

Estimation and Decomposition of Total Factor Productivity Growth of the 2-Digit Manufacturing Industries in India: An Interstate Analysis

Prasanta Kumar Roy*

Abstract

The study estimates and decomposes the sources of total factor productivity growth (TFPG) of the 2-digit manufacturing industries as well as total manufacturing industry in 15 major industrialized states in India as well as in All-India during the period from 1981-82 to 2010-11 (total study period), pre-reform period (1981-82 to 1990-91), post-reform period (1991-92 to 2010-11) and for two decades of the post-reform period (i.e., 1990-91 to 2000-01 and 2001-02 to 2010-11), using stochastic frontier production function. The methodology necessitates decomposition of the sources of TFPG into technological change, technical efficiency change, allocation efficiency change and scale change. The main findings of our decomposition are that the growth rates of TFP in most of the 2-digit industries in the major industrialized states in India as well as in All-India have declined during the post-reform period. Also, this decline in TFPG is mainly accounted for by the decline in technical efficiency change and allocation efficiency effect that happened during that period. With respect to scale effect, its contribution to TFPG in the 2-digit industries in the major industrialized states has become very negligible although the manufacturing industries of different states under study and India as a whole have benefitted from economies of scale. The behaviour of the allocation efficiency component clearly indicates inefficient resource allocation in almost all the 2-digit industries under study during the post-reform period. This implies that liberalization of the economy during the post-reform period has increased the price distortion measured by the gap between price and marginal cost of the product of 2-digit manufacturing industries in the major industrialized states in India and in All-India as well. However, the rates of technological progress of almost all the 2-digit industries in most of

the states under study have increased. Notwithstanding, as the combined effect of technical efficiency change and allocation efficiency change of these industries outweigh the joint effect of scale change and technological change of the same, TFPG of these industries has declined during the post-reform period.

Keywords: 2-Digit Manufacturing Industries, Stochastic Frontier Production Function, Total Factor Productivity Growth, Technological Progress, Technical Efficiency Change, Scale Change and Allocation Efficiency Change

JEL Classification Codes: C23, L6, O33, O47

Introduction

Growth of output which is not accounted for by the growth in factor inputs is generally treated as total factor productivity growth (TFPG). While measuring the sources of output growth, the contribution of TFPG is, therefore, estimated as a residual, after accounting for the growth of primary inputs, such as, labour and capital. If industries operate on their production possibility frontier producing the maximum possible output or realizing the full potential of the technology, then it implies that improvement in TFP arises from technological progress. This is the main idea behind the growth-accounting measure of TFPG. The objective of the growth-accounting measure of TFPG is to determine how much of output growth is due to the use of primary inputs and how much is due to technological progress. In other words, growth-accounting measure of TFPG determines how much of the growth can be explained by movements along a production function and how much would be attributed to a shift in production

* Assistant Professor, Department of Economics, Midnapore College (Autonomous), Midnapore, West Bengal, India.
Email: prasanta.agnik@gmail.com

function. However, growth-accounting measure of TFPG is based on the assumption that industries are operating on the production possibility frontier with full potential of technical efficiency. Further, under growth-accounting approach, it is assumed that there exists CRS (constant returns to scale) in the production process. The assumptions of perfect competition also hold true in this approach.

When it is difficult to satisfy these assumptions, a direct econometric estimation of the production function is usually taken up, which, however, has several limitations too. One of the major disadvantages of the production function approach (PFA) is the problem of identification of production function. Further, the problems of autocorrelation and multi-collinearity encountered in the use of PFA are likely to produce misleading estimates. A further drawback of this approach is the difficulty of explaining the econometric technique to a wide range of users, and the difficulty in replicating and producing productivity estimates on an ongoing basis. Once again, if a more flexible form of production function (like translog production function) is used, it would be difficult to equate output elasticities with factor shares. Further, in the production function estimation approach, we relax the assumption of Hicks neutral technological progress. Moreover, both in the growth-accounting approach as well as in the production function estimation approach, technological progress is usually considered to be the unique source of TFPG. Given the limitations of these approaches and that TFPG has several sources other than the technological progress, such as, change in technical efficiency, economic scale change and allocation efficiency change, the research question boils down to decomposition of the sources of TFPG into several components other than technological progress.

A stochastic frontier model [Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977)] is usually undertaken to decompose the sources productivity growth as the model could minimize the intensity of the problems like multi-collinearity and autocorrelation, and it has the ability to provide information on the specified production technology and technical inefficiency component. Further, stochastic frontier approach (SFA) assumes a given functional form for the relationship between inputs and output. Whenever the functional form is specified, the unknown parameters of the function could

be estimated using econometric methods. The stochastic frontier model has been used intensively to decompose the sources of TFPG at the firm, industry, state, and also at the national levels by a good number of researchers. Although a vast number of empirical applications have contributed to identify the sources of TFPG by applying stochastic frontier approach, representative studies are Nishimizu and Page (1982), Baur (1990), Kumbhakar and Lovell (2000), Kim and Han (2001) and Sharma, Sylwester and Margono (2007), to mention only a few. The decomposition of TFPG into efficiency changes and technological progress was first proposed by Nishimizu and Page (1982) using stochastic production frontier. Bauer (1990) estimated a translog cost frontier using data on the US airline industry to decompose TFPG into efficiency changes, technological progress, and scale changes. With the help of translog stochastic production frontier, Kumbhakar and Lovell (2000), Kim and Han (2001) and Sharma et al. (2007) decomposed TFPG into four components: technological progress (TP), technical efficiency change (TEC), allocation efficiency change (AEC) and economic scale change (SC).

Objectives of the Study

The objective of the study is to estimate and decompose the sources of TFPG of the 2-digit major manufacturing industries in India and in its major industrialized states (based on total value added) into four components: technological progress (TP), technical efficiency change (TEC), and effect of scale change (SC) and allocation efficiency effect (AEC).

The 2-digit manufacturing industries considered in our study are:

- Manufacture of food, beverages and tobacco products (20-22),
- Manufacture of textile and textile products (23+24+25+26),
- Manufacture of wood and wood products; furniture and fixtures (27),
- Manufacture of paper and paper products (28),
- Manufacture of chemicals and chemical products (30),
- Manufacture of rubber, petroleum and coal products (31),

- Manufacture of non-metallic mineral products (32),
- Manufacture of basic metals and alloys (33),
- Manufacture of metal products and machinery equipment (34-36),
- Manufacture of transport equipment (37), and
- Total manufacturing industry.

The 15 major industrialized states in India (based on total value added) considered for estimating and decomposing the growth rates of TFPG are:

Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal, and All-India.

Period of study: 1981-82 to 2010-11 (Whole Study Period),

Pre-reform period: 1981-82 to 1990-91,

Post-reform period: 1991-92 to 2010-11, and;

Two decades of the post-reform period: 1991-91 to 2000-01, and 2001-02 to 2010-11.

Hypotheses of the Study

We have made two sets of hypothesis. The first set relates to the objective of the study. The set consists of the following four hypotheses:

- (1) The growth rates of TFP and those of the components of TFPG of the 2-digit manufacturing industries across states under study during different sub-periods have not been significantly different from one another.
- (2) No significant change in the growth rates of TFP of the 2-digit manufacturing industries in the states under study and in All-India as well has been occurred between the pre-reform and the post-reform periods, i.e., between 1981-82 to 1990-91 and 1991-92 to 2010-11, respectively.
- (3) The components of TFPG of the 2-digit manufacturing industries in the states under study and in All-India have not improved in the post-reform period over the pre-reform period.

- (4) The growth rates of total factor productivity (TFP), and the growth rates of the components of TFP of the same do not show any significant difference during the two decades of post-liberalization period (1991-92 to 2000-01 and 2001-02 to 2010-11).

To test these hypotheses, we need to construct a suitable model that will contain the parameters relating to technological progress, technical efficiency, scale effect and allocation efficiency effect. The hypotheses made for this purpose are stated below:

- (M1) The Cobb-Douglas production is an appropriate functional form in the sense it gives good fit to the data sets.
- (M2) There has been no technological change in these industries over the periods under study.
- (M3) The technological progress in these industries during the study periods has remained neutral.
- (M4) The next null-hypothesis is that the technical inefficiency effects are absent.
- (M5) The variables used in the inefficiency effects model have no effect on the level of technical efficiency.
- (M6) Each production unit is operating on the production possibility frontier and that the asymmetric and random technical efficiencies in the inefficiency effects model are zero.

We have tested all the above-mentioned hypotheses using appropriate testing methods that are discussed.

The hypotheses M1 through M6 are all about the specification of the model and the contributions of different components of TFPG.

Methodologies

The study uses stochastic production frontier approach for the estimation and decomposition of productivity growth of the 2-digit manufacturing industries (according to the data availability) in India and in its 15 major industrialized states (based on total value added). The translog production function is used in this study as it is assumed to be more appropriate to describe production technology at the disaggregated industry level as well as at the aggregate state/country level.

A stochastic frontier production function as proposed by Aigner et al. (1977) and Meeusen and van den Broeck (1977) is given by

$$y_{it} = f(x_{it}, \beta, t) \exp(v_{it} - u_{it}) \quad (1)$$

where y_{it} is output of the i^{th} industry ($i = 1 \dots N$) in the t^{th} time period ($t = 1 \dots T$); $f(\cdot)$ denotes the production frontier of the i^{th} industry at time 't'; x_{it} is the vector of input of industry 'i' at time 't'; β is the vector of unknown parameters to be estimated; 't' is the time trend served as a proxy for technological change; v_{it} is a symmetric random error term, independently and identically distributed as $N(0, \sigma_v^2)$, intended to capture random variation in output due to external shocks; u_{it} is a non-negative random variable intended to capture technical inefficiency of industry 'i' at time 't' such that u_{it} is obtained by truncation at zero of the normal distribution with mean $z_{it}\delta$ and variance σ_u^2 . Therefore, technical inefficiency effects u_{it} in the stochastic frontier model (1) can be written as

$$u_{it} = z_{it}\delta + w_{it} \quad (2)$$

where z_{it} represents the vector of explanatory variable which may affect technical inefficiency effects of the i^{th} industry in the year 't' and δ is the corresponding parameters vector to be estimated and w_{it} is defined by truncation of the normal distribution with zero mean and variance σ^2 . Given that specification, the technical efficiency (TE) level of industry 'i' at time 't' is then defined as

$$TE_{it} = \exp(-z_{it} - w_{it}) \quad (3)$$

where technical efficiency index in equation (3) varies between zero and unity. A measure equal to one indicates that the industry is operating with full technical efficiency. 'TE' is below unity means production process is not optimal.

Taking logs and total differentials of equation (1) with respect to time gives the growth rates of output at time 't' for the i^{th} industry as given by

$$\dot{y}_{it} = \frac{\partial \ln f(x_{it}, \beta, t)}{\partial t} + \sum_j \frac{\partial \ln f(x_{it}, \beta, t)}{\partial x_{jt}} \cdot \dot{x}_{jt} - \dot{u}_{it} \quad (4)$$

The first two terms on the right-hand side of equation (4) measure the change in frontier output caused by technological progress (TP) and by change in input use, respectively. From the formula of output elasticity of

input 'j', $\mathcal{E}_j = \frac{\partial \ln f(x_{it}, \beta, t)}{\partial \ln x_{jt}}$, the second term can be expressed as $\sum_j \mathcal{E}_j \dot{x}_{jt}$ where a dot over a variable indicates its rate of change. So that equation (4) can be written as

$$\dot{y}_{it} = TP_{it} + \sum_j \mathcal{E}_j \dot{x}_{jt} - \dot{u}_{it} \quad (5)$$

Therefore, the overall growth of output is not only affected by TP and changes in input use, but also by changes in technical efficiency (TE).

To examine the effect of TP and the change in TE on TFPG, let us now express TFPG as output growth unexplained by input growth:

$$TFP_{it} = \dot{y}_{it} - \sum_j S_j \dot{x}_{jt} \quad (6)$$

where S_j denotes the observed expenditure share of input 'j'.

Substituting equation (5) into (6), and after some algebraic manipulation, we get

$$TFP_{it} = TP_{it} - \dot{u}_{it} + (\epsilon - 1) \sum_j \lambda_j \dot{x}_{jt} + \sum_j (\lambda_j - S_j) \dot{x}_{jt} \quad (7)$$

where $\epsilon = \sum_j \mathcal{E}_j$ denotes measurement of returns to scale (RTS) and $\lambda_j = \mathcal{E}_j / \epsilon$. The first component on the right-hand side of equation (7) represents technological progress (TP). It measures the shift in production frontier over time. The second component, $-\dot{u}_{it}$, is the change in technical efficiency. It measures the movement of production towards the known frontier. The third component measures the effect of scale change (SC). It shows an industry can be benefitted from economies of scale through access to a larger market. The more it can produce, the lower will be its average fixed cost. The last component, allocation efficiency effect (AEC), measures inefficiency in resource allocation resulting from the deviation of input prices from the value of their marginal products. The last component captures the impact of deviations of inputs' normalized output elasticities from their expenditure shares [Kumbhakar and Lovell (2000)].

