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PRODUCTIVE EFFICIENCY OF PRIVATIZED CEMENT PLANTS IN TURKEY

Cengiz YAVİLİOĞLU[*]
Onur ÖZSOY[**]

Abstract

The purpose of this study is to use Data Envelopment Analysis (DEA-CCR and DEA-BCC Models) to evaluate the productive efficiency of cement plants in Turkey between 1989 and 2006. Total of 25 cement plants were privatized between 1989 and 2003 and over one billion US dollar income generated. Among the cement plants that were analyzed, Iskenderun, Ankara, Söke, Trakya and Denizli cement factories have worked efficiently with comparison to the others between 1987 and 2006. However, it is not possible to conclude that the productive efficiency of privatized cement plants performed better than the pre-privatized period.

Keywords: DEA-CCR, DEA-BCC Models, cement plants, productive efficiency, privatization, Turkey, data envelopment analysis.

Öz

Türkiye'de Özelleştirilmiş Olan Çimento Fabrikalarının Üretim Verimliliği

Bu çalışmanın temel hedefi, Veri Zarflama Analizi (VZA) yöntemini kullanarak 1989 ve 2006 yılları arasında Türkiye'de çimento tesislerinin verimlilik ve etkinliklerini analiz etmektir. 1989 ve 2003 yılları arasında toplam 25 çimento tesisi özelleştirilmiş ve bu özelleştirmelerden bir milyar doların üzerinde gelir elde edilmiştir. Analize tabi tutulan çimento tesisleri arasında, , Iskenderun, Ankara, Söke, Trakya ve Denizli çimento fabrikaları diğerlerine göre daha verimli hale gelmişlerdir. Fakat özelleştirilen çimento fabrikalarının özelleştirilmeden önceki dönemle karşılaştırıldıklarında verimliliklerinin arttığı yönünde bir sonuca ulaşmak mümkün görünmemektedir..

Anahtar Sözcükler: DEA-CCR, DEA-BCC Modelleri, çimento tesisleri, verimlilik, etkinlik, özelleştirme, Türkiye, veri zarflama analizi.

[*] Dr., Privatization Administration, Ankara, TURKEY, Cyavilioglu@oib.gov.tr
[**] Assoc. Prof., Ankara University, Faculty of Political Sciences, Department of Economics, 06590 Ankara-TURKEY, ozsoy@politics.ankara.edu.tr

INTRODUCTION

The world has witnessed an intensive privatization processes during the last two and a half decades. The privatization of SEEs around the world has gained a considerable momentum after the Thatcher government launched a heavy privatization program in England during the beginning of 1980s. With a few exceptions[1], the governments of developed countries have had no significant resistance towards privatizing SEEs. On the other hand, the governments of developing countries have had difficulty in finding enough public and political advocates to regularly continue the privatization programs. As a result of this, privatization processes often face cutbacks in the developing countries. The repugnance to divestiture of SEEs in the developing countries is usually related to the suspicions about the whole privatization processes. There are many opposition groups of privatization processes in the developing world. For instance, labor unions frequently argue that privatizations lead former SEEs to layoff workers; local private service providers and retailers, conduct business within the territories of the SEEs under the consideration of privatization most often afraid that the possible worker layoffs would reduce the purchasing power in the area that would have negative impact on their businesses; political leaders may be afraid that higher performance of privatized companies are obtained at the expense of the rest of the society (Torero, 2003).

Although large scale privatization activities were conducted by the Adenauer government in Germany in 1961[2], it is widely accepted that modern privatization activities began during the Margret Thatcher government in England in 1979.

Following the privatization start up in England, Privatization policies have been included in the economic programs of many developed and developing as well as in the economic agenda of economies in transition countries with different motivations and perhaps similar purposes. The primary motivation behind SEEs divestiture programs in all countries is to lessen the burden of SEEs on public budget. Additionally, the main purpose and decision of privatizing SEEs is based on the idea that inefficient use of resources, poor performance, and insufficient operations of SEEs by the state. Moreover, privatizing SEEs create room for competition to increase efficiency and performance of SEEs, and to reduce the misuse of public resources. Consequently, many governments around the world, including the former socialist countries involved in privatization activities. As Kikeri et al. (1994) asserted that due to the high burden and insufficient performance of SEEs, many governments around the world introduced privatization programs.

This study utilizes DEA to evaluate the productive efficiency of privatized cement factories in Turkey between 1989 and 2006. The second part of this paper evaluates the efficiency analysis of privatized SEEs in the literature. The third part of this paper overviews the cement industry in Turkey and reports some crucial descriptive statistics. The fourth part of the paper introduces the DEA analysis and describes the variables and sources of data used in this study and discuss the results. Finally, the fifth part of this paper concludes with underlying results obtained from the study.

1. LITERATURE REVIEW

Researchers have employed many techniques for analyzing efficiency and performance of privatized SEEs. A comprehensive literature survey on empirical studies of privatized SEEs can be found in Megginson and Netter (2001). They evaluated many empirical studies conducted to measure the performance of SEEs before and after privatization in developed, developing and transition economies. Most of the empirical studies included in Megginson and Netter (2001) found that efficiency and productivity of SEEs increase after privatization. Most of these studies employed such financial variables as sale revenues, profitability, operational productivity, leverage ratio, and dividend ratio. They found that privatized SEEs got better in terms of their financial structures.

