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Manufacturing an engine of growth in India – Analysis in the post-nineties

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Abstract:
The traditional neoclassical model, under the assumptions of access to similar technology, comparable saving-rates and an identical rate of labor force growth, predicts that due to decreasing returns to capital accumulation, convergence in GDP per capita will more or less automatically occur. It is quite clear that this notion does not consider the relevance of investment (through manufacturing, as it is the locus of technical change) or other supporting factors required to catch-up. Incidentally, all the standard assumptions of neo-classical model can be satisfied at sub-national level, where different regions or states have not only access to the same technology, but also governed by more or less similar credit availability, labour supply. This implies that testing for convergence hypothesis and whether manufacturing acts as a engine of growth is less controversial at the sub-national level than at the supra -national level. Under this backdrop this paper tests: Is there any evidence that manufacturing has acted as an "engine of growth" for the Indian states?; Has dualism (presence of unorganized sector) abetted industrialization? and lastly, is the current path of industrialization sufficient to generate the jobs necessary to absorb the growing population?

Keywords: Engine of Growth, Manufacturing, Productivity, Industrial Sector, Dynamic Industries

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1. Introduction

The conceptualization of economic growth has seen a sea change in recent past. The traditional neoclassical growth models have given way to endogenous growth models where idea of perfect competition, decreasing returns and exogenous technology yielded to more realistic characterization with firms having market power, scale economies and investing in R&D to determine technology endogenously. In this new characterization, according to Cornwall (1977), manufacturing plays a pivotal role as it is the locus of technological change. There are several other arguments, which though need empirical verification in the current scenario of increasing use of information and communication technology (ICTs), yet suggest how manufacturing can be an engine of growth.[12]

In recent economic growth literature, issue of 'convergence' of countries is keenly debated (Baumol, 1986; DeLong, 1988; Barro, 1991; Barro and Sala-i-Martin, 1991, 1992, 1995; Mankiw *et al*., 1992; Loayza, 1994; Sala-i-Martin, 1996, 1994; Pritchett, 1997). The traditional neoclassical model, under the assumptions of access to similar technology, comparable saving-rates and an identical rate of labor force growth, predicts that due to decreasing returns to capital accumulation, convergence in GDP per capita will more or less automatically occur.[3] It is quite clear that this notion does not consider the relevance of investment (through manufacturing, as it is the locus of technical change) or other supporting factors required to catch-up, which Cornwall (1977) and other researchers working on endogenous growth models have considered imperative. Perhaps due to these contrasting views only, literature on convergence has spawned in the last two decades. Incidentally, all the standard assumptions of neo-classical model can be satisfied at sub-national level, where different regions or states have not only access to the same technology, but also governed by more or less similar credit availability, labour supply. This implies that testing for convergence hypothesis and whether manufacturing acts as an engine of growth is less controversial at the sub-national level than at the supra-national level.

Under this backdrop, the present study aims to find whether manufacturing has acted as an "engine of growth" at sub-nation level in one of the fastest growing economy of the world, i.e., India.[4] The choice of India is appropriate as the unshackling of reforms in 1991 removed several barriers to grow and offered avenues to enhance productivity especially for the manufacturing sector.[5] Yet, the impact of reforms has been quite differential. Some of the industrialized states like Gujarat, Maharashtra or Tamil Nadu have grown faster than the states like Uttar Pradesh, Bihar or Madhya Pradesh. The former having average growth rate of 5.7% during 1991-92 to 2003-04 against 4.1% of the latter states for the same period. In this paper we ask: is there any evidence that manufacturing has acted as an "engine of growth" for the Indian states? This is followed by what role has been played by the dynamic sectors in industrialization.

[1] Refer Szirmai (2008, 2009) for a brief discussion and evidence of all these arguments.

[2] Though share of services is increasing in most economies, many of the knowledge intensive service sectors like software, banking etc. have manufacturing as their locus.

[3] In absence of these conditions, the convergence would be conditional and countries with similar characteristics i.e., having same labour force growth and saving rate would form convergence club (Barro and Sala-i-Martin, 1995).

[4] Among all developing countries (and even developed countries) India has recorded an impressive average growth of 7.3% in the last 10 years (1998 to 2007). Only China has grown faster (9.8%) than India during this period.

[5] The reforms specifically targeted manufacturing sector due to the realization that the sector offered much greater prospects for capital accumulation, technical change and linkages and hence job creation, especially for the semi-skilled and poorly educated segment of the labour force, which comprises most of India's working poor.

Dualism in Indian manufacturing – with the presence of a large number of informal/unorganized firms[6] - is well acknowledged. It is estimated that the unorganised sector contributes around 80 per cent of the manufacturing employment and about 17 per cent to manufacturing output. In the second stage, paper looks into what role unorganized sector has played in India's growth. Lastly, the paper attempts to answer following question – is the current path of industrialization sufficient to generate the jobs necessary to absorb the growing population?

Thus, the specific objectives of the present paper are: i) Is there any evidence that manufacturing has acted as an "engine of growth" for the Indian states? ii) Has dualism (presence of unorganized sector) abetted industrialization? and lastly, iii) Is the current path of industrialization sufficient to generate the jobs necessary to absorb the growing population?

The first objective is addressed using the methodology as given by Cornwall (1977) and later modified by Fagerberg and Verspagan (1999, 2002). The methodology involves regressing the real growth rates on growth rates of manufacturing. If the coefficient of manufacturing growth is higher than the share of manufacturing in GDP, this is interpreted as supporting the engine of growth hypothesis.

Since output growth may be at the expense of using more inputs rather than utilizing the inputs more efficiently. The analysis would be reinforced by computing productivity levels and productivity growth of both organized and unorganized manufacturing sector across major Indian states. This is done by employing a recently developed technique by Levinsohn and Petrin (2003) that accounts for simultaneity bias.[7] In order to do so, the study uses unit level data for both organized and unorganized sectors and aggregates at 4-digit level.

The remaining paper is organized as follows: section 2 gives different arguments supporting manufacturing as an engine of growth. Section 3 gives methodology to find whether manufacturing is engine of growth or not. The section also gives the methodology to compute TFP. Section 4 gives in brief the data and the variable used. The preliminary results are given in Section 5. The paper concludes with section 6.

2. Manufacturing an Engine of Growth - Arguments[8]

There are eight different channels which illustrate how manufacturing can act as engine of growth. The development path as followed by a large number of present day rich countries is from Agriculture to manufacturing to services. The productivity being higher in the manufacturing sector and the sector being more dynamic, the transfer of labour / resources from agriculture to manufacturing would immediately lead to increased productivity (termed as a *structural change bonus*), thereby contributing to growth. On the other hand, according to Baumol, the transfer of resources from manufacturing to services provides a *structural change burden* (termed as Baumol's disease). This is because productivity is less in services

[6] The enterprises employing less than 20 workers without the use of electricity or 10 workers with the use of electricity or are not producing hazardous substances (such as chemicals) fall under unorganized/informal sector. These firms are not required to register with the authorities under the Indian Factories Act of 1948.

[7] Simultaneity bias or endogeneity problem arises because productivity is observed by the profit maximizing firms early enough to influence their input levels. This means that the firms will alter their use of inputs in case of any productivity shocks. This knowledge of productivity shock has been ignored by researchers in the past while computing productivity, hence leading to the bias.

