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Efficiency and Regional Comparative Advantage: Revisiting the Factory Sector in India

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Abstract

This paper seeks to estimate trends in Factor Productivity, Technological Progress, and Technological Efficiency in the organised manufacturing sector and examines their relative importance over the last three decades. Levinsohn-Petrin technique has been used to estimate TFP and Stochastic Frontier Production Function Approach has been used to compute Technical Efficiency. Both Factor productivity and Technical Efficiency were observed to decline in the nineties but have picked up in the last decade. Technical progress is still low and does not contribute much to the factor productivity growth. Disparity exists among regions and product groups regarding Efficiency, Technical Progress and their trends. Wider diffusion rather than greater capital use is thus recommended for productivity rise. A Regional Efficiency Matrix has been developed to help states focus on specific industries where they have comparative advantages.

1. Introduction

1.1 India has emerged as one of the fastest growing economies in the present times. However, the current slowdown points out that long-run growth can be sustained only through efficiency improvements and global competitiveness, especially in the manufacturing sector. The manufacturing sector, more specifically the registered factory sector, has been the hotbed of the Structural Adjustment Programme, witnessing a major shift from the Regulation-Nationalization-Protection (RNP) regime to Liberalization-Privatization-Globalization (LPG) environment and dynamics of this sector creates ripples in the economy through various linkage effects. To understand the productivity, efficiency, and comparative advantage of the Indian economy in the long run, it is therefore crucial to understand what has been happening in the manufacturing sector. As efficiency and competitiveness is the buzzword in the new regime, economists have called for technological upgradation of Indian manufacturing sector (Ferrantino, 1992; Mamgain and Awasthi, 2001; Kathuria, 2002; GOI, 2006). Joshi and Little (1996), Agarwal (2001), Forbes (2001), Kathuria (2002), Mitra et al (2002), Rajan and Sen (2002), Ray (2002), Driffield and Kambhampati (2003), and Kambhampati (2003) are some of the studies that estimate productivity trends, efficiency levels, and technological progress in the manufacturing sector in India. However, those studies either consider the manufacturing sector in its totality, ignoring the basic fact that industry level estimates are crucial, or, they have

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considered only single time point/duration not attempting to determine trends in efficiency levels. Earlier work by the present authors (Mukherjee and Majumder, 2008) broke new grounds by looking at *Industry* specific estimates of productivity and efficiency over a long time span. It was observed that in the immediate post-reform period the registered factory sector (henceforth RFS) in India had witnessed a fall in total factor productivity, slowing down of efficiency improvement and deceleration of technological progress. It was argued that improvements in production process in the Indian context should rely more on better mastering of the existing technologies or diffusion rather than simply augmenting the capital-labour ratio. Subsequent developments through the next decade has seen unprecedented growth in the economy – over 6 per cent pa compared to 2.3 per cent pa during 1975-90 and about 4.5 per cent pa during 1990-2000. This period also witnessed a quantum jump in RFS growth – approximately 15 per cent pa growth in output compared to just 9.8 per cent in the 1990s and below 8 per cent during 1980s. Naturally it will be interesting and enlightening to revisit this sector and explore the nature of this growth in light of productivity and efficiency changes. Moreover, in a large country like India different regions have efficiency in production of different commodities and hence a schema of comparative advantage can also be built up for the regions so that specific states encourage those industries in which they have comparatively greater efficiency. Also of interest would be to examine whether the regional matrix has changed during the last decade and what the new regional comparative advantage matrix looks like. The present paper adds value to the existing body of research by exploring the issues of:

a) Total Factor Productivity Growth (TFPG) in the RFS in India, separately for industry groups and states over the last three decades using the Levinsohn-Petrin semi-parametric technique for TFP estimation;
b) Determining trends in productive efficiency of the sector;
c) Disassociating the effects of pure Technological Progress (TP) from those of Technological Efficiency Change (TEC – Diffusion or Learning-by-Doing);
d) Examining relative importance of TP, TEC and TFPG in the sector;
e) Building up a state level comparative advantage matrix so that states may focus on development of specific industries;

1.2 The paper has eight sections. In the next section we discuss the methodological background of the study. The third to sixth sections analyse the results obtained and interprets them. The seventh section builds up a regional comparative advantage matrix. The final section summarises the main findings and provides few policy suggestions in their light.

2. Data & Methodology

a) Database and Operationalisation

2.1 The period of our study is 1980 to 2010. We have used the database obtained from the Annual Survey of Industries brought out by Central Statistical Organization (CSO) in our study. To make the new series comparable with the previous one we have used the concordance tables between NIC-1987-98, NIC-1998-2004, and NIC-2004-08 prepared by

CSO. This requires clubbing some of the industrial activity groups together and we get 14 separate industry groups for our study.[i] Thus, we have a continuous panel data of 14 industry groups and 19 major states for the 1980-2010 period, providing us with 266 observations [(19 states) X (14 sectors)] for each of the 30 years. We consider these 266 observations as *productive units* (e.g. Leather product industry in West Bengal as one *unit*, textile industry of Gujarat as another, and so on). We also try to analyse regional and sectoral dynamics by combining industries into broad groups like consumer non-durables, semi-durables, intermediate capital goods, and equipment; and regions like North, East, West, South, and Central.[ii]

b) Methodological Issues

2.2 Improvements in labour productivity as a consequence of increase in capital stock have often been termed cosmetic on grounds that capital deepening shifts in technique of production necessarily lead to a rise in labour productivity and fall in capital productivity. Therefore, changes in productivity levels are advised to be measured by changes in total factor productivity or *Total Factor Productivity Growth*. TFPG can be estimated using both the Production Function Approach (PFA) and the Growth Accounting Approach (GAA).

i) The Production Function Approach

2.3 In the PFA, TFP is measured as the residual from the estimation of a log-linear *n* factor Cobb-Douglas production function. For the analysis, the production function of state ‘i’ in NIC 2-digit group ‘j’ at time ‘t’ is assumed to have the following form:

$$Y_{ijt} = A_{ijt} [L_{ijt}]^{\alpha j} [M_{ijt}]^{\beta j} [K_{ijt}]^{\theta j} \qquad \text{..........(1)}$$

where Y is a measure of output, and L, M, and K are labour (in mandays), material inputs (in value terms), and capital (in value terms) with their shares in output being α, β, and θ respectively. The subscripts i, j, t refer to state, 2-digit NIC group, and time-period respectively.

