Measurement of Efficiency in The Turkish Banking Sector in the 2009-2011 Period: A DEA Approach

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Doi:10.5901/mjss.2013.v4n10p744

Abstract

The purpose of this study is to measure the efficiency of banks, which are leading actors in the financial system, using the Data Envelopment Analysis and investigate whether there is a development in their efficiency on a yearly basis by the help of Malmquist Total Factor Productivity Index. In this context, we have used uninterrupted data belonging to 20 commercial banks in the Turkish banking sector with public and private capital between 2009 and 2011. According to the results of the analysis determined using the input and output components by adopting the intermediary approach, the efficiency levels of the banks were high and there was a slight increase in their total factor productivity on a yearly basis.

1. Introduction

Although increasing competition has affected all sectors and economy, it has led especially the banking sector to seek new ways. In particular, rising risks and entry of risk management into the markets with its derivative products after the collapse of the Bretton-Woods system in 1973 caused the bank management to gain importance and the financial competition in the world to increase further. Scales of banks changed and in order to achieve success in the competition, the phenomenon of growth came to the foreground to minimize risks and fund costs and maximize revenues as well as increasing funds. As the banks grew, many banks went international by crossing over the country's borders and sought ways to strengthen their positions in foreign countries.

The concept of efficiency has come to the foreground in today's banking sector in parallel to the developments in economy and intensive efforts have been made to increase efficiency. It is now a necessity to work efficiently and not to cause waste of resources in global economies where a stiff competition prevails. Being efficient is one of the most important conditions for being competitive. Banks that can increase their efficiency can reach a larger customer mass at lower costs.

The purpose of this study is to measure financial efficiency in the Turkish banking sector using the data envelopment analysis (DEA). In this context, efficiency of 20 public and private capital commercial banks operating in Turkey between 2009 and 2011 was tested using the DEA and then an attempt was made to measure whether there was an increase in the efficiency of these banks on a yearly basis by using Malmquist Total Factor Productivity Indexes.

2. Literature Review

There are a large number of studies in the literature concerning the banking sector using DEA. Most of these studies concentrate on the technical efficiency of the banks. Efficiency measurement indicates whether the banks have used a minimum number of inputs in order to produce a certain number of outputs or whether they can produce maximum output using a certain number of inputs (Fethi and Pasiouras, 2010: 190). On the other hand, although the samples and variables of the academic studies conducted in this regard have been different, their common purpose has been to measure inefficiency of the banks or in a more general sense the service sector (Çukur, 2005: 19). Some prominent ones among these studies are given below.

Berger and Mester (1997) attempted to measure the efficiencies of the banks in the USA between 1990 and 1995 by using econometric efficiency frontier models. According to the findings of the study, while the average cost efficiencies of the American banks were at the level of 86 %, their average profit efficiency scores were 47 %. According to these results, the American banks were able to manage their cost efficiency well but they suffered from serious shortcomings regarding profit efficiency.

Kwan and Wilcox (1999), Akhavein et al. (1997), Berger et al. (1999) and DeYoung and Hasan (1998) concluded in their studies that bank mergers increased efficiency.

In their study on the efficiencies of the banks in Australia, Sturm and Williams (2008) demonstrated that the efficiency levels of the banks with foreign capital were higher and the reason for this was the management mentality of these banks and the regulations they made on banking.

Rezitis (2008), on the other hand, studied the effects of merger and acquisition activities on the efficiency and total factor productivity of Greek banks. According to the results of the study, where Malmquist productivity index was applied, merger and acquisition activities had a negative effect on the technical efficiency and total factor productivity of the Greek banks. In particular, technical efficiencies of the banks that merged fell in the period after the merger. Besides this, the decrease in the total factor productivity that was experienced after the merger were attributed to the increase in technical inefficiency and to the disappearance of the economy of scale.