Model Specification

To estimate the sources of TFPG identified in equation (7), the stochastic frontier production function and the technical inefficiency function are specified below. The

stochastic frontier production function to be estimated here takes the translog form with two inputs labour (L) and capital (K) as:

$$\ln y_{it} = \beta_0 + \beta_L \ln L_{it} + \beta_K \ln K_{it} + \beta_t t + 1/2 \beta_{LL} L_{it}^2 + 1/2 \beta_{KK} K_{it}^2 + 1/2 \beta_{tt} t^2 + \beta_{LK} \ln L_{it} \ln K_{it} + \beta_{Lt} L_{it} t + \beta_{Kt} K_{it} t + v_{it} - u_{it} \quad (8)$$

where the technical inefficiency function is assumed to be defined by

$$u_{it} = \delta_0 + \delta_1 SK_{it} + \delta_2 KI_{it} + \delta_3 D_{it} + w_{it} \quad (9)$$

where \ln denotes the natural logarithm, $i = 1, 2, \dots, 11$ indexes the 11 manufacturing industries, $t = 1, 2, \dots, 30$ indexes the annual observations over the study period 1981-82 to 2010-11, and the variables Y_{it} , L_{it} and K_{it} are, respectively, the output (real value added), labour input, and capital input for the aggregate manufacturing industry in industry 'i' at time 't'; SK_{it} is the index of employers' skill in the organized manufacturing industries of the i^{th} industry in the year 't' measured by the ratio of the number of employees other than workers to total number of employees; KI_{it} denotes the factor intensity of the organized manufacturing industries of the i^{th} industry in the year 't' measured by the ratio of the stock of fixed capital to total number of employees and D_{it} is the reforms dummy which shows the impact of economic reforms on productivity growth (D_{it} takes the value '0' during the pre-reform period and it takes the value '1' during the post-reform period); w_{it} is the random error term, distributed as $N(0, \sigma^2)$ truncated at $-z_{it}\delta$, which ensures that $u_{it} \geq 0$. Equation (9) shows that the TE component is linearly related to the skill of employees, factor intensity and the effects of economic reforms that is measured by industrial dummies.

The stochastic frontier production function and the technical inefficiency function specified by equation (8) and (9), respectively, can be jointly estimated by the maximum likelihood estimation (MLE) method using the software FRONTIER 4.1 (Coelli, 1996). Kumbhakar et al. (2015) used STATA to estimate stochastic frontier model. After estimating the stochastic frontier model the rate of technological progress can be computed by differentiating equation (8) with respect to time (t) as

$$TP_{it} = \partial \ln f_{it} / \partial t = \beta_t + \beta_{Lt} + \beta_{Lt} \ln L_{it} + \beta_{Kt} \ln K_{it} \quad (10)$$

where β_t and β_{Lt} denote 'Hicksian' parameters and β_{Lt} and β_{Kt} denote 'factor augmented' parameters. In case of non-neutral technological change, TP is determined by 'factor augmented' parameters β_{Lt} and β_{Kt} , i.e., TP is augmented by factor inputs labour and capital, respectively. In case of non-neutral TP, the change in TP will be different for different input vectors. To avoid this problem, Coelli et al. (1998, p. 234) suggest that the geometric mean between the adjacent periods be used to estimate the TP component. The geometric mean between time 't' and t+1 is written as

$$TP_{it} = [(1 + \partial \ln f_{it} / \partial t) (1 + \partial \ln f_{i,t+1} / \partial t + 1)]^{1/2} - 1 \quad (11)$$

The associated input elasticities of output can be estimated empirically from the following two equations:

$$\text{Labour elasticity of output } (\epsilon_L) = \partial \ln f_{it} / \partial \ln L_{it} = \beta_L + \beta_{LL} \ln L_{it} + \beta_{LK} \ln K_{it} + \beta_{Lt} t \quad (12)$$

$$\text{Capital elasticity of output } (\epsilon_K) = \partial \ln f_{it} / \partial \ln K_{it} = \beta_K + \beta_{KL} \ln L_{it} + \beta_{KK} \ln K_{it} + \beta_{Kt} t \quad (13)$$

The above two equations show the percentage change in output due to 1% change in factor inputs. They are added to estimate the returns to scale component (ϵ). The scale elasticity output is, therefore, given by the formula

$$\epsilon = \epsilon_L + \epsilon_K \quad (14)$$

If scale elasticity exceeds unity, then the technology exhibits increasing returns to scale (IRS); if it is equal to one, the technology obeys constant returns to scale (CRS), and if it is less than unity, the technology shows decreasing returns to scale (DRS).

Data and Variables

The study is based on panel data collected from various issues of Annual Survey of Industries (ASI), Central Statistical Organization (CSO), Ministry of Statistics and Program Implementation, Government of India, New Delhi. To arrive at the measures of output and inputs in real terms, suitable deflators for the variables were constructed. In cases where the exact deflators were not available, the best suitable proxies for the industry concerned were picked up from the WPI series. Series on real gross value added (GVA) for each industry was

obtained by deflating the nominal figures by GDP deflator that is obtained by dividing nominal and real GDP, the data of which are obtained from different volumes of National Accounts Statistics (NAS). Implicit price deflator, used to deflate the series on capital stock at current prices, is also constructed by taking data on gross fixed capital formation at current and constant prices from different volumes of National Accounts Statistics (NAS).

The variables used in this study are output and labour and capital inputs. GVA has been taken as the measure of output. Gross output is not taken directly as the measure of output, in order to avoid the possibility of double counting. However, it may appear that net value added might have been a better measure of output index, but since the depreciation figures are not always reliable as the entrepreneurs often provide us with inflated figures to avoid tax-laws, we have preferred GVA as a measure of output to net value added. Data regarding GVA are collected from various issues of ASI and the data regarding the price level are collected from different volumes of NAS published by the CSO.

When value-added is used as a measure of output, nominal value-added needs to be converted into real value-added. This conversion can be done by using either single deflation (SD) or double deflation (DD) method. In case of SD, nominal value-added is deflated by the output price index, i.e., both nominal output and nominal material inputs are deflated by the output price index. Whereas in case of DD, GVA is deflated by the manufacturing price index and the material inputs by the weighted index of the material input prices. In this study, we could not use the DD method as i) ASI data consists of large number of multi-product firms; ii) value added as a proportion of output is low in the formal sector which leads to GVA becoming negative for several industries with DD method for cases where the input price deflator is higher than the output price deflator; and iii) the non-availability of industry specific input deflators. Accordingly we used SD method.

The total number of persons employed is taken as the measure of labour input. As workers, working proprietors and supervisory/managerial staff/technicians, etc., can affect productivity; total number of persons engaged is

preferred to number of workers. For recent issues, it is reported in the ASI under the head 'persons engaged', for earlier issues, it is reported as 'number of employees'. This relates to all persons engaged by the factory for wages or not in work directly connected or indirectly with the manufacturing process and includes administrative, technical and clerical staff as also labour used in the production of capital assets for the factory's own use. Implicit in such a measure is the assumption that workers and other than workers are perfect substitutes. This may not be a proper assumption to work with when the objective of the study is to compare productivity growth across industries, and management is one of the vitally important factors in explaining inter-industry differentials. Total emoluments divided by the total number of persons engaged in production are considered as price of labour input.

The measurement of capital input is the most complex of all input measurements. There exists no universally accepted method for its measurement and, as a result, several methods have been applied to estimate capital input. In many studies, the capital unit is treated as a stock concept measured by the book value of fixed assets. Some studies have applied the perpetual inventory accumulation method (PIAM) to construct capital stock series from annual investment data. In this case, it is assumed that the flow of capital is proportional to the stock of capital.

However, it is essential to point out that each of these measures has drawbacks. The book value method has three limitations. First, the use of 'lumpy' capital data underestimates or overestimates the amount of capital expenditure. Second, the book value may not truly represent the physical stock of machinery and equipment used in the production. Third, it does not address the question of capacity utilization. PIAM also does not address the question of capacity utilization. The flow measure is criticized on the ground that the depreciation charges in the financial accounts may be unrelated to the actual wear and tear of hardware.

In this study, however, we compute a new series of capital stock data following the PIAM introduced by Goldsmith (1951). In short, the PIAM consists of adding the net investment data of the current year to an assumed base year of capital stock. Thus, the capital stock series for

Indian manufacturing industries are computed following equation,

$$K_t = K_{t-1} + (1 - \delta) K_{t-1} + I_t$$

where K is capital stock, I is net investment, δ is the depreciation rate (here $\delta = 0.05$) and t denotes time. Rental price of capital which equals the ratio of interest paid and capital invested (Jorgenson & Griliches (1967)) is treated as price of capital in this study.

Empirical Results

Estimation of Stochastic Frontier Production Function

The maximum likelihood estimates of the translog stochastic frontier production (SFP) function and the technical inefficiency effects model are presented in Table 1. The study employed one-step regression method to simultaneously estimate the translog SFP model and the inefficiency effect model. Frontier 4.1-xp software is used for this purpose. Table 1 presents the estimation results for ten 2-digit manufacturing industries as well as total manufacturing industry, with parameter estimates for the stochastic frontier model reported on the left side of Table 1. Meanwhile, those for inefficiency function are reported on the right side of the table. Judging by the likelihood value and t-ratios reported in Table 1, the empirical models might be adjudged as performing very well. Given that γ is highly statistically significant in almost all the 2-digit industries at the 1% probability level, it can be said that technical inefficiencies do exist in most of the 2-digit manufacturing industries. This implies that the translog stochastic production frontier with some effects variables is appropriate for modelling the 2-digit manufacturing industries in the major industrialized states in India and in All-India as well.

Almost all the coefficients of the translog stochastic production function in most of the 2-digit industries (on the left side of Table 1) are found to be statistically significant. However, as in the translog specification there may exist multicollinearity due to the existence of interaction and

squared terms, certain estimated coefficients are found to be statistically insignificant (Gounder & Xayayong 2004).

So far as the inefficiency effects are concerned, it is found that almost all the coefficients of the technical inefficiency effects model in all the 2-digit industries are found to be statistically significant. This means that a significant amount of output variation is due to the presence of technical efficiency effect. The estimated coefficients of employers' skill variable (δ_1) are found to be negative in all but three 2-digit industries. This implies that an increase in employees' skill will reduce technical inefficiency effects in all the 2-digit industries except the three. They are found to be positive in case of textile and textile products (23-26), wood and wood products (27) and paper and paper products (28) implying that there exists a positive relationship between employers' skill and technical inefficiency in these three industries although the findings are not statistically significant in case of wood and wood products (27). The estimated coefficients of the capital intensity variable (δ_2) are, however, found to be negative in case of food, beverages and tobacco products (20-22), textile and textile products (23-26), wood and wood products (27), and paper and paper products (28). This means that there exists an inverse relationship between capital intensity and technical inefficiency in these industries although they are not statistically significant in three industries (20-22, 27 and 28). However, for the manufacture of textile and textile products (23-26) these coefficients are statistically significant at 1% probability level. The estimated coefficients of the capital intensity variable (δ_2) in all other industries are found to be positive and statistically significant except in petroleum and coal products (31). This means that an increase in capital intensity in these industries leads to increase in their technical inefficiency. The estimated coefficients of dummy variables (δ_3) are found to be positive in all but three 2-digit industries. This means that economic reforms have boosted technical inefficiency in all these industries except three. In the manufacture of paper and paper products (28), non-metallic mineral products (32) and manufacture of transport equipment (37) the values of δ_3 are found to be negative. This implies that economic reforms have reduced technical inefficiency effects in these three 2-digit manufacturing industries.

