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Comparison of Turkish State Banks' Performances via Multi-Criteria Performance Measurement Method

Asst. Prof. Dr. S. Öznur SAKINÇ

(Business Adminstration/Hitit University Vocational High School, TURKEY)

ABSTRACT

The banks are the most efficient aspects of countries. As efficiency and reliability of the banks increase, contributions of account owners to national economy increase as well. Increasing competitiveness and market share are important targets in banking sector as in other sectors. Banks need to increase their efficiency and productivity in order to enhance competitive capacity. Administrations are required to be aware of their strategies' deficient, weak and strong aspects to develop their competitive capacity. Therefore, operations need to carry out performance analysis. According to the analysis results, revisions are made, new targets are aimed and strategies are taken if necessary. The market share of Turkish state banks in the banking sector is 30%. This share has not changed despite the development of the private sector. Moreover, these banks support areas which the private sectors do not support via credit. Thus, state banks constitute data set to be used in performance measurement methods in the current study. Four-years of financial data were used between the years of 2010-2013. Financial ratios such as liquidity, capital sufficiency, profitability and active quality determine these banks' performance rank. In this study, banks' performance measurement methods were carried out by using the Grey Relational Analysis, one of the multi-criteria performance methods, and TOPSIS, and the results were compared.

KEYWORDS: *Banking Sector, State Bank, Turkish State Bank, Performance Measurement in Banks, Grey Relational Analysis Method, TOPSIS.*

JEL: G1, G2, O2

I. INTRODUCTION

There is a close relationship between the increase of production and savings volume in order for a country to develop its economy and decrease its dependence on foreign sources. Banks act as a bridge between the production and saving holders. There is a fund exchange between the banks which aim to increase their production volume and entrepreneurs who wish to valorise their savings. Efficient and reliable service is required to sustain increase in this fund flow by the banking sector.

Banks are required to identify their weak and strong aspects to increase their efficiency and reliability. After the identification of these weak and strong aspects, necessary strategies should be devised and precautions should be taken to empower the weak points. Therefore, the banks possess competitive capacity and opportunity for increasing market share.

Banks benefit from the performance measurement methods in the identification of their weak and strong aspects. Since they take part in the service sector, performance measurement is of more importance in comparison to other sectors. Capital adequacy, liquidity, active quality and profitability are the issues they dwell upon as performance measurement methods. The results of performance measurements help administrators to make plans for the future and come up with strategies. At the same time, these

results contribute to the people and firms interested in the banks to have opinions about them. Thus, banks secure their places by increasing their shares in the sector thanks to this dual effect.

There are various measurement methods. These methods analyse the same inputs by using different applications. This causes a difference in the results acquired through these methods. For this reason, performances of the banks were measured by using the Grey Relational Analysis and the TOPSIS method in the current study. Compatibility of these two methods was investigated by comparing the results acquired with them.

Banks have the aim of profitability like any other organizations. For this reason, they might be reluctant to supply fund to the classes not able to make a profit. Welfare of the society is of more importance than margin of profit for the state banks. Thus, state banks try to serve the ones who are in need of capital without taking margin of profit into account. Also, the existence of these banks balances competition, quality of service and prices by preventing the sector from being monopolised. Therefore, state-funded banks were investigated in this study (Micco and et al, 2004).

According to the June 2015 data, there are 34 deposit, 13 development and investment and 5 participation banks which are 52 in total in the Turkish Banking Sector. State banks provide service with 5 deposit, 4 development and investment and 1 participation banks. In the banking sector, state-funded banks have 19% share. In spite of this, these banks have a 28% personnel rate, 29% in branch numbers and have the second rank after local banks and 17.03% in the first ranks in terms of capital adequacy (BDDK).

II. LITERATURE REVIEW

Grey relational analysis has been adopted for several purpose, such as devising airway networks (Hsu and Wen, 2000), carrying out comparative studies regarding financial indicators of corporations (Feng and Wang, 2000), sales forecasting (Lin and Hsu, 2002). Chang (2006) investigated the business manner and financial performance relationship of 15 trade banks in Taiwan by means of the Grey Relational Analysis. Ho and Wu (2006) used the Grey Relational Analysis method to compare 3 banks. Yuan (2007) made performance comparison via Grey Relational Analysis method. Wang (2009) employed the Grey Relational Analysis to measure performance of the transportation sector in Taiwan. Uçkun and Girginer (2011) made use of the Grey Relational Analysis in order to evaluate performances of state and private banks in the Turkish banking sector. As a result, 'Ziraat Bankası' ranked as the first concerning performance as a state bank, 'Anadolu Bankası' ranked as the first as a private bank. Girginer and Uçkun (2012) utilized the Grey Relational Analysis method to measure the effect of financial crisis on Turkish banks. As a result, performance ranking was carried out as state banks, foreign banks and private banks. Elitaş et al. (2012) adopted this method to measure the performances of insurance companies. Doğan (2013) evaluated the financial performances of 10 banks in Istanbul Stock Exchange (BIST) by means of the Grey Relational Analysis. Ecer (2013) evaluated performances of private banks in Turkey by using Grey Relational Analysis. Altan and Candoğan (2014) investigated the Grey Relational Analysis applications on the participation banks operating in Turkey. The application of performance measurement results using traditional 1 rate with the Grey Relation Analysis provided different results. Sakınç (2014) utilized the Grey Relational Analysis method to measure the performances of state banks.

