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Evaluating the Financial Performance of Turkish Banking Sector: A Fuzzy MCDM Approach

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At the turn of the century Turkish economy was meltdown due to the one of the harshest crises experienced throughout her history. Since then, thanks to very strict measures taken by Turkish government, the economy proceeded to the recovery period. This period, however, seems to be interrupted once more again by 2008-2009 global financial crisis. In this study, we assess the financial performances of the different segments of the Turkish banking sector for the period between 2002 and 2010. In doing this, a combined methodology of Fuzzy Analytic Hierarchy Process (FAHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods is utilized. The results indicate that the adverse effect of the 2001 financial crisis on the Turkish banking sector is enormous while the ongoing global crisis is not so destructive in the sector.

1. Introduction

All organizations should measure their performances to some extent in order to detect organizational problems and provide improvement. The need for a flawless system of performance measurement is even more crucial in today's competitive business environment. Banking sector is not exception to this. The measurement of the performance in the banking sector has been always one of the major issues for the banks, governments and academicians. However, it is not easy to evaluate performances of the banks given that their products and services are of an intangible nature. For this reason, there is abundant literature discussing different research methods applied to performance measurement of banks.

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Performance measurement of banks has been traditionally achieved by help of several financial ratios such as return on assets (ROA), return on equity (ROE) and earnings per share (EPS). However, the usefulness of traditional financial performance measurement systems started to be discussed as the business environment changed in the last couple of the decades. As a result, the researchers have attempted to overcome the drawback of the traditional measurement system. This can be achieved with two different ways. Firstly, multidimensional performance measurement systems which incorporate both financial and non-financial measures such as customer satisfaction, management capacity and employee relations are introduced. SMART pyramid (Lynch and Cross, 1991), the balanced scorecard (Wu et al. 2009), CAMEL (Christopoulos et al., 2011), DEA (Aydin et al., 2009) and TOPSIS (Secme et al., 2009) are examples of this new performance measurement system. Secondly, instead of using financial ratios individually, sets of these ratios are started to be used. Most of these sets of the ratios are based on ROE and divide ROE into its component ratios. The examples of the sets of ratios are Dupont System of Finacial Analysis (McGowan et al., 2011) and Schierenbeck's Basic ROE Scheme (Badreldin, 2009). Since each of these contemporary performance measurement methods has its own advantages and disadvantages, none of them can be seen as perfect. Thus, evaluating pro and cons of each method, one can select the most suitable method according to her study's particular situation.

In this study, we determined our aim as evaluating the overall financial performances of the different segments of the Turkish banking sector. As explained in the following section, there are plenty of literature on performance measurement of the Turkish banks individually. For this reason, in this study, we focused on assessing the overall performances of the different banking segments instead of an individual evaluation at bank level. In addition, although we were aware of the fact that non-financial measures show up as important performance measurement criteria in the banking sector, in this study we deliberately focused on only financial measures because of several reasons. First, it is not an easy task to quantify non-financial measures such as customer satisfaction, quality and flexibility, management capacity, innovation capability and employee relations at individual bank level. At the more aggregated segments level, it is more difficult and even meaningless to try to take into account these non-financial measures. Second, different from the traditional ratio analysis which relies on limited number of financial measures, in this study, we took into account a large number of financial measures (29 in total) within a combined framework of Fuzzy Analytic Hierarchy Process (FAHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods. With FAHP method, the weights attached to these financial performance criteria by expert decision markers are determined. Then, TOPSIS method is used to rank the financial performances of the different segments of the Turkish banking sector.

The remaining of the study is as follows: In the next section, literature review on performance measurement in Turkish banking sector is presented. This is followed by a section explaining the research methodology including FAHP and TOPSIS methods. Then, empirical results are provided, and in the final section, the results of the study are discussed.

2. Performance Measurement in Turkish Banking Sector

In the banking literature, three different approaches have been employed in assessment of the efficiency of the banking sector according to the activities of the banks. These are “production approach”, “intermediation approach” and “profitability approach”. In the production approach, banks are assumed to produce deposits and provide loans by using their workforce and capital. In the intermediation approach, banks are considered to serve as intermediaries between those who deposit and those who withdraw money. In other words, the main functions of the banks are to convert the deposits which they collect into loans. And finally, according to the profitability approach, the main motivation of a bank is to increase its profit (Drake, Hall and Simper, 2005). The approach used in the assessment of the banking efficiency is crucial given that the input/output variables, and probably the results of the applications, may vary depending on the approach used.

A review of the literature on assessing efficiency of the Turkish banking sector reveals that a great number of studies employing all three types of these approaches seem to be conducted. However, these studies generally utilize the non-parametric approaches such as Data Envelopment Analysis (DEA) rather than parametric approaches such as

Stochastic Frontier Analysis (SFA). Among the motivations of these studies, two become prominent: First, the studies are motivated to investigate the effects of liberalization policies on the efficiency of Turkish banking sector. Second, the effects of the ownership structure of banks on their performances are frequently examined by using different time periods.

Some of the studies which are conducted to investigate the relationship between the efficiency and financial liberalization in Turkey are as follows: Based on an intermediation approach, Zaim (1995) analyzes the effects of the liberalization policies of the 1980s on the efficiency of the Turkish commercial banks for the 1981-1990 period. This study witnesses substantial improvements in the efficiencies of the banks following to the liberalization of capital movements. Mercan and Yolalan (2000) also reaches similar results for the 1989–1998 period: The financial performance of the banks increases after the financial reforms but starts deteriorating with the 1994 crisis. However, this result is not in line with Yildırim (1999) and Denizer et al. (2000). Analyzing the efficiency of Turkish commercial banks throughout 1988-1996, Yildirim (1999) reaches the conclusion that efficiency levels in Turkish banking sector did not increase following the liberalization. Denizer et al. (2000), using both the intermediation and the production approaches simultaneously for the period 1970-1994, claims that bank efficiency decreased following the liberalization in Turkey.

