

DID PRODUCTIVITY CONVERGE IN MANUFACTURING SECTOR ACROSS INDIAN STATES?**Badri Narayan RATH***
S. MADHESWARAN**Abstract**

This paper aims to explore the labour productivity convergence in manufacturing sector across fifteen major Indian states during 1979-80 to 2000-01, using cross-section analysis. The analysis examines the convergence hypothesis taking both absolute and conditional convergence into consideration. The results indicate that though absolute β convergence in labour productivity does not exist during overall period of analysis, labour productivity does converge in pre-reform period. Analyzing conditional convergence using dynamic panel model, we find that labour productivity in rich states grew faster with reasonably high initial productivity levels, indicating a divergence across the states. In light of the above-affirmed empirical results, the study suggests that better endeavors for productivity growth of manufacturing sector in backward states are quite essential. The government should give more emphasize to the labour intensive manufacturing industries which can absorb the mass un-skilled labour force in eastern and northern states of India.

Keywords: Labour productivity, Convergence, Indian manufacturing, Dynamic Panel Model

JEL classification: O14, O41, O47, C23

1. Introduction

Despite more than five decades of development planning that aimed to reduce income disparities across regions in India, the country still experiences enormous differences in regional growth rates. The economists also have different of opinions on the course of regional imbalances during the process of development. One group of economists proposes that there exists a trade-off between economic growth at the national level and reduction of regional disparities within the nation. The other group opines that the gap between rich and poor narrowed down in India, but the regional disparities still exists especially after 1991 economic reform. From the beginning of the five year plans considerable attempts have been made to scrutinize the regional dimensions of economic growth. In fact, an understanding of the causes and nature of differences in levels and growth rates of productivity across regions assumes immense importance as even small differences in growth rates, if cumulated over a long period of time, may have a substantial impact on the standards of living [Barro and Sala-i-Martin, 1995]. Further, inequality in any respect could lead to social and political tension, subsequently affecting growth and development. Therefore, it is important to understand the dynamics of long run growth paths for achieving equity and raising the standards of living of people in different states.

The test of convergence is one approach that can illustrate the dynamics of long run growth paths and thus the sources of productivity improvement. A few studies like

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Baumol (1986), Dollar and Wolff (1988), Barro and Sala-i-Martin (1991), and Bernard and Jones (1996a, 1996b) examine the issue of productivity convergence in the Western countries. In the Indian context, there are few recent studies which analyze growth and convergence in terms of per capita income across major states. Rao et.al. (1999), Marjit and Mitra (1996) and Adabar's (2004) paper measured income convergence for aggregate economy using per capita Net Domestic Product across the major states in India. The results of these studies support income divergence among Indian states. Kalirajan et.al. (2000) examine the issue of per capita income convergence among the fourteen major states in India over pre and post reform periods. They further probed the existence of convergence of agricultural growth rates across Indian states. Their findings indicate that overall per capita income across states over the period has shown divergence while convergence was found in agricultural growth rates. Subhash Ray (2002) uses the state level data on manufacturing inputs and outputs for the year 1985-86 through 1995-96 to measure Tornqvist and Malmquist indices of productivity growth. According to him, the annual rate of productivity growth is higher during the post-reform period than in the pre-reform period and there is a tendency towards convergence in the productivity growth rates across states. Trivedi (2004) examines the inter-state differences in productivity movements in organized manufacturing sector during 1980-81 to 2000-01. Her study empirically confirms the existence of inter-state differences in productivity levels and growth rates. Mukherjee and Ray (2004) analyze state level data from the manufacturing sector in India for the period 1986-87 to 1999-00 to study the efficiency dynamics of a "typical" firm in individual states during the pre-reform and reform periods. They observe no major change in the efficiency ranking of states after the reform and no evidence was also found for convergence in the distribution of efficiency during the reform period.

However, except Kalirajan et.al.'s (2000) study, none of the above Indian studies have examined the test for convergence at the sectoral level. Kalirajan et.al.'s (2000) paper examines the issue of convergence only in case of agriculture sector. But industrial sector can also play an important role for poverty alleviation and employment generation in Indian context. Within the industrial sector, manufacturing plays a dominant role and after 2002 India suddenly experienced a spurt in brain-intensive manufacturing, involving design, customization and innovation. The sector has grown at an impressive average growth of over 9 per cent during 2003-04 to 2006-07 (Kumar and Sen Gupta, 2008). The manufacturing sector surge buttressed the earlier services spurt, and hence the overall GDP growth crossed 8 percent. Given the importance of manufacturing sector, a study of productivity convergence of Indian manufacturing becomes imperative. The issue of productivity convergence would identify, whether the improved growth in manufacturing is flourishing in rich regions as compared to poor regions. If the manufacturing sector is only thriving in rich regions then inter-state disparities will become wide and may create more inequality. It will also reduce the inter-state competitiveness of manufacturing in the long run.

