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PRODUCTIVITY CHANGE: AN EMPIRICAL STUDY ON TURKISH STATE UNIVERSITIES

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Abstract

As it is known universities are public institutions providing educational and training services. They are also engaged with research activities. The services provided by these institutions concerns very closely both the public opinion and the public officials from numerous aspects. Thus, the resources allocated to the activities of these institutions must be evaluated to what extent it is used efficiently. In addition, the development of the institutions over time is also noteworthy. In this context, a DEA-based approach known as MPI (Malmquist Productivity Index) is used to evaluate the efficiency of state universities and to reveal the technological change and "catching-up" over time if there exists. MPI is a method of measuring the influence of time shift. It is designed to calculate the efficient frontier shift in a certain period of time. The efficiency shifts between two periods of time give the institutions the opportunity to compare and evaluate their relative competitive positions. This study comprises two academic periods, namely, 2000/01 and 2009/10 in order to investigate the productivity change on a sample from the state universities of Turkey.

Keywords: Total factor productivity, Malmquist Productivity Index, Data Envelopment Analysis, Turkish State universities

VERİMLİLİK DEĞİŞİMİ: TÜRK DEVLET ÜNİVERSİTELERİ ÜZERİNE AMPİRİK BİR ÇALIŞMA

Özet

Bilindiği üzere üniversiteler eğitim ve öğretim hizmeti veren kamu kuruluşlarıdır. Üniversiteler ayrıca araştırma faaliyetleriyle de ilgilidirler. Bu kurumlar tarafından sağlanan hizmetler çeşitli açılardan kamuoyu ve resmi kurumları çok yakından ilgilendirmektedir. Dolayısıyla, bu kurumların faaliyetlerine tahsis edilen kaynakların ne ölçüde verimli kullanıldığının değerlendirilmesi gerekmektedir. Bunun yanında, bu kurumların zaman içindeki gelişimi de dikkat çekici bir konudur. Bu bağlamda bu çalışmada, MVE (Malmquist Verimlilik Endeksi) olarak bilinen DEA-temelli bir yaklaşım, devlet üniversitelerinin etkinliğini değerlendirmek ve varsa zaman içindeki teknolojik değişimini ve etkinlik sınırına yakınlığını ortaya çıkarmak için kullanılmaktadır. MVE zaman değişiminin etkisini ölçmede kullanılan bir yöntemdir. MVE belli bir zaman diliminde etkin üretim sınırındaki kaymayı hesaplamak için geliştirilmiştir. İki zaman dilimi arasındaki etkinliğin ölçümü kurumlara göreli yarışmacı konumlarını değerlendirme ve karşılaştırma fırsatı tanımaktadır. Bu çalışma, Türk devlet üniversitelerinden oluşan bir örneklem üzerinden 2000/01 ve 2009/10 akademik dönemlerindeki verimlilik değişimini incelemeyi amaçlamaktadır.

Anahtar Kelimeler : Toplam faktör verimliliği, Malmquist Verimlilik Endeksi, Veri Zarflama Analizi, Türk Devlet üniversiteleri

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1. INTRODUCTION

As it is known universities are institutions engaged in education and training, besides the research activities. The services provided by these institutions are directly related to public officials and the public opinion in many ways. Turkey has a growing young population demanding high level education every year. While the governments allocate big budgets for these public services, governments have the responsibility to be transparent and accountable to budgetary expenditures. Being transparent and accountable to the public necessitates controlling and pursuing efficiency and productivity in the allocation and management of public resources [2]. As a public institution the universities have also the responsibility to take necessary steps to be efficient while expending the public budget and to pursue productivity every year. Besides, the development of the institutions over time is also noteworthy. Higher education is one of the main sources of economic growth. Thus inefficiency in the university sector may cause a real welfare loss as does the misallocation of resources elsewhere in the economy. So it is vital to design and make improvements in educational policy which may lead to higher economic growth [1].

Efficiency can be measured either for a specific point of time or to evaluate the change of efficiency between two or more time periods. The latter points regress or progress in the efficiency if exists. In this study the purpose is to track the productivity change in Turkish public universities by taking into account the changes both in efficiency and technology.