The TOPSIS method was used by Hwang Yoon in 1981 for the first time. Cheng-Ru Wu (2008) used this method for multi-purpose inventory planning. Feng and Wang (2000) manipulated this method to measure performances of airline operators. Cheng-Min Feng, Rong-Tsu Wang (2001) carried out financial performance analysis of coach operators via TOPSIS. Chang (2003) utilized the TOPSIS for performance analysis of airlines. Yurdakul (2003) benefited from this method for performance analysis of automotive firms. Elhag (2006) and Amiri, (2010) used this method to evaluate performances of hotel business. Benitez (2007) evaluated data mining through the TOPSIS method. Mahmoodzadeh et al. (2007) determined project rankings by

using TOPSİS and FAHP evaluation methods. Shih et al. (2007) benefited from this method to choose personnel. Wang (2008) determined the performances of local airline operators' performances via TOPSIS. Likewise, Ching-Shih Tsou (2008) utilized the TOPSIS method to evaluate performances of insurance companies. Hui Yin Tasai (2008) made use of the TOPSIS method in the evaluation of banking sector. Manabendra (2009) adopted the TOPSIS method in order to carry out risk evaluation in the firms. Ertuğrul (2009) implemented the TOPSIS method to evaluate financial performances of cement factories. Similarly, Bülbül (2009) utilized the TOPSIS method to evaluate performances of food companies. Seçme (2009) made use of the TOPSIS method in the evaluation of banking sector. Gökdalay (2009) manipulated this method to measure the performances of airlines. Wang and Yu-Jie (2009) benefited from this method to evaluate the performances of transportation companies. Moreover, Wang, Dashti, (2010) made use of the TOPSIS method in determining the place of facilities. Dumanoğlu (2010) utilized the TOPSIS method to evaluate performances of technological firms. Demireli (2010) used it to analyse state banks' financial performances. Yükçü (2010) carried out performance analysis in accordance with the TOPSIS method. Dumanoğlu and Ergul (2010) applied the TOPSIS method to technology companies trading at Istanbul Stock Exchange.

III. GREY RELATIONAL ANALYSIS

Devised by Julong Deng in 1982, the Grey Relational Analysis is used in situations in which information is not complete, clear and precise. Data can be classified, graded and used to acquire the required information via this method (Lin and et al. 2004:198).

In the Grey Relational Analysis method, colours are used in the classification of information. Colours determine the level acknowledgement of data and information. Black refers to non-data area, grey partial data area and white data area (Wen, 2004:5).

Grey Relational Analysis is one of the multi criteria decision making methods. In this method, the evaluation is carried out through not clear, precise, and limited information (Liu and Lin, 2006:11).

In this method, easy and comprehensible calculations are done instead of complex formula. The fact that the formulas to be employed are easy and graded respectively make this method quite easy to implement in comparison to other methods (Deng, 1982:288).

The calculation steps of the grey relational analysis method are given below (Wen, 2004:6):

Step 1: The Formation of Decision Matrix:

$$X_i = \begin{bmatrix} x_1(1) & x_1(2) & \cdots & x_1(n) \\ x_2(1) & x_2(2) & \cdots & x_2(n) \\ \vdots & \vdots & \ddots & \vdots \\ x_n(1) & x_n(2) & \cdots & x_n(n) \end{bmatrix}$$

Step 2: The Formation Of Reference Series:

Reference series $x_0 = (x_0(1), x_0(2),...,x_0(j),...,x_0(n))$

This series is stated as given above. The criterion of 0x (j) , j. refers to the largest value within the criteria's normalized values. Reference matrix is acquired by writing it in the first line of the reference series.

Step 3: Operation of Normalization and Forming Normalization Matrix:

In this step, data set is normalized and three possible situations are encountered:

I. Utility status: If the purpose is to obtain a better or higher value, number 2 formula is used. Number 2 formula is:

$$x_i^* = \frac{x_i(j) - \min_j x_i(j)}{\max_j x_i(j) - \min_j x_i(j)|}$$

II. Cost status: If the purpose is to obtain a smaller or less value, number 3 formula is used. Number 3 formula is:

$$x_i^* = \frac{\max_j x_i(j) - x_i(j)}{\max_j x_i(j) - \min_j x_i(j)}$$

III. Optimal status: If the purpose is to acquire an optimal value, number 4 formula is used. Number 4 formula is:

$$x_i^* = \frac{|x_i(j) - x_{0b}(j)|}{\max_j x_i(j) - x_{0b}(j)}$$

In this formula $X_{ob}(j)$, j is the target value of the criteria and takes place within the range of: $\max_j x_i(j) \geq x_{0b}(j) \geq \min_j x_i(j)$

