

A Comparative Performance Evaluation on Bipolar Risks in Emerging Capital Markets Using Fuzzy AHP-TOPSIS and VIKOR Approaches

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Effective decision making in the financial markets is an important issue for individual and institutional investors in a competitive and risky environment. However, the majority of the investors do not integrate conflict hazards with financial risks in this environment. Accordingly, the best way to select the right market for profitable investments requires the evaluation of bipolar risks covering conflict risk and financial risk using multi-criteria decision-making approaches.

The aim of the paper is to discover the comparative performance of emerging markets based on the bipolar risks of the capital markets using hybrid multi-criteria decision analysis methods in economics. Fuzzy AHP-TOPSIS (FAHP) and Fuzzy AHP-VIKOR methods were used to analyze the financial and conflict risk-based performance levels of selected emerging economies. The seven determinants in this model have been derived from the Advanced and Emerging Market Financial Stress Index and Conflict risk index.

The findings demonstrate that the comprehensive performance results of the emerging markets vary based on the competencies of the bipolar risks. The two methods, with different steps for ordering the alternatives, had the same performance results in ranking the emerging economies. The overall performance of each method demonstrates that both methods give coherent results in ranking the E7 economies under the fuzzy environment.

The originality of the study is that the FAHP gives more sensitive results than classic AHP method in evaluating the alternatives under a fuzzy environment. In addition, a comparative analysis was applied to evaluate the bipolar risk-based performance results using a hybrid approach under the fuzzy environment.

Keywords: *Emerging economies, capital markets, fuzzy, AHP, VIKOR, TOPSIS.*

Introduction

The negative effects of the 2008–2009 *Global Financial Crisis* on global economic activity has raised critical questions about the stability and capitalization of financial markets in the emerging markets. Bartram and Bodnar considered that the global equity market capitalization by the end of February 2009, which stood over \$22 trillion, but which had dropped by 56 % or more than \$29 trillion, reflected a loss in wealth to investors of about 50 % of GDP from 2007 (Bartram & Bodnar, 2009, p. 1246–1292).

Hacıoglu and Dincer (2013) pointed out that higher risks attached to financial instruments following the negative effects of instability in the financial system increased overall macroeconomic risks globally. The weaker growth rates and higher risks have been examined in the literature, including their effects on Sovereign Debts and portfolio investments in emerging markets, which have also been attached to concerns about financial stability and fiscal discipline in advanced economies (Conyon *et al.*, 2011, p. 399–404; Naes *et al.*, 2011, p. 139–142; Rjoub, 2011, p. 83–95). According to the Global Financial Stability Report, the Credit Default Swaps (CDSs) of advanced economies reached their peak and investors had doubts about their current and next positions in portfolio investment (GFSR, 1012, p. 16–22). In addition to instability in financial system, inefficiency and weak performance of the banking system and other financial

institutions have been questioned, together with their effects on equity and asset prices, and new measures have been taken in the European banking system. Banks were urged to reduce the balance sheet size by €2,6 trillion by the end of 2013, which is equal to almost 7 % of their total assets (GFSR, 1012, p. 17). Hacıoglu and Dincer said that measures in the European banking system and doubts related to the global economy are expected to have negative effects on bank profits and equity prices.

During the turmoil, the major focus of investors and the attention of regulators were on stability in the international banking system and the credit mechanism, which had been accepted earlier as the major components of stable world economic system. Studies in the finance literature had not sufficiently considered non-financial risks affecting the global economy and financial system. However, an interdisciplinary perspective which included political risk factors and conflict risk had not previously been attached to the consideration of behavioral issues in finance. In 2013 and 2014, investors experienced some losses in capital markets because of fluctuations in asset prices attached to increased tensions arising from political and armed conflict between marginal groups in the Ukraine, Syria and Iraq, which are now spreading over the Middle East and contributing to increased tension between Security Council Members. These conflicts have been threatening the petroleum industry, transportation, FDI, international trade and the other economic activities. The

turmoil on the political stage will reinforce international terrorism in the long run. Increased prices of oil and derivative products have negative effects on general price levels in emerging economies which are mainly importing petroleum and its derivatives. In his study (Long, 1974, p. 131–170) demonstrated that future prices of consumption goods are uncertain and that there are investment opportunities in common stocks and risk-free instruments. Therefore, shifts in prices affect interest rates and are reflected in portfolio choices and equilibrium stock prices.

At the global level, the attention on increasing political risk factors for individual investors and portfolio managers has brought with it concerns about existing portfolio strategies. Stock pricing and portfolio selection are mostly attached to quantitative methods and approaches. (Sharpe, 1964; Lintner, 1965) developed the Capital Asset Pricing Model (CAPM) to determine a suitable rate of return for a financial instrument as a part of a well-diversified portfolio. The sensitivity of the financial instrument to non-diversifiable risk, which is known as systematic risk, is used by portfolio managers (Fama, 2004, p. 25–46; French, 2003, p. 60–72; Chong *et al.*, 2013; Muradoglu *et al.*, 2003, p. 316–328).

Financial and non-financial parameters affecting risky assets and equities determine the level of sensitivity of portfolio investments. Non-financial risk factors which include the ethnic, political, cultural and religious origins of conflict have not had much attention in the capital markets. On the one hand, it should be said that the roots of these conflicts do not attract the attention of decision makers in advanced economies as much in emerging markets, as the latter are more directly influenced by issues concerning the international political economy. On the other hand, multinational companies operating overseas are also affected by political turmoil in some places where they have invested. Political risks concerning the success of organizational performance and stock market volatility (Morales *et al.*, 2009, p. 144–156; Andrade, 2009, p. 671–695; Le & Zak, 2006, p. 308–329) play a vital role in developing scenarios and implementing effective investment decisions. In this study, we have examined and combined the conflict risk factors for portfolio investment in the capital markets of emerging economies. This study evaluates the boundaries and components of the conflict risk parameters affecting the stock performance of multinational companies operating in emerging economies.