In measuring productivity change for a specific set of decision making unit (DMU) between two or more time periods, two approaches have been used: (i) the econometric estimation of a production function, (ii) the construction of index numbers. While the former approach necessitates a functional form on the structure of production technology the latter approach does not require it. Once one decides to use the index number approach he/she may have three choices: (i) Fisher index, (ii) Törnqvist index, (iii) Malmquist index [15]. In this study Malmquist index approach is selected in measuring the productivity change in higher education. This selection highly depends on two reasons. Malmquist index rests exclusively on quantity information which means that it does not require price information. Because, obtaining price information for high level education institutions would be inappropriate regarding the outputs and inputs of these organizations. Particularly, in the analysis of the growth for public sector institutions, the data about the prices of inputs and outputs does not exist. For example, if one considers the inputs (academic or non-academic staff), and the outputs (number of published articles, graduate or post-graduate students) of higher education institutions, what price can be assigned to them? Secondly, it is a non-parametric approach which does not require a functional form for the production technology. Besides, the Malmquist approach gives the opportunity to decompose the productivity change into constituent sources of this change as technical and efficiency changes [15]. Thus, Malmquist index of total factor productivity change has gained great popularity in recent years.

In the following sections, Malmquist total productivity index and data envelopment methodology will be introduced and in the last section the Malmquist approach will be applied to a sample of Turkish public universities to measure productivity change with the aid of spreadsheet.

2. MALMQUIST INDEX

A total factor productivity index measures the change in total output relative to the change in the usage of all inputs. The change, if exists can be decomposed into two components, namely, the change in technical efficiency, and the change in technology. While the former change shows the relative closeness to the efficiency frontier, the latter change shows the shift in the efficiency frontier. It is an index representing Total Factor Productivity (TFP) growth of a DMU, in that it reflects progress or regress in efficiency along with progress or regress of the frontier technology over time under the multiple inputs and multiple outputs framework. Total factor productivity index relies on the works of Malmquist [18], Caves et al. [5], Fare et al. [11], Fare et al. [12] chronologically [4].

The Malmquist index is calculated by using distance functions. First a production frontier is constructed using data on multiple inputs and multiple outputs of all the DMUs in the sample in time periods *t* and *t+1*. In the next step, the radial distance for a specific DMU is computed relative to the production frontier in time *t* and in time *t+1* constructed in the first step. For the MPI to be computed we need to calculate four distances. Two distance measures for two single periods and other two distance measures for two mixed periods. Supposing that we have *n* DMUs, with each using *m* inputs, $x_i = 1,\ldots,m$ and produce *s* outputs $y_r = 1,\ldots,s$. If $d_0^t\left(x_0^t, y_0^t\right)$ is the distance measure for a specific DMU_0 for time period *t*, $d_0^{t+1}\left(x_0^{t+1}, y_0^{t+1}\right)$ for time period *t+1* and if $d_0^t\left(x_0^{t+1}, y_0^{t+1}\right)$ is the distance from period *t+1* observation to period *t* frontier and $d_0^{t+1}\left(x_0^t, y_0^t\right)$ is the distance from period *t* observation to period *t+1* frontier then input-oriented Malmquist productivity index can be expressed as:

$$= M_0\left(x_t, y_t, x_{t+1}, y_{t+1}\right) = \left[\frac{d_0^t\left(x_0^{t+1}, y_0^{t+1}\right)}{d_0^t\left(x_0^t, y_0^t\right)} x \frac{d_0^{t+1}\left(x_0^{t+1}, y_0^{t+1}\right)}{d_0^{t+1}\left(x_0^t, y_0^t\right)}\right]^{0.5} \quad (1)$$

M_0 measures the productivity change between periods *t* and *t+1*. If M_0 takes the value one, it indicates that there is no change (stagnation) in productivity. In case the value is greater than unity, it indicates an improvement (growth) in productivity and if it is less than unity it indicates declination in productivity. The distances measured may be either input or output oriented, and accordingly the Malmquist indices may give different results. But if it is assumed that the underlying production technology exhibits constant returns to scale (CRS) for the time periods, then the input and output oriented Malmquist TPF indices are equal [8; 21].