La Porta and López-de-Silanes (1999) employed financial tables and surveys to analyze efficiency of privatized SEEs in Mexico between 1983 and 1991. They used 218 SEEs from 26 different sectors. La Porta and López-de-Silanes (1999) illustrated that privatized SEEs increased their sales by 54.3%, in spite of reduction in workforce and modest increase in capital. During the period of investigation, prices increased by 2.9%. they also differentiated increases in profitability of SEEs. Approximately 10% increase in profit gain was caused by increases in prices and 33% was due to reduced employment, while 57% gain in profit was originated from productivity gains.

Privatized SEEs are faced with market mechanism and competitions from the existing firms in the same and related industries. As a result of this, efficiency of privatized SEEs increases (Richard and Mansoor, 1998). Additionally, since the government subsidies no longer exist to compensate losses of SEEs after privatization, they have to use all of their resources as efficiently as possible to increase profitability (Kikeri et. al., 1992).

Furthermore, in many cases, SEEs go through major reforms during the pre-privatized period. As a result of this, efficiency of SEEs increases even

before they are fully privatized (Barberis et. al., 1996). Moreover, the owners of privatized firms are directly responsible for losses and gains of their firms. Therefore, the owners of privatized SEEs are expected to find ways to operate efficiently to increase profitability.

It is also argued that the managers of privatized SEEs are employed by the owner of these firms to increase efficiency to fulfill profit maximizing purpose of these firms. This argument is in accordance with empirical studies conducted to assess the firm performance after privatization both in developed and developing countries around the world. For instance, Viving and Boardman (1992), and Megginson et. al. (1994) used different techniques and measured that privatized firms are more efficient than that of non-privatized ones.

Researchers used different techniques to measure efficiency of privatized firms. For example, Megginson et. al. (1994), Boubraki and Cossett (1998) defined efficiency as real sales revenue per worker. Bishop and Thompson (1992), Bishop and Green (1995) defined efficiency as total factor productivity. Martin and Parker (1995) used annual rate of growth of added value per worker to measure efficiency.

Most of the studies conducted to measure the efficiency of privatized firms used ratio analysis. Macedo (2000) used ratio analysis to investigate performance of privatized SEEs in Brazil. He found that performance of privatized SEEs is increased. Pinheiro and Schneider (1995) employed ratio analysis and compared 50 Brazilian SEEs before and after privatization. He concluded that performance of privatized SEEs increased and this is supported with government regulations.

Sun and Tong (2002) also used ratio analysis and investigated performance of privatized 24 SEEs in Malaysia between 1983 and 1997. The SEEs included in their study were privatized through equity sales in the Stock Exchange Market of Malaysia. The main findings of this study are, as expected increase in profitability, increase in dividend payments, and decrease in leverage ratio. Another study conducted by Naceur et al. (2006) used ratio analysis and evaluated the performance of 95 privatized SEEs in Egypt, Morocco, Tunisia, and Turkey. They found that profitability and labor layoffs increased, leverage ratio decreased in all of the cases included in their study. Additionally, worker layoffs were found to be the highest in Egypt and leverage ratio was the lowest in Morocco among the countries included in this study.

Furthermore, since there has been no report of re-publicized privatized SEEs in the world, one could assert that SEEs privatization processes have been successful since the late 1970s (Nellis, 2002).

Therefore, privatization process is so crucial in the process of increasing economic efficiency and productivity. Megginson and Natter (2001) evaluated 65 studies conducted previously to analyze the performance of privatized SEEs. These studies analyzed the performance and efficiency of privatized SEEs in firm, country, industrial levels and concluded that except for one study, privatization increased efficiency and productivity (Martin and Parker, 1995).

There are some emprical studies conducted to analyze the performance of privatized Turkish cement plants (Ozmucur, 1998; Saygılı and Taymaz, 2001: Tallant, 1993; Ökten and Arın, 2006). These empirical studies analyzed the impact of privatization on the cement plants from the view point of productive-allocative efficiency, market structure and input choices. The results of these empirical studies are all mixed. Ozmucur's sample included both public and private cement plants for the time period 1981-1995. Ozmucur estimated a separate equation for each cement plant to find out the year of structural change for employment and labor productivity. He found out that the level of employment decreased and productivity were higher in the privatized cement plants after privatization. Talant (1993) also analyzed the relative efficiency of public sector and compared the results with the results of private sector cement plants. He found out that private cement plants were more efficient than the public cement plants. He also figured out that western cement plants performed better than others. This is an indication that the initial locations of cement plants are important. Saygılı and Taymaz (2001) evaluated the impact of ownership and privatization on technical efficiency. They used panel data belong to both public and private cement plants for the period of 1980-1995 and measured the relative performance of private or privatized cement plants with respect to the six cement plants that remained public during the indicated time period. They concluded that the private cement plants were far more efficient than the public cement plants. However, they indicated that average technical efficiency of private and privatized public cement plants showed no statistically significant results for 1989.

Ökten and Arın (2006) analyzed the impact of productive and allocative efficiency of 22 cement plants for the period 1983-1999 in Turkey. They found out that ownership effects are sufficient to achieve improvements in labor productivity. Their results further indicated that allocative efficiency dependent upon changes in the competitive environment. They also pointed out that all cement plants increased the labor productivity by reducing the work force. They illustrated that cement plants sold to foreign investors also increased their capital and investment significantly.