In our study, the Fuzzy AHP-TOPSIS method was adopted as a hybrid model for evaluating the best possible ranking of emerging economies based on the effects of conflict on capital market performance. Bipolar risk refers to the simultaneity of conflict risk and market risk in emerging markets. This study has analyzed a comparative performance evaluation of bipolar risks in emerging capital markets using Fuzzy AHP-TOPSIS and VIKOR approaches.

This paper is organized as follows. Section one of this paper considers and evaluates the latest studies of conflict in the literature, while section two tries to determine a clear cut methodological explanation of the research method. The third section concerns the implementation of the research model, and the final section provides conclusions and summarizes the major implications for investors and other researchers.

Literature Review

Financial Stress Index and its Application to Emerging Economies

As noted in the first part of this paper, the latest financial crisis, which had its origins in the USA, affected the global financial system and the world economy. Financial stress in emerging economies spilled over into the global markets and world economy in 2008 and 2009 (White, 2008, p. 37; Ackermann, 2008, p. 329–337). Studies of the era of the global economic crisis have highlighted how the financial stress in the developed countries was transmitted to financial risks in form of the banking crisis in emerging economies. These studies have demonstrated that the stress in capital markets and the banking system in advanced economies at the beginning of the financial crisis became an important financial risk indicator for capital and portfolio investments in developed and emerging economies (Illing & Liu, 2006, p. 243–265; Hakkio & Keeton, 2009, p. 5–25). The transmission of these risks was reflected in the capitalization of the banking systems of emerging economies and trade transactions, resulting in liquidity shortages. The sovereign debt crisis in advanced economies also had negative effects on the stability of the banking system in emerging economies, which was in parallel to the volatility in the capital markets of advanced economies that were simultaneously exposed to financial uncertainty during the sovereign debt crisis in Europe in the middle of 2010. The financial development and growth of emerging economies has been weakened as a result (Torre & Schmukler, 2007, 1–9; Robinson, 1952; Allen, 1990, p. 3–30; Lucass, 1988, p. 3–42; Levine, 2005, p. 7–28).

The studies by Cardelli *et al.*, (2011) illustrated how the financial stress can be interpreted by an index. Based on the proposed index, the actual level of financial stress in emerging economies can be evaluated in the form of a long-term investment measurement kit, which could be a component of capital flows to emerging economies. Moreover, the process for the transformation of financial stress from high currency countries to emerging economies has sparked the interest of decision makers in portfolio investments. The major characteristics of financial stress in capital markets are: large shifts in equity prices, volatility, liquidity droughts and concerns about the stability of the banking system (Balakrishnan *et al.*, 2009, p. 6; Abbas & Christenson, 2007, p. 7–14; Chami *et al.*, 2009, 1–12).

(Cardelli *et al.*, 2011) combined the major components into a single and unique index in order to demonstrate the stability of the banking system and the credit mechanism in the banking system, stock exchange and other capital markets. The Financial Stress Index for advanced (AE_{FSI}) and emerging (EM_{FSI}) markets has been developed. The main components of EM_{FSI} (Balakrishnan *et al.*, 2009, p. 7) are banking-sector beta, β , stock market returns (SMR), time-varying stock market return volatility (SMV), sovereign debt spreads (SDs) and the Exchange Market Pressure Index (EMPI). The overall aggregated index illustrates the degree of financial stress associated with (i) large swings in asset prices, (ii) abrupt changes, (iii) liquidity conditions and (iv) financial intermediation. The model developed by (Cardelli *et al.*, 2011) has five components, as follows:

$$EM_{FSI} = \beta + SMR + SMV + SDs + EMPI \quad (1)$$

where β denotes the *banking-sector beta*, which is the standard capital asset pricing model (CAPM) beta; SMR refers to *stock market returns*, which are computed as the year-on-year; SMV is *stock market volatility*, which is a time-varying measure of market volatility obtained by GARCH(1,1); SDs refers to *sovereign debt spreads*, which are defined as the bond yields minus the 10-year US Treasury yields using JPMorgan EMBI Global Spreads; and the EMPI demonstrates exchange rate depreciations and declines in international reserves. EMPI is defined for county i in month t in as:

$$EMPI_{i,t} = \frac{(\Delta e_{i,t} - \mu_{i,\Delta e})}{\sigma_{i,\Delta e}} - \frac{(\Delta RES_{i,t} - \mu_{i,\Delta RES})}{\sigma_{i,\Delta RES}} \quad (2)$$

where Δe and ΔRES denote the month-to-month percentage changes in the exchange rate and total reserves minus gold, respectively.