Berger et al. (2009) conducted a study to measure the efficiency of the Chinese banks in the period between 1994 and 2003 and determine the influence of the privatization and foreign partnerships within the framework of the Chinese government's reform efforts on the Chinese banks. According to the results of the study, it has been observed that banks with foreign capital attained the highest levels of efficiency. Banks with foreign partners that had minority shares, on the other hand, increased their efficiency considerably on a yearly basis. It was also seen that the four largest public banks that dominated the country's banking sector had the lowest efficiency values. On the basis of the findings of their study, Berger et al. pointed out that if these four largest banks joined forces with a foreign partner, even if with a minority share, their performance could increase significantly.

Das and Ghosh (2009) conducted a study using DEA aimed at determining the effects of financial deregulation on the cost and profit efficiencies of the commercial banks in India between 1999 and 2004. They found out in this study that higher levels of cost efficiency and lower levels of profit efficiency indicated the inefficiency of the income part of the banking activity. They emphasized that the decrease in profit efficiency resulted from allocation inefficiency. According to Das and Ghosh, the size of banks, their ownership structure, product diversity and positive financial indicators are important variables that lead to differences in efficiency levels.

There are several studies in the relevant literature on efficiency and productivity analyses in the Turkish banking system. Studies conducted by Aydoğan and Çapoğlu (1989), Zaim (1993), Dağlı (1995), Yolalan (1996), Ertuğrul and Zaim (1996), Ergin and Aypek (1997), İnan (2000), Cingi and Tarım (2000), Çolak and Altan (2002) and Atan and Çatalbaş (2005) can be given as examples in this regard. A common point in these studies is that they use financial rates that are determined using the production or intermediary approach in measuring the performance of the banking sector both individually and as a sector and make efficiency and productivity evaluations.

In addition to these studies, Aydoğan (1992), Yolalan (1996), Denizer et al. (2000), Işık (2000) and Yiğidim (2001) investigated whether the rapid change that took place in the banking sector after the financial liberation in Turkey altered efficiency of the whole sector and the banks individually. Fields et al. (1993) and Çolak and Kılıçkaplan (2000), on the other hand, conducted efficiency and productivity analyses in their studies taking into consideration the costs and size of the scale of banks.

3. Methodology

Since the model of analysis that will be used in the measurement of efficiency and the differences among the data that will be used in the model will have an effect on the results of the analysis, selection of model and variables is extremely important. Methods for measuring efficiency in the banking sector are divided into three, namely ratio analysis, parametric and non-parametric methods.

Ratio analysis is a method that is applied by monitoring in the course of time the ratio that arises from a comparison of a single input with a single output and is the most frequently used efficiency method. The ratio analysis method is based on the calculation of the items on financial tables of companies as percentages or multiples of one another. However, ratio analysis is stationary by virtue of its nature. Data obtained using this method reflect performance of businesses only by periods. Each ratio handled in the analyses made using this method concentrates on only one of the dimensions related to efficiency and ignores other factors connected with efficiency. When it is viewed from the perspective of productivity of the banking sector, this situation does not allow a comprehensive analysis as it involves a lot of inputs and outputs. The facts that the ratio that is obtained needs to be observed on a yearly basis and other values are also required for a comparison are weaknesses of this method (Büker et al., 2009: 81). Moreover, difficulties are experienced in determining inputs and outputs in the banking sector in terms of their quality. A ratio that is considered an input in one approach can be considered an output in another approach and there are situations where inputs and outputs are not expressed using the same units (İnan, 2000: 83). Due to all these drawbacks, ratio analyses may prove to be insufficient in evaluating the productivity of the banking sector from a wider and accurate perspective.

Measurement of efficiency in parametric methods is based on the assumption that there is an analytical function concerning production in the relevant branch of industry and an attempt is made to determine the parameters of this function (Yeşilyurt and Alan, 2003: 93). Methods of this kind involve the parametric relationship between technical efficiency in the output and input levels. An advantage of parametric methods is that they include the term error in the development of the efficiency value. However, when the term error is included, this time the question of separating it from the term error that arises from inefficiency emerges (Weill, 2003: 579). In general, these methods suffer from three shortcomings. First, since multiple regression takes into account only one output, it requires that all outputs be reduced to a single value via the common unit. This situation renders this method extremely impractical in such a sector as the banking where there are very many outputs. Therefore, the units that are found to be efficient as a result of investigation are only units that have a productivity level above the average. Finally, regression analysis attempts to define the production function parametrically. The assumption that the production function must be defined only in one way does not fit the nature of decision units that are subject of efficiency analysis in the banking analysis.

