

ESTIMATION AND DECOMPOSITION OF OUTPUT AND PRODUCTIVITY GROWTH OF THE ORGANIZED MANUFACTURING INDUSTRIES OF FOOD, BEVERAGES AND TOBACCO PRODUCTS IN INDIA: AN INTER-STATE ANALYSIS

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The paper estimates and decomposes output and productivity growth of the organized manufacturing industries of food, beverages and tobacco products in India and in its fifteen major industrialized states. A stochastic frontier model with a translog production function is used to decompose output and total factor productivity growth (TFPG) of the said manufacturing industries in fifteen major industrialized states in India and in All-India too during the period from 1981-82 to 2010-11, during the entire period, pre- & post-reform period (1981-82 to 1990-91 and 1991-92 to 2010-11) and during two decades of the post-reform period (1991-92 to 2000-01 and 2001-02 to 2010-11). The attributes of output growth are input growth effect and TFPG and again TFPG composed of adjusted scale effect (ASC), technological progress (TP) and technical efficiency changes (TEC). The empirical results show that input growth effect is the major contributor to output growth of the organized manufacturing industries of food, beverages and tobacco products, and total factor productivity growth (TFPG) has also a positive and significant effect on output growth of the same. Of the components of TFPG the technological progress is found to be the major contributors to TFPG while the scale effect and technical efficiency effect has no significant contribution on TFPG. The relevant policy implication for the development of the organized manufacturing industries of the food, beverages and tobacco products is the need to improve economic scale effect and technical efficiency effect of the same during the forth-coming years.

Keywords: Organized Manufacturing Industries in Andhra Pradesh, Stochastic Frontier Production Function, Total Factor Productivity Growth, Adjusted Scale Effect, Technological Progress and Technical Efficiency Effect

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INTRODUCTION

The Food and Beverages sector provides safe, high quality, healthy and affordable food to millions of people worldwide. Together with the tobacco industry, the sector is a large source of manufacturing output in India. But the sector faces a confluence of challenges such as climate change, changes in food supply and demand, and imbalances in the governance of food production systems, food price volatility and food security. Addressing decent work deficits contributes to tackling these issues and to broader development goals. In spite of that Indian food processing industry continued to see an impressive growth rate. Overall economic growth was favourable for the food and beverages market, with more products becoming affordable due to rising incomes, changing lifestyles and a rapidly growing population. It is also experiencing good growth from the modern trade format. Processed food products, impulse food products and packaged grocery are the segments that have witnessed immense growth from urban Indian modern stores. The growth in the tobacco industry is, however, greatly dependent on the policies of the government (both excise related and ban of public

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smoking). Higher duties result in higher prices of the product. Contraband cigarettes have become competitively priced as compared to domestic brands given the frequent excise (price) hikes. It has started affecting volume growth of domestic companies as the consumers are showing resistance to price hikes.

Growth of the organized manufacturing industries of food, beverages and tobacco products is usually attributed to growth in factor inputs and improvement in total factor productivity (TFP). While measuring the sources of output growth of the said industries, the contribution of TFP is generally estimated as a residual, after accounting for the growth in factor inputs. If the industries operate on their production possibility frontiers producing the maximum possible output or realizing the full potential of the technology, then it implies that improvement in productivity of the aforesaid industries arises from technological progress. Operation on the production possibility frontier can be achieved if industries follow the best practiced methods of technology commonly referred to as technical efficiency. The classical growth models assume that there exists technical efficiency in the production process and production always occurs on the production possibility frontier. But the existence of technical inefficiency in the production process cannot be ruled out altogether. The stochastic frontier model (Aigner, Lovell and Schmidt and Meeusen and Van den Broeck, 1977; Battese and Coelli, 1988 and 1992; Greene, 2005) can be used to check whether there exists technical inefficiency in the production process. Further, using this model output growth can be decomposed into input growth effect and total factor productivity growth (TFPG) and again TFPG into various components like adjusted scale effect (ASC) technological progress (TP) and technical efficiency change (TEC).

The objective of our study is to estimate and decompose output and productivity growth of the organized manufacturing industries of food, beverages and tobacco products in fifteen major industrialized states in India as well as in All-India during 1981-82 to 2010-11, during the pre-reform period, post-reform period and during two decades of the post-reform period by using stochastic frontier approach assuming that the industries are not able to fully utilize their existing resources and technology because of various non-price and organizational factors that might have led to technical inefficiencies in the production process. The fifteen major industrialized states considered in our study are: Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. Using panel data of the afore-mentioned industries in the aforesaid fifteen major states including All-India over a period from 1981-82 to 2010-11 (entire study period), and during the pre-reform period (1981-82 to 1990-91), post-reform-period (1991-92 to 2010-11) and also during two decades of the post-reform period, i.e., during 1991-92 to 2000-01 and during 2001-02 to 2010-11], we decomposed output growth of the organized manufacturing industries of food, beverages and tobacco products in the above mentioned fifteen major industrialized states and in All-India too into input growth effect and TFPG. TFPG is again been decomposed into adjusted scale effect (ASC), technological progress (TP) and technical inefficiency effects (TEC) in order to examine the trend and variations in the TFPG and its different components. To the best of our knowledge, none of the existing studies has decomposed output and TFP growth of the organized manufacturing industries of food, beverages and tobacco products in the said industrialized states as we propose to do.

