Decomposition of Total Factor Productivity Growth in Selected Indian Food Product Companies

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Abstract

The study evidenced that fifty two companies productivity was deteriorated, whereas five companies evidenced productivity gain much during the study period. On the whole the deteriorating productivity was due to decline in both technical efficiency at (-) 3 per cent and technical change at (-) 1 per cent. In other words the negative sign of both efficiency and technology suggested that there was a declining total factor productivity growth of Indian food product industry during 1991 to 2016.

INTRODUCTION

The Indian food industry is poised for huge growth, increasing its contribution in world food trade every year. In India, the food sector has emerged as a high-profit sector on the back of the scope it offers for value addition, particularly with the food processing industry getting recognized as a high-priority area. Accounting for about 32 per cent of the country's total food market, the food processing industry is one of the largest industries in India and is ranked fifth in terms of production, consumption, export and expected growth. The total food production in India is likely to double in the next 10 years with the country's domestic food market estimated to reach US$ 258 billion by 2015. During 2011 to 2016, India's exports of processed food and related products (inclusive of animal products) grew at a Compound annual growth rate of 11.74 per cent, reaching US$ 16.2 billion. Main export destinations for food products have been the Middle East and Southeast Asia. In 2017 India's exports stood at US$ 1.3 billion.

REVIEW OF EARLIER STUDIES

Manikandan (2017) explored the impact of M&A on total factor productivity growth in Indian textile industry. The study concluded that the total factor productivity index of the industry in the initial year (1995) was 96.12. Taking 1994 as a base year, there was a decline in the total factor productivity in the very next year and the declining trend continued upto 2001 and was a marginal improvement there after. M&A has impacted the determinants of total factor productivity growth significantly. Technical progress was impressive (5.72 as against 4.59). The technical efficiency change 94.15 as against -0.74), scale efficiency change (3.06 as against -1.43) and allocative efficiency changes (3.65 as against -3.02) were positive and impressive. The results confirm that the alternative hypothesis were accepted.

Biswas et al., (2015) explained the performance of Indian food products industry, a study of structure, innovation and growth, 2000 – 2010. They observed that there is an urgent need of substantially raising the technology levels of the Indian food manufacturing: processing, storage/ preserving, transporting, all require major up gradation of technology. This is required not only for exporting but also to serve domestic market, prevent wastage, recovery of food nutrients, and serving the people round the year good quality food. Role of state in this process of technology development/ up-gradation is all the more important; it has to raise R&D activities and create various incentives for enterprises to adopt new or improved technology. In this regard existing scheme for technology up-gradation may be widened.

Ray (2011) reported the total factor productivity performance and efficiency growth pattern for cement industry in India for the period, 1979-80 to 2008-09. Malmquist Data Envelopment Analysis (DEA) has been adopted to estimate different performance measures viz. productivity growth, technological change, and technical efficiency change for the entire period. They observed that there is an accelerating trend in productivity during post-reform period. Industry also experienced increase in technological progress along with stagnation in technical efficiency. The study found that the increasing technical change along with non- responding technical efficiency change were the main ingredients responsible for accelerating productivity change in India's cement industry. Moreover, the study concluded that gross mark up and growth in output, Foreign Direct Investment (FDI) variables have significant positive impact on total factor productivity growth but openness impacted negatively which is beyond our expectation. In this sector, there was an urgent need to improve both technical efficiency and technological progress.

Singh (2001) estimated the Total Factor Productivity (TFP) in Indian manufacturing sector during 1973-74 to 1993-94 for the ten industries, which constituted about 70 per cent of GDP in India. He found that food products industry showed improvement in TFP during the period and recorded a trend growth rate of 2.68 per cent followed by transport equipments industry at 2.19 per cent.