Non-parametric methods, on the other hand, attempt to measure the distance to the efficient frontier by using linear-programming-based techniques. Since these methods, as in the case of parametric methods, do not have to be based on behavioral assumptions related to the structure of the production unit, they are relatively more advantageous. Moreover, the methods in question enjoy the additional advantage of being able to use more than one explanatory and explained variable (Seyrek and Ata, 2010: 69). However, besides these advantages, they may transfer data and measurement errors and chance and other errors to the model as they do not possess a random error term and determine the efficient frontier wrongly.

There are two fundamental approaches in the relevant literature as non-parametric efficiency measurement methods, Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH) (Berger and Humprey, 1997: 200). Of these two methods, the one that is more frequently used in the banking sector is the DEA method, which was developed by Charnes et al. in 1978.

DEA is a linear programming-based technique that aims to measure the relative efficiency and productivity of the decision-making units in cases where inputs and outputs measured with more than one and different scales or having different measurement units render making comparison difficult (Uzgören and Şahin, 2011: 196).

The method in question is used for performance evaluations in relations of production that involve multiple inputs and outputs and where the classic regression technique can not be applied. DEA, which produces the same kind of outputs by using the same kind of inputs that are assumed to be homogeneous, compares the decision-making units among themselves, determines the best observation which generates the highest number of outputs by using the fewest number of inputs and adopts this as the efficient frontier. It tries to measure the relative efficiencies of other decision-making units according to this efficient frontier (Cihangir, 2004: 170). The important thing about DEA is that the efficiency of the calculated efficiency values of the units are measured according to the units that constitute the observation set.

DEA can be used both ways, namely input oriented or output oriented. Input-oriented DEA models investigate what the most appropriate input composition should be to generate a certain output composition in the most efficient way. Output-oriented DEA models, on the other hand, investigate the highest possible number of output compositions using a certain input composition (Atan and Çatalbaş, 2005: 52).

In this study, the DEA method, which is frequently used in measuring efficiency of banks, was used to determine the efficiency values of 20 public and private capital commercial banks operating in the Turkish banking sector on the basis of their annual data for the 2009-2011 period.

4. Data Set

There are three basic approaches, namely production, intermediary and profitability approaches, in studies intended to measure efficiency in the banking sector regarding what the banking products and inputs are. The production approach regards banks as units that use production factors such as capital and workforce as input and produce balance sheet items such as deposits, credits, securities portfolio. The intermediary approach concentrates on the banks' function as intermediary in financial markets and is based on the assumption that banks obtain funds by drawing deposits to be turned into credits, securities and other assets. According to this approach, deposits and other resources are considered inputs whereas interest costs and workforce and real capital costs are regarded as total cost components. The profitability approach, on the other hand, sees banks as firms that seek to get profits and hence adopts profitability as one of the most important components for banks to continue their activities. Within the framework of this approach, items that are classified as interest expenses in the income statement are used as inputs whereas items that provide interest revenues are used as outputs.

The intermediary approach was used in this study to measure the efficiency and productivity of banks. Since deposit totals were taken into account in this study, development and investment banks were omitted from the analysis. The analysis was conducted in the DEA under the assumption of constant returns to scale using the DEAP 2.1. package software. The model formed in this study was input-oriented, constant focus multiple-stage DEA.

The data in the study about the banks were obtained from the official web page of the Banks Association of Turkey (www.tbb.org.tr). The input-oriented approach was adopted with the assumption that banks had more influence on the inputs. What is important about this choice is that input and output-oriented models predict exactly the same frontiers and the decision-making units on the efficient frontier are the same. Only the levels of efficiency of inefficient decision-making units may exhibit variation in these approaches (Bumin and Cengiz, 2009: 81).

