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The Determination of Deposit and Participation Banks' Efficiency by Data Envelopment Analysis: A Research on Banks in Turkey

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Abstract. The determination of productivity and efficiency of firms directs strategic decisions in the eye of decision makers. The importance of productivity and efficiency measurement in banking sector which especially attracts foreign investors in Turkey increases gradually. In this context, efficiency measurement of 15 banks operating in Turkey has been done by using their data. Data Envelopment Analysis (DEA) technique which is used as a decision making tool in multiple input multiple output processes and is not parametric is used. In the method, number of staff, total assets and capital are used as input units and general deposit, total credits and net profit are used as output units. In the results, the efficiency of banks in 2013-2014 has been measured and efficiency difference between private capital deposit banks and participation banks has been examined.
Keywords. Data envelopment analysis, Banking, Financial management, Stock returns
Jel. G21, C89, M29
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1. Introduction

Current conditions in finance sector in which competition increases continuously forces banks to use their resources in the most effective way. As a result, productivity and efficiency measurement for banking sector whose weight increases thanks to its important share in Turkish financial system is a fact that keeps up to date. This situation require efficiency measurement and compare with rival banks' efficiency for decision makers who are bank managers, shareholders and potential investors. On the other hand, banking operations whose share in economic size is big in terms of both employment and capital is the leading sector for Turkey, so it is important to measure the efficiency by input-output analysis in banking sector.

DEA is one of the techniques used in efficiency measurement. It helps to make a decision by presenting a comparative efficiency of the firms to decision makers. DEA that uses linear programming bound and is non-parametric has been used commonly in the studies lately. The aim of the study is to measure the efficiency of deposit and participation banks operating in Turkey in 2013-2014 by DEA and compare them.

2. Theory and Literature

DEA was developed by Charnes, Cooper and Rhodes in 1979 to measure the efficiency of the schools. In 1984, Banker Charnes and Cooper developed the fixed

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scale that they used in the previous model and contributed DEA's becoming more effective analysis by sliding scale. The first application in banking was by Sherman in 1995. Major studies employing DEA and their results are given in the literature below.

Ferrier & Lovell (1990) carried out a study in which inputs were the number of staff, hardware and equipment expenses and outputs were deposit account, real estate credits, facility credits and commercial credits. In the results, the banks were seen to be working inefficiently on an average of 21%. Neely & Wheelock (1997) searched the profitability of USA commercial banks within saving deposits insurance fund between 1980 and 1995. A positive relation between banks' performances and target customer groups' annual per capita was found out. Ayadi, Adebayo & Omolehinwa (1998) did an efficiency analysis on banks in Nigeria and by DEA technique. In the analysis, the sample included 10 banks in 1991-1994 term while input units were interest on deposits, staff and management expenses and output units were total credits, interest income and non-interest income. Noulas (1999) evaluated the performances of private capital and state banks. According to analysis results, while state banks' productivity increased faster than private capital ones, technical efficiency is higher in private capital banks.

In their study that evaluated the efficiency of Indian banks between 1992 and 1995 by DEA technique, Saha & Ravisankar (2000) took number of offices and staff, investment expenses, noninterest investment expenses and external costs as inputs and deposit money, running accounts, investments, total income, interest income, non-interest income, available fund and interest width as outputs. Worthington (2000) used the DEA technique in his study. In further deposits, term deposits, deposits, personal loans, housing loans, commercial loans, securities, were used as an input unit. On the other hand capital, number of employees and number of branches were used as output units. Mercan & Yolalan (2000) analyzed the effectiveness of commercial banks between 1989 and 1998 by DEA. In the study in which rates were used as input and output units, it was seen that ownership structure was important on banks' efficiency degrees. Another finding was that currency risk was an important factor of performance measurement. Ben, Naceur & Goaied (2001) examined Tunisia banking sector's performance between 1980 and 1995. The results show Banks with a good performance have high working and capital productivity and they increase their equity capital by keeping some of activity profits.

Ekren & Emiral (2002) examined the effectivity of Turkish banking system between 1998 and 2000 on 71 banks. Effectiveness values of development and investment banks are higher than commercial banks. Isık & Hassan (2002) tried to measure technical, scale and allocative ineffectiveness in Turkish banking system. Input units were number of staff, capital, deposit money, while outputs were short-term credits, long-term credits, non-cash loans and other incomes. Analysis results showed that banking system was not effective enough. Casu & Molyneux (2003) analyzed the development of productivity effectiveness of the European banks in terms of adjustment laws between 1993 and 1997. They concluded that effectiveness changes in the European banking sector was dominantly determined by national factors. Kasman (2003) tried to analyze the effectiveness of 29 banks in financial crisis period. In the study, stochastic edge approach was used. As a result of analysis in which 3 input and 2 output units were used, state banks' average effectiveness were higher than private and foreign banks.