Majumdar (1996) analyzed the pattern of productivity growth of Indian Industrial sector since 1950s. The study empirically proved the positive impact of liberalisation measures on productivity. The reforms process did not exacerbate entry threats for the sitting incumbents in Indian industry, but the environment was equally competitive for the new entrants. Attainment of efficiency was a key survival criterion in such situations and the Indian firms had so far yielded positive efficiency outcomes. The adoption of technological and organisational innovations had a very large impact on productivity at the firm level. The policy changes that took place in India in the 1990s did significantly enhance potential opportunities on one hand and increase the uncertainties and ambiguities levels on the other.

DATA AND METHODOLOGY

DATA

The study is based on the secondary data collected from the electronic data base "PROWESS" compiled by the Centre for Monitoring Indian Economy (CMEI). The data base consists of data on various aspects of Indian manufacturing and is compiled from the annual reports submitted by the firms. The sample consists of 58 Indian food products companies between 1991 and 2016 with a total of 1874 observations[1].

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[1] Firms for which unacceptable values were recorded for certain variables, such as negative or zero values for fixed assets, and those for which a continuous time series was unavailable were subsequently excluded from the sample.

PERIOD OF THE STUDY

The required data was collected for the period 1991 to 2016; the latest year for which the complete set of data available and thus the study covers a period of 26 years.

METHODOLOGY

MALMQUIST PRODUCTIVITY INDEX

The Data Envelopment Analysis (DEA) is a special mathematical linear programming model and test to assess efficiency and productivity. It allows use of panel data to estimate changes in total factor productivity and breaking it down into two components namely, technological change (TC) and technical efficiency change (TEC). TFP growth measures how much productivity grows or declines over time. When there are more outputs relative to the quantity of given inputs, then TFP has grown or increased. TFP can grow when adopting innovations such as electronics, improved design, or which we call “technological change” (TC). TFP can also grow when the industry uses their existing technology and economic inputs more efficiently; they can produce more while using the same capital, labour and technology, or more generally by increases in “technical efficiency” (TEC). TFP change from one year to the next is therefore comprised of technological change and changes in technical efficiency. The TEC is further decomposed into pure technical efficiency change (PTEC) and scale efficiency change (SEC).

This study uses the output-oriented model of DEA-Malmquist to put much weight on the expansion of output quantity out of a given amount of inputs. Therefore, TFP index is a ratio of the weighted aggregate outputs to weighted aggregate inputs, using multiple outputs and inputs. Input and output quantities of industries are sets of data used to construct a piece-wise frontier over the data points. Efficiency measures are then calculated relative to this frontier that represents an efficient technology. The best-practice industry determines the production frontier, that is, those that have the highest level of production given a level of economic inputs. Points that lie below the piece-wise frontier are considered inefficient while points that lie on or above the frontier are efficient. Since many inputs are used, and shared outputs may be produced, the Malmquist approach was developed to combine inputs and outputs and then measure changes.

The Malmquist index measures the total factor productivity change (TFPC), between two data points over time, by calculating the ratio of distances of each data points relative to a common technology.

As per Malmquist Productivity Index (MPI) approach, total factor productivity can increase not only due to technical progress (shifting of frontier) but also due to improvement in technical efficiency (catch-up). This approach has become quite popular because: (i) it does not require price data, therefore suitable when price data are not available or price data are distorted, (ii) it rests on much weaker behavioural assumptions, since it does not assume cost minimizing or revenue maximizing behaviour, (iii) it uses time serious data and provides a decomposition of productivity change into two components – technical change and technical efficiency change. The significance of the decomposition is that it provides information on the source of overall productivity change **(Singh and Agarwal, 2006).**

The measurement of the Malmquist productivity index is based on distance functions. For simplicity, $z^t = (x^t, y^t)$ *and* $z^{t+1} = (x^{t+1}, y^{t+1})$, where x^t is the vector of inputs used in production and y^t is the vector of outputs. Now, for each time period $t=1,\ldots.T,$ the output distance function is defined as follows:

$$D^t(z\ )=\inf\{\theta : y^t/\theta \in P^t(x)\}$$
$$=[\sup\{\theta : y^t \in P^t(x)\}]^{-1} \qquad (1)$$

where superscript t and D^t denote that technology in period t is used as the reference technology. θ is scalar, and its value is the efficiency score for each production activity. It satisfies $0<\theta\leq 1$ for a non-negative output level, with a value of 1 indicating a point of the frontier, and thus a technically efficient production activity. This output distance function is defined as the reciprocal of the maximal proportional expansion of output vector y^t with the given input vector x^t in relation to the technology at t.

