscellaneous industrial, agricultural and earthmoving machinery, nuclear power plants and equipment, chemical plants and equipment, portland cement, and switchgear. The output of each of these 18 products has been imputed to the sector to which it belongs. The corresponding inputs of these 18 products have also been attributed to 15 producing sectors accordingly. So, the input coefficients of these 15 sectors are estimated from the company data of inputs in order to derive an alternative solution. For this alternative solution, the columns and rows, corresponding to the relevant inputs of these products have been replaced in the columns and rows of input coefficients given in the I-O table of the economy.

Modeling of Production Activities

This paper has used Prakash Model for analyzing micro company - macro economy inter-relations. An attempt has been made to experiment with a single company's partial model in the general equilibrium framework. In this experimental model, we have enmeshed the inputs of raw materials and components, and output of main products of the company that relate to 15 sectors with the economy level data of the remaining 29 sectors of the 44 x 44 table. It is assumed that any change in the raw material inputs would correspondingly cause a proportionate change in the products manufactured. Similarly, change in output shall be associated with approximately proportionate change in inputs.

The direct impact of this change can be gauged from the difference in the technology matrix A and A′. But the overall effect may be spread over many more than 15 sectors, which may be estimated from the inverse of the two matrices.

Two alternative solutions worked out are derived from the standard Leontief model:

$X = (I - A)^{-1} \cdot F$ …….(1)

$X' = I - A')^{-1} \cdot F$ …….(2)

where A is the technology matrix of the economy, as given in the 1993-94 Table published by Central Statistical Organization, Ministry of Statistics and Programme Implementation, Govt of India;

A′ is the modified technology matrix of the economy in which the coefficients of 15 rows and columns were estimated from company data which to be meshed with economy level data to synthesize the company technology matrix into the technology matrix of the economy'; and F is the final demand vector of the economy.

Modeling Linkages

The formulae for estimating linkages from the above input output model are given hereunder.

Static Backward Linkages Index:

$$I^{BS}{}_j = \sum_{i=1}^{n} x_{ij} / x_j = \sum_{i=1}^{n} a_{ij} \qquad \text{……..(4)}$$

Where x_j is output of j^{th} industry, x_{ij} is supply of inputs of commodity i to cement and miscellaneous manufacturing industry, designated as industry j.

I^{BS} *is static backward linkage* index and a_{ij} is input of i^{th} commodity per rupee worth of output of L & T (cement and miscell.mfg. industry). This is the conventional backward linkage formula.

Static Forward Linkage Index:

$$I^{FS}{}_j = x_{j1} / x_1 + x_{j2} / x_2 + ... + x_{jn} / x_n = \sum_{i=1}^{n} a_{ji} \qquad \text{……(5)}$$

where I_j^{FS} is the conventional forward static linkage index of industry j, x_{ji} is the supply of products of L & T (cement and misc.mfg industry) j to i^{th} industry, i = 1,2,……..

Total Linkage Index (TLI)

TLI is derived as a simple average of backward and forward linkage indices:

$$I_j^{TS} = \frac{1}{2n}(I_j^{BS} + I_j^{FS}) = \frac{1}{2n}(\sum_{i=1}^{n} a_{ij} + \sum_{i=1}^{n} a_{ji}) \quad \text{……(6)}$$

The above conventional formulae have been revised by Prakash (1991) as follows with a view to capture both the direct and indirect linkage effects.

$$I_j^{TBS} = \sum_{i=1}^{n} A_{ij} \quad \text{…….(7)}$$

$$I_j^{TFS} = \sum_{i=1}^{n} A_{ji} \quad \text{…….(8)}$$

where Aij are the elements of Leontief Static Inverse.

$$I_j^{TDS} = \frac{1}{2n}(I_j^{BS} + I_j^{PS}) = \frac{1}{2n}(\sum_{i=1}^{n} A_{ij} + \sum_{i=1}^{n} A_{ji}) \quad \text{…….(9)}$$

Indices of Dynamic Linkages may be derived from Leontief Dynamic Inverse (Prakash, 1991) analogously.