Equation (2) can be equivalently expressed as:

$$= M_0\left(x_t, y_t, x_{t+1}, y_{t+1}\right) = \frac{d_0^{t+1}\left(x_{t+1}, y_{t+1}\right)}{d_0^t\left(x_t, y_t\right)} x \left[\frac{d_0^t\left(x_0^{t+1}, y_0^{t+1}\right)}{d_0^{t+1}\left(x_0^{t+1}, y_0^{t+1}\right)} x \frac{d_0^t\left(x_0^t, y_0^t\right)}{d_0^{t+1}\left(x_0^t, y_0^t\right)}\right]^{0.5}$$

(2)

The equation shows the decomposition of the Malmquist index into a product of two measures: (I) the change in the technical efficiency and (ii) the geometric mean of the change in the frontier. The first part of the index measures the change in technical efficiency between two time periods [20]. This component is also termed as "catch-up" which compares the closeness of DMU_0 in each period's efficient boundary. For values greater than one indicates an improvement in relative technical efficiency during the period considered. The ratio inside the bracket measures boundary shift. A value greater than unity will indicate that there is a technological progress in the industry the DMUs operate. Precisely, the decomposition of the index as in equation (2), provides valuable information about the sources of the overall productivity change.

In order to capture the impact of any scale size changes on productivity, equation (2) can further be decomposed into pure technical efficiency change, scale efficiency change and technological change components which was first put forth by Fare et al.(1994b) and can be stated as in equation (3) [21]**.** The first component, the pure technical efficiency change, is the ratio of the efficiency measured at time *t+1* to the efficiency measured at time *t* under variable returns to scale (VRS) assumption, which in turn is termed as pure technical efficiency catch-up. It is interpreted as the technical efficiency term in equation (2). The only difference is the assumption of the production technology used as either CRS or VRS. The second component, scale efficiency change, indicates to what extent the DMU_0 has become more scale efficient (SCE) between two time periods. Therefore it captures the impact of any change in scale size of DMU_0 on its productivity [21]. Scale efficiency is the ratio of two efficiency scores which are measured under two production technologies, namely, VRS and CRS at a point of time. Thus, the scale efficiency catch-up is the proportion of these two scale efficiencies measured at two different point of time. Consequently, M_0 can be expressed as:

$$= M_0\left(x_t, y_t, x_{t+1}, y_{t+1}\right) = \frac{d_{0-VRS}^{t+1}\left(x_0^{t+1}, y_0^{t+1}\right)}{d_{0-SCE}^t\left(x_0^t, y_0^t\right)} \cdot \frac{d_{0-SCE}^{t+1}\left(x_0^{t+1}, y_0^{t+1}\right)}{d_{0-SCE}^t\left(x_0^t, y_0^t\right)} \cdot \left[\frac{d_0^t\left(x_0^{t+1}, y_0^{t+1}\right)}{d_0^{t+1}\left(x_0^{t+1}, y_0^{t+1}\right)} \cdot \frac{d_0^t\left(x_0^t, y_0^t\right)}{d_0^{t+1}\left(x_0^t, y_0^t\right)}\right]^{0.5} \quad (3)$$

This component can attain a value greater than, equal to, or less than unity according to the DMU0's scale size contribution to productivity change. A value of greater than unity indicates that scale size has positive impact on the productivity change, which means that the DMU0 is in the direction of technical optimal scale. On the contrary if it is less than unity scale size has negative impact on productivity change meaning that DMU0 is in the direction away from the technical optimal scale [15].

3. DEA and MALMQUIST INDEX

DEA was originated by the seminal paper of Charnes, Cooper and Rhodes in [6]. Since then DEA has become a well-known technique to deal with efficiency and productivity measurement. It was originally designed to measure of a set of homogeneous decision making units like universities, hospitals and schools which are non-profit organizations. However, later on, more and more DEA research has been adopted and applied to measure the performance of profit organizations.

It is a non-parametric technique in the sense that it does not require a priori specification of input and output weights. DEA applications generally use cross-section data to measure performance of DMUs that is the performance at the same time of point. DEA can also calculate the productivity change of a DMU over time. Thus it became applicable to panel data to measure the productivity changes between two time periods [7].