Table 1

Maximum Likelihood Estimates for Parameters of the Stochastic Production Frontier and Technical Inefficiency Effects Model of the 2-Digit Manufacturing Industries in Major Industrialized States in India as well as in All-India												
Variables	Parameters	Coefficients										
Panel-1: Stochastic frontier model		20-22	23+24+25+26	27	28	30	31	32	33	34+35+36	37	Total
Constant	β_0	-5.21*** (0.91)	-5.02*** (0.89)	-2.76*** (0.89)	0.48 (0.78)	-2.78*** (0.78)	-0.32 (1.02)	-4.96*** (1.03)	-0.68 (1.10)	-6.55*** (0.90)	-4.64*** (0.66)	-2.07*** (1.10)
lnL	β_L	2.09*** (0.37)	1.38*** (0.37)	1.41*** (0.42)	0.55*** (0.22)	1.01*** (0.30)	-0.52 (0.50)	1.45*** (0.36)	0.036 (0.53)	3.25*** (0.39)	1.99*** (0.24)	2.77*** (0.47)
lnK	β_K	-0.70** (0.32)	0.27 (0.28)	-0.29 (0.32)	-0.03 (0.14)	0.42** (0.21)	1.51*** (0.36)	0.25 (0.23)	0.99*** (0.37)	-1.51** (0.31)	-0.43*** (0.17)	-1.82*** (0.42)
t	β_t	0.19*** (0.03)	-0.0065 (0.02)	0.06** (0.03)	0.13*** (0.02)	0.0073 (0.025)	-0.07** (0.04)	-0.003 (0.024)	-0.036 (0.032)	0.10*** (0.027)	0.08*** (0.02)	0.20*** (0.024)
lnL ²	β_{LL}	-0.15*** (0.035)	-0.058* (0.04)	-0.14*** (0.05)	-0.05*** (0.02)	-0.026 (0.035)	0.11** (0.06)	-0.006 (0.03)	-0.0082 (0.067)	-0.28*** (0.047)	-0.088*** (0.028)	-0.14*** (0.09)
lnK ²	β_{KK}	-0.097*** (0.037)	-0.017 (0.03)	-0.14*** (0.03)	-0.07*** (0.02)	0.015 (0.022)	-0.0049 (0.026)	0.058*** (0.03)	-0.06* (0.039)	-0.12*** (0.034)	0.009 (0.016)	0.0099 (0.08)
t ²	β_{tt}	-0.0029*** (0.0004)	0.0009*** (0.0003)	-0.0013*** (0.0004)	-0.0005** (0.0003)	0.001** (0.0005)	-0.0029*** (0.0005)	0.0008*** (0.0003)	-0.0003 (0.0003)	0.00048*** (0.0003)	-0.00005 (0.0003)	-0.0009*** (0.0002)
lnL*lnK	β_{LK}	0.239*** (0.064)	0.051 (0.07)	0.27*** (0.08)	0.15*** (0.03)	-0.0054 (0.049)	-0.11* (0.07)	-0.08** (0.046)	0.062 (0.098)	0.38*** (0.078)	0.06** (0.04)	0.14 (0.17)
lnL*t	β_{Lt}	-0.029*** (0.005)	0.0025 (0.005)	-0.019*** (0.007)	-0.017*** (0.003)	0.0062 (0.0058)	0.0005 (0.0058)	-0.0004 (0.003)	-0.0052 (0.007)	-0.019*** (0.0075)	-0.016*** (0.004)	-0.03*** (0.0046)
lnK*t	β_{Kt}	0.026*** (0.006)	-0.0034 (0.004)	0.022*** (0.005)	0.0089*** (0.003)	-0.0084** (0.0057)	0.016*** (0.0055)	0.0003 (0.0026)	0.012*** (0.0052)	0.012*** (0.0064)	0.011*** (0.003)	0.02*** (0.0044)
Panel-2: Inefficiency effects model												
Intercept	δ_0	-0.31*** (0.05)	-2.20*** (0.79)	-0.74 (1.08)	-9.71** (4.44)	-3.78* (2.98)	-8.34 (8.95)	0.80*** (0.22)	-5.76* (3.58)	0.77*** (0.20)	-4.52*** (1.79)	0.69*** (0.11)
Employers' Skill(OE/TE)	δ_1	-1.09*** (0.27)	3.04*** (0.79)	0.33 (0.47)	11.35*** (4.92)	-25.82*** (7.47)	-1.27 (1.19)	-4.00*** (0.96)	-6.36** (3.21)	-2.21*** (0.46)	11.97*** (3.41)	-2.62*** (0.60)
Capital Intensity(K/L)	δ_2	-0.07 (0.18)	-2.53*** (0.21)	-0.25 (0.28)	-0.000006 (0.000007)	0.84*** (0.30)	0.22 (0.25)	0.11*** (0.039)	0.22*** (0.088)	-0.32*** (0.18)	1.41*** (0.40)	0.13* (0.11)
Reform Dummy(D)	δ_3	0.80*** (0.14)	0.77*** (0.16)	1.40* (0.96)	-4.05** (1.94)	0.035 (0.28)	1.08 (1.84)	-0.04 (0.08)	2.54** (1.30)	0.18** (0.09)	-4.16*** (1.42)	0.12*** (0.04)
Panel-3: Variance parameters												
Sigma squared	σ^2	0.09*** (0.01)	0.47*** (0.11)	0.20*** (0.02)	2.41** (1.06)	4.36*** (1.69)	2.41 (2.59)	0.10*** (0.008)	2.01*** (1.02)	0.076*** (0.011)	2.58*** (0.76)	0.04*** (0.03)
Gamma	γ	0.07** (0.03)	0.93*** (0.015)	0.51*** (0.14)	0.98*** (0.0095)	0.97*** (0.01)	0.91*** (0.11)	0.05 (0.25)	0.97*** (0.016)	0.57*** (0.095)	0.96*** (0.14)	0.37* (0.27)
Log-Likelihood		-117.39	1.03	-241.08	-141.58	-375.76	-404.70	-142.22	-257.60	40.09	-287.64	126.08
Standard errors are mentioned in the parenthesis												
***, ** & * denote statistical significance at the 1%, 5% and 10% levels, respectively												
Source: Authors' own calculation												

Notes:

- σ^2 refers to variance of the total random term, i.e., $\sigma^2 = \sigma_u^2 + \sigma_v^2$
- γ refers to proportion of inefficiency error in the total random error, i.e., $\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$. It indicates the level of operation of the industries of their potential output as determined by the frontier technology.

So, it is clear that the estimated coefficients of employers' skill variable in the inefficiency functions are negative in most of the industries, indicating the improvement in technical efficiency in those industries during the last 30 years. Surprisingly, the estimated coefficient of capital intensity variable does not provide a plausible economic interpretation. It is positive in more than 60% of industries. It is to be noted that a positive estimated coefficient means negative gains in technical efficiency and negative effects on productivity growth.

Likewise, the estimated coefficients of dummy variable are positive in almost all the 2-digit industries, indicating

that liberalization of the Indian manufacturing industries created a significant negative impact on technical efficiency improvement in these industries.

Lastly, panel 3 of Table 1 reports the estimates of the variance parameters σ^2 and γ that test for the validity of technical inefficiency effect. Both the estimated coefficients (except the value of gamma parameter in the non-metallic minerals product) are found to be statistically significant at the conventional levels which confirm the presence of technical inefficiency effect in the output residual as shown in panel 3. The estimated values of gamma (γ) are found to be more than 50% in as

many as eight 2-digit industries. These estimated values are 0.93, 0.51, 0.98, 0.97, 0.91, 0.97, 0.57 and 0.96, respectively, in the manufacture of textile and textile products (23+24+25+26), wood and wood products; furniture and fixtures (27), paper and paper products (28), chemicals and chemical products (30), rubber, petroleum and coal products (31), basic metals and alloys (33), metal products and machinery equipment (34-36) and the manufacture of transport equipment (37). They are found to be statistically significant at less than 1% probability level, implying that output variation in these 2-digit manufacturing industries is significantly dominated by inefficiency error components. Although the estimated values of gamma (γ) are found to be very low in case of the manufacture of food, beverages and tobacco products (20-22), manufacture of non-metallic mineral products (32) and in total manufacturing. This implies that output variations in these 2-digit manufacturing industries are remarkably influenced by random factors.

Tests of Hypotheses

The hypotheses M1 to M6 are tested using likelihood ratio (LR) tests. The likelihood ratio test statistic is $\lambda = -2 [L(H_0) - L(H_1)]$, where $L(H_0)$ and $L(H_1)$ are the values of log-likelihood function under null and general hypotheses respectively. If null is true, then test statistic (λ) has approximately a Chi-Square (or mixed chi-square) distribution with degrees of freedom equal to the number of restrictions. If null hypothesis includes $\gamma = 0$, then test statistic λ is approximately distributed according to a mixed chi-square distribution. Table 2 presents the test results of various null hypotheses as mentioned below:

At first, we carried out a generalized likelihood ratio test to choose between the null hypotheses of traditional Cobb-Douglas functional form and the alternative of the translog production function specification. All the values of the tests statistics are found to be significantly greater than the critical chi-square table value of 16.81 and 12.59 with six degrees of freedom at, respectively, 1% and 5% levels of significance in almost all the 2-digit industries. We, therefore, reject the null hypotheses of the traditional Cobb-Douglas functional form for most of the 2-digit industries except three, namely, the manufacture of textile and textile products (23-26), chemical and chemical products (30), and petroleum and coal products

(31). These results clearly indicate presence of translog production function specification to the Cobb-Douglas representation for as many as eight 2-digit industries. Only these three industries are exceptions.

The second test we have conducted to test the null hypothesis that there is no technological change over time. This implies that all the parameters in equation (9) do not belong to the stochastic production frontier. The values of the generalized likelihood ratio tests as shown in Table 2 are significantly greater than the critical values at 1% probability level. Therefore, the null hypothesis of 'no technological change over time' is strongly rejected.

The third null-hypothesis is that the technological progress is neutral. But the translog specification of stochastic production frontier allows for non-neutral technological progress. Technological progress is neutral if β_{Lt} and β_{Kt} are equal to zero. Here, for the manufacture of textile and textile products (23-26), chemical and chemical products (30), petroleum and coal products (31), and non-metallic mineral products (32), the null hypothesis is accepted. Statistical tests, therefore, suggest the existence of neutral technological progress in the data set of these three industries. However, in case of all other industries, the null hypothesis is rejected, thereby implying, the existence of non-neutral technological change in the data set of these industries.

The fourth null hypothesis states that there is no technical inefficiency effect. The alternative hypothesis in this case is that technical inefficiency is experienced by the industries. Note that the null hypotheses assert that all the coefficients of the technical inefficiency effects model are zero. By applying the restrictions on the original model, the value of likelihood ratio tests is found to be greater than the tabled chi-square values for almost all the 2-digit industries. The results thus provide evidences that technical inefficiencies are present in almost all the 2-digit industries except in petroleum and coal products (31). This implies that the traditional production function is not an adequate representation for the 2-digit manufacturing industries except for the petroleum and coal products (31). So, it can be inferred that inefficiencies are present in the 2-digit manufacturing industries in India (except petroleum and coal products) and they are stochastic.

The fifth null hypothesis asserts that inefficiency effect is not a linear function of each of the explanatory variables, i.e., $H_0: \delta_1 = \delta_2 = \delta_3 = 0$. The test results reject the null hypothesis in case of all but four industries. This indicates that the joint effect of these explanatory variables on the level of technical inefficiencies of those industries (except the four) is statistically significant (Table 2). It is only in case of four industries, namely, textile and textile products (23-26), chemical and chemical products (30), petroleum and coal products (31), and manufacture of transport equipment (37), the null-hypothesis is accepted implying

that the explanatory variables have no effect on technical inefficiency for these four industries.

The final null-hypothesis specifies that each industry is operating on the technically efficient frontier ($H_0: \mu = 0$). This hypothesis is also rejected in favour of the presence of inefficiency effects at the conventional levels of significance in all the 2-digit industries except the four. In case of food, beverages and tobacco products (20-22); wood and wood products (27); chemical and chemical products (30), and petroleum and coal products (31) the null-hypotheses are accepted in favour of the absence of inefficiency effect.

Table 2: Hypothesis Tests for Model Specification and Statistical Assumptions

Null Hypothesis	Log-Likelihood Value		Test Statistics	Critical Value		Decision
	$L(H_1)$	$L(H_0)$		At 1% Level	At 5% Level	
<i>Cobb-Douglas Production Specification</i> $H_0: \beta_{LL} = \beta_{KK} = \beta_{LK} = \beta_{tt} = \beta_{L_t} = \beta_{K_t} = 0$			$\lambda = -2[L(H_0)-L(H_1)]$			Reject H_0 / Accept H_0
Food, Beverages & Tobacco (20-22)	-117.39	-136.24	37.70	16.81	12.59	Reject H_0
Textile & Textile Products(23+24+25+26)	1.03	11.78	-21.50	16.81	12.59	Accept H_0
Wood & Wood Products (27)	-241.08	-277.38	72.60	16.81	12.59	Reject H_0
Paper & Paper Products (28)	-141.58	-160.43	37.70	16.81	12.59	Reject H_0
Chemical & Chemical Products (30)	-375.76	-352.28	-46.96	16.81	12.59	Accept H_0
Petroleum & Coal Products (31)	-404.70	-403.76	-1.88	16.81	12.59	Accept H_0
Non-Metallic Mineral Products (32)	-142.22	-165.74	47.04	16.81	12.59	Reject H_0
Basic Metal & Alloys Industries (33)	-257.60	-265.42	15.62	16.81	12.59	Reject H_0
Metal Products & Machinery (34+35+36)	40.09	31.31	17.56	16.81	12.59	Reject H_0
Transport Equipment (37)	-287.64	-299.18	23.08	16.81	12.59	Reject H_0
Total Manufacturing	126.08	61.85	128.46	16.81	12.59	Reject H_0
<i>No Technological Change</i> $H_0: \beta_t = \beta_{tt} = \beta_{L_t} = \beta_{K_t} = 0$			$\lambda = -2[L(H_0)-L(H_1)]$			Reject H_0 / Accept H_0
Food, Beverages & Tobacco (20-22)	-117.39	-158.26	81.74	13.28	9.49	Reject H_0
Textile & Textile Products(23+24+25+26)	1.03	-57.66	117.38	13.28	9.49	Reject H_0
Wood & Wood Products (27)	-241.08	-259.31	35.46	13.28	9.49	Reject H_0
Paper & Paper Products (28)	-141.58	-213.37	143.58	13.28	9.49	Reject H_0
Chemical & Chemical Products (30)	-375.76	-392.43	33.34	13.28	9.49	Reject H_0
Petroleum & Coal Products (31)	-404.70	-428.69	47.98	13.28	9.49	Reject H_0
Non-Metallic Mineral Products (32)	-142.22	-170.85	57.26	13.28	9.49	Reject H_0
Basic Metal & Alloys Industries (33)	-257.60	-292.30	69.40	13.28	9.49	Reject H_0
Metal Products & Machinery (34+35+36)	40.09	-81.61	83.04	13.28	9.49	Reject H_0
Transport Equipment (37)	-287.64	-326.12	76.96	13.28	9.49	Reject H_0
Total Manufacturing	126.08	-206.68	161.20	13.28	9.49	Reject H_0
<i>Technological Change is Neutral</i> $H_0: \beta_{L_t} = \beta_{K_t} = 0$			$\lambda = -2[L(H_0)-L(H_1)]$			Reject H_0 / Accept H_0
Food, Beverages & Tobacco (20-22)	-117.39	-144.96	55.14	9.21	5.99	Reject H_0
Textile & Textile Products(23+24+25+26)	1.03	0.87	0.32	9.21	5.99	Accept H_0
Wood & Wood Products (27)	-241.08	-270.02	57.88	9.21	5.99	Reject H_0
Paper & Paper Products (28)	-141.58	-154.43	25.70	9.21	5.99	Reject H_0
Chemical & Chemical Products (30)	-375.76	-370.19	-11.14	9.21	5.99	Accept H_0
Petroleum & Coal Products (31)	-404.70	-407.26	5.12	9.21	5.99	Accept H_0
Non-Metallic Mineral Products (32)	-142.22	-142.48	0.52	9.21	5.99	Accept H_0