2. THE OVERVIEW OF CEMENT INDUSTRY IN TURKEY

The vital impact of cement industry on the socio-economic development and economic growth were understood and has been given enough attention in Turkey from the early 1900s. As a result, the first cement production was started in 1911 in Darıca. The capacity of Darıca cement mill was 20 thousand tons/year (Başaran and Turunç, 1995). However, the cement industry grew quickly during and after 1950s in Turkey. There were 60 cement factories in Turkey as of end of 2006. The Turkish cement industry is the seventh biggest in the world and second biggest in Europe[3]. Consequently, the Turkish cement industry is crucial both for Turkey and for the Middle Eastern Region as a whole. The Turkish construction companies have been playing vital role in the rebuilding process of Iraq. This makes the Turkish cement industry even more important.

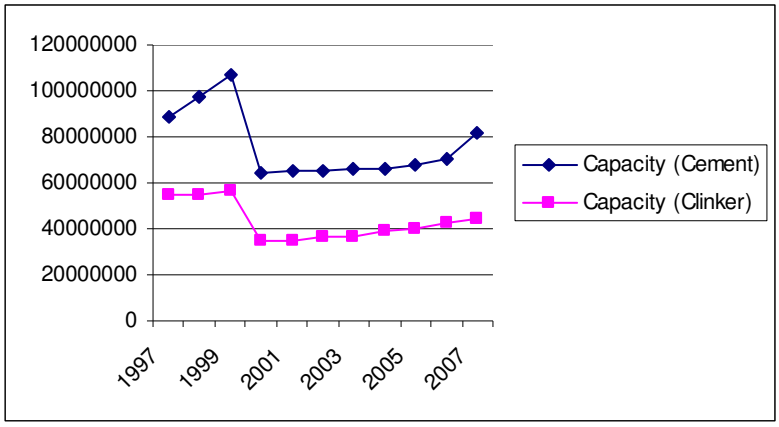
Table 1: Privatized Cement Factories in Turkey: 1989-2003

Privatized Cement Factory	Date of Privatization	Revenue From Privatization ($)
Adana	1991-1994	45090828
Afyon	1989-1994	24585963
Ankara	1989	33000000
Aşkale	1993	31158000
Balıkesir	1989	23000000
Bolu	1990-1994	41839459
Çorum	1992	35000000
Denizli	1992	70100000
Elazığ	1996	27850000
Ergani	1997	46700000
Gazi Antep	1992	52695898
İskenderun	1992	61500000
Kars	1996	22250000
Konya	1990-1993	27182205
Kurtalan	1998	28100000
Ladik	1993	57598687
Lalapaşa	1996	125890000
Mardin	1990-1993	19532914
Niğde	1991-1993	25150548
Pınarhisar	1989	25000000
Sivas	1992	29400000
Şanlı Urfa	1993	57405988
Trabzon	1992	32551000
Ünye	1990-2003	22200889,29
Van	1996	24500000
	Total	**989282379,3**

Source: The Turkish Privatization Administration.

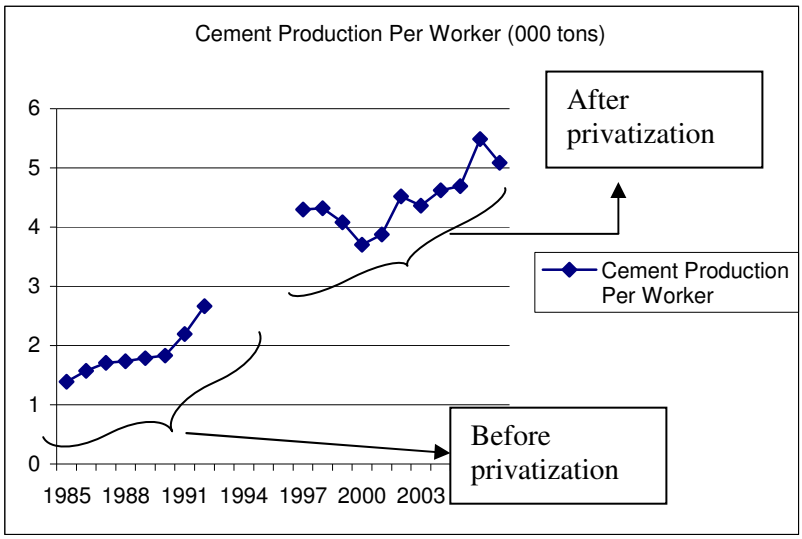
As observed from table 1, total of 25 cement factories were privatized in Turkey between 1989 and 2003 and approximately one billion US dollar revenue generated.