Linear programming is the underlying methodology that makes DEA particularly powerful compared with alternative productivity management tools. Fare et al. [1992] have used DEA model as a mathematical programing-based methodology to compute Malmquist index of productivity change which is applied to Swedish pharmacies. After this seminal study, there have been a considerable number of studies in the literature about the framework, decomposition and computation of the Malmquist index using DEA approach. DEA-based Malmquist productivity index has been used extensively in diverse scientific and economic fields. One can mention the relevant studies in literature as: Fare et al. [10] investigate the productivity changes in Swedish pharmacies between 1980-1989; Fare et al [10] employ MPI to investigate the productivity change in Swedish hospitals; Fare et. [12] analyzes productivity growth in 17 OECD countries over the period 1979-1988; Şentürk [19] uses MPI to estimate and analyze the TFP growth rates of public and private Turkish manufacturing industries over the period 1985 to 2001 using DEA linear programming technique; Flegg et al. [13] uses MPI to examine the technical efficiency of 45 British universities in the period 1980/81-1992/93; Kao Chiang and Liu Shinang-Tai [16] measures the efficiency of 22 Taiwanese commercial banks for the period 2009-2011; Brennan et al.[3] applies the methodology to analyze productivity of Dutch schools using 2002-2007 data; Forsund Finn R. and Edvordson [14] studies the performance of local taxes overtime using DEA to calculate MPI; Yi-Hsing et al. [17] investigates relative efficiency of management and variation of managerial efficiency among 37 domestic banks in Taiwan and so forth.

Following Fare et al. [10] in order to compute Malmquist index four efficiency calculations are needed. Two for two single time periods *t* and *t+1* and two for two mixed periods. The two sing le period measures can be obtained by the DEA_{CRS} model given below. Efficiency models for time *t* and *t+1* are respectively can be stated as:

$$\begin{aligned} &\theta_0^t\left(x_0^t, y_0^t\right) = \min \theta_0 \\ &s.t. \\ &\sum_{j=1}^{n} \lambda_j x_j^t \le \theta_0 x_0^t \qquad \text{(M.1)} \\ &\sum_{j=1}^{n} \lambda_j y_j^t \ge y_0^t \\ &\lambda_j \ge 0,\ j = 1,\ldots, n \end{aligned}$$

$$\begin{aligned} &\theta_0^{t+1}\left(x_0^{t+1}, y_0^{t+1}\right) = \min \theta_0 \\ &s.t. \\ &\sum_{j=1}^{n} \lambda_j x_j^{t+1} \le \theta_0 x_0^{t+1} \qquad \text{(M.2)} \\ &\sum_{j=1}^{n} \lambda_j y_j^{t+1} \ge y_0^{t+1} \\ &\lambda_j \ge 0,\ j = 1,\ldots, n \end{aligned}$$

And the efficiency models for DMU_o for the two mixed periods; the first model of the two, compares x_0^{t+1} data to the production technology (boundary) at time *t* and the second model compares x_0^t data to boundary at time *t+1* can be stated as:

$$\begin{aligned} &\theta_0^t\left(x_0^{t+1}, y_0^{t+1}\right) = \min \theta_0 \\ &s.t. \\ &\sum_{j=1}^{n} \lambda_j x_j^t \le \theta_0 x_0^{t+1} \qquad \text{(M.3)} \\ &\sum_{j=1}^{n} \lambda_j y_j^t \ge y_0^{t+1} \\ &\lambda_j \ge 0,\ j = 1,\ldots, n \end{aligned}$$

$$\begin{aligned} &\theta_0^{t+1}\left(x_0^t, y_0^t\right) = \min \theta_0 \\ &s.t. \\ &\sum_{j=1}^{n} \lambda_j x_j^{t+1} \le \theta_0 x_0^t \qquad \text{(M.4)} \\ &\sum_{j=1}^{n} \lambda_j y_j^{t+1} \ge y_0^t \\ &\lambda_j \ge 0,\ j = 1,\ldots, n \end{aligned}$$

4. PRODUCTIVITY CHANGE IN TURKISH UNIVERSITIES

The data consists of annual observation of a sample of 37 Turkish public universities for the period between 2000/01 and 2009/10. There are total of 185 universities. 109 of them are the public and 76 of them are the private university. Private universities are excluded out of the scope of the analysis due to the lack of appropriate data for the mentioned time periods.