<i>Technological Change is Neutral</i> $H_0: \beta_{Lt} = \beta_{Kt} = 0$	$L(H_1)$	$L(H_0)$	$\lambda = -2[L(H_0)-L(H_1)]$	<i>At 1% Level</i>	<i>At 5% Level</i>	<i>Reject H_0/ Accept H_0</i>
Basic Metal & Alloys Industries (33)	-257.60	-272.84	30.48	9.21	5.99	Reject H_0
Metal Products & Machinery (34+35+36)	40.09	44.16	8.14	9.21	5.99	Reject H_0 at 5% level
Transport Equipment (37)	-287.64	-295.45	15.62	9.21	5.99	Reject H_0
Total Manufacturing	126.08	62.60	126.96	9.21	5.99	Reject H_0
<i>Null Hypothesis</i>	<i>Log-Likelihood Value</i>		<i>Test Statistics</i>	<i>Critical Value</i>		<i>Decision</i>
<i>No Technical Inefficiency Effects</i> $H_0: \gamma = \delta_0 = \delta_1 = \delta_2 = \delta_3 = 0$	$L(H_1)$	$L(H_0)$	$\lambda = -2[L(H_0)-L(H_1)]$	<i>At 1% Level</i>	<i>At 5% Level</i>	<i>Reject H_0/ Accept H_0</i>
Food, Beverages & Tobacco (20-22)	-117.39	-125.71	16.64	16.81	12.59	Reject H_0
Textile & Textile Products(23+24+25+26)	1.03	-14.04	30.14	16.81	12.59	Reject H_0
Wood & Wood Products (27)	-241.08	-266.23	50.30	16.81	12.59	Reject H_0
Paper & Paper Products (28)	-141.58	-169.09	50.02	16.81	12.59	Reject H_0
Chemical & Chemical Products (30)	-375.76	-395.34	39.16	16.81	12.59	Reject H_0
Petroleum & Coal Products (31)	-404.70	-406.81	4.22	16.81	12.59	Accept H_0
Non-Metallic Mineral Products (32)	-142.22	-159.42	34.40	16.81	12.59	Reject H_0
Basic Metal & Alloys Industries (33)	-257.60	-270.91	26.62	16.81	12.59	Reject H_0
Metal Products & Machinery (34+35+36)	40.09	26.36	27.46	16.81	12.59	Reject H_0
Transport Equipment (37)	-287.64	-310.83	46.38	16.81	12.59	Reject H_0
Total Manufacturing	126.08	83.81	84.54	16.81	12.59	Reject H_0
<i>Inefficiency Effects are not a Linear Function of each of the Inefficiency Factors</i> $H_0: \delta_1 = \delta_2 = \delta_3 = 0$	$L(H_1)$	$L(H_0)$	$\lambda = -2[L(H_0)-L(H_1)]$	<i>At 1% Level</i>	<i>At 5% Level</i>	<i>Reject H_0/ Accept H_0</i>
Food, Beverages & Tobacco (20-22)	-117.39	-124.01	13.24	11.34	7.81	Reject H_0
Textile & Textile Products(23+24+25+26)	1.03	-1.78	5.62	11.34	7.81	Accept H_0
Wood & Wood Products (27)	-241.08	-266.23	50.30	11.34	7.81	Reject H_0
Paper & Paper Products (28)	-141.58	-149.46	15.76	11.34	7.81	Reject H_0
Chemical & Chemical Products (30)	-375.76	-379.44	7.36	11.34	7.81	Accept H_0
Petroleum & Coal Products (31)	-404.70	-406.94	4.48	11.34	7.81	Accept H_0
Non-Metallic Mineral Products (32)	-142.22	-160.34	36.24	11.34	7.81	Reject H_0
Basic Metal & Alloys Industries (33)	-257.60	-261.77	8.34	11.34	7.81	Reject H_0 at 5% level
Metal Products & Machinery (34+35+36)	40.09	31.50	17.18	11.34	7.81	Reject H_0
Transport Equipment (37)	-287.64	-291.36	7.44	11.34	7.81	Accept H_0
Total Manufacturing	126.08	83.98	84.20	11.34	7.81	Reject H_0
<i>Each Industry is Operating on Technical Efficiency Frontier</i> $H_0: \mu = 0$	$L(H_1)$	$L(H_0)$	$\lambda = -2[L(H_0)-L(H_1)]$	<i>At 1% Level</i>	<i>At 5% Level</i>	<i>Reject H_0/ Accept H_0</i>
Food, Beverages & Tobacco (20-22)	-117.39	-117.86	0.94	6.63	3.84	Accept H_0
Textile & Textile Products(23+24+25+26)	1.03	-5.70	13.46	6.63	3.84	Reject H_0
Wood & Wood Products (27)	-241.08	-242.22	2.28	6.63	3.84	Accept H_0
Paper & Paper Products (28)	-141.58	-156.76	30.36	6.63	3.84	Reject H_0
Chemical & Chemical Products (30)	-375.76	-376.90	2.28	6.63	3.84	Accept H_0
Petroleum & Coal Products (31)	-404.70	-405.70	2.20	6.63	3.84	Accept H_0
Non-Metallic Mineral Products (32)	-142.22	-149.47	14.50	6.63	3.84	Reject H_0
Basic Metal & Alloys Industries (33)	-257.60	-261.19	7.18	6.63	3.84	Reject H_0
Metal Products & Machinery (34+35+36)	40.09	35.77	8.64	6.63	3.84	Reject H_0
Transport Equipment (37)	-287.64	-290.17	5.06	6.63	3.84	Reject H_0 at 5% level
Total Manufacturing	126.08	106.89	38.38	6.63	3.84	Reject H_0

Source: Authors' own calculation

Thus, on the basis of the test results, we can make the following inferences: 1) the translog production function specification is an appropriate one for as many as eight industries; while for only three industries, namely, manufacture of textile and textile products (23-26), chemical and chemical products (30), and petroleum and coal products (31), Cobb-Douglas production happens to be the best functional specification. 2) The technological progress is found to be non-neutral for as many as seven industries. For only four industries, it happens to be neutral. 3) Furthermore, for the seven industries there exists a linear relationship between inefficiency effect term, on the one hand, and the effects variables, on the other. This relationship is non-linear for the remaining four industries. Thus, the test results relating to model specification guide us to finally select the more appropriate models for two sets of industries-one set consists of seven and the other set consists of the remaining four industries and we carry out the estimation of the parameters of these models. The estimation results are presented in Tables 3 through 7 in Appendix.

Decomposition Results

Based on the translog production function estimates presented in Table 1, we have obtained the four measures of the 2-digit industries across states: technological progress (TP) [Table 3 in the Appendix], the growth of technical efficiency (TEC) [Table 4 in the Appendix], economic scale effect (SC) [Table 5 in the Appendix] and allocative efficiency effect (AEC) [Table 6 in the Appendix]. Adding four measures, we obtain total factor productivity growth (TFPG) [Table 7 in the Appendix] of them. As translog specification is used, the performance of these measures varies depending on industries and years. The estimated results are interpreted below:

We know that economic reform of the early 1990s is a significant milestone in the economic growth of India (Goldar & Sengupta, 2016). However, Table 7 (in the Appendix) shows that in almost all the 2-digit industries in most of the states under study as well as in All-India the rates of TFPG have declined during the post-reform period. The decline in the rates of TFPG of these industries can be accounted for by the decline in TEC and AEC in these industries during the reference periods. This is because although in six out of eleven industries, TP has increased significantly and SC has also increased marginally in most of the industries in almost all the states under study

and in All-India as well during the post-reform period, the increasing effect of these two could not offset the declining effects of TEC and AEC of the same during the aforesaid period.

Thus, the above results clearly show that although the innovating manufacturing industries in many states under study and in All-India are adopting new technologies, contributing to technological progress, and at the same time reaping the fruits of increasing returns to scale, it appears that these industries failed to follow the best practice technologies of the adopted technology because of their incomplete knowledge of best practice and deviation of factor prices from the factors' marginal productivities. As a result, the major manufacturing industries under study in most of the industrialized states in India as well as in All-India failed to achieve maximum efficiency and the level of efficiency seems to be insufficient to increase TFPG over the years.

As regards the contribution of technical efficiency change to TFPG, only a few industries in a few states under study including All-India enjoyed positive growth rates of technical efficiency over the period. The positive growth rate of technical efficiency change indicates a movement towards the production frontier, which also means an increase in output growth over time. The remaining industries in all other states under study suffered from a declining change in technical efficiency over the period. It reveals that inputs have not been used efficiently in these industries of the states under study over the period.

However, in most of the 2-digit industries increase in TP and SC have often been outweighed by the declining technical as well as allocation efficiency change. Thus, the decline in technical and allocation efficiency changes are the main causes of the low and declining rates of TFPG of the manufacturing industries in India and in its major industrialized states during the post-reform period. It may be mention here that the manufacture of metal products and machinery equipment (34-36) and the manufacture of transport equipment (37) have experienced maximum growth rates of TFP in almost all the states under study during the whole study period and in the post-reform period. On the other hand, it is the manufacture of food, beverages and tobacco products (20-22) that has experienced the highest growth rate of TFP during the pre-reform period. This may be due to better performances of TP in these industries under study during the study periods. However, manufacture of wood

and wood products (27) and petroleum and coal products (31) show worse performance during the aforesaid study periods so far as the rates of TFPG are concerned.

But statistical tests suggest that the translog production function specification in case of a few important industries like manufacture of textile and textile products (23-26), chemical and chemical products (30) and petroleum and coal products (31) is not applicable. In case of these three industries, Cobb-Douglas production function represents the better functional specification. Further, for these industries, technological progress is found to have been neutral. Moreover, in case of these industries there is no linear relationship of the inefficiency effect term with the effects variables. So, the estimates of TP itself represent the TFPG estimates in these three important industry groups. Thus, productivity growth decomposition using stochastic frontier model along with translog production specification is not applicable in case of these three industries under the study. However, in case of all other industries the chosen model represents best model specification and decomposition of TFPG using this model remained effective in almost all the 2-digit industries in case of the major industrialized states under study as well as in All-India during the aforementioned study periods.

Summary and Conclusion

The study estimates and decomposes the sources of TFPG of the 2-digit manufacturing industries as well as total manufacturing industry in fifteen major industrialized states in India as well as in All-India during the period from 1981-82 to 2010-11, for the entire period, pre-reform period (1981-82 to 1990-91), post-reform period (1991-92 to 2010-11) and also for the two decades of the post-reform period (1990-91 to 2000-01 and 2001-02 to 2010-11) using stochastic frontier approach. The methodology entails decomposition of the sources of TFPG into technological progress, technical efficiency change, allocation efficiency change and scale change.

The main findings of decomposition is that TFPG in most of the 2-digit industries in major industrialized states in India as well as in All-India have declined during the post-reform period. So far as the sources of TFPG are concerned, it is found that the productivity growth of the Indian manufacturing industries is significantly driven by

technological progress. The contributions of scale effect to TFPG of the same in the major industrialized states under study are also found to be positive although they are found to be very negligible. But the decline in TFPG of most of the 2-digit industries in the major industrialized states under study may be partly ascribed to the declines in the TEC and AEC of these industries which have swamped the positive growth in TP and SC of them.

However, it is found that the scale effects in almost all the 2-digit industries including that of total manufacturing industry have increased in most of the states under study during the 2nd half of the post-reform period. So, it can be inferred that the manufacturing industries of different states under study including those in All-India have benefitted from economies of scale during the recent years. But the estimates of scale effects are still far below the estimates of all other components of TFPG. Thus, although factor accumulation may have led to TFP growth through increasing returns to scale, TFPG in most of the 2-digit industries in almost all the states under study have declined during the post-reform period and the decline in TFPG of the same is mainly responsible for the decline in AEC and TEC of them during that period. This means that deregulation of the economy during the post-reform period has increased the price buckle measured by the gap between price and marginal cost of production of the organized manufacturing industries in the major industrialized states in India as well as those in All-India. Therefore, resource allocations in almost all the 2-digit industries under study has been made more inefficiently during the post-reform period. Moreover, factor inputs have been used more inefficiently, i.e., they are producing below their optimal capacity.

Most of the studies on productivity analysis of the organized manufacturing industries in India have also shown that TFPG of the manufacturing industries in India have declined during the post-reform period although the reasons are different. Goldar and Kumari (2003) in their study have shown that the decline in agricultural productivity and the deterioration of capacity utilization are mainly responsible for the decline in TFPG of the Indian manufacturing industries. Kathuria et al. (2014) and Goldar and Sengupta (2016) have shown that the decline in TFPG of the major manufacturing industries in India during the post-reform period is mainly responsible for the decline in technological progress of the same during that period.

