Applying the Multi-Criteria Decision Making Model for Ranking Commercial Banks: The Case of Vietnam

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Abstract

Banking has always played an important role in the economy because of its effects on individuals as well as on the economy. In the process of renovation and modernization of the country, the system of commercial banks has changed dramatically. Business models and services have become more diversified. Therefore, the performance of commercial banks is always attracting the attention of managers, supervisors, banks and customers. Bank ranking can be viewed as a multi-criteria decision model. This article uses the technique for order of preference by similarity to ideal solution (TOPSIS) method to rank some commercial banks in Vietnam.

Keywords: Financial ratios; multi- criteria; performance's bank; TOPSIS.

JEL code: C02, C69, G21, G32.

1. Introduction

This paper aims at developing a technique for order of preference by similarity to ideal solution (TOPSIS) model, one of the multi-criteria decision making models, based on the fuzzy triangular model for ranking the commercial bank system in Vietnam. The commercial bank system, one of the central units, plays an important role in transferring funds from surplus units to deficit agencies in an economy (Mishkin and Eakins, 2012). It therefore canallocate funds effectively so that economic development is promoted, especially in a bank-based financial system like that of Vietnam (Pinto et al., 2017). However, if a bank is weak or even bankrupt, it would affect not only themselves, but also the whole financial system as well as the economy. There are several methods to assess the performance of banks. Tao et al. (2013) combine the data envelopment analysis (DEA) method and the axiomatic fuzzy set (AFS) clustering method to comprehensively measure the performance of online banking based on financial and non-financial indicators. This study shows the difference between banks, capturing their strengths and weaknesses. In the view of Pinto et al. (2017), there is a positive and important relationship between the leverage and the profitability of banks. This study, by means of regression, assessed the financial performance of eight commercial banks in Bahrain from 2005 to 2015. Dong et al. (2016) reviewed the cost and profitability of 142 commercial banks in China. By stochastic frontier analysis (SFA), they compared the performance of these banks through different types of bank ownership in the two periods before and after the move to the World Trade Organization (WTO). Cetin and Cetin (2010) used the VIKOR method to evaluate and rank banks based on financial indicators.

Hwang and Yoon (1981) introduced the TOPSIS method, which has been recognized as one of the most effective methods for solving multi-criterion decision problems.The main idea of TOPSIS is calculation of the distances from the options to the positive ideal solution (PIS) and the negative ideal solution (NIS). The selected option must have the shortest distance to the PIS and the longest to the NIS. Because of its practical applications this method has been extended into many environments such as fuzzy numbers, fuzzy intervals and fuzzy intuitionistic logic. Kelemenis and Askounis (2010) solved problems in human resource selectionby the TOPSIS method, in which they developed a new ranking method. Wang (2014) applied the fuzzy TOPSIS method to assess the financial performance of Taiwanese transportation companies. By using the fuzzy TOPSIS method, transport companies can recognize their strengths and weaknesses relative to their competitors. Based on the fuzzy TOPSIS method, Mahdevari et al. (2014) provided the basis for decision makers to have appropriate policies to balance the risks of human health and the costs of coal mining in coal mines in Iran. Şengül et al. (2015) used the fuzzy technique for order of preference by similarity to ideal solution (FTOPSIS) methodology to rank renewable energy supply systems in Turkey by employing criteria such as land use, operating and maintenance costs, installed capacity, efficiency, break-even time, investment costs, amount of work generated, and amount of carbon dioxide (CO2) emissions. He found

that hydroelectric stations met the criteria best, followed by thermoelectricity and wind power.

This paper contributes to the literature review in novel ways. First, in Vietnam, previous studies' assessment or ranking of the performance of banks almost always has concentrated on DEA or logistic methods. Therefore, this is the first paper to employ the multi-criteria decision making model, especially the TOPSIS methodology, in ranking the banking system based on evaluation of bank performance. Second, unlike previous Vietnamese studies, the capital adequacy ratio is added in the model to assess the banking performance.

The remainder of the paper is structured as follows. The second section provides an overview of fuzzy set theory, especially the TOPSIS model. Based on the financial data of eight banks, the next section applies the multi-criteria decision-making model for ranking banks in Vietnam. The final section is concluding remarks and policy recommendations.

