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Assessing Efficiency Trends in the Indian Sugar Industry

S. P. Singh

Abstract**—**This paper measures technical and scale efficiencies of 40 Indian sugar companies for the period from 2004-05 to 2013-14. The efficiencies are estimated through input-oriented DEA models using one output variable—value of output (VOP) and five input variables—capital cost (CA), employee cost (EMP), raw material (RW), energy & fuel (E&F) and other manufacturing expenses (OME). The sugar companies are classified into integrated and non-integrated categories to know which one achieves higher level of efficiency. Sources of inefficiency in the industry are identified through decomposing the overall technical efficiency (TE) into pure technical efficiency (PTE) and scale efficiency (SE). The paper also estimates input-reduction targets for relatively inefficient companies and suggests measures to improve their efficiency level. The findings reveal that the TE does not evince any trend rather it shows fluctuations across years, largely due to erratic and cyclical pattern of sugar production. Further, technical inefficiency in the industry seems to be driven more by the managerial inefficiency than the scale inefficiency, which implies that TE can be improved through better conversion of inputs into output.

Keywords**—**Sugar industry, companies, technical efficiency, data envelopment analysis, targets.

I. Introduction

IN India, sugar is the second largest agro-based industry, after cotton textile. It plays a dominant role in the rural economy by way of supporting the livelihood of more than 50 million farmers and providing direct jobs to about 5 lakhs workers [19]. With its annual turnover of over Rs.41000 crore, it contributes more than Rs. 2500 crore per annum to the government in the form of taxes [7]. Several ancillary activities, such as production of ethanol, energy from cogeneration, potable and industrial alcohol, directly depend on it. Moreover, the industry is more eco-friendly as it fulfills its energy needs through generating electricity and steam from bagasse and has potential to generate surplus energy through cogeneration.

The industry is politically most sensitive and therefore has been subjected to a number of controls and regulations. These controls and regulations, including fixation of State Advised Prices (SAP) of sugarcane over and above the centrally determined Fair and Remunerative Price (FRP) would have adverse impact on the economics of the industry. Therefore, Government of India constituted several committees to ease the controls and liberalise the industry [16]-[18]. These committees made a number of recommendations to remove the industry's bottlenecks and improve its performance. The government accepted some of their recommendations and the industry was de-licensed in 1998 and subsequently partially de-controlled. However, even today, it faces a number of regulations, such as fixation of prices of sugarcane, control over supply of sugarcane and sugar by-products like molasses. It may be noted that performance of a company, among others, depends on how efficiently it uses its inputs in production and distribution processes. To survive in a competitive environment, it has to improve its performance not only relative to its own past performance but also relative to its competitors in the industry. Since, efficiency is a key indicator of performance; its assessment can help the sugar companies in setting benchmark for monitoring their progress. It is, in this context that this paper examines overall TE and its sources in the Indian sugar companies. Since, our data source (capitaline) does not include cooperative and government owned sugar mills; the study is confined only to the private sugar companies.

Rest of the paper is organized as follows: Next section presents a brief profile of the industry; section third overviews the relevant literature; data and methodology, including DEA models, are described in section four; empirical findings are discussed in section five, which is followed by conclusion in the last.

II. Status of the Indian Sugar Industry

Sugar is one the leading agro-based industries in India. It contributes about 17% to the global sugar production and stands second in the world, after Brazil [19]. Sugar is primarily produced in 10 states of India: Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Maharashtra, Punjab, Uttar Pradesh, Uttarakhand and Tamil Nadu. The industry is classified into two sectors—organised and unorganized. Sugar mills belong to the organized sector, while traditional sweeteners such as *gur* and *khandsari* come under the unorganized sector. This paper studies only the organized sector's sugar mills. The industry consists of 700 sugar mills, which are under different ownership and management structure. Cooperative sector comprises the highest number (324), closely followed by the private sector (314). However, out of total installed mills, 180 remained close during 2013-14 (Table I).

Table I shows that Maharashtra stands first in terms of number of sugar factories (227), followed by Uttar Pradesh (158) and Karnataka (73). Uttar Pradesh is the largest producer of sugarcane, but its substantial share goes to unorganized sector's units to produce *khandsari* and *gur.* Further, this state has more sugar mills under private

S. P. Singh is Professor of Economics with the Department of Humanities & Social Sciences, IIT Roorkee, India (e-mail: singhfhs@iitr.ac.in).

ownership, while in Maharashtra they are mostly under cooperative ownership. It is significant to note that during 2013-14 more than 25 per cent of sugar mills were remained closed. The sectoral composition of closed mills indicates that the percentage of such mills is highest in government sector (51.5%), followed by the cooperative (26.5%) and private (19.7%).

TABLE I
STATE-WISE NUMBER OF INSTALLED SUGAR FACTORIES IN INDIA (2013-14) [38]

State	Private	Public	Cooperative	Total
Maharashtra	59 (12)	0.0	168 (47)	227 (59)
Uttar Pradesh	97 (20)	33 (13)	28 (5)	158 (38)
Karnataka	46 (7)	3 (1)	24 (5)	73 (13)
Tamil Nadu	27 (3)	3 (1)	16 (0)	46 (4)
Andhra Pradesh	29 (5)	1(0)	14 (4)	44 (9)
Bihar	13 (4)	15 (13)	0	28 (17)
Gujarat	4 (0)	0	22 (7)	26 (7)
Punjab	8 (1)	0	16 (7)	24 (8)
Haryana	3 (0)	0	13 (2)	16 (2)
Uttarakhand	4 (1)	2	4	10 (1)
India	314 (62)	62 (32)	324 (86)	700 (180)

Note: Figures in parentheses are number of factories remained closed during 2013-14

Table II presents the status of the Indian sugar industry. During the last 21 years, area under sugarcane grew at a compound annual growth rate (CAGR) of 1.33% and as a result, it increased from 3.84 million hectares (Mha) in 1991-92 to 5.04 Mha in 2011-12. During the same period, sugarcane production has increased at the annual rate of 1.41%. It went up from 253.97 million tons (MT) in 1991-92 to 361.04 MT in 2013-14. Per hectare yield of sugarcane does not evince any growth; it actually fluctuates across years. This indicates that increase in sugarcane production is mainly due to increase in area under its cultivation.

Number of sugar mills in operation has increased from 392 in 1991-92 to 529 in 2011-12, thus recording an annual growth rate of 1.48%. The percentage share of sugarcane crashed by sugar mills increased at the annual rate of 1.91%. Sugar production recorded impressive growth rate of 3.53% per annum and hence, the production doubled from 13.40 MT in 1991-92 to 26.34 MT in 2013-14. There may be three factors behind this remarkable growth—increase in area under sugarcane, rise in the percentage share of sugarcane crashed by mills and improvement in sugar recovery. During this period, sugar recovery increased at an annual rate of 0.17%. However, main challenge is how to increase per hectare yield of sugarcane, which does not achieve any growth during the period.

Difference between sugarcane prices fixed by the government for sugar mills and the prices prevailing in the open market is one of the main concerns of the industry. Whenever open market prices are higher than the prices fixed by the government, farmers would prefer to sell their produce in the open market and sugar mills get less quantity to be processed. Similarly, when open market prices are lower than the government fixed prices, farmers would like to supply more quantity to sugar mills. This is the reason why percentage of sugarcane crashed by the mills varies substantially across years, ranging from 42.82% to 78.55%. Average crushing duration also varies significantly across years. Erratic supply of sugarcane and high variation in the crushing duration seem to be the major problems.