Another stream in the literature is examining the effects of the ownership structure of banks on their financial performances: Yolalan (1996) compares the efficiency performances of foreing, private and state-owned banks operation in Turkey during the years 1988-1995 by using financial ratios as inputs and outputs. This study shows that foreign banks in Turkey are more efficient than their domestic counterparts. Among the domestic banks, private banks have higher efficiency scores than public ones. This finding is also supported by Jackson, Fethi, and Inal (1998), Cingi and Tarim (2000) and Mercan and Yolalan (2000). Examining 1992-1996 period by help of a production approach, Jackson et al. (1998) reveals that private commercial banks operated more efficiency than public banks during the 1994 crisis. Cingi and Tarim (2000) applies a mixture of the intermediation and production approaches for the years 1989-1996, and concludes that private commercial banks are more efficient compared to state-owned banks. Mercan and Yolalan (2000) indicates that both private and foreign banks operate more efficiently than state-owned ones during the before and after 1994 crisis. Atan and Catalbas (2005) also analyzes the impacts of the differentiation in the capital structure of banks and concludes that private and foreign banks are more efficient than state-owned banks. Onal and Sevimeser (2006) also concludes that foreign banks in Turkey operate more efficiently than state-owned and private banks although their growth trends are rather similar. Isık and Uysal (2006) find that private and foreign banks in Turkey are better at adapting themselves to changing operational environments and better motivated to utilize emerging opportunities. Aydin et al. (2009) assesses the efficiency of the banking segments for the period 2002-2004 by using DEA method. Acordingly, the most efficient banks are state-owned, followed by foreign and private banks, respectively. This finding of Aydin et al. (2009) does not comply with findings of earlier research in literature.

In literature, several studies aim to compare the efficiencies of the banking sectors in different countries. For example, employing DEA method on four homogenous groups of countries, Stavárek (2006) examines whether the differences among regions and countries in their stages of European integration and economic development are also visible in banking efficiency. Results suggest that differences in banking efficiency exist among the regions analyzed, and the hierarchy corresponds with the hierarchy of regions in terms of economic development and degree of integration. However, the rapid growth of banking intermediation efficiency recorded in Central and East European countries could trade off the actual efficiency gap compared to traditional EU members. Andries (2011) studies the determinants of the efficiency and productivity of the banking systems of seven central and east European countries by help of DEA and SFA. The results show that the average efficiency of banks in central and east European countries grew during a five-year period, from 2004 to 2008. The improvement is attributed to the increased competition upon EU accession and the entry of foreign banks, as well as to extensive legislative changes that led banks to become more efficient. Based on the results, the highest level of technical efficiency is recorded for the banking systems of Romania and the Czech Republic, and the lowest is recorded for Slovenia.

Performance assessment of the banking sector has been also achieved in a multi-criteria decision making (MCDM) framework. The aim of the MCDM is to obtain the optimum choice that provides the highest degree of satisfaction considering all of the relevant criteria. To the best of our knowledge, Secme et al. (2009), Cetin and Cetin (2010) and Demireli (2010) are the studies which evaluate the performances of Turkish banks using a MCDM model. Secme et al. (2009) proposes a fuzzy performance evaluation model with both financial and non- financial performance indicators for five commercial banks in the Turkish banking sector by using FAHP and TOPSIS methods together. This study suggests that not only financial performance but also non-financial performance such as customer satisfaction and service quality should be taken into account in a competitive environment. Cetin and Cetin (2010) evaluates the financial performances of the Turkish banks which are traded in Istanbul Stock Exchange (ISE) by using Vise Kriterijumska Optimizacija I Kompromisno Resenje (VIKOR) method. Çetin and Çetin (2010) concludes that the researchers using VIKOR method may test their results with alternative criteria's weights given that this method is sensitive to these weights. Demireli (2010) analyzes the performances of three state-owned commercial banks. In doing this, equal weights are given to the financial criteria which are used in the study, and then performance scores are obtained by using TOPSIS method. This study concludes that the state-owned commercial banks are being effected from local and global financial crisis, the performance scores continuously fluctuate, and they cannot show any outstanding performance improvements over time.

3. Research Methodology

3.1. Fuzzy Analytic Hierarchy Process (FAHP)

Analytic Hierarchy Process (AHP), firstly proposed by Saaty (1980), has a wide range of applications. AHP uses hierarchical structures to represent a problem and then calculate weights for alternatives according to the judgments of the decision makers in a pairwise comparison framework. The conventional version of AHP method is often criticized owing to using the exact and crisp judgments of the decision makers. On the other hand, decision makers are more confident about interval judgments than fixed value judgments. Because of the vagueness and ambiguous are inherent of the human judgments and preferences, real life situations can be modeled more adequately by using fuzzy values than the exact numerical values. Another handicap of the AHP method is that the preferences in AHP are essentially human judgments based on their subjective perceptions. Therefore, a fuzzy version of the AHP method, called Fuzzy Analytic Hierarchy Process (FAHP), has been introduced in order to take into consideration subjective uncertainty of the variables.

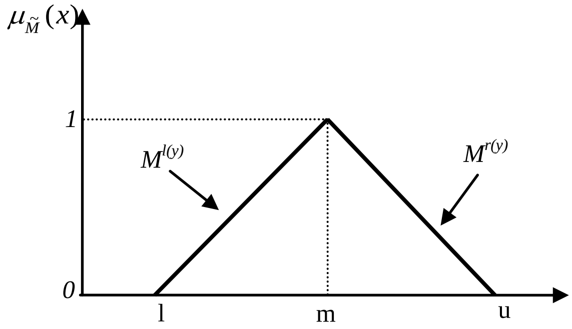
A fuzzy number is a special fuzzy set $A = \{x \in R \mid \mu_A(x)\}$, where x takes its values on the real line $\Re^1 : -\infty < x < +\infty$ and $\mu_A(x)$ is a continuous mapping from $\Re^1$ to the closed interval [0, 1]. Triangular fuzzy numbers and trapezoidal fuzzy numbers are the most popular fuzzy numbers thanks to their computational simplicity. Triangular fuzzy numbers are preferred for representing the linguistic variables in this study.