Graph 1: Cement and Clinker Capacity in Turkey between 1997 and 2006



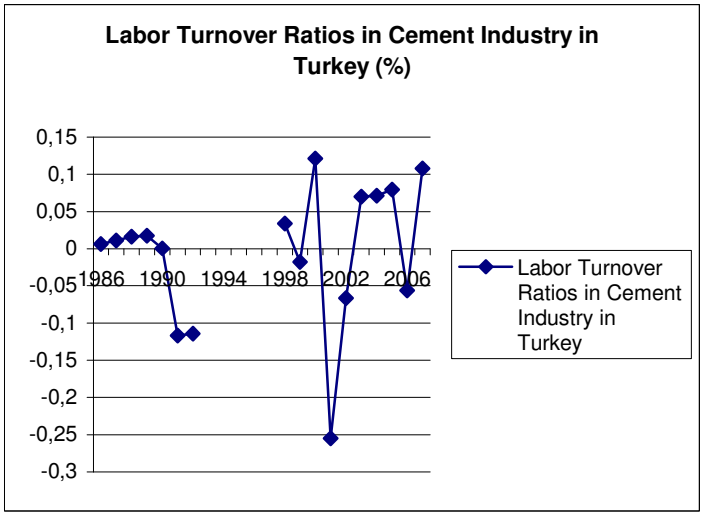
Cement and clinker capacities in Turkey between 1997 and 2006 are shown in graph 1. As observed, cement production declined between 1999 and 2000. This was due to the economic crises of November of 2000 and February of 2001. Following the economic crisis period, cement production increased reasonably in Turkey.

Graph 2: Cement Production per Worker in Turkey between 1985 and 2006



As illustrated in graph 2, cement production per worker has increased before and after privatization periods. However, the rate of increase in productivity was higher after the privatization period.

Graph 3: Labor Turnover Ratios in Cement Industry in Turkey



As shown in graph 3, there were no big labor turnover ratios in cement industry in Turkey before and after privatization periods. Employment rates remained almost unchanged especially after, 1997 and increased after 2001. The main reason for the increase in employment rates after 2001 was that the crucial role played by the Turkish construction companies in the rebuilding processes of neighboring Iraq.

3. DEA MODEL AND EMPRICAL ANALYSIS

3.1. DEA Model

Researchers most often measured the efficiency of privatized SEEs by using ratio analysis. However, in recent years, nonparametric and non-stocastic models have been heavily employed to evaluate the efficiency of privatized SEEs both in developing and in developed countries. Among these models, the DEA is considered to be the most crucial and most commonly used models in efficiency analysis.

The most widely used DEA model in efficiency analysis was developed by Charnes, Cooper and Rhodes (1978) and it is known as CCR model. The CCR model based on two inputs one output concept. Additionally, the CCR model observes constant returns to scale. As a result of this the CCR model aims to measure the overall technological efficiency of DMUs under the constant returns to scale assumption. The CCR model was extended by Banker, et al. (1984) to include variable returns to scale. This model is known as BCC model.[4] The BCC model measures the overall technical efficiency under the variable returns to scale assumption. Consequently, these two models are the main DEA models that have been widely used to measure performance of various sectors.

In this study, we used the DEA model, developed by Charnes, Cooper and Rhodes (1994) (CCR model), by Banker, et al. (1984), and extended by Sherman and Ladino (1995) (BCC model) to measure overall productivity of 25 cement plants, which were privatized between 1989 and 2006 in Turkey.

The DEA is especially used to analyze the performances of firms in the service industry. However, the DEA model can also be employed to evaluate the performances of firms in other industries, such as the cement industry.

With DEA, actual performances of each cement factory can be analyzed and compared with others and those which are operating inefficiently can be identified. The best performing factories are identified by a DEA efficiency score of 100%. The inefficient factories are identified by a DEA efficiency score less than 100%.

DEA measures the relative ratio of a DMU's total weighted outputs to total weighted inputs. DEA is used to evaluate the relative productive efficiency of each unit (each cement plant).

According to Charnes et al. (1978) the efficiency, h0, of a DMU0 can be determined by solving the following ***CCR model:***

$$\max h_{0(u,v)} = \frac{\sum_{r=1}^{s} U_r Y_{r0}}{\sum_{i=1}^{m} V_i X_{i0}}$$

$$\text{Subject to } \frac{\sum_{r=1}^{s} U_r Y_{rj}}{\sum_{i=1}^{m} V_i X_{ij}} \le 1, \qquad (1)$$

$$j = 1,2,...n \text{ where } U_r \ge 0, r = 1,2,...s;\ V_i \ge 0, i = 1,2,...m.$$

In model (1), the y_{rj}, $x_{ij} > 0$ depicts outputs and inputs for DMUj with the ranges for i, r, and j. In addition to this, in model (1) U_r represents the weight given to output r, V_i shows the weight given to input i, s is the number of outputs, m is the number of inputs, n is the number of DMUs, and h_0 is the efficiency value of DMU_0. The constraints in model (1) indicate that an optimal $h_0^* = \max h_0$ will always satisfy $0 \le h_0^* \le 1$ with the optimal solution values $U_r^*, V_r^* > 0$. Therefore, the model is a nonlinear fractional mathematical programming model that has to be solved.

On the other hand, Banker, et al. (1984) extended the CCR model to include variable returns to scale (BCC model). ***BCC model*** is equivalent to fractional

problem, can be mathematically stated as follows:

$$\max \frac{\sum_{r=1}^{s} U_r Y_{r0} - U_0}{\sum_{i=1}^{m} V_i X_{i0}}$$

$$\text{Subject to } \frac{\sum_{r=1}^{s} U_r Y_{rj} - U_0}{\sum_{i=1}^{m} V_i X_{ij}} \leq 1, \qquad (2)$$

$$j = 1,2,..n \text{ where } U_r \geq 0, r = 1,2,...s;\ V_i \geq 0, i = 1,2,..m$$

In model (2), U_0 is unconstrained in sign. The CCR and BCC models, described above are used to determine the productive efficiency of privatized cement factories in Turkey. In order to maximize the productive efficiency scores of cement factories under evaluation, weighted input and outputs are selected.