TABLE II
STATUS OF THE INDIAN SUGAR INDUSTRY [38]

Year	Area under Sugarcane (Mha)	Sugarcane Production (MT)	Yield (T/ha)	No. of Sugar Mills	Cane crashed as % of Cane Production	Sugar Production (MT)	Average crushing duration (days)	Recovery (%)
1991-92	3.84	253.97	66.07	392	52.76	13.40	173	10.02
1992-93	3.57	228.03	63.84	393	45.17	10.61	123	10.31
1993-94	3.42	229.66	67.11	394	42.82	9.83	111	10.00
1994-95	3.87	275.54	71.25	408	53.58	14.64	159	9.92
1995-96	4.15	281.10	67.78	416	62.16	16.45	181	9.42
1996-97	4.17	277.56	66.50	412	46.97	12.91	130	9.9
1997-98	3.93	279.54	71.13	400	46.22	12.86	123	9.95
1998-99	4.06	288.72	71.20	426	54.57	15.54	141	9.87
1999-00	4.22	299.32	70.93	423	59.64	18.20	152	10.2
2000-01	4.32	295.96	68.57	436	59.69	18.51	139	10.48
2001-02	4.41	297.21	67.36	434	60.67	18.53	140	10.27
2002-03	4.52	287.38	63.58	453	67.62	20.14	141	10.36
2003-04	3.94	233.86	59.39	423	56.66	13.55	100	10.22
2004-05	3.66	237.09	64.76	400	52.63	12.69	96	10.17
2005-06	4.20	281.17	66.91	453	67.10	19.27	126	10.22
2006-07	5.15	355.52	69.02	504	78.55	28.36	174	10.17
2007-08	5.06	348.19	68.88	516	71.77	26.36	149	10.55
2008-09	4.42	285.03	64.56	488	50.86	14.54	87	10.03
2009-10	4.18	292.30	70.01	490	63.48	18.91	108	10.2
2010-11	4.89	342.38	70.07	527	70.04	24.39	136	10.17
2011-12	5.04	361.04	71.66	529	71.18	26.34	137	10.25
CAGR (%)	1.33*	1.41*	0.081	1.48*	1.91*	3.53*	-0.96	0.17**

Note: * and ** significant at 1% and 5% level of significance, respectively

Fig. 1 reveals that the industry experiences a cyclical pattern in sugar production. In recent years, sugar prices are determined by the market forces, largely influenced by the global market, while prices of sugarcane are still fixed by the government. This creates sugar cycle in the industry. The 2-3 year sugar cycle, observed in the industry mainly due to lack of alignment between prices of sugarcane and recovered prices of sugar, leads to sugarcane arrears and indebtedness among sugar mills. The sugar cycle raises the inventory level of sugar output and as a result, arrears of sugarcane payments to the farmers. Consequently, some farmers shift to other crops, creating sugarcane shortages to the industry in next year. In both the cases, the industry suffers due to the erratic supply of sugarcane.

Table III demonstrates that out of 40 sugar companies that we have studied, 26 were found running in losses in 2013-14. The number of loss making companies varies considerably across years. Fluctuations in market prices of sugar and constant rise in the sugarcane prices generally lead to economic crisis in the industry. It is observed that average profit per company was highest in 2008-09, followed by 2005-06 and 2004-05. The industry incurred heavy losses in 2013-14, followed by 2011-12. It may be noted that first two years of the study period have been quite good for the industry, as out of 40 companies, 38 to 39 have generated profit.

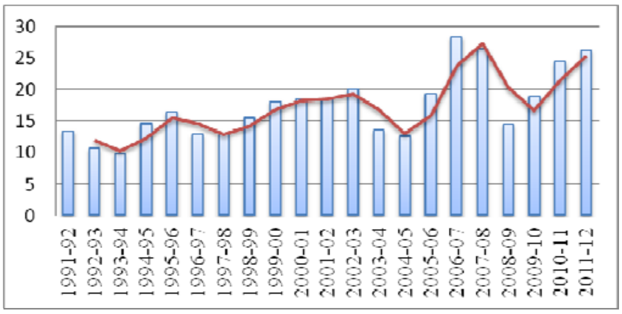

Fig. 1 Cyclicality in sugar production (million tons)

TABLE III
PROFITABILITY IN THE INDIAN SUGAR COMPANIES (2004-05 TO 2013-14)

Year	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Av. Profit before Tax (Rs. Lakhs at 2004-05 prices)	39.30	56.96	16.85	5.58	60.61	38.34	18.37	-2.66	29.28	-48.30
No. of companies earning profit	38	39	26	18	34	32	28	23	31	14
No. of Companies running in loss	2	1	14	22	6	8	12	17	9	26
Total Companies	40	40	40	40	40	40	40	40	40	40

Source: Author’s estimation based on capitaline data

A. Controls and Regulations in the Industry

Studies show that trade distorted policies and widespread interventions and controls have created an inefficient pattern of world production, consumption and trade of sugar [6]; [11]; [13]; [24]; [27]. India also followed the policies of regulations and controls to protect the competing interest of consumers, farmers and sugar mills. The state interventions comprised fixation of minimum statutory price of sugarcane, levy quota of sugar, quota of free sale sugar, reservation of sugarcane area for each sugar mill, packing of sugar in jute bags, control over the prices and supply of by-products, such as, molasses. Since 1951, government policies related to sugar control and decontrol changed several times [28]. In 1967, the government introduced policy of partial decontrol and 60 per cent of total sugar production was fixed as levy for sugar mills and remaining 40 per cent as free-sale in the open market [1]. During the last two decades, levy sugar quota has gradually reduced to 10 percent and finally abolished in 2013.

On the recommendations of the Rangarajan Committee [18], in April 2013, control on the sales of sugar was removed and now sugar mills are free to supply sugar at the market determined prices. However, the industry still faces several regulations, including fixation of prices of sugarcane, control over supply of sugarcane and sugar by-products like molasses. The government did not accept the Rangarajan Committee’s recommendation to fix sugarcane prices at 75% of value of sugar produced from one quintal of sugarcane or 70% of the sales revenue for sugar, molasses, bagasse and press-mud produced from a quintal of sugarcane. The major problem in its implementation seems to be that sugar prices are determined by the market mechanism, while prices of sugarcane are fixed by the government. If prices of sugarcane are linked with the revenue realised by the industry, then sugarcane prices should also be linked to the farm input prices, which do not have a cyclical pattern. Another problem is related to the state control over sugar's by-products like molasses, which limits the mills to optimize their utilization. Since sugar is regulated both at the central and the state levels; it is usually subjected to policy conflicts, arising due to different perspectives of the two governments. For example, the central government announces FRP for sugarcane, but some state governments fix SAP over and above FRP, and regulate prices and supply by-products such as molasses. In fact, SAP has become the main source of rent-seeking by the politicians in power.