Mercan, et. al. (2003) carried out an effectiveness measurement of banks in group level in 1989-1999 period by using 2 input and 3 output units. According to the results, banks with state capital had lower effectiveness level. Mercan & Reisman (2003) examined the effect of liberalization and crisis in nearby countries

on banks operating in Turkish banking sector between 1989 and 1999 by using DEA. Galagedera & Edirisuriya (2005) measured the performances of Indian banks between 1995 and 2002 period by DEA technique. Bakırcı (2006) determined the effectiveness of firms in automotive sector by DEA method and stated that 6 out of 13 firms were not effective in inputs. Çetin (2006) evaluated the effectiveness of 22 textile enterprises whose shares were publicly traded in İMKB by DEA method. Eleren & Özgür (2006) measured the effectiveness level of deposit banks with foreign capital in Turkey by DEA method. The data within the study came from 2001-2005 period. Inputs were deposits and interest expenses and outputs were credit and interest incomes. While effectiveness values showed a falling tendency in the years in which economic and political stability started to develop, there was an increase in effectiveness levels due to the decrease in interest rates and increase in personal loan size after 2004.

Turgutlu, Kök & Kasman (2007) examined the effectiveness of Turkish insurance companies between 1990 and 2004. In the study, a clear ineffectiveness was seen in other than life insurance fields in the mentioned period. Yalama & Sayım (2008) carried out a performance evaluation of the sub-units of manufacturing sector by using financial statements of financial analysis rates gained from December-2005 period and with 8 input and 2 output variables. In the end of the study employed DEA technique, the effectiveness of the sub-units of manufacturing was determined. Ertuğrul & Tuş Işık (2008) used DEA method with 2 inputs and 2 outputs while benefiting from 2003-2007 period financial statements of base metal companies that were publicly traded in İMKB 100. They gave the order of effectiveness in terms of years. Babacan, Kısakürek & Özcan (2009) tried to evaluate the performance of the enterprises which were publicly traded in 2001. The performance evaluation of the enterprises was done by DEA method through fifteen inputs and five outputs and firms publicly traded in 2001 were seen to be working in disadvantaged situations. Behdioğlu & Özcan (2009) performed an effectiveness evaluation by DEA method through the data obtained from 29 commercial banks operating in Turkey between 1999 and 2005. In the study, the average effectiveness of the banks was determined as 43,3%.

Kula, Kandemir & Özdemir (2009) calculated the effectiveness values of enterprises registered to İMKB and working in cement sector through their activities between 2001 and 2007 and by DEA method. In the study, the change of these effectiveness values was evaluated by using Malmquist Total Factor Productivity index. Özer, Öztürk & Kaya (2010) tried to evaluate the effectiveness of 24 enterprises that were publicly traded in İMKB in 2007-2008 and operating in food and drink sector by DEA method. Six inputs and two outputs were used. Besides, cluster analysis and TOPSIS method were compared to DEA. Srairi (2011) measured the banks' productivity increase and the effects of financial liberalization in Gulf Cooperation Council countries between 1999 and 2007 period by using DEA and Malmquist Total Factor Productivity index. Budak (2011) calculated 22 banks' effectiveness performance between 2008 and 2010 through using 3 inputs and 4 outputs and by DEA and tried to show which banks were effective. Cenger (2011) measured the effectiveness of 12 companies operating in cement sector and were publicly traded in İMKB by DEA method through their financial statements for the period of 1999-2003 and with four inputs and two outputs. Küçükaksoy & Önal (2013), examined the effectiveness of 15 banks in the period of 2004-2011 by input focused DEA method under the variable return to scale hypothesis. Banks' effectiveness order according to their effectiveness value was determined in the study.

3. Aim, Data Set and Method

The study aims to measure the effectiveness of private capital deposit banks and participation banks operating in Turkey. With this aim, the data from 15 banks operating between 2013 and 2014 was used and the data was obtained from the web site of the banks association of Turkey. DEA was used in order to measure pre-mentioned effectiveness.

