Performance Evaluation of Turkish Banks with TOPSIS and Stepwise Regression

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Abstract

This paper investigates the key criteria in the bank efficiency and performance analysis and the relative performances of 11 Turkish banks based on these pre-determined criteria over the years 2015-2017. The main purpose of this study is to introduce a robust and easy-to-calculate mathematical model for the assessment of the financial performance of banks. In the first stage of the analysis, we measure performance by employing the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methodology. The next stage includes stepwise regression analysis in order to determine the most significant criteria for the proposed model. While there are 13 entering criteria in the initial step, the most significant criteria are selected as, Average Return on Assets; Financial Assets (Net) / Total Assets; Total Loans and Receivables / Total Assets; and Loans under Follow-up (Net) / Total Loans and Receivables. At the final stage, the performances of the banks are re-calculated based on a new robust model and the banks are ranked and compared according to their relative performances.

Keywords: bank efficiency; bank performance; stepwise regression; TOPSIS

1. Introduction

Banks have an intermediary function in economies by collecting idle facilities and abilities from the areas of fund surplus and transferring them to the areas where there is a fund deficit (Seçme et al., 2009). The significance of banks for the global economy is premised on the grounds that, they are the main capital providers for infrastructure, innovation, development, creation of new jobs and overall welfare. Any problem in banking sector may cause detrimental effects on stakeholders and the general economy. A strong and efficient banking sector is the key to stabilize the financial system and to overcome the effects of negative shocks as in the case of global financial crisis in the year 2008. Serving as an early warning system against such shock the performance end efficiency of banks attracts much more attention for the last decade.

Measurement of financial performance of the banks is important because of several reasons: improving managerial performance, providing information of comparisons between the best and the worst practices for stakeholders, investigating the effects of some macroeconomic changes on bank performance in order to establish appropriate policies.

Although there is a common sense that how important to evaluate bank performance, the methods and performance indicators may vary widely. In literature, one can observe traditional efficiency measurement methods such as data envelopment analysis (DEA) (Chortareas et al., 2012; Fernandes et al.,2017) and stochastic frontier analysis (SFA) (Dong et al., 2016; Huang et al., 2017) as well as contemporary and hybrid ones including neural networks (Wanke et al., 2016B) and multi-criteria decision making aids (Doumpos and Zopounidis, 2010). While the main efficiency determinants include inputs (i.e. labor costs and interest expenses) and outputs (i.e. total loans and net interest income), selected variables among 40 or more financial ratios may be used in a model. However, these ratios are correlated and it is difficult to choose the right variables fitting the model well.

In this study, we offer a robust model for measuring bank performance by using the Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) methodology and stepwise regression analysis. In the first step of the analysis, the performances of the banks are determined by chosen set of financial ratios (criteria). Then in the second step, stepwise regression is applied to find the criteria which explain the performance better. Afterwards, the performances of the banks are recalculated by TOPSIS method using these refined criteria. The banks are ranked and compared via strengthened performance analysis to define the best and the worst performing banks in the sector.

The next section of this study explains the methodology used. The third section gives general information about the Turkish banking sector and defines the selected data. The analysis and results are introduced in the fourth section. The conclusion of the study and further studies are discussed in the last section.

2. Methodology

The methodology used in this study includes two steps. First one is "Technique for Order Performance by Similarity to Ideal Solution" method and the second one is "Stepwise Regression" technique.

2.1 . TOPSIS Methodology

Developed by Hwang and Yoon (1981), TOPSIS is one of the most frequently used MCDM methods. The basic principle of TOPSIS methodology is that the best alternative should have the longest distance from the negative-ideal solution, i.e. the solution which maximizes the cost criteria and minimizes the profit criteria, and the shortest distance from the positive-ideal solution, i.e., the solution that maximizes the profit criteria and minimizes the cost criteria (He et al., 2016; Wanke et al, 2017).