The rest of the paper is organized as follows. The next section outlines the stochastic frontier production function and the methodology that involve decomposition of output and TFP growth. The econometric specifications of the stochastic frontier production function and the time-varying technical inefficiency function have also been done in this section. Data sources and the measurement

of variables are presented in Section 3. Section 4 presents the results of estimation and tests of hypotheses and other empirical results and their analyses. The final section contains concluding remarks.

METHODOLOGY

The occurrence of technical inefficiency in a production function can be shown by using a stochastic frontier model (Aigner et al and Meeusen and van den Broeck, 1977; Battese and Coelli, 1988 and 1992; Greene, 2005):

$$Y_t = F(X_{1t}, X_{2t}, \dots, X_{nt}, t) e^{-u_t}, \quad (1)$$

where Y is the actual level of output; F is the potential production function with 'n' inputs; X_{it} is i^{th} input; and ' u ' is a normally distributed random variable with a positive mean. The inclusion of ' t ' in ' F ' allows for the production function to shift over time due to technological progress. The last term e^{-u_t} measures technical inefficiency.

Following Li and Liu (2011), we may write

$$\dot{Y}_t = \sum_i s_{it} \dot{X}_{it} + (e_t - 1) \sum_i s_{it} \dot{X}_{it} + \dot{A}_t + TE_t \quad (2)$$

That is output growth is decomposed into four components: sum of input growth effect, adjusted scale effect, technological progress, and growth effect of technical efficiency.

Hence TFP growth composed of:

$$TFP_t = (e_t - 1) \sum_i s_{it} \dot{X}_{it} + \dot{A}_t + TE_t \quad (3)$$

That is TFP growth has three components: adjusted scale effect, technological progress, and growth effect of technical efficiency (Bauer, 1990; Kumbhakar and Lovell, 2000, pp. 284)¹.

Model Specification

The empirical estimation involves the panel data estimation of the organized manufacturing industries of food, beverages and tobacco products in fifteen major industrialized states in India as well as in all-India for the sample period from 1981-82 to 2010-11. The output for the production function is the real value-added (Y) of the organized manufacturing industries of food, beverages and tobacco products in different states in India as well as in All-India and the inputs are labor (L) indicated by the total number of employees and capital (K).

The estimation model is the production function with a second-order transcendental logarithmic (translog) form:

$$\ln Y_{it} = \beta_0 + \beta_L \ln L_{it} + \beta_K \ln K_{it} + \beta_t t + 1/2 \beta_{LL} L_{it}^2 + 1/2 \beta_{KK} K_{it}^2 + 1/2 \beta_{tt} t^2 + \beta_{LK} \ln L_{it} \ln K_{it} + \beta_{Lt} L_{it} t + \beta_{Kt} K_{it} t + v_{it} - u_{it} \quad (4)$$

where the subscript ' i ' is the i^{th} state and t is the time period. The random error v_{it} is symmetric and normally distributed with $v_{it} \sim N(0, \sigma_v^2)$ and ' u_{it} ' is a non-negative truncated normal random error with the probability distribution of $N(\mu, \sigma_u^2)$, where μ is the mode of normal distribution.

The non-negative property of the random error ' u_{it} ' is used to measure technical inefficiency as in Equation (4). Technical inefficiency can either be time variant (u_{it}) or time invariant (u_i).

¹ Allocation efficiency effect is absent here as cost minimization technique is applied

Here the technical inefficiency function is defined by

$$u_{it} = \delta_0 + \delta_1 SK_{it} + \delta_2 KI_{it} + \delta_3 D_{it} + w_{it} \quad (5)$$

where Y_{it} , L_{it} and K_{it} are respectively the value added, labour input, and capital input for the aggregate manufacturing industry in state 'i' at time 't'; SK_{it} denotes the index of employers' skill in the organized manufacturing industries of the i^{th} state 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 capital intensity of the organized manufacturing industries of the i^{th} state 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 (5) shows that TE component has been correlated to the skill of employees, capital intensity and the effects of economic reforms that is measured by industrial dummies.

The stochastic frontier production function defined by Equation (4), and the technical inefficiency effects, specified by Equation (5) can be jointly estimated by the maximum likelihood estimation (MLE) method using the software such as FRONTIER, LIMDEP etc. In this paper, we have employed FRONTIER 4.1 (Coelli, 1996) to estimate the stochastic frontier model.

