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alphanumeric journal

The Journal of Operations Research, Statistics, Econometrics and Management Information Systems

Volume 5, Issue 1, 2017

Received: September 21, 2016
Accepted: March 23, 2017
Published Online: June 30, 2017

AJ ID: 2017.05.01.OR.02
DOI: 10.17093/alphanumeric.323832

Analyzing Financial Performance of Insurance Companies Traded In BIST via Fuzzy Shannon's Entropy Based Fuzzy TOPSIS Methodology

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ABSTRACT

Analyzing firms' performance appropriately is essential issue for decision makers working in financial sector under the conditions of imprecise and incomplete information. Additionally, it can be useful tool for firms in terms of competitive power and sector development. In this study financial performance of six insurance companies traded in BIST is analyzed by using six financial indicators within the period of 2011-2015. For this purpose, firstly weights of criteria related to financial ratios are obtained by using fuzzy Shannon's entropy based on α-level set. Following to this firms' final rankings are determined by means of fuzzy TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method.

Keywords: Performance Analysis, Insurance Companies, Multi Criteria Decision Making, Fuzzy Shannon's Entropy, Fuzzy TOPSIS

BİST'te Faaliyet Gösteren Sigorta Şirketlerinin Finansal Performanslarının Bulanık Shannon Entropi Tabanlı Bulanık TOPSIS Yöntemiyle İncelenmesi

ÖZET

Finansal sektörde belirsizlik ve eksik bilgi altında karar verme durumunda olanlar için firmaların performansının analiz edilmesi önem arz eden bir konu olmaktadır. Buna ilaveten gerçekleştirilecek analiz ile firmalar sektörel gelişim ve rekabet gücü kapsamında ilerleme kaydedebileceklerdir. Bu çalışmada BIST'te faaliyet gösteren altı sigorta şirketinin finansal performansı 2011-2015 yılları aralığındaki altı finansal orandan yararlanılarak incelenmiştir. Bu amaçla ilk olarak finansal oranlarla ilişkili kriterlerin ağırlıkları alfa kesime dayalı bulanık Shannon entropisi yöntemi kullanılarak elde edilmiştir. Sonrasında firmalara yönelik gerçekleştirilecek sıralamada bulanık TOPSIS yöntemi temel alınmıştır.

Anahtar Kelimeler: Performans Analizi, Sigorta Şirketleri, Çok Kriterli Karar Verme, Bulanik Shannon Entropisi, Bulanık TOPSIS

1. Introduction

Efforts made with the aim of protecting individuals from risks and hazards daily faced, providing assurance and preventing being damaged underlie the idea of insurance. Insurance is an agreement giving customers financial protection against loss or harm in return for payment of a premium paid by policymaker to insurer. This agreement gives assurance to individuals within the context of havings. Insurance companies as an enterprise need to be sustainable in terms of profitability, image and stability.

Insurance companies as a part of Turkish financial system with increasing importance have an impact on economic growth via insurance transactions and functions namely resource allocation, managing various financial risks and resource savings. In addition to that insurance companies provide resource allocation and economic growth by accumulated funds in large amounts (Ćurak, Lončar & Poposki, 2009: 30-33).

It is important to determine performance criteria and measure financial performances of insurance companies with regard to increasing ratio of insurance in financial sector and intense competition. A number of criteria should be take into the account in measuring financial performances of insurance companies. In this study ratios namely currency ratio, net profit margin, cash ratio, debt ratio, return on investment and return on equity are used for financial performance analysis. Purpose of study is to determine importance levels (or weights) of ratios used for measuring insurance companies traded in BIST within the period of 2011-2015 and rank these companies by using weights in the context of fuzzy TOPSIS methodology. The rest of the paper is organized as follows: In Section 2 a literature review about financial performance analysis of insurance companies is shortly given. In the third section methodology for this study namely entropy and fuzzy TOPSIS is presented. In Section 4 results of proposed methodology are given. Finally in the last section concluding remarks and future recommendations are given.

1. Literature Review

In this section, a literature review of the publications concerning performance measurements of the insurance companies operating in Turkey were made, and it was seen that data envelopment analysis was mainly used method in that studies.

Asunakutlu (1993) evaluated the performance of the insurance agencies via regression analysis. Net premiums were defined as the financial performance measure, and total costs were revealed the most effective variable on producing net premiums. According to the results of study agencies should take notice of their risk policy.

Çiftçi (2004) investigated the effectiveness of life and non-life insurance companies via data envelopment analysis (DEA). The most important problem of insurance sector was stated as the lack of demand. Furthermore, other issues of the sector were indicated as high cost, disruption of the asset/liability balance, complex and unstable insurance system, financial crisis, administrative organization and management problems, governments' protection policy. As a result of DEA, it was found that 11 of 41 non-life insurance companies and 3 of 12 life insurance companies were efficient.