The methodology is summarized step by step as follows (Wanke et al, 2016A):

1. Formulation of decision matrix consisting of m alternatives, and n criteria.
2. Calculation of normalized matrix by using the following equation:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, i = 1,2, \ldots . = 1,2, \ldots n \quad (1)$$

where, x_{ij} is the decision matrix and r_{ij} is the normalized matrix.

3. Calculation of weighted normalized matrix (if there exists weights) for performance assessment:

$$W = (w_{ij}) = (w_j r_{ij})_{mxn} \quad (2)$$

where, w_j is the weight given to criteria j.

4. Identification of positive ideal and negative ideal solutions:

$$A_a = \{\langle \min (w_{ij} | i = 1,2, \ldots , m, j \in J_+ \rangle, \langle \max (w_{ij} | i = 1,2, \ldots , m | j \in J_- \rangle \} = \{\alpha_{aj} | j = 1,2, \ldots , m\} \quad (3)$$

$$A_b = \{\langle \max (w_{ij} | i = 1,2, \ldots , m, j \in J_+ \rangle, \langle \min (w_{ij} | i = 1,2, \ldots , m | j \in J_- \rangle \} = \{\alpha_{aj} | j = 1,2, \ldots , m\} \quad (4)$$

where, $J_+ = \{j | j \in positive\}$ and $J_- = \{j | j \in negative\}$, which are a set of positive and negative attributes respectively.

5. Calculation of distances of each alternative from positive ideal (d_{ia}) and negative ideal (d_{ib}) :

$$d_{ia} = \sqrt{\sum_{j=1}^{n} (x w_{ij} - \alpha_{aj})^2}, i = 1,2 \ldots . , m \quad (5)$$

$$d_{ib} = \sqrt{\sum_{j=1}^{n} (x w_{ij} - \alpha_{bj})^2}, i = 1,2 \ldots . , m \quad (6)$$

6. Calculation of similarities to ideal solution

$$S_i = d_{ia} / (d_{ia} + d_{ib}) \quad (7)$$

where, $0 \leq S_i \leq 1, i = 1,2, \dots, m$

7. Ranking the alternatives according to S_i, where a higher value of S_i indicates a better solution.

2.2. Stepwise Regression

Stepwise regression is a combination of the forward and backward selection techniques. Goldberger (1961) uses the parameters of the multiple linear regression model for estimating a stepwise procedure as follows:

$$y = X_1\beta_1 + X_2\beta_2 + \varepsilon \quad (8)$$

According to this study, variables and coefficients are determined as below; y

is the N x 1 vector of observations on the regressand,

X_1 is the N x K_1 matrix of observations on the first K_1 regressors: x_i (i=1,…, K_1),

β_1 is the K_1 x 1 vector of coefficients of the first K_1 regressors,

X_2 is the N x K_2 matrix of observations on the second K_2 regressors: x_j (j=K_1+1,…, K_1+K_2),

β_2 is the K_2 x 1 vector of coefficients of the second K_2 regressors, is

the N x 1 vector of disturbances.

On the other hand, the stepwise least squares procedure first estimates β_1, then regress the residuals. After this process, β_2 is estimated with matrix inversions. In stepwise regression analysis, after each step in which a variable is added, all candidate variables in the model are checked to see depend on their significance. If a nonsignificant variable is found, it is removed from the model. Stepwise regression requires two significance levels: one for entering variables and one for removing variables. The variable selection process stops when all variables in the model meet the criterion to stay and no variables outside the model meet the criterion to enter (Rawlings et al., 2001).

3. Selected Data

Turkish banking sector has an asset size of 3.258 billion Turkish Liras (TL) at the end of 2017 and the total ratio of asset size of Turkish banking sector to GDP is 1.05 by the year 2017 (Turkish Banking and Supervision Agency). The market share of 33 banks operating in Turkey with respect to the total assets are shown in Table 1.

Table 1: Market share of Turkish Banks

BANK OWNERSHIP	TOTAL ASSETS
State-owned Banks	32.6%
Privately-owned Domestic Banks	36.5%
Foreign Banks	25.1%
Development and Investment Banks	5.7%

Source: Turkish Banking and Supervision Agency, 2018

In this study, 11 commercial banks having the highest market share are selected to be analysed and compared with each other. The distribution of these banks are as follows: 3 state banks, 5 private domestic banks and 3 foreign banks. Table 2 lists the banks and their ownership structure.