After these operations, the decision matrix in number (1) becomes as shown below: Number 5 formula is:

$$X_i^* = \begin{bmatrix} x_1^*(1) & x_1^*(2) & \cdots & x_1^*(n) \\ x_2^*(1) & x_2^*(2) & \cdots & x_2^*(n) \\ \vdots & \vdots & \ddots & \vdots \\ x_n^*(1) & x_n^*(2) & \cdots & x_n^*(n) \end{bmatrix}$$

Step 4: The Formation of Absolute Value Table: Number 6 formula is:

The absolute value $\Delta_{oi}(j)$ between x_0^* and x_i^* is acquired as below:

$$\Delta_{0i}(j) = |x_0^*(j) - x_i^*(j)| = \begin{bmatrix} \Delta_{01}(1) & \Delta_{01}(2) & \cdots & \Delta_{01}(n) \\ \Delta_{02}(1) & \Delta_{02}(2) & \cdots & \Delta_{02}(n) \\ \vdots & \vdots & \ddots & \vdots \\ \Delta_{0m}(1) & \Delta_{0m}(2) & \cdots & \Delta_{0m}(n) \end{bmatrix}$$

Step 5: The Formation of the Grey Relational Coefficient Matrix: Number 7 formula is:

$$\gamma_{0i}(j) = \frac{\Delta\min + \xi\Delta\max}{\Delta_{0i}(j) + \xi\Delta\max}$$

In this formula ξ is distinguishing coefficient and gets a value in the range of [0, 1], yet it is advised to take it as 0.5 in operations. Moreover, it is calculated as:

$$\Delta\max = \max_i \max_j \Delta_{oi}(j) \qquad \Delta\min = \min_i \min_j \Delta_{oi}(j)$$

Step 6: The Calculation of Degree for Relation: Number 8 formula is:

$$\Gamma_{oi} = \frac{1}{n}\sum_{j=1}^{n}\gamma_{oi}(j)$$

In this formula T_{oi}, i. illustrates the degree of grey relation of the element and is used when the criteria are accepted to be equally important. If different weights of criteria are in question, number 9 formula is used:

$$\Gamma_{oi} = \sum_{j=1}^{n}[W_i(j)\gamma_{oi}(j)]$$

IV. DATA SET AND APPLICATION

The performances of public banks in the Turkish state banks were investigated utilizing the Grey Relational Analysis, which is one of the performance measurement methods in the present study. In the Turkish banking sector there are three banks with public capital. Four-years of financial data were employed between 2010-2013 years for the analysis. 15 financial ratios having capital adequacy, liquidity, active quality, profitability criteria were adopted to analyze the data. These 15 financial ratios operated for this analysis are shown below (Sakınç, 2014:484)

Table 1: Financial Ratios Used In the Grey Relational Analysis Method

s1	Shareholder's equity / (Credit + Market+ Operational risk-based amount)
s2	Shareholder's equity / Total assets
s3	(Shareholder's equity – Fixed assets) / Total assets
s4	Net Balance Position / Shareholder's equity
a1	Financial assets (net) / Total assets
a2	Total Credits and Debt / Total assets
a3	Total Credits and Debt / Total funds collected
a4	Non-performing loan (gross) / Total Credits and Debt
l1	Liquid assets / Total assets
l2	Liquid assets / Short-term liabilities
l3	TP Liquid assets / Total assets
l4	TP Liquid assets / Shareholder's equity
k1	Net Profit (loss) / Total assets
k2	Net Profit (loss) / Shareholder's equity
k3	Continuing operations Pretax Profit (Loss) / Total assets

In this table **s** is for capital adequacy, **a** for active quality, **l** for liquidity, and **k** is used for profitability.

Step 1: The Formation of Decision Matrix: The financial ratios for the banks are shown below in Table 2 . **Table 2:** Financial Ratios by Years

	CAPITAL ADEQUACY				**ASSET QUALITY**			
2013	**s1**	**s2**	**s3**	**s4**	**a1**	**a2**	**a3**	**a4**
ZİRAAT BANKASI	0,21	0,12	0,11	7,13	0,25	0,57	0,87	0,02
HALKBANK	0,22	0,15	0,14	5,51	0,1	0,66	1,01	0,03
VAKIFBANK	0,18	0,14	0,13	6,07	0,15	0,72	1,09	0,05

	LIQUIDITY				PROFITABILITY		
2013	**l1**	**l2**	**l3**	**l4**	**k1**	**k2**	**k3**
ZİRAAT BANKASI	0,34	0,51	0,023	0,19	0,013	0,14	0,02
HALKBANK	0,23	0,61	0,028	0,18	0,015	0,15	0,02
VAKIFBANK	0,27	0,49	0,017	0,12	0,009	0,09	0,01