Three categories of output are used in the analysis: (i) undergraduate completions, (ii) postgraduate completions and (ii) published articles. The inputs included in the analysis are full time equivalent (i) academic staff, (ii) non-academic staff. The input and output specifications are consistent with the studies in the literature.

The input and output data used in the analysis were obtained from the Council of Higher Education of Turkey for the time period 2009/10. For the time period 2000/01 the input and output data is obtained by scanning the annual reports of the universities sent to the Council of Higher Education.

In the current study models M.1, M.2, M.3 and M.4 are employed to evaluate the productivity changes in high education sector. Models M.1 and M.2 allows to determine the technical efficiency (TE) of each university for each academic year assuming CRS technology. The results are depicted in Table 1 in the third and fourth columns under the heading TE_t and TE_{t+1}. The fifth and sixth columns denote the technical efficiency results assuming VRS technology. The last two columns are the technical efficiency results for each university for the mixed time periods. Considering the arithmetic mean and the standard deviation for the two time periods we can express that the efficiency scores of the universities tend to rise from the first period to the second period of time. Also the decline in standard deviation indicates a reduction in the amount of variation in performance across the university sector.

TE scores for the two time period plotted in Figure 1 supports the upward trend in efficiency scores.

Table 1. Efficiency scores for the universities between 2000/01 and 2009/10

DMU	University	TE_t	TE_{t+1}	Te_t(VRS)	TE_{t+1}(VRS)	$TE_{t\text{-üretim}}$	$Te_{t+1\text{-üretim}}$
1	ADNAN MENDERES	0,296	0,655	0,462	0,676	1,226	1,449
2	ATATÜRK	0,462	0,622	0,856	0,649	1,996	0,997
3	BALIKESİR	0,646	1,000	0,826	1,000	1,913	0,624
4	CELAL BAYAR	1,000	0,747	1,000	0,761	2,191	6,393
5	CUMHURİYET	0,483	0,539	0,598	0,553	1,281	1,797
6	ÇUKUROVA	0,540	0,715	0,682	0,749	3,511	1,987
7	DİCLE	0,285	0,529	0,295	0,584	2,163	0,905
8	DOKUZ EYLÜL	0,404	0,479	0,575	0,536	2,014	0,923
9	DUMLUPINAR	1,000	1,000	1,000	1,000	5,951	1,499
10	ERCİYES	0,434	1,000	0,557	1,000	2,596	1,255
11	BOĞAZİÇİ	0,846	0,766	0,896	0,840	3,417	2,500
12	GALATASARAY	0,263	0,987	1,000	1,000	5,796	1,023
13	GAZİANTEP	0,657	0,816	0,718	0,989	1,503	2,448
14	GAZİOSMANPAŞA	1,000	0,754	1,000	0,853	1,455	6,081
15	HACETTEPE.	0,390	0,683	0,794	1,000	1,485	1,485
16	HARRAN	0,450	0,597	0,615	0,741	1,545	1,114
17	İSTANBUL	0,595	0,827	1,000	1,000	4,239	0,527
18	KARADENİZ TEKNİK	0,570	0,686	0,916	0,728	1,686	1,145
19	ODTÜ	0,755	1,000	0,758	1,000	4,154	2,006
20	KOCAELI	0,673	0,914	0,905	1,000	1,718	1,576
21	PAMUKKALE	0,267	0,677	0,359	0,679	2,068	0,861
22	TRAKYA	0,427	0,472	0,586	0,542	1,834	1,416
23	SELÇUK	0,682	1,000	1,000	1,000	3,545	0,702
24	ONDOKUZ MAYIS	0,595	0,699	0,902	0,703	1,320	1,036
25	MERSIN	0,461	0,618	0,529	0,653	1,163	2,121
26	MARMARA	1,000	1,000	1,000	1,000	5,598	1,521
27	İNÖNÜ	0,529	0,563	0,698	0,634	2,367	2,373
28	GAZİ	0,595	0,692	1,000	1,000	2,911	0,375
29	EGE.	0,413	0,598	0,482	0,897	1,748	1,060
30	FIRAT	0,379	1,000	0,392	0,993	5,339	0,936
31	YILDIZ TEKNİK	1,000	0,725	1,000	0,823	1,904	2,022
32	YÜZÜNCÜ YIL	0,492	0,608	0,503	0,679	2,560	1,344
33	İSTANBUL	1,000	0,721	1,000	0,743	2,567	4,630
34	AKDENIZ	0,367	0,531	0,372	0,553	1,047	1,757
35	ANKARA	0,633	0,522	1,000	0,702	2,229	1,532
36	SAKARYA	0,994	1,000	1,000	1,000	3,831	2,490
37	ULUDAĞ	0,559	0,608	1,000	0,671	1,392	1,323
	MEAN	0.60	0.74				
	Std.Deviation	0.24	0.18				