The Malmquist productivity index is defined as follows:

$$TFP = M^t = \frac{D^t(z^{t+1})}{D^t(z^t)} \qquad (2)$$

This formulation is called the output-oriented Malmquist productivity index in period t, $M^t\ (z^{t+1},z)$, where the technology in period t is the reference technology for two differing pairs of outputs and inputs. Alternatively, we can define M^{t+1} where the technology in period $t+1$ is employed as the reference technology.

Consistent with the study of Fare *et al*., (1994), the output-based Malmquist productivity index is defined as the geometric mean of two output-distance functions, in order to avoid selecting an arbitrary benchmark:

$$M(z^{t+1},z^t)=[M^t.M^{t+1}]^{1/2}$$
$$=\left[\left(\frac{D^t(z^{t+1})}{D^t(z^t)}\right)\left(\frac{D^{t+1}(z^{t+1})}{D^{t+1}(z^t)}\right)\right]^{1/2} \qquad (3)$$

Equation (3) can be rewritten as:

$$M(z^{t+1},z^t)=\left(\frac{D^{t+1}(z^{t+1})}{D^t(z^t)}\right)X\left(\frac{D^t(z^{t+1})}{D^{t+1}(z^{t+1})}\right)\left(\frac{D^t(z^t)}{D^{t+1}(z^t)}\right)^{1/2} \qquad (3`)$$

where the ratio outside the brackets measures the change in relative efficiency between t and $t+1$, and the geometric mean inside the brackets measures the shift in frontier. That is, the Malmquist productivity index can be decomposed into change in efficiency and change in technical progress[2].

In a previous empirical work, **Fare *et al.*, (1994**) utilized non-parametric linear-programming techniques. As can be seen in (3`), we must solve four different linear programming problems: $D^t(z^t)$, $D^t(z^{t+1})$, $D^{t+1}(z^t)$, *and* $D^{t+1}(z^{t+1})$. Calculating the Malmquist index relative to the variable returns to scale technology. $D_j^t(z^t)$ for each

[2] See **Fare *et al.*, (1994)** for a graphical explanation.

industry, $j \in k = 1,\ldots\ldots,K$, one of the four different linear programming problems, can be stated as[3]:

$$\left[D_j^t\left(z_j^t\right)^{-1} = \max_{\theta,w} \theta_j\right] \quad (4)$$

subject to $\theta_j y_{m,j}^t \leq \sum_{k=1}^{K} w_k^t y_{m,k}^t$ $\quad m = 1,\ldots..,M$ (4a)

$$\sum_{k=1}^{K} w_k^t x_{n,j}^t \leq x_{n,j}^t \quad n = 1,\ldots..,N \quad (4b)$$

$$w_k^t \geq 0 \; k = 1,\ldots.,K \quad (4c)$$

where $n = 1,\ldots.,N$ are inputs, $m = 1,\ldots.,M$ are outputs, and w_k^t is an intensity variable indicating the production intensity of a particular activity. (Here, each industry is an activity). These intensity variables are used as weights in taking convex combinations of the observed outputs and inputs in both (4a) and (4b). From Equation 4, the reciprocal of the output distance function can be used to find the maximum of θ, which gives the maximal proportional expansion of output given constraints (4a)–(4).

For the other distance functions, the computation of $D^{t+1}(z^{t+1})$ is exactly the same as (4), where $t + 1$ is substituted for t. Two other distance functions require information from two periods, $D^t(z^{t+1})$ can be computed by replacing $y_{m,j}^t$ and $x_{n,j}^t$ in (4a) and (4b) with $y_{m,j}^{t+1}$ and $x_{n,j}^{t+1}$, respectively, and $D^{t+1}(z^t)$ is the same as $D^t(z^{t+1})$, where the t and $t + 1$ superscripts are exchanged[4].