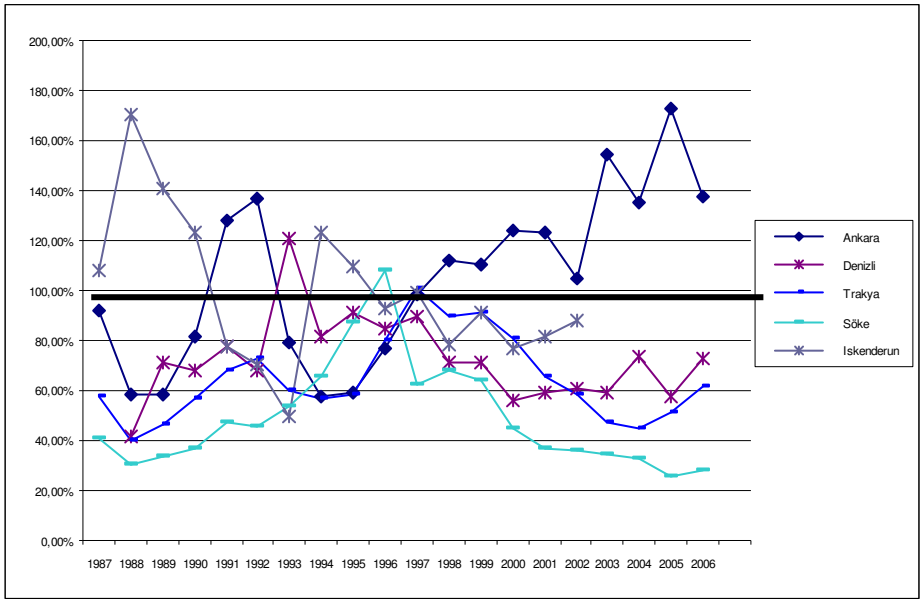
In this study, productive efficiency of cement factories are evaluated before and after privatization periods. It is assumed that the number of inputs is "g" and outputs "ç" respectively for each cement factory.

3.2. Empirical Analysis

The empirical analysis is conducted by using two inputs and one output. The inputs used in this analysis are amount of clinker and number of employees and the output is the amount of cement produced by the factories under consideration. Data were collected from Turkish Privatization agency, WEB pages of cement factories, and Turkish Cement Producers Association.[5]

The results illustrated here, are the relative efficiency of privatized 25 cement plants after evaluating under DEA-CCR and DEA-BCC. DEA-CCR model is input oriented under constant returns to scale and DEA model is also input oriented under variable returns to scale assumptions. The efficiency scores of all privatized 25 cement plants were computed by running the appropriate DEA model. The empirical results were obtained by using the statistical package program, Efficiency Measurement System (EMS).[6] The data was arranged in MS Excel and ran by using EMS to obtain the productive efficiency results for the privatized cement plants included in this study. DEA scores, slacks, and returns to scale for each cement plant were calculated.

Graph 4: Results of Data Envelopment Analysis



Efficiency scores obtained from running the input oriented DEA-CCR model with the assumption of constant returns to scale for selected privatized cement plants are illustrated in Graph 4. The thicker horizantal line in graph 4 is the treshhold for productive efficiency of cement plants included in this study. If the efficiency score is below the efficiency trashhold line, the factory is considered to be inefficient. On the other hand, efficiency scores above the trashhold line are efficient. As can be observed from graph 4, Iskenderun, Ankara, Söke, Trakya and Denizli cement factories have worked efficiently from time to time during the studied time period. When the average efficiency of 24 cement factories that are included in this study are evaluated, it is clearly figured out that except for Ankara Cement Factory, others were unable to fulfill the efficiency score of 1. The average efficiency score for Ankara Cement Factory calculated to be 1,05 for the period 1987-2006. Ankara Cement Factory performed efficiently especially after the privatization and the others performed inefficiently on average.

Efficiency scores obtained from running the input oriented DEA-CCR model with the assumption of returns to scale for privatized cement plants are also shown in table 2. As can be observed from table 2, some cement plants have operated efficiently from time to time. However, non of the cement plant has operated efficiently through out the entire time period included in this study. Therefore, it is impossible to conclude for sure that the cement plant has operated more efficiently after they were privatized.

