Possibility of upgrading technical and managerial efficiency of Iranian sugar factories in the existing of current technology

Seyed-Masoud Seyedi

Department of Management, Shiraz Branch, Islamic Azad University, shiraz, Iran
phd.seyedi@gmail.com

Abstract: Targeted subsides will, directly or indirectly, affect the price cost of domestic products, including sugar factories productions and reduce their ability to compete against imports. Since the technological modernization for improving productivity and reducing price cost of sugar production within the country accounts as a long term strategy for exit out of this crisis, short-term strategies, including promote technical efficiency in these firms have priority. In this regard, efficiency analysis of sugar beet firms was the main objective of this study that was performed using Data Envelopment Analysis (DEA). This analysis using documentary data of these firms in 2004 year showed that optimum management of using some effective inputs including labor and technical management of increasing target product value conduce the promotion of technical efficiency in the firms which in the managerial efficiency compared to others weren't at desirable level. However, when the firms are managed in an efficient manner, full-scale changes are effective on improving their technical efficiency. Herein, the technical efficiency of each firms were analyzed and suggestions were presented.
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1. Introduction

Subsidy to goods and production inputs, especially in the era after the Islamic Revolution of Iran, led to a significant portion of the funds in the annual government budget allocated to this matter. In this regard, the Islamic Republic government and planners argued that current method of payment subsidies, not only is contrary by the principle of justice, but also keeping low the prices of important sources including energy in the presence of subsidies payment lead to non-optimal uses of them in the production and non-manufacturing sectors. Thus they call for changes in the current method of subsidies payment as economic development plan. With this project, the subsidies are paid to targeted and vulnerable groups (anonymous, 1387).

Production costs, directly or indirectly, would be affected by targeted subsidy. This will reduce the competitiveness of domestic products including sugar industries against imports. That's while the government's import policies made the domestic sugar production reduced from about 3.1 million tons to 500 thousand tons (Janan Sefat, 1388). There is a challenge for preventing the closure of these industries. Technological modernization of factories for more efficient use of energy is the most important issues that can and should be placed on the agenda (Kamguyan, 1388). Since the technological modernization costs are enormous changes and their financing is not possible in the short term, it is being considered as a long term solution to the crisis. Short-term solutions such as improving the productivity in the presence of existing technologies are the priorities.

Productivity is defined as a certain amount of product to specified amount of one or more inputs. Productivity coefficients are calculated to compare the units such that the unit(s) who has(have) highest outputs to inputs ratio, has(have) the highest productivity (Abtahi and Kazemi, 1380). Improving the efficiency is one of the most important strategies for improving the productivity of firms. Efficiency in a simple definition is the ratio of output value to input value such that the firms with a comparable technology and proper management practices, are more efficient when obtain more output from a certain amount of inputs (Khaki, 1382).

There are different solutions to improve technical and economic efficiency of sugar firms. Technical discussions about different solutions presented so far. For instance, molasses production with low degree of purity is included as strategies for increasing efficiency and profitability of units (Elahi, 1388). Also, changing and reforming the evaporation systems of factories is one of the ways to optimize energy consumption (Astryjs, 1388). As reviewed studies, discussions regarding the promotion of economic efficiency are rare. The current study analyzes the efficiency of sugar factories of Iran based on Data Envelopment Analysis (DEA) approach (Coelli et al 2002).

2. Material and Methods

Data Envelopment Analysis (DEA) was introduced for the first time by Charns, et al (1978). This method is a nonparametric technique assuming undefined production function is. As Farrell (1957) the main idea of this method consists of measuring efficiency by comparing each individual firm with other units of the sample. DEA is based optimization using linear programming, which is also called the nonparametric method. In this way, efficient frontier curve is created by a series of linear programming points. Linear programming method, after optimization determines whether the decision unit has been on-line performance or not, to thereby efficient and inefficient units are separated from each other. With helps of this method can maximize the objective function (output) with attention to certain inputs, or using its dual, minimize the inputs given a certain output (Coelli, 1996). Since the DEA technique covers all figures and the information, it is called Data Envelopment Analysis. In this method, there is no need to specify the type of function. This method also provides returns to scale separately for firms.