Therefore, the manufacturing sector can be vital units to look at in the Indian context for ensuring a balanced regional approach. The analysis in this paper is pitched at state level for two reasons. First, the poor are concentrated in backward states and therefore, analysis of inter-state productivity disparities is relevant for evolving an effective strategy to combat poverty. Second, whether the industrial and trade reforms have contributed to reduce the inter-state differences in per capita output levels is also an important issue to be addressed. In light of this, the present study makes an attempt to

examine the productivity convergence of manufacturing sectors across 15 major Indian states¹ from 1979-80 to 2000-01. The productivity convergence analysis will help the government to identify whether the manufacturing industries in poorer states are converging towards the rich states or not. If the poorer states 'catch up' with the richer states in terms of productivity then it would enhance inter-state competitiveness and increase the standard of living. The study deals with two major issues. First, we examine the issue of productivity convergence among the 15 major states. Second, we attempt to identify factors causing variations in productivity growth rates. In this paper, labour productivity (per capita output) is used for the convergence analysis. Even if some of the studies in productivity literature say that Total Factor Productivity (TFP) is the superior measure than partial labour productivity, but it may not be true always. Both the productivity measures are having their own importance as both the concepts serve different purposes. If we are looking into how efficiently all the input factors of production are utilized then Total Factor Productivity (TFP) is important. "But it is labour productivity that comes closer to the issue of the economy's ability to increase living standard".²

This paper is set out as follows: the next section provides the analytical framework to address the notion of convergence. In section 2, we explain the methodology adopted to estimate the conditional convergence of productivity. Data source and measurement of the variables are presented in section 3. Estimation results and their interpretation are delineated in section 4. The last section contains some concluding remarks.

2. Analytical Framework

The concept of productivity convergence owes its origin to the traditional neoclassical growth theory and its central notion of a transitional growth path to a steady state. The introduction of new or endogenous growth theories generated some controversy about the issue of convergence. The Solow-Swan neoclassical growth model (Solow 1956, Swan 1956) postulates convergence of per capita output, driven by the assumption of diminishing returns to capital accumulation for the overall economy. The dynamics of the model imply that initial differences in per capita output and capital endowments would vanish in the long run due to declining growth rates as regions approach the steady state. In the steady state, diminishing returns are offset by technological progress, the principal source of long-run economic growth. New or endogenous growth theory (see, e.g., Lucas 1988 and Romer 1990) yields a more diverse picture of the pattern of convergence. In their view, economic growth is ultimately driven by the accumulation of knowledge or human capital, which is (at least partially) a public good. Hence, cross-country convergence depends on the extent of international

¹ 15 major states are Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. These 15 major states account for 93 per cent of population and around 95 per cent of Gross Value Added in manufacturing sector, therefore, be taken as representative for the whole country. States like Jammu Kashmir, Himachal Pradesh and all northeastern states except Assam, are considered special category states by the Planning Commission and, have been excluded from the analysis due to the significant differences in the structure of these economies from the rest of the states (Rao et al., 1999).

² Quoted from Baumol, 1998.

knowledge spill-overs, allowing less productive countries to catch-up with more advanced economies. In the next section, we explain the framework for σ -convergence and β -convergence.

2.1. σ and Absolute β -convergence

Sala-i-Martin (1996) define both sigma and beta convergence in his path breaking paper. We will make use of both the concepts from his paper. A negative relation between the growth rate of productivity and the initial level of productivity would indicate the existence of beta convergence. In other words, there is β -convergence if poor economies tend to grow faster than rich ones. Sigma convergence says that the dispersion of real per capita output across groups of economies tends to fall over time. Although they are conceptually different, the two concepts of convergence are related. Sigma convergence studies how the distribution of productivity evolves over time and β -convergence studies the mobility of productivity within the same distribution. We estimate the speed of convergence β by regressing the average growth rate of a set of states between times t_0 and $t_0 + T$ at initial level of productivity. The following equation is used in order to measure absolute β convergence, assuming that productivity converges towards a unique steady state for all the states.

$$\frac{1}{T} \ln \left(\frac{y_{i,t_0+T}}{y_{i,t_0}} \right) = a - \left(\frac{1 - e^{-\beta \cdot T}}{T} \right) \cdot \ln(y_{i,t_0}) + u_{it_0, t_0+T} \quad (1)$$

where a and β are constants, with $0 < \beta < 1$, y is the labour productivity and u_{it_0, t_0+T} represents an average of the error terms, u_{it} , between times t_0 and $t_0 + T$. In our data set t_0 implies the initial year, i.e. 1979-80 and $t_0 + T$ is 2000-01. Equation (1) could be estimated using both non-linear least squares (NLS) and ordinary least squares (OLS). The speed of convergence β can be directly computed in equation (1) using NLS method. But in case of OLS, we need certain transformations in order to compute β . We employ OLS method using following transformation of Eq. (1) as

$$\frac{1}{T} \ln \left(\frac{y_{i,t_0+T}}{y_{i,t_0}} \right) = a - (1 - \lambda_T) \cdot \ln(y_{i,t_0}) + u_{it_0, t_0+T} \quad (2)$$

The speed of λ could then be computed using the equality $(1 - \lambda_T) = ((1 - e^{-\beta T}) / T)$.

So, $\lambda = -[1/T \ln(\beta + 1)]$ with T denoting the time and the half life (H) is derived from $e^{-\beta H} = 0.5 \Rightarrow H = \ln(2)/\beta$. The reason for choosing OLS is that we found the autoregressive coefficient, λ_t , is negative of our sample period in some of the states.