The Leontief Dynamic Inverse is given below:

$(I-A-GB)^{-1} = [I-GB(I-A)^{-1}]^{-1}(I-A)^{-1}$ ……. (10)

The *reciprocal of the smallest positive Frobinius root,* defining the existence of solution to the above model (Mathur, 1967), will furnish *technically feasible and economically maximal growth rate, if all sectors of the economy grow at the same constant rate:*
$g_i=g_j=G$ for all i and j.

In case of unbalanced growth, G shall be a diagonal matrix of sectoral growth rates, $g_i \neq g_j$.

As the B matrix, corresponding to A matrix of 1993-94, is not available, the direct and indirect sectoral investment requirements have been estimated from the information about the *sectoral gross fixed capital formation and change in stock,* contained in I-O Table of 1993-94:

$b_j = c_j + \Delta s_j$ …….. ..(11)

$b_j = \sum_i b_{ij}$ is output of all sectors used up for capital formation in sector j, $s_j = \sum_i s_{ij}$, s_{ij} is the output of sector i held as capital/ stock in sector j, and Δ is the change operator. Thus, b_j denotes total investment in capital inputs of all producer goods in sector j. This furnishes the Sector-wise Investment Vector b = (b_j), j=1, ……n for the economy as a whole. Sum/total of investment, comprising of both direct and indirect investment requirement per unit of final demand, will be given by

$B = (I- A)^{-1} b$ …….. (12)

The dynamic linkages may then be estimated as follows:

$$I^{BD} = \sum_i a_{ij} + b_{.j} \quad \text{……(13)}$$

and

$$I^{FD} = \sum_i a_{ji} + b_{j.} \quad \text{……(14)}$$

where $b_{j.}$ will show the supply of investment goods from L & T to all other industries and $b_{.j}$ will display the investment made in L & T, as estimated from relation 12.

We develop a criterion to identify those sectors of the economy whose residentiary linkages are stronger than the Hirschmanian linkage effects. First linkage index of this type is given by

$$V_J^{RBS} = V_j / I_j^{DBS} \leq 1 \quad \text{……(15)}$$

where superscripts RBS denote residentiary static linkage relative to direct backward linkage effect

and $V_j = 1 - \sum_{i=1}^{n} a_{ij}$. Obviously V_j is value added per unit of output of good *j.*

Similarly, another index has been developed which is given by

$$V_j^{RFS} = f_j / \sum_{i=1}^{n} a_{ji} \leq 1 \quad \text{…….(16)}$$

where superscripts RFS denote residentiary relative to direct static forward linkage effect. Here f_j is the final demand for good *j per unit of output of j.*

Then, residentiary linkage effect may be considered in relation to overall Hirchamanian linkage effect by means of the following index:

$$I_j^{RDS} = V_j / I_j^{TDS} \leq 1 \quad \text{……(17)}$$

where superscripts RDS denote residentiary relative to direct Hirschmanian static linkage effect.
As against this, both direct and indirect requirements are taken into account in estimating residentiary linkage if relation is formulated as follows:

$$I_j^{RTS} = \left(\sum_{i=1}^{n} V_i A_{ij} + \sum_{i=1}^{n} V_j A_{ji} \right) \Big/ I_j^{TS} \begin{matrix} \leq 1 \\ > \end{matrix} \quad \text{.....(18)}$$

where superscripts RTS denote residentiary relative to total static Hirschmanian linkage effect.

$$I_j^{RTD} = \left(\sum_{i=1}^{n} V_j B_{ji} + \sum_{i=1}^{n} V_i B_{ij} \right) \Big/ I_j^{DD} \begin{matrix} \leq 1 \\ > \end{matrix} \quad \text{.....(19)}$$

where superscripts RTD denote residentiary relative to total dynamic linkage effect.