The Government of India also set up Sugar Development Fund (SDF) with the purpose to promote R&D, maintain buffer-stocks of sugar, provide transportation subsidies for sugar exports, and soft loan for ethanol production and rehabilitation and modernisation of sugar mills. The government collects Rs. 240 per ton of sugar production from the mills as contribution towards this fund [15]. These policy changes along with diversification of activities of the industry ranging from production of sugar to ethanol, cogeneration, bio-gas, bio-plastics and carbon credits are expected to improve its economic condition. There is increasing demand from the farmers and the mill owners for allowing the sugar mills to have an option to directly produce ethanol from sugarcane juices, as is being done in Brazil. This demand is not yet accepted, probably due to its several implications, including its effect on food security. Thus, the policy-induced factors, such as de-licensing and decontrol, incentives for setting up new sugar and cogeneration plants and expansion of the existing plants, etc. would not only help sugar mills to expand their production capacity and achieve economies of scale but also motivate them to diversify their activities. However, key issue is related to the supply-side. There is a limited scope of bringing more land and water resources under sugarcane cultivation as they are scarce and have competitive uses. Therefore, the SDF can be used to support sugarcane R&D and extension activities along with efficient irrigation technology so that sugarcane productivity per unit of land and water may be enhanced.

III. Overview of Literature

Sugar industry has considerable attention from policy makers, trade analysts, researchers and political economists. Hence, a huge literature is available on its various aspects. Most of the initial studies were concentrated on: productivity, factor substitution, and returns to scale [12]; [25]; [35]; [10]; government policies of protection, controls and regulations [22]; [21]; [24]; [6]; [26]; [28]; [13]; [36]; and political economy of sugar [4]; [29]; [5]; [2]; [20]; [37]. Most of these studies argue that sugar industry was subjected to a number of regulations and controls, which were made to protect the interest of several competing stakeholders, including industry, farmers and consumers. Farmers and sugar mills represented influential pressure groups, who tried to influence the policy making. Politicians representing farmers used their agrarian political base to seek rent. High level of protection, controls and regulations were supposed to have negative effect on the industry and reduce the consumer's welfare. Recent studies examine capacity utilization, efficiency and total factor productivity (TFP) in the sugar industry [14]; [30]-[34]; [23]; [1]. These studies use input-output data, measure TE and TFP and identify their sources. A few of them also apply censored regression analysis to identify the impact of various background/environmental variables on the efficiency. Most of them argue that inefficient sugar units (companies) may improve their efficiency level through efficient conversion of inputs into output(s) and adjusting their scale of operations to the optimum level. The above citations indicate that there is no dearth of studies on the theme. However, earlier studies are either production function based or examine political economy aspects related to the regulations and controls. More recent studies [1]; [24]; [33]; [35] use DEA approach to measure TE and TFP. The present study also applies DEA to measure the TE and its sources. However, it takes all inputs and output as flow variables, unlike some previous studies [24]; [34]; [35] that take capital and labour as stock variables. Since sugar output is flow, it is justified to consider flow inputs to measure TE. Moreover, as the industry has undergone significant policy changes in the recent years (such as removal of sugar levy, introduction of FRP, removal of restriction on sugar release in the open market, amendment in the SDF Act, etc.); inclusion of latest years' data in the analysis would help to understand how these changes may affect the performance of the industry.

IV. Methodology

This paper applies DEA, a nonparametric approach, to measure the technical and scale efficiencies of individual sugar companies. The data for the study comes from capitaline database built by Capital Market India Pvt Ltd, Mumbai. Out of total 119 sugar companies in the database, 40 companies, for which data are consistently available for a period of 10 years from 2004-05 to 2013-2014, have been considered for the study. List of these companies is given in Appendix Table IX.

In order to identify which group of companies is more efficient, the select companies are classified into two groups—integrated and non-integrated. To measure efficiency, we consider VOP as output variable and CA, EMP, RW, E&F and OME as input variables. To neutralize the inflation factor, values of all output-input variables are converted from current prices to constant 2004-05 prices.

VOP refers to the value of sugar produced by a company during a financial year. CA includes mainly the cost of fixed capital consumption (depreciation) and interest payment by a company. EMP comprises wages and salaries paid to the employees. RW represents cost of sugarcane purchased by the company and other raw materials used in the sugar manufacturing. E&F includes value of all items of fuels, lubricants, electricity, gasoline, water, etc. used. OME comprises all other operating expenses. Average descriptive statistics of these variables are presented in Table IV. A perusal of the table shows that sugar companies in India vary in their size as reflected by the minimum and maximum values of variables and their coefficient of variation.

TABLE IV
Average Summary Statistics of Output-Input Variables (2004-05 to 2013-14) (Rs. Crore at 2004-05 Prices)

Statistics	VOP	CA	EMP	RW	E&F	OME
Mean	519.54	54.58	24.83	364.17	17.40	31.15
SD	749.90	87.79	26.16	592.72	38.93	29.73
CV	144.34	160.85	105.36	162.76	223.74	95.44
Min	7.97	1.37	0.47	2.35	0.08	2.09
Max	8707.32	678.32	134.91	6968.50	334.22	149.86

Source: Author's calculation based on Capitaline Data.

A. Description of DEA Models Applied in the Study

DEA is applied to assess the performance of sugar companies. We prefer to apply it as it can handle multiple inputs and outputs; it does not require prior weights (as in index numbers); it emphasizes on individual observations rather than statistical estimates (as in regression analysis); and it is a dynamic analytical decision-making tool that not only provides relative efficiency score of a firm, but also sets benchmark for improving its efficiency [9]; [33]. However, it also has several limitations and therefore, some precautions are required to be taken before its application. For instance, number of observations should be at least three times greater than the sum of input and output variables; the variables should be correctly identified; and data scaling should be done [9]. The DEA efficiency scores are sensitive to outliers, input-output specification and the sample size. Moreover, since it measures the relative efficiency, comparison of a company outside the reference set cannot be made.

DEA was initially developed by Charnes, Cooper and Rhodes [8] in 1978 (CCR model) and further extended by Banker, Charnes, and Cooper [3] in 1984 (BCC model). It defines TE for any DMU as a weighted sum of outputs divided by a weighted sum of inputs, where all the TE scores are restricted to remain between zero and one. If value of TE score of a company is one, it is relatively efficient and if it is less than one, the company is relatively inefficient. Variables in the DEA model are input-output weights and the linear programming (LP) solution produces the weights most favourable to the unit under reference.

The CCR model is based on the assumption of constant returns to scale (CRS); whereas BCC assumes variable returns to scale (VRS). The CCR model measures overall TE; while the BCC model estimates PTE. If TE is equal to PTE of a company, it is said to operate at the most productive scale size (MPSS). To estimate efficiency scores, one can use either input orientation or output orientation of these models. In input-orientation, inputs are minimised with the given level of output(s); while in output orientation, output is maximised with the given level of inputs. In this study, we apply input-oriented DEA models. First we estimate TE of individual sugar companies through CCR model and then TE is decomposed into PTE and SE through BCC model to know whether technical inefficiency in a company is due to inefficient conversion of inputs into outputs or due to its disadvantageous scale-size. LP formulations of these models are presented as follows:

1. CCR Model

This model generalises the usual input/output ratio measure of efficiency for a given firm in terms of a fractional linear program formulation. Mathematically, the relative efficiency of the k^{th} DMU is given by:

$$\text{Max } h_k = \frac{\sum_{r=1}^{s} u_{rk} y_{rk}}{\sum_{i=1}^{m} v_{ik} x_{ik}}$$