The output-oriented Malmquist indices of productivity change are computed using the data envelope approach discussed below. We used the computer software DEAP **(Coelli, 1996)** to calculate these indices.

The following tables presented estimated mean values are geometric mean of Malmquist indices viz; total factor productivity changes (TFPCH), decomposed into technical efficiency change (EFFCH) and technological change (TECHCH). TECHCH is further decomposed into pure technical efficiency change (PECH) and scale efficiency change (SECH). The companies are arranged in descending order of their Malmquist productivity indices (TFPC). The value of TFPC higher than unity reveals productivity growth and lower than one indicates decline in productivity. Percentage change in productivity is given by (TFPC-1) x 100. The same rule applies to other indices presented in the table.

The total factor productivity change can be decomposed as,

TFP change = Technical efficiency change (catching up effect)
x Technical change (frontier effect)

Further technical efficiency change decomposed as,

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[3] **Ray and Desli (1997)** emphasized the importance of variable-returns-to-scale (*VRS*) in using a reference technology. In some cases, however, the *VRS* method has an infeasible solution **(Ray and Desli, 1997, p.1037).** In response to **Ray and Desli (1997), Fare *et al.*, (1997)** commented that constant-returns-to-scale captures long-run results, whereas the *VRS* is appropriate for the short-run. Since our study analyzes the long-run productivity trend for 1991 to 2016, we use the method of **Fare *et al.*, (1994).**

[4] See **Coelli (1996), p.27** for more details.

Technical efficiency change = Scale efficiency change x Pure efficiency change

RESULTS AND DISCUSSION

ESTIMATES OF COMPANY MEANS OF TOTAL FACTOR PRODUCTIVITY GROWTH DURING 1991 to 2016

Table 1 presents the estimation of Malmquist Productivity Index (MPI) for companies of Indian food products industry. The given MPI were the geometric mean of the fifty seven companies for the study period (1991-2016). The industry as a whole witnessed the deteriorated change in the productivity growth during the study period and this declining pattern was mainly contributed by both technical efficiency (-3 per cent) and technical change (-1 per cent). The maximum productivity growth was reported in Peria Karamalai Tea & Produce Co. Limited at 3.60 per cent followed by 2.40 per cent in Sir Shadi Lal Enterprises Limited and 1.70 per cent in Warren Tea Limited during the study period under review. The Oudh Sugar Mills Limited was evidenced no change in the productivity growth.

There were fifty two companies witnessed productivity deterioration during the period in the Indian food products industry. In case of Bajaj Hindusthan Sugar Limited, it was observed that maximum productivity was worsen at (-) 16.90 per cent due to the poor result of efficiency change at (-) 19.50 per cent. There were no companies who improved both technical efficiency and technical change in the selected Indian food product companies except Peria Karamalai Tea & Produce Co. limited. The result also suggested that, there were fourteen companies utilised the technology more efficiently during the study period.

Table 1

Sources of Total Factor Productivity Change in Selected Indian Food Products Companies during 1991 to 2016

