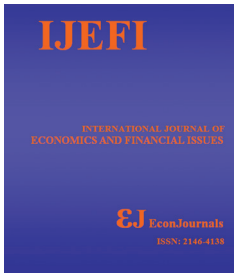

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Measuring Efficiency and Total Factor Productivity using Data Envelopment Analysis: An Empirical Study from Banks of Turkey

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ABSTRACT

The main purpose of this study is to assess the performance of deposit banks operating in the Turkish Banking Sector for the years 2014-2015 using Data Envelopment Analysis (DEA) and malmquist productivity index (MPI) methodologies. In the light of this aim, 21 deposit banks' data obtained from The Banks Association of Turkey between 2014 and 2015 is used. There are 2 inputs and 2 outputs variables for Production Approach and 3 inputs and 3 outputs variables for Intermediation Approaches. To measure productivity changes over time, MPI index is calculated from DEA scores. Thus, the influencing factors of relative efficiency and the efficient (or inefficient) banks are determined. As a result, average # of Staff per Branch, total personal expenses/total assets and total deposits/total assets have important role for efficiency in production approach. In intermediation approach, non-interest expenditure/total assets, total loans/total assets and non-interest income/total assets are associated with the efficiency.

Keywords: Data Envelopment Analysis, Turkish Banking Sector, Malmquist Productivity Index
JEL Classifications: C440, G210

1. INTRODUCTION

There are many goals of financial institutions, one of which is maximizing the shareowners' wealth. Just like all corporations, banks share the same target. In addition to this, they have an important role in financial and economic growth by providing funds for investments. It is anticipated that efficient and productive banks should reveal excellent performance in terms of financial ratios hence this information gives the investors a lead for better future financial results. Banks, therefore, are considered as a heart of the financial system and evaluating banks' performance and monitoring their financial condition are very important for depositors, potential investors and regulators. There are 50 banks in Turkey and they are classified under Banks in Turkey could be classified under two main groups which were deposits banks (commercial banks) and those not accepting deposits (non-depository banks) banks. Each group could be divided into three subgroups: State-owned, privately-owned and foreign banks. Commercial banks perform the more traditional banking operations such as foreign exchange operations and marketing of securities, deposit taking, payment services and other financial products. They may be privately owned or state owned, but there is no difference between them in terms of their activities (BAT, 2015). As at the end of March 2015, there were 11,191 branches in the banking system. Of which, 3,529 were state owned commercial banks' branches, 5.404 were privately owned commercial banks' branches and 2,258 were foreign banks' branches (BAT, 2015). In this study, first quarter financial ratios of 21 deposit banks (out of 30), which were obtained from The Banks Association of Turkey (BAT), were taken into consideration for the analysis.

The main purpose of this study is to present an insight about the relative efficiency of deposits banks in Turkey for the period between March 2014 and March 2015 using Data Envelopment Analysis (DEA) and MPI methodologies. Thus, the influencing

factors of relative efficiency and the efficient (or inefficient) banks in 2014 while they were inefficient (or efficient) in 2015 (Işık and Hassan, 2002) could be determined.

The paper is organized as follows. The previous efficiency measurements and applications in banking sector are discussed in Section 2. Specifications of the DEA methodology and Malmquist productivity index (MPI) approach are described in Section 3. Empirical results of the model are summarized in Section 4, and Section 5 is a brief discussion section of the study.

2. THE LITERATURE REVIEW

There are many different approaches that can be used to assess the efficiency and/or the productivity change of a corporate, a sector or a country in particular period of time. In the literature, there are many studies about assessing efficiency using parametric and nonparametric statistical methods such as Ratio Analysis, Regression Analysis or DEA in different sectors.

Benli and Değirmen (2013) studied on measuring the total factor productivity of banks in Turkish Baking Sector.

Kutlar, Kabasakal and Sarıkaya measured the performance of railway companies via DEA (Kutlar et al., 2013). In 2012, Karagiannis and Velentzas (2012) studied on productivity and quality changes in Greek hospitals during the period 2002-2007 via malmquist index.

In educational field, the effects of The Bologna process reforms on the teaching efficiency in Italy during the period of 2000-2010 were examined in 2015 (Guccio et al., 2015). It was clearly found that Italian Higher Education Institutions have become more efficient over time. In another study, productivity, efficiency and technology changes of public high schools were assessed using mamlquist index approach (Parteka and Wolszczak-Derlacz, 2013). As a result of the study, there were significant (national) differences, with German, Italian and Swiss HEIs performing better in terms of productivity change than HEIs from the other countries examined.

