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Efficiency Dynamics of Sugar Industry of Pakistan

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1. INTRODUCTION

Sugarcane is among the most valuable crops of Pakistan. It is a source of raw material for entire sugar industry. At present, the sugar industry is second largest agro-based industry in Pakistan. The future of this industry in Pakistan is mainly attributed to the poduction efficiency because of higher cost of production; increase in the imports and due to declining competitiveness of the domestic sugar industry. Productive efficiency can be improved by the adoption and development of new production technologies but at present it is difficult due to limited income and credit to the out growers. Therefore, this industry can improve the efficiency of its operations using currently available technology.

Measures of productivity, its growth and sources for the sugar industry of Pakistan play a significant role for policy development. Productivity growth can be decomposed into three components: technical change, scale effects, and changes in the degree of technical efficiency [Coelli, *et al.* (2005)]. Technical change means progress in technology not only physically in the form of improved machinery but also innovations in the knowledge base. Regarding scale effects, it relate to economies in production. If there exists increasing economies of scale it indicates that the production of additional outputs will require a less than proportional increase in inputs. Improvements in the degree of technical efficiency arise from situations where resources can be used more efficiently by applying practices from the present stock of knowledge.

The most comprehensive measure of aggregate or sectoral productivity is Total Factor Productivity (TFP). However, given the paucity of good data, this area of research has remained quite limited in Pakistan [Ali (2004)]. There are some studies on manufacturing sector of Pakistan which include Raheman, *et al.* (2008), where TFP and its sources are estimated using Malmquist Productivity growth index for major manufacturing industries of Pakistan using aggregate firm level financial data but sugar industry is not among the industries analysed. The results of the study highlighted the

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role of efficiency change in the TFP growth while deficiencies in terms of technological progress. Similarly, another study by Mahmood, *et al.* (2007) examined the efficiency of the large scale manufacturing sector of Pakistan by using the stochastic production frontier approach for periods 1995-96 and 2000-01. Afzal (2006) also analysed the TFP for the large scale manufacturing sector from 1975 to 2001 using three different approaches. There are no reported productivity efficiency studies for the sugar industry in Pakistan.

This study attempts to fill this gap by estimating firm level efficiency and total factor productivity growth and its components for a sample of twenty sugar firms in the sugar industry and to assess the variations in TFP growth between firms and over Time. The TFP growth is estimated for the period 1998 to 2007. This study, therefore, would provide a fresh perspective on the growth of TFP in sugar sector for use in developing appropriate policy responses towards this sector of Pakistan's economy.

There are several techniques available, parametric and non-parametric, to estimate total factor productivity. The most widely used example of a non-parametric technique is DEA [Coelli (1995); Seiford (1996)]. Parametric techniques encompass stochastic frontier techniques and Bayesian methods [Kalirajan and Shand (1999)]. In this paper we employ DEA to estimate Malmquist TFP indices from panel data set. The reason for the choice of DEA as the method of estimation is that the methodology has been employed widely to conduct benchmarking analysis [for example, see Jaforullah and Whiteman (1999)]. Most of the existing studies that employs panel data for estimation of efficiency and productivity change reports estimates for the entire data period, while in the present study our focus is on the annual estimates because we wish to examine how productivity changes through time at the firm level.

The basic objective of this paper is to use the Data Envelopment Analysis (DEA) as a tool for the measurement of TFP growth for sugar industry and sugar firms. The objective/purpose is also to decompose TFP growth into technical change, efficiency change and scale efficiency change in order to understand the source of productivity for Pakistani sugar firms listed at Karachi Stock Exchange. This decomposition enables policymakers to trace lagging productivity to particular factors. For example, if slowing technical progress causes declining TFP growth, the production frontier can be shifted upward through investment in research and development (R&D); if slow productivity growth is traced primarily to deteriorating technical efficiency (TE), learning-by-doing processes and managerial practices can be targeted for this purpose; if there will be benefits from SE, production scales should be adjusted toward optimum values. The specific objective of the study is to provide policy implications and strategies for improvement in the production efficiency of sugar firms. Policymakers can recommend policies that improve the productivity of firms only if they understand the sources of variation in productivity growth.

Generally, studies at country level on productivity growth are based on the overall or aggregate data; therefore, the results of those studies are average of the overall economy which comprises of different sectors. Hence contribution in each country's productivity has different proportion of sectors. This study uses financial data of sugar firms extracted from annual reports obtained from different sources. This data allows examination of the TFP performance of individual firms, which was not previously done.

The structure of this article is as follows. In the following section, an overview of sugar industry of Pakistan is presented followed by the third section which describes the data used in the analysis and methodology opted for analysis including discussion of input and output variables. Then the results of our Malmquist TFP estimates are presented. In the final section we discuss the results presented and provide conclusions.

2. OVERVIEW OF SUGAR INDUSTRY OF PAKISTAN

Sugarcane is an important industrial and cash crop in Pakistan. Pakistan is an important sugarcane producing country and is ranked fifth in terms of area under sugar cultivation, 60th in yield and 15th in sugar production. Sugarcane is grown on over a million hectares and provides the raw material for Pakistan's 84 sugar mills which comprise the country's second largest agro-industry after textiles [Pakistan Annual Sugar Report (2009)]. The sugar sector constitutes 4.2 percent of manufacturing. In size, the sugar sector matches the cement sector. Sugar industry has an indirect socio-economic impact in overall terms which is significantly larger than its direct contribution to GDP because of it's backward (sugarcane growers) and forward linkages (food processors) in the economy.

The sugar cane yield for some important countries of the world is given in the following Table 1.