	CAPITAL ADEQUACY				ASSET QUALITY			
2012	**s1**	**s2**	**s3**	**s4**	**a1**	**a2**	**a3**	**a4**
ZİRAAT BANKASI	0,24	0,12	0,12	6,83	0,25	0,49	0,69	0,03
HALKBANK	0,24	0,16	0,14	5,08	0,11	0,64	0,88	0,04
VAKIFBANK	0,2	0,08	0,14	5,33	0,14	0,71	1,03	0,05

	LIQUIDITY				PROFITABILITY		
2012	**l1**	**l2**	**l3**	**l4**	**k1**	**k2**	**k3**
ZİRAAT BANKASI	0,37	0,94	0,046	0,36	0,016	0,16	0,02
HALKBANK	0,22	0,5	0,024	0,15	0,023	0,21	0,04
VAKIFBANK	0,27	0,87	0,032	0,2	0,014	0,12	0,02

	CAPITAL ADEQUACY				ASSET QUALITY			
2011	**s1**	**s2**	**s3**	**s4**	**a1**	**a2**	**a3**	**a4**
ZİRAAT BANKASI	0,19	0,09	0,09	9,23	0,25	0,47	0,72	0,01
HALKBANK	0,24	0,14	0,12	6,05	0,12	0,6	0,87	0,04
VAKIFBANK	0,22	0,15	0,13	5,45	0,17	0,66	0,9	0,05

	LIQUIDITY				PROFITABILITY		
2011	**l1**	**l2**	**l3**	**l4**	**k1**	**k2**	**k3**
ZİRAAT BANKASI	0,33	1,91	0,047	0,49	0,013	0,15	0,01
HALKBANK	0,19	0,9	0,04	0,28	0,022	0,22	0,04
VAKIFBANK	0,25	1,04	0,035	0,23	0,013	0,13	0,02

	CAPITAL ADEQUACY				ASSET QUALITY			
2010	**s1**	**s2**	**s3**	**s4**	**a1**	**a2**	**a3**	**a4**
ZİRAAT BANKASI	0,25	0,1	0,09	8,79	0,27	0,39	0,5	0,01
HALKBANK	0,22	0,13	0,12	6,25	0,1	0,59	0,81	0,05
VAKIFBANK	0,24	0,15	0,13	5,4	0,21	0,59	0,89	0,07

	LIQUIDITY				PROFITABILITY		
2010	**l1**	**l2**	**l3**	**l4**	**k1**	**k2**	**k3**
ZİRAAT BANKASI	0,36	1,63	0,059	0,58	0,024	0,27	0,03
HALKBANK	0,18	1,19	0,052	0,38	0,027	0,26	0,04
VAKIFBANK	0,29	1,73	0,05	0,32	0,015	0,13	0,02

Table 3: Decision Matrix:

	CAPITAL ADEQUACY				ASSET QUALITY			
AVERAGE	**s1**	**s2**	**s3**	**s4**	**a1**	**a2**	**a3**	**a4**
ZİRAAT BANKASI	0,22	0,10	0,10	7,99	0,25	0,48	0,69	0,02

HALKBANK	0,23	0,14	0,13	5,72	0,10	0,62	0,89	0,04
VAKIFBANK	0,21	0,13	0,133	5,56	0,16	0,67	0,97	0,05

	LIQUIDITY				**PROFITABILITY**		
AVERAGE	**l1**	**l2**	**l3**	**l4**	**k1**	**k2**	**k3**
ZİRAAT BANKASI	0,35	1,25	0,044	0,41	0,016	0,18	0,02
HALKBANK	0,20	0,8	0,036	0,25	0,022	0,21	0,04
VAKIFBANK	0,27	1,03	0,033	0,22	0,012	0,12	0,02

Step 2: The Formation of Reference Matrix

Table 4: Reference Matrix

	CAPITAL ADEQUACY				**ASSET QUALITY**			
	s1	**s2**	**s3**	**s4**	**a1**	**a2**	**a3**	**a4**
REFERANS	**0,23**	**0,14**	**0,133**	**7,99**	**0,25**	**0,67**	**0,97**	**0,05**
ZİRAAT BANKASI	0,22	0,10	0,10	7,99	0,25	0,48	0,69	0,02
HALKBANK	0,23	0,14	0,130	5,72	0,10	0,62	0,89	0,04
VAKIFBANK	0,21	0,13	0,133	5,56	0,16	0,67	0,97	0,05

	LIQUIDITY				**PROFITABILITY**		
AVERAGE	**l1**	**l2**	**l3**	**l4**	**k1**	**k2**	**k3**
REFERANS	**0,35**	**1,25**	**0,044**	**0,41**	**0,02**	**0,21**	**0,04**
ZİRAAT BANKASI	0,35	1,25	0,044	0,41	0,02	0,18	0,02
HALKBANK	0,20	0,8	0,036	0,25	0,02	0,21	0,04
VAKIFBANK	0,27	1,03	0,033	0,22	0,01	0,12	0,02

Reference matrix was formed by using the highest ratios as reference.