Evaluating the performance of banks is an important part of the literature. In 2015, financial performance of the European Banks participated in the stress test of EAB was examined (Doumpos et al., 2015). In the study of Tortosa-Ausinaa et al. in 2008, productivity growth and productive efficiency for Spanish savings banks were explored over the (initial) post-deregulation period 1992-1998. Asmild et al. (2004) studied on measuring the productivity change of the Canadian Banks over time combining DEA with malmquist index. Lozano-Vivas and Humprey (2002) studied on the bias of malmquist index and Stochastic Cost Frontier Approaches in banking sector.

In the literature, there are important studies about measuring the performance of Turkish Banking sector. Dinçer et al. (2011) examined the efficiency of Turkish deposit banks under three categories which were state owned, privately owned and foreign banks for the years 2002 and 2009 using CAMELS approach. Fukuyama and Matousek (2011), technical and allocative efficiency of the Turkish Banking System from 1991 to 2007 was analyzed via DEA. Unvan and Tatlıdil (2012) analyzed Turkish banking sector performance between 2002 and 2008 years by combining Logit/Probit models and Discriminant Analysis using financial ratios. Kasman and Kasman (2011) investigated the link between stock performance and bank performance of commercial banks in Turkey over the period between 1998 and 2008. Işık and Hassan (2002) studied on determining the efficiency of Turkish banks over the period between 1988 and 1996 using DEA. Mercan et al. (2003) studied on financial performance of commercial banks during the period between 1989 and 1998.

3. METHODOLOGY

3.1. DEA

DEA which was introduced by Charnes, Cooper and Rhodes in 1978 was also named as Frontier Analysis. Although this mathematical programming approach was represented by Charnes, Cooper and Rhodes (CCR), basic terms of relative efficiency were proposed by Farrel (Oral et al., 1992). DEA was a non-parametric technique based on linear programming and used for measuring relative efficiency of organizational units (Decision-Making Unit: DMU) (Üte, 2002). In this technique, efficient DMU could be determined by maximizing the largest ratio of total weighted output over total weighted input for all units (Perçin and Ayan, 2006). Also, efficiency score of the best practice DMUs which were on the production frontier was equal to 1.

There were two basic models which were input and output oriented DEA models. Furthermore, in these two approaches, there were two different linear programming solution techniques which were called constant return to scale (CRS) and variable return to scale.

In output oriented DEA model based on CRS formulation (Cooper et al., 2011) was shown in Equation (1) (Thagunna and Poudel, 2013).

$$E_k = Min\left(\sum_{i=1}^{m} v_i X_{ik}\right)$$
$$\left(\sum_{r=1}^{p} u_r Y_{rk}\right) = 1$$
$$\left(\sum_{r=1}^{p} u_r Y_{rj}\right) - \sum_{i=1}^{m} v_i X_{ij} \le 0$$
$$u_r \ge \varepsilon \quad v_i \ge \varepsilon$$
$$j = 1,...,n \quad r = 1,...,p \quad i = 1,...,m \qquad (1)$$

Dual problem of output oriented CCR model was showed in Equation (2).

$$E_k = Max\beta + \varepsilon\left(\sum_{i=1}^{m} s_i^-\right) + \varepsilon\left(\sum_{r=1}^{p} s_r^+\right)$$
$$\left(\sum_{j=1}^{n} X_{ij}\lambda_j + s_i^- - X_{ik}\right) = 0$$
$$\left(\sum_{j=1}^{n} Y_{rj}\lambda_j - s_i^+ - \beta Y_{rk}\right) = 0$$
$$\lambda_j \geq 0$$
$$j = 1,...,n \quad r = 1,...,p \quad i = 1,...,m \tag{2}$$

u_r: Output weights,
v_i: Input weights,
X_{ik}: Observed amount of input of the i^{th} type of k^{th} DMU,
Y_{rk}: Observed amount of output of the r^{th} type of k^{th} DMU,
ε: Positive small number (for example 0,00001).

After getting solution of mathematical programming problem and dual problem, it was determined which DMU was efficient. Furthermore, it could be revealed which indicators should be decreased/increased for inefficient DMUs to be efficient.

A DMU was efficient if it was provided the situation below:
1. Optimal solution value equals to 1.
2. In dual problem, α = 1 and all slack variables (s_i^- *ve* s_i^+) equal to zero.