Table 1

Sugarcane Yield of World

Country	Cane Yield (T/ha)	Sugar Recovery (%)	Sugar Yield (t/ha)
Australia	100.4	13.8	13.85
Egypt	110.8	11.5	12.74
Brazil	68.4	14.5	9.91
USA	80.2	11.7	9.38
Colombia	80.5	11.5	9.26
Mexico	79.5	11.6	9.22
India	66.9	9.9	6.64
Pakistan	49.0	9.2	3.54
World Avg.	64.4	10.6	6.82

*Source: www.pakboi.gov.pk/word/**Sugar**%20.doc*

According to the Table 1, Egypt is the highest in terms of sugarcane yield per hector which is 110.8 tons per hector while the Pakistan is the lowest in terms of this yield. As far as the sugar recovery is concerned, Brazil has the highest percentage and again Pakistan is at the lowest. If we analyse the sugar yield from sugarcane, Australia has the highest sugar yield in these countries and again Pakistan is at the lowest with 3.54 tons per hector. It indicates that in Pakistan, improvements can be made in terms of sugarcane yield, sugar recovery and sugar yield.

The area under cultivation has increased more rapidly than any other major crops. The Table 2 presents the area production and yield during period 1997-98 to 2007-08.

Table 2

Pakistan Sugarcane Area and Yield

Year	Area (000 Ha)	Produced 000 Tonnes	Yield per Hectare	Utilisation % by Sugar Mills
1997-98	1,056.2	53,104	50.28	77.32
1998-99	1,155.1	55,191	47.78	77.90
1999-00	1,009.8	42,000	41.59	69.00
2000-01	960.0	43,620	45.40	67.47
2001-02	999.7	48,041	48.10	76.33
2002-03	1,099.7	52,049	47.30	80.28
2003-04	1,074.8	53,800	50.10	81.15
2004-05	966.4	43,533	45.00	73.74
2005-06	907.0	44,292	48.80	67.94
2006-07	1,033.0	54,871	53.12	73.78
2007-08	1160.0	61,503	53.02	–
2008-09	1045.0	55,385	53.00	–

Source: Pakistan Sugar Mills Association Annual Report: 2007, 2008.

During the year 2007-08 production of sugar was estimated at 61.5Million Metric Ton (MMT), an increase of 12 percent over previous year due to increase in area under cultivation and yield. While during 2008-09 sugar production is estimated at 55MMT a decline of 10 percent over the previous year. According to press reports [*Jang* Weekly *News*, August (2009)], Pakistan's 2009-10 sugar production is expected around 3 millions tons as against 3.2 million tons in the last year. The annual consumption of sugar varies in between 3.6 to 4.2 million tons, but according to the industry's officials, it has gone down since October due to economic slowdown and higher prices that resulted in lower demand from industries like drink producers. With this scenario, Pakistan has to import sugar which exposes it to the effects of shortage and rising prices in the world.

The consumption of sugar is showing an increasing trend for the last 15 years. In 1995-96, it was 2.89 million tons, which increased to 3.95 million tons in 2005-06. This is mainly due to increase in the population growth of the country, which is now almost 170 million. According to a rough estimate, the country will need approximately 5.5 million tons of sugar to meet the local demand by year 2020. It will require about 1.5 million hectares of area under cultivation which is at present about 1 hector. The per capita sugar consumption is around 25kg per year which is highest in the developing countries. The demand of sugar will increase in the coming years at the rate of about 2.3 percent because of growth in the population which is about 2.3 percent.

The sugarcane production in terms of sugarcane crushed, sugar made and recovery percentage is presented in the Table 3 for period 1997-98 to 2006-07.

Table 3

Sugarcane Production and Recovery

Year	No. of Mills	Cane Crushed Tonnes	Sugar Made Tonnes	Recovery
1997-98	71	41,062,268	3,548,953	8.64%
1998-99	71	42,994,911	3,530,931	8.21%
1999-2000	69	28,982,711	2,414,746	8.33%
2000-01	65	29,408,879	2,466,788	8.39%
2001-02	69	36,708,638	3,197,745	8.71%
2002-03	71	41,786,689	3,652,745	8.74%
2003-04	71	43,661,378	3,997,010	9.15%
2004-05	71	32,101,739	2,922,126	9.10%
2005-06	74	30,090,632	2,588,176	8.59%
2006-07	77	40,483,977	3,516,218	8.69%

Source: Pakistan Sugar Mills Association Annual Report: 2007.

This table is showing an increasing trend in terms of sugarcane crushed and sugar made except for years 2004-05 and 2005-06. During these two years Pakistan sugar industry faced the crisis due to decline in area under cultivation which causes decline in production and yield. Otherwise number of mills increased during this period.

After getting an overview of the sugar industry, we develop the methodology for estimating productivity growth of sugar industry in Pakistan by examining this issue at firm level.

3. METHODOLOGY

Total factor productivity growth and its sources are estimated using Data Envelopment Analysis approach. Malmquist productivity growth indices are calculated for twenty sugar firms and also for sugar industry. The Malmquist Productivity Index also includes the sources of productivity growth for these firms.

3.1. Malmquist TFP Index

The Data Envelopment Analysis (DEA) methodology was initiated by Charnes, *et al.* (1978) who built on the frontier concept started by Farell (1957). The methodology used in this paper is based on the work of Fare, *et al.* (1994) and Coelli, *et al.* (1998) and Raheman, *et al.* (2008). The DEA-Malmquist Index has been used to calculate the total factor productivity growth of sugar firms listed at Karachi stock exchange where each firm in the sugar industry is a Decision Making Unit (DMU).