In order to measure σ convergence, we take the coefficient variation of log of labour productivity because standard deviation is not a unit free measure and hence the sample of variance.

Equation (3) below indicates the measure of standard deviation of log labour productivity.

$$\sigma = \sqrt{\frac{1}{n} \sum_{i=1}^n [\ln(y_{it}) - \ln(\bar{y})]^2}, \text{ where } \ln(\bar{y}) = \frac{1}{n} \sum_{i=1}^n \ln(y_{it}) \text{ and C.V.} = \sigma / \bar{y} \quad (3)$$

³ Taken from Sala-i-Martin, 1996, equation (5), pp. 1334.

Where $\bar{y}$ is the sample mean of $\ln(y_{it})$. 'If there is no β -convergence so that $\beta < 0$, then the cross-sectional variance increases over time. That is, if there is no β -convergence, there cannot be σ -convergence. Put in another way, β -convergence is a necessary condition for σ -convergence⁴.

2.2. Conditional β -convergence

Following Barro and Sala-i-Martin (1991), and Sala-i-Martin (1996), it can be summarized the hypothesis that poor economies tend to grow faster per capita than rich ones- without conditioning on any other characteristics of economies is referred to as *absolute convergence*. But if we allow for heterogeneity across economies, in particular, if we drop the assumption that all regions have the same parameters, and therefore, there exist different steady-state positions are considered a concept of *conditional convergence*. In the Indian context, where lot of diversification exists across the regions, the inclusion of conditioning variables would be appropriate. Hence, we reformulate equation (1) into a panel data model with individual state-specific effects; the Dynamic Panel data model is used to measure the conditional β -convergence. It is not possible to take into account the individual state specific effect in the cross section regression framework. The dynamic panel model can be used to overcome this problem.⁵ Consider the linear dynamic panel data specification given by:

$$\ln y_{it} = \gamma y_{it-1} + \beta_j \ln X_{it}^j + \mu_i + \eta_t + \varepsilon_{it} \quad (4)$$

where y is the labour productivity, X is the vector of explanatory variables, y_{t-1} is the industry's past year productivity, μ_i is an unobserved state-specific effect, η is the time dummy and ε_{it} is the transitory error term that varies across states and time periods. The model captures dynamic processes in the industry as determinants are probably determined endogenously by its past productivity. An autoregressive term is included in the baseline equation to account for the possibility that the independent variables may have an ongoing impact on productivity. For instance, a rise in wage rate or skill factor could have an effect on per capita productivity spread over several years. So, using the Least Square Dummy Variables (LSDV) estimator, the baseline equation (4) is inconsistent and has a biased coefficient because the lagged endogenous variable is always related to the error term. This is due to the fact that both dependent and lag dependent variables are a function of μ_i . As a result, y_{it-1} is correlated with the error term.

There are several ways of controlling for this unobserved state specific heterogeneity. We present the dynamic panel data model, which is estimated using the Arellano and Bond (1991) GMM estimation procedure, bearing in mind again the limitations of using the dynamic panel estimator in macroeconomic studies where the N dimension is typically short.

First-differencing this specification eliminates the individual effect and produces an equation of the form:

$$\Delta \ln Y_{it} = (\gamma - 1)\Delta \ln Y_{it-1} + \Delta \ln X_{it}^j \beta_j + \Delta \varepsilon_{it} \quad (5)$$

Under the assumptions that:

⁴ Quoted from Sala-I-Martin, 1996, pp.1329.

⁵ For details, see Islam 1995,1132.

- (a) The error term, ε , is not serially correlated, and
 b) The independent variables, X , are weakly exogenous, i.e. they are uncorrelated with future realisations of the error term.

We propose the following moment conditions:

$$E[\Delta Y_{i,t-s} (\varepsilon_{it} - \varepsilon_{i,t-1})] = 0 \quad (6)$$

$$E[X_{i,t-s} (\varepsilon_{it} - \varepsilon_{i,t-1})] = 0 \quad (7)$$

For $s > 1$ and $t = 3, \dots, T$. This technique thus uses the lagged levels of variables as instruments for estimating the baseline equation (4) in differences. Furthermore, by following Arellano and Bond's approach (1991), the variables included in the matrix of instruments are multiplied by a time dummy. This technique cannot be applied to all the variables in the matrix because this would considerably increase the number of instruments. It is applied only in the case of the lagged endogenous variable and the wage variable, i.e. the variable suspected most strongly for endogeneity. The remaining lagged independent variables are included in the matrix of instruments without being multiplied by a time dummy. Let Z be the matrix of instruments, which is evaluated using a Sargan test. We obtain the results using equation (5).

3. Data Source and Measurement of Variables

The database of the study is drawn from the Annual Survey of Industries (ASI) for the period 1979-80 to 2000-01 across fifteen major states. For unconditional convergence, the period's overall productivity growth is regressed on its initial productivity levels for all the states. The data set for the dynamic panel model is constructed following the methodology in Islam (1995). The panel framework is made possible by dividing the total period into several shorter time spans. The natural question that arises is what the appropriate length of such time spans would be. According to Islam (1995), the furthest you can go is to one year time span, which is technically feasible given that the underlying data set provides annual data. However, for several reasons it seems that the yearly time span is too short to be appropriate for studying convergence. Short-term error terms may appear large in such brief time spans, so, we opt for three-year time intervals. Thus, considering the period 1979-80 to 2000-01, we have seven data points for each state: 1981-82, 1984-85, 1987-88, 1990-91, 1993-94, 1996-97 and 1999-2000. For example, when $t = 1981-82$, at that time, $t-1$ is 1979-80. The dependent variable is the natural log of labour productivity in the end point of each three-year span while the lagged dependent variable is the natural log of labour productivity at the beginning of the each three-year period. Independent variables such as capital intensity, firm size, wages etc. are averaged over the three-year period for each state.