In this study, the efficiency levels of the banks between the years 2009 and 2011 were measured using DEA and efficient and inefficient banks were determined. The target input and output levels of the inefficient banks were formed. Likewise, reference sets were formed for the inefficient banks.

Input and output values are variables that constitute banks' balance sheet items. The values are in ratios and units. The reason why the values are handled as ratios is that the banks were compared in the study irrespective of differences in their scale size in order to make the analysis more reliable.

4.1 Determination of Decision-Making Units

Input and output variables that constitute the data set need to be selected reliably and accurately in order to conduct efficiency measurement using DEA. To what extent the results of the analysis will be significant is, by virtue of the nature of DEA, directly correlated with the fact that the selected inputs and outputs should be to the point and correct items. This is so much so that the model will determine the decision-making units that it will classify as efficient or inefficient at the end of the analysis thanks to the input and output variables to be determined.

In order to measure the efficiency of decision-making units, it is necessary to determine the input and output variables belonging to these units and at the same time in order for the DEA model to yield successful results in the decision-making problem, the number of inputs and outputs need to be as many as possible. However, all of the selected input and output components need to be used for each decision-making unit. If the number of inputs selected for a DEA model is (m) and the number of outputs is (p), at least (m+p+1) decision-making units are a requisite constraint for the reliability of the study. Moreover, the number of decision-making units must be at least twice the number of variables (Çolak and Altan, 2002: 44-45).

Since 3 input and 2 output variables were used in the model that was applied in the study, the number of the decision-making units must be at least;

Number of Inputs + Number of Outputs + 1 = 6 and (Number of Inputs + Number of Outputs) x 2 = 10.

In the light of this information, 20 commercial private and public capital banks operating in the Turkish banking sector were determined as decision-making units. Thus, conditions required for the reliability and accuracy of the study were met. Table 1 shows decision-making units.

Table 1. Set of Decision-Making Units

Code	Banks	Code	Banks
1	Türkiye Cumhuriyeti Ziraat Bankası A.Ş.	11	Türkiye Garanti Bankası A.Ş.
2	Türkiye Halk Bankası A.Ş.	12	Türkiye İş Bankası A.Ş.
3	Türkiye Vakıflar Bankası T.A.O.	13	Yapı ve Kredi Bankası A.Ş.
4	Akbank T.A.Ş.	14	Arap Türk Bankası A.Ş.
5	Alternatif Bank A.Ş.	15	Citibank A.Ş.
6	Anadolubank A.Ş.	16	Denizbank A.Ş.
7	Şekerbank T.A.Ş.	17	Deutsche Bank A.Ş.
8	Tekstil Bankası A.Ş.	18	Eurobank Tekfen A.Ş.
9	Turkish Bank A.Ş.	19	Finans Bank A.Ş.
10	Türk Ekonomi Bankası A.Ş.	20	HSBC Bank A.Ş.

4.2 Determination of Input and Output Variables

Besides the decision-making units, determination and selection of input and output variables is one of the most important issues in analyses of non-parametrical efficiency. A joint decision can not be taken in determining inputs and outputs especially in the efficiency analyses of banks. A fundamental reason for this is that the services that banks produce (outputs) can not be observed concretely and therefore do not have measurable counterparts.

While on the one hand studies in the relevant literature were made use of in the selection of inputs and outputs that would be used in the study, an evaluation was also made in terms of banking on the other hand. Determination of inputs and outputs to be used in the best possible manner is important in increasing the reliability and validity of the study and providing better feedback about in what way and how the improvements to be recommended to the inefficient decision-making units can be performed Table 2 shows the inputs and outputs that are used in the intermediary approach.