Empirical Results:

The above model of linkages has been applied to the I-O table of 1994. The Direct Static Linkages for all the 44 sectors have been worked out as under:

Table - II

	SECTORS	Forward linkage Eq - 5			Backward linkage eq 4		
		table data	own data	% difference in linkage	table data	own data	% difference
1	Paddy,etc	0.7703522	0.769679	0.09	0.4452319	0.434591	2.39
2	sugarcane,etc	1.364991	1.364991	-	0.7086711	0.7086711	-
3	tea,etc	0.8011937	0.8011937	-	1.7816483	1.7816483	-
4	rubber, etc	0.0562509	0.0561118	0.25	0.1306449	0.1306449	-
5	Tobacco	0.1450549	0.145033	0.02	0.5708931	0.5708931	-
6	Other crops, milk, livestock products, etc	1.0457668	1.0471007	(0.13)	0.2285427	0.2274488	0.48
7	Forestry and logging, fishing	0.4472732	0.4472732	-	0.1258726	0.1258726	-
8	Coal and lignite, petroleum	1.5773541	1.576213	0.07	0.3003135	0.3003135	-
9	Iron ore, manganese, bauxite, etc	0.209234	0.209234	-	0.2518153	0.2518153	-
10	Lime stone, non-metallic minerals	0.2079874	0.2005176	3.59	0.1448252	0.0448252	69.05
11	Sugar	0.3588348	0.3588348	-	0.8329666	0.8329666	-
12	hydrogenated oil(vanaspati)	0.054118	0.054118	-	0.8196284	0.8196284	-
13	miscellaneous food products	0.0595907	0.0595967	(0.01)	0.7738995	0.7738995	-
14	Khadi, miscellaneous textile products	0.4408217	0.4408906	(0.02)	0.8899214	0.8899214	-
15	jute,hemp,mesta textiles	0.0743401	0.0740521	0.39	0.7568049	0.7568049	-
16	furniture and fixtures-wooden	0.3265949	0.3269812	(0.12)	0.5410812	0.5410812	-
17	paper,paperprods. & newsprint	0.5840293	0.5851378	(0.19)	0.7001868	0.7001868	-
18	leather footwear	0.8595731	0.787938	8.33	0.7301212	0.7301212	-

19	Petroleum products	0.3613217	0.3567156	1.27	0.9092285	0.0922849	89.85
20	coal tar products	0.1584828	0.1510338	4.70	0.8808563	0.8085632	8.21
21	Inorganic heavy chemicals, others	1.8732178	1.8665428	0.36	0.8743263	0.743263	14.99
22	drugs and medicines	0.0399687	0.0567215	(41.91)	0.7884469	0.7884469	-
23	soaps, cosmetics & glycerin	0.2042116	0.2021885	0.99	0.7679539	0.7679539	-
24	Structural clay products, others	0.4398081	0.4396393	0.04	0.7385095	0.7385095	-
25	Cement	0.0505217	0.0446817	11.56	0.6753973	0.6753973	-
26	iron, steel and ferro alloys	1.8021607	1.8021607	-	0.9338588	0.3385883	63.74
27	non-ferrous basic metals	1.3808627	1.6348815	(18.40)	0.4458082	0.441727	0.92
28	hand tools, hardware	0.1988536	0.1988536	-	0.1409415	0.1409415	-
29	tractors and agri. Implements	0.123851	0.123851	-	0.4519229	0.4192285	7.23
30	industrial machinery(f&t)	0.4697843	0.893111	(90.11)	0.7568479	0.7568479	-
31	office computing machines	0.012503	0.1581816	(1,165.15)	0.0083082	0.0083082	-
32	electrical industrial machinery	0.1085837	0.1085837	-	0.6189691	0.189691	69.35
33	electrical wires &cables	0.3170396	0.3170725	(0.01)	0.5189674	0.5189674	-
34	electronic & communication equipments	0.2047088	0.8154059	(298.32)	0.946645	0.946645	-
35	ships and boats	0.0264587	0.0264587	-	0.102615	0.102615	-
36	rail equipments	0.7718618	0.0583494	92.44	0.2007204	0.2007204	-
37	motor vehicles	0.4454038	0.4454679	(0.01)	0.7510913	0.7510913	-
38	bicycles, cycle-rickshaw	0.2861623	0.2861729	(0.00)	0.4391503	0.4391503	-
39	misceiianeous manufacturing	0.4529959	0.3327058	26.55	3.7455513	1.4555133	61.14
40	construction. Electricity, railways	4.4656216	4.4895508	(0.54)	0.8628289	1.8628289	(115.90)
41	communication, trade, banking	3.9819266	3.9907955	(0.22)	0.1844884	0.1844884	-
42	education and research	0.0511055	0.0433989	15.08	0.8307893	0.8307893	-
43	medical and health	0.7915776	0.7945997	(0.38)	0.0950631	0.0950631	-
44	Other services	0	0	0	0	0	0