Subjected to:

$$\frac{\sum_{r=1}^{s} u_{rk} y_{rj}}{\sum_{i=1}^{m} v_{ik} x_{ij}} \leq 1 \quad \forall\, j = 1\ldots.\, k\ldots.\, n$$

$$u_{rk} \geq \varepsilon \quad \forall\, r = 1\ldots\ldots s$$

$$v_{ik} \geq \varepsilon \quad \forall\, i = 1\ldots\ldots.m$$

where: y_{rk} = the amount of the r^{th} output produced by the k^{th} DMU; x_{ik} = the amount of the i^{th} input used by the k^{th} DMU; u_{rk} = the weight given to the r^{th} output of the k^{th} DMU; v_{ik} = the weight given to the i^{th} input of the k^{th} DMU; n= no. of DMUs ; s= no. of outputs; m= no. of inputs; and ε = a non-Archimedean (infinitesimal) constant

$$\text{Max } w_k = \sum_{r=1}^{s} \mu_{rk} y_{rk}$$

Subjected to

$$\sum_{i=1}^{m} v_{ik} x_{xk} = 1$$

$$\sum_{r=1}^{s} \mu_{rk} y_{rj} - \sum_{i=1}^{m} v_{ik} x_{ij} \leq 0 \qquad \forall j = 1\ldots\ldots n$$

$$\mu_{rk} \geq \varepsilon \qquad \forall r = 1\ldots\ldots s$$

$$v_{ik} \geq \varepsilon \qquad \forall i = 1\ldots\ldots.m$$

Since number of DMUs is generally larger than total number of inputs and outputs, solving the dual of the model can reduce computational burden. Mathematically, dual formulation of the above model is:

$$\text{Min } z_k = \theta_k - \varepsilon \sum_{r=1}^{s} S_{rk}^{+} - \varepsilon \sum_{i=1}^{m} S_{ik}^{-}$$

Subjected to

$$\sum_{j=1}^{n} \lambda_{jk} y_{rj} - S_{rk}^{+} = y_{rk} \qquad \forall r = 1\ldots\ldots\ldots.s$$

$$\sum_{j=1}^{n} \lambda_{jk} x_{ij} + S_{ik}^{-} = \theta_k x_{ik} \qquad \forall i = 1\ldots\ldots\ldots m$$

$$\lambda_{jk} \geq 0 \qquad \forall j = 1\ldots\ldots\ldots n$$

$$\theta_k \quad free$$

$$S_{rk}^{+}, S_{ik}^{-} \geq 0\ ; r = 1\ldots.. s, i = 1\ldots\ldots m$$

where: S_{rk}^{+} = slacks in the i^{th} input of the k^{th} DMU; S_{ik}^{-} = slacks in the r^{th} output of the k^{th} DMU; λ_{jk} 's = non-negative dual variables; θ_k (scalar) is the (proportional) reduction applied to all inputs of DMU $_k$ to improve efficiency. A DMU k will be Pareto optimal only when θ_k^* =1 and its all input-output slacks are zero. The non-zero slacks and (or) $\theta_k^* \leq 1$ show the sources and amount of any inefficiency in the DMU under reference.

2. BCC Model

The primary difference between BCC and CCR models is the convexity constraint. In the BCC model λ_{jk} s are restricted to summing to one (i.e. $\sum_{j=1}^{n} \lambda_{jk}$ =1). The TE measured by the CCR model includes the effects of both SE and PTE. The BCC model measures the PTE net of scale effect. It captures the pure resource-conversion efficiency, irrespective of whether a company operates at increasing, decreasing or constant returns to scale. SE of a company is calculated dividing TE by PTE. As PTE is more than or equal to the TE, value of SE will always be less than or equal to one.

V. Empirical Findings

A. Trends in Overall TE

Table V presents the summary statistics of TE for the last 10 years. The mean value indicates that it ranges from 0.927 in 2004-05 to 0.964 in 2011-12 and 2013-14. Average TE score 0.964 for the year 2013-14 suggests that average sugar company in this year can make redial reduction in its inputs by 3.6 per cent with the given level of output under CRS technology assumption. Average TE does not evince any trend; it fluctuates across years. During the first three years, it rises from 0.927 to 0.957 and thereafter it declines for the two consecutive years and then remains stagnant during 2009-10 and 2010-11. It shows rise and fall during the last three years. Years 2011-12 and 2013-14 show the highest TE scores among all the years. As far as number of sugar companies on the frontier is concerned, the table reveals that number of such companies is highest (22) in 2006-07, followed by 2004-05 and 2011-12 (19 in each). The number is found lowest in 2007-08 (13), followed by 2008-09 (15).

TABLE V
AVERAGE SUMMARY STATISTICS OF TE IN THE SUGAR COMPANIES (2004-05-2013-14)

Stat	*2004-05*	*2005-06*	*2006-07*	*2007-08*	*2008-09*	*2009-10*	*2010-11*	*2011-12*	*2012-13*	*2013-14*	*Av*
Mean	0.927	0.945	0.957	0.934	0.931	0.931	0.931	0.964	0.959	0.964	0.943
SD	0.091	0.064	0.062	0.073	0.075	0.077	0.077	0.051	0.053	0.044	0.045
C OV	9.82	6.77	6.48	7.82	8.06	8.27	8.27	5.29	5.53	4.56	4.77
Min	0.660	0.731	0.807	0.707	0.720	0.765	0.765	0.799	0.798	0.851	0.837
Max	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.0
No. of Eff. Firms	18	16	20	13	15	16	16	19	16	15	4
Count	40	40	40	40	40	40	40	40	40	40	40

Source: Author's estimation

Since, sugar companies are largely affected by the erratic supply of sugarcane, which depends on a number of factors, including monsoon, prices of sugarcane vis-à-vis other competing crops, and sugarcane arrears, etc., this creates cyclical pattern in sugarcane and sugar production, and consequently affects the TE scores. A comparative look at the year-wise average values of TE and their coefficient of variation (COV) indicates that COV is inversely related to the average values of TE (correlation coeff.= -0.96). This implies that variations in the TE scores across sugar companies affect the overall performance of the industry. The average TE scores are relatively lower in those years in which the magnitudes of COV are relatively higher.

Company-wise trends in TE are shown in Appendix Table X. If we look at the overall performance of the sugar companies for the entire study period, we observe that out of 40 companies only four (F2, F21, F24, and F34) have consistently remained on the frontier throughout the period. Next to these companies are F3, F29, F4 F25, F7, F14, F13, F28, F33 and F9, which also remain on the frontier during most of the years. The relatively poor performers in terms of TE scores are F26, F20, F16, F17, F30, F10, F37, F32, F36 and F27. Average TE scores of these companies for the entire period are less than 90 per cent and they remain below the frontier during most of the years. Overall, F26 has the lowest TE (0.85), followed by F20 (0.87) and F16 (0.88). Lower the efficiency of a company, higher is the scope for reduction in its inputs (while maintaining the levels of outputs) relative to the best practice companies that are used as benchmark to assess its efficiency. Inefficient companies can follow best practices of their peers to improve TE.