Formulation of reference set containing efficient DMUs for inefficient DMUs was shown Equation (3) (Thanassoulis, 2001).

$$X^{KB} = \left(\sum_{j=1}^{n} X_{ij}\lambda_j\right)$$
$$Y^{KB} = \left(\sum_{j=1}^{n} Y_{ij}\lambda_j\right) \tag{3}$$

Since there were no strict assumptions in DEA, it was preferred rather than parametric techniques. Furthermore, if there were multiple inputs and outputs should be taken into consideration to assess the efficiency, DEA would be one of the most useful techniques.

3.2. Total Factor Productivity

The malmquist total factor productivity index (MPI) is a widely-used method in order to evaluate the productivity change of a financial institution because of its advantages. Firstly, there is no assumption about optimizing behavior of the producers and it allows for inefficiency. Secondly, it uses a nonparametric approach, which is similar to DEA, instead of econometric estimation. MPI was first introduced by Sten Malmquist in 1953 and it was developed by many researchers. The MPI was a bilateral index that can be used to compare the production technology of two economies. The MPI was based on the concept of the production function which was a function of maximum possible production with respect to a set of inputs. MPI consists of two different effects which were "catch-up effect (C)" and "frontier-shift effect (F)." Catch-up term related to the degree to which a DMU improves or worsens its efficiency. Frontier-Shift term related to the change in the efficiency frontiers between two time periods.

Equation (4) shows MPI between period t (the base period) and t+1 with inputs (x) and outputs (y).

$$C = \left[\left(\delta^{t+1}(x,y)^{t+1}\right) \Big/ \left(\delta^{t}(x,y)^{t}\right)\right]$$
$$F = \left[\left[\left(\delta^{t}(x,y)^{t+1}\right) \Big/ \left(\delta^{t}(x,y)^{t}\right)\right]\left[\left(\delta^{t+1}(x,y)^{t+1}\right) \Big/ \left(\delta^{t+1}(x,y)^{t}\right)\right]\right]^{1/2}$$
$$MPI = C \times F \tag{4}$$

In Equation (4) (Zhu, 2003);

In MPI, input and output oriented MPI scores were equal but mathematical programming formulations of input and output models were different (Thanassoulis, 2001). C, F and MPI contain 3 kinds of information (Thanassoulis, 2001).
1. Productivity increased if MPI > 1. Similarly, technical efficiency improvement and technical progress occurred when C > 1 and F > 1 respectively.
2. Productivity decreased if MPI < 1. Similarly, technical efficiency decrease and technical progress was not occurred when C < 1 and F < 1 respectively.
3. Productivity was stable if MPI = 1. Similarly, technical efficiency and technical progress were stable when C = 1 and F = 1 respectively.

4. EMPIRICAL RESULTS

4.1. Data and Descriptive Statistics

The data used for this work were collected from BAT the years between 2014 and 2015. 9 Banks were excluded from the data because their number of branches were lower than 10. Since it was recommended that few input and output variables should be used in DEA, 2 inputs and 2 outputs variables for production approach and 3 inputs and 3 outputs variables for intermediation approaches were used for assessing the efficiency (Unvan and Tatlıdil, 2011). Intermediation approach measures the economic viability of the banks. In this approach, the cost of intermediation process and funds can be barrowed are considered as inputs of the model, while funds can be loan out are considered as outputs of the model. In Production Approach, the cost of efficiency of banks is measured. In this approach, services and products are considered as outputs while the resources are considered as inputs. Since the goal of this approach is minimizing the cost, the input oriented DEA model was performed.

Input/output variables in the analysis were shown in Tables 1 and 2.

A descriptive statistics of the variables of 21 banks used in the analyses are given in Table 3.

CRS models have higher discriminatory power than Variable Return to Scale models. Thus, prevents the systematic bias present when calculating Malmquist index based productivity changes from non-constant returns to scale models as shown (Grifell-Tatje and Lovell, 1995).

4.2. Efficiency Scores

Data were analyzed using input oriented DEA approach and also MPI used for determining efficiency change from 2014 to 2015 under the CRS assumption using EMS package program. Input oriented DEA efficiency score in 2014 and 2015 for each bank in terms of intermediation approach are given in Table 4.