2. Methodology

Fuzzy set theory was introduced by Zadeh (1965). It provided a mathematical tool to deal with uncertain information through linguistic variables. Linguistic variables are represented by phrases (for example, good, low, high,etc.), which are used in states that are too complex or cannot be determined by normal quantitative values. Triangular and trapezoidal fuzzy numbers were used commonly. In this paper we use triangular fuzzy numbers to express the linguistic variables. We will introduce some necessary concepts of triangular fuzzy numbers as follows:

Definition 1: (Dat et al., 2015) A triangular fuzzy number (TFN) is described as any fuzzy subset of the real line R with membership function $f_A(x)$ satisfying the following conditions:

(a) f_A is a continuous mapping from R to the interval [0, 1];

(b) $f_A(x) = 0$ for all or $x \in [c, +\infty)$;

(c) f_A is strictly increasing on [a, b] and strictly decreasing on [b, c]

Where *a, b, c* are real numbers. A fuzzy number A can be denoted by $A = (a, b, c)$ and the membership $f_A(x)$ can be represented by

$$f_A(x) = \begin{cases} (x-a)/(b-a), & a \le x \le b \\ (x-c)/(b-c), & b \le x \le c \\ 0 & \text{otherwise} \end{cases}$$

Definition 2: (Seçme et al., 2009) Let $A = (a,b,c)$, $B = (a_1,b_1,c_1)$ be two triangular fuzzy numbers, the operations of A and B are defined by:

$A + B = (a + a_1, b + b_1, c + c_1)$, $A - B = (a - a_1, b - b_1, c - c_1)$

kA = (ka,kb,kc), A.B = (a.a_1,b.b_1,c.c_1),

$$A^{-1} = \left(\frac{1}{c}, \frac{1}{b}, \frac{1}{a}\right).$$

The distance between two triangular fuzzy numbers is defined by

$$d(A,B) = \sqrt{(a-a_1)^2 + (b-b_1)^2 + (c-c_1)^2}$$

In the next part, we introduce the TOPSIS method for decision-making problems which is based on the method of Hwang and Yoon (1981) and Shen et al. (2013). Let us assume that there are m alternatives $(A_i, i = 1,\ldots,m)$ which are evaluated by a committee of h decision-makers (D_q, q = 1,…,h) through n selection criteria (C_p, $p = 1,\ldots,n$), where the evolution of alternatives under each criterion and the weights of all criteria, are expressed by triangular fuzzy numbers. The method includes the following steps:

Step 1: Determine the normalized fuzzy decision matrix $R = [r_{ij}]$

$$r_{ij} = \left(\frac{a_{ij}}{c_j}, \frac{b_{ij}}{c_j}, \frac{c_{ij}}{c_j} \right), c_j = \max_i c_{ij}, j \in B \quad (1)$$

$$r_{ij} = \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}} \right), a_j^- = \min_i a_{ij}, j \in C \quad (2)$$

where B and C are sets of benefit and cost criteria, respectively.

Step 2: Calculate weight normalized values as follows:

$$G_i = \frac{1}{n} \sum_{j=1}^{n} r_{ij} \mathrm{w}_j, i = 1,2,...,m; j = 1,2,...,n, \quad (3)$$

w_j is the weight of the criterion C_j.

Step 3: The positive-ideal solution (PIS, A*) is $A^+ = (1,1,1)$ and negative-ideal solution (NIS, A–) is $A^- = (0,0,0)$. The distance from the each alternative to A^+ and A^- is calculated by:

$$d_i^+ = d(G_i, A^+), d_i^- = d(G_i, A^-). \quad (4)$$

Step 4: The closeness coefficient (CCi) of each alternative is calculated as:

$$CC_i = \frac{d_i^-}{d_i^+ + d_i^-} \quad (5)$$

The alternative is better if the closeness coefficient is higher.

3. The multi-criteria decision making model for ranking banks

In this section, we apply the fuzzy TOPSIS model for ranking the commercial banks. We compare the operating efficiency of eight banks, namely: The Bank for Foreign Trade of Vietnam (VCB), Vietnam Bank for Industry and Trade (CTG), Joint Stock Commercial Bank for Investment and Development of Vietnam (BIDV), Vietnam Technological And Commercial Joint Stock Bank (TCB), Asia commercial bank (ACB), Saigon-Hanoi Commercial Joint Stock Bank (SHB), Military Commercial Joint Stock Bank (MBB) and Vietnam International Commercial Joint Stock Bank (VIB). The data gained from the annual financial report of each bank is fromthe 2016 financial year. The proposed approach consists of two steps including: determining the criteria and evaluating and selecting the best alternative.