This Malmquist productivity index can be decomposed into efficiency change, technical change and total factor productivity growth. TFPG is geometric mean of efficiency change and technical change. We have used the DEAP software developed by Coelli (1996) to compute these indices. Following Fare, *et al.* (1994), the Malmquist output-orientated TFP change index between periods *s*(the base period) and period *t* (the subsequent period) is calculated as follows:

$$m_0(y_s, x_s, y_t x_t) = \left[\frac{d_0^s(y_t, x_t)}{d_0^s(y_s, x_s)} X \frac{d_0^t(y_t, x_t)}{d_0^t(y_s, x_s)} \right]^{\frac{1}{2}} \quad \ldots \quad \ldots \quad (1)$$

In the above equation, $d_0^5(y_t, x_t)$ represents the distance from the period *t* observation to the period *s* technology, *y* represents output and *x* represents input. Like the DEA specification, each of the distance functions is calculated as a linear program. While interpreting the Malmquist index, when m_o is greater than 1 this indicates that the TFP index has grown between periods t and s while m_o less than 1 indicates that TFP has declined. This productivity index can also be written in the following way.

$$m_0(y_s, x_s, y_t x_t) = \frac{d_0^t(y_t, x_t)}{d_0^s(y_s, x_s)} \left[\frac{d_0^s(y_t, x_t)}{d_0^t(y_t, x_t)} X \frac{d_0^s(y_s, x_s)}{d_0^t(y_s, x_s)} \right]^{\frac{1}{2}} \quad \ldots \quad (2)$$

By re-expressing the Malmquist index in this way we have derived the following components. The ratio outside the bracket measures the change in the output-oriented measure of technical efficiency between period *s* and *t*. The other part of Equation 2 measures the technical change which is measured as a geometric mean in the shift in the production technology between two periods evaluated at x_t and x_s.

In the above model efficiency change (catching up effect) and a technical change (frontier effect) as measured by shift in a frontier over the same period. In this methodology, we will use the output oriented analysis because most of the firms and sectors have their objectives to maximise output in the form of revenue or profit.

3.2. Variables

We have applied the Data Envelopment Analysis (DEA) approach to the revenue producing firms by converting the financial performance measures to the firm's technical efficiency equivalents. Ee have followed the methodology of Raheman, *et al.* (2008) which is also based on Feroz, *et al.* (2003) and Wang (2006), who have converted the financial performance measures to the firm's technical efficiency equivalent using DuPont Model.[1] The DuPont model is a technique for analysing a firm's profitability using traditional performance management tools. For enabling this, DuPont model integrates income statement elements with balance sheet.

This process of measuring financial performance indicators can be converted into output and input variables. Where, sales revenue can be used as output variable while cost of goods sold, operating expenses, total assets and shareholder's equity as input variables. In this way long term resources total assets and equity and short term resources cost of goods sold and operating expenses are used to produce output in the form of sales revenue.

[1]The Dupont formula and discussion regarding conversion of financial performance measures to firm's technical efficiency equivalents can be seen in Raheman, *et al.* (2008).

3.3. Data

There are 38 sugar firms listed in the sugar and allied sector on Karachi stock exchange. We have used the data only for those sugar firms which have performed the operations and are among the listed firms on the Karachi Stock Exchange during the study period 1998 to 2007. Furthermore, only those firms are included in the analysis which have their shareholder's equity positive because of the consideration of the imitates of Data Envelopment Analysis Programme (DEAP) and their annual reports (financial statements) are available for all the ten years. Hence, finally 20 firms are selected for the analysis. Malmquist productivity Index has been used to calculate the Total Factor Productivity Growth and its sources for these twenty sugar firms.

4. RESULTS AND DISCUSSION

The data of twenty sugar firms is used to construct a grand frontier using TFP Index technique where each firm is compared to the frontier. We have calculated Malmquist total factor productivity Index which shows TFP growth, efficiency change, technical change, pure technical efficiency and scale change component for all the sugar firms in the sample.

4.1. Total Factor Productivity Growth in Sugar Sector

Malmquist Index of firm means for efficiency change, technical change, pure efficiency change, scale efficiency change and TFP growth are presented in Table 4. Sugar industry experienced an overall negative TFP growth of –0.1 percent during 1998–2007 which is insignificant. It means that during the study period there is no substantial

Table 4

Malmquist Index of Firm Means (1998–2007)

No.	Firm	TE Change	Tech. Change	PE Change	SE Change	TFP Change
1	Adam Sugar Mills Limited	0.967	1.021	0.978	0.988	0.987
2	Al Abass Sugar Mills Limited	0.996	1.008	0.999	0.997	1.004
3	Al Noor Sugar Mills Limited	1.000	0.996	1.000	1.000	0.996
4	Chashma Sugar Mils Limited	1.000	0.993	1.000	1.000	0.993
5	Dewan Sugar Mills Limited	0.987	1.007	1.000	0.987	0.993
6	Faran Sugar Mills Limited	1.000	0.980	1.000	1.000	0.980
7	Habib Sugar Mills Limited	1.000	1.012	1.000	1.000	1.012
8	Haseeb Waqas Sugar Mills Limited	0.983	1.005	0.987	0.996	0.988
9	Husein Sugar Mills Limited	1.001	0.999	0.998	1.003	0.999
10	JDW Sugar Mills Limited	1.000	0.999	1.000	1.000	0.999
11	Kohinoor Sugar Mills Limited	0.979	1.001	0.981	0.998	0.980
12	Mirpurkhas Sugar Mills Limited	0.998	1.058	0.995	1.002	1.056
13	Noon Sugar Mills Limited	0.991	0.999	0.989	1.002	0.990
14	Sanghar Sugar Mills Limited	1.011	1.008	1.007	1.004	1.019
15	Shahtaj Sugar Mills Limited	1.000	0.999	1.000	1.000	0.999
16	Shakarganj Mills Limited	1.002	1.112	1.000	1.002	1.114
17	Sind Abadgar Sugar Mills Limited	1.000	1.022	1.000	1.000	1.022
18	Tandlianwala Sugar Mills Limited	1.000	1.008	1.000	1.000	1.008
19	The Frontier Sugar Mills and Distillery Limited	0.910	0.998	1.000	0.910	0.908
20	The Thal Industries Corporation Limited	1.015	0.937	1.000	1.015	0.951
Mean Sugar Sector		0.992	1.008	0.997	0.995	0.999