Turanlı & Köse (2005) evaluated the insurance companies in terms of liquidity, capacity, and profitability via linear goal programming. Six assets and liabilities, and three income statement items were described as decision variables. Target values of liquidity, capacity, and profitability in 2003 were determined by applying the inflation increase rate on data of 2002. Model was solved by simplex algorithm, and from 36 non-life insurance companies; 17 companies were found as failed. Additionally from successful ones 12 companies succeeded one goal, 2 companies succeeded two goals, 4 companies succeeded all of goals.

Başkaya & Akar (2005) evaluated the twelve insurance companies consisting 80 percent of insurance sector via DEA. While the number of policy and amount of premium were defined as output variables, the number of agency, branch banks, and staff were handled as input ones. According to the analysis results six companies were found as effective.

Ege & Bayrakdaroğlu (2009) divided the insurances companies into two groups namely national and foreign-capitalized, and compared the performances of two groups based on the data of 2006. Financial factors were used as criteria and as a result foreign-capitalized insurance companies were found as better than the national ones in terms of effectiveness of assets, asset quality and liquidity, capital adequacy and profitability.

Köse (2010) investigated the efficiency of life insurance and pension companies via DEA for the period of 2004-2008. While the number of staff, total costs, and total equity were determined as input variables, total income and premium production were handled as output ones. As a result, three companies were found as efficient and stable for analyzed period.

Peker & Baki (2011) found the best three insurance companies from the viewpoint of premium production in 2008 and compared the performance of them in terms of liquidity, leverage and profitability ratios via grey relational analysis (GRA). As a result, liquidity ratio standings and overall standings were obtained as the same.

Akyüz & Kaya (2013) evaluated the performance of life/pension and non-life insurance companies within the period of 2007-2011 via TOPSIS methodology. Ten financial ratios were used as criteria. According to the results of analysis while the most successful year for non-life insurance sector was determined as 2007, it is valid for life/pension sector as 2008. Conversely the most unsuccessful year for non-life insurance sector was found 2008 and it is valid for life/pension sector as 2009.

Kaya & Kaya (2015) examined the factors affecting financial performance by using the datas of 17 life insurance companies in the period of 2008-2013 via panel data analysis. Return on assets was used as financial performance criterion. Consequently, company size, currency ratio, activity period of companies, gross premium, and insurance leverage ratio were found as significantly effective on financial performance.

Kula, Kandemir & Baykut (2016) investigated the financial performance of one pension and seven insurance companies traded in BIST via GRA. Currency ratio, net profit margin, earnings per share, equity ratio, equity profitability, return on assets, market value, size of assets, short-term debt ratio and debt ratio were handled as criteria. As a result, it was emphasized the importance of equity, efficient liquidity management, and profitability level.

2. Fuzzy Set Theory

Fuzzy set theory which is firstly proposed by Zadeh (1965) aims to overcome vagueness and ambiguity condition of human cognitive processes, describes the degree to which an element belongs to some sets (Jie, Meng & Cheong, 2006: 1). A fuzzy set which is extension of crisp one allow partial belonging of element by membership functions ranging from 0 (non-membership) to 1 (complete membership) and describe actual objects similar to human language (Huang & Ho, 2013, p. 983; Ertuğrul & Karakaşoğlu, 2009, p.704). Main advantage of fuzzy set theory is capability of representing ambiguous data and allowing mathematical operators to apply in fuzzy domain (Mahmoodzadeh, Shahrabi, Priazar & Zaeri, 2007, p.272).

A fuzzy set composed of items where there are not including any boundaries between items that belong to it or not. A fuzzy set $\left(\tilde{A}\right)$ can be defined as follows:

$$\tilde{A} = \{x, \mu_{\tilde{A}}(x)\}, \quad \forall x \in U \tag{1}$$

According to Equation (1) $\mu_{\tilde{A}}(x)$ is membership function matching a real number in $[0,1]$ interval to each point of X and U is called the universe of discourse (Cavallaro, Zavadskas & Raslanas, 2016, pp.3-4) .

Triangular and trapezoidal fuzzy numbers are one of the mostly used in practice (Baykal & Beyan, 2004). Triangular fuzzy numbers are used in this study due to computational easiness and representation usefulness. A triangular fuzzy number $\left(\tilde{A}\right)$ is represented as $\tilde{A} = (a_1, a_2, a_3)$ and membership function $(\mu_{\tilde{A}}(x))$ of triangular fuzzy number is shown as:

$$\mu_{\tilde{A}}(x) = \begin{cases} \frac{x-a_1}{a_2-a_1} & a_1 \le x \le a_2 \\ \frac{a_3-x}{a_3-a_2} & a_2 \le x \le a_3 \\ 0 & otherwise \end{cases} \tag{2}$$