Whatever the reasons for the decline in TFPG of the organized manufacturing industries in India are, policies should be geared to allocate resources optimally and to use factor inputs more efficiently. Policies should further be taken to increase scale of production so that per unit cost of production decline and price will tend towards marginal costs. Policy measures intended to improve TFP growth rate might be misdirected if they focus on accelerating the rate of innovation in circumstances where the low rate of TFP growth is brought about by suboptimal size of the firms and low rate of technology diffusion (technical inefficiency), which really

happened in the case of the organized manufacturing sector in general. A thorough examination of industrial policy resolutions reveals that the importance and contribution of efficiency in industrial growth has been neglected or given less priority in the framework of industrial strategy (Madheswaran et al., 2007). In this context, the governments should take some policy initiatives to improve productive efficiency of the organized manufacturing industries. Once efficiency increases, it enhances competitiveness by realizing the potential TFP growth of the organized manufacturing industries in India.

Appendix

Table 3(a): Average Annual Rates of Technological Progress (TP) during 1981-82 to 2010-11 (Entire Study Period)

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	-0.74	1.88	2.69	3.16	2.90	3.67	-1.75	2.84	3.10	2.50	2.81	3.95	2.15	2.71	2.03	1.11
23-26	1.63	2.12	2.33	1.42	1.68	1.82	1.79	1.61	1.44	2.05	1.51	1.50	1.51	1.57	1.88	1.34
27	2.22	1.59	-0.24	1.84	2.78	2.19	1.32	2.14	2.74	2.26	1.46	1.83	1.23	3.36	1.37	3.17
28	2.64	4.59	3.38	2.36	3.49	2.99	3.14	3.12	1.80	3.57	3.71	3.27	1.95	2.19	2.18	0.50
30	1.51	2.53	2.26	1.06	2.39	2.01	1.90	1.97	1.27	1.85	2.23	1.47	1.97	1.33	1.70	0.95
31	0.82	-0.15	-0.11	2.32	-1.91	0.24	0.28	-1.04	2.48	-3.52	-3.18	-1.21	1.26	1.12	0.41	5.78
32	2.44	2.39	2.39	2.43	2.42	2.45	2.41	2.46	2.44	2.43	2.42	2.45	2.43	2.41	2.41	2.41
33	3.12	-0.52	3.84	2.80	1.79	2.69	0.65	3.53	3.21	3.67	0.95	1.72	2.42	2.33	3.02	4.79
34-36	2.89	3.90	3.82	2.80	3.20	3.15	3.76	3.44	2.43	4.57	3.09	4.03	2.55	3.00	2.42	1.19
37	2.50	2.23	3.29	2.76	3.24	2.94	3.95	3.24	2.87	4.12	1.88	3.05	2.40	2.72	1.28	1.62
Total	2.61	4.41	5.28	4.14	4.07	3.69	3.04	4.94	3.16	6.47	3.49	4.89	2.29	3.65	2.92	0.96

Table 3(b): Average Annual Rates of Technological Progress (TP) during 1981-82 to 1990-91 (Pre-Reform Period)

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	2.92	6.06	6.06	6.96	6.41	7.23	2.16	5.28	7.26	6.60	6.94	8.18	5.92	5.68	6.13	4.87
23-26	0.19	0.45	0.63	-0.06	0.20	0.23	0.24	0.22	-0.02	0.31	0.05	-0.04	0.01	0.05	0.31	-0.15
27	4.20	3.11	1.61	2.56	2.75	3.07	2.51	3.35	2.95	3.79	2.21	2.13	1.57	3.58	1.65	3.88
28	3.16	6.45	3.42	3.04	3.88	3.84	4.18	3.69	2.26	3.40	4.45	3.86	2.69	2.86	2.48	0.99
30	-0.14	0.63	0.51	-0.08	0.86	0.45	-0.14	0.75	-0.18	0.92	1.31	0.04	0.09	-0.22	0.24	-0.50
31	5.54	3.51	4.93	5.04	2.43	3.42	4.79	1.51	6.54	-0.72	1.10	3.19	5.55	5.48	4.59	10.4
32	0.77	0.73	0.71	0.74	0.73	0.77	0.73	0.79	0.75	0.76	0.77	0.79	0.76	0.73	0.72	0.73
33	2.28	-0.55	4.05	1.36	1.23	1.46	0.79	3.81	2.43	3.40	0.85	1.84	1.98	1.77	2.82	4.53
34-36	1.65	2.71	1.83	1.04	1.60	1.61	2.72	1.93	0.85	3.18	1.89	2.42	1.07	1.59	0.60	-0.42
37	2.26	1.10	3.02	2.04	2.79	2.33	4.60	2.60	2.23	2.50	1.38	1.74	1.48	1.47	0.49	0.92
Total	3.59	5.17	6.09	4.42	5.47	4.40	4.77	6.05	3.81	7.05	5.20	6.21	3.45	4.36	3.29	1.83

Table 3(c): Average Annual Rates of Technological Progress (TP) during 1991-92 to 2010-11 (Post-Reform Period)

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	-2.58	-0.22	1.00	1.26	1.15	1.89	-3.71	1.61	1.03	0.45	0.74	1.83	0.26	1.22	-0.01	-0.76
23-26	2.34	2.95	3.18	2.16	2.43	2.62	2.57	2.30	2.17	2.92	2.24	2.26	2.26	2.33	2.67	2.08
27	1.23	0.83	-1.17	1.48	2.80	1.75	0.72	1.54	2.63	1.50	1.09	1.67	1.06	3.25	1.23	2.81
28	2.38	3.67	3.36	2.02	3.29	2.57	2.62	2.84	1.56	3.66	3.34	2.98	1.59	1.85	2.03	0.25
30	2.34	3.48	3.14	1.63	3.16	2.78	2.92	2.58	2.00	2.31	2.69	2.18	2.91	2.10	2.44	1.68
31	-1.54	-1.98	-2.63	0.96	-4.09	-1.35	-1.97	-2.32	0.44	-4.92	-5.33	-3.41	-0.89	-1.06	-1.68	3.48
32	3.27	3.22	3.23	3.27	3.26	3.29	3.25	3.30	3.28	3.27	3.24	3.28	3.27	3.25	3.26	3.25
33	3.55	-0.50	3.73	3.52	2.06	3.30	0.57	3.39	3.60	3.81	1.01	1.66	2.63	2.61	3.11	4.92
34-36	3.51	4.49	4.81	3.68	3.99	3.92	4.28	4.20	3.22	5.26	3.70	4.84	3.29	3.71	3.33	1.99
37	2.62	2.80	3.43	3.11	3.46	3.25	3.62	3.56	3.20	4.92	2.13	3.71	2.85	3.35	1.67	1.97
Total	2.13	4.03	4.88	4.01	3.37	3.33	2.18	4.38	2.84	6.18	2.63	4.23	1.72	3.29	2.74	0.53

**Table 3(d): Average Annual Rates of Technological Progress (TP) during 1991-92 to 2000-01
(Post-Reform Period: Decade 1)**

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	-1.01	2.16	2.83	3.23	2.70	3.60	-1.32	3.70	2.98	3.03	3.05	4.48	2.18	2.83	1.87	1.11
23-26	1.61	2.12	2.46	1.42	1.66	1.85	1.80	1.54	1.43	2.17	1.49	1.45	1.52	1.49	1.87	1.32
27	0.99	1.95	-0.07	1.80	3.91	2.03	0.92	2.22	2.72	3.15	1.82	2.11	1.12	3.76	0.87	3.17
28	2.55	4.24	3.16	2.53	3.43	2.89	2.82	3.11	2.06	3.61	3.61	3.19	2.16	2.44	2.41	0.52
30	1.48	2.99	2.37	0.73	2.22	2.15	1.96	1.59	1.14	1.57	1.86	1.22	2.07	1.13	2.17	0.81
31	0.36	-0.42	-0.89	1.87	-1.73	0.18	0.17	0.02	2.64	-2.61	-3.10	-1.13	1.34	1.27	0.30	5.29
32	2.48	2.44	2.44	2.48	2.47	2.50	2.45	2.51	2.48	2.48	2.49	2.50	2.47	2.46	2.46	2.46
33	3.82	-0.63	3.81	3.48	1.90	2.76	0.69	3.31	3.38	3.58	1.00	1.95	2.56	2.77	3.31	4.94
34-36	2.87	2.96	3.76	2.93	3.37	3.17	3.71	3.61	2.69	4.63	3.33	4.21	2.67	3.13	2.55	1.31
37	2.56	2.48	2.81	2.25	3.54	2.93	3.87	3.68	3.13	4.39	2.07	3.01	2.44	3.18	1.14	1.68
Total	2.64	4.25	5.08	4.42	4.10	3.76	2.99	4.80	3.28	6.49	3.6	5.08	2.44	4.19	3.05	1.09

**Table 3(e): Average Annual Rates of Technological Progress (TP) during 2001-02 to 2010-11
(Post-Reform Period: Decade 2)**

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	-4.15	-2.60	-0.83	-0.70	-0.40	0.18	-6.11	-0.48	-0.93	-2.13	-1.58	-0.82	-1.66	-0.38	-1.90	-2.63
23-26	3.08	3.79	3.89	2.90	3.20	3.39	3.33	3.07	2.91	3.68	2.99	3.07	3.01	3.16	3.47	2.84
27	1.47	-0.29	-2.27	1.15	1.70	1.48	0.51	0.86	2.54	-0.15	0.36	1.24	0.99	2.73	1.58	2.45
28	2.21	3.10	3.56	1.50	3.16	2.25	2.43	2.56	1.07	3.71	3.07	2.76	1.01	1.26	1.65	-0.01
30	3.20	3.97	3.91	2.53	4.10	3.41	3.87	3.56	2.86	3.05	3.51	3.15	3.76	3.07	2.70	2.54
31	-3.44	-3.54	-4.37	0.05	-6.44	-2.88	-4.10	-4.65	-1.75	-7.22	-7.55	-5.70	-3.11	-3.38	-3.66	1.68
32	4.06	4.00	4.01	4.06	4.05	4.08	4.04	4.09	4.08	4.06	4.00	4.06	4.06	4.05	4.06	4.03
33	3.27	-0.36	3.65	3.56	2.23	3.85	0.45	3.47	3.82	4.04	1.01	1.37	2.71	2.46	2.92	4.91
34-36	4.16	6.03	5.86	4.44	4.62	4.66	4.86	4.78	3.75	5.89	4.07	5.46	3.92	4.28	4.12	2.67
37	2.68	3.12	4.04	3.97	3.37	3.57	3.38	3.44	3.26	5.46	2.20	4.40	3.27	3.51	2.20	2.26
Total	1.61	3.82	4.67	3.59	2.63	2.90	1.36	3.96	2.40	5.88	1.66	3.37	0.99	2.40	2.43	-0.03

Source: Authors' own calculation

S/I- States/Industries

**Table 4(a): Average Annual Rates of Technical Efficiency Change (TEC) during 1981-82 to 2010-11
(Entire Study Period)**

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	-0.97	-0.80	-0.32	-0.59	-0.33	-0.34	-1.09	-0.33	-0.34	-0.82	-0.73	-0.64	-0.64	-0.17	-0.53	-0.61
23-26	0.39	-1.37	0.12	0.26	0.26	-0.15	-0.04	0.17	0.21	0.03	0.33	0.12	0.03	0.10	-0.32	0.17
27	-0.64	-2.00	-2.11	-1.47	-1.23	-1.54	-2.02	-0.78	-0.62	-1.01	-1.81	-1.68	-2.33	-0.36	-0.89	-1.52
28	0.24	1.00	0.19	-0.01	-0.35	0.52	0.08	-1.25	0.01	0.26	3.05	0.57	0.15	0.39	-0.21	1.06
30	-0.41	6.24	-0.02	0.05	-0.18	1.92	0.19	0.90	0.41	0.66	0.52	0.13	-2.05	0.11	1.69	0.38
31	-0.17	0.04	3.12	-0.44	-0.57	0.05	-0.48	-2.45	0.24	0.33	0.24	-0.01	-0.57	-0.16	-0.56	-0.45
32	0.81	-1.60	0.52	-1.04	-0.09	-0.17	0.17	-0.86	-0.50	0.10	-1.86	-0.95	-1.51	-0.71	-0.57	0.06
33	-0.70	-0.21	0.51	-1.61	-1.70	-0.89	-1.09	-0.76	-1.77	-2.52	-1.56	-0.12	-0.74	0.26	-4.20	-1.31
34-36	0.14	-0.87	-0.34	0.28	0.13	0.14	-0.67	-0.05	0.20	-1.30	0.33	-0.50	0.09	0.49	0.18	0.26
37	1.10	0.52	-0.18	-0.29	-0.74	-0.34	0.84	0.47	-0.44	0.48	0.26	0.98	-0.10	0.27	0.12	-0.45
Total	-0.81	-0.62	-1.84	-2.19	-1.47	-1.66	-0.92	-1.76	-0.99	-4.03	-0.92	-1.55	-1.12	-0.09	-1.72	-1.36