3.1. Determining the criteria

Financial ratios have a significant impact on the assessment of banks. The most common ones are return on assets (ROA) and Return on Equity (ROE) (Ayadi et al., 1998; Badreldin, 2009; Karr, 2005). However, these financial ratios also have certain limitations. The comparison of financial ratios between banks may be inaccurate due to the scale of operation and the time of operation between different banks. In addition, Sherman and Gold (1985) point out that financial ratios reflect primarily short-term rather than long-term performance. Kaplan and Norton (1996) point out that non-financial matters also have impact on the operational results of banks. Jelena and Evelina (2012) evaluated banking performance on three groups of indicators, including financial, non-financial indicators and qualitative values. In the context of integration with the world economy, applying Basel II to Vietnamese banks is an indispensable and obligatory trend. This also creates many difficulties and challenges for the banking system. According to international practice, the minimum capital adequacy ratio (CAR) of commercial banks is 9%. Thus the CAR coefficient is an important criterion in the valuation of banks.

From this, we selected some criteria, which are referred to in the above literature. Overall, the evaluation process consists of the following criteria: operating cost /operating income ratio (Cr_1) reserve of loan losses/total loans ratio (Cr_2), profit before tax/ operating income ratio (Cr_3), CAR (Cr_4), ROE ratio (Cr_5), ROA ratio (Cr_6). The experts evaluated that (Cr_1), is a type of cost criterion.

3.2. The evaluation and selection of the best bank

To evaluate the performance of banks, we asked four people who are leading experts and who have experience in the banking industry. This expert group was responsible for evaluating the importance weights of criteria and evaluating the performance of banks through a scale, which is in the form of a linguistic variable set. The results are calculated by Excel, the process ranking the banks is expressed as follows:

Step 1: Determine the normalized fuzzy decision matrix

The committee assessed eight commercial banks through the criteria based on a scale for the scoring of the bank of $S = \{VL, L, M, H, VH\}$ where: VL = very low = (0, 1, 3); L = low = (1, 3, 5); M = medium = (3, 5, 7); H = high = (5, 7, 9); VH = very high = (7, 9,10). The scores of each bank and normalized fuzzy decision matrix are expressed in Table 1 to Table 6, which are calculated by Equation (1) or (2).

Step 2: Calculate weighted normalized values

The experts assess the importance of criteria using linguistic variables,which represented by the triangular fuzzy set{UI, LI, I, VI, OI}, where UI = Unimportant = (0, 0.1, 0.3); LI = less important = (0.2, 0.3, 0.4); I = important = (0.3, 0.5, 0.7); VI = very important = (0.7, 0.8, 0.9) and AI = absolutely important = (0.8, 0.9, 1). The weights of the criteria are determined by the average values of evaluation and the weight normalized values are calculated by Equation (3).These are shown in the last column of Table 7.

Step 3: Calculate the distance from each alternative to A^+ and A^- by Equation (4)

Step 4: Calculate the closeness coefficient (CC_i) of each alternative.

The ranking of banks based on the closeness coeficient and it is shown in the Table 8.

There are some main findings as follows:

Table 1: The scores of each bank under criterion Cr_1 and normalized fuzzy decision matrix

Banks	Decision makers				Aggregated ratings	Normalized decision matrix
	D_1	D_2	D_3	D_4		
CTG	M	H	M	M	(3.5, 5.5, 7.5)	(0.033, 0.045, 0.071)
VCB	L	L	L	L	(1, 3, 5)	(0.05, 0.0833, 0.25)
VIB	VH	VH	VH	H	(6.5, 8.5, 9.75)	(0.026, 0.029, 0.038)
BIDV	VL	L	L	VL	(0.5, 2, 4)	(0.063, 0.125, 0.5)
SHB	L	L	L	L	(5, 7, 8.75)	(0.05, 0.0833, 0.25)
ACB	VH	H	M	H	(1.5, 3.5, 5.5)	(0.029, 0.036, 0.05)
TCB	VL	VL	L	L	(0.5, 2, 4)	(0.063, 0.125, 0.5)
MBB	L	L	M	L	(1.5, 3.5, 5.5)	(0.045, 0.071, 0.167)

Source: Authors' calculation.