Bihar, Madhya Pradesh and Uttar Pradesh are bifurcated states, as three new states, viz. Jharkhand, Chattisgarh and Uttarachal, were carved out of Bihar, Madhya Pradesh and Uttar Pradesh, respectively. For the period of the study, two National Industrial Classification (NIC) codes were used for data collection. The details of NIC codes (1987 and 1998) of the industries covered in this study are provided in Annexure 1. Since price deflators are not available at the state level, the appropriate national price indices were used in order to obtain real figures. Gross value added figures are deflated by the 'wholesale price index of manufactured products' (1993-94 = 100). City-wise data on the consumer price index of industrial workers is available in various issues of the RBI

bulletin and the Bulletin of Food Statistics. There is no specific Consumer Price Index of industrial workers at the state level. A single general price index number is calculated by taking the average of all available CPI of industrial workers across the cities for a particular state. This index is used as a proxy for the representative state. The nominal emolument is converted to real emolument by using the state specific CPI for industrial workers series (1982-83 =100).

The study chooses the aggregate manufacturing industry and six two-digit industry groups for investigation. The industries are: (i) Food Products (20-21); (ii) Textiles and textile products (23-26); (iii) Chemical and chemical products (30); Basic Metals (33); Machinery and equipments (35-36) and Transport and parts (37). These six industries are selected based on their share of value added, employment and export performance. The second reason for choosing these industries is the consistency of data on these industries across the states.

Y stands for the labour productivity and it is measured by gross value added divided by total number of employees. CI stands for capital intensity measured as the ratio of total fixed capital to total number of employees. Firm Size (FSIZE) is measured as the ratio of total output to the number of factories. Skilled manpower represents the trained manpower including supervisory, administrative and managerial staff. It is measured as the percentage of total workers who are supervisors or managers. Wage rate is defined as the ratio of real emoluments to total number of employees.

4. Empirical Results

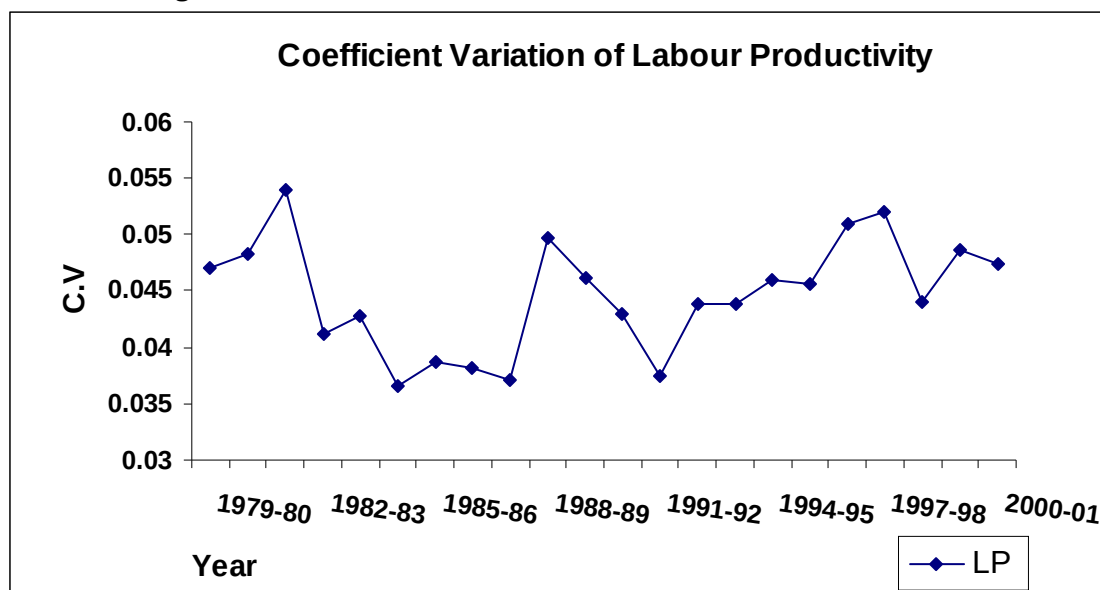
Before discussing the convergence results, let us first examine whether the labour productivity across the states is significantly different in the initial period from the average productivity. The main intention of the above exercise is to test whether some states were rich or not by accumulating capital and thereby the labour productivity in the initial period. To test this, we use one sample T test procedure, which has been shown in Table 1. One sample T test procedure tests whether the mean of labour productivity across the states significantly differ or not. In other words, it tests the average difference between each data value and the hypothesized test value for each parameter like mean, standard deviation and standard error of the mean. Results from the table reject the null hypothesis that there is no significance difference in labour productivity across the states in the initial period (i.e.1979-80). This implies the labour productivity across the states in the initial period is significantly different and hence our data allow us to go for convergence analysis.