B. Sources of TE

In order to know whether inefficiency in a company is due to inefficient use of inputs or due to its disadvantages scale-size, TE is decomposed into PTE and SE using BCC model. Table VI shows that average SE (0.978) is higher than the average PTE (0.964) for the entire period. This implies that overall technical inefficiency in the industry is more due to inefficient conversion of inputs into output rather than due to disadvantageous scale size of an average company. Looking at the year-wise average PTE, we find that it ranges from 0.949 to 0.975. It also shows the pattern similar to that of the average TE. It initially rises during the first three years and then consecutively falls for the next three years and thereafter shows rise and fall. It is observed that the number of companies on the VRS frontier is highest in 2006-07, followed by 2004-05 and 2005-06. On an average, 8 out of 40 companies were able to achieve 100 per cent PTE continuously during the entire study period. There companies are F2, F21, F24, F25, F28, F29, F30 and F34.

Trend in average SE is also shown in Table VI. On an average, the industry achieves 97.8 per cent SE during the entire period. This indicates that relative contribution of SE to the TE is higher than that of PTE. Year-wise average SE presented in the table reveal that it is highest in 2013-14 (0.992) and lowest in 2004-05 (0.957). A perusal of year-wise pattern of PTE and SE reveals that these two sources of TE are not highly correlated to each other, though the correlation coefficient is positive (0.13). However, correlation of PTE with TE is higher (0.786) than the correlation of SE with TE (0.713). This indicates that variation in the PTE scores across companies has more impact on TE than that in SE. Since average SE is higher than average PTE, it can be concluded that inefficiency in the industry is more due to managerial inefficiency rather than disadvantageous scale-size.

TABLE VI
AVERAGE SUMMARY STATISTICS OF PTE AND SE IN THE SUGAR COMPANIES (2004-05-2013-14)

Stat	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	Av
PTE											
Mean	0.968	0.971	0.975	0.963	0.952	0.949	0.949	0.975	0.975	0.972	0.964
SD	0.057	0.056	0.047	0.056	0.067	0.074	0.074	0.043	0.046	0.043	0.042
C OV	5.93	5.74	4.77	5.77	7.07	7.74	7.74	4.44	4.71	4.45	4.37
Min	0.768	0.744	0.847	0.717	0.722	0.791	0.791	0.801	0.802	0.855	0.854
Max	1	1	1	1	1	1	1	1	1	1	1
No. of Eff. Firms	27	27	29	20	20	20	20	25	22	22	8
Count	40	40	40	40	40	40	40	40	40	40	40
SE											
Mean	0.957	0.973	0.982	0.970	0.978	0.981	0.981	0.988	0.984	0.992	0.978
SD	0.073	0.041	0.028	0.059	0.042	0.029	0.029	0.024	0.031	0.015	0.026
C OV	7.57	4.24	2.85	6.09	4.33	2.92	2.92	2.45	3.16	1.51	2.65
Min	0.694	0.850	0.917	0.707	0.854	0.878	0.878	0.904	0.851	0.932	0.879
Max	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
No. of Eff. Firms	18	16	20	16	16	16	16	20	17	19	6
Count	40	40	40	40	40	40	40	40	40	40	40

It may also be noted that on an average, only four companies (F2, F21, F24 and F34) have the value of these three efficiencies equal to one (TE=PTE=SE =1). These companies are operating at MPSS. Some companies achieve 100 per cent PTE (for example F25, F28, F29, F30), but they are overall inefficient because of their disadvantageous scale-size (their size may be either too big or too small to the optimum size). They can become efficient by readjusting their size to the optimum level. Similarly, there are a few companies which have continuously achieved 100 SE throughout the study period, but they are inefficient due to their managerial inefficiency (for example, F3, F4).

Fig. 2 shows year-wise percentage of companies operating under three different returns to scale. It depicts that percentage of companies operating at CRS varies from 37.5 to 50, while percentage of those operating at DRS ranges from 12.5 to 35. Similarly, percentage of those operating at VRS varies from 15 to 37.5. It shows cyclical pattern of companies operating at different returns to scale, which seems to be due to fluctuations in supply of raw materials to the sugar companies across years.

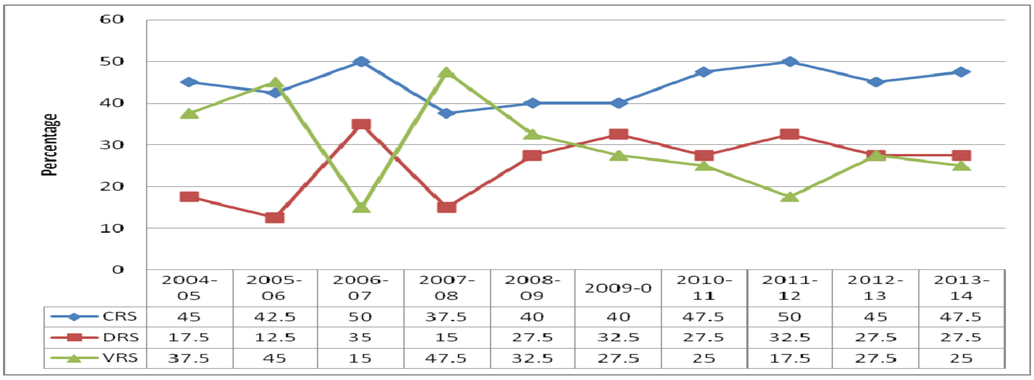

Fig. 2 Year-wise Percentage Distribution of Sugar Companies Operating under Different RTS

C. Efficiency Differences between Integrated and Non-Integrated Companies

To know efficiency differences between integrated and non-integrated sugar companies, we estimate year-wise average TE, PTE and SE for these two groups of companies. Integrated companies include cogeneration and distillery units along with sugar, while non-integrated include sugar only. Table VII shows that on an average, integrated companies achieve slightly higher TE (0.945) than non-integrated ones (0.937). It is interesting to note that up to 2010-11, performance of integrated companies in terms of TE has been better than their counterparts. However, during the last three years, performance of the non-integrated companies improves and becomes slightly better than that of the integrated ones.

TABLE VII
EFFICIENCY COMPARISON OF INTEGRATED AND NON-INTEGRATED COMPANIES (2004-05 TO 2013-14)