increase or decrease in the total factor productivity growth. The analysis of sugar mills revealed that TFP growth increased for seven out of twenty mills. The decline in technical efficiency by 0.8 percent is offset by a same percentage increase in the technical change which resulted in insignificant overall TFP growth. The technical change in 11 out of 20 firms is more than 1. Pure efficiency change and scale efficiency change results in technical efficiency change. In case of pure efficiency change, it is one or more than one in most of the firms but overall the pure efficiency of sugar industry declined by 0.7 percent while for scale efficiency change, value close to unity shows that most of the firms are operating at optimum scale but again the scale efficiency of sugar industry declined by 0.5 percent. Therefore, both scale efficiency and pure technical efficiency have contributed to the decline in efficiency change.

In the above table, the comparison of total factor productivity change in different firms shows that Shakarganj Mills Limited on average has the highest growth in TFP (11.4 percent) during 1998 to 2007, followed by the Mirpurkhas Sugar Mills Limited that has (5.6 percent) total factor productivity growth. The worst performer in terms of total factor productivity growth is the Frontier Sugar Mills and Distillery Limited and the Thal Industries Corporation Limited. Total factor productivity of these two mills decreased on average by –9.2 percent and –4.9 percent respectively.

The results presented in Table 5 show that TFP growth has been volatile with little apparent trend. The changes in TFP growth closely follow changes in technical progress with changes in technical efficiency. The years 2002 and 1999 appear to be the years where the total factor productivity growth was the highest at 5.3 percent and 5.2 percent respectively. During years 2001 and 2007, the TFP growth is lowest at 4.7 percent and 4.4 percent respectively. If we analyse the efficiency change over period, it indicates that during year 2003 the efficiency increased by 3.9 percent while it decreased by –5.9 percent during 2006. On the other hand the technological change increased by 8.7 percent during year 2002 where the TFP growth is also maximum. Similarly technical change is negative in the similar years where TFP growth was negative i.e. year 2001 and 2007.

Table 5

Malmquist Index of Yearly Means of All Sugar Firm (1998-2007)

Year	TE Change	Tech. Change	PE Change	SE Change	TFP Change
1999	0.998	1.054	0.994	1.005	1.052
2000	0.957	1.036	0.970	0.986	0.991
2001	1.005	0.948	1.016	0.989	0.953
2002	0.969	1.087	0.965	1.004	1.053
2003	1.039	0.999	1.023	1.016	1.038
2004	1.024	0.960	1.015	1.009	0.983
2005	0.985	1.026	0.990	0.995	1.011
2006	0.941	1.022	0.985	0.956	0.962
2007	1.010	0.947	1.014	0.996	0.956
Mean	0.992	1.008	0.997	0.995	0.999

These above results show an overall picture of TFP growth, efficiency change and technical change for the sugar industry. For firm level analysis, these measures of productivity need to be analysed at firm level during period 1998 to 2007.

4.2. Total Factor Productivity Growth

Yearly comparative results of TFP growth for individual firms during 1998–2007 are presented in Table 6 which provides a complete understanding about the performance of these sugar firms.

During first year of analysis, The Thal Industries Corporation Limited performed best among all the firms with TFP growth 24.2 percent followed by The Frontier Sugar and Distillery Limited where the productivity increased by 19.9 percent. Habib sugar mill is the worst performer with decline in TFP growth by –6.6 percent. This year was also the most favourable for sugar industry where the TFP of 15 out of 20 firms increased and TFP for sugar industry increased by 5.2 percent. During year 2000, the total factor productivity of 10 out of 20 firms increased with the Husein sugar mills limited has the highest TFP growth of 9.6 percent. In the next year 2001, the TFP declined for thirteen sugar mills and the Chashma sugar mill was the worst performer in terms of TFP growth which declined by 25.2 percent and the TFP declined by 4.7 percent for the overall sugar industry which is the worst performance for the overall sugar industry during the study period. The next three years 2002, 2003 and 2004 were relatively better years for the sugar firms where the TFP increased for 12 out of 20 firms in all the three years. Mirpurkhas sugar mill was the best performer during year 2002 while Faran sugar mill was the best performer during year 2003 and Chashma sugar mill during 2004. TFP growth for the sugar industry increased during 2002 and 2003 while declined during 2004. Shakarganj sugar mill played a leading role in total factor productivity growth with highest (best performance) 76.6 percent during year 2005. Year 2006 was suitable for nine sugar mills in terms of total factor productivity with highest TFP growth for Dewan sugar mill at 35.9 percent. In this year the TFP for the sugar industry declined by 3.8 percent. Year 2006-07 was a crucial year for the sugar industry where the productivity change for fourteen out of twenty firms declined and the TFP for the sugar industry declined by 4.4 percent. In this year the best performer was the Chashma sugar mill with a growth of 23 percent in total factor productivity. These results serve to show that firm-level results can display a great deal of variations.