Table 1: One Sample T Test for Labour Productivity

	Test value = 0				
	t	Significance (2-tailed)	Mean Difference	95% Confidence interval of the difference	
				Lower	Upper
LP	41.936	0.000	4.47	4.25	4.69

4.1. Sigma Convergence

Fig.1: Coefficient Variation of Log Labour Productivity for Aggregate Manufacturing across Indian States



Source: Author's calculation based on ASI data

This section presents productivity convergence by estimating equation (3). Fig.1 reveals that the coefficient of variation of labour productivity looks like a unit root process, which is not for or against of σ -convergence. The graph indicates that the variation in log labour productivity among the state is less during 1983-84 to 1987-88. The trend line also reveals that the variation in total manufacturing productivity is increased after 1991-92 across Indian states, except the year 1998-99, where there was a poor performance of manufacturing sector. In a nutshell, Figure-1 shows a gloomy picture about the sigma convergence. It is well noticed that the growth of labour productivity in Indian manufacturing sector has improved after 1980s as compared to 1960s and 1970s. All the major 15 states attained a positive growth from 1980s onwards, but substantial variations in the labour productivity growth rates have been observed. The variation was less during 1979-80 to 1987-88 because of the significant growth of manufacturing sector in the poor states of Andhra Pradesh, Orissa and Uttar Pradesh. But after 1991 reform, the variation of labour productivity among the major states has increased mainly due to increased regional disparities. The labour productivity of Assam, Kerala, Bihar, Orissa, Madhya Pradesh and Uttar Pradesh has accelerated after 1991 reforms, but at a slower pace as compared to 1980s. At the same time, a significant acceleration in the labour productivity growth has been noticed in the industrially developed states like Maharashtra, Gujarat, West Bengal and Punjab.

4.2. Beta Convergence

This section presents the results of absolute Beta convergence in Table 2. Beta convergence is measured by using the OLS method (Equation 2). We divide the whole

time period (1979-80 to 2000-01) in to two sub-periods viz., 1979-80 to 1991-92 and 1992-93 to 2000-01 in order to see the impact of 1991 economic reforms on labour productivity in manufacturing sector across the major states.

Table 2: Absolute β -convergence for Aggregate Manufacturing

Labour Productivity				
Period	β	S.E.	R²	Implied λ
1979-80 to 2000-01	-0.1527	0.22	0.034	0.00789
1979-80 to 1991-92	-0.2371***	0.11	0.23	0.02255
1992-93 to 2000-01	0.090901	0.10	0.05	-0.0108

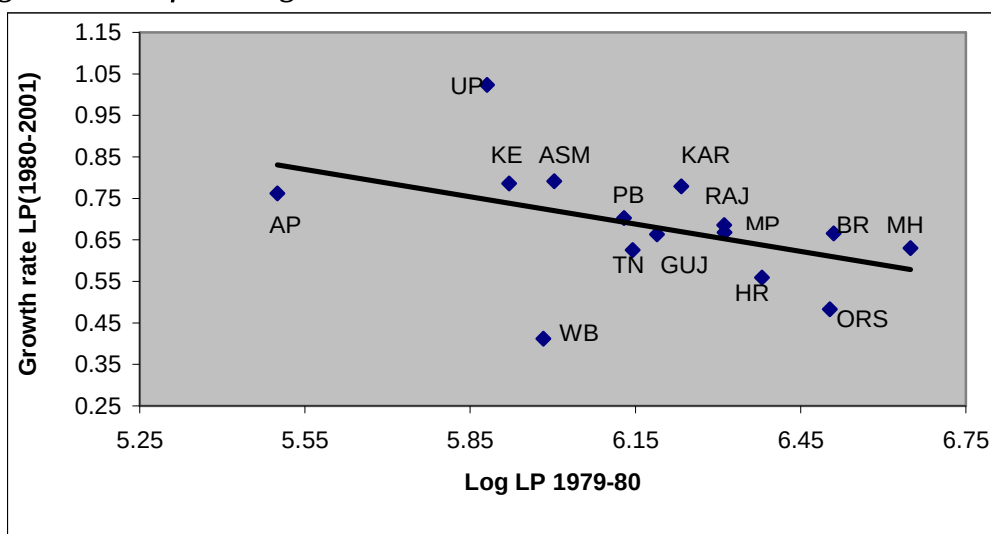
Asterisks denote level of significance at 10 per cent.