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[i] The Industry groups after clubbing are: Food and beverages; textiles; textile products; wood products; paper products; leather products; basic chemicals; rubber and plastic; non-metallic minerals; basic metals; metal products; electrical, electronic and non-electrical equipment; transport equipment; and, manufacture not elsewhere classified. The textiles sector according to National Industrial Classification 1998 (NIC-1998) includes cotton textiles, natural fibre products and wool and silk textiles.

[ii] The Product Groups are as follows: non-durables – food and beverages and textiles; durables – textile products, wood products, paper products, and leather products; intermediates – basic chemicals, rubber and plastic, non-metallic minerals, basic metals, and metal products; machinery-equipment – electrical, electronic and non-electrical equipment, and transport equipment; and, manufacture not elsewhere classified. The 19 major states are regionalised as: Northern – Punjab, Haryana, Himachal Pradesh & Uttarakhand; Eastern – Assam, Bihar, Jharkhand, West Bengal, & Orissa; Western – Rajasthan, Gujarat, & Maharashtra; Southern – Andhra Pradesh, Karnataka, Kerala, & Tamil Nadu; and Central – Uttar Pradesh, Chattisgarh, & Madhya Pradesh.

Transforming equation (1) into logarithms allows for linear estimation of TFP with the equation for the general form written as:

$$\ln A_{ijt} = \ln Y_{ijt} - \alpha_j \ln L_{ijt} - \beta_j \ln M_{ijt} - \theta_j \ln K_{ijt} \qquad \text{..........(2)}$$

2.4 A simultaneity problem arises in estimating equation (2) using OLS when there is contemporaneous correlation between the factors of production and the errors, caused, for example, by the fact that the number of workers hired by a firm and the quantity of materials purchased may depend on productivity shocks that are unobserved by the researcher. This will cause the OLS estimates to be biased. Researchers in the past had tried to correct this bias by using techniques like fixed effect estimation. Recently however, the Levinsohn-Petrin technique (LP method, see Levinsohn and Petrin, 2003 for details) of Instrumental Variable and 2-stage estimation is the preferred method. In this method it is assumed that the firms observe productivity shocks early enough to allow for a change in factor input decisions. The error term in the production function is therefore assumed to be additively separable in two distinct components ω and η which changes the econometric form of equation (1) in log form to:

$$y_{ijt} = a_{ijt} + \alpha_j l_{ijt} + \beta_j m_{ijt} + \theta_j k_{ijt} + \omega_{ijt} + \eta_{ijt} \qquad \text{..........(3)}$$

where ω is the part of the error term that is observed by the firm and correlated with the inputs; and η is a true error term uncorrelated with factor inputs.

2.5 The LP technique then uses firms' material inputs as proxy for the unobserved productivity shocks. Assuming that the firms' demand for material inputs increases monotonically with its productivity conditional on its capital, the demand function for material inputs can be written as:

$$m_{ijt} = m(\omega_{ijt}, k_{ijt}) \qquad \text{..........(4)}$$

and the inverse demand function as:

$$\omega_{ijt} = \omega(m_{ijt}, k_{ijt}) \qquad \text{..........(5)}$$

One can then rewrite equation (3) as:

$$y_{ijt} = \alpha_j l_{ijt} + \varphi_{ijt}(m_{ijt}, k_{ijt}) + \eta_{ijt} \qquad \text{..........(6)}$$

where

$$\varphi_{ijt}(m_{ijt}, k_{ijt}) = a_{ijt} + \beta_j m_{ijt} + \theta_j k_{ijt} + \omega(m_{ijt}, k_{ijt}) \qquad \text{..........(7)}$$

LP method also assumes that materials adjust to productivity shocks with a one period lag following a first-order Markov process, or:

$$\omega_{ijt} = E[\omega_{ijt} \mid \omega_{ijt-1}] + \xi_{ijt} \qquad \text{..........(8)}$$

Therefore equation (7) now becomes:

$$\varphi_{ijt}(m_{ijt}, k_{ijt}) = a_{ijt} + \beta_j\, m_{ijt} + \theta_j\, k_{ijt} + E[\omega_{ijt} \mid \omega_{ijt-1}] + \xi_{ijt} \qquad \text{..........} (9)$$

and equation (6) can be re-written as:

$$y^*_{ijt} = y_{ijt} - \alpha_j\, l_{ijt} = a_{ijt} + \beta_j\, m_{ijt} + \theta_j\, k_{ijt} + E[\omega_{ijt} \mid \omega_{ijt-1}] + \eta^*_{ijt} \qquad \text{..........} (10)$$

where $\eta^*_{ijt} = \xi_{ijt} + \eta_{ijt}$

In the first stage, α_j is obtained from equation (6) using a semi-parametric technique where ö$_{ijt}$ is approximated by a polynomial function.

In the second stage, β_j and θ_j are obtained from equation (10) using generalized method of moments techniques for identification.