[8] This section takes mainly from Szirmai (2008).

compared to manufacturing. Hence, as the share of the service sector increases, aggregate per capita growth will tend to slow down (Szirmai, 2009).[9] Of late, the increased use of ICTs in wide variety of sectors including education, healthcare, and supply-chain has made services very dynamic; thereby the argument may not be entirely valid.

Opportunities for capital accumulation and for *embodied and disembodied technological progress* are other two reasons for manufacturing to act as an engine of growth (Cornwall, 1977). Capital accumulation can be more easily realised in spatially concentrated manufacturing than in spatially dispersed agriculture. Technological advance is concentrated in the manufacturing sector and diffuses from there to other economic sectors such as the service sector.

The manufacturing sector also offers significant opportunities for *economies of scale* in large number of key industries like steel, cement, automobiles, which are less available in agriculture or services. Incidentally, due to the increasing use of ICTs in service sectors and their inherent characteristic of negligible marginal cost, these economies are no longer restricted to manufacturing.

Linkages – both forward and backward - and *spillover effects*[10] – within manufacturing and other sectors - are stronger for manufacturing than for agriculture or mining. Increased final demand for manufacturing output will induce increased demand in many sectors supplying inputs. In addition to these backward linkages, Cornwall (1977) emphasizes that the manufacturing sector also has many forward linkages, through its role as a supplier of capital goods (and the new technologies that these goods embody). Lastly, *Engel's law* states that as per capita incomes rise, the share of agricultural expenditure in total expenditure declines and the share of expenditure on manufactured goods increases. The implication of this is that if countries specialize in agricultural and primary products, they will not gain from expanding world markets for manufacturing goods.

3. Methodology

According to Pollard (1990), industrialization is a single process in which individual countries have followed different paths depending on their initial conditions and moment of their entry. Different ways exist to find out whether manufacturing is engine of growth or not. These include using growth accounting techniques and econometric analysis (Szirmai, 2008). In growth accounting techniques, the contribution of growth of manufacturing is found for a given growth rate of national income. The contribution obtained from these techniques is often underestimation as they do not take various external effects and spillovers into account of dynamic sectors like chemical, machine tools etc. These spillover effects are better captured with econometric techniques. The present paper also uses econometric techniques to find whether manufacturing is engine of growth or not. The paper essentially uses the conceptual framework of Cornwall (1977) as improved by Fagerberg and Verspagan (1999).

Besides, the paper also computes total factor productivity (TFP) growth for manufacturing industry using a recently developed technique - Levinsohn and Petrin (2003) - that accounts for simultaneity bias.

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[9] The structural change thus have implication for catch-up as developing countries with higher shares of manufacturing will have larger growth vis-à-vis developed countries which on account of larger services share would have lower growth.

[10] Spillover effects refer to the disembodied knowledge flows between sectors.

Manufacturing as Engine of Growth

According to Cornwall (1977), the manufacturing sector would act as engine of growth for two reasons – it displays dynamic economies of scale through "learning by doing" (Young, 1928, Kaldor, 1966, 1967). With increased output, the scope for learning and productivity increase becomes larger. Thus, the rate of growth of productivity in manufacturing will depend positively on the rate of growth of output in manufacturing (called as the Kaldor-Verdoorn law). Secondly, manufacturing sector leads to enhanced productivity growth through its linkages with other manufacturing and non-manufacturing sectors.

Cornwall's model of economic growth can be summarized in following two equations:

$$\mathbf{Q = c_1 + a_1 Q_m} \qquad \text{--------------- (1)}$$

$$\mathbf{Q_m = c_2 + a_2 Q + d q_r + e(I/Q)_m} \qquad \text{--------------- (2)}$$

where Q and Q_m are output and manufacturing output respectively, q_r is GDP per capita relative to the technology leader (e.g., the U.S.), I/Q is investment as a fraction of output, c, a, b, d and e are parameters. Equation (1) states that if manufacturing is the engine of growth, the parameter a_1 would not only be positive but also greater than the share of manufacturing in GDP. Equation (2), on the other hand, introduces a feedback from overall demand growth on manufacturing production (due to linkages), thus a_2 would also be positive. The equation allows for catching up by (industrial) latecomers (hence d is expected to be negative). The inclusion of the investment share (e positive) suggests Cornwall's emphasis on investment as a necessary supporting factor for successful catch-up (Fagerberg and Verspagan, 1999).

Estimation of above model implies both Q and Q_m are endogenously determined, hence ordinary least squares (OLS) estimates would yield biased results. Both however cannot be estimated simultaneously, as the second equation is not identified. It does not satisfy the order condition.[11] Hence, it cannot be estimated by any estimation technique. The first equation, however, is over-identified, and may be estimated by a single equation technique that takes the simultaneous equation bias into account, such as, the instrumental variables/two-stage least squares method (2SLS) (Fagerberg and Verspagan, 1999).

To estimate the equation using instrumental variable (IV) technique, we selected following instruments (exogenous variables): *Initial state domestic product (SDP) per capita* (in log-form), *education* (average literacy rate over 1994-2001), and *unemployment rate* (mean value over 1995-2001).

Measuring Productivity

We have employed both partial and total factor productivity (TFP) approaches to estimate productivity. Labour productivity, defined as output per labour, is the partial factor productivity measure used in this context. Capital-labour ratio, measured as real gross fixed assets divided by total number of persons engaged, is the other factor ratio used in the study.

[11] In order to satisfy order condition, the equation must exclude at least *N*-1 exogenous variables, where *N* is the number of equations in the model (in this case 2).

As regards TFP growth, we estimate the Cobb-Douglas (CD) production function in equation (3) separately for each of the 15 major Indian states.[12]

$$\ln Y_{ijt} = A_{it} + \beta_L \ln L_{ijt} + \beta_K \ln K_{ijt} \qquad \text{--------------- (3)}$$

The subscripts 'i', 'j' and 't' indexes the state, industry and time period. The variables Y, L and K represent the real value added, labour and capital input respectively. 'A' is TFP which represents the efficiency of the firm in transforming inputs into output.

The estimation of the coefficients of labour and capital using OLS method implicitly assumes that the input choices are determined exogenously. However, firm's input choices can be endogenous too. For instance, the number of workers hired by a firm and the quantity of materials purchased may depend on unobserved productivity shocks. These are overlooked by the researcher but they certainly represent the part of TFP known to the firm. Since input choices and productivity are correlated, OLS estimation of production functions will yield biased parameter estimates. To correct this endogeneity bias, we employed a methodology recently developed by Levinsohn and Petrin (2003).[13]

Levinsohn and Petrin (LP) Methodology

Simultaneity arises because productivity is observed by the profit maximizing firms (but not by the econometrician) early enough to influence their input levels (Marschak and Andrews, 1944). This means that the firms will increase (decrease) their use of inputs in case of positive (negative) productivity shocks. OLS estimation of production functions thus yield biased parameter estimates because it does not account for the unobserved productivity shocks.

LP method overcomes the simultaneity problem by using intermediate inputs (*m*) as a proxy to proxy unobserved productivity shocks. [14] In LP, the first stage involves estimating the following equation:

$$y_{it} = \beta_0 + \beta_l l_{it} + \emptyset_t(m_{it}, k_{it}) + \varepsilon_{it} \qquad \text{------------------------------- (4)}$$

where $\emptyset_t(m_{it}, k_{it}) - \beta_k k_{it} + f_t^{-1}(m_{it}, k_{it})$ is a non-parametric function. The estimates of β_l and $\emptyset_t$ are obtained in the first stage.