The Financial Stress Index for the capital markets of advanced economies (AE_{FSI}) by Cardarelli et al., (2011) is composed of seven components related to capital markets: the banking-sector Beta, β , the TED spreads (TEDs), inverted term spreads (ITs), corporate debt spreads (CrDs), stock market return (SMR), stock market volatility (SMV) and exchange market volatility (EMV). The model proposed by Cardarelli et al., (2011) is as follows:

$$AE_{FSI} = \beta + TEDs + ITs + CrDs + SMR + SMV + EMV \quad (3)$$

Conflict Risk and its Effect on Capital Markets

In the middle of 2014, the nature of conflict and the devastating situations in Ukraine, Syria and Iraq became some of the most potentially catastrophic factors affecting portfolio investment, as conflict has an effect on macroeconomic conditions and the petroleum and transportation industries. According to the World Bank's Multilateral Investment Guarantee Agency's (MIGA) World Investment and Political Risk Evaluation Report, the latest global economic recession and meltdown in global economic activity has caused budget deficits in advanced and emerging economies with pressure on exchange rates (Hacioglu & Dincer, 2013). At the micro level, the negative effects of economic turmoil have sparked political and social tensions around the world. These tensions and conflicts among ethnic groups have negative effects on international trade and growth, causing instability in the capital markets of economies with ties to these countries. Moreover, the deteriorating conditions for international business organizations have resulted in capital outflows and an increase in the pressure on foreign exchange rates (Hacioglu & Dincer, 2013).

Studies described in the literature have sufficiently defined the concept of conflict. In most cases, the conflict issue is attached to ethnic, religious, cultural and economic dimensions within a society (Mayer, 2000; Boulding, 1963; Dougherty & Pfaltzgraff, 1990; Andrade, 2009, p. 671–695; Le & Zak, 2006, p. 308–329; Kyaw et al., 2011, p. 55–67; Busse & Hefeker, 2007, 397–415; Saleem & Vaihekoski, 2008, p. 40–56). There have been a wide spectrum of definitions of conflict. Studies argue intensely over the methodology of conflict analysis. One school is focused on econometric models and the implications for

society (Collier, 1999, p. 13; Collier & Hoeffler, 2004; Collier et al., 2006, p. 3–12; Starr, 2004, p. 1–3; Justino, 2004, p. 1–15; Addison & Murshed, 2000, 2–5), while another school has argued that statistics should be treated with suspicion because of manipulation and misuse, and the unreliability of results (Sambanis, 2001; Elbadawi & Sambanis, 2002; Lujala et al., 2005; Hegre & Sambanis, 2006; Korf, 2006, p. 459–476; Suhrke et al., 2005, p. 329–361; Wimmer et al., 2009, p. 3).

The conflict in emerging countries creates disharmony at the micro level among different elements of society and in the workplace. Deteriorating conditions and business atmosphere impact on individual aspirations, desires and motives. According to Hacioglu and colleagues, a conflict situation has negative impacts on international business and affects firm performance and equity prices in the long term (Hacioglu et al., 2012, p. 1–5).

Conflict, with its negative effects on investment climate, economic and financial stability, business and trade activities, and the workforce, also affects the stock performance of international business organizations operating in a post-conflict society (Hacioglu & Dincer, 2013). (Collier et al., 2006) demonstrated the negative effects of conflict on society and explained the post-conflict risk situation through a game-theoretical model. They remarked that the interdependence between risks and consumption can create a situation which is counter-productive for investment (Collier et al., 2006, p. 6) and that post-conflict peace is typically fragile: around half of all civil wars are due to post-conflict relapses (Collier et al., 2003).

The Conflict Risk Index

A hybrid model is required for evaluating the bipolar effects of financial and political risk on the capital markets of emerging economies, and to assist investors and decision makers in capital markets in the portfolio selection process. A methodology for the conflict risk index has been developed on the basis of existing literature about the pre-conflict, conflict and post-conflict situation. However, there is no consensus about the variables to be included in a conflict index model. Notwithstanding this, a conflict risk index can be developed as a risk assessment tool, as took place in the in Conway and Kishi's *Conflict Risk Assessment Report* (2001) and UNOCHA's *Natural and Conflict related Hazard in Asia-Pacific Report* (2009). However, UNOCHA's proposed risk assessment method is limited only to state-based internal armed conflict. International conflict risk has not been covered in these studies. The development of a conflict index is required, based on an interstate form streaming data from the CIA World Fact Book and UCDP/PRIO's Armed Conflict Dataset (Hacioglu & Dincer, 2013).

The following is a suggested index model, which can be used for actual conflict risk evaluation:

$$CRI = PCR_{index} + ACR_{index} + SER_{index} \quad (4)$$

where PCR_{index} illustrates Collier's proposed Post-Conflict Risk Model. If a conflict was experienced within the last decade, the index value then will be calculated and

placed in the *Conflict Risk Index*. Otherwise, the PCR_{index} is equal to 0 and it becomes an inefficient parameter.

$$ACR_{index} \mu = \frac{1}{n} \sum_{i=1}^n x_i = \frac{1}{n} (x_1 + \dots + x_n) \quad (5)$$

Illustrates the focus of the conflict risk element. Experts evaluated the conflict situation based on five different categories: 1 *no data* – peace, 2 *low* – some contractual disputes, 3 *medium* – economic and diplomatic stress, 4 *high* – confrontation and 5 *extreme* – armed conflict. The SER_{index} implies the socio-economic risk index which has been developed by UN OCHA-NGI.

$$SER_{index} = HDI + HPI + GDP + IMR + CI \quad (6)$$

where HDI represents the Human Development Index, HPI the Human Poverty Index, GDP the gross domestic product, IMR the infant mortality rate and CI the Composite Index including variables for electricity, health, education and nutrition (UNOCHA-NGI, 2009; Hacıoglu & Dincer, 2013).