When own data are substituted in the matrix, it is found that Forward linkages of sectors like computers, electronic & communication equipment and industrial machinery are very much higher, showing that the efficiency of the company is very high in these sectors. Of course, the data of the company also affects the other sectors, as may be seen from the fact that rail equipment, miscellaneous manufacturing and education are showing negative difference in linkage index, thereby indicating the contribution of these sectors to the company.

The estimates based on relations 4,5 and 8 are reported below for four important sectors to which the company mainly belongs:

Linkage indices
Static Linkages
Table - III

Linkage Type	Backward				Forward			
LARSEN & TOUBRO Sector	Cement	Indl machinery	Miscell manufacturing	Construction, etc	Cement	Indl machinery	Miscell manufacturing	Construction, etc
Direct ($I^{BS\&FS}$): Own data	0.67539	0.75684	1.45551	1.86283	0.04468	0.89311	0.33271	4.48955
Table data	0.6753	0.7568	3.7455	0.8628	0.0505	0.4697	0.4529	4.4656
Both Direct and Indirect (I_j^{TDS}) : Own data	2.89490	7.31540	3.40480	1.46470	1.73160	5.06920	2.08560	19.2129
Table data	2.8288	3.1194	14.478	1.4647	1.6834	2.1802	2.3422	17.705
Overall direct & indirect : Own data				15.0798				28.0993
Table data				21.8909				23.9108

These results substantiate the i) hypothesis that L & T, like other manufacturers, has high backward linkages ranging from 0.675 to 1.863. It means that *the inducement mechanism through intermediate demand generation, oprationalized by backward linkages of L & T is quite strong and it makes the contribution of manufacturing company important/crucial to the growth of economy.* But this inference is based on the result furnished by the conventional approach, which overlooks *the indirect effects of linkages*. The overall backward linkage effect, calculated from relation 7, is as high as 7.315 in case of industrial machinery and 3.405 for miscellaneous manufacturing. *It is 10 times and 2.3 times respectively higher than the direct backward linkage effect.* This supports *the thesis that the indirect effect, like in several other cases, is more important in the manufacturing sector of the company than the direct effect.*

It has been observed that *the direct forward linkage effect* of construction sector *is much higher (4.49) than its direct backward linkage effect (1.86)*. In fact, *it is 2.4 times higher than the direct backward linkage index.* The total forward linkage (both direct and indirect) this sector is 19.21, which is *13 times higher than the total backward linkage effect.* Besides, *the overall forward linkage index is twice as high as the overall direct backward linkage index.* It may, therefore, be deduced *that L & T's business at micro level has indeed impacted the growth of the macro national economy through its forward linkages;* the industry may, in fact, be said to be among the significant contributors to the growth of Indian economy.

Dynamic Linkages
Table – IV

Linkage Type	Backward				Forward			
Sector	Cement	Indl machinery	Miscell. manufacturing	Construction, etc	Cement	Indl machinery	Miscell. manufacturing	Construction, etc
Dynamic ($I^{BD\&FD}$) : Own data	1.1697	4.5097	8.3320	14.424	2.2260	8.8221	8.9621	31.774
Table data	0.7200	1.6499	4.0782	5.3523	0.5449	4.2226	7.3294	17.026
Linkage Type	Backward				Forward			
Sector	Cement	Indl machinery	Miscell. manufacturing	Construction, etc	Cement	Indl machinery	Miscell. manufacturing	Construction, etc

Residentiary ($I^{TS\&TD}$) : Own data	0.4806	0.3212	-0.312	-0.463	0.0012	0.5322	0.0196	2.4853
Table data	0.4806	0.3212	-0.733	0.1589	1.8469	0.7883	7.6741	8.0666

Here again, the forward linkage effect is more pronounced than the backward linkage effect for both Dynamic and Residentiary linkages. In case of own data of dynamic linkages, the backward linkage indices range from 1.1697 to 14.424, whereas the forward indices range between 2.226 to 31.774. These ranges are much broader than those of the table data indices are.