From Equation (4), the output elasticity of labor and capital for state 'i' and time t, which are denoted as e_{Lit} and e_{Kit} , respectively, can be derived as follows:

$$e_{Lit} = \partial \ln F / \partial \ln L_{it} = \beta_L + \beta_{LL} \ln L_{it} + \beta_{LK} \ln K_{it} + \beta_{Lt} \quad (6)$$

$$e_{Kit} = \partial \ln F / \partial \ln K_{it} = \beta_K + \beta_{KL} \ln L_{it} + \beta_{KK} \ln K_{it} + \beta_{Kt} \quad (7)$$

The returns to scale is measured as $e_{it} = e_{Lit} + e_{Kit}$. The cost shares of inputs are $s_{Lit} = \frac{e_{Lit}}{e_{it}}$ and $s_{Kit} = \frac{e_{Kit}}{e_{it}}$.

The maximum likelihood method is generally used to estimate the parameters in a stochastic frontier production function (Battese and Coelli, 1988 and 1992; Kumbhakar and Lovell, 2000; Kumbkakar, 1990). After estimating the parameters in Equation (4), Equations (6) and (7) are used for the calculation of output elasticities and the adjusted scale effect. Given the estimates of the parameters in Equation (4) and (5), the technical efficiency level of the state 'i' at time 't' (TE_{it}), defined as the ratio of the actual output to the potential output, determined by the production frontier, can be written as

$$TE_{it} = \exp(-u_{it}) \quad (8)$$

and TEC is the change in TE, and the rate of technological progress (TP_{it}) is defined by

$$TP_{it} = \partial \ln F / \partial t = \beta_t + \beta_{Lt} + \beta_{Lt} \ln L_{it} + \beta_{Kt} \ln K_{it} \quad (9)$$

where β_t and β_{it} are 'Hicksian' parameters and β_{Lt} and β_{Kt} are 'factor augmented' parameters. It is noted that when technological progress is non-neutral, the change in TP may be varied for different input vectors. To avoid such problems, Coeli et al (1998) suggest that the geometric mean between the adjacent periods be used to estimate the TP component.

DATA AND VARIABLES

The study is based on panel data collected from various issues of Annual Survey of Industries (ASI) and National Accounts Statistics (NAS) published by, Central Statistical Organization (CSO), Ministry of Statistics and Program Implementation, Government of India, New Delhi, for the period from 1981-82 to 2010-11. The variables used in this exercise are output and labour and capital inputs. Deflated value added has been taken as the measure of output. The ratio of nominal and real GDP, the values of which are obtained from different volumes of NAS is treated as deflator. Total number of persons engaged is used as the measure of labour input. Since working proprietors, owners and supervisory, managerial staff have a significant influence on the productivity of industries, the number of persons engaged is preferred to number of workers. Price of labour is obtained by dividing the total emoluments by the total persons engaged. Net fixed capital stock at constant prices has been taken as the measure of capital input. The net fixed capital stock series has been constructed from the series on gross fixed capital formation (at constant prices) using the Perpetual Inventory method. The annual rate of depreciation of fixed assets has been taken as 5 per cent. Rental price of capital equals the ratio of interest paid and capital invested (Jorgenson and Griliches, 1967) is treated as price of capital.

EMPIRICAL RESULTS

The estimation of parameters in the stochastic frontier model given by Equations (4) and (5) are carried out by maximum-likelihood (ML) method, using the programme FRONTIER 4.1(Coelli,

1996). Instead of directly estimating σ_v^2 and σ_u^2 , FRONTIER 4.1 seeks to estimate $\gamma = \sigma_u^2 / \sigma^2$

and $\sigma^2 = \sigma_v^2 + \sigma_u^2$, the results of which are presented in Table 1. These are associated with the variances of the stochastic term in the production function, v_{it} and the inefficiency error term u_{it} . The parameter γ must lie between zero and one. If the hypothesis $\gamma = 0$ is accepted, this would indicate

that σ_u^2 is zero and thus the inefficiency error term, u_{it} should be removed from the model, leaving a specification with parameters that can be consistently estimated by OLS. Conversely, if the value of γ is one, we have the full-frontier model, where the stochastic term is not present in the model.

Table 1 reports the maximum likelihood estimates of the stochastic frontier production for a panel of sixteen manufacturing states in India including All-India during the period from 1981-82 to 2010-11 giving a total of 496 observations. The maximum likelihood estimates for the translog stochastic frontier production function are reported in panel 1 of Table 1. Almost all the estimated coefficients of the translog stochastic frontier production function are found to be statistically significant. Panel 2 of the Table reports the estimated coefficients for the technical inefficiency effects model. All the coefficients of the technical inefficiency effects model are also found to be statically significant except that of capital intensity (K/L) which implies that a significant amount of output variation is due to the presence of technical inefficiency effect. The estimated value of δ_1 is found to be negative and statistically significant at 1% probability level which implies that an increase in employees' skill will lower the technical inefficiency effects. However, the estimated value of δ_3 is found to be positive and it is statistically significant, indicating that economic reforms boosted technical inefficiency effects in the organized manufacturing industries of food, beverages and tobacco products in India and in its major industrialized states.