Table 2 shows the results of absolute Beta convergence for the total time span, pre-reform period and post-reform period. The results indicate that there is no convergence of labour productivity in manufacturing sector across Indian states in the entire time period and in post-reform period. However, we find a negative relationship between overall labour productivity growth and its initial labour productivity during pre-reform period. This implies that labour productivity in manufacturing sector across the states shows convergence during the pre-reform period. In Table 2 the slope coefficient of beta for pre-reform (1979-80 to 1991-92) period is negative (-0.2371) and significant at 10 per cent level. So, in the pre-reform period, the states which had low labour productivity in the initial period (i.e.1979-80) grew much faster than the rich states in the 1980s'. As a result, we found a tendency towards convergence during the pre-reform period. The speed of convergence in labour productivity across fifteen major states is only 2.25 percent (see implied λ value) in the pre-reform period. The time needed for labour productivity to move halfway of its initial level and to its steady state will take 30.75 years. Now, it would be interesting to know why labour productivity in manufacturing sector exhibit convergence during pre-reform period, but not in the post-reform period. The plausible answers have well explained in the previous section of Sigma convergence. However, a few observations on the growth trends across states may extend additional support to our results. First, prior to 1980s, the growth of Indian manufacturing sector was below 5 per cent, thereby, the labour productivity was very less especially in poorer states (Kumar, 2001). But during that phase rich states were performing well owing to their strong industrial base. On the other hand, in 1980s, poor states like Rajasthan, Orissa, Assam, Uttar Pradesh grew much faster than the rich states, which might have reflected in the convergence of labour productivity during pre-reform period. Second, the deregulatory measures introduced in the early 1980s might have helped to accelerate the growth of labour productivity across the states in the pre-reform period.

The average labour productivity growth rate from 1980-81 to 2000-01 against the log of the initial period's labour productivity are plotted in Fig.3. The figure reveals that neither convergence nor divergence of labour productivity is prevalent in the Indian states during 1979-80 to 2000-01. But for some states there is a strong negative correlation between the growth of labour productivity and the initial level of labour productivity. A

few interesting observations can also be drawn from this figure. A minute look at the graph reveals that the states like Maharashtra, Bihar, Karnataka and Madhya Pradesh are having higher initial labour productivity as compared to other states like West Bengal, Tamil Nadu and Gujarat. But these states with high initial labour productivity are growing faster than low initial labour productivity states, which contradicts the neo-classical notion of convergence. On the other hand, if we compare the labour productivity growth of Harayana, Tamil Nadu, Orissa, Gujarat with Kerala, Assam and Uttar Pradesh, then the results support the neo-classical notion of convergence. Thus, the overall graph does not indicate any evidence for convergence in labour productivity across the states.

Fig.3: Absolute β -convergence of LP across the Indian States, 1980-2001



Note: AP = Andhra Pradesh, UP = Uttar Pradesh, KE = Kerala, ASM = Assam, PB = Punjab, WB = West Bengal, TN = Tamil Nadu, GUJ = Gujarat, KAR = Karnataka, RAJ = Rajasthan, MP = Madhya Pradesh, HR = Harayana, BR = Bihar, ORS = Orissa, MH = Maharashtra.

The results of the two-digit disaggregate manufacturing sector are presented in Table 3. Three industries, viz. food products, textiles and transport and parts show convergence and the coefficients are statistically significant at 10 per cent level. The labour productivity of food products industry in Punjab, Harayana, Maharashtra and Gujarat was higher as compared to other states in the year 1979-80. Though over the years, the labour productivity has increased in most of the states, the annual average growth rate of labour productivity for the period 1979-80 to 2000-01 was higher in Madhya Pradesh, Karnataka, Bihar and Uttar Pradesh. This result indicates convergence of labour productivity in food products industry across Indian states. The other reason for convergence in food products industry could be high output growth in poor states. The states where labour productivity was low in the initial periods have shown a substantial output growth over the years as compared to rich states. At the same time, the employment growth of these poor states was lower than their output growth. The reform initiated in early 1980s helped the food products industry to generate more output with less number of employees.

Table 3: Absolute β -convergence for Disaggregate Manufacturing

Labour Productivity				
INDUSTRY	β	t	R²	Implied λ
Food Products	-12.85***	1.74	0.13	0.1194
Textiles	-7.75***	1.90	0.16	0.0986
Chemical	-4.39	0.21	0.003	0.0765
Basic Metals	-2.87	0.63	0.03	0.0615
Machinery	-2.03	1.41	0.07	0.0503
Transports	-38.40***	1.85	0.15	0.1669

Asterisks denote level of significance at 10 per cent.

The textiles industry shows convergence mainly because of two reasons. First, the variation in labour productivity among the states was less in the initial year of the present study, but the productivity has increased substantially in most of the states from late 1980s onwards. The states like Kerala, Rajasthan, Harayana and Maharashtra, which were having high productivity in the initial period, have shown a low productivity growth in post-refom period. On the other hand, states like Madhya Pradesh, Andhra Pradesh, Uttar Pradesh and Punjab show high labour productivity growth over the period of analysis despite their low initial productivity. Second, the increase in employment growth in post-reform period for most of the states is one of the leading factors for productivity convergence. The manufacturer of transport equipment and parts shows productivity convergence across the states in India. The transport and equipment industry comprises of ship and boat building, locomotive and parts, railways, and automobile industry including heavy motor vehicles. The growing domestic demand escalates the production of transport equipment in the country. As a result, most of the states started producing their products by using more capital and technology. The labour productivity data of transport industry shows that in poor states labour productivity growth is higher than the industrial states mainly because diffusion of technology from rich states to poor states.