Table 2: Turkish Banks included in the study

BANKS		OWNERSHIP
ZB	Ziraat Bank	State
HB	Halk Bank	State
VB	Vakıflar Bank	State
AB	Akbank	Private Domestic
SB	Sekerbank	Private Domestic
TEB	Turk Ekonomi Bank	Private Domestic
IB	Is Bank	Private Domestic
YKB	Yapı Kredi Bank	Private Domestic
DB	Denizbank	Foreign
QNB	QNB Finansbank	Foreign
GB	Garanti Bank	Foreign

Source: Banks Association of Turkey, 2018

Our data set is compiled from the 2018 annual publication of the Banks Association of Turkey. This publication contains over 40 financial ratios for every bank operating in Turkish banking system. Since these ratios are mostly correlated and quite a lot in number, they are limited by 13 ratios which are most relevant to the purpose of this study. Selected financial ratios (criteria) and their types are listed in Table 3.

Table 3: Financial performance criteria

	CRITERIA (FINANCIAL RATIOS)	TYPE OF CRITERIA
R1	Capital Adequacy Ratio	Maximum
R2	Shareholders' Equity / Total Assets	Maximum
R3	(Shareholders'Equity - Permanent Assets) / Total Assets	Maximum
R4	Funds Borrowed / Total Assets	Minimum
R5	Financial Assets (Net) / Total Assets	Maximum
R6	Total Loans and Receivables / Total Assets	Maximum
R7	Loans under Follow-up (Net) / Total Loans and Receivables	Minimum
R8	Liquid Assets / Total Assets	Maximum

R9	Liquid Assets / Short-term Liabilities	Maximum
R10	Average Return on Assets	Maximum
R11	Average Return on Shareholders' Equity	Maximum
R12	Net Interest Income After Specific Provisions / Total Assets	Maximum
R13	Net Interest Income After Specific Provisions / Total Operating Income	Maximum

Source: Banks Association of Turkey, 2018

4. Results and Discussion

In order to measure the financial performances of banks, we applied easy-to-use TOPSIS methodology. The main idea is finding the best performed bank by comparing the data of the bank against the best performing bank (maximum ideal) and the worst performing bank (minimum ideal) for a specific criterion. Then all the banks are ranked beginning from the first to the last. In these performance calculations, financial ratios of eleven Turkish banks for the years 2015, 2016 and 2017 are used. Table 4 shows the decision matrix for the year 2017.

Table 4: The decision matrix for the year 2017

BANK	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13
ZB	15.2	10.8	8.1	6.7	16.6	68.7	0.1	26.0	42.1	2.0	18.6	3.6	79.0
HB	14.2	8.3	5.7	5.6	16.1	66.6	0.7	23.3	39.8	1.4	16.0	2.2	62.2
VB	15.5	8.6	6.2	10.5	11.9	68.0	0.6	21.3	38.5	1.5	17.5	2.4	54.1
AB	17.0	12.8	10.2	9.4	21.9	60.3	0.1	29.8	56.5	2.1	17.0	2.8	63.7
SB	15.4	8.7	2.6	7.5	9.2	65.9	2.2	23.6	37.9	0.4	4.4	2.7	51.9
TEB	16.1	10.5	8.5	14.9	7.7	73.8	1.1	22.8	36.6	1.3	12.7	3.7	69.5
IB	16.7	11.9	6.4	10.6	16.4	66.3	0.3	24.9	44.3	1.6	13.4	3.1	68.0
YKB	14.5	10.1	6.1	13.1	14.5	65.5	1.1	24.8	44.5	1.3	12.9	2.2	51.0
DB	19.5	10.6	3.2	11.5	10.6	62.9	1.1	24.1	41.9	1.7	16.1	2.9	57.9
QNB	15.0	9.7	6.5	12.9	16.7	65.7	1.0	22.4	41.9	1.4	14.4	3.7	73.5
GB	18.7	12.7	8.9	12.5	15.7	64.5	0.5	22.5	40.8	2.1	16.5	4.0	74.7