The second stage of the LP estimation obtains the estimate of β_k. Here, like OP, LP assumes that productivity (ω) follows a first-order Markov process, and is given by

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[12] The states included are Andhra Pradesh (AP), Assam, Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh (MP), Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu (TN), Uttar Pradesh (UP), and West Bengal (WB). Figure 1 in appendix 1 gives the location of these states.

[13] Some of the researchers in the past corrected this bias using techniques such as the fixed effect estimation or the semi-parametric methodology developed by Olley and Pakes (1996) (henceforth OP). The fixed effects estimation however eliminates only unobservable *fixed* firm characteristics that may affect simultaneously input choices and TFP; there may still be unobserved *time varying* firm characteristics affecting input choices and TFP. OP method overcomes the simultaneity problem by using the firm's investment decision to proxy unobserved productivity shocks. Since a large number of units in unorganized sector hardly go for investment in capital for years together, this may lead to a considerable drop in the number of observations in our dataset, an obvious efficiency loss. LP method is similar to OP method but uses some other variable as instrument.

[14] LP use electricity as a proxy in their study. We could not use electricity as majority of firms in the unorganized sector are working without power which would have led to dropping considerable number of firms from our sample.

$$\omega_{it} = E[\omega_{it}|\omega_{it-1}] + \epsilon_{it}$$ ---------------------------------- (5)

This assumption states that capital does not respond immediately to ϵ_{it}, which is the innovation in productivity over last period's expectation (i.e., the shock in productivity). It leads directly to the following moment condition:

$$E[\epsilon_{it}|k_{it}] = 0$$ ------------------------------- (6)

The equation (6) states that the unexpected part of the innovation in productivity in the current period is independent of this period's capital stock, which was determined by the previous period's investment. Using this moment condition, β_k can be estimated from the following expression:

$$\epsilon_{it}(\beta_k) = \omega_{it} \quad E[\omega_{it}|\omega_{it-1}] = (\hat{\varnothing}_{it} \quad \beta_k k_{it}) \quad \hat{\varphi}(\beta_k)$$ ---------------------------- (7)

This moment condition identifies the capital coefficient, β_k. The saliency of this strategy lies in the assumption that the current period's capital stock is determined before the shock in the current period's productivity.

4. Data and variables

Data for the 'Engine of Growth' analysis

The first objective of our study is to examine whether or not the manufacturing sector has acted as an engine of growth for the major Indian states. We require data on growth of manufacturing output and net state domestic product (NSDP) for the period 1994-95 to 2004-05 which are obtained from various sources. As stated earlier, we considered output for the overall manufacturing sector rather than for the registered manufacturing sector given that unregistered manufacturing sector occupies significant share in output and employment. To arrive at this figure, we merged the output figures for the organized and unorganized sectors obtained from Annual Survey of Industries (ASI) and National Sample Survey Organisation (NSSO) datasets respectively for the selected years. It is to be noted that ASI gives annual data for registered manufacturing sector, whereas NSSO gives data on informal or unorganized manufacturing sector periodically. Data on NSDP for the same years were drawn from the *Handbook of Statistics on the Indian Economy* published by the Reserve Bank of India (RBI).

Data for Productivity Measurement

Since a large portion of the manufacturing workforce is in the informal sector, for productivity measurement also we consider the combined manufacturing sector for the analysis. Data for the informal manufacturing sector for the selected states are obtained from the NSSO surveys on the unorganized manufacturing sector for 1994-95, 2000-01 and 2005-06 respectively.[15] Data for the same three years for the organized sector were obtained from the ASI.[16] We have aggregated the unit level data to arrive at the four-digit industry level data for each state. The data cleaning as necessitated by the technique requirement and research question in mind involved following steps: a) the study has considered only

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[15] The NSSO conducts surveys on the unorganized manufacturing sector quinquennially. Though the NSSO initiated this survey in 1978-79, a complete firm level dataset was available only from 1994-95. This fits well with our objective also.

[16] It is important to note here that the ASI data for 2005-06 is yet to be released. On account of it, we have considered the ASI dataset for the year 2004-05.

those industries for which three year data was available. Secondly, b) while aggregating the data up to four digit level, we have omitted units reporting zero or negative capital stock, zero output and zero employment. And lastly, c) as in 2000, Bihar, MP and UP were bifurcated and three new states Uttrakhand, Chattisgarh and Jharkhand were formed. In the present analysis, these three states were merged with their parent states so as to have consistent data for all the three time periods. In the end, the total number of industries used for estimation ranged from 39 in Assam to 98 in UP and Maharashtra in the organized sector while it varied between 44 in Assam and 98 in UP in the unorganized sector (Table 1).

Table 1: Number of Industries used for analysis (at four digit level)

	Region	**States**	**Organized Sector**	**Unorganized Sector**	**Overall Industries**
1	North	Punjab	84	69	91
2		Haryana	84	60	91
3		Rajasthan	85	63	92
4		Uttar Pradesh (UP)	98	98	98
5	East	Bihar	87	80	86
6		Assam	39	44	69
7		West Bengal (WB)	94	84	97
8		Orissa	65	53	80
9	Central	Madhya Pradesh (MP)	90	67	92
10	West	Gujarat	92	70	96
11		Maharashtra	98	90	100
12	South	Andhra Pradesh (AP)	95	69	97
13		Karnataka	95	64	97
14		Kerala	86	64	91
15		Tamil Nadu (TN)	97	81	100

Variables

Net State Domestic Product (NSDP)

The NSDP figures were obtained from the report on Handbook of Statistics on Indian Economy published by RBI. The values are expressed in 1993-94 prices.

Output

The output figures refer to production for the combined manufacturing sector (organized and unorganized). Industry level Wholesale Price Index (WPI) for manufactured products at 1993-94 prices is used to deflate the nominal values of output.

Gross value added

We used double deflated value added to estimate total factor productivity growth (TFPG). Like Output, we used the industry level WPI for manufactured products at 1993-94 prices to bring them to constant prices. Similarly, WPI for all commodities at 1993-94 prices is used to deflate nominal values of intermediate inputs in the organized and unorganized manufacturing sectors. In the case of the latter, we have used the WPI figures at the aggregate level due to the non-availability of industry level data. In case of few firms, real value added was negative, we converted them to one for log transformation required for estimation of production function.

Capital

Studies using capital have often used perpetual inventory method (PIAM) to arrive at the time series of the capital stock. In the present study, we have used data for different time points and the data does not give the accumulated depreciation, hence could not employ PIAM. Instead we have used the total fixed assets as given in the ASI and NSSO reports to represent capital input in the organized and unorganized sector respectively. The capital input includes land, buildings and other construction, plant and machinery, transport equipment, tools and other fixed assets that have a normal economic life of more than one year from the date of acquisition. The total fixed assets were deflated by WPI for machine and machinery tools in both the sectors to arrive at values in 1993-94. Since the WPI for machine and machinery tools are not available at the industry level, this forced us to use all India figures to deflate gross fixed assets.

Labour

Total number of persons engaged is used as the measure of labour input. Since working proprietors / owners and supervisory/managerial staff have a significant influence on the productivity of a firm, the number of persons engaged was preferred to the total number of workers.