There were 11 and 13 banks in efficient group in 2014 and 2015 respectively. In Table 4, ING Bank A.Ş. has the highest and Tekstil Bankası A.Ş. has the lowest efficiency score in 2015. In 2014, ING Bank A.Ş. and Turkland Bank A.Ş. have maximum and minimum efficiency scores, respectively. HSBC Bank A.Ş., Tekstil Bankası A.Ş., Türkiye Halk Bankası A.Ş. and Yapı ve Kredi Bankası A.Ş. were included in efficient group in 2014 and inefficient group in 2015. Burgan Bank A.Ş., Fibabanka A.Ş., Finans Bank A.Ş. and Türkiye Vakıflar Bankası T.A.O. were included in inefficient group in 2014 and efficient group in 2015.

Table 1: Input and output variables for intermediation approach

Inputs	Outputs
I1 - Total deposits/total assets	O1 - Total loans/total assets
I2 - Total interest expenditure/ total assets	O2 - Interest income/ total assets
I3 - Non-interest expenditure/ total assets	O3 - Non-interest income/ total assets

Table 2: Input and output variables for production approach

Inputs	Outputs
I1 - Mart average # of staff per branch	O1 - Total deposits/total assets
I2 - Total personal expenses/ total assets	O2 - Total loans/total assets

In Intermediation Approach, Overall Turkish Banking Sector efficiency score decreased to 1.0179 in 2015 from 1.0255 in 2014, which means that sector efficiency was decreased in 2015. However comparing pure DMU's efficiency over time was not a suitable way to decide if DMU's (Banks in this study) total efficiency score increased or not. In literature, MPI was used for comparing DMU's efficiency over time because it decomposes the total efficiency into changes in efficiency "catching-up" and changes in frontiers "technical change." Catching-up, technical change and MPI of banks were given in Table 5.

According to the Table 5, there were 12 banks (out of 20) were efficient in terms of malmquist total productivity index. These banks were Akbank T.A.Ş, Anadolubank A.Ş., Burgan Bank A.Ş, Denizbank A.Ş, Finans Bank A.Ş, ING Bank A.Ş, Odea Bank A.Ş, Turkland Bank A.Ş, Türk Ekonomi Bankası A.Ş, Türkiye Cumhuriyeti Ziraat Bankası A.Ş, Türkiye Halk Bankası A.Ş. and Türkiye Vakıflar Bankası T.A.O. Furthermore, Burgan Bank A.Ş, Türk Ekonomi Bankası A.Ş, Türkiye Vakıflar Bankası T.A.O, Anadolubank A.Ş and Akbank T.A.Ş. were efficient as not only Catching-Up but also Frontier Shift Effects.

Şekerbank T.A.Ş, Fibabanka A.Ş. and Türkiye İş Bankası A.Ş. were efficient in terms of Catch-Up Effect and Yapı ve Kredi Bankası A.Ş. was efficient in terms of Frontier Shift Effect. However, in these banks, increasing Frontier Shift or Catching-Up Effects was not enough for them to become efficient banks in terms of MPI.

Efficiency scores of 2014 and 2015 analyzed separately in order to understand which factors should be improved for inefficient banks to become efficient banks. In 2014 and 2015, almost every inefficient bank should increase total loans/total assets ratios to become an efficient bank (Figure 1).

According to MPI approach, input 1-total deposits/total assets ratio was increased 0.56% and 2.27% (on average) in 2015 for both efficient and inefficient banks, respectively. Input 2-non-interest expenditure/total assets ratio was decreased 3.84% (on

Table 3: Descriptive statistics of input and output variables

Approaches and inputs/outputs	2015 March		2014 March	
	Average	Standard deviation	Average	Standard deviation
Production approach				
Inputs				
Average # of staff per branch	18.221	3.050	18.183	3.127
Total personal expenses/total assets	0.003	0.001	0.003	0.001
Outputs				
Total deposits/total assets	61.084	6.951	60.463	7.147
Total loans/total assets	67.423	5.684	64.771	6.273
Intermediation approach				
Inputs				
Total deposits/total assets	61.084	6.951	60.463	7.147
Total interest expenditure/total assets	0.011	0.002	0.011	0.002
Non-interest expenditure/total assets	0.646	0.216	0.668	0.202
Outputs				
Total loans/total assets	67.423	5.684	64.771	6.273
Interest income/total assets	0.020	0.002	0.020	0.003
Non-interest income/total assets*	0.315	0.160	0.336	0.163

*Turkish Bank A.Ş. values were excluded because it was outlier

Table 4: Banks' efficiency scores the year between 2015 and 2014 for intermediation approach