Table 1: Maximum Likelihood Estimates for Parameters of the Stochastic Production Frontier and Technical Inefficiency Effects Model of the Manufacture of Food, Beverages and Tobacco Products in India and in its Major Industrialized States

Variables	Parameters	Coefficients
Panel-1: Stochastic Frontier Model		
Constant	β_0	-5.21*** (0.91)
lnL	B_L	2.09*** (0.37)
lnK	β_K	-0.70** (0.32)
t	β_t	0.19*** (0.03)
lnL ²	β_{LL}	-0.15*** (0.035)
lnK ²	β_{KK}	-0.097*** (0.037)
t ²	β_{tt}	-0.0029*** (0.0004)
lnL*lnK	β_{LK}	0.239*** (0.064)
lnL*t	β_{Lt}	-0.029*** (0.005)
lnK*t	β_{Kt}	0.026*** (0.006)
Panel-2: Inefficiency Effect Model		
Intercept	δ_0	-0.31*** (0.05)
Employees Skill (OE/TE)	δ_1	-1.09*** (0.27)
Factor Intensity (K/L)	δ_2	-0.07 (0.18)
Reform Dummy (D)	δ_3	0.80*** (0.14)
Panel-3: Variance Parameters		
Sigma Squared	σ^2	0.09*** (0.01)
Gamma	γ	0.07** (0.03)
Log-Likelihood		-117.39

Standard errors are mentioned in the parenthesis

***, ** & * denote statistical significance at the 1%, 5% and 10% levels, respectively

Source: Authors' own calculation

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 are found to be statistically significant at less than 1% probability level which confirms the presence of technical inefficiency effect in the output residual. The estimated value of gamma (γ) is found to be 0.07, which is far below unity. This implies that output variation in the organized manufacturing industries in India is significantly dominated by random error (v_{it}).

TESTING OF HYPOTHESIS

Various tests of hypotheses of the parameters in the stochastic frontier production function can be performed using the generalized likelihood ratio-test statistic, defined by

$$\lambda = -2 [L(H_0) - L(H_1)]$$

where $L(H_0)$ is the log-likelihood value of a restricted frontier model, as specified by a null hypothesis, H_0 ; and $L(H_1)$ is the log-likelihood value of the general frontier model under the alternative hypothesis, H_1 . This test statistic has approximately a Chi-Square distribution (or a mixed chi-square) with degrees of freedom equal to the difference between the parameters involved in the null and alternative hypotheses. If the inefficiency effects are absent from the equation, as specified by the null hypothesis $H_0: \gamma=0$, then the test statistic λ is approximately distributed according to a mixed chi-square distribution. Table 2 presents the test results of various null-hypotheses as shown below:

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	
Cobb-Douglas Production $H_0: \beta_{LL}=\beta_{KK}=\beta_{LK}=\beta_{tt}=\beta_{Lt}=\beta_{Kt}=0$	-117.39	-136.24	37.70	16.81	12.59	Reject H_0
No Technological Change $H_0: \beta_t=\beta_{tt}=\beta_{Lt}=\beta_{Kt}=0$	-117.39	-158.26	81.74	13.28	9.49	Reject H_0
Neutral Technological Change $H_0: \beta_{Lt}=\beta_{Kt}=0$	-117.39	-144.96	55.14	9.21	5.99	Reject H_0
No Technical Inefficiency Effects $H_0: Y=\delta_0=\delta_1=\delta_2=\delta_3=0$	-117.39	-125.71	16.64	16.81	12.59	Reject H_0
Inefficiency Effects are not a Linear Function of each of the Inefficiency Factors $H_0: \delta_1=\delta_2=\delta_3=0$	-117.39	-124.01	13.24	11.34	7.81	Reject H_0
Each Industry is Operating on Technical Efficiency Frontier $H_0: \mu=0$	-117.39	-117.86	0.94	6.63	3.84	Accept H_0

Source: Authors' Own Calculation

The first likelihood test is conducted to test the null hypothesis that the technology in the organized manufacturing sector in Andhra Pradesh is a Cobb-Douglas ($H_0: \beta_{LL}=\beta_{KK}=\beta_{LK}=\beta_{tt}=\beta_{Lt}=\beta_{Kt}=0$), is rejected. This is shown in Table 2 where a likelihood ratio of the value 37.7 indicates the rejection of null hypothesis at both 5% and 1% significance level. Thus, Cobb-Douglas production function is not an adequate specification for the organized manufacturing industries of food, beverages and tobacco products, given the assumption of the translog stochastic frontier production model, implying that the translog production better describes the technology of the said manufacturing industries.

