Sources of Productivity Growth in Selected Indian Sugar Companies

S.Alakendran[a], R.Shanthi[b]
[a]Research Scholar, Department of Business Administration, Kaamadhenu Arts and Science College, Sathyamangalam, Erode, Tamil Nadu, India.
[b]Associate Professor, Department of Business Administration, Kaamadhenu Arts and Science College, Sathyamangalam, Erode, Tamil Nadu, India.

Abstract

Sugar is an important ingredient which is unavoidable in our day to day life. The prime objective of the study is to find out the sources of productivity growth in selected Indian sugar companies. The study is based on the secondary data collected from the electronic data base “PROWESS” compiled by the Centre for Monitoring Indian Economy (CMIE). The inference made in the present study reveals that out of 33 companies 29 companies productivity declined whereas 3 companies evidenced productivity gain. On the whole the deteriorating productivity was due to technical regress at (-) 20.50 per cent along with positive efficiency change at 19.20 per cent in the Indian sugar industry. In other words the positive sign of efficiency along with negative sign of technology suggested that there is a declining in the total factor productivity growth.

INTRODUCTION

Globally, Sugar is mainly extracted from either sugarcane or sugar beet. Around 80 per cent of global sugar is extracted from sugarcane, and remaining 20 per cent from sugar beet. In India, sugar is extracted from sugarcane. Sugar industries development is backbone to economic development of the nation. In India, sugar industry is the second largest agro-based industry and it contributes significantly to the socio economic development of the nation. The sugar industry employs 0.5 million workers and also provides substantial indirect employment through various ancillary activities. Indian Sugar Mills Association has lowered India’s 2018-19 sugar production estimated by 11.26 per cent at 315 lakh tonnes as compared to its earlier estimate of 355 lakh tonnes. Sugar production during the current 2018-19 SS is being reported to be lower than what was expected about 3-4 months back. The crop in the three main sugarcane growing States, namely, Uttar Pradesh, Maharashtra and Karnataka which contribute for around 80 per cent of country’s sugar, have all been adversely impacted due to various reasons.

REVIEW OF EARLIER STUDIES

Datturaya Shivaraj and Tumkunte Devidas (2018) studied the growth and performance of Indian sugar industry: special reference to Karnataka Sugar Industry. Sugar industry contributes an estimated Rs. 17 billion annually to national exchequer and treasuries of various state Governments by way of excise duty and purchase tax on Sugarcane. Sugarcane farmers and their families number over 45 million, constituting about 7.5 per cent of the rural population.

Ganeshgouda et al., (2016) analyzed the performance of sugar industry in major sugar producing states of India relating to various parameters such as area under sugarcane, sugarcane production, productivity of sugarcane, sugar production, cane utilization for sugar production, number of factories in operation, installed capacity, capacity utilization, sugar recovery percent and duration of cane crushing. The growth rate technique was employed to assess the performance of sugar factories for the period 1985-86 to 2012-13. The results of the study revealed that majority of the states showed positive significant growth in the area under sugarcane, sugarcane yield, sugarcane production, number of sugar factories in operation, utilization of sugarcane for sugar production, installed capacities and sugar production.

Patil (2011) examined the liquidity position of the industry on the basis of some ratios; the data was collected from the published annual reports of the sugar industry over the period 2005-06 to 2009-10. For analyzing the performance of liquidity management of the industry, ratio analysis, comprehensive rank test, and Spearman's rank correlation analysis have been used. To test the significance of relationship between liquidity and profitability rank correlation coefficient and students 't' test have been employed.

Fare *et al.*, (1994) analysed productivity growth, technical progress and efficiency Change in 17 OECD countries over the period 1979-98. The data was obtained from the Penn World Tables. These data built from the benchmark studies of International Comparison programmes of United Nations National Accounting data. A non-parametric method (activity analysis) was used to compute productivity growth. They concluded that US productivity growth is slightly higher than the average, all of which is due to technical change. Japan's productivity growth is the highest in the sample, with almost half due to efficiency change.

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:

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

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:

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

Equation (3) can be rewritten as:

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

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[1].

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. $D_j^t\left(z^t\right)$ for each industry, $j \in k = 1,\dots\dots, K$, one of the four different linear programming problems, can be stated as[2]:

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

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

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

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

where $n = 1,\dots.,N$ are inputs, $m = 1,\dots.,M$ 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)

---

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

[2] **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 2000 to 2016, we use the method of **Fare *et al*., (1994).**

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[3].