Proposed models with the Fuzzy AHP-TOPSIS and VIKOR methods

Integrated models for the stock selection process

In the study, a novel hybrid performance evaluation model which includes the bipolar risks was applied by using the Analytic Hierarchy Process (AHP), *Vlsekriterijumska Optimizacija I Kompromisno Resenje* (VIKOR; “Multi-criteria Optimization and Compromise Solution”) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) under a fuzzy environment. The major index for bipolar risk is composed of AEFSI, EMFSI and CRI. There are also sub-indexes, as presented in Table 1.

Table 1

Comparative performance evaluation with major and sub-indices

Goal	Major Index	Sub-index
Performance Evaluation Based on Conflict and Financial Stress	AEFSI	Beta, TEDs, ITs, CrDs, SMR, SMV, EMV
	EMFSI	Beta, SMR, SMV, SDs, EMPI
	CRI	PCR, ACR, SER

Source: Hacıoglu & Dincer, 2013

Table 2

The derived determinants for bipolar risk-based performance evaluation

	Derived Determinants	Source
CC1	Future expectations for the stock market	AEFSI-EMFSI
CC2	Financial stability in the capital markets	
CC3	Stability in Sovereign Debt	
CC4	Strength of currency	
CC5	Post-conflict recovery	ACR- CRI
CC6	Socio-economic conditions	
CC7	Political stability	

Source: Hacıoglu & Dincer, 2013

The first of the proposed models compared in the application was built with the fuzzy AHP and fuzzy VIKOR methods, and the second comparison model was constructed with the fuzzy AHP and fuzzy TOPSIS

approaches. Thus, comprehensive results are obtained to evaluate the performance of two proposed models of the capital markets in the E7 economies using the determinants derived from Advanced and Emerging Market Financial Stress Index and Conflict Risk Index (table 2).

Each model involves some different steps as well as some similarities in reaching the ranked results. The process is initiated with the calculation of the weights of the criteria via the AHP method under the fuzzy environment, and continues with the construction of the fuzzy model with an alternative process for selection (see Figure 1).

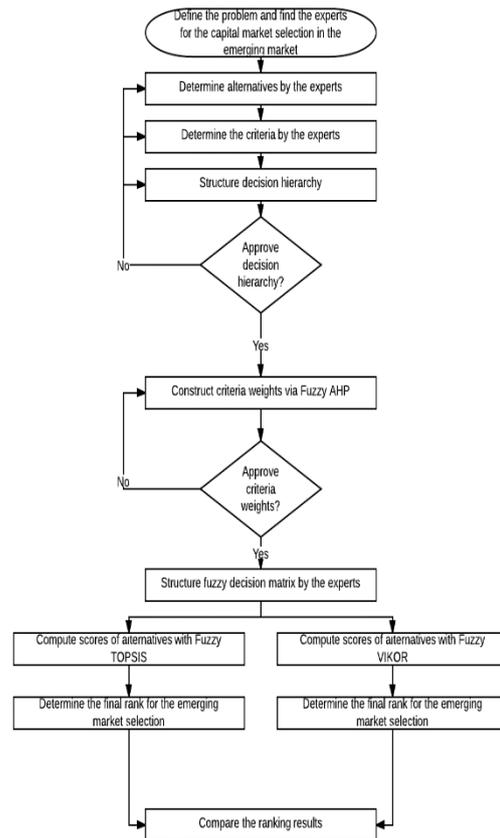


Figure 1. Capital market selection process with FAHP-Fuzzy TOPSIS and VIKOR methods

The first proposed model, the Fuzzy AHP-VIKOR method, can be built by carrying out the steps described in the following.

Firstly, the weights for the criteria are found by the Fuzzy AHP (FAHP) approach. The origins of the FAHP approach is next summarized.

Satty (1980) first introduced the Analytic Hierarchy Process (AHP) approach, which is frequently used for multi-criteria decision making. The approach classifies the judgements of decision makers according to a pre-determined scale (Saaty, 1980; Wang & Chen, 2007; Gao & Hailu, 2012; Kutlu & Ekmekcioglu, 2012; Yu *et al.*, 2011; Yazdani-Chamzini *et al.*, 2013). The AHP-based weights for the criteria in the fuzzy environment are calculated using the following pair-wise comparison decision matrix:

$$\tilde{A} = \begin{bmatrix} 1 & \tilde{a}_{12} & \tilde{a}_{13} & \dots & \tilde{a}_{1n} \\ \tilde{a}_{21} & 1 & \tilde{a}_{23} & \dots & \tilde{a}_{2n} \\ \tilde{a}_{31} & \tilde{a}_{32} & 1 & \dots & \tilde{a}_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \tilde{a}_{n3} & \dots & 1 \end{bmatrix} \begin{bmatrix} 1 & \tilde{a}_{12} & \tilde{a}_{13} & \dots & \tilde{a}_{1n} \\ 1/\tilde{a}_{12} & 1 & \tilde{a}_{23} & \dots & \tilde{a}_{2n} \\ 1/\tilde{a}_{13} & 1/\tilde{a}_{23} & 1 & \dots & \tilde{a}_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1/\tilde{a}_{1n} & 1/\tilde{a}_{2n} & 1/\tilde{a}_{3n} & \dots & 1 \end{bmatrix} \quad (7)$$