Table 2: Productive Efficiency Scores of Cement Factories Before and After Privatization (Input oriented DEA-CCR Model with constant returns to scale)*

DMUs	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Ankara	92,31%	58,57%	58,43%	81,27%	128,27%	137,13%	79,44%	57,32%	59,04%	76,94%	98,38%	111,80%	110,01%	123,75%	123,04%	105,14%	154,58%	135,41%	172,63%	137,23%
Aşkale		28,62%	30,07%	33,21%	44,82%	44,19%	44,91%	34,33%	42,25%	53,36%	74,35%	67,79%	47,54%	42,91%	55,40%	52,20%	41,80%	45,51%	25,84%	26,98%
Afyon	62,12%	36,06%	47,95%	56,82%	70,42%	70,04%	62,12%	41,67%	40,99%	51,86%	62,48%	59,87%	68,70%	53,97%	53,97%	65,21%	64,69%	61,14%	54,16%	43,68%
Çorum	46,09%	27,34%	31,48%	36,47%	50,79%	44,02%	34,00%	33,77%	40,68%	48,71%	62,28%	57,38%	83,90%	74,03%	75,33%	71,16%	57,87%	67,23%	40,74%	31,01%
Denizli		41,64%	71,10%	68,33%	77,96%	67,97%	121,05%	81,38%	91,44%	84,84%	89,88%	71,08%	70,90%	56,21%	59,56%	60,97%	59,51%	73,85%	57,93%	72,87%
Balıkesir	53,76%	31,55%	40,75%	46,08%	76,49%	68,64%	54,76%	40,09%	41,79%	56,21%	71,85%	63,52%	70,11%	46,80%	46,29%	41,13%	39,06%	43,93%	41,92%	39,99%
Elazığ-Altınova					35,83%	30,22%	22,64%	17,15%	16,01%	27,56%	47,10%	45,35%	59,37%	55,85%	74,46%	68,31%	62,24%	43,18%	31,36%	
Trakya	57,56%	39,93%	46,22%	56,97%	68,10%	72,93%	60,07%	56,61%	58,75%	79,64%	101,15%	89,44%	90,90%	80,81%	65,99%	58,37%	47,29%	44,57%	51,02%	61,34%
Van					26,34%	27,60%	23,15%	17,87%	18,18%	24,87%	32,45%	29,08%	37,56%	29,05%	1,13%	23,86%	25,51%	24,82%		
Trabzon	55,61%	34,23%	38,93%	43,15%	63,14%	48,18%	33,86%	43,19%	43,51%	66,35%	57,26%	42,15%	39,27%	26,50%	9,55%	32,36%	30,44%	34,36%		
Ş.Urfa		32,95%	38,50%	40,08%	45,24%	41,58%	41,02%	25,45%	33,79%	45,89%	36,52%	43,35%	44,08%	19,72%	8,77%	36,29%	35,43%	48,19%		
Lalapaşa					42,41%	46,44%	61,31%	46,86%	40,64%	53,71%	77,86%	58,40%	82,21%	18,68%	8,07%	72,60%	53,77%	67,32%		
Ladik		39,10%	41,74%		73,29%	64,31%	82,61%	47,73%	48,59%	64,23%	61,28%	59,26%	73,79%	48,16%	25,04%	58,61%	42,29%	44,81%		
Gümüşhane					9,18%	45,10%	39,28%	25,64%	24,98%	29,67%	3,02%	74,86%		36,68%	21,56%	48,79%	41,11%	44,94%		
Gaziantep	69,76%	36,16%	45,48%	44,04%	60,22%	60,33%	73,03%	49,68%	55,19%	87,29%	75,15%	69,05%	77,93%	19,03%	6,08%	26,76%	33,53%	36,39%		
Ergani						33,22%	26,09%	12,71%	20,71%	22,88%	28,76%	40,28%	41,61%	14,28%	6,68%	24,42%	23,57%	19,82%		
Bartın		29,33%	30,51%	33,77%	35,75%	27,88%	36,03%	32,97%	32,54%	44,15%	29,59%	20,39%	35,99%	44,70%	36,48%	35,76%	34,70%	32,91%	25,27%	28,00%
Söke	41,14%	30,46%	33,47%	36,72%	47,58%	45,71%	53,55%	65,88%	87,09%	108,18%	62,36%	67,65%	64,18%	54,33%	61,81%	51,72%	53,02%	39,59%	42,07%	39,94%
Sivas	38,64%	21,32%	25,21%	25,92%	35,39%	33,29%	28,52%	26,34%	40,99%	41,51%	54,41%	49,27%	60,03%	37,33%	70,72%	62,66%	49,94%	32,77%	27,75%	21,04%
Siirt-Kurtalan							19,66%	13,36%	15,02%	19,91%	25,10%	30,55%	35,11%	57,23%	50,06%	66,13%				
Niğde	48,01%	31,48%	33,47%	39,73%	46,90%	62,79%	73,36%	43,00%	49,00%	61,88%	72,19%	68,67%	69,15%	33,25%	45,57%	46,58%	34,81%	30,90%	25,40%	27,29%
Kars					28,61%	23,52%	17,77%	15,37%	14,58%	19,59%	27,48%	28,67%	29,65%	76,96%	81,27%	88,06%				
Iskenderun	108,33%	170,74%	140,65%	123,05%	77,25%	70,48%	49,54%	122,87%	109,36%	92,43%	98,86%	78,45%	90,83%	69,10%	79,03%	95,11%	49,28%	47,06%	35,30%	40,31%
Adıyaman				50,06%	58,09%	43,23%	33,77%	23,23%	36,51%	63,21%	71,00%	73,91%	80,56%							

*The blank cells in the table 2 were not calculated due to the deficiency of data for those years.