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,

Technical efficiency change = Scale efficiency change x Pure efficiency change

DATA AND VARIABLES

The study is based on the secondary data collected from the electronic data base "PROWESS" compiled by the Centre for Monitoring Indian Economy (CMIE). The data base consists of data on various aspects of Indian manufacturing and is compiled from the annual reports submitted by the firms. The company level data were obtained from the electronic database PROWESS, and there are 135 Indian sugar companies listed in CMIE database out of which 33 companies are selected between 2000 and 2016.

Output

Gross value added, calculated by deleting total purchases of intermediate inputs from gross outputs, was taken as a measure of output, and was then deflated by the wholesale prices index of the sugar industry, with the base of 2004 = 100.

Capital

The PROWESS database provides total fixed assets net of accumulated depreciation, including capital work-in-progress and revalued assets, if any. The total fixed assets were deflated by the wholesale prices index of machinery and machine products, and thus real total fixed assets were included in the function as a measure of capital stock.

Labour

The PROWESS database does not provide employment details. To estimate the number of workers engaged in an industry, the average wage rate of the industry concerned was calculated from the ASI data for all years of the study. The average wage rate was estimated by dividing the total emolument of the industry by the number of workers in the industry. This average wage rate, obtained from the ASI data, was then used to divide the total wages and salary of each industry, in order to estimate the number of workers in the industry.

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

Table 1

Sources of Total Factor Productivity Change in Selected Indian Sugar Companies

Companies	TFPCH	EFFCH	TECHCH	PECH	SECH
Bajaj Hindusthan Sugar Ltd.	0.973	1.195	0.814	1.052	1.136
Balrampur Chini Mills Ltd.	1.000	1.255	0.796	1.059	1.185
Bannari Amman Sugars Ltd.	0.974	1.213	0.803	1.034	1.173
Dalmia Bharat Sugar & Inds. Ltd.	0.949	1.192	0.796	1.004	1.187
Dhampur Sugar Mills Ltd.	0.987	1.252	0.789	1.056	1.186
Dharani Sugars & Chemicals Ltd.	0.944	1.132	0.834	0.990	1.143
E I D-Parry (India) Ltd.	0.917	1.178	0.779	0.987	1.193
Gayatri Sugars Ltd.	0.951	1.152	0.825	1.036	1.112
Gobind Sugar Mills Ltd.	0.962	1.234	0.780	1.056	1.169
K C P Sugar & Inds. Corpn. Ltd.	0.927	1.214	0.763	1.002	1.212
K M Sugar Mills Ltd.	1.005	1.247	0.806	1.110	1.123
Kesar Enterprises Ltd.	0.920	1.211	0.759	1.019	1.188
Kothari Sugars & Chemicals Ltd.	0.987	1.217	0.811	1.044	1.166
Mawana Sugars Ltd.	0.948	1.217	0.779	1.018	1.195
Modi Industries Ltd.	0.975	1.269	0.768	1.060	1.197
Naraingarh Sugar Mills Ltd.	0.842	0.996	0.845	1.000	0.996
Oudh Sugar Mills Ltd. [Merged]	0.945	1.234	0.766	1.022	1.207
Parrys Sugar Inds. Ltd. [Merged]	0.923	1.110	0.832	1.010	1.099
Ponni Sugars (Erode) Ltd.	0.922	1.188	0.776	1.048	1.133
Prudential Sugar Corpn. Ltd.	0.858	1.060	0.809	1.133	0.936
Rajshree Sugars & Chemicals Ltd.	0.962	1.234	0.780	1.060	1.164
Rana Sugars Ltd.	0.957	1.189	0.806	1.053	1.128
Riga Sugar Co. Ltd.	0.948	1.215	0.780	1.061	1.145
S B E C Sugar Ltd.	1.051	1.291	0.814	1.189	1.086
Seksaria Biswan Sugar Factory Pvt. Ltd.	0.972	1.246	0.780	1.076	1.158
Shree Ambika Sugars Ltd.	0.975	1.174	0.831	1.023	1.148
Shree Renuka Sugars Ltd.	1.051	1.257	0.836	1.132	1.110
Sir Shadi Lal Enterprises Ltd.	0.930	1.218	0.764	1.023	1.191
Thiru Arooran Sugars Ltd.	0.937	1.150	0.815	0.982	1.171
Triveni Engineering & Inds. Ltd.	0.940	1.234	0.762	1.000	1.234
Ugar Sugar Works Ltd.	0.989	1.280	0.773	1.055	1.213
United Provinces Sugar Co. Ltd.	0.906	1.148	0.789	1.003	1.145
Uttam Sugar Mills Ltd.	0.786	0.996	0.789	0.996	1.000
Sugar Industry Mean	**0.947**	**1.192**	**0.795**	**1.041**	**1.144**
Source: CMIE: Centre for Monitoring Indian Economy PROWESS database. Note: All Malmquist index averages are geometric means.					