5. Results

Before testing for manufacturing as engine of growth, we look at how share of manufacturing, agriculture and services change as the States become more developed. This is carried out by regressing the share of manufacturing, services and agriculture respectively on the level of per capita income. All the regressions are based on 13 years data from 1993-94 to 2005-06 by pooling for all the 15 states.[17] In each case linear and non-linear specifications were tested. Figure 1 and Table 2 give the results.

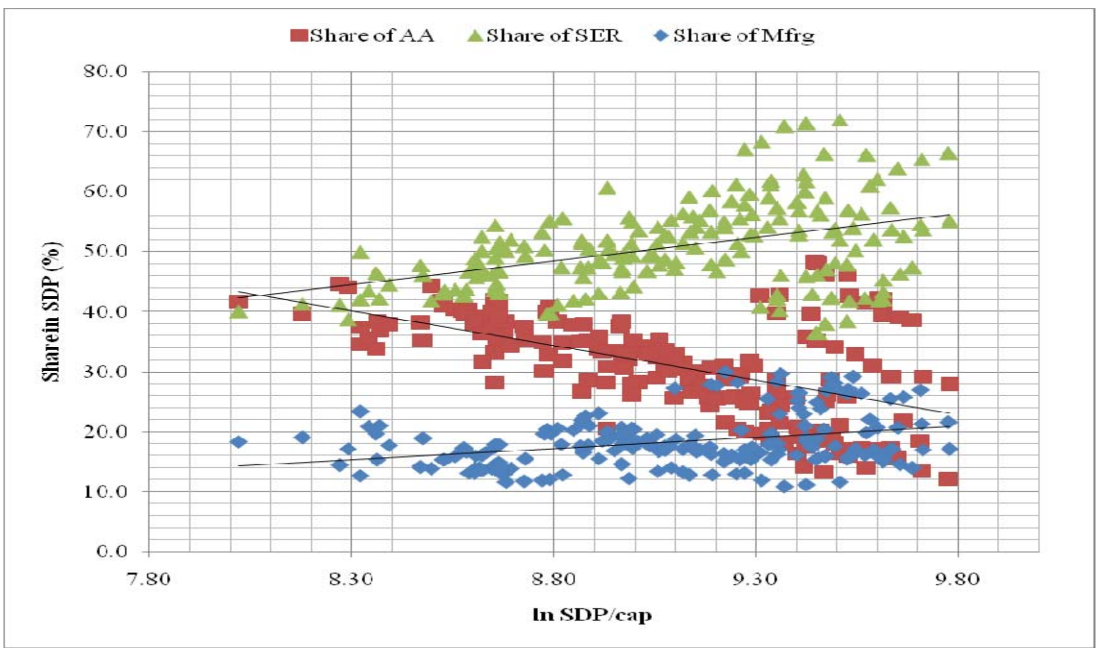


Figure 1: Sub-national relationship between State Domestic Product (SDP) and manufacturing, services and agriculture share in SDP – 1993-94 to 2005-06 (at 1993-94 prices)

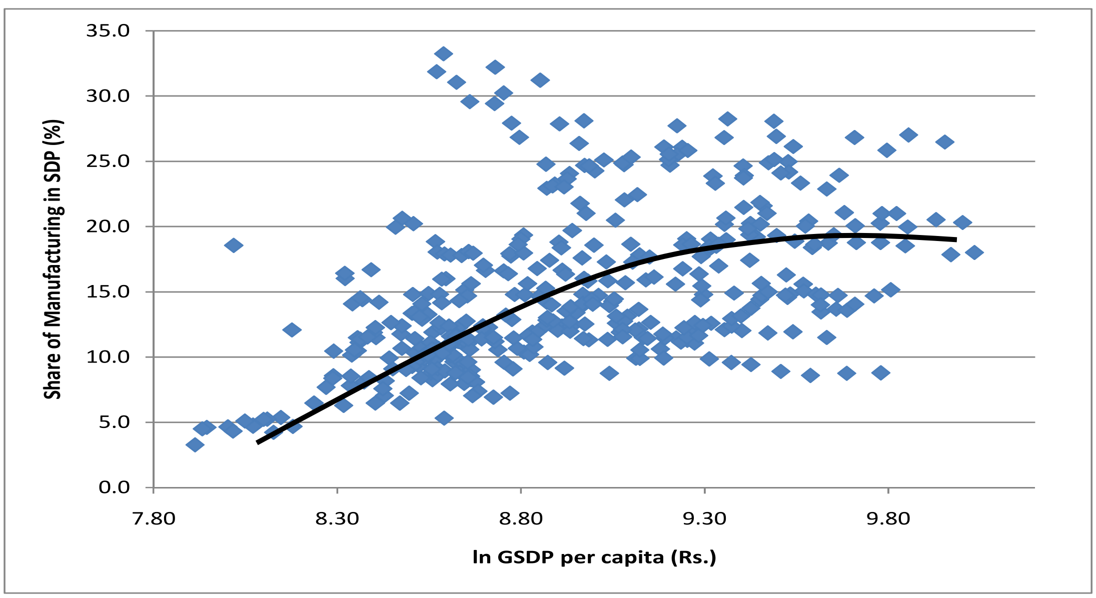
[17] For six states, at the time of analysis the data was until 2004-05. Inclusion of 2005-06 data however did not change the results.

Table 2: Regression results - how per capita SDP affects sectoral share?

Variable	Dep. Var = share of manufacturing (1)	Dep. Var = share of Services (2)	Dep. Var = share of Agriculture (3)
Constant	-15.65* (6.96)	-449.31* (189.84)	136.07* (12.54)
Ln(NSDP/cap)	3.73* (0.78)	103.10* (42.72)	-11.56* (1.42)
Ln(NSDP/cap)^2	-	-5.28* (2.40)	-
R^2	0.11	0.20	0.30
F value	23.0 (0.00)	43.04 (0.00)	66.17 (0.00)
N	184	184	184

Notes: * - indicates the coefficient is statistically significant at minimum 5 per cent level. Figures in the parentheses are the standard errors.

It needs to be mentioned at the outset that these estimations are underspecified as the purpose of these regressions are not to fully explain the factors influencing sectoral shares rather than to appreciate the basic relationship between economic development and sectoral shares. The negative coefficient of agriculture clearly indicates its declining role as economy grows (Figure 1). For services, which already forms over half of the share in SDP for many of the Indian states, the relation seems to be inching closer to inverted U. For manufacturing also, though we envisaged an inverted relationship, the coefficient is positive and relation is linear. However, for longer time period (1980-81 to 2007-08), non-linear relation becomes evident (Figure 2). The explanatory power of the model also rises with longer time period.



ln(Mfrgshare) = -39.62 + 8.924*ln(SDP/cap)-0.468*ln(SDP/cap)^2 (R^2=0.37, N = 420, $F_{(2,417)}$ = 102.1)

Figure 2: Sub-national relationship between State Domestic Product (SDP) and manufacturing share in SDP – 1980-81 to 2007-08 (at 1993-94 prices)

From the non-linear relation, one can find the threshold level of per capita income beyond which the share of manufacutring starts declining and softening of economy takes place. The estimation indicates that the threshold level of per capita SDP is approximately Rs. 15,000 and at that level of per capita SDP, the share of manufacturing is nearly 18%. Any further increase in SDP leads to economy moving towards services with reduced manufacturing share.