Step 3: Operation of Normalization and Formation of Normalization Matrix

Table 5: Normalized Matrix

	CAPITAL ADEQUACY				**ASSET QUALITY**			
	s1	**s2**	**s3**	**s4**	**a1**	**a2**	**a3**	**a4**
ZİRAAT BANKASI	0,50	0,00	0,00	1,00	1,00	0,00	0,00	0,00
HALKBANK	1,00	1,00	0,91	0,06	0,00	0,73	0,71	0,66
VAKIFBANK	0,00	0,75	1,00	0,00	0,40	1,00	1,00	1,00

	LIQUIDITY				PROFITABILITY		
	l1	**l2**	**l3**	**l4**	**k1**	**k2**	**k3**
ZİRAAT BANKASI	1,00	1,00	1,00	1,00	1,00	0,66	0,00
HALKBANK	0,00	0,00	0,27	0,16	1,00	1,00	1,00
VAKIFBANK	0,46	0,51	0,00	0,00	0,00	0,00	0,00

Normalized matrix was formed by using reference values for ratios.

Step 4: The Formation of Absolute Values

Table 6: Absolute Values Table

	CAPITAL ADEQUACY				ASSET QUALITY			
	s1	**s2**	**s3**	**s4**	**a1**	**a2**	**a3**	**a4**
ZİRAAT BANKASI	0,50	1,00	1,00	0,00	0,00	1,00	1,00	1,00
HALKBANK	0,00	0,00	0,09	0,94	1,00	0,27	0,29	0,34
VAKIFBANK	1,00	0,25	0,00	1,00	0,60	0,00	0,00	0,00

	LIQUIDITY				PROFITABILITY		
	l1	**l2**	**l3**	**l4**	**k1**	**k2**	**k3**
ZİRAAT BANKASI	0,00	0,00	0,00	1,00	0,00	0,34	1,00
HALKBANK	1,00	1,00	0,73	0,16	0,00	0,00	0,00
VAKIFBANK	0,54	0,49	1,00	0,00	1,00	1,00	1,00

Absolute Values Table was formed by using number 6 Formula.

Step 5: The Formation of Grey Relational Coefficient Matrix:

Table 7: Grey Relational Coefficient Matrix

	CAPITAL ADEQUACY				ASSET QUALITY			
	s1	**s2**	**s3**	**s4**	**a1**	**a2**	**a3**	**a4**
ZİRAAT BANKASI	0,50	0,33	0,33	1,00	1,00	0,33	0,33	0,33
HALKBANK	1,00	1,00	0,85	0,34	0,33	0,64	0,63	0,59
VAKIFBANK	0,33	0,66	1,00	0,33	0,45	1,00	1,00	1,00

	LIQUIDITY				PROFITABILITY		
	l1	**l2**	**l3**	**l4**	**k1**	**k2**	**k3**
ZİRAAT BANKASI	1,00	1,00	1,00	1,00	1,00	0,59	0,33
HALKBANK	0,33	0,33	0,41	0,37	1,00	1,00	1,00
VAKIFBANK	0,48	0,51	0,33	0,33	0,33	0,33	0,33

Grey Relational Coefficient Matrix was formed by using number 7 Formula.

Step 6: The Degree of Relation Calculation

Table 8: The Degree of Relation

	CAPITAL ADEQUACY	ASSET QUALITY

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	Degree	Rank	Degree	Rank
ZİRAAT BANKASI	0,54	**3**	0,49	**3**
HALKBANK	0,80	**1**	0,54	**2**
VAKIFBANK	0,58	**2**	0,86	**1**

	LIQUIDITY		PROFITABILITY	
	Degree	**Rank**	**Degree**	**Rank**
ZİRAAT BANKASI	1,00	**1**	0,48	**2**
HALKBANK	0,36	**3**	1,00	**1**
VAKIFBANK	0,41	**2**	0,33	**3**

	DEGREE OF RELATION			LAST RANK	
	Degree	**Rank**		**Degree**	**Rank**
ZİRAAT BANKASI	0,63	**2**	**HALKBANK**	0,68	**1**
HALKBANK	0,68	**1**	**ZİRAAT BANKASI**	0,63	**2**
VAKIFBANK	0,55	**3**	**VAKIFBANK**	0,55	**3**

As can be understood from Table 8, among three banks Halkbank ranked 1st, Ziraat Bankası is 2nd and Vakıfbank is ranked as 3rd according to the Grey Relational Analysis method.

V. TOPSIS

One of the full-featured decision making methods, TOPSIS was designed by Yoon and Hwang in 1981. In this method, data to be compared are decided upon certain criteria. Comparisons are carried out according to the ideal situation between maximum and minimum values of these criteria (Yurdakul and İç, 2003:11).

