TECHNOLOGICAL AND ECONOMIC DEVELOPMENT OF ECONOMY
ISSN 2029-4913 / eISSN 2029-4921

2018 Volume 24(2): 534–560
doi:10.3846/20294913.2016.1213201

A MULTI-CRITERIA PERFORMANCE ANALYSIS OF INITIAL PUBLIC OFFERING (IPO) FIRMS USING CRITIC AND VIKOR METHODS

Neşe YALÇIN[a], Ulaş ÜNLÜ[b]

[a]*Department of Business Administration, Nevşehir Hacı Bektaş Veli University, 50300, Nevşehir, Turkey*
[b]*Department of Banking and Finance, Nevşehir Hacı Bektaş Veli University, 50300, Nevşehir, Turkey*

Received 23 August 2015; accepted 12 June 2016

Abstract. As Initial Public Offering (IPO) is a significant milestone in the financial strategy of a firm, this study aims to evaluate performance of IPOs using multiple measures including accounting-based performance (ABP), value-based performance (VBP) and overall performance (OP) in the pre-and post-IPO periods. Therefore, we present two combined approaches based on a compromise MCDM method-VIKOR and objective weighting methods-CRITIC and MW (Mean Weight) to evaluate and rank IPOs to help shareholders with understanding on how their performance changes under the different measures. Since the compromise solution (one or a set) proposed by VIKOR depends substantially on criteria weights, VIKOR-CRITIC can show more realistic results because of the differential weights assigned to criteria by CRITIC. In this study, a case study is conducted in order to evaluate the performance of Turkish IPOs based on ABP, VBP and OP measures using the combined methods. The results show that the compromise solution results obtained by VIKOR-CRITIC may be a guideline for investors in making more profitable investment decisions before leaping into any investment decision.

Keywords: initial public offering, accounting-based performance, value-based performance, MCDM, VIKOR, CRITIC, objective weights.

JEL Classification: G10, M10, C44.

Introduction

One of the inevitable stage of a firm life cycle is going public that is known to be as Initial Public Offering (IPO) concept since firms can raise their capital by issuing stocks and selling them to the public. The decision for a firm to going public is one of the most critical decisions changing the whole structure and ownership of that firm. There are numerous benefits for a company going public. One of the biggest advantages for a company is the prestige of having their stock publicly traded on a stock exchange. A public company has direct access to the capital markets. Other advantage of the going public is to gain capital

Corresponding author Neşe Yalçın
E-mails: *nyalcin@nevsehir.edu.tr; nyalcins@hotmail.com*

without certain restrictions of other options to raise money. Publicly traded companies are usually more prestigious than non-publicly traded ones. In addition, publicly traded firms are able to offer stock options, which have the potential to substantially increase in firm's value.

IPOs have interested financial economists and academicians for many decades. A number of papers have been studied on the topic of IPOs, and it has been rapidly increasing in recent years. Before a firm goes public, issuing firm and investors have different expectations. For example, firms are willing to get as high as possible issuing price for higher cash flow to the firm. When an IPO is undervalued, investors can realize significant returns in a short-term period. In the IPO literature when the offer price is lower than the first trade price, the stock is considered to be under-priced. The long-run underperformance of IPOs has been reported as a global phenomenon. In a seminal study, evidence of long-run underperformance of IPOs was first presented by Ritter (1991). Various studies have also investigated the long-run underperformance of IPOs for developed and developing countries (such as Latin America, US, Australia, China, Germany, UK, Turkey, Tunisian, etc.) and provided further evidence on this issue (e.g. Aggarwal *et al.* 1993; Loughran, Ritter 1995; Lye 1999; Chen *et al.* 2000; Goergen, Renneboog 2003; Yalama, Ünlü 2010; Rekik, Boujelbene 2013). In addition, several studies have found that accounting performance of IPOs deteriorates following going public (e.g. Jain, Kini 1994; Mikkelson *et al.* 1997; Kim *et al.* 2004; Wang 2005).