The remaining three industries, viz. chemical, basic metals and machinery do not show any convergence across the states. In case of chemical industry, Gujarat, Maharashtra and Rajasthan recorded the highest labour productivity growth in both 1980s and 1990s. But, the bottom-ranking states like Bihar, Orissa and West Bengal's labour productivity growth was very slow, which is one indication for no convergence in the chemical industry. The basic metal industry does not exhibit convergence primarily because of three rich metal based states, viz. Bihar, Madhya Pradesh and Orissa which have been performing better as compared to other states in both 1980s and 1990s. The average labour productivity of these states was high as compared to other states and the growth rate of labour productivity in these three states was high in 1990s as compared to 1980s. The labour productivity growth has increased in 1990s mainly because of the negative employment growth in the metal industry. The introduction of 1991 economic reforms has helped both domestic and foreign producers to produce more output using more capital and less labour. As a result, the labour productivity has increased in the post-reform period. The machinery industry also does not show any convergence largely because of its capital-intensive nature. Maharashtra continued to be the topper state in terms of labour productivity in machinery industry, where as, West Bengal and Andhra Pradesh were the worst performers especially in the post-reform period.

4.3. Conditional β -convergence

In this section, we tried to examine the productivity convergence using the conditional convergence approach. The results obtained from the absolute convergence show that each state is progressing towards its own 'steady state', as a result, all the parameters like output, population and capital do not seem to grow at constant rate for all the 15 states in India. Therefore, this section explains the conditional convergence results of labour productivity based on GMM estimates. In case of conditional convergence we assume that the productivity level converges to multiple steady state equilibria which are conditional on state-specific characteristic. We may note that equation (4) is based on approximations around the steady state and is supposed to capture the dynamics towards the steady state. We obtain the results of the dynamic panel data model using equation (5).

Table 4: Arellano-Bond Dynamic Panel Data Estimation

Dependent Variable: Log Labour Productivity (yit)	
Variables	GMM
Lag ΔLP	0.34* (3.85)
ΔCI	0.43** (1.17)
$\Delta FSIZE$	0.78* (5.13)
$\Delta SKILL$	0.11 (0.77)
$\Delta WAGE$	0.88* (7.95)
Constant	-0.02** (1.93)
Sargan test Chi-square (13)	7.85 (0.089)
Arellano-Bond test that average autocovariance in residuals of order 1 is 0: H0: no autocorrelation $z = -3.37$ $Pr > z = 0.08$	
Arellano-Bond test that average autocovariance in residuals of order 2 is 0: H0: no autocorrelation $z = 0.67$ $Pr > z = 0.51$	
Implied $\lambda = 0.0975$, Halfway life = 2.04 years	
Numbers in Parentheses are the t-statistics. *, **, Denotes that coefficients are significant at 1%, and 5% level respectively. GMM assumes regressors are exogenous.	

Table 4 contains the results of the dynamic panel regression using GMM estimation. The result indicates that the coefficient of initial labour productivity ($y_{i,t-1}$) is positive and significant at 1 per cent level. This implies that there is a positive relation between productivity growth and its initial productivity, which is contrary to the neo-classical notion of convergence. Thus, the result indicates divergence in the manufacturing sector across Indian states. The speed of divergence is quite high at 9.75 per cent. This divergence clearly indicates the presence of regional disparity within the manufacturing sector. The growth of productivity gap became wider between rich states and poor states over the period of analysis. Besides the individual state specific characteristics, the growth rates of three variables viz., wage rate, capital intensity, and firm size are also responsible factors for this divergence. The results specify that 1 per cent increase in the real wage growth rate in a state would cause the labour productivity growth to accelerate by 0.88 per cent. The wage rate has a positive effect on labour productivity, which acts as a powerful incentive for the worker to contribute greater efforts and skills. In India, though there is a minimum wage Act, high per capita income states still provide better wages and incentives to their workers. As a result, the labour

productivity growth is higher in rich states compared to the poor states. Poor states are unable to catch up with rich states in terms of wages rates and thus there exists a divergence in labour productivity in the manufacturing sector.

The positive impact of capital intensity on labour productivity signifies the degree of mechanization. Mechanization plays a major role in determining the consumption levels and expansion of capital constitutes economic progress of the state. More than 65 per cent of manufacturing plants are located in the western and southern parts of India. As a result, the infrastructure facilities and flow of investment to the manufacturing sector have also flourished in these regions. The flow of investment has tended to be skewed in favour of rich states and the relatively fast moving reformer states have attracted more FDI approvals. All these factors help the southern and western Indian states to produce more output using capital-intensive techniques. High capital-labour ratio boosted the labour productivity in western and southern regions as compared to northern and eastern regions in India. The north and eastern regions are typically heavily endowed with unskilled labour, which could be one of the major constraints for enhancement of labour productivity. But, the skill factor is not statistically significant in Table 4 and hence, it may not be a crucial factor for labour productivity divergence in the manufacturing sector. The productivity growth is high in rich states mainly because they are trying to specialize in skill intensive industries within the manufacturing sector in order to have a comparative advantage in the world market.

In a nutshell, the results of absolute convergence show that there is no convergence in labour productivity over the period 1979-80 to 2000-01, whereas, convergence exists during the pre-reform period. Using the dynamic panel data approach, we conclude that labour productivity of manufacturing sector in rich states like Maharashtra, Gujarat and Punjab have grown relatively faster with high initial level productivity. At the same time, Bihar, West Bengal and Orissa have observed low growth rates with severe joblessness. The only notable exceptions is Uttar Pradesh, which has lowest initial labour productivity, but was the fastest growing states in 1980s and 1990s. This evidence implies that β -convergence does not support the hypothesis that being relatively backward in productivity implies a potential for rapid advancement. Furthermore, the results also indicate that divergence depends on cross-state differences in steady-state characteristics. We find that one of the fundamental determinants for labour productivity divergence is the wage rates. Moreover, we also observe that capital intensity and firm size factors contribute to labour productivity growth, while the skill factor does not play any role in explaining cross-state differences in labour productivity growth.