The second null hypothesis, that there is no technological change over time ($H_0: \beta_t=\beta_{tt}=\beta_{Lt}=\beta_{Kt}=0$) is also strongly rejected. The value of the test statistic as shown in Table 2 is 81.74 which is significantly larger than the critical value of respectively 9.49 and 13.28 at 5% and 1% probability level. This indicates the existence of technological change over time in the manufacture of food, beverages and tobacco products, given the specified production model.

The third null-hypothesis is that, the technological change is Hicks neutral ($H_0: \beta_{Lt}=\beta_{Kt}=0$). The value of the test statistic in this case becomes 55.14 which is much greater than the critical value of 5.99 and 9.21 respectively at 5% and 1% probability level. This indicates that the translog parameterization of the stochastic frontier model does not allow for Hicks neutral technological change.

Fourth, testing the model specification for technical inefficiency shows that the null-hypothesis that technical inefficiency effects are absent, i.e., $H_0: \gamma=\delta_0=\delta_1=\delta_2=\delta_3=0$, is rejected (Table 2). This implies that the traditional production function is not an adequate representation for the organized manufacturing industries of food, beverages and tobacco products. In this case, it can be said that inefficiencies are present in the said manufacturing industries in India and in its fifteen major industrialized states and they are stochastic too.

The fifth null hypothesis asserts that the variables included in the inefficiency effects model have no effect on the level of technical inefficiency, i.e., $H_0: \delta_1=\delta_2=\delta_3=0$. The test result shows that the null hypothesis is rejected confirming that the joint effect of these explanatory variables on technical inefficiency is statistically significant (Table 2).

The final null-hypothesis specifies that each production unit is operating on the technically efficient frontier and that the asymmetric and random technical efficiency in the inefficiency effects are zero ($H_0: \mu=0$). This hypothesis is, however, accepted in favour of the presence of technical efficiency.

Estimation and Decomposition of Output and Productivity Growth

Based on the translog production function estimates presented in Table 2 we derive the following measures: the output elasticity with respect to factor inputs (e_L & e_K), returns to scale ($e = e_L + e_K$), the adjusted scale effect (ASE), rate of technological progress (\dot{A}_t), and the rate of technical efficiency change (\dot{E}_t). These measures are then used to derive output and total factor productivity growth

(\dot{TFP}_t). Because the translog specification is used, the performance of these measures varies depending on industries and years. For the four sources of the output growth, Tables (3) to (5) in the Appendix show that the major contributor to the output growth is the primary inputs, while

technological progress (\dot{A}_t) is the major contributor to the TFPG. On an average, the growth of inputs effect accounts for more than sixty percent of output growth in case of the manufacture of food, beverages and tobacco products in most of the states in India during the whole study period as

well as during both the pre-and the post-reform periods.

So far as the estimates of TFPG is concerned it is found that the components of TFPG of the organized manufacturing industries of food, beverages and tobacco products in almost all the states in India including that of All-India have declined during the post reform period. Further, the contribution of technical efficiency in the organized manufacturing industries of food, beverages and tobacco products in all the states in India vis-a-vis All-India are found to be negative during the whole study period as well as during both the pre-& post-reform periods. The contribution of adjusted scale effects is also found to be negative in many states during the aforementioned study periods. It is also clear from Tables 3, 4 and 5 in the Appendix that TFP growth rates in the organized manufacturing industries of food, beverages and tobacco products in almost all the states in India as well as that in All-India have declined during the post-reform period. Now the contribution of TP to the TFPG is so high that the decline in TFPG during the post-reform period is mainly responsible for the decline in TP of the same during this period.

However, so far as the growth rates of output are concerned it is found from Table 3 in the Appendix that Haryana is the only state among the 15 industrialized states in India that has achieved more than 8 percent average annual growth rate of output during 1981-82 to 2010-11. Total five states out of these 15 states have achieved average annual growth rate of output in the range of 8 percent to 6 percent; six states and India as a whole have achieved average annual growth rate of output in the range of 5 percent to 6 percent, two states have experienced average annual growth rates of output in the range of 3 percent to 4 percent. Two states, namely Kerala and Bihar, have achieved very low average annual growth rate of output 1.96 and 2.66 percents respectively during the study period (1981-82 to 2010-11). So far as the shares in the average annual growth rates of output of the four components of output growth are concerned, the primary inputs, i.e., labour and capital taken together, are found to have the maximum share in as many as twelve states and in India as a whole, while the rate of change in technological progress (\dot{A}) have been the highest contributor to the output growth of the remaining states during this period. The shares of the other two components of the total factor productivity growth (TFPG) such as ASE and TE are very insignificant; in the case of TE its share has been negative in almost all along. So what we see is that the average annual growth rate of output of the manufacturing sector during 1981-82 to 2010-11 is accounted for by only two factors-the primary input factors consisting of labour and capital and the technological progress. The scale effect and technical efficiency effects are very negligible in most of the states and their effects have been negative too in many cases.