In this method, the data to be evaluated are ranked according to the ideal situation which is determined between positive and negative ideal solution. The ideal situation is the one which is the closest and furthest to the positive and negative ideal solution. In positive ideal situation benefit criterion is maximum and cost criterion is minimum. On the other hand, the negative ideal situation is exactly the opposite. Ranking should be done by starting to the closest data to the ideal situation (Cheng-Min, 2001:465).

The steps to be taken and their order are pre-set in the TOPSIS method as in the Grey Relational Analysis. The method consists of six steps. Therefore, the application and evaluation of this method is simple and apprehensible (Mahmoodzadeh et al., 2007:336).

Step 1 : Forming Decision Matrix (A)

Decision points whose superiorities take place in the decision matrix lines while evaluation factors to be used for making decisions are put in the columns. Matrix A is the starter one which is created by the decision maker. The decision matrix is shown as follows:

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$$A_{ij} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ . & & & . \\ . & & & . \\ . & & & . \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix}$$

In A_{ij} matrix m shows the decision point number whereas n points to the evaluation factor number.

Step 2 : Forming Standard Decision Matrix (R)

Standard Decision Matrix is calculated by means of elements of A matrix using formula below:

$$r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{k=1}^{m} a_{kj}^2}}$$

R matrix is acquired as shown below:

$$R_{ij} = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ . & & & . \\ . & & & . \\ . & & & . \\ r_{m1} & r_{m2} & \dots & r_{mn} \end{bmatrix}$$

Step 3 : Forming Weighted Standard Decision Matrix (V)

First of all, the weighted values concerning the evaluation factors (w_i) are determined ($\sum_{i=1}^{n} w_i = 1$).

Later, V matrix is formed by multiplying w_i value of the elements in each column of R matrix. V matrix is shown below:

$$V_{ij} = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \dots & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & \dots & w_n r_{2n} \\ . & & & . \\ . & & & . \\ . & & & . \\ w_1 r_{m1} & w_2 r_{m2} & \dots & w_n r_{mn} \end{bmatrix}$$

Step 4 : Forming Ideal (A^*) and Negative Ideal (A^-) Solutions

The TOPSIS method assumes that each evaluation factor has a monotone increasing or decreasing tendency.

In order to form the ideal solution test, the highest factor (if concerning the evaluation is minimisation oriented, then the lowest one), that is, the highest weighted evaluation factors in the V matrix is chosen. Identification of the ideal solution set is shown in the formula below:

$$A^* = \left\{ (\max_i v_{ij} \,|\, j \in J), (\min_i v_{ij} \,|\, j \in J' \right\}$$

The data set to be calculated by using this formula could be shown as $A^* = \{v_1^*, v_2^*, ..., v_n^*\}$. Negative ideal solution set is formed choosing the lowest of the column values, (if concerning evaluation is maximisation oriented, then the highest one) that is, the weighted evaluation factors in the V matrix. Identification of the negative ideal solution set is shown in the formula below:

$$A^- = \left\{ (\min_i v_{ij} \,|\, j \in J), (\max_i v_{ij} \,|\, j \in J' \right\}$$

Data set to be calculated by using this formula could be shown as $A^- = \{v_1^-, v_2^-, ..., v_n^-\}$

In both formulas, J benefit shows (maximisation), J' shows a deficiency (minimisation) value.

Both ideal and negative ideal solution sets consist of m element, namely, evaluation factor number.

Step 5: Calculation of Separation Measurements

In order to identify the deviations from ideal and negative ideal solution test in relation to each decision point in the TOPSIS method, Euclidian Distance Approach is employed. Deviation values acquired in relation to these decision points are called Ideal Separation (S_i^*) and Negative Ideal Separation (S_i^-) measurements. Calculation of ideal separation measurement (S_i^*) is shown in formula, and negative ideal separation (S_i^-) is given in formula.

$$S_i^* = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^*)^2}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2}$$

S_i^* and S_i^- numbers will be inherently as many as decision point number.

Step 6 : Calculation of Relative Closeness To The Ideal Solution

In the calculation of each decision point to relative closeness to the ideal solution (C_i^*), negative and ideal negative separation measurements are used. The measurement used is the share of negative ideal separation measurement in the total separation measurement. Calculation of the relative closeness to the ideal solution value is shown in the formula below:

$$C_i^* = \frac{S_i^-}{S_i^- + S_i^*}$$

C_i^* value takes place between $0 \le C_i^* \le 1$ range and $C_i^* = 1$ demonstrates closeness of the relevant decision point to the ideal solution while $C_i^* = 0$ points to absolute closeness of the relevant decision point to the negative ideal.

VI. DATA SET AND APPLICATION

In this study, the performances of public banks in the Turkish banking system was analyzed using the other performance measurement methods TOPSİS. The same data set was used with the grey rational analysis in TOPSİS.