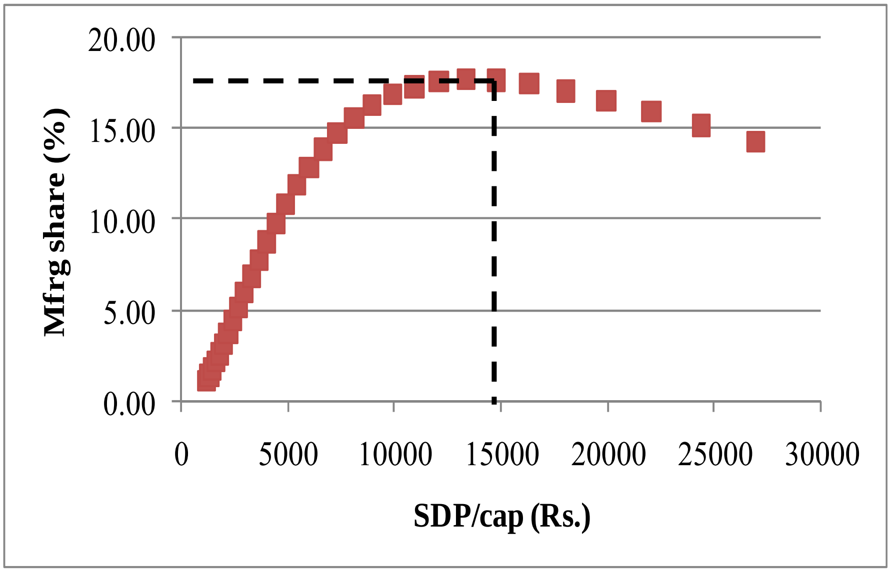


Figure 3: Threshold level of per capita SDP and corresponding manufacturing share

Based on the threshold per capita SDP, we find that there are States like Assam, Bihar, MP, Orissa, Rajasthan, UP and WB, where manufacturing share is likely to increase with increased income. We also plot growth in manufacturing output and NSDP growth for different states for the period 1994-2005 (Figure 4).

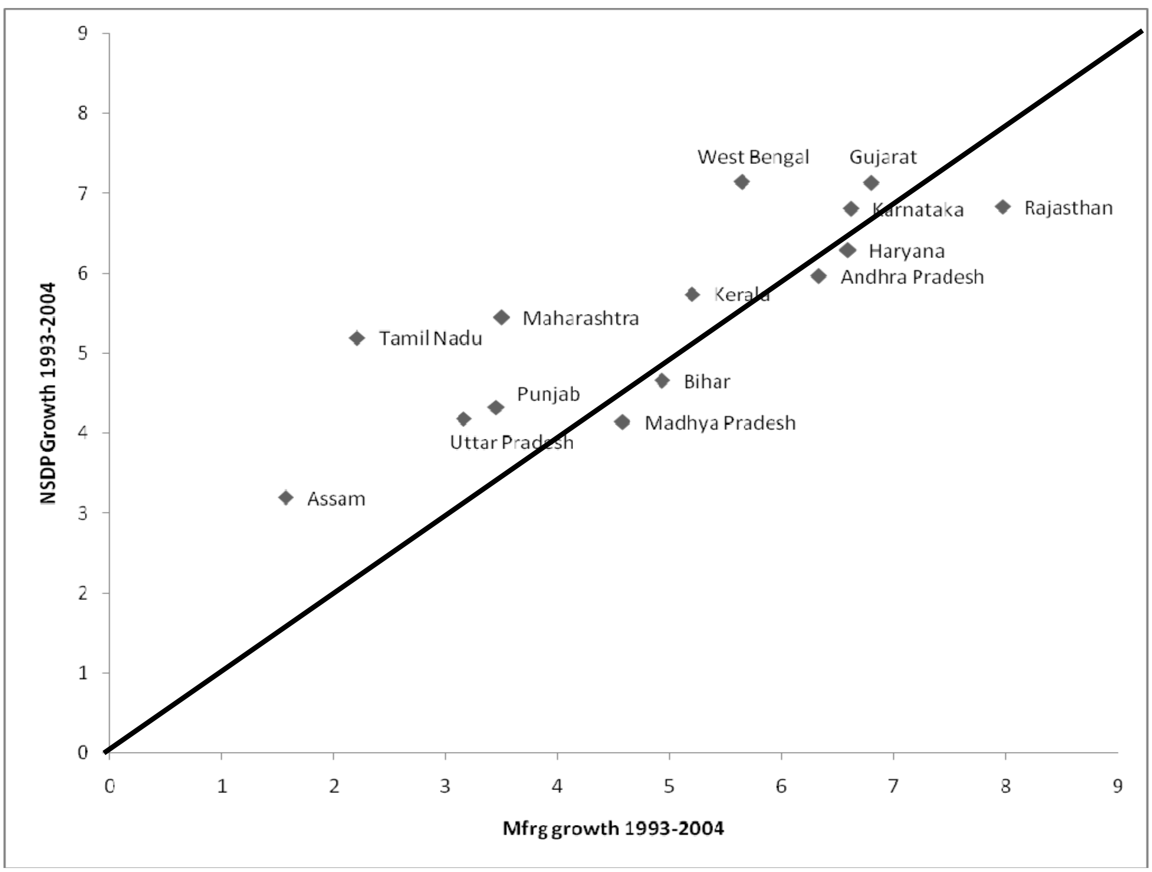


Figure 4: Scatter plot of Manufacturing growth vs. NSDP growth

It can be seen from the figure that growth of manufacturing output and NSDP growth are moving in the same direction in all the states. In Assam, UP, Punjab, TN, Maharashtra, Kerala, Karnataka, WB, Gujarat NSDP grew faster than the manufacturing output. In the remaining states, the growth of manufacturing is more than that of the NSDP.[18] The exact relation whether manufacturing is engine of growth or not can only be seen using methodology given in section 3.

Testing for manufacturing as engine of growth

The results of the instrumental variable (IV) /2SLS estimations and OLS are given in Table 3. The table gives results for three variants – original model, model with dummy for states which have taken pro-active initiatives in reforms and model with dummy for states which are non-Bimaru.[19] In order to see whether feedback from overall growth on manufacturing output is important, we tested for endogeneity. Wooldridge's (1995) robust score test indicates that the test statistic is not significant, thereby rejecting endogeneity for all the variants. Hence, simultaneity bias does not seem to an important problem.

For the sample as a whole and for the other two variants of the models there appears to be a significant positive relationship between manufacturing growth and GDP growth, with coefficient estimates close to 0.28. The results thus support the idea of manufacturing as an engine of growth, as the coefficient value is greater than the share of manufacturing in SDP, which is approximately 0.2 (Table 4). However for the states which have taken pro-active initiatives in reforms (row 3), and the non-Bimaru states (row 4), the results show that they contribute significantly to NSDP growth.