DEA is a method developed by Charnes, Cooper & Rhodes in 1979 in order to measure the effectiveness of similar units. It is a linear programming based technique which aims measuring the effectiveness of similar decision making units when there are many inputs and outputs (Cooper et al., 2011). In DEA which is non-parametric, the existence of the functional relation between input and output is not searched for. Besides, measurement errors within the data might affect effectiveness results negatively as error units are not taken into consideration. (Berger, 1993). The data obtained within the study was analyzed by DEAP Version 2.1 which is a DEA program.

The study included 15 banks as samples and their classification is given below in Table-1:

Table 1. *Banks Taken into Analysis*

Code	Deposit Banks	Code	Participation Banks
M1	Adabank	K1	Albaraka Türk
M2	Akbank	K2	Bank Asya
M3	Alternatif Bank	K3	Kuveyt Türk
M4	Anadolu Bank	K4	Türkiye Finans
M5	Şeker Bank		
M6	Tekstil Bank		
M7	Turkish Bank		
M8	Türk Ekonomi		
M9	Garanti Bank		
M10	İş Bank		
M11	Yapı Kredi		

In DEA technique, decision units should be selected after observation cluster is formed. The number of decision units shouldn't be less than the required number by linear programming model that will be used in the study. When Input is shown as I and Output as O, following formula should be employed and given number of decision units should be taken: I+O+1 (3+3+1=7) Besides, it is important for the reliability of the research that the number of decision units at least doubles (2 x (3+3) = 12) the total number of variables. This study includes 3 input, 3 output and 15 decision units and output maximization model has been formed accordingly.

Under the model developed by Charnes, Cooper & Rhodes (1978), model and the constraints used in this study are as follows:

$$E_k = max\beta - \mathcal{E}\sum_{i=1}^{3} s_{i-} + \mathcal{E}\sum_{i=1}^{3} s_{r+} \quad (1)$$

Subject to:

$$\sum_{j=1}^{15} X_{ij}\,\lambda_j + s_{i-} - X_i = 0 \qquad i = 1, \ldots .3 \quad (2)$$

$$\sum_{j=1}^{15} Y_{rj}\,\lambda_j - s_{i+} - \beta Y_{rk} = 0 \qquad r = 1, \ldots 3 \quad (3)$$

$$\lambda_j \geq 0, j = 1, \ldots..15 \qquad s_{i-} \geq 0, i = 1, \ldots..3 \qquad s_{i+} \geq 0 \quad r = 1, \ldots 3$$

In sembols;
Ek: *The* efficiency value of the decision-making unit
Yrk: *r*'output produced by *k*' decision making unit
Yrj: *r*'output produced by *j* decision making unit
Xij: *i*' input produced by *j* decision making unit
ε: a small positive number
β: Expansion coefficient

The last step in DEA is the determination of inputs and outputs. Input and output units that were formed taking into consideration the existing literature are given in Table-2:

Table 2. *Input and Output Units Used in the Analysis*

Code	Input Units	Code	Output Units
X1	Number of Employees	Y1	Net Profit
X2	Total Assets	Y2	Total Loans
X3	Capital	Y3	Total Deposits

The main inputs of the banks are generally labor-force, capital and current assets. Banks collect deposits, open credits and profit in the end by using these inputs. So, input and output units are determined as in Table-2.

4. Findings

4.1. Findings Related to Input and Output Units of the Banks

2013 year-data related to the banks which was used as the decision unit in the study is shown in Table-3 and 2014 year-data related to the banks which was used as the decision unit in the study is shown in Table-4.

Table 3. *Activity Report Data Belonging to the Banks for 2013 (TL)*

Decısıon	Input Units			Output Units (000.000)		
Unıts	X1	X2	X3	Y1	Y2	Y3
M1	513	49.886	42.234	0	6.456	0
M2	16246	183.737	23.845	2.942	105.276	110.675
M3	1413	10.989	420	71	4.980	6.440
M4	2111	9.022	600	101	5.927	6.049
M5	4500	19.676	1.000	221	12.729	13.648
M6	853	3.854	420	43	2.521	2.832
M7	204	1.147	165	0	644	540
M8	10000	56.204	2.204	568	35.533	38.135
M9	12000	196.896	4.200	3.005	106.405	118.671
M10	22587	210.500	4.500	3.163	120.975	134.843
M11	16680	160.309	4.347	4.586	88.481	100.623
K1	3057	17.217	900	241	10.878	11.987
K2	5074	27.785	900.000	181	18.511	20.705
K3	4642	25.894	1.700	300	17.030	16.232
K4	3990	25.126	1.755	329	15.141	17.447