Recent studies of the analytic hierarchy process have focused on the fuzzy approach because of the uncertainty of the scale for weighting the criteria; thus the FAHP method has mostly been used to assess the relative importance of items in interval judgments for evaluating alternatives, and the method combines the fuzzy set theory and hierarchical structure. Judgment with fuzziness is often expressed by fuzzy sets and is performed by linguistic methods (Ma *et al.*, 2010; Fouladgar *et al.*, 2012b). For this reason, the scale of fuzzy numbers is utilized using the FAHP method instead of Saaty and Vargas's (1991) basic scale for a pair-wise comparison matrix. In the next step, to determine the weights of the criteria, the geometric mean technique is applied to adjust the fuzzy geometric mean for each criterion by equation (8) and (9) (Hsieh *et al.*, 2004; Sun, 2010).

$$\tilde{r}_i = (\tilde{a}_{i1} \otimes \tilde{a}_{i2} \dots \otimes \tilde{a}_{in})^{1/n} \quad (8)$$

$$\tilde{w}_i = \tilde{r}_i \otimes (\tilde{r}_1 \oplus \tilde{r}_2 \dots \oplus \tilde{r}_n)^{-1} \quad (9)$$

where \tilde{a}_{in} is the fuzzy comparison value of each criterion and \tilde{w}_i is the weight of the criteria under the fuzzy environment.

The Fuzzy VIKOR method is the first proposed approach that is integrated with FAHP for the construction of the comparative final ranking, which is detailed in the following steps.

Firstly, linguistic variables must be appointed to compute the value of the ranking in the interval scale for evaluating alternatives. That is why, in this study, the fuzzy scale used by (Chen & Wang, 2009; Chen & Huang, 1992) is considered for each of the two alternative evaluation methods.

The aggregated fuzzy ratings \tilde{x}_{ij} of alternatives and a fuzzy decision matrix are generated via linguistic evaluations obtained from the experts by equation (10) (Chen & Klein, 1997):

$$\tilde{x}_{ij} = \frac{1}{k} \left[\sum_{e=1}^n \tilde{x}_{ij}^e \right], i=1,2,3,\dots,m \quad (10)$$

After the aggregated normalization process, the fuzzy best value \tilde{f}_j^* and fuzzy worst value \tilde{f}_j^- for all criterion functions are calculated by the formula (11)

$$\tilde{f}_j^* = \max_i \tilde{x}_{ij}, \text{ and } \tilde{f}_j^- = \min_i \tilde{x}_{ij}, \quad (11)$$

Mean group utility and maximal regret are computed by equations (12) and (13)

$$\tilde{S}_i = \sum_{j=1}^n \tilde{w}_j \frac{(|\tilde{f}_j^* - \tilde{x}_{ij}|)}{(\tilde{f}_j^* - \tilde{f}_j^-)} \quad (12)$$

$$\tilde{R}_i = \max_j \left[\tilde{w}_j \frac{(|\tilde{f}_j^* - \tilde{x}_{ij}|)}{(\tilde{f}_j^* - \tilde{f}_j^-)} \right] \quad (13)$$

where \tilde{W}_j are the fuzzy weights of criteria calculated by FAHP, demonstrating the experts' choices; \tilde{S}_i is A_i with respect to all criteria calculated by the total of the distance for the fuzzy best value, and \tilde{R}_i is A_i with respect to the j -th criterion, calculated by maximum distance of the fuzzy best value.

\tilde{Q}_i is computed for the final ranking by the fuzzy VIKOR method; the value is discovered by the following formula (14):

$$\tilde{Q}_i = v(\tilde{S}_i - \tilde{S}^*) / (\tilde{S}^- - \tilde{S}^*) + (1-v)(\tilde{R}_i - \tilde{R}^*) / (\tilde{R}^- - \tilde{R}^*) \quad (14)$$

$$\text{where } \tilde{S}^* = \min_i \tilde{S}_i, \tilde{S}^- = \max_i \tilde{S}_i, \tilde{R}^* = \min_i \tilde{R}_i,$$

$$\tilde{R}^- = \max_i \tilde{R}_i \text{ and } v \text{ is presented as the weight of the}$$

strategy of maximum group utility, whereas $1 - v$ is the weight of the individual regret (Kaya & Kahraman, 2010). In this study, v is assumed to have the value of 0,5.

After the defuzzification process of the \tilde{Q}_i by the maximizing set and minimizing set method (Chen, 1985), the values of Q_i are ranked in ascending order for the alternatives. In addition, to check the final ranks, two conditions must be carried out:

Condition 1: Acceptable Advantage, described by

$$Q(A^{(2)}) - Q(A^{(1)}) \geq 1/(j-1) \quad (15)$$

where $A^{(2)}$ is the second position in the alternatives ranked by Q (minimum).

Condition 2: Acceptable stability in decision making.

The alternative $A^{(1)}$ must also be the best ranked by S or/and R . This compromise solution is stable within a decision-making process, which could be the strategy of maximum group utility (when $v > 0.5$ is needed), or ‘‘by consensus’’ $v \approx 0.5$, or ‘‘with veto’’ ($v < 0.5$).

If one of the conditions is not satisfied, a set of compromise solutions is selected. The compromise solutions are composed of (1) alternatives $A^{(1)}$ and $A^{(2)}$ if only condition C2 is not satisfied, or (2) alternatives $A^{(1)}$, $A^{(2)}$. . . , $A^{(M)}$ if condition C1 is not satisfied. $A^{(M)}$ is calculated by the relation $Q(A^{(M)}) - Q(A^{(1)}) < 1/(j-1)$ for maximum M (the positions of these alternatives are close) (Wang & Tzeng, 2012; Opricovic & Tzeng, 2007; Bazzazi *et al.*, 2011; Shemshadi *et al.*, 2011; Yucenur & Demirel, 2012; Dincer & Hacıoglu, 2013; Antucheviciene *et al.*, 2011; Balezentis *et al.*, 2012; Safaei *et al.*, 2014; Abbasianjahromi *et al.*, 2013).