In terms of total factor productivity change, Shakarganj sugar mill has relatively more stable results. In this firm TFP change in seven out of nine years is greater than unity. Due to this reason, this firm topped in ranking in terms of total factor productivity. As discussed earlier year 2006-07 was the most crucial year for most of the firms where TFP declined for fourteen firms in the sample. Excluding this year from the analysis, the overall TFP growth for the sugar industry would increase to 0.53 percent which is now –0.1 percent including year 2007. The Frontier sugar mill is the worst performer in terms of TFP growth followed by the Thal industries corporation limited which has negative TFP growth for six out of nine years.

Two sources of total factor productivity named technical efficiency change and technical change are presented in the next section.

Table 6

Comparative Total Factor Productivity Change in all Sugar Firms During (1998–2007)

Sector	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean
Adam Sugar Mills Limited	1.101	0.914	1.277	1.082	0.916	0.976	1.020	0.865	0.811	0.987
Al Abass Sugar Mills Limited	1.046	0.952	1.056	0.894	1.128	1.087	0.882	1.016	1.000	1.004
Al Noor Sugar Mills Limited	1.022	1.005	0.947	0.944	1.032	0.990	1.051	1.012	0.967	0.996
Chashma Sugar Mils Limited	1.118	0.984	0.748	1.199	0.769	1.222	0.966	0.852	1.230	0.993
Dewan Sugar Mills Limited	1.030	0.988	0.995	0.818	1.141	1.062	0.967	1.091	0.888	0.993
Faran Sugar Mills Limited	1.034	1.070	1.045	0.768	1.668	0.591	0.892	1.359	0.789	0.980
Habib Sugar Mills Limited	0.934	1.020	0.965	0.925	1.063	1.135	0.996	1.125	0.971	1.012
Haseeb Waqas Sugar Mills Limited	0.992	1.046	0.885	1.138	1.019	1.001	1.067	0.822	0.964	0.988
Husein Sugar Mills Limited	1.053	1.096	0.770	1.667	0.794	1.013	0.999	0.874	0.956	0.999
JDW Sugar Mills Limited	1.069	0.892	1.284	0.792	1.072	0.998	1.036	0.994	0.923	0.999
Kohinoor Sugar Mills Limited	1.079	1.023	0.832	1.154	0.888	1.082	1.040	0.979	0.804	0.980
Mirpurkhas Sugar Mills Limited	0.976	1.025	1.003	1.812	0.943	0.879	1.175	1.064	0.864	1.056
Noon Sugar Mills Limited	1.059	1.054	0.935	1.079	0.963	1.007	0.996	0.851	0.984	0.990
Sanghar Sugar Mills Limited	1.066	0.976	1.051	0.716	1.249	1.131	0.963	1.213	0.919	1.019
Shahtaj Sugar Mills Limited	1.062	0.893	0.966	1.164	0.921	0.985	0.964	0.979	1.082	0.999
Shakarganj Mills Limited	1.020	0.961	1.080	1.024	1.085	1.203	1.766	0.984	1.070	1.114
Sindh Abadgar Sugar Mills Limited	0.986	1.016	0.974	0.929	1.121	0.871	1.015	1.298	1.039	1.022
Tandlianwala Sugar Mills Limited	0.995	0.978	0.941	1.184	0.840	1.015	1.047	1.013	1.089	1.008
The Frontier Sugar Mills and Distillery Limited	1.199	1.005	0.762	1.146	1.124	1.202	0.855	0.387	0.892	0.908
The Thal Industries Corporation Limited	1.242	0.944	0.762	1.210	1.368	0.565	0.787	0.970	0.999	0.951
Mean	1.052	0.991	0.953	1.053	1.038	0.983	1.011	0.962	0.956	0.999

4.3. Technical Efficiency Growth

Firm-wise technical efficiency movement is presented in Table 7 for understanding the contribution made by technical efficiency in the productivity growth of sugar firms.

The results in general suggest that technical efficiency is an important factor in dampening the total factor productivity growth of the sugar industry. The average efficiency change for eight mills is less than one while for nine firms it is equal to one which means there is no change in the managerial efficiency during study period for these firms. During year 1999, the technical efficiency change for eight firms is less than one and Habib sugar mills the worst performer with a decline in efficiency change by –8.7 percent. In this year six mills did not show any change in their efficiency. Managerial efficiency further declined in year 2000, where 14 mills have their efficiency change in negative and three mills have no change in efficiency. During this year AL Abass sugar mill was the worst performer with a decline in efficiency change by 13.8 percent. Year 2001 was relatively better for the sugar industry in terms of managerial efficiency where thirteen mills were having their efficiency change equal to or more than one**.** The efficiency change for sugar industry declined during years 2002, 2005 and 2006 by –3.1 percent, –1.5 percent and –5.9 percent respectively. The maximum decline in the managerial efficiency for the sugar industry was during year 2006. On the other side efficiency change increased during years 2003, 2004 and 2007.

The firm level changes in managerial efficiency shows that many mills remain static as their efficiency change remain equal to one in most of the years. These firms include Faran sugar mills, JDW sugar mills and Shahtaj sugar mills limited. Thal industries corporation limited which is on top in ranking according to managerial efficiency based on aggregate efficiency change is also more stable firm where efficiency change is more than one in seven out of nine years.