RESULTS AND DISCUSSION

ESTIMATES OF COMPANY MEANS OF TOTAL FACTOR PRODUCTIVITY GROWTH DURING THE STUDY PERIOD

Table 1 presents the estimation of Malmquist Productivity Index (MPI) for companies of Indian sugar industry. The given MPI is the geometric mean of the thirty three companies for the study period (2000 to 2016). The industry as a whole witnessed the deteriorated change in the productivity growth and this was due to negative growth of (-) 5.30 per cent during the study period.

Out of thirty three companies, three companies recorded productivity improvement while twenty nine companies recorded productivity deterioration and one company found that no change in productivity during the study period. The maximum productivity growth was found in Shree Renuka Sugars Limited and S B E C Sugar Limited at 5.10 per cent and it contributed efficiency change positively whereas technical change contributes negatively. Followed by K M Sugar Mills Limited productivity gain at 0.50 per cent and positively contributed efficiency change of 24.70 per cent and technology regress of -19.40 per cent during the period under review. It could be observed that these two companies' productivity gain was due to positive and high in efficiency change.

There twenty nine companies witnessed productivity deterioration during the period in the Indian sugar industry. In the case of Uttam Sugar Mills Limited it was observed that maximum productivity worsened at (-) 21.40 per cent due to the poor results in both efficiency change at (-) 0.40 per cent and (-) 21.10 per cent in technical change. There are three companies are the sole contributors of efficiency to the productivity gain. The result implies that these three companies' productivity improvement contributed to more than unity in efficiency change. It is also observed in the result of one company that there is no change in the productivity improvement during the period under review.

The change in the efficiency result was due to changes in both pure and scale efficiency. The technical efficiency deteriorated in 2 out of 33 companies as a result of 19.20 per cent in the industry average. This increasing trend was due to increasing of both scale efficiency change at 14.40 per cent and pure efficiency at 4.10 per cent. In the case of pure efficiency change there was more than unity in twenty three companies while thirty companies in scale efficiency change.

CONCLUSION

The inference made in the present study reveals that out of 33 companies 29 companies productivity declined whereas 3 companies evidenced productivity gain. On the whole the deteriorating productivity was due to technical regress at (-) 20.50 per cent along with positive efficiency change at 19.20 per cent in the Indian sugar industry. In other words the positive sign of efficiency along with negative sign of technology suggested that there is a declining in the total factor productivity growth.

REFERENCES:

1. 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.

2. Datturaya Shivaraj and Tumkunte Devidas (2018), "Growth and Performance of Indian Sugar industry: special reference to Karnataka Sugar Industry", International Journal of Current Trends in Science and Technology, Vol. 8, No. 01.

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. Ganeshgouda Patil I., Mahajanashetti S. B, and Patil Somanagouda I. (2016), "Performance of Sugar Industry in Major Sugar Producing States of India", International Journal of Agriculture Science, Vol 8, Iss. 61, pp. 3414-3417.

5. Patil.R.M (2011) "Liquidity Management: A case study of Godavari Bio-Refineries (GBR)", Southern Economist, Vol.50 No.2 pp.34-36.

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. 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.

8. https://www.alphainvesco.com/blog/indian-sugar-industry/
9. http://currentsciences.info/index.php/ctst/article/view/217
10. http://informaticsjournals.com/index.php/bims/article/view/16249/13595
11. https://economictimes.indiatimes.com/news/economy/agriculture/isma-has-lowered-indias-2018-19-sugar-production-estimate-by-11- 26/articleshow