In addition the degree of membership of a fuzzy number for left and right side representation is shown as follows and Figure 1 provides visual representation of this (Choudhary & Shankar, 2012, p.513):

$$\tilde{A} = \left(A^{L(y)}, A^{R(y)}\right)$$

$$\tilde{A} = (a_1 + (a_2 - a_1)y, a_3 + (a_2 - a_3)y), \qquad y \in [0,1] \tag{3}$$

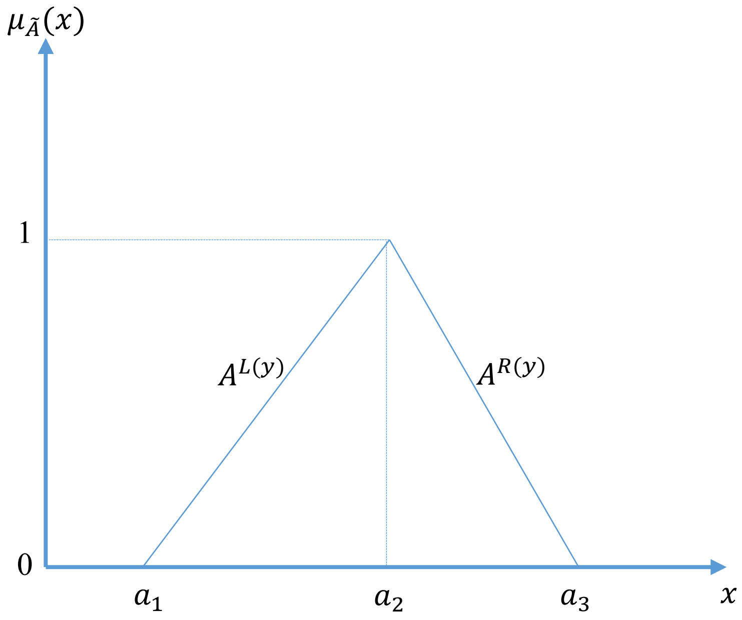

Figure 1. Membership function of triangular fuzzy number $\tilde{A}$

One of the essential points that should be take into the consideration is α-level sets. An α-level set of fuzzy set $\tilde{A}_\alpha$ shown as Equation (4) which includes all items of the universal set X having degree of membership of $\tilde{A}$ greater than or equal to the value specified by α (Cavallaro, Zavadskas & Raslanas, 2016, p.4).

$$\tilde{A}_\alpha = \{x \in X | \mu_{\tilde{A}}(x) \geq \alpha\} \qquad \alpha \epsilon [0,1] \tag{4}$$

3. Shannon's Entropy

Decision making is an activity depends on subjective or objective judgments. According to the subjective weighting methods decision makers take their experiences and opinions into the account in criteria weighting process. Apart from decision makers' preferences and judgments, mathematical models and algorithms are used to weight criteria in objective weighting methods.

Entropy method depends on objective judgments emphasizes the importance of both subjective judgments and criteria specifications on the importncelevels (or weights) of criteria.

Entropy is a measure of uncertainty in information which is also considered in probability theory. It is firstly applied in physics, mathematics and information sciences. After that Shannon developed the concept of information entropy weight (IEW). According to the information theory entropy is a measure of uncertainty associated with a random variable (Zhang et al., 2011, p. 444). Decision matrices used in entropy based method are consisted of information related to importance levels of criteria (Çınar, 2004, p.103). Accordingly, decision makers need to understand the uncertainty of conditions. So the concept of entropy is a mathematical expression based on expected value of an evant probability (Çiçek, 2013, p.1-6).

The entropy concept ,which was firstly proposed by Shannon in 1948, was developed by Wang and Lee as weighting method in 2009. Steps of Shannon's entropy method can be summarized as follows (Cavallaro, Zavadskas & Raslanas, 2016, p.7; Hosseinzadeh & Fallahnejad, 2010, p.55):

1- Arranging decision matrix: While the rows of decision matrix are consisted of alternatives, columns are comprised of evaluation criteria. Thus, decision matrix D can be shown as below:

$$D = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix}_{mxn} \quad (5)$$

According to the Equation (5) decision matrix D is consisted of m alternatives and n evaluation criteria.