**Table 4(b): Average Annual Rates of Technical Efficiency Change (TEC) during 1981-82 to 1990-91
(Pre-Reform Period)**

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	-0.01	0	-0.01	0	-0.01	0.01	-0.01	0	-0.01	-0.01	0	0	0	0	0.01	-0.01
23-26	0.36	-0.02	0.38	0.63	0.93	0.54	0.45	0.44	0.63	2.17	0.67	0.88	0.52	0.34	-1.02	0.47
27	0.83	0.37	-0.32	0.10	0.26	0.26	-0.38	0.07	-0.04	0.06	0.22	-0.24	-0.04	-0.18	0.05	0.13
28	0.52	3.51	-3.17	0.96	0.20	1.33	-0.25	0.52	0.18	0.10	9.28	1.24	0.61	1.17	0.46	2.29
30	-0.94	16.2	-1.21	-0.40	-0.39	6.93	-0.67	2.43	1.45	-9.64	1.98	6.41	-0.97	0.25	5.43	0.78
31	0.17	0.27	9.07	-0.96	-0.8	0.97	-0.14	-0.42	0.54	0.06	0.07	0.51	0.01	0	-0.42	-0.20
32	4.46	-3.46	2.22	0.24	-1.57	1.28	0.63	0.27	0.44	1.76	-1.59	-0.05	0.25	1.16	0.33	0.69

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
33	-3.87	0.61	2.23	-0.27	-0.66	0.46	-0.72	-0.41	-0.70	0.33	-0.12	-0.80	-0.66	0.63	-4.20	-0.41
34-36	0.55	0.81	-1.35	1.30	0.58	0.56	-0.60	0.44	0.52	-1.14	1.28	-0.18	0.68	1.48	0.35	1.74
37	3.15	0.82	0.93	0.71	0.08	-0.23	1.05	1.46	0.17	2.03	0.74	1.86	0.76	0.57	0.74	-0.59
Total	-0.95	1.69	-0.07	-0.87	-0.74	0.45	-0.66	-0.21	-0.36	-0.51	-1.30	-0.07	-0.11	1.30	-1.35	-0.50

Table 4(c): Average Annual Rates of Technical Efficiency Change (TEC) during 1991-92 to 2010-11 (Post-Reform Period)

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	-1.46	-1.21	-0.47	-0.89	-0.49	-0.51	-1.64	-0.50	-0.50	-1.23	-1.10	-0.96	-0.96	-0.25	-0.80	-0.92
23-26	0.40	-2.05	-0.01	0.08	-0.07	-0.50	-0.29	0.04	-0.01	-1.05	0.15	-0.25	-0.22	-0.01	0.02	0.02
27	-1.38	-3.19	-3.01	-2.26	-1.98	-2.45	-2.84	-1.20	-0.92	-1.55	-2.83	-2.40	-3.48	-0.45	-1.36	-2.34
28	0.11	-0.26	1.88	-0.49	-0.63	0.12	0.25	-2.14	-0.08	0.33	-0.07	0.24	-0.08	0	-0.55	0.45
30	-0.15	1.24	0.57	0.27	-0.08	-0.58	0.62	0.14	-0.11	5.80	-0.21	-3.01	-2.58	0.04	-0.18	0.17
31	-0.34	-0.08	0.15	-0.18	-0.45	-0.41	-0.65	-3.47	0.09	0.47	0.33	-0.28	-0.86	-0.24	-0.62	-0.58
32	-1.01	-0.67	-0.33	-1.67	0.66	-0.89	-0.05	-1.42	-0.98	-0.73	-1.99	-1.40	-2.39	-1.65	-1.01	-0.25
33	0.89	-0.62	-0.34	-2.28	-2.21	-1.57	-1.28	-0.94	-2.31	-3.94	-2.28	0.22	-0.77	0.07	-4.20	-1.76
34-36	-0.07	-1.70	0.16	-0.23	-0.10	-0.07	-0.70	-0.29	0.03	-1.38	-0.14	-0.66	-0.20	-0.01	0.09	-0.49
37	0.07	0.38	-0.74	-0.79	-1.15	-0.4	0.74	-0.02	-0.75	-0.29	0.02	0.53	-0.53	0.12	-0.19	-0.38
Total	-0.74	-1.78	-2.73	-2.84	-1.83	-2.72	-1.05	-2.53	-1.30	-5.80	-0.72	-2.29	-1.63	-0.79	-1.91	-1.78

Table 4(d): Average Annual Rates of Technical Efficiency Change (TEC) during 1991-92 to 2000-01 (Post-Reform Period: Decade 1)

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	-3.69	-2.99	-1.63	-1.51	-1.89	-1.80	-3.10	-1.65	-1.35	-2.49	-2.02	-1.25	-2.18	-1.24	-1.79	-1.93
23-26	-0.22	-1.04	-1.49	-0.04	0.12	-0.29	-0.69	0.02	-0.29	-5.97	-0.31	-0.31	-0.48	-0.42	0.14	-0.30
27	-7.44	-10.8	-6.77	-4.73	-4.70	-1.56	-9.10	-10.0	-3.51	-5.11	-6.47	-6.88	-7.21	-4.51	-7.20	-5.81
28	-0.23	0.94	2.82	-1.37	-1.17	-0.13	-0.39	-0.93	-0.77	-0.96	-5.82	-1.79	0.32	-1.09	0.54	0.40
30	-0.81	0.17	-9.52	-0.65	-1.78	-0.83	0.24	0.14	-0.13	-2.10	-0.22	-0.15	-2.83	-1.30	-1.52	-0.56
31	-1.92	-4.04	-2.28	-0.28	-1.15	-8.89	-1.07	-0.29	-0.49	-0.07	-0.31	-0.73	-0.93	-2.48	-8.76	-1.82
32	2.08	-0.13	-0.52	-1.30	1.59	0.59	0.59	-0.01	-0.23	-0.30	-0.46	-0.56	-2.90	0.25	0.04	0.48
33	1.50	1.06	-0.61	-1.42	-0.58	-5.60	0.78	-0.35	-7.17	-1.48	-6.66	0.48	-6.02	-1.30	-2.22	-1.32
34-36	0.35	1.03	0.35	-0.42	0.04	-0.12	-0.59	-0.68	-0.01	-0.21	0.41	0.09	-0.33	-0.66	-0.30	-1.31
37	-0.62	0.94	-0.38	-5.28	-1.46	-0.39	0.82	-0.19	-1.67	-0.79	-1.20	-4.87	-0.77	-4.76	-1.65	-2.06
Total	-0.42	-4.74	-3.42	-3.39	-1.72	-3.60	-1.37	-1.96	-1.52	-3.78	-1.07	-1.96	-2.46	-1.95	-2.42	-2.19

Table 4(e): Average Annual Rates of Technical Efficiency Change (TEC) during 2001-02 to 2010-11 (Post-Reform Period: Decade 2)

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	0.77	0.58	0.69	-0.27	0.90	0.78	-0.18	0.65	0.34	0.04	-0.18	-0.66	0.25	0.73	0.20	0.10
23-26	1.02	-3.06	1.47	0.20	-0.26	-0.71	0.11	0.05	0.29	3.88	0.62	-0.20	0.04	0.39	-0.10	0.35
27	4.67	4.40	0.76	0.21	0.73	-3.33	3.43	7.63	1.67	2.01	0.82	2.08	0.25	3.62	4.48	1.13
28	0.44	-1.46	0.93	0.39	-0.09	0.37	0.88	-3.35	0.61	1.63	5.69	2.27	-0.48	1.10	-1.63	0.49
30	0.51	2.31	10.7	1.20	1.62	-0.34	1.00	0.15	-0.09	13.7	-0.19	-5.87	-2.33	1.38	1.16	0.91
31	1.23	3.88	2.57	-0.08	0.24	8.07	-0.23	-6.65	0.67	1.01	0.96	0.18	-0.79	2.00	7.51	0.67
32	-4.10	-1.21	-0.14	-2.05	-0.28	-2.36	-0.69	-2.84	-1.72	-1.16	-3.53	-2.24	-1.87	-3.55	-2.07	-0.99
33	0.28	-2.31	-0.08	-3.13	-3.85	2.46	-3.34	-1.54	2.56	-6.40	2.10	-0.05	4.47	1.45	-6.19	-2.20
34-36	-0.48	-4.44	-0.02	-0.04	-0.23	-0.02	-0.82	0.10	0.08	-2.55	-0.69	-1.41	-0.08	0.64	0.48	0.34
37	0.77	-0.18	-1.10	3.70	-0.84	-0.4	0.65	0.14	0.17	0.21	1.24	5.94	-0.3	5.01	1.27	1.29
Total	-1.06	1.18	-2.04	-2.29	-1.94	-1.85	-0.73	-3.09	-1.08	-7.81	-0.38	-2.62	-0.79	0.38	-1.40	-1.37

Source: Authors' own calculation

S/I- States/Industries

Table 5(a): Average Annual Rates of Scale Effect (SC) during 1981-82 to 2010-11 (Entire Study Period)

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	-0.60	-0.01	-0.02	0.02	0.15	0.08	-0.38	0.03	-0.03	0.09	0.03	0.10	-0.04	-0.03	-0.03	-0.50
23-26	0.27	-0.12	-0.35	0.05	0.59	0.27	0.26	0.22	0.02	-0.66	0.52	0.37	0.01	0.20	0.01	-0.37
27	0.17	-1.16	0.14	0.17	-0.14	0.08	0.10	-0.18	0.14	-0.11	-0.52	0.71	0.15	0.19	0.16	0.01
28	-0.09	4.17	0.12	-0.21	0.03	-0.15	0.14	0.13	0.03	0.29	-0.07	-0.30	-0.07	-0.12	-0.12	0.22
30	1.32	0.84	-0.03	0.46	0.61	0.63	0.44	2.09	0.30	2.92	0.89	0.66	0.48	0.95	0.18	-0.19
31	0.83	-1.29	0.64	-0.24	1.64	0.27	0.58	0.91	0.26	-3.30	1.57	-1.94	0.66	-0.28	0.43	0.37
32	0.28	0.59	-0.08	0.15	0.41	0.65	0.43	0.59	0.27	0.41	2.01	0.76	0.40	0.33	0.45	-0.98
33	-0.89	-0.01	-0.01	-0.37	0.02	-0.28	-0.07	-0.36	-0.24	-0.63	0.27	0.09	-0.19	-0.29	-0.21	-0.23
34-36	0.23	-2.43	0.19	0.37	0.23	0.42	0.07	0.18	0.25	0.01	0.20	0.59	0.16	0.47	-0.17	-0.25
37	-0.03	4.73	0.03	0.71	1.01	0.55	-0.43	0.61	0.26	-0.15	0.10	0.56	0.39	0.57	0.06	-0.43
Total	-0.26	0.05	0.08	0.44	-0.38	-0.14	-0.41	0.23	0.15	0.72	-0.30	0.02	-0.43	0.01	0.22	0.22

Table 5(b): Average Annual Rates of Scale Effect (SC) during 1981-82 to 1990-91 (Pre-Reform Period)

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	-0.30	0.02	-0.11	-0.02	0.14	-0.01	0.10	-0.03	0	-0.14	0.08	-0.20	0.04	-0.04	-0.06	-0.26
23-26	0.33	-0.41	-0.77	-0.05	0.30	0.29	-0.25	0.14	0	0.37	0.76	0.60	0.13	0.22	0.02	-0.25
27	-0.05	-0.04	0.16	-0.06	0.07	-0.08	0.01	-0.12	-0.05	-0.27	-0.05	0.04	-0.14	0.06	0.05	0.01
28	0.21	13.1	0.60	0.06	0.06	0.02	0.46	-0.03	0.25	0.07	-0.15	0.08	0.16	0.26	-0.13	0.26
30	3.01	-1.99	0.19	1.07	1.12	0.95	1.46	5.80	0.82	7.98	2.17	0	1.04	2.18	-0.09	-0.11
31	-0.07	-2.58	0.32	0.37	1.15	0.12	-0.36	-0.57	0.01	-9.30	2.75	-7.31	-0.09	-1.09	0.21	-0.25
32	0.55	1.10	-0.07	-0.14	0.43	0.38	0.41	0.80	0.15	0.29	1.17	0.94	0.14	-0.08	-0.10	-1.16
33	-2.12	0.28	-0.11	-0.14	0	-0.05	-0.12	-0.35	-0.16	-0.42	0.06	-0.07	-0.30	-0.04	-0.19	-0.27
34-36	0.49	0.77	0.35	0.19	0.18	0.43	0.18	0.33	0.13	1.29	0.47	0.54	0.21	0.50	0.05	-0.14
37	0.01	-2.41	-0.51	0.17	1.35	0.66	-0.96	0.77	0.03	0.30	0.04	-0.28	0.01	0.02	0.25	-0.43
Total	-0.10	0.15	-0.09	0.06	-0.01	-0.09	-0.07	0.43	0.09	0.29	0.08	0.16	-0.18	0.39	-0.02	0.27

Table 5(c): Average Annual Rates of Scale Effect (SC) during 1991-92 to 2010-11 (Post-Reform Period)