A triangular fuzzy number can be donated as $\tilde{M} = (l, m, u)$ and its membership function $\mu_{\tilde{M}}(x) : \Re^1 \to [0,1]$ can be given as

$$\mu_{\tilde{M}}(x) = \begin{cases} 0 & x < l \ or \ x > u \\ (x-l)/(m-l) & l \le x \le m \\ (x-u)/(m-u) & m \le x \le u \end{cases} \quad (1)$$

where $l \le m \le u$ and *l, m,* and *u* describe the smallest possible value, the most promising value, and the largest possible value of a fuzzy event, respectively. Membership function of a triangular fuzzy number $\tilde{M}$ is illustrated in Figure 1 (Deng, 1999):

Figure 1: A Triangular Membership Function, $\mu_{\tilde{M}}(x)$



Let $\tilde{M}_1 = (l_1, m_1, u_1)$, $\tilde{M}_2 = (l_2, m_2, u_2)$ be two triangular fuzzy numbers, the basic operations of triangular fuzzy numbers used in this study are defined as follows:

$$\begin{aligned} &\tilde{M}_1 \oplus \tilde{M}_2 = (l_1 + l_2, m_1 + m_2, u_1 + u_2), \\ &\tilde{M}_1 \otimes \tilde{M}_2 \approx (l_1 l_2, m_1 m_2, u_1 u_2), \\ &\lambda \otimes \tilde{M}_1 = (\lambda l_1, \lambda m_1\ \lambda u_1), \lambda > 0, \lambda \in R, \\ &\tilde{M}_1^{-1} \approx (1/u_1, 1/m_1, 1/l_1) \end{aligned} \tag{2}$$

where $l_1, m_1, u_1, l_2, m_2, u_2 > 0$

In this study, criteria weights of the performance measures are calculated by using extent analysis of Chang (1996). To describe the extent analysis of Chang (1996), firstly let $X = \{x_1, x_2, ..., x_n\}$ an object set, and $G = \{g_1, g_2, ..., g_n\}$ be a goal set. According to the method, extent analysis for each goal is performed respectively. Therefore, m extent analysis values for each object can be obtained:

$$M_{gi}^1, M_{gi}^2, ..., M_{gi}^m, \quad i=1,2,\ldots,n, \tag{3}$$

where all M_{gi}^j (j=1,2,…,m) are triangular fuzzy numbers. In this framework, Chang's extent analysis can be given as follows (Ertugrul and Karakasoglu, 2009):

Step 1: The value of fuzzy synthetic extent with respect to the *i*th object is defined as follows:

$$S_i = \sum_{j=1}^{m} M_{gi}^{j} \otimes \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} \quad (4)$$

To obtain $\sum_{j=1}^{m} M_{gi}^{j}$, the fuzzy addition operation of *m* extent analysis values for a particular matrix is performed as follows:

$$\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j\right) \quad (5)$$

and to obtain $\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1}$, the fuzzy addition operation of M_{gi}^{j} (j=1,2,…,*m*) values is performed as follows:

$$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i\right) \quad (6)$$

and then the inverse of the vector above is computed as follows:

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = \left(1\Big/\sum_{i=1}^{n} u_i, 1\Big/\sum_{i=1}^{n} m_i, 1\Big/\sum_{i=1}^{n} l_i\right) \quad (7)$$

Step 2: When $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$ are two triangular fuzzy numbers, the degree of possibility $M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$ is defined as

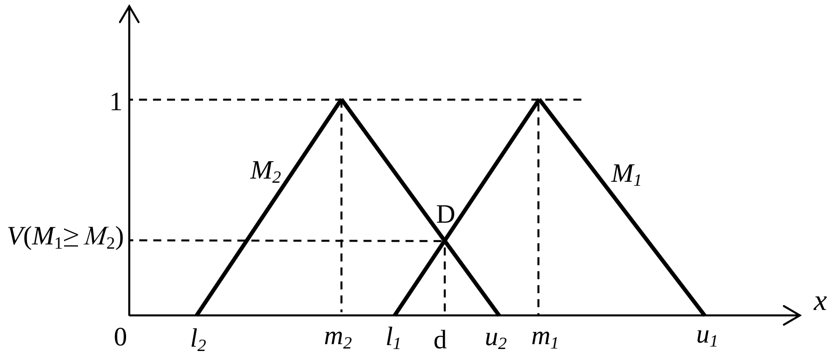
$$V(M_2 \geq M_1) = \sup_{y \geq x}\left(\min\left(\mu_{M_1}(x), \mu_{M_2}(y)\right)\right) \quad (8)$$

and can be equivalently stated as:

$$V(M_2 \geq M_1) = hgt(M_1 \cap M_2) = \mu_{M_2}(d) = \begin{cases} 1, & if \quad m_2 \geq m_1, \\ 0, & if \quad l_1 \geq u_2, \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & otherwise \end{cases} \quad (9)$$

Figure 2 illustrates equation (9) where d is the ordinate of the highest intersection point D between $\mu_{M_1}(x)$ and μ_{M_2} (Zhu et al., 1999). The values of both $V(M_1 \geq M_2)$ and $V(M_2 \geq M_1)$ are needed to compare M_1 and M_2.

Figure 2: Intersection Between M_1 and M_2



Step 3: The degree of possibility for a fuzzy number to be greater than k fuzzy numbers M_i $(i = 1,2,...,k)$ can be defined by

$$V(M \geq M_1, M_2,..., M_k) = V[(M \geq M_1) \text{ and } (M \geq M_2) \text{ and } (M \geq M_k)] \quad (10)$$

$$= \min V(M \geq M_i),\ i = 1,2,...,k \quad (11)$$

Assume that $d'(A_i) = \min V(S_i \geq S_k)$ for $k = 1,2,...,n; k \neq i.$ Then the weight vector is given by

$$W' = (d'(A_1), d'(A_2),..., d'(A_n))^{\mathrm{T}} \quad (12)$$

where A_i $(\mathrm{i} = 1,2,...,n)$ are n elements.