Step 1 : Forming Decision Matrix (A)

Table 9: Decision Matrix (A)

	CAPITAL ADEQUACY				ASSET QUALITY			
wi	**0,625**	**0,625**	**0,625**	**0,625**	**0,625**	**0,625**	**0,625**	**0,625**
	s1	**s2**	**s3**	**s4**	**a1**	**a2**	**a3**	**a4**
ZİRAAT BANKASI	0,22	0,1	0,1	7,99	0,25	0,48	0,69	0,02
HALKBANK	0,23	0,14	0,13	5,72	0,1	0,62	0,89	0,04
VAKIFBANK	0,21	0,13	0,133	5,56	0,16	0,67	0,97	0,05

	LIQUIDITY				PROFITABILITY		
wi	**0,625**	**0,625**	**0,625**	**0,625**	**0,9**	**0,8**	**0,8**
	l1	**l2**	**l3**	**l4**	**k1**	**k2**	**k3**
ZİRAAT BANKASI	0,35	1,25	0,044	0,41	0,016	0,18	0,02
HALKBANK	0,2	0,8	0,036	0,25	0,022	0,21	0,04
VAKIFBANK	0,27	1,03	0,033	0,25	0,012	0,12	0,02

In this table **s** is for capital adequacy, **a** for asset quality, **l** for liquidity, and **k** is used for profitability.

Step 2 : Forming Standard Decision Matrix (R)

Table 10: Decision Standard Matrix (R)

	CAPITAL ADEQUACY				ASSET QUALITY			
	s1	**s2**	**s3**	**s4**	**a1**	**a2**	**a3**	**a4**
ZİRAAT BANKASI	0,0484	0,01	0,01	63,8401	0,0625	0,2304	0,4761	0,0004
HALKBANK	0,0529	0,0196	0,0169	32,7184	0,01	0,3844	0,7921	0,0016
VAKIFBANK	0,0441	0,0169	0,017689	30,9136	0,0256	0,4489	0,9409	0,0025
İaj	0,38131352	0,215639	0,211161	11,29035	0,313209	1,031358	1,486304	0,067082

	LIQUIDITY				PROFITABILITY		
	l1	**l2**	**l3**	**l4**	**k1**	**k2**	**k3**
ZİRAAT BANKASI	0,1225	1,5625	0,001936	0,1681	0,000256	0,0324	0,0004
HALKBANK	0,04	0,64	0,001296	0,0625	0,000484	0,0441	0,0016
VAKIFBANK	0,0729	1,0609	0,001089	0,0625	0,000144	0,0144	0,0004
iaj	0,48518	1,806488	0,065734	0,541387	0,029732	0,301496	0,04899

Step 3 : Forming Weighted Standard Decision Matrix (V)

Table 11: Weighted Standard Matrix (V)

	CAPITAL ADEQUACY				ASSET QUALITY			
	s1	**s2**	**s3**	**s4**	**a1**	**a2**	**a3**	**a4**
ZİRAAT BANKASI	0,57695306	0,463739	0,473572	0,707684	0,798189	0,465406	0,464239	0,298142
HALKBANK	0,60317819	0,649234	0,615644	0,506627	0,319275	0,601149	0,598801	0,596285
VAKIFBANK	0,55072792	0,602861	0,629851	0,492456	0,510841	0,649629	0,652626	0,745356

	LIQUIDITY				PROFITABILITY		
	l1	**l2**	**l3**	**l4**	**k1**	**k2**	**k3**
ZİRAAT BANKASI	0,721381	0,69195	0,669361	0,757314	0,538138	0,597022	0,408248
HALKBANK	0,412218	0,442848	0,547659	0,461777	0,73994	0,696526	0,816497
VAKIFBANK	0,556494	0,570167	0,502021	0,461777	0,403604	0,398015	0,408248

Step 4 : Forming Ideal (A^*) and Negative Ideal (A^-) Solutions

Table 12: Ideal (A^*) and Negative Ideal (A^-) Solutions

	CAPITAL ADEQUACY				ASSET QUALITY			
	s1	**s2**	**s3**	**s4**	**a1**	**a2**	**a3**	**a4**
ZİRAAT BANKASI	0,36059566	0,289837	0,295983	0,442302	0,498868	0,290879	0,290149	0,186339
HALKBANK	0,37698637	0,405772	0,384777	0,316642	0,199547	0,375718	0,37425	0,372678
VAKIFBANK	0,34420495	0,376788	0,393657	0,307785	0,319275	0,406018	0,407891	0,465847
İdeal +	0,37698637	0,405772	0,393657	0,442302	0,498868	0,406018	0,407891	0,465847
İdeal -	0,34420495	0,289837	0,295983	0,307785	0,199547	0,290879	0,290149	0,186339