4.4. Technology Adoption

The comparative technical change for twenty sugar firms during period 1998 to 2007 is presented in Table 8. Generally, the technical change can be seen in eleven firms where Shakarganj mills limited at the top with 11.2 percent change followed by the Mirpurkhas sugar mills limited with 5.8 percent. In year 1999, the comparative technical change shows positive change where all mills have their technical change more than one and Thal industries corporation top in ranking followed by the Chashma sugar mills limited. In this year technical change increased by 5.4 percent for the overall sugar industry. Year 2000 was also better in terms of technical change where it was positive for sixteen mills and sugar industry overall recorded a 3.6 percent technical progress. In this year Haseeb Waqas sugar mills limited was the best performer where technical change increased by 13 percent while Shahtaj sugar mills limited was the worst performer with decline in technical progress by 10.7 percent. Years 2001 and 2007 were the worst in terms of technical progress where it declined by 5.2 percent and 5.3 percent respectively. In these years only three to four mills were having their technical change in positive. The best year according to technical progress was the year 2002 where the technical change increased by 8.7 percent for the overall sugar industry and eighteen firms have their technical change above one. In this year Mirpurkhas sugar mill was highest in ranking

Table 7

Comparative Efficiency (Managerial Efficiency) Change in all Sugar Firms during (1998–2007)

Sector	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean
Adam Sugar Mills Limited	1.000	0.981	1.019	1.000	0.966	0.990	0.996	0.884	0.877	0.967
Al Abass Sugar Mills Limited	0.992	0.862	1.169	0.839	1.158	1.030	0.857	1.057	1.061	0.996
Al Noor Sugar Mills Limited	1.000	0.985	0.995	0.891	1.076	0.951	1.025	1.052	1.034	1.000
Chashma Sugar Mils Limited	1.000	1.000	0.886	1.128	0.814	1.227	0.945	0.862	1.229	1.000
Dewan Sugar Mills Limited	0.984	0.948	1.071	0.789	1.115	1.026	0.936	1.085	0.968	0.987
Faran Sugar Mills limited	1.000	1.000	1.000	0.825	1.212	1.000	1.000	1.000	1.000	1.000
Habib Sugar Mills Limited	0.913	0.920	1.083	0.862	1.094	1.115	0.917	1.085	1.051	1.000
Haseeb Waqas Sugar Mills Limited	0.954	0.925	1.035	1.063	0.987	1.005	1.041	0.820	1.043	0.983
Husein Sugar Mills Limited	1.016	1.071	0.819	1.221	0.956	1.038	0.967	0.953	1.012	1.001
JDW Sugar Mills Limited	1.000	0.882	1.134	0.951	1.052	1.000	1.000	1.000	1.000	1.000
Kohinoor Sugar Mills Limited	1.038	0.947	0.930	1.082	0.913	1.075	0.984	1.011	0.857	0.979
Mirpurkhas Sugar Mills Limited	0.919	1.012	1.053	1.072	0.952	0.843	1.136	1.097	0.933	0.998
Noon Sugar Mills Limited	1.029	0.961	1.049	1.000	1.000	1.000	0.964	0.874	1.052	0.991
Sanghar Sugar Mills Limited	1.042	0.935	1.116	0.664	1.292	1.127	0.983	1.066	1.000	1.011
Shahtaj Sugar Mills Limited	1.000	1.000	0.977	1.023	1.000	1.000	1.000	1.000	1.000	1.000
Shakarganj Mills limited	0.965	0.912	1.155	0.968	1.033	1.000	1.000	1.000	1.000	1.002
Sind Abadgar Sugar Mills Limited	0.944	0.992	1.025	0.878	1.143	0.924	1.122	1.000	1.000	1.000
Tandlianwala Sugar Mills Limited	0.961	0.923	1.011	1.115	0.870	0.987	1.008	1.025	1.127	1.000
The Frontier Sugar Mills and Distillery Limited	1.135	0.890	0.870	1.074	1.156	1.213	0.871	0.396	0.935	0.910
The Thal Industries Corporation Limited	1.097	1.013	0.810	1.136	1.119	1.000	1.000	0.914	1.092	1.015
Mean	0.998	0.957	1.005	0.969	1.039	1.024	0.985	0.941	1.01	0.992

Table 8

Comparative Technical Change in all Sugar Firms during (1998-2007)