This method assumes that all firms are in the high or low iso-quant curve (Emami Meybodi, 1379). Initially, the model was introduced based on the minimization of inputs assuming constant returns to scale (CRS). Point to variable returns to scale (VRS), make DEA method extended (Coelli, 1996). If there are information about K outputs and M inputs for N firms, the process will be calculated as follows:

$$\max\ u'Y_i$$

$$s.t. \qquad v'X_i = 1$$

$$u'X_j - v'X_j \le 0$$

$$u \ge 0, v \ge 0 \quad j = 1,2,...N$$

where u include a vector of outputs weights, v a vectors of inputs weights, X matrix a $K \times N$ matrix of inputs, and Y a $M \times N$ matrix of outputs. The matrices represent all information about N firms. In this regard, the aim is obtaining optimal values v and u so that the total weight of outputs to the total weight of inputs (efficiency rate per firm) is to be maximum; subject to the efficiency of each firm size should be smaller or equal one. Recent issue can be solved using linear programming.

This study used documentary data of sugar factories, according to database of Sugar Industry Association of Iran (Anonymous, 1388 b). Since the factories was using the different technologies according to their the lifetime, and complete information on the use of various inputs such as energy has not been provided for all units of the country, it was impossible to consider all inputs in this study. Consequently, we used two major inputs including raw material (sugar beet) and permanent and temporary labor for producing sugar, the most important product of factories, considering their nominal production capacity. Also, because sugar plants faced with the financial crises in recent years so that their production placed in abnormal conditions, 2005 which was relatively a normal year selected to carry out this analysis. It was done using the DEAP software.

3. Results and discussions

There were 41 sugar producing factory in the whole country in 2005, of which, 38 cases were active (Table 1). In this year, about 54 percent of the total sugar production of the country has been devoted to 31 active sugar beet factories. Their production capacity was at least 500 (Ghahestan) up to 5000 (Moghan) tons per day (Table 2). Overall, the firms purchased 4625954 tons of sugar beet from all regions of the country. This rate has been changed to 631,191 tons of sugar using the 5862 temporary and 13146 permanent labors (man-day) during the operation period.

Table 1: Statistics of sugar factories in 2005

Factory type (based on raw material)	Total units	Active units	Production (Tons)	Percentage
Sugar beet	34	31	631191	54.18%
Cane	7	7	533799	45.82%
Total	**41**	**38**	1164990	**100.00%**

Table 2: Technical characters of sugar beet factories in 2005

No.	Factory Name	Capacity (Tons/day)	Purchased beet	Labor		Sugar production (Tons)
				Temporary	Permanent	
1	**Abkouh**	2500	175471	564	174	26418
2	**Torbat-e-Hedarieh**	3000	214174	572	198	31803
3	**Torbat-e-Jaam**	1500	151425	315	201	21521
4	**Jovein**	4000	301141	240	466	34420
5	**Esfahan**	4000	307832	734	231	44872
6	**Fasa**	800	89795	485	190	12748
7	**Bisotoun**	2200	152614	750	280	18760
8	**Oroomieh**	1500	189896	387	112	27287
9	**Ahvaz**	2500	143719	25	400	12961
10	**Chenaran**	1000	125756	540	170	16824
11	**Shirvaan**	4000	152315	978	271	22307
12	**Shirin**	3000	183443	1235	262	25317
13	**Fariman**	2500	210007	1153	274	31099
14	**Ghahestan**	500	73682	220	103	9005
15	**Neishabour**	1500	145885	310	208	18663
16	**Shahroud**	1100	82315	265	77	9655
17	**Piranshahr**	1500	217179	486	150	29873
18	**Khoie**	1500	206432	300	200	28443
19	**Miandoab**	1800	240111	531	108	30494
20	**Eslamabad**	1500	172818	393	61	27164
21	**Lorestan**	1500	158805	235	134	22696
22	**Shazand**	600	82305	170	229	10482
23	**Ghazvin**	2000	167859	274	108	22494
24	**Naghsh-e-Jahan**	1500	134090	356	152	19887
25	**Hamedan**	1500	114174	462	179	14576
26	**Eghlid**	1500	172371	425	339	26726
27	**Pars**	1500	65890	167	241	8729
28	**Marvdasht**	1650	129203	430	230	18239
29	**Bardsir**	1000	65247	144	114	7728
30	**Chrmahal**	1000	110852	240	163	16613
31	**Moghan**	5000	103415	300	150	11363
	Total	**54650**	**4625954**	**13146**	**5862**	**631191**

The production efficiency of firms was investigated using the noted method and accordingly, technical, managerial, and scale efficiency obtained (Table 3). The results show that there were 19 units which are not technically 100 percent efficient. Meanwhile, Marvdasht, Chenaran, Shirin, Neishabour, Shahroud, Hamedan, Pars, Bisotoun, and Bardsir with efficiency range of less than 90 percent have suffered from inefficient conditions. However, the average of technical efficiency rate of the studied factories is 95 percent indicated relatively good performance of the units.