Table 3: Productive Efficiency Scores of Cement Factories Before and After Privatization (Input oriented DEA-BCC Model with variable returns to scale)*

DMUs	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Ankara	1	1	60,12%	1	1	1	81,89%	66,15%	60,99%	80,04%	98,65%	121,41%	119,86%	1	1	105,99%	165,40%	138,01%	174,76%	148,61%
Aşkale		63,90%	67,97%	68,39%	52,41%	52,05%	56,17%	42,31%	54,58%	59,88%	77,67%	68,09%	51,63%	49,35%	59,21%	54,17%	48,28%	48,15%	35,31%	39,92%
Afyon	65,32%	54,50%	60,64%	65,43%	77,07%	77,67%	72,86%	51,21%	49,93%	56,48%	67,13%	60,19%	75,42%	68,74%	68,01%	75,51%	82,54%	77,32%	103,24%	97,37%
Çorum	58,00%	49,02%	51,87%	52,74%	54,33%	48,19%	44,68%	49,93%	52,62%	55,83%	67,43%	57,75%	126,09%	132,17%	127,63%	134,78%	153,62%	152,17%	98,18%	84,46%
Denizli		67,34%	71,97%	72,11%	78,69%	68,29%	1	139,02%	1	1	1	98,20%	1	56,83%	59,85%	1	1	1	1	1
Balıkesir	62,15%	50,13%	53,33%	56,23%	81,98%	76,21%	66,89%	51,39%	52,30%	60,50%	74,26%	63,81%	76,26%	62,16%	62,02%	56,14%	61,24%	61,37%	90,76%	103,20%
Elazığ-Altınova					42,22%	36,17%	31,87%	26,80%	27,12%	36,86%	50,85%	45,57%	63,45%	63,11%	79,58%	73,33%	70,62%	52,98%	48,33%	
Trakya	66,39%	55,10%	56,83%	60,92%	70,87%	77,55%	66,63%	1	62,66%	88,83%	105,23%	89,46%	91,61%	84,24%	72,35%	64,23%	60,76%	56,20%	77,71%	82,46%
Van					38,54%	39,62%	41,39%	40,78%	40,98%	45,19%	50,81%	29,83%	85,26%	67,77%	69,57%	65,71%	56,56%	58,47%		
Trabzon	71,68%	59,17%	65,62%	65,23%	68,12%	54,14%	43,46%	51,45%	53,10%	69,34%	67,83%	42,56%	62,79%	58,99%	60,15%	58,97%	53,49%	50,51%		
Ş.Urfa		67,34%	70,03%	68,83%	51,97%	47,76%	54,71%	42,54%	46,94%	50,49%	49,55%	43,85%	69,23%	58,99%	64,00%	62,73%	55,61%	60,57%		
Lalapaşa					70,39%	56,17%	68,40%	46,88%	44,68%	56,55%	78,80%	58,79%	91,27%	78,85%	81,63%	81,93%	69,02%	76,61%		
Ladik		64,94%	66,45%	66,46%	74,79%	65,37%	83,03%	51,74%	49,72%	69,12%	67,31%	59,59%	81,24%	60,97%	59,70%	68,93%	58,85%	57,66%		
Gümüşhane					263,83%	296,77%	210,00%	132,43%	137,50%	231,11%	351,52%	2725,00%	82,49%	65,08%	74,77%	64,46%	60,05%	58,55%		
Gaziantep	71,82%	50,76%	52,93%	55,64%	62,86%	62,15%	76,64%	51,90%	56,23%	96,44%	78,08%	69,25%	81,00%	56,55%	60,15%	52,27%	51,25%	49,41%		
Ergani						39,80%	35,61%	27,07%	29,13%	27,68%	41,42%	40,87%	74,31%	75,23%	68,38%	55,65%	49,29%	49,64%		
Bartın		67,11%	67,97%	68,39%	43,83%	35,46%	53,92%	49,92%	50,37%	53,02%	46,42%	21,03%	78,65%	48,11%	40,91%	38,93%	38,18%	35,83%	34,09%	39,68%
Söke	83,51%	74,07%	78,20%	80,00%	59,25%	58,72%	73,12%	78,33%	90,71%	110,72%	62,54%	1	67,43%	68,42%	73,44%	64,10%	73,17%	50,67%	85,71%	78,50%
Sivas	58,84%	51,02%	53,06%	53,81%	41,39%	38,49%	38,75%	43,17%	51,60%	49,08%	59,40%	49,63%	38,64%	43,54%	73,54%	64,24%	53,85%	38,28%	38,52%	39,01%
Siirt-Kurtalan			63,61%				31,83%	28,17%	28,41%	26,59%	30,93%	30,78%	74,35%	68,19%	62,37%	72,58%	57,05%			
Niğde		58,14%		65,03%	52,74%	69,92%	85,86%	57,08%	59,76%	65,82%	74,22%	68,91%	47,09%	47,40%	61,07%	60,33%		45,50%	70,59%	75,30%
Kars					39,49%	33,65%	32,19%	35,13%	34,33%	29,71%	35,80%	29,05%	98,62%	91,22%	94,88%	100,68%				
Iskenderun		185,24%	1	141,39%	84,92%	77,62%	61,57%	133,32%	113,83%	97,33%	107,64%	78,83%	81,97%	71,35%	79,72%	123,21%	50,37%	48,26%	47,01%	55,47%
Adıyaman				67,95%	62,38%	48,01%	41,02%	29,80%	39,78%	66,92%	71,03%									

Efficiency scores obtained from running the input oriented DEA-BCC model with the assumption of variable returns to scale for privatized cement plants are illustrated in table 3. As can be observed from table 3, some cement plants have operated efficiently from time to time. However, none of the cement plant has operated efficiently through out the entire time period included in this study. Therefore, it is impossible to conclude for sure that the cement plant has operated more efficiently after they were privatized.