Step 4: The normalized weight vectors are obtained by normalization as

$$W = (d(A_1), d(A_2),..., d(A_n))^{\mathrm{T}} \quad (13)$$

3.2. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

TOPSIS is originally proposed by Hwang and Yoon (1981), and became one of the classical MCDM methods. According to this method, alternatives to be evaluated by *n* attributes in a MCDM problem are presented as points in an *n*-dimensional space. A fundamental assumption of TOPSIS is that each attribute has a tendency towards monotonically increasing or decreasing utility. In this method, firstly positive ideal solutions (PIS) and negative ideal solutions (NIS) are determined. The positive ideal solution is a solution that maximizes the benefit criteria and minimizes the cost criteria, whereas the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria (Wang and Elhag, 2006). In short, the positive ideal solution is composed of all best values attainable of criteria, whereas the negative ideal solution consists of all worst values attainable of criteria (Wang, 2008). TOPSIS method considers the distances to both the PIS and the NIS simultaneously by defining "relative closeness to ideal solution". The alternative which is the closest to positive ideal solution and farthest from the negative ideal solution is selected as the best alternative.

To explain the algorithm of TOPSIS, suppose we have *m* alternatives $(A_1, A_2, ..., A_m)$, and *n* decision criteria $(C_1, C_2, ..., C_n)$. Each alternative is evaluated with respect to the *n* criteria. All the rating scores assigned to the alternatives with respect to each criterion form a decision matrix denoted by $X = (x_{ij})_{mxn}$. Let $W = (w_1, w_2, ..., w_n)$ be the relative weight vector about criteria, satisfying $\sum_{j=1}^{n} w_j = 1$. The algorithm of TOPSIS is as follows (Ertugrul and Karakasoglu, 2009):

Step 1: Decision matrix $X = (x_{ij})_{mxn}$ is normalized by dividing each performance rating of the decision matrix with its norm, which is called vector normalization procedure. In other words, for benefit attributes, the normalized value r_{ij} is obtained by

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \qquad (14)$$

while for cost attributes, r_{ij} is computed as

$$r_{ij} = \frac{(1/x_{ij})}{\sqrt{\sum_{i=1}^{m}(1/x_{ij}^2)}} \tag{15}$$

where x_{ij} is the performance rating of *i*th alternative for attribute C_j.

Step 2: Weighted normalized decision matrix $V = (v_{ij})_{mxn}$ is obtained by multiplying normalized matrix with the weights of the criteria:

$$v_{ij} = r_{ij} \cdot w_j \tag{16}$$

where i=1,2,…,m and j=1,2,…n.

Step 3: Positive ideal solution (PIS) and negative ideal solution (NIS) are determined:

$$\text{PIS} = \{v_1^+, v_2^+, ..., v_n^+\} \text{ where } v_j^+ = \max_i (v_{ij}) \tag{17}$$

$$\text{NIS} = \{v_1^-, v_2^-, ..., v_n^-\} \text{ where } v_j^- = \min_i (v_{ij}) \tag{18}$$

Step 4: The distance of each alternative from PIS and NIS are calculated:

$$d_i^+ = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_j^+)^2} \tag{19}$$

$$d_i^- = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_j^-)^2} \tag{20}$$

where i=1,2,…,m.

Step 5: The closeness coefficient of each alternative (CC_i) is calculated:

$$CC_i = \frac{d_i^-}{d_i^+ + d_i^-} \text{ where } i=1,2,\ldots,m \tag{21}$$

Step 6: The ranking of the alternatives are determined according to CC_i values: The bigger CC_i, the better the relevant alternative. In other words, the alternative with the highest closeness coefficient is determined as the best alternative.

4. Application

Following very severe financial crisis experienced in 2001, rather heavy regulations regarding financial institutions were introduced in Turkey. In this study, we analyze the overall financial performances of the different segments of the Turkish banking sector through the period between 2002 and 2010. The data used in this study is obtained from Banks Association of Turkey (BAT).

Turkish financial sector has been always dominated by banks: According to the asset sizes, as of February 2012, 77% of the assets belong to the banks. As can be seen from Table 1, 44 banks in total operate in Turkey, 31 of them being deposit and 13 development and investment banks. The banks which operate in different segments of the Turkish banking sector are illustrated in Figure 3. Amongst deposit banks, there are 3 state-owned banks, 11 private banks and 16 foreign banks. The Deposits Insurance Fund (DIF) owns 1 bank. As parallel to the growth in the financial market in Turkey, the number of branches and employees of banks increase continuously. As of February 2012, the number of branches and employees reach to 9,841 and 181,277, respectively. Total asset of the banking sector is approximately 626 billion US Dollars. Almost all of this total is owned by the deposit banks. Indeed, the deposit banks dominate not only banking sector, but also all financial sector.