Year	TE			PTE			SE		
	Integrated	Non-integrated	Total	Integrated	Non-integrated	Total	Integrated	Non-integrated	Total
2004-05	0.934	0.909	0.927	0.955	0.981	0.968	0.978	0.927	0.957
	(40.9)	(50.0)	(47.5)	(59.9)	(77.8)	(67.5)	(40.9)	(50.0)	(45.0)
2005-06	0.945	0.940	0.945	0.962	0.979	0.971	0.982	0.960	0.972
	(45.5)	(33.3)	(40.0)	(59.9)	(77.8)	(67.5)	(45.5)	(33.3)	(40.0)
2006-07	0.962	0.947	0.957	0.981	0.965	0.975	0.981	0.982	0.982
	(54.5)	(44.4)	(55.0)	(81.8)	(61.1)	(72.5)	(54.5)	(44.4)	(50.0)
2007-08	0.948	0.910	0.934	0.967	0.954	0.963	0.981	0.954	0.970
	(36.4)	(27.8)	(32.5)	(45.5)	(55.6)	(50.0)	(45.5)	(33.3)	(40.0)
2008-09	0.938	0.915	0.931	0.952	0.945	0.952	0.985	0.968	0.978
	(36.4)	(38.9)	(37.5)	(50.0)	(50.0)	(50.0)	(40.9)	(38.9)	(40.0)
2009-10	0.931	0.924	0.931	0.945	0.948	0.949	0.984	0.975	0.981
	(40.9)	(38.9)	(40.0)	(45.5)	(55.6)	(50.0)	(40.9)	(38.9)	(40.0)
2010-11	0.931	0.924	0.931	0.945	0.948	0.949	0.984	0.975	0.981
	(40.9)	(38.9)	(32.5)	(45.5)	(55.6)	(50.0)	(40.9)	(38.9)	(40.0)
2011-12	0.962	0.963	0.964	0.973	0.975	0.975	0.989	0.988	0.989
	(45.5)	(50.0)	(47.5)	(68.2)	(55.6)	(62.5)	(45.5)	(55.6)	(50.0)
2012-13	0.952	0.963	0.959	0.969	0.980	0.975	0.983	0.983	0.984
	(31.8)	(50.0)	(42.5)	(45.5)	(66.7)	(55.0)	(36.4)	(50.0)	(42.5)
2013-14	0.953	0.976	0.964	0.964	0.980	0.972	0.989	0.996	0.992
	(31.8)	(44.4)	(40.0)	(59.1)	(50.0)	(55.0)	(36.4)	(61.1)	(47.5)
Average	0.945	0.937	0.944	0.961	0.965	0.965	0.983	0.971	0.978

Note: Figures in parentheses are percentages of efficient firms in each year.

Average PTE is estimated to be slightly lower for the integrated (0.961) than the non-integrated companies (0.965). The year-wise scores indicate that except for three consecutive years (2006-07 to 2008-09), in all the years, PTE is observed higher for non-integrated companies. Contrary to this, average SE is found higher in integrated (0.983) than non-integrated (0.971) companies. However, in some years, SE in non-integrated companies is either equal or slightly higher than that in the integrated companies. It can be inferred from the analysis that on an average, higher TE in the integrated companies is mainly due to SE as their PTE scores are lower than that in the non-integrated companies.

D. Targets for Inefficient Companies

A sugar company can be Pareto efficient only when its TE is equal to one and all inputs and outputs slacks are zero. As we apply input-oriented model, slacks are only observed in inputs. On the basis of TE score (θ) and slacks, we can identify the targeted value of inputs for an inefficient sugar company by:

$$\left.\begin{aligned} \overline{x_i} &= \theta x_i - S_i^- = X\lambda \\ \overline{y_i} &= y_i + S_i^+ = Y\lambda \end{aligned}\right\}$$

where: $\overline{x_i}$ and $\overline{y_i}$ are the target inputs and outputs for ith company; x_i = actual inputs of ith company; yi = actual outputs of ith company; θ = optimal efficiency score of ith company S_i^- = optimal input slacks of ith company; and S_i^+ = optimal output slacks of ith company. The input-output level ($\overline{x_i}$, $\overline{y_i}$) are the coordinates of the efficient frontier used as a benchmark for evaluating ith company. Table VIII shows actual and targeted values of all inputs along with percentage reduction in them under CRS technology assumption for the period from 2004-05 to 2013-14.

It is obvious that on average, 27.87 per cent of CA, 14.66 per cent of EMP, 8.86 per cent of RW, 14.57 per cent of energy & fuel and 13.19 per cent of OME could be reduced to produce the given output if an average inefficient company were to operate at the level of efficient companies. However, there is significant variation in the reduction requirement of various inputs across years. The highest reduction in CA is required in 2009-10 (39.96%), followed by 2012-13 (37.59%) and 2011-12 (34.11). The reduction requirement is observed lowest in 2010-11. In case of EMP, average reduction requirement is 14.66 per cent. The percentage of reduction in it is as low as 6.68 in 2013-14 and as high as 33.66 in 2007-08. Relatively, RW requires least reduction, while CA needs the highest. Looking at the individual inputs, it is observed that CA is grossly underutilized in most of the inefficient companies.

TABLE VIII
ACTUAL AND TARGETED VALUES OF INPUTS OF AN AVERAGE INEFFICIENT SUGAR COMPANY

Year	CA		EMP		RW		E&F		OME	
	Actual	Target	Actual	Target	Actual	Target	Actual	Target	Actual	Target
2004-05	21.25	16.72 (21.31)	12.72	10.39 (18.35)	140.66	123.15 (12.45)	9.62	6.24 (35.11)	19.55	14.02 (28.27)
2005-06	23.54	20.57 (12.63)	16.37	14.03 (14.28)	203.73	182.30 (10.52)	11.24	9.79 (12.91)	23.87	19.94 (16.44)
2006-07	47.31	35.99 (23.94)	28.14	23.37 (16.96)	317.33	290.35 (8.50)	12.71	12.08 (4.98)	41.44	34.54 (16.65)
2007-08	55.20	37.11 (32.77)	24.44	16.21 (33.66)	236.98	215.51 (9.06)	15.34	13.08 (14.73)	32.91	28.80 (12.49)
2008-09	43.07	34.13 (20.76)	23.23	19.55 (15.83)	193.02	173.89 (9.51)	11.70	9.99 (14.60)	26.07	20.64 (20.84)
2009-10	70.70	42.45 (39.96)	30.60	24.88 (18.69)	465.56	411.77 (11.55)	14.78	12.42 (15.92)	34.40	29.15 (15.27)
2010-11	81.17	77.46 (4.56)	30.15	26.57 (11.89)	466.77	441.12 (5.49)	14.03	12.71 (9.44)	32.37	29.88 (7.70)
2011-12	85.05	56.04 (34.11)	30.97	28.45 (8.16)	435.77	408.63 (6.23)	13.59	12.08 (11.14)	35.05	32.27 (7.94)
2012-13	80.06	49.96 (37.59)	30.38	27.91 (8.12)	489.31	452.20 (7.58)	10.53	8.39 (20.33)	36.49	33.53 (8.11)
2013-14	77.28	51.29 (33.63)	29.72	27.74 (6.68)	436.37	411.08 (5.80)	12.05	10.51 (12.74)	33.39	31.15 (6.71)
Average	58.46	42.17 (27.87)	25.67	21.91 (14.66)	338.55	311.00 (8.86)	12.56	10.73 (14.57)	31.55	27.39 (13.19)

Note: Figures in parentheses are percentage reduction in respective inputs

It may be noted that all inputs are not freely disposable and therefore it can become difficult for the management to reduce such inputs. For example, labour cannot be reduced to the level of targeted values because there are government policies regarding retrenchment of manpower. However, in recent years, ratio of contract workers to the total workers has increased in Indian industries. The companies have more flexibility in employing such workers. Directly employed regular workers cannot be easily retrenched but contract workforce may be readjusted.

VI. CONCLUSION

This paper studies status of the Indian sugar industry and assesses trends in its technical and scale efficiencies for the period from 2004-05 to 2013-14. The study is mainly based on the unit level data of 40 private sugar companies. Input-oriented DEA models are applied to estimate the efficiencies. Sources of efficiency are also identified by decomposing TE PTE and SE. Average TE in the industry is estimated to be 0.94, which implies that an average sugar company can become efficient if it reduces its existing inputs by 6 per cent. Further, on an average, SE is slightly higher (0.978) than the PTE (0.965), indicating that TE can be increased by making better utilization of inputs, especially capital input, which observes slacks in most of the inefficient companies. We also find that on an average, integrated companies achieve relatively higher TE than the non-integrated ones, mainly due to their higher SE. Targets set for the inefficient companies suggest that they can become efficient if they adjust their inputs to the associated target point determined by the efficient companies in their reference set. Further, there is a need to rationalize the sugarcane price policy and improve sugarcane productivity and water-use efficiency by using the SDF to promote sugarcane R&D and efficient irrigation technology and practices. Diversification of activities of the industry and its vertical integration with sugarcane farmers may help to improve their efficiency and profitability.