Once the estimates of α_j, β_j and θ_j are obtained, TFP can be obtained as:

$$\ln TFP = a_{ijt} = y_{ijt} - \alpha_j\, l_{ijt} - \beta_j\, m_{ijt} - \theta_j\, k_{ijt} = \omega_{ijt} + \eta_{ijt} \qquad \text{..........} (11)$$

and changes in ln TFP will provide us with estimates of TFPG over time.

ii) The Growth Accounting Approach

2.6 In the growth accounting approach formulated by Solow (Solow, 1957), Output growth is decomposed into two components – growth due to changes in inputs, and that due to other factors. The technique uses the following form:

$$TFPG = [\ln Q_{ijt} - \ln Q_{ijt-1}] - 0.5\, [(s^l_{ijt} - s^l_{ijt-1}).(\ln L_{ijt} - \ln L_{ijt-1}) + (s^k_{ijt} - s^k_{ijt-1}).(\ln K_{ijt} - \ln K_{ijt-1}) + (s^m_{ijt} - s^m_{ijt-1}).(\ln M_{ijt} - \ln M_{ijt-1})] \qquad \text{..........} (12)$$

Where s^l, s^k, and s^m are shares of Labour, Capital, and Materials in total Output respectively.

The above equation is based on a general neo-classical production function where the elasticity of substitution need not be constant and the technical change is assumed to be of Hicks-neutral type.

iii) Stochastic Frontier Production Function Approach

2.7 By decomposing output growth into TFPG and that accounted for by input growth, researchers have compared the relative importance of the two, calling for technological upgradation as the main policy instrument for productivity increase whenever TFPG has been significantly positive. However, TFPG in both the production function approach and the growth accounting approach is a residual measure and encompasses the effect of not only TP, but also of better utilisation of capacities, learning by doing, improved labour efficiency, etc. Thus, it is a combination of improved technology and the skill with which known technology is applied by the units, i.e. Technological Efficiency. This second component, i.e. growth in output because of greater experience and skill of workers, better organization by the entrepreneurs, better utilisation of existing resources, etc. are more significant in a developing economy where diffusion of technology is more important than the 'modernity' of the technology itself. In literature pure TP has been distinguished from TEC by using the *Stochastic Frontier Production Function Approach* (SFA) which breaks up observed output growth to lateral movements on or beneath the production frontier (INPG), movement towards the production frontier (TEC), and shifts in the production frontier itself (TP).[iii] One can then study the relative importance of the roles played by each of these three players – Inputs, Technology, and Diffusion, in achieving Output growth.

2.8 The SFA was first formulated by Aigner, Lovell, and Schmidt (1977) and later improved upon by Kumbhakar et al. (1991), Battesse and Coelli (1992), and Kalirajan and Shand (1994). The basic contention is that a firm produces single output Y_i using input vector X_i (multiple inputs) according to the following:

$$Y_i = f(X_i, \beta_i).e^{(v_i - u_i)} \qquad \text{..........(13)}$$

the error term comprising of two components v_i and u_i, both being independent of the inputs. v_i is the traditional symmetric random error term while u_i reflects the *Technical Inefficiency* of the firm that hinders it from achieving maximum possible output with given inputs and technology. u_i-s are assumed to be non-negative and iid. When a firm is fully efficient (technically), u_i is 0 and the firm lies on the frontier, while for a sub-efficient firm u_i is positive and its magnitude measures the *efficiency gap*. SFA can be estimated using MLE and current computational software allows for estimating time-variant technical efficiency coefficients from panel data. It is to be noted that this specification assumes a Hicks-neutral technological change i.e. marginal productivity of all inputs improve equally over time and the production frontiers of subsequent time periods are parallel to the initial one. From estimates of *Inefficiencies*, one can easily obtain estimates of efficiency improvements (Technical Efficiency Change or TEC) over time. Once the estimates of TEC are obtained, one can get estimates of pure Technical Progress by subtracting TEC figures from TFPG figures. The logic becomes clearer from Figure-1 which is adapted from Kalirajan et al (1996).

2.9 While the earlier paper had used GAA for TFPG estimation, in the present paper, we follow the methodologically superior PFA with Levinsohn-Petrin technique. We first use a CD production function with Total Output being dependent on Number of Persondays

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[iii] For theoretical details on Frontier Production Functions, see Aigner et al (1977) and Meeusen and van den Broeck (1977). These original specifications have been altered and extended in a number of ways. For comprehensive reviews of this literature look at Forsund et al (1980), Schmidt (1986), Bauer (1990) and Greene (1993). Battese and Coelli (1992) propose a stochastic frontier production function for (unbalanced) panel data, which has firm-specific 'inefficiency' effects that are assumed to be distributed as truncated normal random variables (as inefficiency can at least be zero when the firm is on the frontier). The 'inefficiency' effects are also permitted to vary over time. This model has been supplemented by their computer programme Frontier Version 4.1 used to empirically measure Efficiency of firms over a number of periods. This programme has been used here.

engaged, Materials consumed, and Fixed Capital and apply LP technique to obtain estimates of TFPG in Indian organised manufacturing. Thereafter, the SFA has been used to decompose TFPG into pure Technical Progress and Technical Efficiency Changes. Output, Input, and Capital values are expressed at constant 1993-94 prices using appropriate price indices.

2.10 Unlike some of the previous studies [like Mukherjee and Ray (2004)], we have estimated the TFPG, efficiencies, and related parameters *separately* for each of the industries, as it is quite natural that different industries will have different production functions. Moreover, we try to analyse not only efficiency levels but also temporal changes in them. In addition, to facilitate regional industrial policy, we have also built up a regional comparative advantage matrix to provide us with state-level focus groups. Let us now explore the results in details.