Table 2: The scores of each bank under criterion Cr_2 and normalized fuzzy decision matrix

Banks	Decision makers				Aggregated ratings	Normalized decision matrix
	D_1	D_2	D_3	D_4		
CTG	G	G	G	G	(5, 7, 9)	(0.513, 0.718, 0.923)
VCB	G	VG	VG	G	(6, 8, 9.5)	(0.615, 0.821,0.9741)
VIB	VL	VL	VL	VL	(0, 1, 3)	(0, 0.103, 0.308)
BIDV	G	VG	G	G	(5.5, 7.5, 9.2 5)	(0.564, 0.769, 0.948)
SHB	VL	L	L	VL	(0.5, 2, 4)	(0.051, 0.205, 0.41)
ACB	VL	L	L	VL	(0.5, 2, 4)	(0.051, 0.205, 0.41)
TCB	VG	VG	G	VG	(6.5, 8.5, 9.75)	(0.667, 0.872, 1)
MBB	VL	L	L	L	(0.75, 2.5, 4.5)	(0.077, 0.256, 0.462)

Source: Authors' calculation.

Table 3: The scores of each bank under criterion Cr_3 and normalized fuzzy decision matrix

Banks	Decision makers				Aggregated ratings	Normalized decision matrix
	D_1	D_2	D_3	D_4		
CTG	L	L	L	L	(1, 3, 5)	(0.154, 0.462, 0.769)
VCB	M	L	M	M	(2.5, 4.5, 6.5)	(0.385, 0.692, 1)
VIB	L	L	L	L	(1, 3,5)	(0.154, 0.462, 0.769)
BIDV	M	M	M	M	(3, 5, 7)	(0.462, 0.769, 1.077)
SHB	L	L	L	L	(1, 3, 5)	(0.154, 0.462, 0.769)
ACB	L	L	L	L	(1, 3, 5)	(0.154, 0.462, 0.769)
TCB	L	L	L	L	(1, 3, 5)	(0.154, 0.462, 0.769)
MBB	L	L	L	L	(1, 3, 5)	(0.154, 0.462, 0.769)

Source: Authors' calculation.

Table 4: The scores of each bank under criterion Cr_4 and normalized fuzzy decision matrix

Banks	Decision makers				Aggregated ratings	Normalized decision matrix
	D_1	D_2	D_3	D_4		
CTG	G	G	G	G	(5, 7, 9)	(0.5, 0.7, 0.9)
VCB	VG	VG	VG	VG	(7, 9, 10)	(0.7, 0.9, 1)
VIB	VG	VG	VG	VG	(7, 9, 10)	(0.7, 0.9, 1)
BIDV	G	G	G	G	(5, 7, 9)	(0.5, 0.7, 0.9)
SHB	VG	VG	VG	VG	(7, 9, 10)	(0.7, 0.9, 1)
ACB	VG	VG	VG	VG	(7, 9, 10)	(0.7, 0.9, 1)
TCB	VG	VG	VG	VG	(7, 9, 10)	(0.7, 0.9, 1)
MBB	VG	VG	VG	VG	(7, 9, 10)	(0.7, 0.9, 1)

Source: Authors' calculation.

First, the TOPSIS model suggested that the ranking order of banks is VCB, TCB, CTG, BIDV, MBB, ACB, SHB, and VIB. Notably, Vietcombank is found to be the leading bank in the sample. This finding is consistent with the ranking report published by well-known credit rating agencies (e.g. Moody, Standard and Poors, Vietnam Report). Second, interestingly, the TOPSIS model ranked Techcombank second in the list, above Vietinbank and BIDV. It could be explained by the outstanding financial performance of Techcombank in the year 2016. Third, the State Bank of Vietnam evaluates and ranks commercial banks based only on finan-

Table 5: The scores of each bank under criterion Cr_5 and normalized fuzzy decision matrix

Banks	Decision makers				Aggregated ratings	Normalized decision matrix
	D_1	D_2	D_3	D_4		
CTG	G	G	G	G	(5, 7, 9)	(0.5, 0.7, 0.9)
VCB	VG	VG	VG	VG	(7, 9, 10)	(0.7, 0.9, 1)
VIB	L	VL	L	L	(0.75, 2.5, 4.5)	(0.075, 0.25, 0.45)
BIDV	VG	VG	VG	VG	(7, 9, 10)	(0.7, 0.9, 1)
SHB	L	L	L	L	(1, 3, 5)	(0.1, 0.3, 0.5)
ACB	M	M	M	M	(3, 5, 7)	(0.3, 0.5, 0.7)
TCB	VG	VG	VG	VG	(7, 9, 10)	(0.7, 0.9, 1)
MBB	VG	G	G	VG	(6, 8, 9.5)	(0.6, 0.8, 0.95)

Source: Authors' calculation.