Companies	TFPCH	EFFCH	TECHCH	PECH	SECH
Agro Tech Foods Ltd.	0.981	1.012	0.970	1.021	0.990
Amrit Corp. Ltd.	0.943	0.925	1.020	0.946	0.977
B & A Ltd.	1.008	0.954	1.056	0.953	1.002
Bajaj Hindusthan Sugar Ltd.	0.831	0.805	1.033	1.000	0.805
Balrampur Chini Mills Ltd.	0.949	0.976	0.972	0.980	0.996
Bannari Amman Sugars Ltd.	0.917	0.958	0.958	0.956	1.002
Britannia Industries Ltd.	0.950	0.973	0.976	0.941	1.035
Cian Agro Inds. & Infrastructure Ltd.	0.877	0.913	0.961	0.897	1.018
Dalmia Bharat Sugar & Inds. Ltd.	0.968	0.991	0.977	0.996	0.995
Dhampur Sugar Mills Ltd.	0.945	0.937	1.009	0.900	1.041
Dharani Sugars & Chemicals Ltd.	0.976	0.982	0.994	0.973	1.009
E I D-Parry (India) Ltd.	0.979	0.974	1.005	0.966	1.008
Foods & Inns Ltd.	0.939	0.932	1.008	0.927	1.006
G M Breweries Ltd.	0.940	0.962	0.977	0.961	1.002
Glaxosmithkline Consumer Healthcare Ltd.	0.931	0.956	0.974	0.949	1.008
Gobind Sugar Mills Ltd.	0.965	0.966	0.999	0.934	1.034
Goodricke Group Ltd.	0.898	0.937	0.959	0.929	1.008
Jagatjit Industries Ltd.	0.953	0.969	0.982	0.962	1.008
Jay Shree Tea & Inds. Ltd.	0.948	0.941	1.008	0.919	1.023
K S E Ltd.	0.958	0.971	0.987	0.952	1.020

Kesar Enterprises Ltd.	0.973	0.973	1.000	0.958	1.016
Khandelwal Extractions Ltd.	0.997	0.975	1.022	0.974	1.002
Khoday India Ltd.	1.008	0.987	1.022	0.998	0.988
Kothari Sugars & Chemicals Ltd.	0.938	0.961	0.976	0.975	0.986
Kovilpatti Lakshmi Roller Flour Mills Ltd.	0.951	0.979	0.972	0.972	1.007
Ledo Tea Co. Ltd.	0.953	0.953	1.000	0.922	1.034
Lotte India Corpn. Ltd.	0.972	0.966	1.006	0.948	1.019
Marico Ltd.	0.961	0.975	0.986	0.954	1.022
Milkfood Ltd.	0.981	0.989	0.991	0.988	1.001
Modi Industries Ltd.	0.946	0.972	0.974	0.948	1.025
Modi Naturals Ltd.	0.927	0.964	0.962	0.978	0.985
Mondelez India Foods Pvt. Ltd.	0.946	0.980	0.966	0.990	0.989
Neelamalai Agro Inds. Ltd.	0.963	1.001	0.962	0.967	1.036
Orient Beverages Ltd.	0.975	0.990	0.986	0.965	1.025
Oudh Sugar Mills Ltd. [Merged]	1.000	1.010	0.990	0.982	1.029
Peria Karamalai Tea & Produce Co. Ltd.	1.036	1.027	1.009	1.036	0.991
Prima Agro Ltd.	0.967	0.944	1.024	0.959	0.985
Rajshree Sugars & Chemicals Ltd.	0.980	0.998	0.983	1.001	0.997
Ravalgaon Sugar Farm Ltd.	0.962	0.970	0.992	0.989	0.981
Riga Sugar Co. Ltd.	0.944	0.959	0.984	0.969	0.990
Ruchi Soya Inds. Ltd.	0.976	0.983	0.992	0.973	1.011
S M Dyechem Ltd.	0.947	0.964	0.983	0.956	1.008
Sir Shadi Lal Enterprises Ltd.	1.024	1.000	1.024	1.000	1.000
Stanes Amalgamated Estates Ltd.	0.937	0.944	0.993	0.954	0.990
Sunil Agro Foods Ltd.	0.982	0.986	0.996	0.986	1.000
Tasty Bite Eatables Ltd.	0.952	0.982	0.969	0.979	1.003
Tata Coffee Ltd.	0.985	0.992	0.994	1.014	0.978
Tata Global Beverages Ltd.	0.960	0.964	0.995	0.983	0.981
Thiru Arooran Sugars Ltd.	0.969	0.992	0.976	0.981	1.011
Triveni Engineering & Inds. Ltd.	0.913	0.935	0.977	0.947	0.987
Ugar Sugar Works Ltd.	0.995	1.000	0.995	1.028	0.973
United Nilgiri Tea Estates Co. Ltd.	0.986	0.988	0.997	0.970	1.018
United Provinces Sugar Co. Ltd.	0.979	0.996	0.982	1.009	0.987
Universal Starch-Chem Allied Ltd.	0.923	0.951	0.971	0.996	0.954
Upper Ganges Sugar & Inds. Ltd. [Merged]	0.980	1.003	0.978	0.977	1.026
Vadilal Industries Ltd.	0.990	1.023	0.967	1.008	1.015
Vippy Industries Ltd.	0.952	0.971	0.980	1.004	0.967
Warren Tea Ltd.	1.017	0.993	1.024	1.017	0.977
Food Products Industry Mean	**0.960**	**0.970**	**0.990**	**0.971**	**0.999**
Food Products Industry Mean Percentage (%)	**-4.00**	**-3.00**	**-1.00**	**-2.90**	**-0.10**
Source: CMIE: Centre for Monitoring Indian Economy PROWESS database. Note: All Malmquist index averages are geometric means.					