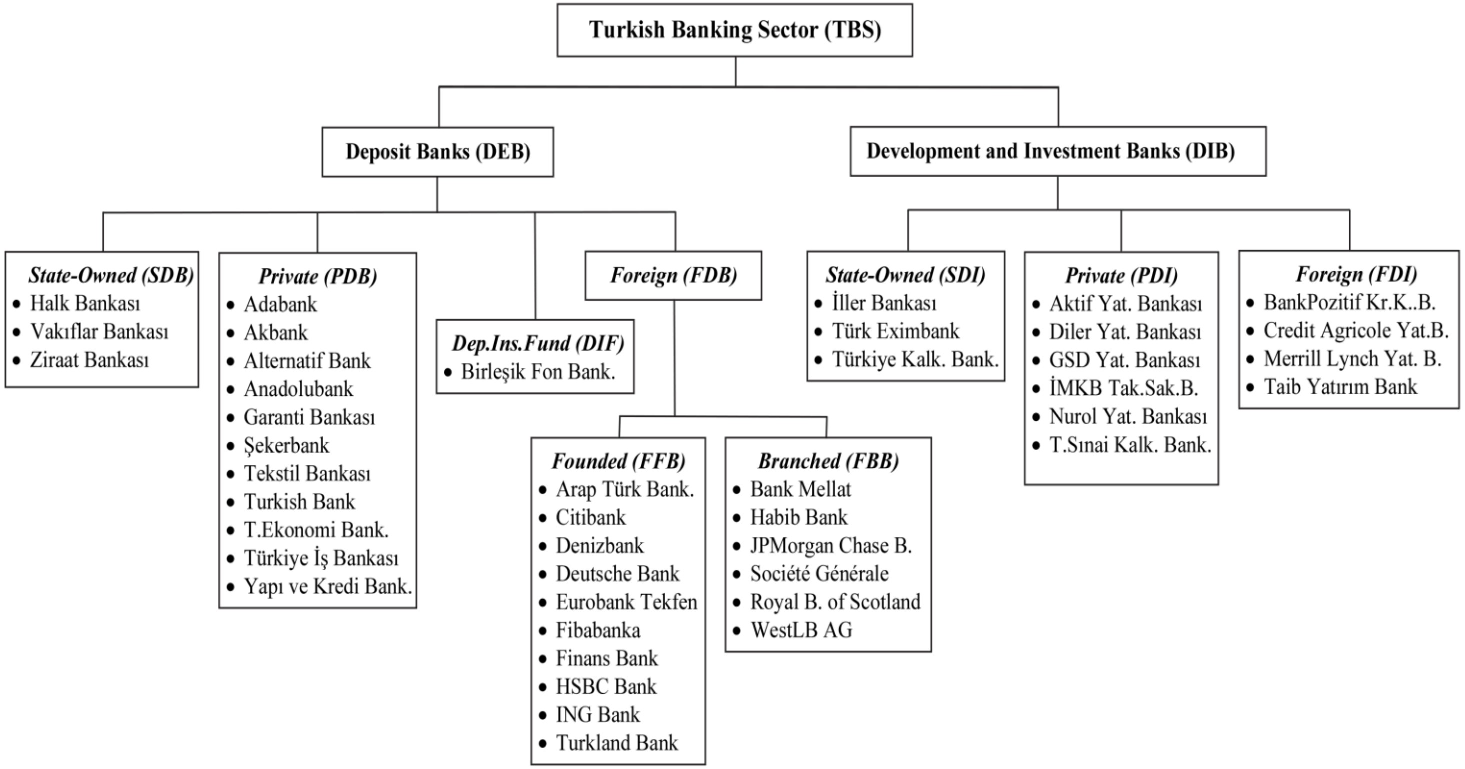
Table 1: Number of Banks, Branches, Employees and Total Asset in Turkish Banking Sector

	Bank	Branch	Employee	Total Asset
Turkish Banking Sector (TBS)	44	9,841	181,277	626,043
Deposit banks (DEB)	31	9,798	176,032	605,570
State-owned banks (SDB)	3	2,894	49,218	185,958
Private banks (PDB)	11	4,996	89,154	334,696
Banks in DIF (DIF)	1	1	243	445
Foreign banks (FDB)	16	1,907	37,417	84,472
Founded (FFB)	10	1,882	36,852	80,281
Branched (FBB)	6	25	565	4,190
Dev't. and inv. banks (DIB)	13	43	5,245	20,472
State-owned banks (SDI)	3	22	3,881	11,543
Private banks (PDI)	6	16	1,030	7,678
Foreign banks (FDI)	4	5	334	1,252

Notes:
(1) The meanings of the abbreviations denoting the segments of the banking sector are as follows: TBS: Turkish Banking Sector, DEB: Deposit Banks, SDB: State-owned Deposit Banks, PDB: Private Deposit Banks, DIF: Banks Under the Deposit Insurance Fund, FDB: Foreign Deposit Banks, FFB: Foreign Banks Founded in Turkey, FBB: Foreign Banks Having Branches in Turkey, DIB: Development and Investment Banks, SDI: State-owned Development and Investment Banks, PDI: Private Development and Investment Banks, FDI: Foreign Development and Investment Banks.
(2) Source: BAT
(3) Total assets are in million USD.

In analyzing the financial performance of different segments of Turkish banking sector, FAHP and TOPSIS methods are used together. While FAHP is used for determining the weights of main and sub-criteria in the light of opinions of an expert group, the TOPSIS method is used for evaluating the performances of the segments. Meanwhile, the expert group consists of three decision makers. The first decision maker is selected from a state-owned deposit bank while the second one is from a private deposit bank. And the third one is an academician with a considerable experience on banking.

Figure 3: Banks and Segments of Turkish Banking Sector



Although there are many types of financial ratios used in the evaluation of financial performance in banking sector, assessment results can vary according to the different ratios. A bank or banking segment showing a high performance according to one ratio may have a very low performance according to another ratio (Secme et al., 2009). For this reason, we tried to obtain the evaluations of the expert group regarding the relative importance of all available financial ratios. Bearing this in mind, we determined 29 financial ratios which may be relevant, and grouped them under 6 main criteria. These main criteria are Capital Ratios, Balance-Sheet Ratios, Assets Quality, Liquidity Ratios, Profitability Ratios and Income-Expenditure Structure. To determine the relative importance of two criteria, Saaty' 1-9 scale (Saaty, 1980), illustrated in Table 2, is employed. In this study, we only explained how the weights for main criteria are calculated. The explanations regarding sub-criteria were not presented here, but may be provided upon request. The abbreviations denoting financial criteria and their meanings are presented in Table 3. This table also includes the calculated weights for all main and sub-criteria in parentheses.

Table 2: Scales for Pairwise Comparison

Preferences in linguistic variables	**Preferences in numeric variables**
Equal importance	1
Moderate importance	3
Strong importance	5
Very strong importance	7
Extreme importance	9
Intermediate values if necessary	2,4,6,8