Table 3: Estimation results - Manufacturing as Engine of Growth for 15 major Indian States

		OLS Results			2SLS/IV Results		
		1	**2**	**3**	**4**	**5**	**6**
1	Constant	4.02* (10.87)	4.10* (8.6)	3.19* (6.4)	4.99* (3.87)	3.93* (5.04)	2.78* (2.16)
2	Manufacturing Growth	0.28* (4.12)	0.26* (3.47)	0.29* (4.61)	0.088 (0.33)	0.19 (1.11)	0.38# (1.6)
3	Dummy for Reform Initiatives		0.94* (1.71)			1.06* (2.19)	
4	Dummy for non-BIMARU states$			1.32* (2.61)			1.35* (2.55)
5	Instruments				NSDP per capita, literacy rate, unemployment rate		
6	R Square	0.35	0.42	0.49	0.18	0.40	0.46
7	F-value/Chi-square	16.9	11.0	12.4	0.11	7.93	6.65

Notes: Figure in parenthesis are t-values and *, # indicate significance at minimum 10% and 11% levels.

The manufacturing acting as an engine of growth for Indian states is interesting because the contribution of manufacturing is not very high in the State Domestic Product. Not only the share is low, even it is declining as is evident from Table 4, which gives the share of manufacturing and services in state domestic product for 1994-95 and 2004-05 respectively. Given an average share of 0.2, the coefficient indicates that manufacturing acts an engine of growth.

[18] If we bifurcate the sample into two time periods – 1994 to 2000 and 2000 to 2004, the position of most of the states remains same except for UP in period 1 and TN in period 2. Both these states experience negative growth in manufacturing though registering a growth in NSDP in the respective periods.

[19] The literal meaning of BIMARU is sick. BIMARU are few states in North India characterized by poor law enforcement and infrastructure – both physical and human, high illiteracy and entrenched caste system.

Table 4: Share of manufacturing and services to SDP and change – 1994-95 to 2004-05

States	Manufacturing as % of SDP		Change	Services as % of SDP		Change
	1994-95	2004-05		1994-95	2004-05	
Punjab	16.0	14.8	-1.3	36.4	47.4	11.0
Haryana	17.4	17.3	0.0	40.3	55.1	14.8
Rajasthan	18.3	18.9	0.5	45.7	55.8	10.1
Uttar Pradesh	18.4	16.0	-2.3	42.7	52.0	9.3
Bihar	20.5	21.8	1.3	38.7	46.0	7.3
Assam	18.9	16.0	-3.0	44.1	55.1	11.0
West Bengal	21.9	18.6	-3.2	47.4	61.3	13.9
Orissa	21.6	25.9	4.3	43.0	50.5	7.5
Madhya Pradesh	23.8	23.4	-0.4	39.6	51.4	11.8
Gujarat	30.6	28.1	-2.4	42.9	54.6	11.7
Maharashtra	28.1	22.6	-5.5	53.6	66.4	12.8
Andhra Pradesh	20.2	19.0	-1.2	49.6	58.3	8.7
Karnataka	23.3	20.4	-2.8	44.3	61.8	17.5
Kerala	19.2	15.3	-4.0	54.2	72.1	17.9
Tamil Nadu	29.3	20.9	-8.4	46.8	66.1	19.4
Av. of 15 states	**20.5**	**18.4**	**-2.1**	**45.7**	**58.4**	**12.7**

Source: RBI, Handbook of Statistics (2008)

Barring Rajasthan, Orissa and Haryana, for all other states share of manufacturing has fallen. On the other hand, all the States have become more service oriented. Except for Bihar and Punjab, the services contribution is over 50% of SDP for all other states. Interestingly despite continuous increase in the share of services in the last 2-3 decades, it is not unequivocally acting as an engine of growth, as is indicated by coefficient of Service growth (row 2) in Table 5.[20] Only in one variant, its coefficient (0.61) is more than its share in SDP (column 1), which was over 0.58 in 2004-05 (last row, Table 4).

Table 5: Estimation results - Services as Engine of Growth for 15 major Indian States

		OLS Results		2SLS/IV Results	
		1	**2**	**3**	**4**
1	Constant	0.67 (0.68)	1.00 (0.81)	1.32 (0.59)	1.32 (0.44)
2	Services Growth	0.61* (5.31)	0.53* (3.04)	0.52* (1.83)	0.48 (1.11)
3	Dummy for Reform Initiatives		0.49 (0.67)		0.56 (0.61)
4	Instruments			NSDP per capita, literacy rate, unemployment rate	
5	R Square	0.32	0.34	0.32	0.33
6	F-value/Chi-square	28.24	14.3	3.34	8.88

Notes: Figure in parenthesis are t-values and * indicates significance at minimum 10% levels.

Output growth – Factor accumulation or productivity growth

An attempt is also made to examine what is driving output growth in the manufacturing sector. Such an analysis would be useful in suggesting a solution to improve the growth of manufacturing sector for the Indian states. We report output growth, labour productivity growth, employment growth, growth in capital-labour ratio and TFP growth in Table 6. In short, we tried to see whether the output growth in the

[20] Here also, tests do not indicate endogeneity, thus no simultaneity bias. OLS gives unbiased results.

sector is a result of productivity growth or factor accumulation. Figure 5 plots the output growth, productivity growth and capital-labour ratio for different states. Table 6 and the figure clearly show that the growth in output is mostly input driven and not productivity driven in the manufacturing sector in most of the states. We find a move towards more capital intensive production process. Thus, it is the growing investment rather than employment, which is driving output growth in the sector.

Though the sector witnessed a growth in labour productivity in all the states, it is clearly evident from the table that the growth in labour productivity is perhaps an outcome of decline in employment. This argument is further supported by the results of TFP growth which registered a positive growth only in 6 states. TFP grew in Karnataka, MP, Gujarat, UP, Rajasthan and Punjab but TFP growth in these states is accompanied by a decline in employment. Gujarat is an exception where higher productivity growth led to higher output growth. On the other hand, Assam, the state with second highest growth in output, registered a decline in TFP growth. Even in the states pioneering reforms, where manufacturing sector might have acted as an engine of growth, it is the factor accumulation, especially capital, that is driving output growth. This however raises the sustainability issue – whether the output growth fueled by factor accumulation / input growth can be sustained or not?

Table 6: What is causing Output growth – Factor accumulation or productivity change?

States	**Output growth**	**Labour productivity growth**	**Employment growth**	**Growth in K/L**	**TFP growth**		
					Obs.	**Mean**	**SD**
Punjab	1.56	2.41	-2.3	6.66	87	0.80	8.23
Haryana	6.13	4.92	-0.3	8.44	86	-1.53	8.75
Rajasthan	2.97	3.07	-1.7	4.58	88	0.54	13.06
Uttar Pradesh	5.10	4.61	-4.3	6.35	96	1.07	9.57
Bihar	-3.32	0.27	-5.7	7.35	81	-2.51	13.93
Assam	8.10	3.34	0.4	7.35	65	-1.39	13.63
West Bengal	3.39	3.42	-8.2	9.70	95	-1.17	10.79
Orissa	4.00	0.70	-3.5	6.00	76	-2.59	14.65
Madhya Pradesh	2.75	3.71	-2.1	5.11	90	3.52	9.86
Gujarat	8.20	4.40	-4.9	7.40	92	4.16	9.76
Maharashtra	4.53	3.18	-5.6	6.72	74	-1.05	4.15
Andhra Pradesh	2.59	3.15	-4.0	6.52	78	-1.11	5.47
Karnataka	7.21	5.91	-4.1	7.79	85	0.79	7.00
Kerala	3.03	0.52	-3.6	5.12	87	-2.42	8.66
Tamil Nadu	2.36	4.27	-4.0	8.02	91	-1.16	4.75
Mean	**3.91**	**3.40**	**-3.8**	7.03	**85**	**-0.27**	**9.48**

Note: TFP growth is estimated using LP method as discussed in Section 3.