Fuzzy AHP-TOPSIS, which is the second proposed model, can be explored by the following directions. The

same steps are considered for the weights of the criteria in this model. However, the linguistic variables are also identical to the values of the alternative in the first model. Afterwards, the Fuzzy TOPSIS model continues with the following phases (Hacıoglu & Dincer, 2013; Lashgari *et al.*, 2012; Antucheviciene *et al.*, 2012; Antucheviciene *et al.*, 2011; Fouladgar *et al.*, 2012a; Yazdani-Chamzini *et al.*, 2012; Ravanshadnia & Rajaie, 2013).

The ratings of the alternatives under each criterion and normalization process are constructed for the fuzzy decision matrix by formulas (16) (17) (18):

$$\tilde{X}_{ij} = \frac{1}{k} (\tilde{X}_{ij}^1 + \tilde{X}_{ij}^2 + \tilde{X}_{ij}^3 + \dots + \tilde{X}_{ij}^k) \quad (16)$$

where $i = 1, 2, 3, \dots, m$ and $j = 1, 2, 3, \dots, n$; \tilde{X}_{ij}^k is the rating of the alternatives taken from the experts.

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_{ij}^*}, \frac{b_{ij}}{c_{ij}^*}, \frac{c_{ij}}{c_{ij}^*} \right) \quad (17)$$

$$c_{ij}^* = \sqrt{\sum_{i=1}^m c_{ij}^2} \quad (18)$$

The fuzzy positive-ideal solution A^+ and the fuzzy negative ideal solution A^- can be determined by the equations (19–22).

$$A^+ = (\tilde{v}_1^*, \tilde{v}_2^*, \tilde{v}_3^*, \dots, \tilde{v}_n^*); A^- = (\tilde{v}_1^-, \tilde{v}_2^-, \tilde{v}_3^-, \dots, \tilde{v}_n^-) \quad (19)$$

where $\tilde{v}_j^* = (1, 1, 1)$ and $\tilde{v}_j^- = (0, 0, 0)$.

The distances of each alternative from the positive and negative ideal solution are calculated by the formulas (20) and (21):

$$D_i^* = \sum_{j=1}^n d(\tilde{v}_{ij}, \tilde{v}_j^*) \quad (20)$$

$$D_i^- = \sum_{j=1}^n d(\tilde{v}_{ij}, \tilde{v}_j^-) \quad (21)$$

Finally, to reach the final ranking, the similarities to the ideal solution are computed. The equation for the closeness coefficient is stated as:

$$CC_i = \frac{D_i^-}{D_i^+ + D_i^-} \quad (22)$$

Comparison of VIKOR and TOPSIS methods

The two multi-criteria decision-making methods, VIKOR and TOPSIS, are applied to solve ranking problems. Both methods have some limitations and differences in their definitions. (Opricovic & Tzeng, 2004 and 2007) clarified the differences between these two methods, which can be summarized according to their procedural basis, normalization, aggregation and solution.

Procedural basis: Both of these methods consider the existing performance matrix obtained by the evaluation of the alternatives for each criterion. Normalization, aggregation and ranking are the major pillars of the evaluations. Normalization of the procedural basis is used to determine the units of the criterion values. An aggregating function is formulated and used as a ranking index while a ranking list is proposed based on the aggregation function.

Normalization: The VIKOR and TOPSIS methods use different kinds of normalization procedure to eliminate the units of the criterion functions. The VIKOR method considers linear normalization while the TOPSIS method uses vector normalization. The normalized value of the VIKOR method does not depend on the evaluation unit of the criterion function, while the values with vector normalization in the TOPSIS method depend on the evaluation unit.

Aggregation: The main differences in both methods are in the aggregation process. The VIKOR method states an aggregating function, representing the distance from the ideal solution. This ranking index is an aggregation of all the criteria, the relative importance of the criteria, and the balance between total and individual satisfaction. The TOPSIS method considers the aggregating function as closeness to the ideal solution including the distances from the ideal point and the negative ideal point. Thus, the TOPSIS method introduces two reference points without considering their relative importance.

Solution: Both methods order the alternatives according to the ranking list. With VIKOR, the highest ranked alternative is the one closest to the ideal solution. In comparison with VIKOR, the highest ranked alternative with TOPSIS is the best one in terms of the ranking index, which does not mean that it is always the closest to the ideal solution. In addition, the VIKOR method suggests a compromise solution with an advantage rate (Tzeng *et al.*, 2005; Yalcin *et al.*, 2012).

Application to the stock markets of Emerging Economies

An empirical example of the capital market selection process

In this study, the hybrid models under the fuzzy environment were considered for stock market selection in the emerging economies. The Fuzzy AHP-VIKOR and Fuzzy AHP-TOPSIS methods were applied for a comparative performance evaluation.

From the bipolar-based risk criteria, and on the basis of a review of the literature, seven evaluation parameters relating to conflict and financial risks were listed as follows: future expectations of the stock market (C1), financial stability of the capital markets (C2), stability of Sovereign Debts (C3), strength of currency (C4), post conflict recovery (C5), socio-economic condition (C6), and political stability (C7).

Expert questionnaires were used for screening the criteria fit for the evaluation of emerging capital market performance. Seven evaluation criteria were selected by the committee of six experts, comprising four professionals from the finance sector (one economist, two portfolio managers and one investment advisor) and two academicians who had studied the field of stock markets and economics. These experts were appointed to determine the criteria and select the best alternatives.