Table 6: The scores of each bank under criterion Cr_6 and normalized fuzzy decision matrix

Banks	Decision makers				Aggregated ratings	Normalized decision matrix
	D_1	D_2	D_3	D_4		
CTG	VG	VG	G	VG	(6.5, 8.5, 9.75)	(0.65, 0.85, 0.975)
VCB	VG	VG	VG	VG	(7, 9, 10)	(0.7, 0.9, 1)
VIB	VG	VG	VG	VG	(7, 9, 10)	(0.7, 0.9, 1)
BIDV	VL	VL	VL	VL	(0, 1, 3)	(0, 0.1, 0.3)
SHB	VG	VG	G	VG	(6.5, 8.5, 9.75)	(0.65, 0.85, 0.975)
ACB	VG	VG	VG	VG	(7, 9, 10)	(0.7, 0.9, 1)
TCB	VG	VG	VG	VG	(7, 9, 10)	(0.7, 0.9, 1)
MBB	VG	VG	VG	VG	(7, 9, 10)	(0.7, 0.9, 1)

Source: Authors' calculation.

Table 7: Aggregate weight of criteria and weight normalized decision matrix

Criteria	Decision-makers				Aggregated weights
	D_1	D_2	D_3	D_4	
C_1	VI	AI	AI	AI	(0.775, 0.875, 0.975)
C_2	AI	AI	AI	AI	(0.8, 0.9, 1)
C_3	I	VI	I	VI	(0.5, 0.65, 0.8)
C_4	VI	VI	I	VI	(0.6, 0.725, 0.75)
C_5	AI	AI	AI	AI	(0.8, 0.9, 1)
C_6	AI	AI	AI	AI	(0.8, 0.9, 1)

Source: Authors' calculation.

Table 8: Ranking of the banks

Bank	Weighted normalized values	*di+*	*di-*	*CCi*	Rank
CTG	(0.289, 0.481, 0.708)	0.927	0.904	0.494	3
VCB	(0.377, 0.589, 0.811)	0.770	1.071	0.582	1
VIB	(0.189, 0.351, 0.543)	1.134	0.674	0.373	8
BIDV	(0.265, 0.452, 0.727)	0.957	0.896	0.484	4
SHB	(0.196, 0.374, 0.599)	1.095	0.733	0.401	7
ACB	(0.227, 0.405, 0.604)	1.053	0.762	0.42	6
TCB	(0.366, 0.578, 0.825)	0.781	1.072	0.579	2
MBB	(0.272, 0.463, 0.673)	0.962	0.861	0.472	5

Source: Authors' calculation.

cial data. However, the findings suggested that the State Bank of Vietnam (SBV) should employ a combination of financial data, evaluation by customers on the quality of products, and experts' view and assessment in evaluating and ranking commercial banks.

4. Conclusion

A bank can be viewed as a special entrepreneur responsible for the attraction of financial resources, providing capital and different services. Banks have a significant impact on the growth and development of an economic nation due to the motivation of operating financial flows. Recent years, the Vietnam bank system has changed noticeably thanks to applying new technology in financial services, namely internet, and mobile banking, a live bank without tellers. In addition, banks provide not only traditional banking but also investment banking and insurance services in order to become a financial conglomerate. Those changes might create both high profits and potential risks for banks. Therefore, the performance evaluation of banks should be prerequisite and important information for clients, investors, and managers to select a bank.

Besides, bank customers tend to choose a financial service based on three important criteria including security, good customer services (e.g. simple paperwork, 24/7, fast, etc.), and incentives. The industrial revolution 4.0 has created many challenges as well as opportunities for the banking system to protect customers' information and develop products. Therefore, the banking sector should take the lead in applying technological achievements.

In this paper, we used a multi-criteria decision-making model for ranking banks in Vietnam based on financial indicators in the year 2016. The proposed model can be broadby considering non-financial and financial performance and it can be applied to other decision-making problems in the real world. In the future, this article can broaden the scope of the study as well as add criteria to comprehensively assess the credibility of banks in three aspects: Financial indicators expressing operational performance, value to the customer on the quality of products and services, and the evaluation of banks by experts and the media.

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