Table 2. Inputs and Outputs Used in the Intermediary Approach

INPUT		OUTPUT	
1	Total Deposits / Total Assets (%)	**1**	Total Loans and Receivables / Total Assets (%)
2	Interest Expenses / Total Assets (%)	**2**	Interest Income / Total Assets (%)
3	Other Operating Expenses / Total Assets (%)		

The intermediary approach is one of the three approaches frequently used in efficiency analyses in banking together with the intermediary and profitability approaches. According to this, “Total Deposits / Total Assets”, “Interest Expenses / Total Assets” and “Other Operating Expenses / Total Assets” were determined as number 1, number 2 and number 3 inputs respectively within the scope of the intermediary approach. On the other hand, “Total Loans and Receivables/Total Assets” and “Interest Income / Total Assets” were determined as number 1 and number 2 outputs respectively. Whether the banks operated efficiently or not according to the intermediary approach will be analyzed using the aforementioned inputs and outputs. First, efficiency scores of the banks will be obtained and efficient and inefficient banks will be determined. After the efficiency values of the banks have been determined, the number of times efficient banks have been referred to and potential improvement tables of inefficient banks will be prepared and they will be provided guidance in reaching their objectives.

5. Experimental Results

In the intermediary approach, first the Charnes, Cooper, Rhodes (CCR) model was used and Total Efficiency Values

were calculated for each year. Then, Malmquist Index, Technical Efficiency, Change in Technology, Pure Technical Efficiency and Scale Efficiency values were calculated using the Malmquist Total Factor Productivity Analysis and they were shown in tables by year. Thus, the sources of the changes in the productivity of commercial banks that constitute the observation set will be revealed. Since the variables used in the analysis are taken as ratios, there is no need to distinguish between the banks according their scales of size. The aim here is to make the analyses simpler and the results more accurate in this way.

Table 3 shows the total efficiency scores by year of the commercial banks in the observation between the years 2009 and 2011 according to the production approach.

Table 3. Efficiency Values for the Observation Set According to the Production Approach (2009-2011)

Code	Banks	Technical Efficiency (2009)	Technical Efficiency (2010)	Technical Efficiency (2011)
1	Türkiye Cumhuriyeti Ziraat Bankası A.Ş.	100,0%	100,0%	100,0%
2	Türkiye Halk Bankası A.Ş.	100,0%	100,0%	100,0%
3	Türkiye Vakıflar Bankası T.A.O.	93,7%	100,0%	100,0%
4	Akbank T.A.Ş.	96,1%	100,0%	94,3%
5	Alternatif Bank A.Ş.	100,0%	100,0%	99,7%
6	Anadolubank A.Ş.	92,2%	94,2%	98,9%
7	Şekerbank T.A.Ş.	89,1%	89,8%	84,5%
8	Tekstil Bankası A.Ş.	85,9%	93,4%	99,0%
9	Turkish Bank A.Ş.	62,9%	79,2%	77,3%
10	Türk Ekonomi Bankası A.Ş.	75,3%	79,6%	81,0%
11	Türkiye Garanti Bankası A.Ş.	92,5%	96,4%	95,1%
12	Türkiye İş Bankası A.Ş.	88,5%	87,7%	86,6%
13	Yapı ve Kredi Bankası A.Ş.	83,6%	86,7%	100,0%
14	Arap Türk Bankası A.Ş.	100,0%	100,0%	100,0%
15	Citibank A.Ş.	70,6%	79,8%	79,0%
16	Denizbank A.Ş.	100,0%	100,0%	100,0%
17	Deutsche Bank A.Ş.	31,5%	65,8%	51,6%
18	Eurobank Tekfen A.Ş.	100,0%	100,0%	100,0%
19	Finans Bank A.Ş.	94,8%	94,7%	100,0%
20	HSBC Bank A.Ş.	80,8%	84,0%	88,8%
	Average	**86,9**%	**91.6**%	**91.8**%