Table 3: Hierarchical Criteria Set

Criterion	Explanation and calculated weight
CR	**Capital Ratios (0.20)**
CR1	Shareholders’ Equity / (Amount subject to credit + market + operational risk) (0.20)
CR2	Shareholders' Equity / Total Assets (0.21)
CR3	(Shareholders' Equity - Permanent Assets) / Total Assets (0.21)
CR4	Net On Balance Sheet Position / Total Shareholders' Equity (0.18)
CR5	Net On and Off Balance Sheet Position / Total Shareholders' Equity (0.20)
BR	**Balance-Sheet Ratios (0.06)**
BR1	TC Assets / Total Assets (0.16)
BR2	TC Liabilities / Total Liabilities (0.18)
BR3	FC Assets / FC Liabilities (0.17)
BR4	TC Deposits / Total Deposits (0.15)
BR5	Total Deposits / Total Assets (0.17)
BR6	Funds Borrowed / Total Assets (0.17)
AQ	**Assets Quality (0.20)**
AQ1	: Financial Assets (net) / Total Assets (0.16)
AQ2	: Total Loans and Receivables / Total Assets (0.17)
AQ3	: Total Loans and Receivables / Total Deposits (0.17)
AQ4	: Loans Under Follow-up (net) / Total Loans and Receivables (0.16)
AQ5	: Specific Provisions / Loans Under Follow-up (0.17)
AQ6	: Permanent Assets / Total Assets (0.17)
LR	**Liquidity Ratios (0.19)**
LR1	Liquid Assets / Total Assets (0.43)
LR2	Liquid Assets / Short-term Liabilities (0.28)
LR3	TC Liquid Assets / Total Assets (0.29)
PR	**Profitability Ratios (0.20)**
PR1	Net Profit/Losses / Total Assets (0.18)
PR2	Net Profit/Losses / Total Shareholders' Equity (0.44)
PR3	Profit/Losses Before Taxes after Continuing Operations / Total Assets (0.38)
IE	**Income-Expenditure Structure (0.16)**
IE1	Net Interest Income After Specific Provisions / Total Assets (0.19)
IE2	Net Interest Income After Specific Provisions / Total Operating Income (0.20)
IE3	Non-interest Income (net) / Total Assets (0.16)
IE4	Other Operating Expenses / Total Assets (0.12)
IE5	Personnel Expenses / Other Operating Expenses (0.16)
IE6	Non-interest Income (net) / Other Operating Expenses (0.17)

In constructing the triangular fuzzy numbers from the decision makers' pairwise comparison grades, we used respectively the minimum and maximum grades given by decision makers for the lower (*l*) and upper (*u*) bound of the relevant fuzzy number. As for the most promising value of the fuzzy number, we used the arithmetic mean of the grades given by decision makers. The pairwise comparison matrix including the fuzzy numbers calculated is presented in Table 4.

Table 4: Fuzzy Pairwise Comparison Matrix

	CR	**BR**	**AQ**	**LR**	**PR**	**IE**
CR	(1, 1, 1)	(7, 8.33, 9)	(0.11, 2.7, 7)	(0.11, 5.37, 9)	(0.11, 2.41, 7)	(7, 8.33, 9)
BR	(0.11, 0.12, 0.14)	(1, 1, 1)	(0.11, 0.41, 1)	(0.11, 0.41, 1)	(0.11, 0.41,1)	(0.11, 0.41, 1)
AQ	(0.14, 3.38, 9)	(1, 6.33, 9)	(1, 1, 1)	(0.11, 4.7, 9)	(0.11, 4.7, 9)	(1, 5, 9)
LR	(0.11, 3.08, 9)	(1, 6.33, 9)	(0.11, 3.1, 9)	(1, 1, 1)	(0.11, 3.37, 9)	(0.11, 3.37, 9)
PR	(0.14, 6.05, 9)	(1, 6.33, 9)	(0.11, 3.1, 9)	(0.11, 3.37, 9)	(1, 1, 1)	(1, 6.33, 9)
IE	(0.11, 0.12, 0.14)	(1, 6.33, 9)	(0.11, 0.44, 1)	(0.11, 3.37, 9)	(0.11, 0.41,1)	(1, 1, 1)

Then using the fuzzy numbers in comparison matrix, synthesis values respect to main criteria calculated as in equation (4):

$$S_{CR} = (15.33, 28.15, 42) \otimes (1/206.29, 1/97.48, 1/28.51) = (0.0743, 0.2888, 1.4733)$$

$$S_{BR} = (1.56, 2.75, 5.14) \otimes (1/206.29, 1/97.48, 1/28.51) = (0.0075, 0.0282, 0.1804)$$

$$S_{AQ} = (3.37, 25.12, 46) \otimes (1/206.29, 1/97.48, 1/28.51) = (0.0163, 0.2577, 1.6136)$$

$$S_{LR} = (2.44, 20.26, 46) \otimes (1/206.29, 1/97.48, 1/28.51) = (0.0118, 0.2079, 1.6136)$$

$$S_{PR} = (3.37, 26.19, 46) \otimes (1/206.29, 1/97.48, 1/28.51) = (0.0163, 0.2687, 1.6136)$$

$$S_{IE} = (2.44, 11.67, 21.14) \otimes (1/206.29, 1/97.48, 1/28.51) = (0.0118, 0.1197, 0.7416)$$

By using the equation (9), fuzzy numbers are compared:

$$V(S_{CR} \geq S_{BR}) = 1,\ V(S_{CR} \geq S_{AQ}) = 1,\ V(S_{CR} \geq S_{LR}) = 1,\ V(S_{CR} \geq S_{PR}) = 1,\ V(S_{CR} \geq S_{IE}) = 1$$
$$V(S_{BR} \geq S_{CR}) = 0.29,\ V(S_{BR} \geq S_{AQ}) = 0.42,\ V(S_{CR} \geq S_{LR}) = 0.48,\ V(S_{CR} \geq S_{PR}) = 0.41,\ V(S_{CR} \geq S_{IE}) = 0.65$$
$$V(S_{AQ} \geq S_{CR}) = 0.98,\ V(S_{AQ} \geq S_{BR}) = 1,\ V(S_{AQ} \geq S_{LR}) = 1,\ V(S_{AQ} \geq S_{PR}) = 0.99,\ V(S_{AQ} \geq S_{IE}) = 1$$

$V(S_{LR} \geq S_{CR}) = 0.95,\ V(S_{LR} \geq S_{BR}) = 1,\ V(S_{LR} \geq S_{AQ}) = 0.97,\ V(S_{LR} \geq S_{PR}) = 0.96,\ V(S_{LR} \geq S_{IE}) = 1$
$V(S_{PR} \geq S_{CR}) = 0.99,\ V(S_{PR} \geq S_{BR}) = 1,\ V(S_{PR} \geq S_{AQ}) = 1,\ V(S_{PR} \geq S_{LR}) = 1,\ V(S_{PR} \geq S_{IE}) = 1$
$V(S_{IE} \geq S_{CR}) = 0.8,\ V(S_{IE} \geq S_{BR}) = 1,\ V(S_{IE} \geq S_{AQ}) = 0.84,\ V(S_{IE} \geq S_{LR}) = 0.89,\ V(S_{IE} \geq S_{PR}) = 0.83$