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	-0.75	-0.02	0.03	0.04	0.16	0.13	-0.62	0.07	-0.04	0.20	0	0.25	-0.09	-0.03	-0.01	-0.61
23-26	0.24	0.02	-0.14	0.10	0.73	0.26	0.51	0.27	0.03	-1.18	0.40	0.26	-0.06	0.20	0.01	-0.44
27	0.29	-1.72	0.12	0.28	-0.24	0.17	0.14	-0.22	0.24	-0.03	-0.76	1.05	0.29	0.26	0.21	0.01
28	-0.24	-0.30	-0.11	-0.35	0.01	-0.23	-0.02	0.20	-0.08	0.40	-0.03	-0.50	-0.19	-0.31	-0.12	0.20
30	0.48	2.25	-0.14	0.15	0.35	0.47	-0.07	0.24	0.04	0.40	0.24	1.00	0.19	0.33	0.32	-0.24
31	1.28	-0.65	0.80	-0.54	1.88	0.35	1.05	1.65	0.38	-0.30	0.99	0.74	1.04	0.13	0.55	0.68
32	0.14	0.34	-0.08	0.29	0.40	0.79	0.44	0.49	0.32	0.47	2.43	0.67	0.52	0.53	0.72	-0.90
33	-0.28	-0.16	0.04	-0.48	0.03	-0.39	-0.05	-0.37	-0.28	-0.74	0.38	0.17	-0.14	-0.42	-0.22	-0.21
34-36	0.10	-4.03	0.10	0.46	0.26	0.42	0.01	0.11	0.31	-0.63	0.07	0.62	0.14	0.45	-0.28	-0.31
37	-0.05	8.30	0.30	0.97	0.85	0.50	-0.16	0.53	0.37	-0.38	0.13	0.99	0.58	0.84	-0.03	-0.43
Total	-0.34	-0.01	0.16	0.63	-0.57	-0.16	-0.58	0.13	0.17	0.94	-0.49	-0.05	-0.56	-0.18	0.35	0.19

Table 5(d): Average Annual Rates of Scale Effect (SC) during 1991-92 to 2000-01

(Post-reform Period: Decade 1)

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	-0.77	0.05	-0.07	0.04	0.12	0.13	-0.72	0.13	-0.02	0.43	0.04	0.35	-0.08	-0.05	0.04	-0.59
23-26	-0.05	1.01	-0.39	0.14	1.02	0.44	0.92	0.59	0.01	-0.67	0.29	0.21	0.04	0.10	0.02	-0.46
27	0.36	-3.63	-0.27	0.09	-1.19	0.14	0.10	-0.26	0.23	-0.13	-1.29	1.06	0.18	-0.01	0.03	-0.07
28	0.02	-0.20	1.14	-0.15	0.16	0.04	-0.39	0.9	0.12	0.23	-0.35	-0.49	0.03	0.11	0.11	0.29
30	0.79	2.93	-0.02	0.35	0.43	0.47	0.03	0.47	0.05	0.71	0.28	1.94	0.38	0.53	0.23	-0.26
31	0.62	-0.40	0.73	0.16	1.45	-0.12	0.62	0.45	-0.01	-1.38	1.03	0.16	-0.16	-1.78	0.44	0.23
32	0.39	-0.05	-0.01	0.33	0.31	0.69	0.22	0.34	0.36	-0.01	4.49	0.95	0.71	0.45	0.35	-0.78
33	-0.49	-0.77	0.10	-0.64	-0.08	-0.38	-0.17	-0.56	-0.26	-0.67	0.09	-0.22	-0.41	-0.94	-0.53	-0.13
34-36	-0.01	0.16	-0.41	0.25	0.37	-0.01	0.21	-0.01	0.41	-1.38	0.17	0.20	0.10	0.39	-0.77	-0.20
37	-0.13	17.0	-0.29	-0.19	1.35	0.33	-0.42	0.53	0.46	-1.91	0.29	-0.83	0.64	1.51	-0.03	-0.40
Total	0.10	0.12	0.04	0.63	-0.23	-0.15	-0.16	0.16	0.27	0.16	0.51	0.45	-0.14	0.10	1.11	0.28

**Table 5(e): Average Annual Rates of Scale Effect (SC) during 2001-02 to 2010-11
(Post-Reform Period: Decade 2)**

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	-0.73	-0.10	0.12	0.03	0.20	0.13	-0.52	0	-0.07	-0.02	-0.03	0.15	-0.10	-0.02	-0.07	-0.63
23-26	0.52	-0.97	0.11	0.06	0.44	0.08	0.10	-0.06	0.06	-1.68	0.50	0.31	-0.15	0.30	-0.01	-0.41
27	0.22	0.18	0.52	0.48	0.71	0.19	0.19	-0.17	0.25	0.06	-0.23	1.04	0.41	0.51	0.39	0.09
28	-0.51	-0.41	-1.36	-0.54	-0.14	-0.51	0.35	-0.49	-0.29	0.57	0.28	-0.51	-0.40	-0.72	-0.34	0.11
30	0.17	1.57	-0.26	-0.04	0.27	0.48	-0.17	0.01	0.03	0.09	0.20	0.06	0	0.13	0.40	-0.21
31	1.94	-0.89	0.87	-1.25	2.31	0.82	1.48	2.86	0.78	0.77	0.95	1.32	2.24	2.04	0.65	1.13
32	-0.11	0.73	-0.15	0.25	0.50	0.89	0.66	0.64	0.29	0.95	0.37	0.40	0.33	0.60	1.10	-1.02
33	-0.07	0.46	-0.02	-0.32	0.13	-0.40	0.08	-0.18	-0.31	-0.80	0.67	0.56	0.14	0.10	0.09	-0.30
34-36	0.21	-8.22	0.62	0.68	0.15	0.85	-0.19	0.22	0.20	0.11	-0.03	1.04	0.19	0.50	0.21	-0.42
37	0.03	-0.36	0.90	2.13	0.35	0.67	0.09	0.53	0.28	1.16	-0.03	2.81	0.52	0.17	-0.03	-0.46
Total	-0.77	-0.13	0.28	0.62	-0.91	-0.18	-1.000	0.09	0.08	1.72	-1.48	-0.54	-0.97	-0.45	-0.42	0.11

Source: Authors' own calculation

S/I- States/Industries

**Table 6(a): Average Annual Rate of Allocation Efficiency Change (AEC) during 1981-82 to 2010-11
(Entire Study Period)**

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	4.05	0.49	0.93	-0.05	0.10	-0.38	1.85	-0.99	0.23	-1.53	0.05	-0.89	0.46	1.31	0.82	2.86
23-26	-0.14	-1.91	-0.12	0.35	0.31	1.14	-0.31	0.67	0.54	-1.24	0.17	-0.12	0.85	-0.07	1.81	1.55
27	-0.98	-8.02	-0.92	-3.92	-16.4	-0.23	0.13	-6.98	-1.01	-11.4	-11.3	-6.36	0.07	-4.47	0.05	-0.36
28	-1.80	-25.0	0.28	-1.70	-1.24	-1.67	-0.95	-2.58	-0.84	-2.48	-4.42	-1.27	-2.70	-0.35	-2.01	-1.09
30	1.30	-13.2	4.07	0.01	1.12	0.25	-0.10	-0.84	2.28	-7.35	1.39	-1.13	-0.30	-2.31	-1.48	1.72
31	0.52	2.27	2.66	-0.40	2.46	-1.66	0.58	1.00	0.47	0.50	0.32	-0.75	1.02	-1.55	2.66	-1.52
32	0.85	0.50	0.95	0.93	1.50	1.36	2.02	0.86	1.91	0.76	-1.38	0.28	1.11	1.99	1.69	2.32
33	-4.90	0.78	-0.15	-2.38	-0.22	-0.88	-0.02	0.05	-0.67	-0.91	1.49	-0.46	-0.40	-1.03	0.32	-1.07
34-36	0.22	-7.39	-3.45	0.44	0.01	-0.35	-1.36	-0.75	0.81	-1.68	-0.42	-1.96	0.85	-0.42	0.11	2.58
37	-0.32	3.73	1.08	3.07	0.75	2.34	0.22	-0.27	2.37	-1.21	1.84	1.17	2.48	0.31	0.96	5.88
Total	2.57	-0.28	1.35	1.34	1.24	1.98	0.69	0.67	2.44	0.10	0.58	0.16	2.32	0.35	1.99	3.88

**Table 6(b): Average Annual Rate of Allocation Efficiency Change (AEC) during 1981-82 to 1990-91
(Pre-reform Period)**

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	1.38	0.94	1.44	-0.21	-0.09	-0.58	-0.71	0.89	-0.28	-0.95	-0.05	-1.17	-0.08	2.16	-0.38	2.26
23-26	2.22	-3.10	-1.20	2.13	0.80	2.28	-0.20	1.99	1.49	0.17	1.37	0.21	1.74	1.54	3.91	2.86
27	0.42	0.16	0.11	-0.85	-1.36	-0.90	-4.46	-2.52	0.13	-34.1	2.17	-9.72	0.75	-1.67	2.39	-0.27
28	0.52	-81.8	-1.29	-0.37	-1.48	-2.43	-3.59	-1.75	-0.14	-2.16	-6.32	0.40	-4.59	-0.38	0.10	-0.72
30	5.25	-18.1	3.74	-0.88	4.28	-0.49	0.07	-1.15	5.34	-15.7	3.45	-0.17	3.80	-5.85	-0.35	3.96
31	-0.57	4.32	0.68	-0.79	3.27	0.44	0.26	6.33	1.23	0.63	1.03	-2.62	2.57	-3.80	0.86	-0.60
32	1.84	1.35	-0.63	2.38	0.81	1.83	2.17	1.55	1.84	0.55	1.23	0.85	1.20	1.56	0.23	3.62
33	-13.5	2.83	-0.08	0.81	1.21	-1.04	2.11	-1.06	1.89	0.58	1.58	-0.73	0.05	1.55	2.72	-0.31
34-36	0.22	-2.17	-0.50	0.98	0.42	0.71	-0.64	0.33	1.69	-1.10	-0.63	-0.55	1.18	-0.08	1.83	2.69
37	-1.03	-0.88	-3.65	1.29	0.39	2.52	1.25	-0.06	3.11	-0.01	1.08	0.13	1.20	2.79	0.83	8.57
Total	1.28	-0.99	-0.16	0.93	-0.08	0.50	-0.08	-0.54	2.61	-1.16	0.06	-0.43	1.71	-1.03	2.48	3.25

**Table 6(c): Average Annual Rate of Allocation Efficiency Change (AEC) during 1991-92 to 2010-11
(Post-reform Period)**

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	5.38	0.26	0.68	0.03	0.19	-0.28	3.13	-1.92	0.49	-1.81	0.10	-0.76	0.73	0.88	1.42	3.17
23-26	-1.32	-1.31	0.42	-0.55	0.06	0.57	-0.37	0.02	0.07	-1.94	-0.43	-0.29	0.41	-0.87	0.76	0.89
27	-1.67	-12.1	-1.44	-5.45	-23.9	0.10	2.42	-9.21	-1.57	-0.12	-18.0	-4.68	-0.27	-5.87	-1.12	-0.41
28	-2.96	3.36	1.07	-2.36	-1.12	-1.29	0.38	-3.00	-1.19	-2.64	-3.47	-2.11	-1.75	-0.33	-3.06	-1.27
30	-0.68	-10.7	4.24	0.45	-0.46	0.62	-0.18	-0.69	0.75	-3.17	0.36	-1.61	-2.35	-0.54	-2.04	0.60
31	1.06	1.25	3.65	-0.21	2.05	-2.70	0.74	-1.66	0.09	0.44	-0.03	0.18	0.24	-0.43	3.55	-1.98

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
32	0.35	0.08	1.74	0.21	1.85	1.13	1.94	0.52	1.94	0.87	-2.68	0	1.07	2.20	2.42	1.67
33	-0.59	-0.25	-0.18	-3.97	-0.93	-0.80	-1.08	0.60	-1.95	-1.66	1.44	-0.33	-0.63	-2.33	-0.88	-1.46
34-36	0.23	-10.0	-4.92	0.17	-0.19	-0.88	-1.72	-1.29	0.37	-1.97	-0.31	-2.67	0.69	-0.59	-0.74	2.53
37	0.04	6.04	3.45	3.96	0.94	2.25	-0.30	-0.37	2.00	-1.81	2.22	1.69	3.11	-0.93	1.03	4.54
Total	3.22	0.07	2.11	1.54	1.89	2.72	1.07	1.27	2.36	0.73	0.84	0.45	2.63	1.03	1.74	4.19

Table 6(d): Average Annual Rate of Allocation Efficiency Change (AEC) during 1991-92 to 2000-01 (Post-Reform Period: Decade 1)

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	4.63	-0.34	1.17	-0.85	-0.37	-0.54	4.82	-3.71	0.07	-3.04	-0.55	-2.22	0.28	0.94	1.28	2.78
23-26	-1.74	1.16	0.95	-1.41	0.51	0.95	0.54	-0.23	0.85	-2.19	-0.58	-0.23	0.53	-1.60	0.40	1.58
27	-1.49	-13.6	-2.62	-6.98	-46.6	-0.56	3.29	-12.5	-2.42	-0.37	-29.0	-8.97	1.39	-9.44	0.51	-1.00
28	-4.96	6.98	1.85	-4.27	-1.92	-2.65	0.63	-5.17	-2.08	-4.14	-2.32	-3.55	-2.91	-0.33	-2.78	-1.83
30	-0.93	-22.8	-2.59	0.81	-1.00	-0.03	0.56	-0.85	0.95	-3.04	0.74	-4.50	-4.87	-0.94	-1.71	1.06
31	1.87	6.34	3.16	-0.29	1.23	-5.58	-0.18	-0.57	-0.17	-0.66	-0.10	0.13	-0.32	-2.27	4.42	-3.09
32	0.09	-0.21	3.86	0.66	1.16	0.06	0.19	0.55	2.79	0.65	-3.04	-1.14	0.77	2.49	2.73	2.49
33	-1.88	-0.52	-0.10	-8.02	-0.63	-1.14	-0.79	0.23	-2.33	-2.84	2.03	-1.04	-1.18	-3.88	-1.92	-1.60
34-36	-0.27	0.10	-5.22	0.21	0.03	-0.17	-0.88	-2.20	0.19	-2.37	-0.29	-3.26	0.64	-1.00	-1.30	2.97
37	0.06	12.3	2.68	2.84	1.94	3.27	-1.47	-1.22	3.32	-3.69	2.08	0.78	4.96	-0.40	-0.08	7.20
Total	-0.53	1.45	1.07	1.45	1.31	2.27	0.25	0.10	1.83	-0.53	-0.99	-1.01	1.69	0.95	-0.18	3.22