APPENDIX

TABLE IX
LIST OF SUGAR COMPANIES WITH THEIR CODES

Name of the Company	Code	Name of the Company	Code
Bajaj Hindusthan Sugar Ltd	F1	Ugar Sugar Works Ltd	F21
Balrampur Chini Mills Ltd	F2	Gayatri Sugars Ltd	F22
Bannari Amman Sugars Ltd	F3	Indian Sucrose Ltd	F23
Dalmia Bharat Sugar & Industries Ltd	F4	KCP Sugar & Industries Corporation Ltd	F24
DCM Shriram Industries Ltd	F5	Khaitan (India) Ltd	F25
Dhampur Sugar Mills Ltd	F6	Mawana Sugars Ltd	F26
Dharani Sugars & Chemicals Ltd	F7	Oudh Sugar Mills Ltd	F27
EID Parry (India) Ltd	F8	Piccadily Agro Industries Ltd	F28
Jeypore Sugar Company Ltd	F9	Piccadily Sugar & Allied Inds Ltd	F29
Kesar Enterprises Ltd	F10	Prudential Sugar Corporation Ltd	F30
Kothari Sugars & Chemicals Ltd	F11	Rana Sugars Ltd	F31
Parrys Sugar Industries Ltd	F12	Riga Sugar Company Ltd	F32
Ponni Sugars (Erode) Ltd	F13	Saraswati Sugar Mills Ltd	F33
Rajshree Sugars & Chemicals Ltd	F14	SBEC Sugar Ltd	F34
Sakthi Sugars Ltd	F15	Sri Chamundeswari Sugars Ltd	F35
Shree Renuka Sugars Ltd	F16	United Provinces Sugar Co Ltd	F36
Simbhaoli Sugars Ltd	F17	Upper Ganges Sugar & Industries Ltd	F37
Sir Shadi Lal Enterprises Ltd	F18	Uttam Sugar Mills Ltd	F38
Thiru Arooran Sugars Ltd	F19	Vishnu Sugar Mills Ltd	F39
Triveni Engineering and Industries Ltd	F20	Andhra Sugar	F40

TABLE X
COMPANY-WISE TE TRENDS IN THE INDIAN SUGAR INDUSTRY (2004-05 TO 2013-14)

Code	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	Av.
F1	1.000	0.928	0.951	0.959	1.000	0.957	0.957	0.986	0.905	0.932	0.957
F2	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F3	1.000	1.000	1.000	0.955	1.000	1.000	1.000	1.000	1.000	1.000	0.995
F4	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.922	0.974	0.999	0.989
F5	0.891	0.837	0.922	0.976	0.937	0.859	0.859	0.906	0.913	0.987	0.907
F6	0.867	0.919	0.817	0.937	0.979	0.958	0.958	1.000	0.994	1.000	0.941
F7	1.000	1.000	1.000	0.861	0.992	1.000	1.000	1.000	1.000	1.000	0.984
F8	1.000	1.000	1.000	0.868	0.888	1.000	1.000	1.000	0.950	0.974	0.967
F9	0.999	1.000	1.000	0.944	0.912	1.000	1.000	1.000	0.977	0.918	0.974
F10	0.766	0.845	0.881	1.000	0.928	0.878	0.878	0.904	0.926	0.855	0.884
F11	0.881	0.956	1.000	0.924	0.856	0.961	0.961	1.000	1.000	0.945	0.947
F12	0.881	0.956	1.000	0.924	0.856	0.961	0.961	1.000	1.000	0.945	0.947
F13	0.926	0.927	1.000	1.000	0.991	1.000	1.000	0.981	0.985	0.971	0.978
F14	0.918	0.978	1.000	1.000	1.000	1.000	1.000	1.000	0.961	0.977	0.983
F15	0.899	0.948	0.980	0.918	1.000	0.860	0.860	0.934	0.880	0.890	0.916
F16	0.919	0.865	0.878	1.000	0.889	0.791	0.791	0.883	0.832	0.880	0.871
F17	1.000	1.000	1.000	0.848	0.792	0.819	0.819	0.799	0.902	0.851	0.879
F18	0.899	1.000	0.969	0.976	1.000	0.841	0.841	0.994	0.960	1.000	0.946
F19	1.000	1.000	0.917	1.000	0.952	0.902	0.902	0.949	0.898	0.946	0.946
F20	0.775	0.731	0.892	0.950	0.843	0.789	0.789	0.954	1.000	1.000	0.867
F21	1.000	1.000	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F22	0.988	0.953	1.000	0.846	0.872	0.968	0.968	0.976	0.924	0.926	0.941
F23	0.866	0.957	0.989	0.903	0.895	0.967	0.967	1.000	1.000	1.000	0.953
F24	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F25	1.000	0.974	1.000	0.888	1.000	1.000	1.000	1.000	1.000	1.000	0.986
F26	1.000	1.000	1.000	0.716	0.720	0.765	0.765	0.808	0.798	0.873	0.837
F27	0.864	0.896	0.812	0.915	0.935	0.803	0.803	0.945	0.989	0.969	0.891
F28	0.889	0.877	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.975
F29	1.000	0.912	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.991
F30	0.694	0.893	1.000	0.707	0.869	0.878	0.878	1.000	0.969	0.964	0.879
F31	1.000	1.000	0.938	0.911	0.919	0.933	0.933	0.957	0.970	0.989	0.955
F32	0.863	0.859	0.807	1.000	0.904	0.848	0.848	0.923	0.924	0.937	0.890
F33	1.000	1.000	1.000	0.983	1.000	0.888	0.888	1.000	1.000	1.000	0.975
F34	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F35	0.660	0.948	1.000	0.966	0.950	1.000	1.000	0.967	0.929	0.976	0.934
F36	0.943	0.868	0.866	0.933	0.777	0.891	0.891	0.930	0.851	0.967	0.890
F37	0.899	0.855	0.870	0.930	0.854	0.810	0.810	0.927	0.942	0.973	0.885
F38	1.000	1.000	0.875	0.883	1.000	0.966	0.966	0.921	0.999	0.967	0.957
F39	0.799	0.969	0.960	0.862	0.860	0.947	0.947	0.981	1.000	0.964	0.927
F40	1.000	0.936	0.978	0.857	0.863	1.000	1.000	1.000	1.000	1.000	0.962

TABLE XI
COMPANY-WISE PTE TRENDS IN THE INDIAN SUGAR INDUSTRY (2004-05 TO 2013-14)