A comparison of the performance of output growth of the manufacturing sector and the share of the four output growth components during the pre-and post-reform periods shows that only three states have achieved higher output growth rates (more than seven percent) during the post-reform period (Table 4 in the Appendix). During the post-reform period the share of the primary inputs (labour and capital) in the total output growth is maximum in 8 states (more than 5 percent) in contrast to only 3 states during the pre-reform period. As in the case of the whole period (1981-82 to 2010-11), during the pre-and post-reform periods, the share of technological progress has been greater than the shares of the other two components such as adjusted scale effects (ASE) and the effect technical efficiency (\dot{TE}). The effect of technical efficiency has been negative for almost all the states in the in the pre & post-reform period.

A further division of the post-reform period into two sub-periods of 1991-92 to 2000-01 and 2001-

02 to 2010-11 is made to estimate the relative contribution of the output growth components during these two sub-periods of one decade each (Table 5 in the Appendix). From Table 5 we see that all but one state have registered highest output growth rate (more than 9 percent) during the first half of the post-reform period. In the first decade of the post-reform period the share of primary inputs in the total output growth in as many as only three states have been lower than that of technological progress, while in the second decade of the post-reform period the contribution of technological progress has been negative in almost all the states as well as in all-India. The contribution of technological progress (\dot{A}) to the output growth has been negative in the second decade of the post-reform period in almost all the states under study. But the contribution of the primary inputs in the second decade has been quite high as compared to that in the first decade. The contributions of adjusted scale effect and technical efficiency effects have been negative in most of the states in both the decades after reforms.

SUMMARY AND CONCLUSIONS

The study estimates and decomposes output and productivity growth of the organized manufacturing industries of food, beverages and tobacco products in fifteen major industrialized states in India as well as in All-India. Our theoretical discussion is based on the works of Solow (1957), Denny et al. (1981), Bauer (1990) and Kumbhakar and Lovell (2000). It shows that cost information is not required in estimating the components of output growth and the production function approach is sufficient for our empirical work. Here output growth of the organized manufacturing industries in food, beverages and tobacco products is decomposed into input growth effect, adjusted scale effect, technological progress, and growth in technical efficiency. With this decomposition, the TFP growth simply contains the last three components. The growth of aggregate input is the weighted sum of each input growth and the weight being the cost share of each input. The adjusted scale effect depends on the size of returns to scale. This effect is zero for constant returns to scale, but is adjusted by the aggregate input growth for increasing and decreasing returns to scale. Technological progress in the decomposition represents the shift of the production function over time. The technical efficiency is measured and derived from stochastic frontier model. For our empirical work on the production function, we have derived the series of capital stocks data using the perpetual inventory accumulation method for the organized manufacturing industries of food, beverages and tobacco products in fifteen major industrialized states in India as well as in All-India during the period from 1981-82 to 2010-11.

We have actually extended the estimation and decomposition of output and TFP growth analysis of Li and Liu (2011) using stochastic frontier approach. We have estimated the stochastic frontier translog production function using the maximum-likelihood estimation method. Our empirical results show that the two factor inputs (labor and capital) are the most important for output performance of the organized manufacturing industries of food, beverages and tobacco products in India and in its 15 major industrialized states. While the three sources of the growth of TFP are concerned, we find that the major contributor to the TFP growth of the organized manufacturing industries of food, beverages and tobacco products of the major industrialized states in India under study as well as in All-India, is the technological progress (TP) and the fall in TFPG of the said manufacturing industries of the states under study during the post-reform period is mainly accounts for the decline in TP of the same during that period. The contribution of adjusted scale effect is, however, increasing during the recent years although their improvements are very negligible.

The empirical results do bring forward several policy implications. Policies should be geared to improve technical efficiency and to utilize resources optimally. Further, the industry is seeking more investments to create necessary infrastructure, state-of-the-art-technology and expand production facilities to match the international quality and standards. Moreover, the Government's measures like de-licensing of the sector, several duty and tax relief, financial assistance for infrastructure building etc. too will benefit the sector going forward.