Sector	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean
Adam Sugar Mills Limited	1.101	0.932	1.252	1.082	0.948	0.986	1.024	0.979	0.925	1.021
Al Abass Sugar Mills Limited	1.054	1.104	0.903	1.066	0.974	1.056	1.030	0.961	0.943	1.008
Al Noor Sugar Mills Limited	1.022	1.021	0.952	1.059	0.959	1.041	1.026	0.962	0.935	0.996
Chashma Sugar Mils Limited	1.118	0.984	0.844	1.063	0.945	0.996	1.022	0.988	1.001	0.993
Dewan Sugar Mills Limited	1.047	1.042	0.929	1.038	1.023	1.035	1.033	1.005	0.917	1.007
Faran Sugar Mills Limited	1.034	1.070	1.045	0.931	1.376	0.591	0.892	1.359	0.789	0.980
Habib Sugar Mills Limited	1.024	1.109	0.891	1.073	0.972	1.018	1.086	1.037	0.924	1.012
Haseeb Waqas Sugar Mills Limited	1.039	1.130	0.855	1.071	1.032	0.996	1.025	1.003	0.925	1.005
Husein Sugar Mills Limited	1.036	1.023	0.941	1.365	0.831	0.976	1.033	0.917	0.945	0.999
JDW Sugar Mills Limited	1.069	1.012	1.132	0.833	1.019	0.998	1.036	0.994	0.923	0.999
Kohinoor Sugar Mills Limited	1.039	1.080	0.895	1.067	0.972	1.007	1.056	0.967	0.938	1.001
Mirpurkhas Sugar Mills Limited	1.062	1.013	0.953	1.691	0.990	1.043	1.035	0.970	0.926	1.058
Noon Sugar Mills Limited	1.030	1.097	0.892	1.079	0.963	1.007	1.033	0.974	0.936	0.999
Sanghar Sugar Mills Limited	1.024	1.043	0.941	1.079	0.966	1.004	0.980	1.138	0.919	1.008
Shahtaj Sugar Mills Limited	1.062	0.893	0.988	1.137	0.921	0.985	0.964	0.979	1.082	0.999
Shakarganj Mills limited	1.057	1.054	0.935	1.058	1.050	1.203	1.766	0.984	1.070	1.112
Sind Abadgar Sugar Mills Limited	1.044	1.024	0.950	1.058	0.981	0.942	0.904	1.298	1.039	1.022
Tandlianwala Sugar Mills Limited	1.036	1.059	0.931	1.063	0.965	1.028	1.040	0.989	0.966	1.008
The Frontier Sugar Mills and Distillery Limited	1.056	1.129	0.876	1.067	0.972	0.991	0.982	0.976	0.954	0.998
The Thal Industries Corporation Limited	1.132	0.931	0.940	1.065	1.223	0.565	0.787	1.061	0.916	0.937
Mean	1.054	1.036	0.948	1.087	0.999	0.96	1.026	1.022	0.947	1.008

with a progress of 69 percent followed by Husein sugar mills limited with 36.5 percent. JDW sugar mill was the worst performer where the technical change declined by 16.7 percent. Shakarganj sugar mill was the leading one during year 2004 and 2005, where the technical progress increased by 20.3 percent and 76.6 percent. Further, increase of 76.6 percent is the maximum increase in any mill in a year during period 1998 to 2007.

The ranking of all sugar firms in terms of total factor productivity growth, technical efficiency change and technical change is presented in Table 9. According to the ranking, Shakarganj mills limited is top in ranking according to TFP growth and technical change while at number three according to efficiency change. Mirpurkhas sugar mill is although next in ranking according to TFP growth and technical change but at number thirteen according to managerial efficiency change. Similar type of ranking is for the Sind Abadgar sugar mill which is at third in ranking as per TFP growth and technical change but at number eleven according to efficiency change. This indicates that technical change is the major factor which affects the total factor productivity growth for the sugar firms. The Frontier sugar mills and distillery limited is the laggard firm according to efficiency change and technical change. The other laggard firm is The Thal Industries Corporation limited according to TFP growth and technical change but highest in ranking according to efficiency change. This also indicates that for sugar firms technical change is the major source of total factor productivity.

5. CONCLUSION

Research on productivity growth is very important because economic growth cannot be sustainable without improvement in the Total Factor Productivity. From a policy point of view, the assessment of TFP growth is important as it serves as a guide for resource allocation and investment decisions. In this paper we have applied Data Envelopment Analysis approach for estimating TFP growth, efficiency change and technological progress in Pakistan's sugar industry using data for twenty sugar firms from 1998 to 2007. Productivity Growth is estimated using Malmquist productivity index. The decomposition of TFP growth also helped us to identify improvement in efficiency and contribution of technological progress and innovation to productivity growth in sugar industry. Most of the studies of productivity growth efficiency which are based on panel data discuss the estimates of overall sample or sector. However, we have presented the estimated TFP growth, efficiency change and technical change at each firm level and for each year during 1998 to 2007 which shows that these estimates varies widely at firm level during the data period.

The empirical estimates on the performance of sugar industry yielded several striking results. The Malmquist TFP results reflect a tormenting picture for the sugar industry. Overall sugar industry improved technological progress by 0.8 percent while managerial efficiency change declined by a same percentage. Due this reason the overall TFP growth during 1998–2007 remained almost static with a decline of 0.1 percent.

The results of TFP growth and its components also presents divergent trend in the individual years for the overall sugar industry. The efficiency change declined for nine sugar firms and remained equal to one for nine sugar firms during period 1998 to 2007, while the technical change is positive for eleven out of twenty sugar firms. Therefore, the result shows static TFP Growth. It suggests that sugar industry is lacking in terms of