Code	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	Av
F1	1.000	1.000	1.000	1.000	1.000	0.987	0.987	1.000	0.962	1.000	0.993
F2	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F3	1.000	1.000	1.000	0.955	1.000	1.000	1.000	1.000	1.000	1.000	0.995
F4	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.925	0.976	1.000	0.990
F5	0.957	0.985	1.000	0.977	0.981	0.935	0.935	1.000	1.000	1.000	0.977
F6	0.901	0.920	0.875	0.943	0.980	0.971	0.971	1.000	1.000	1.000	0.955
F7	1.000	1.000	1.000	0.931	1.000	1.000	1.000	1.000	1.000	1.000	0.993
F8	1.000	1.000	1.000	0.876	0.908	1.000	1.000	1.000	1.000	1.000	0.977
F9	1.000	1.000	1.000	0.948	0.924	1.000	1.000	1.000	0.983	0.939	0.979
F10	0.768	0.860	0.890	1.000	0.928	0.887	0.887	0.904	0.927	0.858	0.889
F11	0.916	0.968	1.000	0.943	0.868	0.966	0.966	1.000	1.000	0.946	0.956
F12	0.916	0.968	1.000	0.943	0.868	0.966	0.966	1.000	1.000	0.946	0.956
F13	0.943	0.940	1.000	1.000	0.993	1.000	1.000	0.985	0.999	0.978	0.984
F14	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.988	1.000	0.999
F15	1.000	0.965	1.000	0.919	1.000	0.885	0.885	0.935	0.897	0.899	0.937
F16	0.936	0.867	0.944	1.000	0.890	0.796	0.796	0.908	0.832	0.880	0.883
F17	1.000	1.000	1.000	0.921	0.803	0.842	0.842	0.801	0.911	0.855	0.894
F18	0.957	1.000	1.000	0.976	1.000	0.852	0.852	1.000	0.966	1.000	0.959
F19	1.000	1.000	1.000	1.000	1.000	0.983	0.983	1.000	0.965	1.000	0.993
F20	0.775	0.744	0.893	0.950	0.857	0.791	0.791	0.972	1.000	1.000	0.872
F21	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F22	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.937	0.936	0.987
F23	1.000	1.000	1.000	1.000	0.982	1.000	1.000	1.000	1.000	1.000	0.998
F24	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F25	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F26	1.000	1.000	1.000	0.717	0.722	0.796	0.796	0.893	0.802	0.876	0.854
F27	0.897	0.897	0.847	0.916	0.936	0.804	0.804	0.947	0.994	0.972	0.899
F28	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F29	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F30	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F31	1.000	1.000	0.940	0.916	0.921	0.990	0.990	0.976	0.979	0.994	0.970
F32	0.933	0.930	0.872	1.000	0.909	0.859	0.859	0.928	0.997	0.937	0.921
F33	1.000	1.000	1.000	0.987	1.000	0.904	0.904	1.000	1.000	1.000	0.979
F34	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F35	0.900	1.000	1.000	0.973	0.963	1.000	1.000	0.970	0.937	0.984	0.972
F36	1.000	1.000	0.878	1.000	0.910	0.954	0.954	1.000	1.000	0.980	0.967
F37	0.933	0.857	0.927	0.932	0.858	0.811	0.811	0.931	0.947	0.973	0.896
F38	1.000	1.000	0.940	0.918	1.000	0.997	0.997	0.936	1.000	0.967	0.975
F39	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.981	1.000	0.974	0.995
F40	1.000	0.957	0.987	0.863	0.867	1.000	1.000	1.000	1.000	1.000	0.966

TABLE XII
COMPANY-WISE SE TRENDS IN THE INDIAN SUGAR INDUSTRY (2004-05 TO 2013-14)

Code	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	Av
F1	1.000	0.928	0.951	0.959	1.000	0.969	0.969	0.986	0.941	0.932	0.963
F2	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F3	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F4	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.997	0.999	0.999	0.999
F5	0.931	0.850	0.922	0.999	0.954	0.919	0.919	0.906	0.913	0.987	0.929
F6	0.962	0.999	0.933	0.994	0.999	0.987	0.987	1.000	0.994	1.000	0.985
F7	1.000	1.000	1.000	0.925	0.992	1.000	1.000	1.000	1.000	1.000	0.991
F8	1.000	1.000	1.000	0.990	0.978	1.000	1.000	1.000	0.950	0.974	0.989
F9	0.999	1.000	1.000	0.997	0.986	1.000	1.000	1.000	0.994	0.978	0.995
F10	0.997	0.983	0.990	1.000	1.000	0.990	0.990	0.999	0.999	0.997	0.995
F11	0.962	0.988	1.000	0.980	0.987	0.995	0.995	1.000	1.000	0.999	0.991
F12	0.962	0.988	1.000	0.980	0.987	0.995	0.995	1.000	1.000	0.999	0.991
F13	0.981	0.986	1.000	1.000	0.998	1.000	1.000	0.996	0.986	0.992	0.994
F14	0.918	0.978	1.000	1.000	1.000	1.000	1.000	1.000	0.973	0.977	0.984
F15	0.899	0.982	0.980	0.999	1.000	0.972	0.972	0.998	0.981	0.990	0.977
F16	0.981	0.997	0.931	1.000	0.999	0.994	0.994	0.972	1.000	1.000	0.987
F17	1.000	1.000	1.000	0.921	0.987	0.973	0.973	0.998	0.991	0.995	0.983
F18	0.939	1.000	0.969	1.000	1.000	0.987	0.987	0.994	0.993	1.000	0.987
F19	1.000	1.000	0.917	1.000	0.952	0.917	0.917	0.949	0.931	0.946	0.952
F20	0.999	0.982	0.999	0.999	0.983	0.997	0.997	0.982	1.000	1.000	0.994
F21	1.000	1.000	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F22	0.988	0.953	1.000	0.846	0.872	0.968	0.968	0.976	0.986	0.990	0.953
F23	0.866	0.957	0.989	0.903	0.911	0.967	0.967	1.000	1.000	1.000	0.955
F24	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F25	1.000	0.974	1.000	0.888	1.000	1.000	1.000	1.000	1.000	1.000	0.986
F26	1.000	1.000	1.000	0.998	0.998	0.961	0.961	0.904	0.995	0.997	0.981
F27	0.963	0.999	0.959	1.000	0.999	0.999	0.999	0.998	0.995	0.997	0.991
F28	0.889	0.877	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.975
F29	1.000	0.912	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.991
F30	0.694	0.893	1.000	0.707	0.869	0.878	0.878	1.000	0.969	0.964	0.879
F31	1.000	1.000	0.998	0.995	0.997	0.942	0.942	0.981	0.991	0.995	0.984
F32	0.924	0.923	0.925	1.000	0.994	0.987	0.987	0.995	0.928	1.000	0.966
F33	1.000	1.000	1.000	0.996	1.000	0.982	0.982	1.000	1.000	1.000	0.996
F34	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F35	0.733	0.948	1.000	0.993	0.986	1.000	1.000	0.997	0.991	0.992	0.960
F36	0.943	0.868	0.986	0.933	0.854	0.935	0.935	0.930	0.851	0.987	0.921
F37	0.963	0.997	0.939	0.998	0.995	0.999	0.999	0.995	0.995	1.000	0.988
F38	1.000	1.000	0.931	0.961	1.000	0.969	0.969	0.984	0.999	1.000	0.981
F39	0.799	0.969	0.960	0.862	0.860	0.947	0.947	1.000	1.000	0.990	0.931
F40	1.000	0.978	0.990	0.994	0.995	1.000	1.000	1.000	1.000	1.000	0.996

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