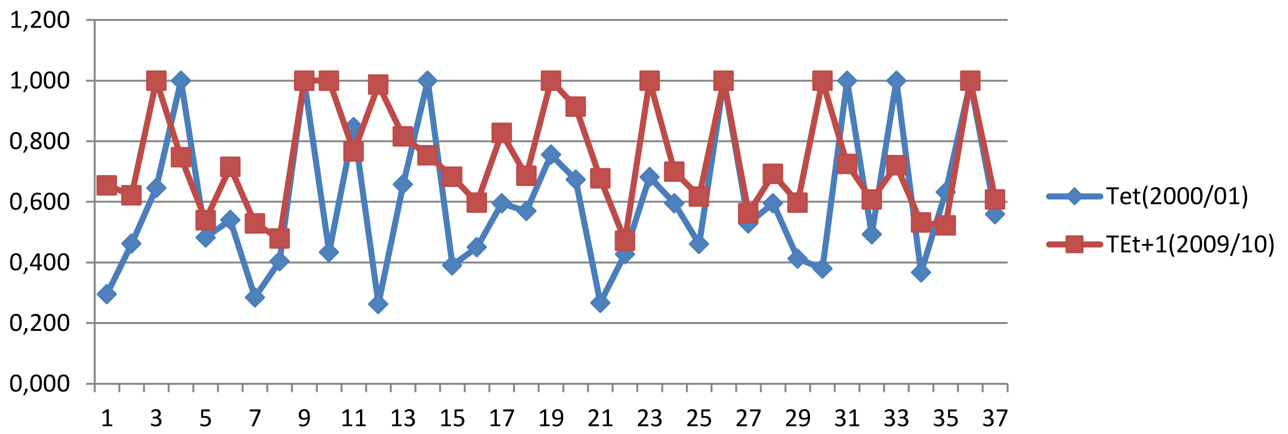

Figure 1. Relative efficiency of 37 public universities in Turkey for periods 2000/01 and 2009/10

The catch-up term compares the closeness of DMU_0 in each period to that period's frontier. A value of one indicates that the DMU_0 has retained its position relative to the frontier in period's *t* and *t+1*. A value above one has the meaning that the DMU_0 has become more efficient in period *t+1* compared to period *t*. Conversely, a value below one implies that the DMU_0 has experienced loss in efficiency. In this context, the first column of Table 2 summarizes this situation. It is obvious that 78% of the universities have experienced growth in efficiency during these two periods.

Boundary shift column in Table 2 shows the measure of the contribution to productivity change of whatever technical change occurs between periods *t* and *t+1* [15]. A value over one indicates a productivity gain by the industry not necessarily by the DMU_0 itself. It states that at the input-output mixes of DMU_0 in periods *t* and *t+1* *efficient production* uses lower input levels in period *t+1* than in period *t* while controlling the output levels [21]. Conversely a value below one indicates productivity loss by the industry. And a value of one implies that there is either a gain or loss in productivity in the industry. On average there is an 18% productivity gain in the higher education sector in Turkey that can be attributable to the boundary shift or technological change in the industry.

Table 2. Efficiency, technological change and productivity growth of Turkish universities.