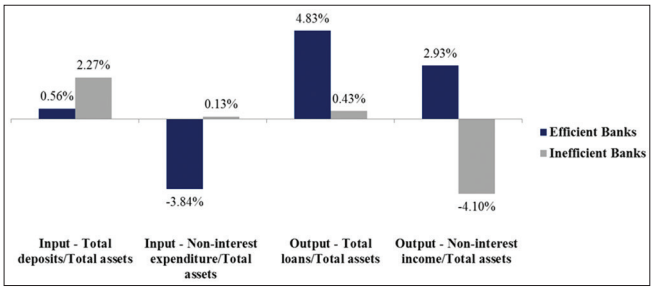
Banks	2015	2014
Akbank T.A.Ş.	1.1015	1.0862
Alternatifbank A.Ş.	1.0398	1.2119
Anadolubank A.Ş.	0.9383	0.9023
Burgan Bank A.Ş.	1.0362	0.9422
Denizbank A.Ş.	0.9957	0.9998
Fibabanka A.Ş.	1.0128	0.9965
Finans Bank A.Ş.	1.0690	0.9519
HSBC Bank A.Ş.	0.9673	1.1387
ING Bank A.Ş.	1.2530	1.2777
Odea Bank A.Ş.	1.1543	1.0909
Şekerbank T.A.Ş.	0.9262	0.9123
Tekstil Bankası A.Ş.	0.8467	1.0157
Turkland Bank A.Ş.	0.8731	0.8742
Türk Ekonomi Bankası A.Ş.	0.9775	0.9025
Türkiye Cumhuriyeti Ziraat Bankası A.Ş.	1.1207	1.0712
Türkiye Garanti Bankası A.Ş.	1.0251	1.0806
Türkiye Halk Bankası A.Ş.	0.9911	1.0081
Türkiye İş Bankası A.Ş.	1.0146	1.0128
Türkiye Vakıflar Bankası T.A.O.	1.0344	0.9804
Yapı ve Kredi Bankası A.Ş.	0.9799	1.0539

Table 5: MPI for intermediation approach

Banks	Catch-up effect	Frontier-shift effect	MPI
Burgan Bank A.Ş.	1.100	1.108	1.219
Finans Bank A.Ş.	1.123	0.977	1.098
Türk Ekonomi Bankası A.Ş.	1.083	1.004	1.087
Türkiye Vakıflar Bankası T.A.O.	1.055	1.020	1.076
Anadolubank A.Ş.	1.040	1.023	1.064
Denizbank A.Ş.	0.996	1.067	1.062
Turkland Bank A.Ş.	0.999	1.061	1.060
Akbank T.A.Ş.	1.014	1.033	1.047
Türkiye Halk Bankası A.Ş.	0.983	1.041	1.024
Türkiye Cumhuriyeti Ziraat Bankası A.Ş.	1.046	0.969	1.013
ING Bank A.Ş.	0.981	1.029	1.009
Odea Bank A.Ş.	1.058	0.953	1.008
Şekerbank T.A.Ş.	1.015	0.975	0.990
Fibabanka A.Ş.	1.016	0.936	0.951
Türkiye İş Bankası A.Ş.	1.002	0.943	0.945
Yapı ve Kredi Bankası A.Ş.	0.930	1.015	0.944
Türkiye Garanti Bankası A.Ş.	0.949	0.933	0.885
HSBC Bank A.Ş.	0.849	0.920	0.782
Alternatifbank A.Ş.	0.858	0.890	0.764
Tekstil Bankası A.Ş.	0.834	0.898	0.748

MPI: Malmquist productivity index

Figure 1: Significant change of the variables from 2014 to 2015 for intermediation approach



average) for efficient banks and increased 0.13% (on average) for inefficient banks. Output 1-total loans/total assets and output 3-non-interest income/total assets ratios were increased 4.83% (on average) and 0.43% (on average) for efficient banks, respectively. These numbers were 2.93% (increase) and 4.10% (decrease) for inefficient banks, respectively. Finally, output 2-interest income/total assets ratio was decreased 0.43% (on average) and 4.02% (on average) for efficient and inefficient banks, respectively. In conclusion, according to the inputs and outputs changes the year between 2014 and 1015, non-interest expenditure/total assets, total loans/total assets, interest income/total assets and non-interest income/total assets had an important role for efficiency.

Data was analyzed as production point of view using output oriented DEA approach and MPI. Input oriented DEA efficiency scores in 2014 and 2015 for each bank in terms of Production Approach were given in Table 6.