The residentiary linkages of miscellaneous manufacturing sector show negative indices indicating that this sector *is highly impacted by imports*. Here also, the forward linkages are much stronger than the backward linkages. Construction sector, particularly, shows much higher linkage indices at 8.0666 and 2.4853 for table data and own data respectively. These linkage effects are bound to be manifested in the differentials of output. This is analyzed in the next section.

Technology Effect on Output

The vector D of differences in the two solution values of output is given by:

$D = (X - X')$ ……(3)

where output vectors X and X′ have been derived from equation (1) and (2) respectively as mentioned before.

Transaction matrix has been subjected to regrouping into fewer sectors. Corresponding outputs and final demand for 115 sectors have been aggregated into 44 sectors. It is for these aggregated schemata that the coefficient matrices A and A′ have been derived. These matrices A and A′ have been used to estimate the two Leontief Inverse. The vector D was estimated from these solutions. The results are reported in Table – I.

Moving from matrix A to matrix A′ involves the change in coefficients of as many as 15 sectors. The company's *technology is under economy level operational scales of these 15 sectors*. Therefore, the change in output of these sectors will be *due to both direct and indirect effect of the company's relationship with the economy* and the operational change in technology. The change is due to pure technology effect as the scale effect has been neutralized through a) considerations of input requirement per unit of output, and b) use of economy's final demand.
Results reported in Table-I (a) and (b) highlight the fact that a) the output of 43 of the 44 sectors of the economy has changed on substitution of A by A′, the other services output having remained unchanged; and b) 29 of the 44 sectors were impacted positively by the substitution of

the initial input coefficients by L&T's coefficients. L&T is thus related directly or indirectly to these 29 sectors that account for 66 per cent of the total sectors of the economy. Of the remaining 15 sectors, 14 had experienced a negative impact.

But the positive impact on output is far greater than the negative impact of L&T's technology on the economy. Incidentally, the output of 9 sectors of the 15 sectors related to L&T, has registered positive change. Thus, sixty per cent of the sectors, using company's technology have registered the positive impact.

Table – I (a)
Economy Output and L & T Output

Sl No	**Sectors**	Original coefficients	New Coefficients (after incl L&T coef.)	Difference	% change + / (-)
1	Paddy,etc	1.2793	1.2805	-0.0012	(0.09)
2	sugarcane,etc	0.4165	0.4175	-0.001	(0.24)
3	tea,etc	0.3121	0.3129	-0.0008	(0.26)
4	rubber, etc	0.0534	0.052	0.0014	2.62
5	Tobacco	0.09	0.0899	0.0001	0.11
6	Other crops, milk, livestock productsetc	1.78	1.7811	-0.0011	(0.06)
7	Forestry and logging, fishing	0.202	0.2013	0.0007	0.35
8	Coal and lignite, petroleum	0.6567	0.6761	-0.0194	(2.95)
9	Iron ore, manganese, bauxite, etc	0.1946	0.2117	-0.0171	(8.79)
10	Lime stone, non-metallic minerals	0.1145	0.1083	0.0062	5.41
11	Sugar	0.1955	0.1961	-0.0006	(0.31)
12	hydrogenated oil(vanaspati)	0.1182	0.1183	-0.0001	(0.08)
13	miscellaneous food products	0.2629	0.2632	-0.0003	(0.11)
14	Khadi, miscellaneous textile products	0.5355	0.5383	-0.0028	(0.52)
15	jute,hemp,mesta textiles	0.0289	0.0286	0.0003	1.04
16	furniture and fixtures-wooden	0.1883	0.1918	-0.0035	(1.86)
17	paper,paperprods. & newsprint	0.2397	0.2463	-0.0066	(2.75)
18	leather footwear	0.5523	0.499	0.0533	9.65
19	petroleum products	0.3974	0.405	-0.0076	(1.91)
20	coal tar products	0.1171	0.1166	0.0005	0.43