	LIQUIDITY				PROFITABILITY		
	l1	**l2**	**l3**	**l4**	**k1**	**k2**	**k3**
ZİRAAT BANKASI	0,450863	0,432469	0,418351	0,473321	0,484324	0,477618	0,326599
HALKBANK	0,257636	0,27678	0,342287	0,28861	0,665946	0,557221	0,653197
VAKIFBANK	0,347809	0,356354	0,313763	0,28861	0,363243	0,318412	0,326599
İdeal +	0,450863	0,432469	0,418351	0,473321	0,665946	0,557221	0,653197
İdeal -	0,257636	0,27678	0,313763	0,28861	0,363243	0,318412	0,326599

Step 5 : Calculation of Separation Measurements

Table 13: Separation Measurements

	CAPITAL ADEQUACY				ASSET QUALITY			
+	**s1**	**s2**	**s3**	**s4**	**a1**	**a2**	**a3**	**a4**
ZİRAAT BANKASI	0,00026866	0,013441	0,00954	0	0	0,013257	0,013863	0,078125
HALKBANK	0	0	7,88E-05	0,015791	0,089593	0,000918	0,001132	0,008681
VAKIFBANK	0,00107462	0,00084	0	0,018095	0,032253	0	0	0

	LIQUIDITY	PROFITABILITY

+	l1	l2	l3	l4	k1	k2	k3
ZİRAAT BANKASI	0	0	0	0	0,032986	0,006337	0,106667
HALKBANK	0,037337	0,024239	0,005786	0,034118	0	0	0
VAKIFBANK	0,01062	0,005793	0,010939	0,034118	0,091629	0,05703	0,106667

	CAPITAL ADEQUACY				ASSET QUALITY			
-	**s1**	**s2**	**s3**	**s4**	**a1**	**a2**	**a3**	**a4**
ZİRAAT BANKASI	0,00026866	0	0	0,018095	0	0	0	0,078125
HALKBANK	0,00107462	0,013441	0,007885	7,84E-05	0,007198	0,007073	0,034722	0,008681
VAKIFBANK	0	0,00756	0,00954	0	0,013257	0,013863	0,078125	0

	LIQUIDITY				PROFITABILITY		
-	**l1**	**l2**	**l3**	**l4**	**k1**	**k2**	**k3**
ZİRAAT BANKASI	0,037337	0,024239	0,010939	0,034118	0,014661	0,025347	0
HALKBANK	0	0	0,000814	0	0,091629	0,05703	0,106667
VAKIFBANK	0,008131	0,006332	0	0	0	0	0

Step 6 : Calculation of Relative Closeness To The Ideal Solution

Table 14: Relative Closeness To The Ideal Solution

ZİRAAT BANKASI	**0,52391287**	**0,504575**	**0,490599**	**2**
HALKBANK	**0,46655337**	**0,572373**	**0,550927**	**1**
VAKIFBANK	**0,60750199**	**0,388772**	**0,390226**	**3**

As can be understood from Table 14, among three banks Halkbank ranked 1st, Ziraat Bankası is 2nd and Vakıfbank is ranked as 3rd according to the TOPSİS.

Table 15: Results of Methods

	GREY RATIONAL ANALYSIS		**TOPSİS**				
	Degree	**Rank**				**Degree**	**Rank**
HALKBANK	0,68	**1**	**HALKBANK**	0,46655337	0,572373	0,550927	**1**
ZİRAAT BANKASI	0,63	**2**	**ZİRAAT BANKASI**	0,52391287	0,504575	0,490599	**2**
VAKIFBANK	0,55	**3**	**VAKIFBANK**	0,60750199	0,388772	0,390226	**3**

As can be understood from Table 15, among three banks Halkbank ranked 1st, Ziraat Bankası is 2nd and Vakıfbank is ranked as 3rd according to the Grey Rational Analysis and TOPSİS.

VII. CONCLUSION

The banks, which have a significant share and role in the service sector, are required to increase their contribution to national economy in order to increase their efficiency and reliability. Like any other sectors, the banks are expected to create interest with their resources.

Firms are required to carry out their activities in an efficient and useful manner to be able to increase their own share in the market along with competition power. Handicaps and deficiencies experienced in the process of realizing their activities bear negative

results for the firms. Therefore, it is significant for these firms to notice these handicaps and step in time. Otherwise, it can lead to big losses and bankruptcies. It is especially important for the banking sector which is closely related to national economy. When the fact that state banks provide support with a low profit margin compared to other banks is taken into consideration, the importance of the analysis of this process becomes imminent for these banks.

Performance measurement methods are used to identify the negative and positive aspects arising during the process. These methods can be analysed, along with process, knowledge and time are acquired for necessary cautions.

Performances of Turkish state banks were measured and ranked using the Grey Relational Analysis and TOPSIS in this study. First, the performance evaluation was carried out according to the Grey Relational Analysis. As a result of the performance evaluation, 'Halk Bankası' ranked the first, 'Ziraat Bankası' was second and 'Vakıfbank' came in third. Later, the same banks were analysed via TOPSIS method and similarly 'Halk Bankası' ranked first, 'Ziraat Bankası' second and 'Vakıfbank third. Finally, the results of these two measurement methods for the Turkish state banks were found compatible.

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