4 banks were in efficient group in 2015; this number was 6 in 2014. In Table 6, Odea Bank A.Ş. has the highest and HSBC Bank A.Ş. has the lowest efficiency score in 2015. In 2014, Odea Bank A.Ş. and HSBC Bank A.Ş. have maximum and minimum efficiency scores, respectively. Akbank T.A.Ş. and Türkiye Halk Bankası A.Ş. were in efficient group in 2014 while they were in inefficient group in 2015. There were no banks in inefficient group in 2014 while they were in efficient group in 2015.

In Production Approach, Turkish Banking Sector overall efficiency score increased to 0.9255 in 2015 from 0.9158 in 2014, which means that sector efficiency was increase in 2015. However Turkish banking sector was still inefficient in terms of MPI. Catching-up, frontier-shift and MPI of banks were given in Table 7.

According to the input oriented DEA analysis under the CRS assumption of Production Approach, 9 banks (out of 21 banks) were efficient in terms of malmquist total productivity index. Finans Bank A.Ş. and Denizbank A.Ş. were just below the efficient frontier. MPI Efficient banks were Anadolubank A.Ş., Turkland Bank A.Ş., Burgan Bank A.Ş., HSBC Bank A.Ş., Tekstil Bankası A.Ş., Turkish Bank A.Ş., Alternatifbank A.Ş., Türkiye Cumhuriyeti Ziraat Bankası A.Ş. and Türkiye Vakıflar Bankası T.A.O. Furthermore, Anadolubank A.Ş., Turkland Bank A.Ş., Burgan Bank A.Ş., HSBC Bank A.Ş., Tekstil Bankası A.Ş., Turkish Bank A.Ş. and Alternatifbank A.Ş. were efficient as not only Catching-Up but also Frontier Shift effects.

Finans Bank A.Ş. and Denizbank A.Ş. were efficient in terms of Catch-Up Effect, and ING Bank A.Ş., Odea Bank A.Ş. and Türkiye Halk Bankası A.Ş. were efficient in terms of Frontier Shift Effect. However, increasing Frontier Shift or Catching-Up Effects of these banks was not enough for them to become efficient in terms of MPI.

2014 and 2015 efficiency scores of the banks were analyzed separately in order to understand which factors should be improved for inefficient banks. In both 2014 and 2015, almost every inefficient bank should increase total deposits/total assets ratios

Table 6: Bank efficiency scores the year between 2015 and 2014 for production approach

Banks	2015 efficiency score	2014 efficiency score
Akbank T.A.Ş.	0.9580	1.0295
Alternatifbank A.Ş.	0.8784	0.7957
Anadolubank A.Ş.	0.8970	0.7275
Burgan Bank A.Ş.	0.9803	0.8921
Denizbank A.Ş.	0.7734	0.7690
Fibabanka A.Ş.	0.9390	0.9569
Finans Bank A.Ş.	0.7948	0.7656
HSBC Bank A.Ş.	0.6839	0.6177
ING Bank A.Ş.	0.8987	0.9552
Odea Bank A.Ş.	1.1726	1.3175
Şekerbank T.A.Ş.	1.1582	1.2507
Tekstil Bankası A.Ş.	0.8186	0.7578
Turkish Bank A.Ş.	0.9292	0.8697
Turkland Bank A.Ş.	0.8559	0.7660
Türk Ekonomi Bankası A.Ş.	0.9048	0.9201
Türkiye Cumhuriyeti Ziraat Bankası A.Ş.	1.1619	1.0090
Türkiye Garanti Bankası A.Ş.	0.8366	0.8700
Türkiye Halk Bankası A.Ş.	0.9234	1.0790
Türkiye İş Bankası A.Ş.	0.8827	0.9163
Türkiye Vakıflar Bankası T.A.O.	1.0735	1.0010
Yapı ve Kredi Bankası A.Ş.	0.9148	0.9665