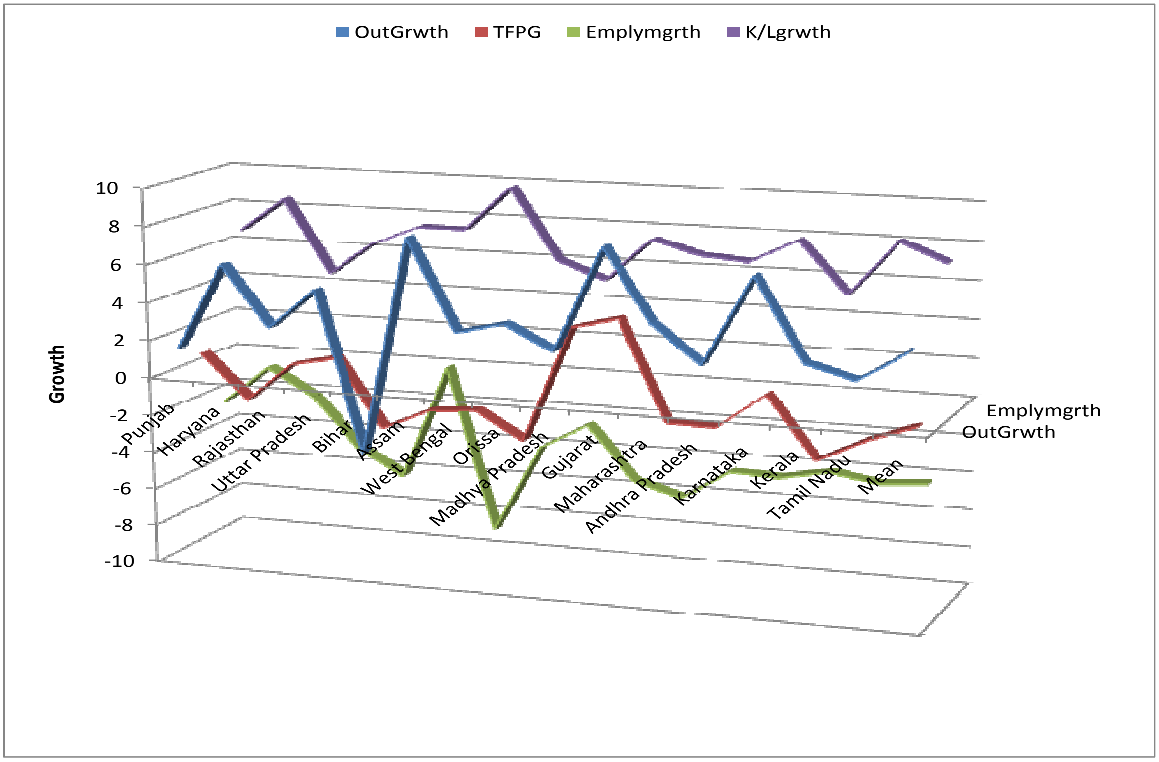


Figure 5: Output Growth – Factor accumulation or productivity growth?

Based on the trend in output growth, TFP growth and employment growth we can identify the states that are lagging behind and the states which are growing without adding to the employment. Such identification can facilitate in devising policies so that the states can be brought to a sustainable growth path given the resource endowments of the state. Table 7 categorizes the states in 8 categories where growth in output, TFP and employment is the most desired and a declining output, TFP and employment is the least preferred option and is a sign of regressive state.

Table 7: Categorisation of Indian states based on Output, TFPG and Employment Growth

	Output Growth	TFP growth	Employment growth	States
Most progressive state(s)	+	+	+	@
Growth sans employment generation	+	+	-	Punjab, Rajasthan, UP, MP, Gujarat and Karntaka
Requires competition to improve productivity	+	-	+	Assam
Lot of slack and move towards capital-intensive production	+	-	-	Haryana, WB, Orissa, AP, Maharashtra, Kerala, TN
Productivity increase but declining industrialization	-	+	+	@
TFP growth at the cost of employment	-	+	-	@
Underutilization of resources	-	-	+	@
Most regressive state(s)	-	-	-	Bihar

Note: @ - indicates no state is falling in this category; + /- indicates increase /decrease in output, employment and productivity.

The above table and the characterisation of States reveal that the current trend of growing without creating employment may not be sustainable. The position of Bihar where neither output nor TFP and employment grew in the past 12 years is a cause of worry. This only points to a need for appropriate policy interventions so that the States follow desired growth path.

6. Conclusions

The traditional neoclassical model, under the assumptions of access to similar technology, comparable saving-rates and an identical rate of labor force growth, predicts that due to decreasing returns to capital accumulation, convergence in GDP per capita will more or less automatically occur. It is quite clear that this notion does not consider the relevance of investment (through manufacturing, as it is the locus of technical change) or other supporting factors required to catch-up, which Cornwall (1977) and other researchers working on endogenous growth models have considered imperative. Incidentally, all the standard assumptions of neo-classical model can be satisfied at sub-national level, where different regions or states have not only access to the same technology, but also governed by more or less similar credit availability, labour supply. This implies that testing for convergence hypothesis and whether manufacturing acts as a engine of growth is less controversial at the sub-national level than at the supra - national level.

The specific objectives of the present paper are: Is there any evidence that manufacturing has acted as an “engine of growth” for the Indian states?; Has dualism (presence of unorganized sector) abetted industrialization? and lastly, is the current path of industrialization sufficient to generate the jobs necessary to absorb the growing population?

The choice of India is appropriate as the 1991 reforms removed several barriers to grow and offered avenues to enhance productivity especially for the manufacturing sector. Yet, the impact of reforms has been quite differential. Some of the industrialized states like Gujarat, Maharashtra or Tamil Nadu have grown faster than the states like Uttar Pradesh, Bihar or Madhya Pradesh. The former having average growth rate of 5.7% during 1991-92 to 2003-04 against 4.1% of the latter states for the same period.

The first objective is addressed using the methodology as given by Cornwall (1977) and later modified by Fagerberg and Verspagan (1999, 2002). The methodology involves regressing the real growth rates on growth rates of manufacturing. If the coefficient of manufacturing growth is higher than the share of manufacturing in GDP, this is interpreted as supporting the engine of growth hypothesis.

Since output growth may be at the expense of using more inputs rather than using the inputs more efficiently. The analysis would be reinforced by computing productivity levels and productivity growth of both organized and unorganized manufacturing sector across major Indian states. This is done by employing a recently developed technique by Levinsohn and Petrin (2003) that accounts for simultaneity bias. In order to do so, the study uses unit level data for both organized and unorganized sectors and aggregates at 4-digit level.

The results indicate that manufacturing has acted as an engine of growth for the period 1994-95 to 2004-05. This is despite its declining share over the period. On the other hand, despite continuous increase in the share of services in the last 2-3 decades, it is not unequivocally acting as an engine of growth.

An attempt is also made to examine what is driving output growth in the manufacturing sector. Analysis yields that it is primarily the factor accumulation, especially the capital, not the productivity growth, that is driving output. TFP grew in six states over the period, but TFPG is accompanied by a decline in employment. Characterisation of states based on output, TFP and employment growth reveals that the current trend of growing without creating employment is not sustainable. This points out to implementing appropriate policy interventions so that states follow desired growth path.