2-Normalization of decision matrix: Criteria of decision matrix should be normalized due to unit differentiation. With this purpose criteria are normalized according to following equation:

$$p_{ij} = \frac{a_{ij}}{\sum_{j=1}^{m} a_{ij}} \quad \text{j=1,2,…,m} \quad \text{i=1,2,…,n} \quad (6)$$

3-Calculating the entropy values: *Entropy values* e_j are computed according to Equation (7) where k is the entropy constant equal to $(lnm)^{-1}$, assuring $0 \leq e_j \leq 1$ and $p_{ij} lnp_{ij} = 0 \; if \; p_{ij} = 0$. If e_j values increases transmitted information by jth criterion decreases.

$$e_j = -k \sum_{j=1}^{m} p_{ij} lnp_{ij} \quad (7)$$

4-Calculating the degree of diversification: The degree of divergence of the information of each criterion are computed as:

$$d_j = 1 - e_j \quad (8)$$

5-Calculating the degree of importance of criterion i: Objective weight of criterion i are computed as:

$$w_j = \frac{d_j}{\sum_{s=1}^{n} d_s} \quad \text{j=1,2,…,m} \quad (9)$$

According to Equation (9) entropy weights show the importance level of useful information. So criteria having bigger entropy weights are considered as more important.

4. Fuzzy Shannon's Entropy Based On Alpha-Level Sets

Hosseinzadeh Lotfi & Fallahnejad (2010) proposed new approach extending original Shannon' entropy by considering interval data cases such as α-level sets. Steps of fuzzy Shannon's entropy based on α-level sets can be summarized as follows (Cavallaro, Zavadskas & Raslanas, 2016, pp.7-8; Hosseinzadeh & Fallahnejad, 2010, p.59):

1-Converting fuzzy data into interval data by using α-level sets: Fuzzy data $\tilde{x}_{ij}$ comprising the decision matrix which is shown as Equation (10) are transformed into interval data according to different α-level sets.

$$\widetilde{D}=\begin{bmatrix}\tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n}\\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n}\\ \vdots & \vdots & \ddots & \vdots\\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn}\end{bmatrix}_{mxn} \quad (10)$$

The α-level set of fuzzy variable $\tilde{x}_{ij}$ can be expressed in following interval form:

$$\left[(\tilde{x}_{ij})_{\alpha}^{L},(\tilde{x}_{ij})_{\alpha}^{R}\right]=\left[\min_{x_{ij}}\left\{x_{ij}\in R\left|\mu_{\tilde{x}_{ij}}(x_{ij})\geq\alpha\right.\right\},\max_{x_{ij}}\left\{x_{ij}\in R\left|\mu_{\tilde{x}_{ij}}(x_{ij})\geq\alpha\right.\right\}\right],\quad 0<\alpha\leq 1 \quad (11)$$

Fuzzy data are transformed into different α-level sets by setting different levels of confidence, namely $1-\alpha$. Then the matrix composed of interval data are obtained as follows:

$$B=\begin{bmatrix}[x_{11}^{L},x_{11}^{R}] & [x_{12}^{L},x_{12}^{R}] & \cdots & [x_{1n}^{L},x_{1n}^{R}]\\ [x_{21}^{L},x_{21}^{R}] & [x_{22}^{L},x_{22}^{R}] & \cdots & [x_{2n}^{L},x_{2n}^{R}]\\ \vdots & \vdots & \vdots & \vdots\\ [x_{m1}^{L},x_{m1}^{R}] & [x_{m2}^{L},x_{m2}^{R}] & \cdots & [x_{mn}^{L},x_{mn}^{R}]\end{bmatrix}_{mxn} \quad (12)$$

2-Normalized values are obtained: The normalized values p_{ij}^{L} and p_{ij}^{R} are calculated as follows:

$$p_{ij}^{L}=\frac{x_{ij}^{L}}{\sum_{j=1}^{m}x_{ij}^{R}} \quad j=1,2,\dots,m\,,\ i=1,2,\dots,n \quad (13)$$

$$p_{ij}^{R}=\frac{x_{ij}^{L}}{\sum_{j=1}^{m}x_{ij}^{R}} \quad j=1,2,\dots,m\,,\ i=1,2,\dots,n \quad (14)$$

3-Lower and upper bound of interval entropy are computed: The lower bound e_{i}^{L} and upper bound e_{i}^{R} of interval entropy are calculated as follows:

$$e_{i}^{L}=min\left\{-e_{0}\sum_{j=1}^{m}p_{ij}^{L}lnp_{ij}^{L},-e_{0}\sum_{j=1}^{m}p_{ij}^{R}lnp_{ij}^{R}\right\},\ i=1,2,\dots,n \quad (15)$$

$$e_{i}^{R}=min\left\{-e_{0}\sum_{j=1}^{m}p_{ij}^{L}lnp_{ij}^{L},-e_{0}\sum_{j=1}^{m}p_{ij}^{R}lnp_{ij}^{R}\right\},\ i=1,2,\dots,n \quad (16)$$

where e_0 is equal to $(lnm)^{-1}$and $p_{ij}^{L}.lnp_{ij}^{L}$ or $p_{ij}^{R}.lnp_{ij}^{R}$ is equal to 0 if $p_{ij}^{L}=0$ or $p_{ij}^{R}=0$.