The decision makers considered seven emerging economies for the alternative selection: Brazil (A1), Russia (A2), India (A3), China (A4), Indonesia (A5), Mexico (A6) and Turkey (A7).

The weighted criteria were conducted with the FAHP method. At this stage, the triangular fuzzy scale is used for detecting the relative importance of the criteria (Chang, 1996; Lee, 2010; Bozbura *et al.*, 2007). The fuzzy scale for the pair-wise comparison is shown in Table 3.

Table 3

The fuzzy scale of the pair-wise comparison

Definition	Triangular fuzzy scale		
Equally important (EI)	0,5	1	1,5
Weakly more important (WI)	1	1,5	2
Strongly more important (SI)	1,5	2	2,5
Very strongly more important (VI)	2	2,5	3
Absolutely more important (AI)	2,5	3	3,5

Source: Chang, 1996; Lee, 2010; Bozbura *et al.*, 2007

The AHP approach under the fuzzy environment was conducted to determine the relative importance of the criteria. The synthetic fuzzy values were calculated with the fuzzy numbers of the pair-wise comparison by all the experts, according to equation (8).

The values of \tilde{r}_i and \tilde{w}_i were consecutively computed by the formulas (8) and (9) to obtain the weight of the criteria with Fuzzy AHP in Table 4.

Table 4

Weight of criteria with Fuzzy AHP

Criteria	a_1	a_2	a_3
C1	0,1362	0,2395	0,3969
C2	0,0897	0,1655	0,2813
C3	0,0736	0,1427	0,2638
C4	0,0716	0,1261	0,2225
C5	0,0715	0,1280	0,2416
C6	0,0624	0,1091	0,2102
C7	0,0545	0,0926	0,1805

The calculation of the weighted criteria with FAHP initiates the step of ranking the alternatives with comparative methods. Linguistic scales were utilized to evaluate the alternatives with the fuzzy approach, as seen in Table 5.

Table 5

Linguistic scales for the rating of alternative

Worst (W)	0	0	2,5
Poor (P)	0	2,5	5
Fair (F)	2,5	5	7,5
Good (G)	5	7,5	10
Best (B)	7,5	10	10

Source: (Chen & Wang, 2009; Chen & Huang, 1992)

The first method for ranking the alternatives is the Fuzzy VIKOR method. Firstly, the weighted normalized decision matrix was calculated with values obtained from the decision makers. To obtain the weighted normalized fuzzy decision matrix, the rating of each alternative under each criterion was computed using the decision makers' linguistic values and then the values were converted to the triangular fuzzy numbers by equation (10).

Table 6

Fuzzy best and worst Values

	Fuzzy Best Value (\tilde{f}_j^*)			Fuzzy Worst Value (\tilde{f}_j^-)		
C1	5,00	7,50	10,00	1,67	3,33	5,83
C2	5,00	7,50	10,00	0,00	2,50	5,00
C3	4,17	6,67	9,17	0,83	3,33	5,83
C4	2,50	5,00	7,50	0,83	3,33	5,83
C5	3,33	5,83	8,33	0,83	2,50	5,00
C6	4,17	6,67	9,17	0,83	3,33	5,83
C7	4,17	6,67	9,17	0,83	3,33	5,83

The fuzzy best and worst values (Table 6) were found by formula (11) for each criterion in the triangular fuzzy numbers. The maximal values are limited to between 2,5 and 10, while the minimal values are between 0 and 5,83.

Table 7

Ranking of Alternatives with the Fuzzy VIKOR Method

Alternatives	Q_i	Ranking of alternatives
A1	0,3978	A7
A2	0,2664	A4
A3	0,4562	A2
A4	0,0971	A1
A5	0,8425	A3
A6	0,9983	A5
A7	0,0536	A6

In the next step, the final ranking of alternatives was calculated with the values of Q_i in Table 7. First, to build the Q_i , the values of \tilde{S}_i and \tilde{R}_i , which represent the mean group utility and maximal regret, were calculated by formulas (12) and (13). Then, the values of the \tilde{Q}_i were defuzzified by the maximizing set and minimizing set method (Chen, 1985). Finally, the values of Q_i were constructed by equation (14) and the values of Q_i were ranked in ascending order for the alternatives, as seen in Table 7. However, it was observed that the results complied with the confirmatory conditions for the VIKOR method. According to the results, Turkey has the best rank for stock market selection with bipolar risk parameters via the FAHP-VIKOR technique.

The Fuzzy TOPSIS Method is another hybrid alternative ordering approach that has been used for comparative analysis. The calculation of the method is explained next.

Although using the same process for building up the fuzzy decision matrix with obtained linguistic variables from each decision maker, the normalization process of fuzzy decision matrix using the Fuzzy TOPSIS method is differentiated by equations (16), (17) and (18).

Table 8

D_i^* and D_i^- values

	D_i^*	D_i^-
A1	6,6860	0,4053
A2	6,6638	0,4302
A3	6,6943	0,3973
A4	6,6396	0,4570
A5	6,7363	0,3521
A6	6,7383	0,3487
A7	6,6019	0,4991

The distances of each alternative from the positive and negative ideal solution were calculated to reach the final ranking of alternatives by formulas (20) and (21), as shown in Table 8.