Table 6(e): Average Annual Rate of Allocation Efficiency Change (AEC) during 2001-02 to 2010-11 (Post-Reform Period: Decade 2)

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	6.13	0.87	0.18	0.92	0.75	-0.02	1.44	-0.14	0.91	-0.58	0.74	0.71	1.18	0.82	1.56	3.55
23-26	-0.89	-3.79	-0.11	0.32	-0.39	0.20	-1.28	0.26	-0.72	-1.69	-0.27	-0.35	0.28	-0.15	1.13	0.20
27	-1.86	-10.6	-0.25	-3.92	-1.16	0.75	1.56	-5.92	-0.73	0.13	-6.94	-0.39	-1.94	-2.29	-2.76	0.18
28	-0.96	-0.26	0.28	-0.45	-0.31	0.07	0.12	-0.82	-0.30	-1.14	-4.62	-0.66	-0.59	-0.34	-3.34	-0.70
30	-0.43	1.29	11.1	0.10	0.08	1.27	-0.93	-0.53	0.55	-3.29	-0.03	1.27	0.17	-0.13	-2.37	0.15
31	0.24	-3.84	4.14	-0.12	2.87	0.17	1.65	-2.75	0.35	1.54	0.03	0.23	0.80	1.40	2.69	-0.88
32	0.61	0.37	-0.39	-0.24	2.54	2.20	3.70	0.49	1.09	1.10	-2.32	1.15	1.36	1.91	2.11	0.84
33	0.70	0.03	-0.25	0.08	-1.24	-0.46	-1.37	0.96	-1.57	-0.47	0.85	0.37	-0.07	-0.77	0.16	-1.31
34-36	0.72	-20.1	-4.62	0.14	-0.41	-1.59	-2.56	-0.39	0.55	-1.56	-0.33	-2.08	0.73	-0.18	-0.19	2.09
37	0.01	-0.19	4.21	5.08	-0.06	1.22	0.86	0.48	0.67	0.07	2.35	2.60	1.27	-1.46	2.13	1.88
Total	6.97	-1.30	3.15	1.63	2.48	3.16	1.90	2.45	2.90	20	2.67	1.91	3.57	1.12	3.67	5.17

Source: Authors' own calculation

S/I- States/Industries

Table 7(a): Average Annual Rate of Total Factor Productivity Growth (TFPG) during 1981-82 to 2010-11 (Entire Study Period)

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	1.73	1.55	3.28	2.54	2.82	3.04	-1.38	1.55	2.98	0.24	2.15	2.52	1.92	3.82	2.30	2.87
23-26	2.15	-1.29	1.97	2.08	2.84	3.08	1.69	2.68	2.21	0.18	2.53	1.87	2.39	1.81	3.38	2.68
27	0.77	-9.60	-3.10	-3.38	-15.0	0.50	-0.48	-5.79	1.25	-10.3	-12.1	-5.50	-0.89	-1.28	0.68	1.30
28	0.99	-15.3	3.98	0.44	1.93	1.70	2.42	-0.59	0.99	1.64	2.74	2.27	-0.67	2.11	-0.16	0.69
30	3.72	-3.59	6.29	1.58	3.94	4.81	2.43	4.12	4.27	-1.92	5.03	1.13	0.10	0.07	2.10	2.85
31	2.00	0.87	6.31	1.24	1.61	-1.10	0.97	-1.58	3.44	-5.99	-1.05	-3.92	2.37	-0.87	2.94	4.18
32	4.38	1.88	3.78	2.47	4.24	4.30	5.03	3.06	4.10	3.71	1.19	2.55	2.43	4.01	3.99	3.80
33	-3.37	0.04	4.19	-1.55	-0.10	0.64	-0.54	2.45	0.53	-0.39	1.16	1.22	1.09	1.26	-1.08	2.18
34-36	3.49	-6.79	0.21	3.90	3.57	3.36	1.80	2.82	3.68	1.60	3.21	2.16	3.66	3.54	2.55	3.77
37	3.25	11.2	4.22	6.24	4.27	5.49	4.58	4.05	5.06	3.24	4.08	5.76	5.16	3.87	2.41	6.62
Total	4.12	3.56	4.87	3.73	3.46	3.87	2.39	4.08	4.77	3.26	2.85	3.52	3.06	3.92	3.41	3.70

Table 7(b): Average Annual Rate of Total Factor Productivity Growth (TFPG) during 1981-82 to 1990-91 (Pre-Reform Period)

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	4.00	7.02	7.38	6.73	6.44	6.65	1.54	6.14	6.99	5.49	6.97	6.81	5.88	7.81	5.70	6.86
23-26	3.10	-3.08	-1.00	2.66	2.23	3.34	0.24	2.79	2.10	3.02	2.86	1.65	2.39	2.15	3.21	2.93
27	5.39	3.61	1.56	1.76	1.72	2.35	-2.32	0.79	2.99	-30.5	4.55	-7.79	2.13	1.78	4.14	3.76
28	4.41	-58.7	-0.40	3.69	2.67	2.77	0.80	2.43	2.56	1.42	9.68	5.59	-1.14	3.91	2.92	2.81
30	7.18	-3.22	3.23	-0.28	5.86	7.84	0.72	7.83	7.43	-16.5	8.91	6.28	3.95	-3.64	5.23	4.13
31	5.07	5.51	15.0	3.66	6.05	4.94	4.55	6.86	8.32	-9.33	4.95	-6.23	8.05	0.6	5.23	9.32
32	7.62	-0.29	2.23	3.23	0.40	4.26	3.94	3.41	3.18	3.36	1.58	2.52	2.35	3.37	1.18	3.88
33	-17.2	3.17	6.09	1.76	1.77	0.83	2.06	1.99	3.45	3.89	2.37	0.24	1.07	3.91	1.15	3.55
34-36	2.90	2.12	0.33	3.51	2.78	3.31	1.67	3.03	3.19	2.23	3.01	2.23	3.14	3.50	2.84	3.87
37	4.40	-1.37	-0.20	4.21	4.61	5.28	5.95	4.76	5.53	4.82	3.24	3.46	3.45	4.86	2.31	8.47
Total	3.82	6.03	5.77	4.53	4.64	5.27	3.95	5.73	6.15	5.67	4.03	5.87	4.87	5.02	4.40	4.84

Table 7(c): Average Annual Rate of Total Factor Productivity Growth (TFPG) during 1991-92 to 2010-11 (Post-reform Period)

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	0.59	-1.19	1.24	0.44	1.01	1.23	-2.84	-0.74	0.97	-2.39	-0.27	0.37	-0.05	1.82	0.60	0.87
23-26	1.67	-0.39	3.45	1.79	3.14	2.96	2.42	2.62	2.27	-1.24	2.36	1.98	2.40	1.64	3.47	2.56
27	-1.54	-16.2	-5.50	-5.96	-23.0	-0.40	0.45	-9.08	0.38	-0.21	-20.5	-4.36	-2.40	-2.81	-1.06	0.07
28	-0.71	6.46	6.19	-1.18	1.56	1.17	3.23	-2.09	0.21	1.75	-0.73	0.61	-0.43	1.21	-1.70	-0.37
30	1.99	-3.77	7.81	2.51	2.97	3.29	3.28	2.27	2.68	5.34	3.08	-1.44	-1.83	1.93	0.53	2.22
31	0.46	-1.46	1.97	0.03	-0.60	-4.10	-0.82	-5.79	1.01	-4.31	-4.05	-2.77	-0.47	-1.60	1.80	1.61
32	2.75	2.96	4.55	2.10	6.16	4.32	5.58	2.89	4.57	3.88	1.00	2.56	2.47	4.33	5.39	3.76
33	3.56	-1.52	3.25	-3.21	-1.10	0.54	-1.84	2.67	-0.94	-2.52	0.55	1.71	1.10	-0.06	-2.19	1.50
34-36	3.78	-11.2	0.15	4.09	3.96	3.38	1.87	2.72	3.93	1.28	3.31	2.13	3.92	3.56	2.41	3.72
37	2.68	17.5	6.44	7.26	4.09	5.60	3.89	3.69	4.82	2.45	4.50	6.91	6.02	3.38	2.47	5.70
Total	4.27	2.32	4.42	3.33	2.86	3.17	1.61	3.26	4.08	2.06	2.26	2.34	2.16	3.36	2.92	3.13

Table 7(d): Average Annual Rate of Total Factor Productivity Growth (TFPG) during 1991-92 to 2000-01 (Post-reform Period: Decade 1)

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	-0.84	-1.13	2.30	0.91	0.56	1.39	-0.31	-1.52	1.68	-2.07	0.52	1.36	0.21	2.49	1.40	1.37
23-26	-0.40	3.25	1.53	0.10	3.30	2.96	2.57	1.93	2.00	-6.67	0.88	1.13	1.62	-0.43	2.43	2.14
27	-7.58	-26.1	-9.70	-9.82	-49.0	0.04	-4.79	-20.6	-2.98	-2.46	-34.9	-12.7	-4.52	-10.2	-5.79	-3.71
28	-2.61	12.0	8.97	-3.26	0.49	0.15	2.67	-2.09	-0.67	-1.26	-4.77	-2.64	-0.40	1.13	0.27	-0.63
30	0.53	-16.7	-9.80	1.23	-0.10	1.76	2.80	1.34	2.01	-2.86	2.67	-1.49	-5.26	-0.59	-0.83	1.05
31	0.94	1.48	0.72	1.46	-0.20	-14.0	-0.46	-0.40	1.97	-4.72	-2.48	-1.57	-0.07	-5.25	-3.59	0.61
32	5.05	2.04	5.77	2.17	5.52	3.83	3.45	3.40	5.40	2.82	3.48	1.75	1.05	5.65	5.58	4.65
33	2.95	-0.86	3.20	-6.60	0.62	-4.40	0.51	2.63	-6.38	-1.42	-3.54	1.16	-5.05	-3.36	-1.36	1.89
34-36	2.94	4.25	-1.50	2.97	3.80	2.87	2.45	0.72	3.27	0.68	3.61	1.24	3.09	1.88	0.18	2.76
37	1.88	32.6	4.82	-0.37	5.37	6.14	2.81	2.80	5.24	-2.01	3.24	-1.92	7.28	-0.47	-0.63	6.42
Total	1.79	1.07	2.77	3.12	3.47	2.29	1.71	3.10	3.87	2.33	2.05	2.56	1.53	3.28	1.55	2.40

Table 7(e): Average Annual Rate of Total Factor Productivity Growth (TFPG) during 2001-02 to 2010-11 (Post-reform Period: Decade 2)

S/I	A.P.	ASSAM	BIHAR	GUJ	HAR	KAR	KERA	M.P.	MAHA	ODISHA	PUN	RAJ	T.N.	U.P.	W.B.	IND
20-22	2.02	-1.25	0.17	-0.03	1.45	1.06	-5.37	0.04	0.26	-2.70	-1.05	-0.62	-0.32	1.15	-0.21	0.38
23-26	3.73	-4.03	5.36	3.48	2.98	2.95	2.26	3.32	2.53	4.19	3.84	2.83	3.17	3.71	4.50	2.98
27	4.50	-6.30	-1.20	-2.09	1.98	-0.90	5.69	2.40	3.74	2.05	-5.99	3.96	-0.29	4.57	3.68	3.85
28	1.18	0.97	3.41	0.90	2.62	2.18	3.78	-2.09	1.09	4.76	3.30	3.86	-0.46	1.30	-3.66	-0.12
30	3.45	9.14	25.4	3.79	6.08	4.82	3.77	3.19	3.35	13.5	3.50	-1.39	1.60	4.46	1.89	3.38
31	-0.02	-4.40	3.22	-1.41	-1.00	6.18	-1.19	-11.2	0.05	-3.90	-5.62	-3.97	-0.86	2.05	7.18	2.60
32	0.45	3.89	3.33	2.02	6.81	4.81	7.71	2.39	3.73	4.95	-1.48	3.38	3.89	3.01	5.20	2.87
33	4.17	-2.19	3.30	0.19	-2.70	5.45	-4.19	2.72	4.51	-3.63	4.63	2.26	7.25	3.23	-3.02	1.11
34-36	4.62	-26.7	1.83	5.22	4.13	3.90	1.29	4.71	4.59	1.89	3.02	3.02	4.76	5.24	4.63	4.68
37	3.48	2.38	8.05	14.9	2.82	5.06	4.98	4.58	4.40	6.90	5.75	15.7	4.75	7.23	5.57	4.97
Total	6.75	3.57	6.06	3.55	2.26	4.04	1.52	3.41	4.29	1.79	2.46	2.12	2.80	3.44	4.28	3.87

Source: Authors' own calculation
S/I- States/Industries

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