3. Trends in Factor Productivity

3.1 One of the major successes of Indian economy in the post-SAP period has been the substantial growth of the organised manufacturing sector, registering 9.8 per cent per annum growth in Output during 1990-2000, and 15 per cent during 2000-10, compared to just 8 per cent during the earlier decade (Table 1). But what part of this growth is due to technological advancement and what part is just through greater input use is to be examined. Historically, most of the growth in manufacturing output in developing economies is attributed to increased input use (close to 70 per cent, Chenery et al, 1986). India's performance has been much worse in this regard – TFPG being (–)0.4 per cent pa during 1960-85 (Ahluwalia, 1991). This miserable situation had improved in the later decades and TFPG during 1979-1990 has been estimated to be around 1.4-1.8 per cent pa during 1980-90 (Unel, 2003; Mukherjee and Majumder, 2008). However, the immediate post-SAP period witnessed a substantial drop in factor productivity with a negative TFPG rate of -1.3 per cent pa indicating that RFS output growth was mainly due to input growth. The situation again bounced back in the last decade when TFPG rate was around 1.4 per cent pa. These aggregate trends however vary across industries and regions. TFPG has been relatively higher in the Central and Western states and also in the Intermediate Goods and Machinery & Equipment sector.

3.2 Even though TFPG have been positive in the last decade, it has played the role of second fiddle to input growth with just about 12 per cent cases where TFPG is higher than Input growth rate. Frequency of TFPG being higher than Input growth was more in Central and Eastern states, though aggregate TFPG is lower in these regions.

4. Technical Efficiency

4.1 We are however more concerned about the efficiency of the RFS in utilising available resources. It is observed that substantial inefficiency exists among this sector with mean efficiency level being 65-70 per cent during in 1980-2000 period. Only in the last decade technical efficiency has improved noticeably and stood at 86 per cent in 2010 (Table 2 and 3). Consistently high efficiency levels are exhibited by the states of Gujarat, Kerala, Maharashtra and Himachal Pradesh. While Tamil Nadu and West Bengal had satisfactory efficiency levels during the eighties, their position declined alarmingly in the immediate post-SAP period, recovering somewhat in the last decade.

4.2 On the other hand, Karnataka, Madhya Pradesh, Punjab, and Rajasthan have sharply improved their mean efficiency levels in the recent past. Assam and Bengal too has had substantial increase in technical efficiency in the last decade.

4.3 Among the industry groups, comparatively higher efficiency levels are exhibited by Wood products, Metal products and Equipment sectors in all the years. Leather products sector lost the efficiency exhibited by it during the eighties, while Paper products (including publishing) and Transport equipment sectors came up the ladder during the nineties. Textiles sector had seen a spurt in efficiency level during the nineties, only to fizzle down in the last decade. Rubber & Plastic, Non-metallic mineral products, Basic Chemicals, and Textile products sector have also shown remarkable increase in technical efficiency levels in the last decade.

5. Technical Efficiency Changes & Technological Progress

5.1 Improvements in efficiency should be a major thrust area in today's globalised scenario where success depends on international competitiveness. In this count however the RFS in India has a mixed performance. Average annual rate of technical efficiency change (TEC) was (-)0.1 percentage points per annum during the whole of nineties compared to an increase at 0.6 percentage points per annum during the eighties (Table 4). The last decade however has witnessed a substantial rise in efficiency at the rate of 1.5 percentage points per annum.

5.2 However, there are substantial regional and inter-industry disparities regarding TEC. While there was a drop in technical efficiency in the eastern states during the nineties, they have shown the highest increase in efficiency in the last decade. In contrast, northern and western states had shown substantial rise in efficiency in the immediate post-SAP period but witnessed a drop in efficiency levels in the last decade.

5.3 Among the industries, efficiency levels had increased only for the Intermediate sectors during the eighties. During the nineties, though efficiency level declined at aggregate, it improved in the non-durables and machinery & equipment sectors. During the last decade, TEC has been positive for all product groups, more so for the machinery & equipment and intermediate goods sectors.

5.4 It is generally perceived that technical progress is the main driving force behind productivity growth, especially in manufacturing industries. In fact TFPG have often been considered synonymous with TP, though that is not so. We have measured TP as the difference between TFPG and TEC. The performance of RFS regarding TP had been fairly satisfactory during the eighties with an average annual rate of 1 per cent (Table 4). TP was positive for all product groups and regions except the central states. Highest TP was exhibited by the Machinery & Equipment sector followed by the Durables sector. Among the regions, northern and southern states showed relatively higher rates of TP. During the nineties, the rate of TP became negative (-1.4 per cent per annum) in the aggregate and in all regions except the eastern states. This was caused mainly due to the huge drop in TP in the Non-durables and Intermediate goods sector and marginal improvement in the rest. The situation somewhat remedied in the last decade with the rate of TP coming out of red, though just so, and a complete reversal at the regional level. At the sectoral level, negative TP continued in the Non-durables sector and manufacture not classified. TP was negative also in the intermediate goods sector while machinery & equipment sector had the highest TP during this decade. A closer inspection reveals that the only sector where efficiency declined in aggregate during the last decade was the Textiles sector in spite of its having the highest rate of TP during this time (Table 5).

6. Upgradation versus Diffusion

a) Broad Results

6.1 It is generally accepted that Technological Progress is the result of Upgradation of technology in the factory floors. On the other hand, Technical Efficiency Changes (rise) are due to diffusion of existing technology across units and across workers in the same unit. If we now compare between the two ingredients of TFPG - TEC and TP - observations can be made regarding the relative roles played by Upgradation and Diffusion in the Indian manufacturing sector in recent times.

6.2 It is observed that in the first two decades of our study, rate of TP has been higher than the rate of TEC both in the positive and negative direction. During the 1980s when TP was positive, TEC was also positive but efficiency was increasing at a lower rate. During the nineties rate of TP was substantially negative and efficiency had also declined but at a lower rate. The strength of TEC was therefore lower compared to TP in the initial two decades. However, in the last decade, TEC and TP are almost equal in magnitude at the aggregate, with TEC holding a slight edge over TP. At the regional level TP is higher than TEC all through, except in the eastern states where it is negative. However, at the sectoral level, TEC outstrips TP in consumer durables, intermediate products, and manufacture unclassified. This is quite encouraging as it is expected that facing a globally competitive atmosphere units will strive that much harder to achieve better organization and utilisation of available inputs and improve their efficiency levels, more so in a situation of technological stagnancy. It is quite evident that this has started in India in the last decade.