Then, according to the equation (11), priority weights are calculated:

$$d'(CR) = \min(1, 1, 1, 1, 1) = 1$$
$$d'(BR) = \min(0.29, 0.42, 0.48, 0.41, 0.65) = 0.29$$
$$d'(AQ) = \min(0.98, 1, 1, 0.99, 1) = 0.98$$
$$d'(LR) = \min(0.95, 1, 0.97, 0.96, 1) = 0.95$$
$$d'(PR) = \min(0.99, 1, 1, 1, 1) = 0.99$$
$$d'(IE) = \min(0.8, 1, 0.84, 0.89, 0.83) = 0.8$$

When we normalize these priority weights of main criteria, we obtain the weight of 0.20 for Capital Ratios, 0.06 for Balance-Sheet Ratios, 0.20 for Assets Quality, 0.19 for Liquidity Ratios, 0.20 for Profitability Ratios and 0.16 for Income-Expenditure Structure. Accordingly, Capital Ratios, Assets Quality and Profitability Ratios are seen almost equally as the most important criteria while Balance-Sheet Ratios is evaluated as the least important criterion.

After determining the weights of the all main and sub-criteria (financial performance criteria), we proceed to the application of TOPSIS method. Herein we explain only application of TOPSIS method to overall Turkish banking sector (TBS) to save space. The explanations about the application of the model to segments may be provided upon request. Financial performance criteria are normalized according to equations (14) and (15). In doing this, all sub-criteria – except BR6, AQ4, AQ6, IE4 and IE5, are considered as benefit attributes rather than cost attributes. Meanwhile, the criteria which are generated from deposit (namely BR4, BR5 and AQ3) are not considered for development and investment banks (DIB, SDI, PDI and FDI) given that these banks do not collect deposit. The weights of these criteria are distributed to other criteria according to their initial weights. After getting the normalized matrix, we multiply each normalized value of sub-criteria with their weights according to equation (16). Then, these weighted normalized values of sub-criteria under each main criterion are aggregated, and Table 5 is obtained. At the end of application, the total values of main criteria are multiplied by the weights of the main criteria (0.20, 0.06, 0.20, 0.19, 0.20, 0.16), and total weighted values of main criteria (Table 6) are obtained.

Table 5: Total Values of Main Criteria for TBS

Years	CR	BR	AQ	LR	PR	IE
2002	-0.061	0.307	0.200	0.304	0.194	0.325
2003	0.222	0.325	0.249	0.358	0.362	0.358
2004	0.180	0.329	0.283	0.351	0.330	0.354
2005	0.262	0.331	0.324	0.372	0.247	0.325
2006	0.131	0.324	0.380	0.351	0.377	0.326
2007	0.129	0.337	0.376	0.345	0.401	0.329
2008	0.181	0.333	0.352	0.241	0.300	0.301
2009	0.131	0.351	0.343	0.317	0.381	0.317
2010	0.132	0.350	0.377	0.323	0.345	0.317

Table 6: Total Weighted Values of Main Criteria for TBS

Years	CR	BR	AQ	LR	PR	IE
2002	-0.012	0.018	0.039	0.058	0.038	0.052
2003	0.044	0.019	0.049	0.068	0.071	0.057
2004	0.036	0.019	0.055	0.067	0.065	0.056
2005	0.052	0.019	0.064	0.071	0.049	0.052
2006	0.026	0.019	0.074	0.067	0.074	0.052
2007	0.026	0.020	0.074	0.066	0.079	0.053
2008	0.036	0.019	0.069	0.046	0.059	0.048
2009	0.026	0.020	0.067	0.060	0.075	0.051
2010	0.026	0.020	0.074	0.061	0.068	0.050

After calculating total weighted values of main criteria, positive ideal solution (PIS) and negative ideal solution (NIS) are determined by taking the maximum and minimum values for each criterion according to equation (17) and (18):

$$\text{PIS} = \{0.052, 0.020, 0.074, 0.071, 0.079, 0.057\} \quad \text{maximum values}$$
$$\text{NIS} = \{-0.012, 0.018, 0.039, 0.046, 0.038, 0.057\} \quad \text{minimum values}$$

Then, the distance of each bank from the positive ideal solution and negative ideal solution with respect to each criterion is calculated by using equation (19) and (20). Distances from positive ideal solution and negative ideal solution are presented in Table 7.

Table 7: Distances from Positive Ideal Solution and Negative Ideal Solution for TBS

Years	Distance from PIS	Distance from NIS
2002	0.085	0.013
2003	0.028	0.070
2004	0.029	0.062
2005	0.033	0.074
2006	0.027	0.067
2007	0.027	0.069
2008	0.037	0.061
2009	0.030	0.062
2010	0.030	0.062

Once the distances from positive ideal solution and negative ideal solution are determined, the closeness coefficients of utilities (CC_i) are calculated by equation (21). And finally, according to the closeness coefficient values, the rankings of the utilities are determined, as presented in Table 8.

Table 8: Rankings of the Years According to Closeness Coefficient Values for TBS

Ranking	Years	Closeness Coefficient
1	2007	0.714
2	2003	0.713
3	2006	0.709
4	2005	0.693
5	2004	0.680
6	2009	0.673
7	2010	0.671
8	2008	0.618
9	2002	0.128

By employing the TOPSIS methods to different segments of the Turkish banking sector, we obtained the financial performances of all segments for the period 2002-2010. Before proceeding to interpret the financial performance scores of the banking segments, presented in Table 9, one important point should be emphasized: In this study, we analyze each banking segment separately using TOPSIS method. For this reason, each banking segment should be analyzed independently. In other words, this study enables us to evaluate the annual financial performances of banking segments over the period 2002-2010. To be more precise, the financial performance scores presented in Table 9 should be interpreted horizontally, not vertically. As an alternative to our study, considering each year individually, one may compare the financial performances of the segments with each others' in a given year. We did not follow this deliberately: It seems to be more meaningful and interesting to analyze each banking segment over the years rather than to compare the different segments which have rather different structures and priorities in a given year. However, admittedly, a cross evaluation of the financial performances of the banking segments in a given year may be carried out, which can be topic of another study.