Table 9

Ranking of Sugar Firms Based on Malmquist TFP and its Components

Rank-ing	Industry	TFP Change	Industry	TE Change	Industry	Tech. Change
1	Shakarganj Mills Limited	1.114	The Thal Industries Corporation Limited	1.015	Shakarganj Mills Limited	1.112
2	Mirpurkhas Sugar Mills Limited	1.056	Sanghar Sugar Mills Limited	1.011	Mirpurkhas Sugar Mills Limited	1.058
3	Sind Abadgar Sugar Mills Limited	1.022	Shakarganj Mills Limited	1.002	Sind Abadgar Sugar Mills Limited	1.022
4	Sanghar Sugar Mills Limited	1.019	Husein Sugar Mills Limited	1.001	Adam Sugar Mills Limited	1.021
5	Habib Sugar Mills Limited	1.012	Al Noor Sugar Mills Limited	1.000	Habib Sugar Mills Limited	1.012
6	Tandlianwala Sugar Mills Limited	1.008	Chashma Sugar Mils Limited	1.000	Al Abass Sugar Mills Limited	1.008
7	Al Abass Sugar Mills Limited	1.004	Faran Sugar Mills Limited	1.000	Sanghar Sugar Mills Limited	1.008
8	Husein Sugar Mills Limited	0.999	Habib Sugar Mills Limited	1.000	Tandlianwala Sugar Mills Limited	1.008
9	JDW Sugar Mills Limited	0.999	JDW Sugar Mills Limited	1.000	Dewan Sugar Mills Limited	1.007
10	Shahtaj Sugar Mills Limited	0.999	Shahtaj Sugar Mills Limited	1.000	Haseeb Waqas Sugar Mills Limited	1.005
11	Al Noor Sugar Mills Limited	0.996	Sind Abadgar Sugar Mills Limited	1.000	Kohinoor Sugar Mills Limited	1.001
12	Chashma Sugar Mils Limited	0.993	Tandlianwala Sugar Mills limited	1.000	Husein Sugar Mills Limited	0.999
13	Dewan Sugar Mills Limited	0.993	Mirpurkhas Sugar Mills Limited	0.998	JDW Sugar Mills Limited	0.999
14	Noon Sugar Mills Limited	0.990	Al Abass Sugar Mills Limited	0.996	Noon Sugar Mills Limited	0.999
15	Haseeb Waqas Sugar Mills Limited	0.988	Noon Sugar Mills Limited	0.991	Shahtaj Sugar Mills Limited	0.999
16	Adam Sugar Mills Limited	0.987	Dewan Sugar Mills Limited	0.987	The Frontier Sugar Mills & Distillery Limited	0.998
17	Faran Sugar Mills Limited	0.980	Haseeb Waqas Sugar Mills Limited	0.983	Al Noor Sugar Mills Limited	0.996
18	Kohinoor Sugar Mills Limited	0.980	Kohinoor Sugar Mills Limited	0.979	Chashma Sugar Mils Limited	0.993
19	The Thal Industries Corporation Limited	0.951	Adam Sugar Mills Limited	0.967	Faran Sugar Mills Limited	0.980
20	The Frontier Sugar Mills & Distillery Limited	0.908	The Frontier Sugar Mills & Distillery Limited	0.910	The Thal Industries Corporation Limited	0.937

managerial efficiency which could be explained by a general reduction in the quality of managerial decision-making among the best practice firms. Regardless of the reason for this decline, it has potentially serious implications for the longer-term financial viability of these sugar firms. Except few firms which are relatively stable include Shakarganj mills limited and Al Abass sugar mills limited, all sugar firms have a mix trend over 1998–2007 which affects the productivity and ranking of firms.

The pattern of TFP growth tends to be driven more by technical change (or technical progress) rather than improvements in technical efficiency. Shakarganj mills limited has highest technical change and also better performance in terms of managerial efficiency change which lead it top in ranking in terms of TFP. This firm has also performed better in terms of stability over the period 1998 to 2007, where the TFP increased for seven out of nine years. The major source for Mirpurkhas sugar mill is the technical change, which lead it to next in ranking. The technical change is also a main source of relatively better performance for Sind Abadgar sugar mill and Habib sugar mill while Sanghar sugar mill is also among the top ranking firms where the main sources is managerial efficiency. The Frontier sugar mill is among the worst performers in terms of productivity over 1998 to 2007 where the problem lies in managerial efficiency and also non adoption of new technologies. Similarly, The Thal Industries is also one of the laggard firms in terms of TFP where the major source is non adoption of new technologies although top in ranking in terms of efficiency change.

The research suggests that the Pakistani sugar industry is facing serious productivity growth problems where no increase is recorded in total factor productivity during 1998 to 2007. Therefore, this industry must increase total factor productivity in most of the firms and efforts must be made to provide a stable pattern to the productivity growth. The improvement is needed in both technical efficiency and technological progress in the sugar industry. For increasing technical efficiency, efforts are needed to improve the quality of inputs like capital and labour. On the other side the management aspect cannot be ignored and it is also very important in terms of capital. Furthermore, the research and development (R & D) activities can also play a vital role in bringing technological progress. Although there is very little increase in the technical change but for further considerable increase in the productivity, efforts could be made to increase the research and development (R & D) activities in this industry. Therefore, firms in the sugar industry need greater investment in (R & D) activities and adoption of new technologies.

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Comments

The paper titled 'Efficiency Dynamics of Sugar Industry of Pakistan' is interesting and analytical technique used in this paper is latest one. However, write up of this paper needs some editing. For example, in abstract and introduction of this paper, it is stated that total factor productivity (TFP) in sugar industry will be decomposed in 3 categories; technical, scale and managerial. But in Table 4, Malmquist indices have been worked out for technical efficiency change, technical change, production efficiency change, scale efficiency change and TFP. Furthermore, only 3 of these indices have been discussed in Sections 5.3 and 5.4.

In abstract of the paper it is mentioned that there are 81 sugar mills in Pakistan whereas on page 4, the number changes to 84. Also subheading 5.1 is exactly same as 5.2 that should be avoided. Similarly, in Table 1 in 'Overview of Sugar Industry', sugar yield in Pakistan is reported as 3.54 while its correct figure comes out 4.51. Column 4 in Tables 2 and 3 of this section are not commented anywhere in the text. Furthermore, the first sentence in paragraph 2 at page 5 states that area under sugarcane cultivation has increased but data in Table 2 and the last sentence in first paragraph at page 6 do not support it. Calculation of Malmquest indices on pages 8 and 9 is not properly explained. I am sure that careful editing of this paper will improve its reading and worth.

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