21	inorganic heavy chemicals, others	0.8024	0.7817	0.0207	2.58
22	drugs and medicines	0.0724	0.0877	-0.0153	(21.13)
23	soaps, cosmetics & glycerin	0.081	0.0823	-0.00130	(1.60)
24	structural clay products, others	0.266	0.2688	-0.0028	(1.05)
25	Cement	0.1689	0.1671	0.0018	1.07
26	iron, steel and ferro alloys	1.1262	1.2319	-0.1057	(9.39)
27	non-ferrous basic metals	0.5988	0.8698	-0.271	(45.26)
28	hand tools, hardware	0.1439	0.1517	-0.0078	(5.42)
29	tractors and agri. Implements	0.0464	0.0463	1E-04	0.22
30	Industrial machinery	0.2912	0.6629	-0.3717	(127.64)
31	office computing machines	0.0056	0.0063	-0.0007	(12.50)
32	electrical industrial machinery	0.103	0.1105	-0.0075	(7.28)
33	electrical wires &cables	0.169	0.2059	-0.0369	(21.83)
34	electronic & communication equipments	0.1315	0.4287	-0.2972	(226.01)
35	ships and boats	0.0123	0.0124	-1E-04	(0.81)
36	rail equipments	0.8121	0.091	0.7211	88.79
37	motor vehicles	1.4068	1.4088	-0.002	(0.14)
38	bicycles, cycle-rickshaw	0.0837	0.0826	0.0011	1.31
39	miscellaneous manufacturing	0.3378	0.2936	0.0442	13.08
40	construction. Electricity, railways	4.2552	4.3618	-0.1066	(2.51)
41	communication, trade, banking	3.3292	3.4505	-0.1213	(3.64)
42	education and research	0.9672	0.9563	0.0109	1.13
43	medical and health	0.7385	0.766	-0.0275	(3.72)
44	other services	1.977	1.977	0	-

Aggregate increase in economy level output due to the company technology: 2.24%

The increase in output due to the use of company's technology ranges from 0.06 % to 226.01% (in parentheses). These are the macro repercussions of micro operations. As against this, the minimum decline in output due to this change in technology is 0.11 per cent, while the maximum decline is 88.79 per cent. The maximum positive impact on output has been in four sectors, namely, electronics & communication equipment, industrial machinery, non-ferrous basic metals, and electrical wires and cables.

Table – I (b) indicated that had the efficiency level of L & T's technology been applied to the national level in 30 sectors of the economy, the national output would have been higher by 17 per cent on an average, while in the remaining 14 sectors, it would have been lower to the tune of 9.13 per cent, as shown in the following table.

Table – I (b)

L &T Output / Economy Output

Sl No	Sectors	Economy output / L&T Output	% change	
1	rail equipments	0.112055		
2	miscellaneous manufacturing	0.869153		
3	leather footwear	0.903494		
4	Lime stone, non-metallic minerals	0.945852		
5	rubber, etc	0.973783		
6	inorganic heavy chemicals, others	0.974202		
7	bicycles, cycle-rickshaw	0.986858		
8	education and research	0.988730		
9	Cement	0.989343		
10	jute,hemp,mesta textiles	0.989619		
11	coal tar products	0.995730		
12	Forestry and logging, fishing	0.996535		
13	tractors and agri. Implements	0.997845		
14	Tobacco	0.998889		
	Average impact	0.908720	9.13	% less output
15	other services	1.000000		
16	Other crops, milk, livestock productsetc	1.000618		
17	hydrogenated oil(vanaspati)	1.000846		
18	Paddy,etc	1.000938		
19	miscellaneous food products	1.001141		
20	motor vehicles	1.001422		
21	sugarcane,etc	1.002401		
22	tea,etc	1.002563		
23	Sugar	1.003069		