6.3 These broad results quite expectedly vary across industries. It is observed that the (consumer) durables sector have witnessed negative efficiency change along with positive TP in the last decade. The Machinery & Equipment sector has experienced both improved efficiency and positive TP, while the (consumer) non-durables, Intermediate goods, and unclassified manufacturing sectors have shown positive efficiency change with negative technical progress.

b) Explaining Inter-industry Differences

6.4 What explains such inter-industry difference? The answer perhaps lies in the dynamics of the sectors in the recent past. The Durables sector has experienced huge technical progress in recent times but efficiency improvements have been non-existent.

The Machinery & Equipment sector has cornered the majority of investment in the last decade – both in terms of domestic and foreign capital. So it has gained access to sophisticated technology and output growth has taken place along with substantial technological progress and efficiency gains. For the consumer non-durables and Intermediate goods sectors on the other hand, the quanta of investment, both domestic and foreign, are lower and thus their access to advanced technology has been limited. Faced with substantial global competition, they had to rely more on better utilisation of available technology and so their growth depended more on efficiency improvements rather than on pure TP. In this regard, presence of larger numbers of small and medium sized firms with lower capital intensity in this sector has also played a significant role.

7. Regional Efficiency Matrix

a) Concept and Methodology

7.1 We have so far discussed levels and trends in productivity, efficiency and TP in RFS in India and have identified certain factors that are affecting such efficiency levels. While policies must aim at improving the efficiency levels of the sector in general, it would be worthwhile to concentrate on areas of strength. Encouraging industries exhibiting high efficiency levels may be one major dimension of policy thrust. It is also imperative that in a geographically vast country like India different states will have efficiency in different industries because of natural, traditional and socio-economic factors. Though federal in nature, states in India are quite independent in framing their industrial and economic policies. This provides ample scope for each of the states to focus on industries where they are efficient. These strengths can be judged from two aspects – interstate comparative advantage and intra-state comparative advantage. There would be industries where a certain state is more efficient relative to other states i.e. where it has ***Inter-State Comparative Advantage***. Secondly, there would be industries where a particular state has greater efficiency compared to other industries *within* that state - indicating ***Intra-State Comparative Advantage***. While from the national macroeconomic standpoint it is optimal that industries are located according to inter-state comparative advantage, for a particular state, its industrial policy should take into account the intra-state comparative advantage also. Industries where a state enjoys both types of comparative advantage should be the ***Focus Group*** for the state. We have therefore constructed a regional comparative advantage matrix where each state-industry combination is denoted by (X_{ij}, Y_{ij}). X_{ij} refers to efficiency rank of i^{th} state in j^{th} industry among all states, and Y_{ij} refers to the rank of j^{th} industry in i^{th} state among all industries in that state. We have used a condition wherein interstate comparative advantage is supposed to exist if $X_{ij} \leq 10$ and intrastate comparative advantage is supposed to exist if $Y_{ij} \leq 5$. From such a matrix, we have identified the focus groups for each state in Table 7, which is self-explanatory.

b) The Comparative Advantage Scenario

7.2 What are the changes that have occurred over the last decade? A comparison with a similar regional matrix for the earlier decade (Mukherjee and Majumder, 2008) provides certain interesting insights. First, the intra-state efficiency set has become much more homogenous across states compared to what it was ten years earlier. This indicates that the sectoral dynamics are now operative on a pan-India level through increased flow of technology and skill across state borders. Second, the inter-state efficiency set has become much more narrower than before, indicating increased scope of regional comparative advantage and regional specialisation. As a result, the focus group for each state has become thin, facilitating the scope of concentrating state level industrial policy on few specific industries. Third, the focus group has undergone drastic changes over the last decade for most of the states (Table 8). Therefore, industrial policies of the last decade would not be appropriate in the recent times and if states do not catch up with the reality, regional industrial development will neither be optimal, nor will they be sustainable.

8. Conclusion

8.1 We have seen that the tremendous growth of registered factory sector in India since the 1990s has been mainly fuelled by rising input use and less by productivity gains. Efficiency improvement had slowed down and technological progress decelerated in the nineties but has picked up in the last decade. Even then, efficiency improvement has been the main driving force for growth in total factor productivity in the recent past. Consequently, policies for the organised manufacturing sector should address these issues. Innovation and adaptation process, which is predominant in this sector, should be encouraged through knowledge sharing. Formation of industrial clusters, sharing experiences of successful units, and even sharing of 'idle' resources may prove helpful in this. Moreover, efforts to improve technology involve greater use of capital goods and requires substantial amount of financial resources. Given the present condition of the economy, this is a costly and difficult proposition. On the other hand, diffusion of existing technology and improvements in organization, skill, and efficiency require less capital and more 'human involvement'. However, shortage of skilled manpower across the spectrum is already rearing its ugly head as a major roadblock for the manufacturing sector. Policies therefore should look into the labour supply issues as well (see Majumder, 2013 for this issue). In addition, it would be crucial for the states to concentrate on specific group of industries rather than try to push all types of industries. The matrix prepared in this study may be an indicator in this regard. Wider diffusion of existing knowledge base, focussed policy thrust and upgraded technology are the three pillars that can ensure sustainable growth of the manufacturing sector in India.