APPENDIX

Table 3 : Average Annual Rates (%) of Output Growth and its Components of the Manufacture of Food, Beverages and Tobacco Products in India and in its Fifteen Major Industrialized States during 1981-82 to 2010-11

States	\dot{Y} (1=2+6)	$\dot{\phi}$ (2)	ASE (3)	\dot{A} (4)	\dot{TE} (5)	\dot{TFP} (6=3+4+5)
A.P.	4.83	7.14	-0.60	-0.74	-0.97	-2.31
Assam	3.57	2.50	-0.01	1.88	-0.80	1.07
Bihar	2.66	0.31	-0.02	2.69	-0.32	2.35
Gujarat	5.31	2.72	0.02	3.16	-0.59	2.59
Haryana	8.42	5.70	0.15	2.90	-0.33	2.72
Karnataka	6.72	3.31	0.08	3.67	-0.34	3.41
Kerala	1.96	5.18	-0.38	-1.75	-1.09	-3.22
M.P.	6.18	3.64	0.03	2.84	-0.33	2.54
Maharashtra	5.99	3.26	-0.03	3.10	-0.34	2.73
Odisha	6.45	4.68	0.09	2.50	-0.82	1.77
Punjab	6.93	4.82	0.03	2.81	-0.73	2.11
Rajasthan	7.27	3.86	0.10	3.95	-0.64	3.41
T.N.	5.13	3.66	-0.04	2.15	-0.64	1.47
U.P.	5.96	3.45	-0.03	2.71	-0.17	2.51
W.B.	5.42	3.95	-0.03	2.03	-0.53	1.47
India	5.81	5.80	-0.50	1.12	-0.61	0.01

Source: Authors' own calculation

Notes: \dot{Y} =rate of output growth, $\dot{\phi}$ = rate of input growth, ASE=adjusted scale effect, \dot{A} = rate of technological progress, \dot{TE} = rate of technical efficiency change & \dot{TFP} = rate of total factor productivity growth

Table 4

Panel 1: Average Annual Rates (%) of Output Growth and its Components of the Manufacture of Food, Beverages and Tobacco Products in India and in its Fifteen Major Industrialized States during 1981-82 to 1990-91 (Pre-reform Period)						
States	\dot{Y} (1=2+6)	$\dot{\Phi}$ (2)	ASE (3)	\dot{A} (4)	\dot{TE} (5)	\dot{TFP} (6=3+4+5)
A.P.	5.69	3.08	-0.30	2.92	-0.01	2.61
Assam	6.85	0.76	0.02	6.06	0.01	6.09
Bihar	3.86	-2.08	-0.11	6.06	-0.01	5.94
Gujarat	6.82	-0.13	-0.02	6.96	0.01	6.95
Haryana	13.43	6.89	0.14	6.41	-0.01	6.54
Karnataka	5.49	-1.74	-0.01	7.23	0.01	7.23
Kerala	2.54	0.29	0.10	2.16	-0.01	2.25
M.P.	11.06	5.80	-0.03	5.28	0.01	5.26
Maharashtra	7.65	0.39	0.01	7.26	-0.01	7.26
Odisha	4.87	-1.58	-0.14	6.60	-0.01	6.45
Punjab	12.82	5.79	0.08	6.94	0.01	7.03
Rajasthan	5.99	-2.00	-0.20	8.18	0.01	7.99
T.N.	7.91	1.94	0.04	5.92	0.01	5.97
U.P.	7.42	1.77	-0.04	5.68	0.01	5.65
W.B.	4.56	-1.52	-0.06	6.13	0.01	6.08
India	7.80	3.20	-0.26	4.87	-0.01	4.60
Panel 2: Average Annual Rates (%) of Output Growth and its Components of the Manufacture of Food, Beverages and Tobacco Products in India and in its Fifteen Major Industrialized States during 1991-92 to 2010-11 (Post-reform Period)						
States	\dot{Y} (1=2+6)	$\dot{\Phi}$ (2)	ASE (3)	\dot{A} (4)	\dot{TE} (5)	\dot{TFP} (6=3+4+5)
A.P.	4.38	9.17	-0.75	-2.58	-1.46	-4.79
Assam	1.91	3.36	-0.02	-0.22	-1.21	-1.45
Bihar	2.06	1.50	0.03	1.00	-0.47	0.56
Gujarat	4.55	4.14	0.04	1.26	-0.89	0.41
Haryana	5.92	5.10	0.16	1.15	-0.49	0.82
Karnataka	7.34	5.83	0.13	1.89	-0.51	1.51
Kerala	1.65	7.62	-0.62	-3.71	-1.64	-5.97
M.P.	3.73	2.55	0.07	1.61	-0.50	1.18
Maharashtra	5.19	4.70	-0.04	1.03	-0.50	0.49
Odisha	7.23	7.81	0.20	0.45	-1.23	-0.58
Punjab	3.99	4.34	0.01	0.74	-1.10	-0.35
Rajasthan	7.92	6.80	0.25	1.83	-0.96	1.12
T.N.	3.73	4.52	-0.09	0.26	-0.96	-0.79
U.P.	5.23	4.29	-0.03	1.22	-0.25	0.94
W.B.	5.86	6.68	-0.01	-0.01	-0.80	-0.82
India	4.82	7.11	-0.61	-0.76	-0.92	-2.29