5. Conclusions

In this paper, we tried to assess the convergence of labour productivity in the case of the Indian manufacturing sector using data on fifteen major states from the period 1979-80 to 2000-01. We have tested the convergence hypothesis using the absolute and conditional convergence approach. The results indicate that the absolute β convergence does not exist in case of aggregate manufacturing during 1979-80 to 2000-01, whereas, the results exhibit labour productivity convergence in the case of three disaggregate manufacturing industries, viz. food products, textiles, and transports. The results also illustrate that the absence of labour productivity convergence during the reform period

may widen the gap between the rich and poor. In case of conditional convergence using the dynamic panel data approach, we observed that labour productivity in rich states with high initial productivity level grows relatively faster than the poor states. The productivity response of various states to liberalization process has been different. The policy reforms do not seem to have impacted positively for the poor states. The deregulated policies and liberalized economic environment also do not help the poor states to catch up the rich states like Maharashtra and Gujarat. Furthermore, the results derived from conditional convergence found that the factors wage rate, capital intensity and firm size prevent the convergence of labour productivity growth, while skill factor does not play any role in explaining cross-state differences in labour productivity growth.

Thus, the overall findings indicate that there exists productivity divergence in organized manufacturing sector across Indian states. The divergence is mainly because industrial states are growing much faster with having high initial productivity. It means, though the labour productivity growth has increased in Indian manufacturing sector over the years, but the growth is mainly appeared in few industrial states. As a result, the productivity gap between rich and poor states has widened, particularly after the 1991 economic reform. Moreover, differences in the intensity of implementation of the policy reforms across the states might have prevented the convergence. The high per capita income states like Maharashtra, Gujarat, Tamil Nadu and Karnataka have been more reform-oriented as compared to other states like West Bengal, Kerala, Harayana and Punjab.

The above results direct us towards the following policy implications. First, the impact of pre-1980s policies combined with 1991 reforms has resulted into a sharp divergence in productivity growth rates across Indian states. The rich states are increasing their productivity by capital deepening process, which is beneficial for the country because higher productivity would enhance the export performance of the manufacturing sector. But at the same time, the government should also emphasize on the regional balanced growth approach. In this direction, the first step for the government would be to target to the labour intensive manufacturing industries located in eastern and northern regions of India. There are many labour intensive manufacturing industries like textiles, food processing and jute which have been shrinking in eastern and northern part of India. Therefore, the government should extend some subsidies or tax rebate to those industries, so that these industries will be able to produce more output by absorbing the mass semi-skilled and un-skilled labour force. Second, the central government should direct the state governments of backward regions to make the regulations and policies more flexible. This improvement in governance and business climate would help both domestic and foreign investors to invest more in the manufacturing sector of the backward states. Third, for accelerating productivity growth the government needs to develop the infrastructural base in industrially backward states. Finally, the capital deepening in the manufacturing sector leads to distortions in labour market. Therefore, removal of labour market distortions would encourage the use of appropriate input-mix through substitution of labour for capital and hence will enhance the employment in the backward states.

There are certain directions in which this work can be extended for further research. The present paper does not explore whether there was productivity convergence in both the group of labour intensive and capital intensive industries across states. Therefore, one can examine the productivity convergence for labour intensive and capital intensive industries separately and draw some policy recommendation. In this paper, we

test the convergence hypothesis using the cross-section approach of neoclassical framework. But the new growth theorists criticized the cross-section approach of convergence. According to them, the cross-section growth regression show that poor region grows faster than rich region in terms of per-capita productivity. But, cross-sectional convergence result does not imply that the region becomes richer in terms of its per-capita productivity growth rate. In their opinion, convergence is a dynamic process that should be observable in time-series data. In time series approach, convergence is defined as a transitory deviation from identical long-run trends either deterministic or stochastic. Thus, the test of convergence through time-series approach would be an interesting research to pursue in future.

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Annexure-1

Classification of Industries:

The database of the study is drawn from Annual Survey of Industries (ASI), which based on the National Industrial Classification NIC-1987 and NIC-1998.

Name of the Industry	NIC 1987 (Two digit)	NIC 1998 (Three digit)
Food Products	20-21	151+152+153+154
Beverages	22	155+160
Cotton Textiles	23	171
Woolen Textiles	24	171
Jute Textiles	25	171
Textiles Products	26	172+173+181
Wood Products	27	201+202+361
Newspaper Products	28	210+221+222+223
Leather Products	29	182+191+192
Chemical Products	30	241+242+243
Rubber, Petroleum, and Coal products	31	23+25
Non-metallic Minerals	32	261+269
Basic Metals	33	271+272+273+371
Metal Products	34	28
Machinery (other prds.)	35-36	29+30+31+32
Transport and Parts	37	34+35
Other Manufacturing	38	33+369

Source: Central Statistical Organization