Source: Banks Association of Turkey, 2018

After completing the ranking of the banks according to their relative performances, the criteria which express the performance model best is selected by stepwise regression technique. We use banking performance scores and 13 ratios as dependent variables and independent variables, respectively. The significance levels for entering (α_e) and removing (α_r) process of independent variables are defined as 0.15. All independent variables regress with dependent variable respectively and the first independent variable is chosen with the smallest p-value for the model.

This model is called the best fitted model with one independent variable. In this methodology, the variables are included in to model one by one in each single step.

As a result 4 of 13 financial ratios are determined as significant for the proposed model. These ratios are: Average Return on Assets; Financial Assets (Net) / Total Assets; Total Loans and Receivables / Total Assets; and Loans under Follow-up (Net) / Total Loans and Receivables. Then the performance measurements are recalculated by using these 4 significant ratios via TOPSIS method. The resulting performance ranking is given in Table 5.

Table 5 : Ranks of the banks according to their performances

2015			2016			2017		
RANK	**BANK**	**PERF.**	**RANK**	**BANK**	**PERF.**	**RANK**	**BANK**	**PERF.**
1	ZB	0.8553	**1**	ZB	0.9306	**1**	AB	0.9265
2	AB	0.8518	**2**	AB	0.9170	**2**	ZB	0.8677
3	GB	0.7669	**3**	GB	0.8395	**3**	IB	0.8000
4	IB	0.7273	**4**	IB	0.8194	**4**	GB	0.7779
5	HB	0.6902	**5**	VB	0.7190	**5**	HB	0.6714
6	VB	0.6507	**6**	HB	0.7129	**6**	VB	0.6586
7	TEB	0.5953	**7**	QNB	0.6945	**7**	QNB	0.5816
8	YKB	0.5666	**8**	YKB	0.6009	**8**	YKB	0.5177
9	QNB	0.5152	**9**	TEB	0.5924	**9**	DB	0.5171
10	DB	0.4853	**10**	DB	0.5501	**10**	TEB	0.4608
11	SB	0.1193	**11**	SB	0.10595	**11**	SB	0.0494

Source: Authors' own calculations

The results show that, Akbank, which is a privately owned domestic bank, shows the best performance for the year 2017. It is followed by Ziraat Bank which is the largest state-owned bank in Turkey and the best performing bank in the previous two years. Although Is Bank is in the third order in 2017, the scores of Is Bank and Garanti Bank are very close to each other for all years. Sekerbank is the worst performing bank among 11 in every year. The tests for a robust method is shown in Table 6.

Table 6: Stepwise regression analysis results

Variable	Coefficient	Std. Error	t-Statistic
R10	0.1329*	0.0317	4.1919
R5	0.0146*	0.0023	6.4873
R7	-0.1931*	0.0196	-9.8296
R6	0.0062*	0.0009	7.0640
R_2	0.9556	**Adjusted R^2**	0.9510

* ➔statistical significance at the 1% level.

Source: Authors' own calculations

5. Conclusion

This paper introduces an analysis of performance of Turkish commercial banks using TOPSIS and stepwise regression analysis. TOPSIS enables us to rank the performance of the banks. Stepwise regression determines the most significant financial criteria for our model and allows us to create a robust model. Since R10, R5, R6 and R7 are the most significant variables according to second step analysis, they are the only variables entering to new performance measurement by TOPSIS.

The 3 year relative performances of banks are re-calculated through this strengthened stepwise model. For the years 2015 and 2016, Ziraat Bank is first ranked with scores 0.8553 and 0.9306 respectively. However Akbank has the highest performance score in 2017 with the score 0.9265. The least performing bank is determined as Sekerbank for all the 3 years.

This study is based on 33 observations related to bank financial performance. Further studies may include a wider range of variables, a longer period of time and cross country comparisons.

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