4-Lower and upper bound of interval diversification are calculated: The lower bound d_{i}^{L} and upper bound d_{i}^{R} of interval diversification are computed as follows:

$$d_{i}^{L}=1-e_{i}^{R} \quad i=1,2,\dots,n \quad (17)$$

$$d_{i}^{R}=1-e_{i}^{L} \quad i=1,2,\dots,n \quad (18)$$

5-Lower and upper bound of interval weight of a criterion are computed: The lower bound w_{i}^{L} and upper bound w_{i}^{R} of interval weight of criterion i are calculated as follows:

$$w_{i}^{L}=\frac{d_{i}^{L}}{\sum_{s=1}^{n}d_{s}^{L}} \quad i=1,2,\dots,n \quad (19)$$

$$w_{i}^{R}=\frac{d_{i}^{R}}{\sum_{s=1}^{n}d_{s}^{R}} \quad i=1,2,\dots,n \quad (20)$$

5. Fuzzy TOPSIS

TOPSIS method developed by Hwang & Yoon (1981) aims to choose alternative having the shortest euclidean distance from positive ideal solution (PIS) which maximizes benefit and minimizes cost, and the farthest distance from negative ideal solution

(NIS) which maximizes cost and minimizes benefit (Behzadian, Otaghsara, Yazdani & Ignatius, 2012).

But TOPSIS method is unable to evaluate criteria and alternatives in terms of shortest and farthest distances in real world applications due to incomplete and inaccurate information. Fuzzy TOPSIS method is developed and applied by many researchers in many fields to overcome this issue. This method applies easily undertandable transparent algorithm that handles both qualitative and quantitative data (Cavallaro, Zavadskas & Raslanas, 2016, p.8).

There are number of fuzzy TOPSIS applications in literature. Chen & Hwang (1992) applied TOPSIS method to fuzzy environment. Then Liang (1999) developed a method based on ideal and anti-ideal points for multi criteria decision making problems and integrated fuzzy set theory and hierarchical structure concept for determining criteria weights and evaluating alternatives with respect to each criterion by means of decision matrices (Erginel, Çakmak & Şentürk, 2010, p.82).

Chen (2000) used triangular fuzzy numbers as linguistic variables in evaluating each criteria and alternatives, and developed TOPSIS method by using vertex approach. Zhang & Lu (2003) applied integrated group decision making method to overcome fuzziness problem in prioritization stage. Wang & Elhag (2006) compared fuzzy TOPSIS method with fuzzy weighted average by applying alpha cut based fuzzy TOPSIS in solving nonlinear programming problems. Wang & Lee (2009) proposed a new fuzzy TOPSIS model with considering subjective and objective judgments in weighting stage. Sun & Lin (2009) applied fuzzy TOPSIS method to evaluate competitive advantage of shopping websites.

Steps of fuzzy TOPSIS can be summarized as follows (Wang & Chang, 2007; Jahanshahloo, Hosseinzadeh & Izadikhah, 2006):

1- Constructing fuzzy decision matrix: A fuzzy decision matrix $\widetilde{D}$ composed of m alternatives $(A_1, A_2, \ldots, A_m)$, n evaluation criteria $(C_1, C_2, \ldots, C_n)$ and fuzzy values $\tilde{x}_{ij}$ denote the rating of alternative A_i with respect to criterion C_j is constructed before normalization process and shown as follows:

$$\widetilde{D} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{bmatrix}_{mxn} \quad i = 1,2,\ldots,m \quad j = 1,2,\ldots,n \tag{21}$$

2-Normalization of fuzzy decision matrix: The normalized fuzzy decision matrix $\tilde{R}$ is obtained by using linear scale transformation and shown as follows:

$$\tilde{R} = \begin{bmatrix} \tilde{r}_{11} & \tilde{r}_{12} & \cdots & \tilde{r}_{1n} \\ \tilde{r}_{21} & \tilde{r}_{22} & \cdots & \tilde{r}_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \tilde{r}_{m1} & \tilde{r}_{m2} & \cdots & \tilde{r}_{mn} \end{bmatrix}_{mxn} \quad i = 1,2,\ldots,m \quad j = 1,2,\ldots,n \tag{22}$$

While the elements of normalized fuzzy decision matrix $\tilde{r}_{ij}$ are obtained by using Equation (23) for benefit criteria (B) , they are found by using Equation (24) for cost ones (C).