Source: Authors' own calculation

Table 5

Panel 1: Average Annual Rate (%) of Output Growth and its Components of the Manufacture of Food, Beverages and Tobacco Products in India and in its Fifteen Major Industrialized States during 1991-92 to 2000-01 (Decade 1: Post-reform Period)						
States	\dot{Y} (1=2+6)	$\dot{\Phi}$ (2)	ASE (3)	\dot{A} (4)	\dot{TE} (5)	\dot{TFP} (6=3+4+5)
A.P.	3.37	8.84	-0.77	-1.01	-3.69	-5.47
Assam	1.79	2.57	0.05	2.16	-2.99	-0.78
Bihar	1.51	0.38	-0.07	2.83	-1.63	1.13
Gujarat	4.18	2.42	0.04	3.23	-1.51	1.76
Haryana	4.78	3.85	0.12	2.70	-1.89	0.93
Karnataka	6.95	5.02	0.13	3.60	-1.80	1.93
Kerala	5.46	10.60	-0.72	-1.32	-3.10	-5.14
M.P.	5.06	2.88	0.13	3.70	-1.65	2.18
Maharashtra	7.19	5.58	-0.02	2.98	-1.35	1.61
Odisha	9.67	8.70	0.43	3.03	-2.49	0.97
Punjab	4.66	3.59	0.04	3.05	-2.02	1.07
Rajasthan	9.24	5.66	0.35	4.48	-1.25	3.58
T.N.	2.95	3.03	-0.08	2.18	-2.18	-0.08
U.P.	4.76	3.22	-0.05	2.83	-1.24	1.54
W.B.	5.76	5.64	0.04	1.87	-1.79	0.12
India	5.64	7.05	-0.59	1.11	-1.93	-1.41
Panel 2: Average Annual Rates (%) of Output Growth and its Components of the Manufacture of Food, Beverages and Tobacco Products in India and in its Fifteen Major Industrialized States during 2001-02 to 2010-11(Decade 2: Post-reform Period)						
States	\dot{Y} (1=2+6)	$\dot{\Phi}$ (2)	ASE (3)	\dot{A} (4)	\dot{TE} (5)	\dot{TFP} (6=3+4+5)
A.P.	5.39	9.50	-0.73	-4.15	0.77	-4.11
Assam	2.04	4.16	-0.10	-2.60	0.58	-2.12
Bihar	2.60	2.62	0.12	-0.83	0.69	-0.02
Gujarat	4.93	5.87	0.03	-0.70	-0.27	-0.94
Haryana	7.06	6.36	0.20	-0.40	0.90	0.70
Karnataka	7.74	6.65	0.13	0.18	0.78	1.09
Kerala	-2.19	4.62	-0.52	-6.11	-0.18	-6.81
M.P.	2.41	2.23	0.01	-0.48	0.65	0.18
Maharashtra	3.16	3.82	-0.07	-0.93	0.34	-0.66
Odisha	4.80	6.91	-0.02	-2.13	0.04	-2.11
Punjab	3.31	5.10	-0.03	-1.58	-0.18	-1.79
Rajasthan	6.60	7.93	0.15	-0.82	-0.66	-1.33
T.N.	4.50	6.01	-0.10	-1.66	0.25	-1.51
U.P.	5.68	5.35	-0.02	-0.38	0.73	0.33
W.B.	5.95	7.72	-0.07	-1.90	0.20	-1.77
India	4.00	7.16	-0.63	-2.63	0.10	-3.16

Source: Authors' own calculation

Table 8

Concordance between NIC'87, NIC'98 & NIC'04 and NIC'08 of 2-Digit Manufacturing Industries

Industries	NIC'87 code	NIC'98 & NIC'04 code	NIC 2008 code
Food, Beverages and Tobacco Products	20-22	151+152+153+154+155 +160	101+102+103+104 +105+106+107+108 +110+120
Textile and Textile Products	23+24+25+26	171+172+173+181	131+139+141+143
Wood and Wood Products	27	20+361	16+310
Paper and Paper Products	28	21+22	17+18
Chemicals and Chemical Products	30	24	20+21
Rubber, Petroleum and Coal Products	31	23+25	19+22
Non-Metallic Mineral Products	32	26	23
Basic Metals and Alloys Industries	33	271+272+273+371	241+242+243
Metal Products and Machinery Equipments	34+35+36	28+29+30+31+32	25+26+27+28
Transport Equipments	37	34+35	29+30
Total Manufacturing			

Source: Article by Pulapri Balakrishnan & M Suresh Babu published in EPW Sept. 20, 2003, Page 4004

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