Table 4: Technical, Pure Technical and Scale Efficiencies

	Technical Efficiency CCR Model	Pure Technical Efficiency BCC Model	Scale Efficiency CCR Model/ BCC Model	Returns to Scale
Ankara	1,05	1,06	0,99	Decreasing
Aşkale	0,44	0,55	0,79	Decreasing
Afyon	0,56	0,70	0,80	Decreasing
Çorum	0,50	0,82	0,61	Decreasing
Denizli	0,72	0,90	0,80	Decreasing
Balıkesir	0,50	0,66	0,76	Decreasing
Elazığ-Altınova	0,42	0,49	0,85	Decreasing
Trakya	0,64	0,74	0,86	Decreasing
Van	0,24	0,52	0,46	Decreasing
Trabzon	0,41	0,58	0,70	Decreasing
Ş.Urfa	0,36	0,56	0,63	Decreasing
Lalapaşa	0,52	0,68	0,76	Decreasing
Ladik	0,54	0,65	0,84	Decreasing
Gümüşhane	0,31	5,43	0,05	Decreasing
Gaziantep	0,55	0,66	0,83	Decreasing
Ergani	0,26	0,45	0,58	Decreasing
Bartın	0,28	0,54	0,51	Decreasing
Söke	0,49	0,65	0,75	Decreasing
Sivas	0,41	0,57	0,71	Decreasing
Siirt-Kurtalan	0,32	0,41	0,78	Decreasing
Niğde	0,54	0,66	0,82	Decreasing
Kars	0,28	0,45	0,62	Decreasing
Iskenderun	0,98	1,04	0,94	Decreasing
Adıyaman	0,55	0,62	0,89	Decreasing

Efficiency scores for each cement plant are illustrated in table 4. The CCR model assumes constant returns to scale and it is considered to be input oriented and thus the CCR scores are called global technical efficiencies. Nonetheless, the BCC model assumes variable returns to scale and it is considered to be input oriented and thus the BCC scores are called local pure technical efficiency. When a cement plant is 100% efficient in both CCR and BCC efficiency scores this means that the cement plant is operating in the most productive scale.

The scale efficiency was found by dividing technical efficiency by pure technical efficiency. The results in table 4 show that none of the cement plants were operated at most productive scale size.[7] In other words, privatized cement plants operated inefficiently. In this paper, the input oriented model is used, thus decreasing returns to scale indicates that increase in a cement plant's inputs result in a less than proportionate decrease in its outputs. This is a very crucial result because it is an indication that scale efficiency is a major problem for all the cement plants.

CONCLUSIONS

This study used DEA model and computed the productive efficiency of cement factories in Turkey between 1989 and 2006. Furthermore, the study compared the performance of cement plants in Turkey before and after the privatization periods. The main finding of this study is that Iskenderun, Ankara, Söke, Trakya and Denizli cement factories have worked efficiently between 1989 and 2006, however on average, none of the cement plant operated efficiently over the entire time period analyzed (see graph 4 and table 2, 3, and 4). The results of this study indicate that the productive efficiency of cement plants included in this study did not change after the privatization period started in 2003.

It is also shown that privatized cement plants operated inefficiently in terms of scales. Moreover, decreasing returns to scale indicates that increase in a cement plant's inputs result in a less than proportionate decrease in its outputs. This is a very crucial result because it is an indication that scale efficiency is a major problem for all the cement plants.

The results of this study are in line with some of the earlier studies. For example, Özmucur (1998) found out that performance of the privatized cement plants were higher than that of non-privatized ones. Talant (1993) also figured out that that private cement plants were more efficient than the public cement plants. He also figured out that western cement plants performed better than

other cement plants. This maybe an indication that the initial location of the cement plant's are important in terms of their performance. On the other hand, results of this study are different from some other studies. For example, Saygılı and Taymaz (2001) concluded that the private cement plants were far more efficient than the public cement plants. However, they indicated that average technical efficiency of private and privatized public cement plants showed no statistically significant results for 1989.

Nonetheless, Ökten and Arın (2006) found out that ownership effects are sufficient to achieve improvements in labor productivity. Their results further indicated that allocative efficiency dependent upon changes in the competitive environment. They also pointed out that all cement plants increased the labor productivity by reducing the work force. They illustrated that cement plants sold to foreign investors also increased their capital and investment significantly.

NOTES

[1] For example, chamber offices tried to put lid on privatization in Belgium, because they wanted government to provide the public utilities and to prevent workers lay off from the SEEs (for more details see www.privatizationbarometer.com).
[2] Large share of Volkswagen, an auto-maker were privatized by the Adenauer government in Germany in 1961 (Megginson and Netter, 2001).
[3] www.tcma.org.tr.
[4] The BCC model was developed and first used by Banker, Charnes Cooper (1984). Therefore, the name of the model is derived from the first letters of the scholars who developed the models.
[5] (for more details see: www.tcma.org.tr).
[6] http://www.wiso.uni-dortmund.de/lsfg/or/scheel/ems/.
[7] The scale efficiency is considered to be maximum at 100%.

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