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right), \quad c_j^* = \max_i c_{ij} \quad j \in B \tag{23}$$

$$\tilde{r}_{ij} = \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right), \quad a_j^- = \min_i a_{ij} \quad j \in C \tag{24}$$

3-Obtaining weighted normalized fuzzy decision matrix: The weighted normalized decision matrix $(\tilde{V})$ is obtained and shown as follows:

$$\tilde{V} = \begin{bmatrix} \tilde{v}_{11} & \tilde{v}_{12} & \cdots & \tilde{v}_{1n} \\ \tilde{v}_{21} & \tilde{v}_{22} & \cdots & \tilde{v}_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \tilde{v}_{m1} & \tilde{v}_{m2} & \cdots & \tilde{v}_{mn} \end{bmatrix}_{mxn} \quad i = 1,2, \dots, m \quad j = 1,2, \dots, n \tag{25}$$

The elements of weighted normalized fuzzy decision matrix $\tilde{v}_{ij}$ are computed by using Equation (26).

$$\tilde{v}_{ij} = \tilde{r}_{ij} \otimes \tilde{w}_j \tag{26}$$

where w_j denotes the weight of criterion C_j.

4-Determining the fuzzy pozitive ideal solution $(FPIS, A^*)$ and fuzzy negative ideal solution $(FNIS, A^-)$: The fuzzy pozitive ideal solution$(FPIS, A^*)$ and fuzzy negative ideal solution $(FNIS, A^-)$ are defined as follows:

$$A^* = (\tilde{v}_1^*, \tilde{v}_2^*, \dots, \tilde{v}_n^*) = \left\{\left(\max_i \tilde{v}_{ij} | j \in J\right), \left(\min_i \tilde{v}_{ij} | j \in J'\right)\right\} \tag{27}$$

$$A^- = (\tilde{v}_1^-, \tilde{v}_2^-, \dots, \tilde{v}_n^-) = \left\{\left(\min_i \tilde{v}_{ij} | j \in J\right), \left(\max_i \tilde{v}_{ij} | j \in J'\right)\right\} \tag{28}$$

$$\tilde{v}_j^* = (1,1,1), \tilde{v}_j^- = (0,0,0), \ j = 1,2, \dots, n \tag{29}$$

5-Calculating the distance of each alternative from A^* and A^-: The distances of each alternative from from A^* and A^- are computed as follows:

$$d_i^* = \sum_{j=1}^{n} d\left(\tilde{v}_{ij}, \tilde{v}_j^*\right), \ \ i = 1,2, \dots, m \tag{30}$$

$$d_i^- = \sum_{j=1}^{n} d\left(\tilde{v}_{ij}, \tilde{v}_j^-\right), \ \ i = 1,2, \dots, m \tag{31}$$

6-Computing closeness coefficient (CC_i) of each alternative and ranking them according to CC_i in descending order: The closeness coefficient (CC_i) of each alternative is calculated as follows:

$$CC_i = \frac{d_i^-}{d_i^* + d_i^-}, \quad i = 1,2, \dots, m \tag{32}$$

Alternatives are ranked in descending order by taking the values of CC_i into the account. As the value of CC_i close to 1 alternative A_i having this value approaches to FPIS. Also while the value of CC_i close to 0 alternative A_i having this value approaches to FNIS.

6. Analysis

Purpose of this study is to assess the performance of 6 insurance companies listed in BIST by the help of financial ratios. Therefore firstly financial ratios of each insurance companies listed in BIST are calculated. Six financial ratios namely currency, cash, debt, net profit margin, return on equity and return on investment are considered as criteria and shown in Table 1. Financial ratios are chosen according to financial sector applications and finance literature. 6 insurance companies quoted in BIST are taken into the consideration as alternatives. Criteria related values of six insurance companies traded in BIST within the period of 2011-2015 are acquired from Public Disclosure Platform and companies' websites.

Ratios	Explanation
Currency Ratio	Current Assets/Short Term Debts
Cash Ratio	(Liquid Assets + Securities)/ Short Term Debts
Debt Ratio	Total Debt/Total Assets
Net profit margin	Net Profit/Net Sales
Return on equity	Net Profit/Owner's Equity
Return on investment	(Earnings-Initial Investment)/Initial Investment

Table 1. Financial ratios

Then weights of criteria are computed by using fuzzy Shannon's entropy objective weighting method via EXCEL 2013 software. Criteria related data are crisp format and need to be transformed as triangular fuzzy numbers. So by adopting Equation (33) proposed by Wang (2014) decision matrix consisted of triangular fuzzy numbers are obtained and shown in Table 2.

Let $x_{ij}(e)$ denote the value of related criteria j for alternative i on peried e and P_{ij} be the performance rating of alternative i on criterion j, where $i = 1,2, \dots, m; j = 1,2, \dots, n; e = 1,2, \dots, t$.

$P_{ij} = \left(p_{1ij}, p_{2ij}, p_{3ij}\right)$ where,

$$p_{1ij} = \min_{1 \le e \le t}\{x_{ij}(e)\}, \;\; p_{2ij} = \frac{1}{t}\sum_{e=1}^{t} x_{ij}(e), \;\; p_{3ij} = \max_{1 \le e \le t}\{x_{ij}(e)\} \qquad (33)$$

After that $[P_{i1}, P_{i2}, \dots, P_{in}]$ denotes the performance matrix of alternative A_i $(i = 1,2, \dots, m)$ on all criteria.