There have been fundamental changes in the worldwide economic situations for the past two decades. In this new state of economy, the managers of businesses have been keeping up with new challenges. On the other hand, the major financial objective of a firm has been the maximization of its shareholders' value, which motivates and enables whole management of that firm to make considerably more rational strategic and organizational decisions. In such a case, traditional accounting-based performance (ABP) measures (e.g. return on assets (ROA), return on equity (ROE), return on sales (ROS), etc.) have been criticized. Two major weaknesses of traditional measures are as follows: firstly, they exclude the opportunity cost of the capital invested in the firm, and secondly, the measures are calculated by considering historical values (Martin, Petty 2000). The perceived inadequacies in ABP measures have motivated modern value-based performance (VBP) measures (e.g. economic value added (EVA), cash value added (CVA), market value added (MVA), etc.) promoted as the measures of a company's real profitability and performance (Stewart 1991; Young, O'Byrne 2001; Erasmus 2008). Thus, VBP measures in evaluating financial performance of firms have become quite popular for policy makers, investors, researchers, etc.

Since IPO is a milestone in a firm's financial strategy, financial performance evaluation of IPOs can be seen as one of the most important issues for shareholders and one of the challenging matters at hand in terms of IPO literature. Since traditional measures evaluate the operation of a firm and analyse its position within its competitors over time, they can be used for performance evaluation (Gallizo, Salvador 2003). On the other hand, modern value-based measures have been introduced to show how a company has created value for its shareholders/owners in the modern industry time. In this context, modern VBP measures may be seen more suitable for measuring performance of firms than traditional ABP

measures. We, therefore, outline various measures of real profitability and consider what role they can play in performance assessment of firms in this study. Our view is basically that they can provide more explicit, rational, and efficient answer to the performance measurement than commonly used measures in the IPO literature. Thus, the paper attempts to extend the research on performance assessment of IPOs in both the pre- and post-IPO periods by considering a multi-dimensional framework including not only ABP measures but also VBP measures. Since the nature of this research has a multi-criteria decision making (MCDM) problem, a methodology considering multi-criteria evaluation is used for evaluating performance of IPOs. The MCDM approach adopted is VIKOR (a compromise ranking method) initially proposed by Opricovic (1998) that proposes a compromise solution by using the initial weights of criteria to rank the alternatives with respect to their distances from the ideal solution. As criteria weights showing the relative importance of criteria in MCDM are the preliminary information of this method, they should be derived by using an appropriate weighting method (subjective or objective methods). Subjective weighting methods depend only on the preference of decision makers, whereas objective weighting methods determine criteria weights by making use of the mathematical models (Diakoulaki *et al.* 1995; Deng *et al.* 2000; Wang *et al.* 2009; Aalianvari *et al.* 2012). The evaluation criteria of this research are quantitative measured data consisting of the values of traditional and modern performance measures. Therefore, objective weighting methods, namely, CRiteria Importance Through Intercriteria Correlation (CRITIC) proposed by Diakoulaki *et al.* (1995) and Mean Weight (MW), are used to determine evaluation criteria weights. The reason of choosing each objective weighting method is that while the CRITIC method extracts all information contained in the evaluation criteria; the MW method assigns equal weights to all evaluation criteria for consistency.

The originality of this paper comes from analysing multi-criteria performance evaluation of IPO firms with respect to not only ABP in the pre-IPO period but also ABP, VBP and overall performance (OP) in the post-IPO period by applying these kinds of combined methods in the literature for the first time. The objective of this paper is to evaluate performance of IPOs with ABP measures in both the pre- and post-IPO periods, with VBP measures in the post-IPO period, and with overall performance (OP) measures, the integration of the ABP and VBP measures, in the post-IPO period to be able to present an opinion for investors in making more profitable investment decisions. Therefore, the two combined approaches based on VIKOR method and objective weighting methods (VIKOR-CRITIC and VIKOR-MW) are employed in order to serve the objective of this study. A case study is conducted in order to evaluate the performance of 16 Turkish IPO firms going public in 2011.

The outline of the reminder of the study is as follows. Section 1 reviews the literature by dividing into two subsections. While the first subsection summarizes the empirical applications of performance assessment of IPOs, the second subsection provides the related summary of literature review on the current MCDM methods for financial performance analysis of firms. Section 2 introduces the traditional and modern performance measures compatible with the aim of this paper. Section 3 expresses the methodology of the study, and Section 4 presents the case study. Finally, last section concludes the paper.