As table 2 shows, the firms in terms of managerial somewhat are better than average

technical efficiency such that the average of managerial efficiency is about 2 percent more than the technical one. It can be noted that technical knowledge in using the current technology according to the used resources, which is expressed as the managerial efficiency, was important among firms. Moreover, results indicate that although the firms of Esfahan, Ghahestan, Pars, Chaharmahal, Neghshe-e-Jahan, Bardsir, Shazand, Shahroud, and Miandoab in are not 100 percent technically efficient, but they are quite efficient in terms of managerial practice. Therefore, these units can improve their technical efficiency by changing the rate of inputs according to their returns to scale. The results of analyzing returns to scale among the firms revealed that there is possibility of increasing efficiency through reducing use of inputs in some units which have decreasing return to scale as well. Also, it seems possible to upgrade the technical efficiency of some units which are in increasing return to scale position if other conditions remain constant.

Table 3: Calculated efficiencies among factories

No.	Factory name	Efficiency type			Return to scale status
		Technical	Managerial	Scale	
1	**Abkouh**	96.7%	96.8%	99.9%	Increasing
2	**Torbat-e-Hedarieh**	100.0%	100.0%	100.0%	Constant
3	**Torbat-e-Jaam**	95.2%	96.1%	99.0%	Increasing
4	**Jovein**	100.0%	100.0%	100.0%	Constant
5	**Esfahan**	97.5%	100.0%	97.5%	Decreasing
6	**Fasa**	100.0%	100.0%	100.0%	Constant
7	**Bisotoun**	85.7%	85.9%	99.7%	Decreasing
8	**Oroomieh**	100.0%	100.0%	100.0%	Constant
9	**Ahvaz**	100.0%	100.0%	100.0%	Constant
10	**Chenaran**	89.9%	92.0%	97.7%	Increasing
11	**Shirvaan**	100.0%	100.0%	100.0%	Constant
12	**Shirin**	89.1%	89.3%	99.8%	Decreasing
13	**Fariman**	94.6%	95.8%	98.7%	Decreasing
14	**Ghahestan**	91.3%	100.0%	91.3%	Increasing
15	**Neishabour**	84.4%	85.4%	98.9%	Increasing
16	**Shahroud**	83.7%	100.0%	83.7%	Increasing
17	**Piranshahr**	100.0%	100.0%	100.0%	Constant
18	**Khoie**	100.0%	100.0%	100.0%	Constant
19	**Miandoab**	95.6%	100.0%	95.6%	Decreasing
20	**Eslamabad**	100.0%	100.0%	100.0%	Constant
21	**Lorestan**	100.0%	100.0%	100.0%	Constant
22	**Shazand**	91.7%	100.0%	91.7%	Increasing
23	**Ghazvin**	100.0%	100.0%	100.0%	Constant
24	**Naghsh-e-Jahan**	`	100.0%	99.1%	Increasing
25	**Hamedan**	88.2%	88.4%	99.8%	Increasing
26	**Eghlid**	97.6%	97.6%	100.0%	Constant
27	**Pars**	89.0%	100.0%	89.0%	Increasing
28	**Marvdasht**	90.4%	90.6%	99.7%	Increasing
29	**Bardsir**	77.7%	100.0%	77.7%	Increasing
30	**Chrmahal**	96.9%	100.0%	96.9%	Increasing
31	**Moghan**	100.0%	100.0%	100.0%	Constant
	Total	94.5%	97.4%	97.3%	

4. Conclusion

Although technological modernization for improving productivity of sugar factories and to increase the competitiveness of their products versus prices of imported products is necessary in the conditions of targeting subsidies, but since it needs the enormous costs of changing machines is possible as a long-term strategy. Along with technical strategies for improving productivity, the results of this study showed that the management optimization of sugar producers is the way to more efficient firms using existing technology. Therefore the optimal management in reducing the use of some inputs such as labor and technical management to increase the target product were recommended strategies for improving the technical efficiency of units, those who did not operate at optimum level according to the managerial efficiency than others. However where units manage efficiently, full-scale changes has a positive effect to improve technical efficiency.

As a result, it can be proposed to reform the scale of sugar producer factory, improve the production management of units to enhance the production target, and optimize labor force employed by the plant managers according to the results of this study.

Corresponding Author:
Dr. S.M. Seyedi
Department of Management,
Shiraz Branch, Islamic Azad University,
Shiraz, Iran
E-mail: phd.seyedi@gmail.com

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