	Currency Ratio	Cash Ratio	Debt Ratio	Net Profit Margin	Return on Equity	Return on investment
Ak	(0.37,0.76,0.95)	(0.84,1.78,3.58)	(0.66,0.7,0.81)	(0.03,0.04,0.05)	(0.06,0.17,0.33)	(0.03,0.05,0.1)
Anadolu Anonim	(1.22,1.27,1.39)	(0.05,0.67,0.86)	(0.03,0.03,0.04)	(0.002,0.02,0.03)	(0.06,0.07,0.08)	(0.002,0.18,0.85)
Anadolu Hayat	(1.06,1.07,1.08)	(0.05,0.74,2.41)	(0.09,0.75,0.94)	(0.09,0.49,1)	(0.02,0.55,1.57)	(0.001,0.001,0.002)
Güneş	(0.09,0.6,1.02)	(0.31,0.35,0.38)	(0.71,0.76,0.79)	(0.008,0.02,0.04)	(0.005,0.07,0.21)	(0.001,0.02,0.04)
Halk	(0.14,0.76,1.27)	(0.88,0.98,1.15)	(0.68,0.74,0.82)	(0.01,0.05,0.1)	(0.08,0.21,0.32)	(0.02,0.08,0.17)
Ray	(1.21,1.31,1.46)	(0.65,0.66,0.68)	(0.71,0.73,0.75)	(0.001,0.01,0.03)	(0.004,0.03,0.09)	(0.001,0.01,0.02)

Table 2. Fuzzy evaluation matrix

After forming fuzzy evaluation matrix, fuzzy data are transformed into interval data by considering α=0.5 (neutral) level set and interval decision matrix is acquired. Normalization process is applied interval data and obtained normalized interval decision matrix is shown as Table 3.

	Currency Ratio	Cash Ratio	Debt Ratio	Net Profit Margin	Return on Equity	Return on investment
Ak	[0.087,0.132]	[0.183,0.375]	[0.172,0.191]	[0.036,0.047]	[0.062,0.134]	[0.056,0.102]
Anadolu Anonim	[0.192,0.205]	[0.05,0.107]	[0.007,0.009]	[0.012,0.027]	[0.035,0.04]	[0.119,0.666]
Anadolu Hayat	[0.164,0.165]	[0.055,0.221]	[0.107,0.215]	[0.308,0.786]	[0.155,0.571]	[0.001,0.002]
Güneş	[0.053,0.125]	[0.046,0.051]	[0.186,0.196]	[0.015,0.032]	[0.02,0.075]	[0.016,0.045]
Halk	[0.069,0.156]	[0.13,0.149]	[0.181,0.198]	[0.034,0.081]	[0.078,0.142]	[0.067,0.164]
Ray	[0.194,0.213]	[0.092,0.094]	[0.182,0.188]	[0.009,0.024]	[0.01,0.034]	[0.007,0.019]

Table 3. Normalized interval decision matrix (α=0.5)

The lower and upper bound of interval entropy $\left(e_i^L\, and\ e_i^R\right)$ and interval diversification $\left(d_i^L\, and\ d_i^R\right)$ values are computed and shown in Table 4.

Ratios	$[e_i^L, e_i^R]$	$[d_i^L, d_i^R]$
Currency Ratio	[0.830, 0.988]	[0.011, 0.169]
Cash Ratio	[0.698, 0.893]	[0.106, 0.301]
Debt Ratio	[0.845, 0.918]	[0.081, 0.154]
Net Profit Margin	[0.427, 0.468]	[0.531, 0.572]
Return on Equity	[0.507, 0.730]	[0.269, 0.492]
Return on Investment	[0.397,0.574]	[0.425, 0.602]

Table 4. The values of $e_i^L,\ e_i^R, d_i^L and\ d_i^R$

Finally weights of financial ratios are found and given in Table 5.

Ratios	Weights
Currency Ratio	0.04078
Cash Ratio	0.10308
Debt Ratio	0.06233
Net Profit Margin	0.31132
Return on Equity	0.20197
Return on Investment	0.28049

Table 5. Weights of financial ratios

According to the importance level of financial ratios net profit margin was found as the most important criterion having the value of 0.31132. On the other hand, currency ratio was obtained as the least important one having the value of 0.04078.

After the weights of criteria are determined, insurance companies are ranked via fuzzy TOPSIS methodology. EXCEL 2013 software is used for this purpose. Within this context the normalized fuzzy decision matrix is obtained and given in Table 6.