Table 9

Ranking of alternatives with the Fuzzy TOPSIS method

Alternatives	CC_i	Ranking of alternatives
A1	0,0572	A7
A2	0,0606	A4
A3	0,0560	A2
A4	0,0644	A1
A5	0,0497	A3
A6	0,0492	A5
A7	0,0703	A6

Finally, to obtain the final ranking results, the similarities with the ideal solution were computed and the equation for the closeness coefficient can be stated by formula (22). Performance results for the closeness coefficient can be found in Table 9.

Results and discussion

This study has been conducted for the performance evaluation of the seven capital markets in terms of bipolar risks in the emerging economies using the hybrid multi-criteria decision-making methods of AHP-VIKOR and AHP-TOPSIS under the fuzzy environment. Based on the results of the comparative analysis, some fundamental findings are discussed next.

As Table 4 shows, the relative importance of the criteria with the fuzzy set theory were determined by the AHP method. The linguistic scales adapted from (Chang, 1996; Lee, 2010; Bozbura *et al.*, 2007) were used for the rating of alternatives (Table 3). Expert choices mainly focused on the relative importance of the future expectations of the stock market and the financial stability in capital markets in the pair-wise comparison of the performance evaluation of bipolar risks in emerging capital markets. Because of the expectations and stability of the markets have the best priorities for ranking the capital markets in emerging economies.

The values of the closeness coefficient are listed in decreasing order in Table 10 and a final ranking result for the capital markets in the emerging economies proves that the Turkish stock market is the first in the ranking in both methods.

Table 10

Comparative ranking results with the Fuzzy VIKOR and TOPSIS methods

The Fuzzy VIKOR Method			The Fuzzy TOPSIS Method		
Ranking	Alternative	Q_i	Ranking	Alternative	CC_i
1	A7	0,3978	1	A7	0,0572
2	A4	0,2664	2	A4	0,0606
3	A2	0,4562	3	A2	0,0560
4	A1	0,0971	4	A1	0,0644
5	A3	0,8425	5	A3	0,0497
6	A5	0,9983	6	A5	0,0492
7	A6	0,0536	7	A6	0,0703

The results obtained for the Fuzzy AHP and VIKOR approach are compared with Fuzzy AHP and TOPSIS. The results demonstrate that the ranking of emerging capital

markets for both methods is in the same order. The ranking order for the Fuzzy AHP and VIKOR method is positioned in ascending order by the Q_i values (A7: 0,0536 < A4: 0,0971 < A2: 0,2664 < A1: 0,3978 < A3: 0,4562 < A5:0,8425 < A6: 0,9983). The ranking order of Fuzzy AHP and TOPSIS is based on closeness coefficient (CC_i) (A7: 0,0703 > A4: 0,0644 > A2: 0,0606 > A1: 0,0572 > A3: 0,0560 > A5: 0,0497 > A6: 0,0492).

In the VIKOR method, the aggregate functions are always closest to ideal values, whereas in the TOPSIS method, the closeness coefficients of the emerging markets are not always closest to the ideal solution. For instance, Turkey (A7) has the highest ranking in the Q_i values of the VIKOR method with aggregate function of 0,9464 (1–0,0536), which is the closest to ideal value 1. However, Turkey (A7) is also at the first rank in the TOPSIS method, with the closeness coefficient value of 0,0703, which is not as close to the ideal value 1 as with the VIKOR aggregate function.

The comparative ranking results obtained in this study demonstrate that the final order for the stock market selection in emerging economies is the same both the FAHP-VIKOR and FAHP-TOPSIS methods. The comparative results are consecutively in order: Turkey, China, Russia, Brazil, India, Indonesia and Mexico. Finally, the empirical results give the highest priority in the stock market selection to the Turkish capital markets, with fair financial and conflict risks and the potential for growth in the Turkish economy after the global financial crisis.

Conclusions

The global financial crisis has revealed the multi-faceted nature of risk awareness for individual and institutional investors. Investment analysis and market selection based on only financial risk competencies could steer the expectations of the traders in the wrong way. Not only financial risk but also conflict risk-based parameters should be considered in making effective investment decisions, taking account of the possibility of global political turmoil. Moreover, evaluating the investment grade of risky economies is more accurate if it includes conflict risk, thus covering many non-financial risks.

The majority of traders in the financial markets have begun to consider the emerging markets with the potential relative higher returns than the developed financial markets. Investors in the competitive capital markets are willing to take risks for the higher returns by making their investments in the emerging economies with a high potential yield.

The paper reports on the findings of a comparative empirical study into the comprehensive risks covering financial and conflict issues, and investigates the performance results of the stock markets in the emerging economies with the Fuzzy AHP-TOPSIS and VIKOR methods. In the study, the fuzzy approach of bipolar risks was applied to stock market selection and the relative performance results of the capital markets were assessed by experts and academicians for each of the seven main bipolar risk competencies.

The empirical results show that the weighted results of the criteria range from 5,4 to 39,7 % in triangular fuzzy

numbers. The FAHP gives more sensitive results than the classic AHP method for evaluating the alternatives under a fuzzy environment. However, although the two methods have different steps for ordering the alternatives, they have the same performance results in ranking the emerging economies. The overall performance of the methods demonstrates that both methods produce coherent results in their rankings of the E7 economies under the fuzzy environment.

For further research, this evaluation method could be combined with other ranking methods and other countries. In addition, the criteria considered in the study could be widened to include other non-financial parameters in the relative evaluation, such as demographic characteristics. In addition, decision makers selected from different sectors as well as experts from other emerging economies could be appointed to assist in determining the criteria and the ranking of the capital markets in emerging economies.

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