DMU	University	TEC(effch) (catch-up)	Boundary Shift	Pure Technical Efficiency catchup	Scale Efficiency(t)	Scale Efficiency(t+1)	Scale Efficiency Cathup	TFP
1	ADNAN MENDERES	2,215	0,618	1,463	0,640	0,969	1,514	1,369
2	ATATÜRK	1,345	1,220	0,758	0,540	0,958	1,774	1,641
3	BALIKESİR	1,547	1,407	1,211	0,783	1,000	1,278	2,177
4	CELAL BAYAR	0,747	0,678	0,761	1,000	0,981	0,981	0,506
5	CUMHURİYET	1,117	0,799	0,925	0,807	0,975	1,208	0,892
6	ÇUKUROVA	1,324	1,164	1,098	0,792	0,955	1,206	1,530
7	DİCLE	1,855	1,135	1,980	0,966	0,905	0,937	2,106
8	DOKUZ EYLÜL	1,186	1,356	0,932	0,702	0,893	1,272	1,608
9	DUMLUPINAR	1,000	1,992	1,000	1,000	1,000	1,000	1,992
10	ERCİYES	2,304	0,948	1,795	0,779	1,000	1,283	2,183
11	BOĞAZİÇİ	0,905	1,229	0,938	0,945	0,912	0,966	1,112
12	GALATASARAY	3,758	1,228	1,000	0,263	0,987	3,758	4,613
13	GAZİANTEP	1,242	0,703	1,377	0,915	0,825	0,902	0,873
14	GAZİOSMANPAŞA	0,754	0,564	0,853	1,000	0,883	0,883	0,425
15	HACETTEPE.	1,751	0,756	1,259	0,492	0,683	1,390	1,323
16	HARRAN	1,326	1,023	1,205	0,732	0,806	1,101	1,356
17	İSTANBUL	1,390	2,497	1,000	0,595	0,827	1,390	3,345
18	KARADENİZ TEKNİK	1,203	1,106	0,795	0,622	0,942	1,514	1,331
19	ODTÜ	1,324	1,251	1,319	0,996	1,000	1,004	1,656
20	KOCAELI	1,357	0,896	1,105	0,744	0,914	1,228	1,217
21	PAMUKKALE	2,536	0,973	1,891	0,744	0,997	1,341	2,468
22	TRAKYA	1,103	1,083	0,925	0,729	0,870	1,193	1,196
23	SELÇUK	1,466	1,856	1,000	0,682	1,000	1,466	2,721
24	ONDOKUZ MAYIS	1,176	1,041	0,779	0,660	0,995	1,509	1,224
25	MERSIN	1,341	0,640	1,234	0,871	0,946	1,086	0,858
26	MARMARA	1,000	1,918	1,000	1,000	1,000	1,000	1,918
27	İNÖNÜ	1,063	0,969	0,908	0,758	0,887	1,171	1,030
28	GAZİ	1,163	2,597	1,000	0,595	0,692	1,163	3,004
29	EGE.	1,449	1,067	1,861	0,856	0,666	0,778	1,545
30	FIRAT	2,636	1,501	2,533	0,968	1,007	1,041	3,879
31	YILDIZ TEKNİK	0,725	1,145	0,823	1,000	0,881	0,881	0,826
32	YÜZÜNCÜ YIL	1,234	1,242	1,350	0,979	0,895	0,914	1,533
33	İSTANBUL	0,721	0,879	0,743	1,000	0,970	0,970	0,632
34	AKDENIZ	1,450	0,641	1,487	0,986	0,961	0,975	0,929
35	ANKARA	0,826	1,327	0,702	0,633	0,744	1,176	1,096
36	SAKARYA	1,006	1,237	1,000	0,994	1,000	1,006	1,244
37	ULUDAĞ	1,089	0,983	0,671	0,559	0,907	1,622	1,070
	MEAN	1,396	1,180	1,154				1,633

Pure technical efficiency catch-up is interpreted as the efficiency catch-up. The difference stems from the technology (variable returns to scale) assumed while measuring the efficiency score. And the scale efficiency catch-up represents the impact of any change in scale size of DMU_0 on its productivity.

The last column in Table 2 shows the productivity growth of each university for the periods. As it can be observed from Table 2 78% of the universities have productivity gain. And the average productivity growth for the periods mentioned is %63.

5. CONCLUDING REMARKS

The purpose of the current study is to investigate regress or progress in productivity growth of Turkish universities over the period 2000/01 and 2009/10 by using a DEA-based Malmquist productivity index. The computed results revealed a rise of 63% productivity growth in higher education institutions in Turkey.

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