	Currency Ratio	Cash Ratio	Debt Ratio	Net Profit Margin	Return on Equity	Return on investment
Ak	(0.25,0.52,0.65)	(0.23,0.49,1)	(0.03,0.04,0.04)	(0.03,0.04,0.05)	(0.03,0.11,0.21)	(0.03,0.06,0.11)
Anadolu Anonim	(0.83,0.86,0.95)	(0.01,0.18,0.24)	(0.75,0.93,1)	(0.002,0.02,0.03)	(0.03,0.04,0.05)	(0.002,0.21,1)
Anadolu Hayat	(0.72,0.73,0.74)	(0.01,0.2,0.67)	(0.03,0.04,0.33)	(0.09,0.49,1)	(0.01,0.35,1)	(0.001,0.001,0.002)
Güneş	(0.06,0.41,0.69)	(0.08,0.09,0.1)	(0.03,0.04,0.042)	(0.008,0.02,0.04)	(0.003,0.04,0.13)	(0.001,0.02,0.05)
Halk	(0.09,0.52,0.86)	(0.24,0.27,0.32)	(0.03,0.04,0.044)	(0.01,0.05,0.1)	(0.05,0.13,0.2)	(0.02,0.09,0.2)
Ray	(0.82,0.89,1)	(0.181,0.186,0.19)	(0.04,0.04,0.042)	(0.001,0.01,0.03)	(0.002,0.02,0.05)	(0.001,0.01,0.02)

Table 6. Normalized fuzzy decision matrix

Then the weighted normalized fuzzy decision matrix is found by using weights of criteria and shown in Table 7.

	Currency Ratio	Cash Ratio	Debt Ratio	Net Profit Margin	Return on Equity	Return on investment
Ak	(0.01,0.02,0.02)	(0.02,0.05,0.1)	(0.002,0.002,0.002)	(0.009,0.01,0.01)	(0.007,0.02,0.04)	(0.09,0.02,0.03)
Anadolu Anonim	(0.03,0.03,0.03)	(0.001,0.01,0.02)	(0.04,0.05,0.06)	(0.0006,0.006,0.009)	(0.007,0.009,0.01)	(0.0006,0.06,0.28)
Anadolu Hayat	(0.02,0.02,0.03)	(0.001,0.02,0.07)	(0.001,0.002,0.02)	(0.02,0.15,0.31)	(0.002,0.07,0.2)	(0.0003,0.0004,0.0006)
Güneş	(0.002,0.01,0.02)	(0.008,0.01,0.01)	(0.002,0.002,0.002)	(0.002,0.006,0.01)	(0.0006,0.01,0.02)	(0.0003,0.008,0.01)
Halk	(0.14,0.76,1.27)	(0.02,0.02,0.03)	(0.002,0.002,0.002)	(0.003,0.01,0.31)	(0.01,0.02,0.04)	(0.006,0.02,0.05)
Ray	(1.21,1.31,1.46)	(0.01,0.01,0.01)	(0.002,0.002,0.002)	(0.0003,0.005,0.009)	(0.0005,0.004,0.01)	(0.0003,0.003,0.006)

Table 7. Weighted normalized fuzzy decision matrix

The distances of each alternative from A^* and A^- are found and shown in Table 8.

Companies	d_i^*	d_i^-
Ak	4.867176	1.14936
Anadolu Anonim	4.884515	1.180107
Anadolu Hayat	4.706278	1.389173
Güneş	4.949329	1.061337
Halk	4.880225	1.136698
Ray	4.932308	1.071514

Table 8. Distances of each alternative from A^* and A^-

Finally, CC_i values of each alternative is found and ranked in descending order as given in Table 9.

Companies	CC_i	**Rank**
Ak	0.191034	3
Anadolu Anonim	0.194589	2
Anadolu Hayat	0.227903	1
Güneş	0.176576	6
Halk	0.188917	4
Ray	0.178472	5

Table 9. CC_i values and ranking of insurance companies according to descending order

According to the firms' ranking related to CC_i values Anadolu Hayat places top position with having the value of 0.227903. On the contrary Güneş places the last position with having the value of 0.176576. Other insurance firms are ranked as Anadolu Anonim, Ak, Halk and Ray according to CC_i values respectively.

7. Conclusions

In this study performances of six insurance companies listed in BIST is analyzed with the help financial ratios. Therefore six financial ratios namely currency, cash, debt, net profit margin, return on equity and return on investment are considered as criteria according to financial sector applications and finance literature. 6 insurance companies traded in BIST are handled as alternatives. For this aim weights of criteria found by using fuzzy Shannon's entropy based on α-level set (α=0.5). Net profit margin was found as the most important criterion. Then insurance companies' final rankings are determined by means of fuzzy TOPSIS methodology. There is not any study based on analyzing the performance of insurance companies via fuzzy

Shannon's entropy based on α-level set and fuzzy TOPSIS methodology. For further researches it is recommended to integrate various weighting and ranking methods with different financial indicators in terms of assessing the performance of insurance companies listed in BIST.

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