References

Barro, R.J. (1991) Economic Growth in a Cross-section of Countries, *Quarterly Journal of Economics*, 106, 407-443.

Barro, R.J. and X. Sala-i-Martin (1991) Convergence Across States and Regions, *Brooking Papers on Economic Activity*, no. 1, 107-158.

Barro, R.J. and X. Sala-i-Martin (1992) "Convergence", *Journal of Political Economy*, 100, 223-251.

Barro, R.J. and X. Sala-i-Martin (1995) *Economic Growth*, New York: Mc Graw Hill.

Baumol, W. (1986) Productivity Growth, Convergence and Welfare: What the Long-Run Data Show", *American Economic Review*, 76, 1072-1085.

Cambridge: Cambridge University Press, 1966.

Cornwall, J. (1977) *Modern Capitalism: It's Growth and Transformation*, New York, St. Martin's Press.

DeLong, B. (1988) Productivity Growth, Convergence and Welfare: Comment, *American Economic Review*, 78, 1138-1154.

Fagerberg, J. and B. Verspagen (2002) Technology-Gaps, Innovation-Diffusion and Transformation: an Evolutionary Interpretation, *Research Policy*, 31, 1291- 1304.

Fagerberg, J. and B. Verspagen (1999), 'Modern Capitalism in the 1970s and 1980s', in M. Setterfield ed., *Growth, Employment and Inflation*, Houndmills, Basingstoke, MacMillan, 1999.

Kaldor, N. (1967) *Strategic Factors in Economic Development*, New York, Ithaca

Kaldor, N., Causes of the Slow Rate of Economic Growth of the United Kingdom. An Inaugural Lecture,

Levinsohn, J. and A. Petrin (2003) Estimating Production Functions Using Inputs to Control for Unobservables, *Review of Economic Studies*, 70, 317–342.

Loayza, N. (1994) A Test of the International Convergence Hypothesis Using Panel Data, Policy Research Working Paper no. 1333, The World Bank.

Mankiw, G.N., D. Romer and D. Weil (1992), A Contribution to the Empirics of Growth, *Quarterly Journal of Economics*, 107, 407-437.

Marschak, J. and Andrews, W. H., (1944) 'Random Simultaneous Equations and the Theory of production,' *Econometrica*, 12, 143–205.

Pollard, S. (1990) Typology of Industrialization Processes in the Nineteenth Century, Harwood, Academic Publishers.

Pritchett, L. (1997) Divergence, Big Time. *Journal of Economic Perspectives,* 11(3): 3-17.

Sala-i-Martin, X. (1994) Cross-Sectional Regressions and the Empirics of Economic Growth, *European Economic Review*, 38, 739-747.

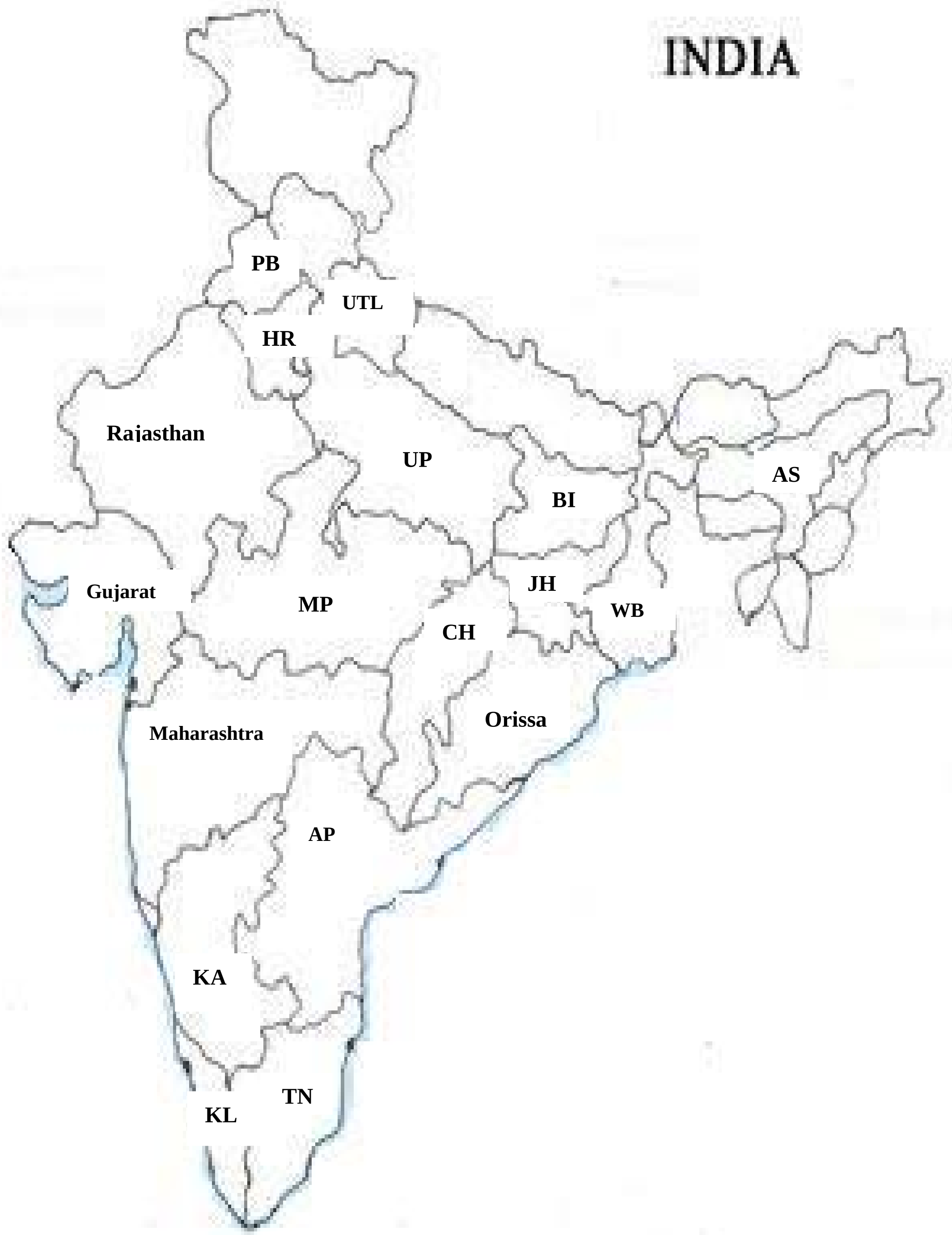
Sala-i-Martin, X. (1996) The Classical Approach to Convergence Analysis, *The Economic Journal*, 106(437):1019-1036

Szirmai, A (2008) Explaining Success and Failure in Development, UNU-MERIT Working Paper, 2008-013, Maastricht.

Szirmai, A (2009) Industrialisation as an engine of growth in developing countries, UNU-MERIT Working Paper, 2009-010, Maastricht.

Young, A. (1928) Increasing Returns and Economic Progress, *The Economic Journal*, 38, 527-542.

Appendix A1 – Map of India showing states covered in the study



Notes: AP, AS, BI, CHT, KL, KA, JHA, KA, KL, MP, PB, TN, UP, UTL, denotes Andhra Pradesh, Assam, Bihar, Chhattisgarh, Haryana, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Punjab, Tamil Nadu, Uttar Pradesh, Uttaranchal and West Bengal respectively.