Table 7: MPI for production approach

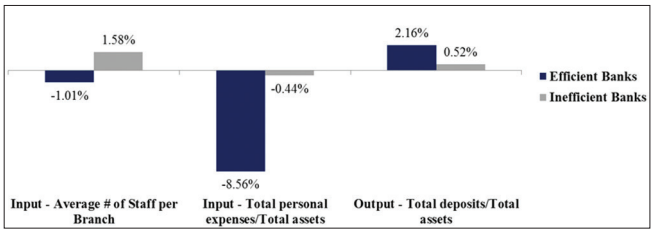
Banks	Catch-up effect	Frontier-shift effect	MPI
Anadolubank A.Ş.	1.2330	1.0527	1.2979
Turkland Bank A.Ş.	1.1174	1.1058	1.2356
Burgan Bank A.Ş.	1.0989	1.1140	1.2242
HSBC Bank A.Ş.	1.1072	1.0978	1.2155
Tekstil Bankası A.Ş.	1.0802	1.1034	1.1920
Turkish Bank A.Ş.	1.0684	1.0681	1.1412
Alternatifbank A.Ş.	1.1039	1.0307	1.1379
Türkiye Cumhuriyeti Ziraat Bankası A.Ş.	1.1515	0.9751	1.1229
Türkiye Vakıflar Bankası T.A.O.	1.0724	0.9884	1.0600
Finans Bank A.Ş.	1.0381	0.9612	0.9978
Denizbank A.Ş.	1.0057	0.9897	0.9954
ING Bank A.Ş.	0.9409	1.0373	0.9759
Türk Ekonomi Bankası A.Ş.	0.9834	0.9690	0.9529
Türkiye Garanti Bankası A.Ş.	0.9616	0.9847	0.9469
Odea Bank A.Ş.	0.8900	1.0566	0.9404
Türkiye İş Bankası A.Ş.	0.9633	0.9657	0.9303
Yapı ve Kredi Bankası A.Ş.	0.9465	0.9666	0.9149
Fibabanka A.Ş.	0.9813	0.9238	0.9066
Akbank T.A.Ş.	0.9305	0.9471	0.8814
Türkiye Halk Bankası A.Ş.	0.8558	1.0149	0.8686
Şekerbank T.A.Ş.	0.9260	0.9185	0.8505

MPI: Malmquist productivity index

to become an efficient bank. More specifically, Anadolubank A.Ş. and Turkland Bank A.Ş. should increase total loans/total assets and Türkiye Garanti Bankası A.Ş. should decrease Average # of Staff per Branch to become an efficient bank (Figure 2).

Furthermore, according to MPI approach, Input 1-average # of staff per branch and input 2-total personal expenses/total assets of efficient banks was decreased 1.01% (on average) and

Figure 2: Significant change of the variables from 2014 to 2015 for production approach



8.56% (on average) in 2015, respectively. For inefficient banks, input 1-average # of staff per branch was increased 1.58% (on average) and input 2-total personal expenses/total assets was decreased 0.44% (on average) in 2015. Output 1-total deposits/total assets was increased 2.16% (on average) for efficient banks. This number was 0.52% (on average) for inefficient banks. In conclusion, according to the inputs and outputs changes between 2014 and 2015, Average # of staff per branch, total personal expenses/total assets and total deposits/total assets had an important role for efficiency.

5. CONCLUSIONS

Within the scope of this study, the efficiency of deposit banks in 2015 was assessed and compared it to the previous year's efficiency score. In this respect, the input and output variables were prepared both intermediation and production approaches. Data was analyzed using input oriented DEA approach in order to provide empirical evidence on the relationship between efficiency and productivity change in Turkish banks during the period 2014-2015.

As a result of analysis, positive development of overall performance was seen in terms production approach. However there was a decrease of performance in terms of Intermediation Approach. Furthermore, with this study, researchers had a chance to understand which factors are effective in efficiency. The empirical results indicate that on average productivity declines have been associated with non-interest expenditure/total assets, total loans/total assets and non-interest income/total assets in intermediation approach. in production approach, average # of staff per branch, total personal expenses/total assets and total deposits/total assets had an important role for efficiency.

In conclusion, this study could be a starting point for further investigation and validation into the efficiency of the Turkish banking sector. This research could provide important information for policymakers as for the openness of the Turkish Banking to new banks. Therefore, more investigation with alternative models can cross validate the present research.

REFERENCES

Asmild, M., Paradi, J.C., Aggarwall, V., Schaffnit, C. (2004), Combining DEA window analysis with the malmquist index approach in a study of the Canadian banking industry. Journal of Productivity Analysis, 21(1), 67-89.