There are five banks that are efficient in all years according to the intermediary approach. These banks are Türkiye Cumhuriyeti Ziraat Bankası A.Ş., Türkiye Halk Bankası A.Ş., Arap Türk Bankası.A.Ş. Denizbank A.Ş. and Eurobank Tekfen A.Ş. The number of banks that were efficient in 2009 was six. These banks were Türkiye Cumhuriyeti Ziraat Bankası, Türkiye Halk Bankası, Alternatif Bank A.Ş., Arap Türk Bankası.A.Ş., Denizbank A.Ş., Eurobank Tekfen A.Ş. The number of banks that were efficient in 2010 was eight. These banks were Türkiye Cumhuriyeti Ziraat Bankası, Türkiye Halk Bankası, Türkiye Vakıflar Bankası T.A.O., Akbank T.A.Ş., Arap Türk Bankası.A.Ş., Denizbank A.Ş. and Eurobank Tekfen A.Ş. The number of banks that were efficient in 2011 was eight. These banks were Türkiye Cumhuriyeti Ziraat Bankası, Türkiye Halk Bankası, Türkiye Vakıflar Bankası T.A.O., Yapı Kredi Bankası A.Ş, Arap Türk Bankası.A.Ş. Denizbank A.Ş. and Eurobank Tekfen A.Ş. When the banks that have the lowest levels of efficiency by year are examined, it is observed that Deutsche Bank A.Ş. is the one with the lowest efficiency in the years 2009, 2010 and 2011.

Table 4. Average Statistics by Year According to the Production Approach

	2009	2010	2011
Level of Average Efficiency	0, 869	0,916	0,918
Number of Banks that Constitute the Observation Set	20	20	20
Number of Efficient Units	6	8	8
Average of Inefficient Units	0,761	0,859	0,799
Level of Lowest Efficiency	0,315	0,658	0,516

The first line of Table 4, which includes average statistics concerning efficiency values of the banks calculated separately for each year according to the production approach, shows the average of the efficiency levels of the banks in the observation set for the relevant years, whereas the second line shows the number of banks that constitute the observation set by year. When average efficiencies are considered, it is seen that they were 91.6 % and 86.9 % respectively in 2009 and 2010.

According to the values given in Table 4, 2011 was the year when the banks' efficiency levels were at their highest. Whereas 2010 was the year when the average of inefficient banks was at the lowest with 0,761 while it was at the same time the year when the number of efficient banks was the lowest (six banks)

In the period when the analysis was made, the banks attained an average increase of 0.002 only in 2011 in their efficiency scores in terms of the average intermediary function. An examination of whether the efficient banks maintained their efficiency throughout the period or not and whether the inefficient banks improved their efficiency scores or not reveals that eight banks could not maintain their efficiency values in 2009 and experienced a decrease in their efficiency values as of the end of 2011 whereas six banks increased their efficiency values. On the other hand, efficiency scores of six banks did not change between the year the analysis started and the year it ended and remained constant. These banks were at the same time fully efficient banks that enjoyed an efficiency level of 1,0. According to the data in Table 4, twelve banks in 2009, fourteen banks in 2010 and twelve banks in 2011 could not demonstrate technical efficiency. In other words, these banks remained below the level of output that they could have attained within the sector according to their scale with their current inputs.

In the final stage of the analysis made using the production approach, Malmquist Production Index was in order to distinguish between technical efficiency and technological change due to the time dimension. Malmquist Production Index was calculated separately for two periods, namely 2010 and 2011.

In Table 6, the results obtained for all of the deposit banks constituting the observation set as a consequence of the implementation of Malmquist Index for the period of 2010-2011 are shown as annual averages.

Table 6. Periodical Comparison of Malmquist Indexes Calculated for the Observation Set According to the Production Approach

Year		Technical Efficiency Change (TE)	Technological Change (TC)	Pure Technical Efficiency Change (PTE)	Scale Efficiency Change (SE)	Malmquist Production Index (M)
2009-2010	Observation Set	1,027	0,995	1,030	0,998	1,023
2010-2011	Observation Set	1,025	1,067	1,004	1,021	1,094

The values given in Table 6 were obtained by calculating the geometrical averages of the Malmquist Production Index values found for each bank. The figures in the last column of the tables indicate the change in the total factor productivity that is the Malmquist Production Index value. If this value is greater than one, it shows an increase in total factor productivity whereas if it is smaller than one, it shows a decrease. If Malmquist production index is equal to one, it indicates that there is no change in total factor efficiency between the two periods that are compared.