As seen from the first two row of the Table 9, Turkish banking sector in general and its deposit banking segment has followed similar financial performances during 2002-2010 period: The worst financial performance was exhibited in 2002, which is the year just after the 2001 financial crisis, while the best performance was shown in 2007, which is the year just before the ongoing financial crisis. Indeed, the similarity between performance trends of the banking sector and its deposit banking segment is not surprising given that Turkish banking sector is dominated by deposit banks. As for the remaining segments of the banking sector, the results are as follows: State-owned deposit banks, state-owned development and investment banks, foreign deposit banks in general and foreign deposit banks founded in Turkey seem to be affected most negatively by the ongoing crisis, thus take the lowest performance scores in 2008, the beginning year of the crisis. On the other hand, banks under the Deposit Insurance Fund, foreign development and investment banks, private deposit banks and development and investment banks in general exhibited their worst financial performances in years 2003, 2004, 2005 and 2007 respectively, while foreign banks having branches in Turkey and private development and investment banks performed poorly in 2006. As for the year in which the best financial performances were shown, the results are somewhat mixed: State-owned deposit banks overperformed in 2004 while private deposit banks showed their best performance in 2008. On the other hand, 2003 was the year when foreign deposit banks in general, foreign deposit banks having branches in Turkey, development and investment banks in general, private and foreign deposit and investment banks exhibited their best financial performances. Foreign deposit banks founded in Turkey and state-owned development and investment banks took their highest performance scores in 2005, deposit banks in general delivered an outstanding performance in 2007.

Table 9: Financial Performance Scores of Different Segments of Turkish Banking Sector

Segment	2002	2003	2004	2005	2006	2007	2008	2009	2010
TBS	0.128	0.713	0.680	0.693	0.709	0.714	0.618	0.673	0.671
DEB	0.125	0.698	0.689	0.681	0.706	0.733	0.618	0.697	0.701
SDB	0.445	0.571	0.717	0.593	0.585	0.671	0.283	0.382	0.387
PDB	0.399	0.593	0.314	0.274	0.364	0.548	0.676	0.634	0.636
DIF	0.450	0.320	0.675	0.536	0.745	0.541	0.540	0.522	0.445
FDB	0.529	0.788	0.619	0.749	0.414	0.235	0.120	0.287	0.207
FF	0.400	0.705	0.631	0.734	0.433	0.243	0.125	0.296	0.218
FB	0.511	0.711	0.379	0.582	0.177	0.432	0.475	0.731	0.528
DIB	0.501	0.664	0.433	0.532	0.574	0.386	0.463	0.487	0.410
SDI	0.569	0.524	0.391	0.607	0.548	0.434	0.380	0.488	0.396
PDI	0.438	0.697	0.526	0.380	0.284	0.292	0.561	0.459	0.365
FDI	0.526	0.824	0.224	0.494	0.467	0.545	0.558	0.543	0.547

Note: The meanings of the abbreviations denoting the segments of the banking sector are as follows: TBS: Turkish Banking Sector, DEB: Deposit Banks, SDB: State-owned Deposit Banks, PDB: Private Deposit Banks, DIF: Banks Under the Deposit Insurance Fund, FDB: Foreign Deposit Banks, FFB: Foreign Banks Founded in Turkey, FBB: Foreign Banks Having Branches in Turkey, DIB: Development and Investment Banks, SDI: State-owned Development and Investment Banks, PDI: Private Development and Investment Banks, FDI: Foreign Development and Investment Banks.

5. Conclusion

The rapid advancements in information technologies and increasing competition in national and international markets have started to challenge all banks to take timely measures to survive. Undoubtedly, the first and crucial step in determining the necessary management decisions is measuring the performances of the banks adequately. However, it is not easy to find the perfect method for the effective evaluation of the performance in banking sectors supplying intangible products and services. For this reason, in literature, a wide range of methods have been applied for performance evaluation of banking sectors. In this study, we aim to assess the overall financial performances of the different segments of the Turkish banking sector. To be more precise, the effects of two financial crises, which are experienced in 2001 and in 2008 and continuing, on different banking segments are assessed. In doing this, different from other studies in the literature, a large number of financial measures (29 in total) are considered within a combined framework of FAHP and TOPSIS methods. FAHP method is used to determine the weights attached to these financial performance criteria by expert decision markers. Then, the financial performances of the different segments of the Turkish banking sector over 2002-2010 period are ranked according to the TOPSIS method.

The results of FAHP method indicates that Capital Ratios, Assets Quality and Profitability Ratios are almost equally the most important criteria while Balance-Sheet Ratios is the least important criterion. According to the TOPSIS method using the fuzzy weights of the criteria calculated by FAHP, all segments of Turkish banking sector were adversely affected by 2001 financial crisis in which almost half of Turkish banks were failed. After exhibiting rather bad financial performance in 2002, a recovery period started thanks to the restructuring measures taken in the first stage of the financial collapse. Turkish banking sector with its all segments has been somewhat affected by the current financial crisis starting in 2008. However, different from 2001 crisis, the adverse effects of the current crisis is not destructive. One may safely claim that the immunity of Turkish banking sector from the global financial crisis is again the result of the favorable restructuring reforms started in 2001-2002 period. Surrounded with heavy regulations and rules, the sector seems to achieve its stability during the current financial crises. Especially, the limitation of exposure to the toxic assets by regulations helps Turkish banks to save their asset quality. As the global financial crisis turned out to be more serious than what was expected, Turkish government took more measures against it at the end of 2010, aiming mostly contracting the loan supply. As long as the political stability is preserved, the Turkish banking sector seems to have capability of overcoming the current financial crises.

This study may be extended in several directions by carrying out a number of consistency analyses. First of all, the performance of the Turkish banking sector can also be assessed with other MCDM models such as VIKOR and ELECTRE. Another topic of a consistency study may be analyzing the robustness of the financial performance estimations by using alternative weight values attached to the performance criteria. The result of a given MCDM method will be more reliable when its decision outcome does not vary significantly depending on the normalization procedure used. Thus, it would be of great interest to repeat this TOPSIS application with alternative linear normalization procedures in addition to the vector normalization procedure.

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