BAT. (2015), The Banking System in Turkey 2011-2015 June. İstanbul:

Banks Association of Turkey.
Benli, Y.K., Değirmen, S. (2013), The Application of data envelopment analysis based on malmquist total factor productivity index: Emprical evidence in Turkish banking sector. Panoeconomicus, 2, 139-159.
Cooper, W.W., Seiford, L.M., Zhu, J. (2011), Handbook on Data Envelopment Analysis. 2nd ed. New York: Springer.
Dinçer, H., Gençer, G., Orhan, N., Şahinbaş, K. (2011), A performance evaluation of the Turkish banking sector after the global crisis via CAMELS ratios. Procedia-Social and Behavioral Sciences, 24, 1530-1545.
Doumpos, M., Zopounidis, C., Fragiadakis, P. (2015), Assessing the financial performance of European banks under stress testing scenarios: A multicriteria approach. Operational Research, 1, 1-13.
Fukuyama, H., Matousek, R. (2011), Efficiency of Turkish banking: Two-stage network system. Variable returns to scale model. Journal of International Financial Markets, Institutions and Money, 21(1), 75-91.
Grifell-Tatje, E., Lovell, C.A. (1995), A note on the malmquist productivity index. Economics Letters, 47(2), 169-175.
Guccio, C., Martorana, M.F., Monaco, L. (2015), Evaluating the impact of the Bologna process on the efficiency convergence of Italian universities: A non-parametric frontier approach. Journal of Productivity Analysis, 1-24. doi: 10.1007/s11123-015-0459-6. Available from: http://link.springer.com/article/10.1007/s11123-015-0459-6.
Işık, İ., Hassan, M.K. (2002), Technical, scale and allocative efficiencies of Turkish banking industry. Journal of Banking & Finance, 26(4), 719-766.
Karagiannis, R., Velentzas, K. (2012), Productivity and quality changes in Greek public hospitals. Operational Research, 12(1), 69-81.
Kasman, S., Kasman, A. (2011), Efficiency, productivity and stock performance: Evidence from the Turkish banking sector. Panoeconomicus, 3, 355-372.
Kutlar, A., Kabasakal, A., Sarıkaya, M. (2013), Determination of the efficiency of the world railway companies by method of DEA and comparison of their efficiency by Tobit analysis. Quality & Quantity, 47(6), 3575-3602.
Lozano-Vivas, A., Humphrey, D.B. (2002), Bias in malmquist index and cost function productivity measurement in banking. International Journal of Production Economics, 76(2), 177-188.
Mercan, M., Reisman, A., Yolalan, R., Emel, A.B. (2003), The effect of scale and mode of ownership on the financial performance of the Turkish banking sector: Results of a DEA-based analysis. Socio-Economic Planning Sciences, 37(3), 185-202.
Oral, M., Kettani, O., Yolalan, R. (1992), An empirical study on analyzing the productivity of bank branches. IIE Transactions, 24(5), 166-176.
Parteka, A., Wolszczak-Derlacz, J. (2013), Dynamics of productivity in higher education: Cross-European evidence based on bootstrapped Malmquist indices. Journal of Productivity Analysis, 40(1), 67-82.
Perçin, S., Ayan, T.Y. (2006), Measuring efficiency of commercial banks in a developing economy: The case of Turkey. Investment Management and Financial Innovations, 3(2), 217-231. Available from: http://www.businessperspectives.org/journals_free/imfi/2006/imfi_en_2006_02_Percin.pdf.
Thagunna, K.S., Poudel, S. (2013), Measuring bank performance of Nepali banks: A data envelopment analysis (DEA) perspective. International Journal of Economics and Financial Issues, 3(1), 54-65. Available from: http://www.econjournals.com/index.php/ijefi/article/viewFile/327/pdf.
Thanassoulis, E. (2001), Introduction to the Theory and Application of Data Envelopment Analysis: A Foundation Text with Integrated Software. 2nd ed. Norwell, Massachusetts: Kluwer Academic Publishers.
Tortosa-Ausinaa, E., Grifell-Tatjéb, E., Armeroc, C., Conesac, D. (2008), Sensitivity analysis of efficiency and malmquist productivity indices: An application to Spanish savings banks. European Journal of Operational Research, 184(3), 1062-1084.
Unvan, Y.A., Tatlıdil, H. (2011), Türk bankacilik sektörünün çok değişkenli istatistiksel yöntemler ile incelenmesi. Ege Akademik Bakış, 11(Özel Sayı), 29-40.
Unvan, Y.A., Tatlidil, H. (2012), Efficiency in the Turkish banking system: A data envelopment approach. International Journal of Basic & Applied Sciences, 12(2), 168-186. Available from: http://www.ijens.org/vol_12_i_02/128802-6464-ijbas-ijens.pdf.
Üte, R. (2002), Veri Zarflama Analizi Tekniği ile Sağlık Sektörünün Operasyonel Etkinliğinin Araştırılması (S. S. Institute, Dü.). Adana: Çukurova University.
Zhu, J. (2003), Quantitative Models for Performance Evaluation and Benchmarking. New York: Kluwer Academic Publishers.