Table 4. *Activity Report Data Belonging to the Banks for 2013 (TL)*

Decısıon	Input Units			Output Units (000.000)		
Unıts	X1	X2	X3	Y1	Y2	Y3
M1	510	50.751	43.003	737	6.427	0
M2	16305	205.450	27.163	3.159	113.355	128.489
M3	1500	10.659	420	130	5.675	7.882

M4	1761	9.477	600	170	6.511	6.248
M5	4500	21.187	1.087	223	13.538	14.632
M6	855	3.656	420	13	2.509	2.799
M7	250	1.400	175	4	905	896
M8	10142	62.992	7.624	665	39.439	45.392
M9	17000	247.051	26.627	3.684	133.425	144.037
M10	23967	237.772	4.500	3.382	133.551	155.315
M11	18500	181.201	4.347	1.845	105.120	121.993
K1	3510	23.046	900	260	13.580	15.474
K2	3210	13.811	900	0	8.887	7.462
K3	5082	34.008	2.287	370	22.144	20.575
K4	4478	33.494	2.600	334	19.112	2.305

4.2. Data Envelopment Analysis Model Results (Effectiveness Measurement)

Model results belonging to 2013-2014 period according to DEA which was formed by using the input and output variables in tables 3 and 4 are given in Table-5:

Table 5. *Effectiveness Analysis Results of the Banks*

Decision Units	2013 Effective Value	2014 Effective Value
M1	1.000	1.000
M2	0.548	0.585
M3	0.902	0.808
M4	1.000	0.779
M5	0.996	0.934
M6	0.959	0.952
M7	1.000	0.840
M8	0.830	0.763
M9	0.461	0.601
M10	0.623	0.603
M11	1.000	0.683
K1	0.548	0.776
K2	0.902	1.000
K3	1.000	0.692
K4	0.996	0.726

According to solution results in Table-5, banks whose aim function and effectiveness coefficient equal to 1 are confirmed as effective. In this context, according to the analysis depending on input and output factors determined for 2013 year, five banks (M1, M4, M7, M11 and K3) are found to be effective. Only two banks (M1 and K2) are found to be effective in 2014 with the same input-output units. The effectiveness of the banks whose effectiveness coefficient is not equal to 1 is relatively low.

No parallelism was identified in banks' effectiveness. In other words, a bank with a high effectiveness in 2013 might have a lower effectiveness in 2014. Only one of the banks out of fifteen was seen to be effective through whole analyze period.

Separate effectiveness value means were calculated for private capital deposit banks and participation banks as one of the sub-problems of the study is to compare the two type of banks. Calculated means are given in Table-6:

Table 6. *Effectiveness Value Means of the Decision Groups*

DECISION GROUPS	Effectiveness Value Mean for 2013	Effectiveness Value Mean for 2014
Private Capital Deposit Banks	0,847	0,777
Participation Banks	0,862	0,798

As can be understand from Table-6, according to the banks' average effectiveness, banks' 2014 effectiveness is lower than 2013. Besides, participation banks can be said to be more effective as their effectiveness is higher than private capital deposit banks in both years.

5. Conslusion

Finance sector in Turkey is a sector in which there is intense competition and attracts foreign investors. Under the light of this information, banks' effectiveness and profitability stand out both for shareholders and prospective investors. Especially bank managers who are in the decision making position should carry out performance measurement regularly and failing points should be identified. Besides, comparative analysis with opponent banks in the sector should be performed. DEA is one of the pioneering methods that can be used with this aim. This method provides carrying out a comparative analysis with many input and output units.

In the study, the effectiveness of private capital deposit banks and participation banks operating in Turkey in 2013 and 2014 years was determined by DEA. In the analysis, input units were the number of staff, total current assets and capital while output units were total deposit, total loan and net profit. According to the analysis results, banks' effectiveness in 2013 and 2014 shows a difference. Only one out of 15 banks was effective in both years. According to comparative analysis done by effectiveness means, private are found to be more effective than deposit banks.

Banking sector is one of the sectors that can obtain more output with the same input. So, qualitative evaluations should be included beside quantitative approaches in the analysis to be done. Diversifying input and output units used in the analysis might cause differences in the results. Input and output units might be reorganized according to the point of views of bank managers and prospective investors.

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