1. Literature Review

1.1. Firm performance and IPOs

In the existing literature on performance of IPOs, many studies are generally focused on examining the accounting performance (also known as operating performance) of IPOs by considering accounting-based measures and determining the effects of performance measures with respect to pre- and post-IPO periods. These studies are potentially related to measurement and evaluation the accounting performance of IPOs by using statistical tests or econometric models to discover whether there is a change in operating performance following IPOs. Almost all studies on performance assessment of IPOs in emerged and emerging markets have found that accounting performance of IPOs becomes a significant decline post-IPO relative to pre-IPO (e.g. Jain, Kini 1994; Mikkelson *et al.* 1997; Kim *et al.* 2004; Wang 2005; Alanazi *et al.* 2011; Alanazi, Liu 2013). According to Jain and Kini (1994) who examine the ABP of US IPOs, accounting performance of the post-IPO has been declining. They argue that managers/owners fail to generate the same level of pre-IPO due to change in ownership structure. Their results are consistent with the agency problem and signalling hypothesis. They find that post-IPO shows poor performance over a six-year period extending from one year prior to the offering to the subsequent five years after the offering. In their study, accounting performance of the post-IPO has been measured by ROA, cash flow/total assets (CF/TA), sales, asset turnover and capital expenditures. Similarly, Mikkelson *et al.* (1997) who examines the ABP of US IPOs confirm accounting-based long-run underperformance of the post-IPO, but unlike Jain and Kini (1994), they have found that post-IPO underperformance is not associated with managerial ownership. They argue that the alteration in accounting-based long-run performance following IPO is generally clarified by firm age and size. They have also found that older and well-established firms tend to have better performance relative to small firms. Kim *et al.* (2004) has examined changes in ABP of Thai IPO firms, and has found that their post-IPO performance declines similar as Jain and Kini (1994) and Mikkelson *et al.* (1997). Their results support that there is a relationship between firm age and the performance, but there is no link between the performance and the size of firm. They argue that firms with "low" and "high" level of managerial ownership indicate positive link between the ownership and post-IPO performance, whereas firms with "intermediate" level of managerial ownership indicate a negative link between the managerial ownership and post-IPO performance. Wang (2005) has examined the changes in operating performance of Chinese IPOs, and has found a sharp decline of their post-IPO performance same as the mentioned studies. They also focus on the effect of ownership and ownership concentration on IPO performance changes, and find that there is no relation between them. Alanazi *et al.* (2011) has measured the financial performance of Saudi IPOs by using two ABP measures (ROA and ROS) to explore factors associated with the financial performance variation between pre- and post-IPO. Their result is also similar as the above-mentioned studies since they find that Saudi IPOs exhibit a sharp decline in the post-IPO performance compared to the pre-IPO period. They have also found that the performance deterioration is significantly associated with the IPO

event. More recently, Alanazi and Liu (2013) have investigated the ABP of IPOs in the Gulf Cooperation Council (GCC) and confirmed that post-IPO performance declines following going public. According to the authors, the cause of the underperformance is related to the firm transition from private into public ownership due to increasing agency costs. Their results support the lack of opportunity theory because they find that the growth of firm in sales and capital expenditure is much stronger in the pre-IPO period than post-IPO period.