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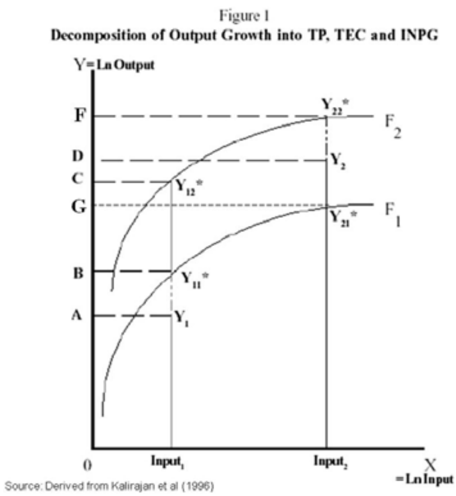

Output growth = $Y_2 - Y_1$ = DA

Inefficiency (period1) TIE_1 = BA

Inefficiency (period2) TIE_2 = FD

Contribution of Input growth (INPG) = FC

TFPG = Output growth – contribution of input growth = DA – FC = CA – FD

= BA – FD + BC

= $[TIE_1 - TIE_2]$ + TP

= $[TE_2 - TE_1]$ + TP

= Technical Efficiency Change + TP

Table 1

Output, Input and Total Factor Productivity Growth - 1980-2010 (% per annum)

	Output Growth			*Input Growth*			*TFP Growth*		
	1980-1990	*1990-2000*	*2000-2010*	*1980-1990*	*1990-2000*	*2000-2010*	*1980-1990*	*1990-2000*	*2000-2010*
Region									
Central	5.7	6.3	11.0	4.5	6.6	8.5	1.2	-0.3	2.6
East	1.2	1.3	15.6	-1.0	2.2	14.9	2.2	-0.9	0.7
North	5.9	7.3	16.5	3.9	8.7	14.9	2.0	-1.4	1.6
South	4.9	7.3	14.9	3.5	9.0	13.4	1.4	-1.7	1.5
West	3.3	7.8	14.9	3.2	9.4	13.0	0.1	-1.6	1.9
All India	**4.0**	**6.5**	**14.8**	**2.6**	**7.8**	**13.4**	**1.4**	**-1.3**	**1.4**
Product Group									
Non-durables	3.2	4.2	10.5	1.8	6.6	10.1	1.4	-2.4	0.4
Durables	0.8	5.5	8.3	0.7	5.9	7.1	0.1	-0.4	1.2
Intermediates	4.6	8.4	17.4	3.4	9.0	15.4	1.2	-0.6	2.0
Machinery & Equip	3.7	5.4	16.9	2.4	6.7	14.8	1.3	-1.3	2.1
Others	12.1	8.6	18.3	12.1	11.0	17.2	0.0	-2.4	1.1
All industries	**4.0**	**6.5**	**14.8**	**2.6**	**7.8**	**13.4**	**1.4**	**-1.3**	**1.4**

Source: Authors' Calculation based on CSO (Various Years).

Note: Output Growth rates are derived by compound regression method and are significant at 5 per cent level; TFPG is derived by compound regression method using TFP estimates obtained using PFA-LP technique; Input Growth Rates are differences between Output and TFP growth rates.

Table 2

Technical Efficiencies of Registered Factory Sector in India – State (average across Industries)

States	*Technical Efficiency*				*Annual Rate of Change*		
	1980	*1990*	*2000*	*2010*	*1980-90*	*1990-00*	*2000-10*
Andhra Pradesh	69.0	53.9	77.6	72.1	-1.5	2.4	-0.6
Assam	62.1	92.6	67.9	82.4	3.1	-2.5	1.4
Bihar	52.2	91.6	75.9	79.0	3.9	-1.6	0.3
Gujarat	100.0	82.0	97.4	81.9	-1.8	1.5	-1.6
Haryana	99.5	76.2	94.5	84.6	-2.3	1.8	-1.0
Himachal Pradesh	92.6	69.3	96.2	77.3	-2.3	2.7	-1.9
Karnataka	71.7	83.9	67.0	68.2	1.2	-1.7	0.1
Kerala	97.2	89.0	100.0	88.5	-0.8	1.1	-1.1
Madhya Pradesh	65.6	79.2	88.3	82.6	1.4	0.9	-0.6
Maharashtra	92.3	94.2	91.9	78.4	0.2	-0.2	-1.3
Orissa	71.9	86.3	64.5	59.1	1.4	-2.2	-0.5
Punjab	67.5	83.0	86.8	74.8	1.6	0.4	-1.2
Rajasthan	83.5	69.4	88.6	79.7	-1.4	1.9	-0.9
Tamil Nadu	90.3	83.5	89.2	81.0	-0.7	0.6	-0.8
Uttar Pr	52.5	81.1	76.4	81.4	2.9	-0.5	0.5
West Bengal	82.5	56.8	63.9	78.6	-2.6	0.7	1.5
All India	**64.4**	**70.8**	**70.1**	**78.0**	**0.6**	**-0.1**	**0.8**

Source: Authors' Calculation based on CSO (Various Years).

Table 3

Technical Efficiency in Registered Factory Sector in India – Industry (average across States)

NIC Groups	*Technical Efficiency*				*Annual Rate of Change*		
	1980	*1990*	*2000*	*2010*	*1980-90*	*1990-00*	*2000-10*
Food & beverages	52.4	42.9	56.7	66.8	-1.0	1.4	1.0
Textiles	76.1	79.8	94.6	70.8	0.4	1.5	-2.4
Textile products	50.5	100.0	46.1	83.2	5.0	-5.4	3.7
Wood products	86.1	100.0	73.5	97.8	1.4	-2.7	2.4
Paper products	62.7	73.5	78.1	92.5	1.1	0.5	1.4
Leather products	100.0	20.5	61.0	65.9	-8.0	4.1	0.5
Basic chemicals	39.6	52.4	53.5	91.2	1.3	0.1	3.8
Rubber and plastic	15.4	53.5	30.5	87.2	3.8	-2.3	5.7
Non-metallic minerals	76.1	66.8	42.3	78.4	-0.9	-2.5	3.6
Basic metals	53.6	57.1	60.0	68.1	0.4	0.3	0.8
Metal products	78.3	78.8	79.8	91.4	0.1	0.1	1.2
Elec & Non-elec Equip	77.6	82.3	73.4	98.9	0.5	-0.9	2.6
Transport Equipment	72.6	34.2	86.6	94.0	-3.8	5.2	0.7
Others	40.2	81.8	60.0	85.6	4.2	-2.2	2.6
All India	**64.4**	**70.8**	**70.1**	**78.0**	**0.6**	**-0.1**	**0.8**

Source: Authors' Calculation based on CSO (Various Years).