24	Khadi, miscellaneous textile products	1.005229		
25	ships and boats	1.008130		
26	structural clay products, others	1.010526		
27	soaps, cosmetics & glycerin	1.016049		
28	furniture and fixtures-wooden	1.018587		
29	petroleum products	1.019124		
30	construction. Electricity, railways	1.025052		
31	paper,paperprods. & newsprint	1.027534		
32	Coal and lignite, petroleum	1.029542		
33	communication, trade, banking	1.036435		
34	medical and health	1.037238		
35	hand tools, hardware	1.054204		
36	electrical industrial machinery	1.072816		
37	Iron ore, manganese, bauxite, etc	1.087873		
38	iron, steel and ferro alloys	1.093855		
39	office computing machines	1.125000		
40	drugs and medicines	1.211326		
41	electrical wires &cables	1.218343		
42	non-ferrous basic metals	1.452572		
43	Industrial machinery	2.276442		
44	electronic & communication equipments	3.260076		
	Average impact	1.169965	17.00	% more output

It may be observed from the above table that 30 sectors show on an average, higher efficiency of 17%, while maximum efficiency is seen in the aforesaid four sectors the company is dealing in.

Out of the 15 sectors the company belongs to, the output of 9 sectors has increased, while that of the remaining 6 has decreased. Productivity effect of the company's technology has reinforced the economy level scale effect on the output of these 9 sectors. But, the negative technology effect of the company has swamped the positive scale effect of the economy on the output of the 6 sectors. The change in output of the remaining 29 sectors may be explained only by the indirect effect of company's technology, which may reflect the linkage effect. The growth of output of the remaining 20 of the 29 sectors has increased due to the indirect technology effect of the company. However, 8 of the remaining 15 sectors, the output of which has declined, have borne the

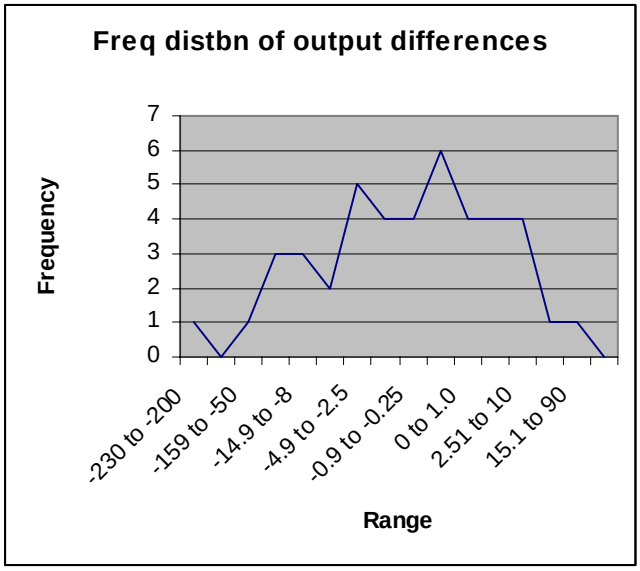
negative technology effect of the company. The output of Other services sector, however, remained unaffected by the company technology.

It is to be noted that the overall total output (all 44 sectors) of the economy increased by 2.24 per cent. This shows the deficiency / loss in growth potential of the economy due to different vintages of technology.

The following table shows the number of sectors along with the various intervals of change in output (Table-I (c) and graph chart). The change in output has naturally been caused due to the level and pattern of sectoral interrelations based on technological linkages.

Table – I (c)

Range (%) refer table I (a)	Frequency
-230 to -200	1
-199 to -160	0
-159 to -50	1
-49.9 to -15	3
-14.9 to -8	3
-7.9 to -5	2
-4.9 to -2.5	5
-2.4 to -1.0	4
-0.9 to -0.25	4
-0.24 to 0	6
0 to 1.0	4
1.01 to 2.5	4
2.51 to 10	4
10.1 to 15	1
15.1 to 90	1
90.1 to 230	0



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