When the values in the last column of Table 6 are examined, it is observed that total productivity of the banks in the observation set increased by 2.3 % in 2009 in comparison to 2010. The Malmquist index for 2010-2011, on the other hand, was 1,094. In other words, total productivity of the banks in the observation set increased by 9.4 % in 2011 in comparison to 2010.

It is possible to explain the change in total factor productivity by using four different indexes. To this end, first, it is necessary to investigate the effects of technical efficiency change (TE) and technological change (TC), which are two of the major components of the Malmquist production index. An index value greater than 1.00 indicates a positive contribution in these indexes whereas a value below one points to a negative contribution.

When the third (TE) and fourth (TC) columns of Table 8 are examined, it is observed that within the framework of the production approach, the technical efficiency change of the banks made a contribution of 2.5 % to the total factor productivity in comparison to the previous year whereas technological change increased by 6.7 % in the same year and made a positive contribution. A positive change in technological efficiency change and technology caused a 9.4 % increase in total factor productivity in 2008 in comparison to the previous year.

While there was an improvement of 2.5 % in the technical efficiency and 6.7 % in technological change of the banks that constituted the observation set in 2011. On the other hand, a 9.4 % increase took place in total factor productivity.

6. Conclusions

The developments that occurred in the banking sector in the international financial system and the increasing importance of banks in global economy rendered measurement of the performance and efficiency of banks vital. The banking sector is in a mutual and continuous interaction with economy. The crises that took place in Turkish economy in the past and political and economic instabilities had traumatic effects on the banking sector. The banking sector's reducing its problems arising from the overall economic structure to a minimum is closely linked to having a strong and healthy financial structure. Banks must avoid wasting sources and work efficiently in order to be competitive in the global environment.

Various studies have been conducted in Turkey and other countries using the DEA regarding the evaluation of efficiency of the banks in the banking sector. The reason why DEA is frequently used in the banking sector is that this sector has many inputs and outputs. An advantage of DEA over other methods of efficiency measurement is that it allows making sound analyses in cases where there are many inputs and outputs and determines inefficient units and sets goals for these inefficient units to attain efficiency.

In this study, efficiencies of 20 commercial banks operating in the Turkish banking sector were investigated by using the data that belonged to the 2009-2011 period. The DEA and Malmquist Total Factor Productivity Index were used in the analyses under the assumption of constant returns to scale. The model formed in the study is the input-oriented, constant focus to scale and multiple stage DEA. Analyses were made according to the intermediary approach, which is frequently used in determining what the products and inputs of banks are and the results were evaluated. The efficiency values of the banks were measured to determine efficient and inefficient banks and then target input and output levels of the inefficient banks were formed. Likewise, reference sets were formed for the inefficient banks and finally whether the banks exhibited any development or not was investigated in the light of Malmquist indexes.

According to the findings obtained in the study, the efficiency scores of the banks increased 0.047 intermediary function in 2009 and 2010 and they demonstrated a slight increase of 0.002 in the year 2011. Four banks were not able to maintain their efficiency levels in 2009 and had lower efficiency values as of the end of 2011 while eleven banks increased their efficiency values. On the other hand, efficiency scores of four banks did not change in the period between the beginning and final years of the analysis and remained constant. Fourteen banks, in 2009, twelve banks in 2010 and twelve banks in 2011 could not exhibit technical efficiency.

According to the results of a periodical comparison of Malmquist production indexes, total productivity of the banks in the observation set increased by 2.3 % in 2010 in comparison to 2009. In the year 2011, on the other hand, total productivity of the banks increased by 9.4 % in comparison to 2010.

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