Table 4

Average annual rates of TEC and TP – 1980-2000

	Average annual rates of TEC			*Average annual rates of TP*		
	1980-1990	*1990-2000*	*2000-2010*	*1980-1990*	*1990-2000*	*2000-2010*
Regions						
Central	2.1	0.2	0.8	-0.7	-0.6	1.8
East	1.5	-1.4	1.3	1.1	0.4	-0.6
North	-1.0	1.6	0.6	3.4	-3.3	1.0
South	-0.4	0.6	0.4	2.0	-2.6	1.1
West	-1.0	1.1	1.1	1.1	-3.0	0.8
All India	**0.6**	**-0.1**	**0.8**	**1.0**	**-1.4**	**0.6**
Product Groups						
Non-durables	-0.3	1.4	0.6	1.9	-4.2	-0.2
Durables	-0.1	-0.9	-0.1	0.2	0.4	1.3
Intermediates	0.9	-0.8	2.5	0.5	0.1	-0.5
Machinery & Equip	-1.7	2.2	1.1	3.2	-3.7	1.0
Others	4.2	-2.2	3.3	-4.2	-0.6	-2.2
All industries	**0.6**	**-0.1**	**0.8**	**1.0**	**-1.4**	**0.6**

Source: Authors' Calculation based on CSO (Various Years).

Table 5

TEC and TP in Registered Factory Sector in India – 2000-10

State/Region	***TEC***	***TP***	***NIC Groups***	***TEC***	***TP***
Andhra Pradesh	-0.6	1.0	Food & beverages	1.0	-0.5
Assam	1.4	0.0	Tobacco	0.3	0.2
Bihar	0.3	3.0	Textiles	-2.4	3.7
Chattisgarh	-1.5	4.1	Textile products	3.7	-3.8
Gujarat	-1.6	4.0	Leather products	0.5	0.3
Haryana	-1.0	2.3	Wood Products	2.5	-1.5
Himachal Pr	-1.9	3.3	Paper products	2.0	0.3
Jharkhand	-0.6	0.3	Publishing etc	0.1	-0.4
Karnataka	0.1	3.0	Coke & Fuel	4.5	-1.7
Kerala	-1.1	2.6	Basic chemicals	2.4	-0.6
Madhya Pr	-0.6	0.1	Rubber and plastic	5.7	-3.9
Maharashtra	-1.3	3.1	Non-metallic minerals	3.6	-1.4
Orissa	-0.5	-1.1	Basic metals	0.8	1.1
Punjab	-1.2	1.9	Metal products	1.2	-0.3
Rajasthan	-0.9	4.1	Elec & Non-elec Equip	2.7	-0.2
Tamil Nadu	-0.8	2.0	Transport Equipment	0.6	1.7
Uttar Pr	-0.1	4.3	Others	2.6	-1.5
Uttarakhand	0.8	1.5			
West Bengal	1.5	1.8			
All India	**0.8**	**0.6**	**All Industry**	**0.8**	**0.6**

Source: Authors' Calculation based on CSO (Various Years).

Table 7

Identification of focus groups for major states

State	***Inter-state efficiency***	***Intra-state efficiency***	***Focus group***
Andhra Pr	Machinery & Equip, Wood Product, Electrical Machinery	Machinery & Equip, Office & Computing Equip, Wood Product, Metal Product, Paper Product, Rubber & Plastic	Machinery & Equip, Wood Product
Assam	Metal Product, Textile Product, Textiles, Tobacco, Rubber & Plastic	Machinery & Equip, Office & Computing Equip, Wood Product, Metal Product, Textile Product, Transport Equip	Metal Product, Textile Product
Bihar	Textiles, Leather Product, Tobacco, Textile Product	Machinery & Equip, Office & Computing Equip, Wood Product, Metal Product, Paper Product, Textiles	Textiles
Chattisgarh	Basic Chemicals, Food & beverage, Transport Equip, Metal Product, Textile Product, Paper Product	Machinery & Equip, Office & Computing Equip, Wood Product, Metal Product, Transport Equip, Paper Product	Metal Product, Paper Product
Gujarat	Machinery & Equip, Office & Computing Equip, Food & beverage, Electrical Machinery	Machinery & Equip, Office & Computing Equip, Wood Product, Paper Product, Metal Product, Food & beverage	Machinery & Equip, Office & Computing Equip, Food & beverage
Haryana	Machinery & Equip, Basic Chemicals, Basic Metals, Wood Product, Metal Product	Machinery & Equip, Office & Computing Equip, Wood Product, Metal Product, Transport Equip, Basic Chemicals	Machinery & Equip, Basic Chemicals, Wood Product, Metal Product
Himachal Pr	Rubber & Plastic, Metal Product, Leather Product, Tobacco, Basic Metals	Machinery & Equip, Office & Computing Equip, Wood Product, Metal Product, Rubber & Plastic, Transport Equip	Rubber & Plastic, Metal Product
Jharkhand	Wood Product, Textiles, Non-metallic Mineral Product, Paper Product, Tobacco, Textile Product	Machinery & Equip, Office & Computing Equip, Wood Product, Paper Product, Metal Product, Transport Equip	Wood Product, Paper Product
Karnataka	Machinery & Equip, Office & Computing Equip, Electrical Machi-nery, LeatherProduct	Machinery & Equip, Office & Computing Equip, Wood Product, Metal Product, Rubber & Plastic, Transport Equip	Machinery & Equip, Office & Computing Equip
Kerala	Tobacco, Rubber & Plastic, Basic Chemicals, Food & beverage, Textiles, Metal Product	Machinery & Equip, Office & Computing Equip, Wood Product, Metal Product, Paper Product, Rubber & Plastic	Rubber & Plastic, Metal Product

Table 7 (Cntd.)