The change in the efficiency result was due to changes in both pure and scale efficiency. The technical efficiency improved in six out of fifty eight companies but the result found that negative value of (-) 3 per cent in the industry average. In case of pure efficiency change, it was more than unity in nine companies whereas thirty three companies in scale efficiency change. There were two companies reported constant return to scale in the Indian food product companies.

CONCLUSION

The study concluded that fifty two companies productivity was deteriorated, whereas five companies evidenced productivity gain much during the study period. On the whole the deteriorating productivity was due to decline in both technical efficiency at (-) 3 per cent and technical change at (-) 1 per cent. In other words the negative sign of both efficiency and technology suggested that there was a declining total factor productivity growth of Indian food product industry during 1991 to 2016.

REFERENCES:

1. Biswas Pradip Kumar; Parthasarathi Banerjee; Sanjib Pohit; Prateek Kukreja; Arundhati Choudhury (2015) ,“Performance of Indian Food Products Industry: A Study of Structure, Innovation and Growth, 2000 – 2010”, Published by CSIR – National Institute of Science Technology and Development Studies.
2. Coelli, Tim (1996), “A guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer) Program.” CEPA Working Paper 96/08, University of New England, Australia.
3. Fare, Rolf; S. Grosskopf, M, Norris, and Z. Zang,(1994), “Productivity Growth, Technical Progress, and Efficiency Change in Industrialised Countries.” American Economic Review, Vol. 84, pp.66-83.
4. Majumdar, Sumit.K(1996), “Fall and Rise of Productivity in Indian Industries. Has Economic Liberalization Had an Impact?”, Economic and Political Weekly, Vol.31, November 30, pp. M46-M53.
5. Manikandan M (2017), “Impact of M&A on Total Factor Productivity Growth in Indian Textile Industry”, LEADER International Journal of Business Management, Vol. pp. 56-68.
6. Ray, S.C. and E. Desli (1997), “Productivity Growth, Technical Progress, and Efficiency Change in Industrialized Countries: Comment.” American Economic Review, Vol. 87, pp.1033-1039.
7. Ray Sarbapriya (2011), “Econometric Analysis of Efficiency in Indian Cement Industry”, Research on Humanities and Social Sciences, Vol. 1, No. 2, pp. 11-22.
8. Singh S.P and Shivi Agarwal, (2006), “Total Factor Productivity Growth, Technical Progress and Efficiency Change in Sugar Industry of Uttar Pradesh,” The Indian Economic Journal, Vol.54, No.2, pp.59-82.
9. Singh, Tarlok (2001), “Total Factor Productivity in the Manufacturing Industries in India”, The Indian Economic Journal, Vol.48, October-December, pp. 108-117.
10. https://www.ibef.org/industry/food-industry-presentation
11. https://www.ibef.org/industry/indian-food-industry.aspx