Identification of focus groups for major states

State	***Inter-state efficiency***	***Intra-state efficiency***	***Focus group***
Madhya Pr	Machinery & Equip, Office & Computing Equip, Food & beverage, LetherProduct, Electrical Machinery, Basic Metals	Machinery & Equip, Office & Computing Equip, Wood Product, Metal Product, Transport Equip, Food & beverage,	Machinery & Equip, Office & Computing Equip, Food & beverage
Maharashtra	Textile Product, Office & Computing Equip, Wood Product, Leather, Product, Electrical Machinery	Machinery & Equip, Office & Computing Equip, Wood Product, Textile Product, Paper Product, Metal Product	Textile Product, Office & Computing Equip, Wood Product
Orissa	Paper Product, Office & Computing Equip, Metal Product, Rubber & Plastic, Non-metallic Mineral Product, Food & beverage	Machinery & Equip, Office & Computing Equip, Wood Product, Paper Product, Metal Product, Rubber & Plastic	Paper Product, Office & Computing Equip, Metal Product, Rubber & Plastic
Punjab	Basic Metals, Non-metallic Mineral Product, Rubber & Plastic, Wood Product, Textile Product, Transport Equip	Machinery & Equip, Office & Computing Equip, Wood Product, Metal Product, Rubber & Plastic, Transport Equip	Rubber & Plastic, Wood Product, Transport Equip
Rajasthan	Food & beverage, Paper Product, Textiles, Electrical Machinery	Machinery & Equip, Office & Computing Equip, Wood Product, Paper Product, Food & beverage, Metal Product	Food & beverage, Paper Product
Tamil Nadu	Machinery & Equip, Tobacco, Transport Equip, Non-metallic Mineral Product, Electrical Machinery, Textiles	Machinery & Equip, Office & Computing Equip, Wood Product, Transport Equip, Metal Product, Paper Product,	Machinery & Equip, Transport Equip
Uttar Pr	Machinery & Equip, Office & Computing Equip, Paper Product, Electrical Machinery, Tobacco	Machinery & Equip, Office & Computing Equip, Wood Product, Paper Product, Metal Product, Transport Equip	Machinery & Equip, Office & Computing Equip, Paper Product
Uttarakhand	Leather Product, Office & Computing Equip, Basic Chemicals, Non-metallic Mineral Product, Electrical Machinery	Machinery & Equip, Office & Computing Equip, Wood Product, Leather Product, Transport Equip, Metal Product	Leather Product, Office & Computing Equip
West Bengal	Non-metallic Mineral Product, Office & Computing Equip, Textiles, Textile Product, Food & beverage	Machinery & Equip, Office & Computing Equip, Wood Product, Metal Product, Textile Product, Non-metallic Mineral Product	Office & Computing Equip, Textile Product

Source: Authors' Calculation, methodology explained in text.

Table 8

Changes in Focus Groups for States

States	***Focus Groups - 2000***	***Focus Groups - 2010***
Andhra Pr	Paper products; metal products; machinery and equipment	Machinery & Equip, Wood Product
Assam	Paper products;leather products; rubber and plastic; non-metallic minerals	Metal Product, Textile Product
Bihar & Jharkhand	Food and beverages; paper products leather products; basic metals	Textiles, Wood Product, <u>**Paper Product**</u>
Gujarat	Textile products; wood products; basic metals	Machinery & Equip, Office & Computing Equip, Food & beverage
Haryana	Food and beverages; non-metallic minerals; basic metals	Machinery & Equip, Basic Chemicals, Wood Product, Metal Product
Himachal Pr	Leather products; basic chemicals; non-metallic minerals; machinery and equip	Rubber & Plastic, Metal Product
Karnataka	Textiles; wood products; paper products; metal products	Machinery & Equip, Office & Computing Equip
Kerala	Paper products; leather products; basic metals; transport equip	Rubber & Plastic, Metal Product
Madhya Pr & Chattisgarh	Textiles; paper products; leather products; basic metals	Machinery & Equip, Office & Computing Equip, Food & beverage, Metal Product, <u>**Paper Product**</u>
Maharashtra	Textiles; basic chemicals; rubber and plastic; machinery and equip	Textile Product, Office & Computing Equip, Wood Product
Orissa	Textile products; leather products; basic metals	Paper Product, Office & Computing Equip, Metal Product, Rubber & Plastic
Punjab	Basic chemicals; rubber and plastic	Rubber & Plastic, Wood Product, Transport Equip
Rajasthan	Textile products; leather products; basic metals; metal products	Food & beverage, Paper Product
Tamil Nadu	Textiles; paper products; non-metallic minerals; metal products; transport equip	Machinery & Equip, Transport Equip
Uttar Pr & Uttarakhand	Wood products; basic metals; machinery and equip	Machinery & Equip, Office & Computing Equip, Paper Product, Leather Product
West Bengal	Textiles; textile products; metal products; transport equip	Office & Computing Equip, <u>**Textile Product**</u>

Source: Authors' Calculation.

Note: Product groups that feature in both years are marked in bold underline.