1.2. Financial performance evaluation and MCDM

As performance evaluation described by numerous multi-dimensional indicators is considered as a MCDM problem, financial performance evaluation of units (such as firms) with the criteria characterizing their multi-dimensional structure from various perspectives is a kind of MCDM problem. In the financial performance evaluation literature, many studies are generally focused on ranking the alternatives to select the best choice with the highest satisfaction degree for all of the relevant performance measures. Therefore, many studies have applied different techniques and approaches of MCDM with its classical or fuzzy versions for financial performance evaluation of firms. Several studies in the literature applying different MCDM methods to evaluate financial performance of firms using a set of financial ratios/measures (traditional and/or modern) are summarized as follows. Yurdakul and İç (2003) have used the TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method to evaluate the financial performance of five big scaled automotive companies operating in the Turkish automotive industry. Ginevičius and Podvezko (2006) have assessed the financial state of construction enterprises described by a set of criteria evaluating their commercial activity from various perspectives applying seven multi-criteria evaluation methods (i.e., SAW (Simple Additive Weighting), GM (Geometric Mean), COPRAS (Complex proportional evaluation method), TOPSIS, and VIKOR). Ertuğrul and Karakaşoğlu (2009) have developed a fuzzy model based on fuzzy AHP (Analytic Hierarchy Process) and TOPSIS to evaluate the financial performance of 15 Turkish cement firms traded on Borsa Istanbul. In their study, they have used fuzzy AHP to calculate the weights of the evaluation criteria (financial ratios) depending on subjective judgments of decision-makers and TOPSIS to rank the cement firms. Wang and Lee (2010) have evaluated the financial performance of Taiwan major container shipping companies by combining Grey Relation Analysis (GRA) and fuzzy MCDM method. They have utilized GRA to cluster financial ratios and find representative indicators, and propose a fuzzy MCDM constructed on strength and weakness indices to evaluate their financial performance. Yalçın *et al.* (2012) have suggested a new financial performance evaluation approach based on ABP and VBP measures to rank the firms of each sector in the manufacturing industry in Turkey by using fuzzy AHP, TOPSIS and VIKOR methods. In their research, they have determined the weights of performance measures by using the fuzzy AHP method, and then ranked the firms of each sector by using the TOPSIS and VIKOR methods as comparatively. Bayrakdaroğlu and Yalçın (2012) have evaluated the Turkish industrial companies traded on Istanbul Stock Exchange 30 (ISE-30) with respect to modern VBP measures by using fuzzy AHP to obtain the weights of the performance measures and

VIKOR to rank the companies. Ergul and Seyfullahogullari (2012) have applied the ELECTRE III (ELimination and Choice Expressing REality) method to rank the retail companies trading on ISE, based on their financial performance for the three years. Baležentis *et al.* (2012) have offered a novel procedure for integrated assessment and comparison of Lithuanian economic sectors on the basis of financial ratios and three fuzzy MCDM methods (fuzzy TOPSIS, fuzzy VIKOR and fuzzy ARAS). Ignatius *et al.* (2012) have examined the performance of Iranian automotive enterprises based on seven financial indices through the PROMETHEE II (Preference Ranking Organization METHod for Enrichment of Evaluations) method, and validated the decision made with PROMETHEE II by the geometrical analysis for interactive aid (GAIA). Bulgurcu (2013) has assessed the financial performance of firms in the Turkish automotive industry in the ISE Market by integrating entropy technique (to determine the weights of the ten financial ratios) and TOPSIS (to rank the ten automotive firms). Kazan and Özdemir (2014) have analysed financial statements of the fourteen large-scale conglomerates traded on ISE. They firstly determine the weights of the nineteen financial ratios calculated over three periods by using the CRITIC method, after they obtain the financial performance scores of these conglomerates by applying TOPSIS method in order to make an inference regarding their future behaviours. Safaei Ghadikolaei *et al.* (2014) have proposed a hybrid fuzzy MCDM approach (fuzzy AHP to determine the weights of criteria, and three outranking methods including fuzzy VIKOR, fuzzy ARAS (Additive Ratio Assessment) and fuzzy COPRAS to rank the companies) to evaluate the financial performance of automotive companies of Tehran stock exchange using ABP and VBP measures. Rezaie *et al.* (2014) have presented a combined MCDM model based on fuzzy AHP (to determine the weights of criteria considering the subjective judgments of decision makers) and VIKOR (to rank the firms) to evaluate the financial performance of 27 Iranian cement firms by financial ratios in the Tehran stock exchange market. Wang (2014) has evaluated the financial performance of Taiwan container shipping companies by a fuzzy MCDM technique. In this evaluating problem, the author firstly applies GRA to partition financial ratios into several clusters and finds representative indices from the clusters to consider as evaluation criteria in the assessment, and then ranks the companies in accordance with their financial performance by using fuzzy TOPSIS. Hsu (2015) has proposed a decision making model for evaluating the efficiency and operating performance of Taiwan's listed semiconductor companies in 2010. In this study, the author firstly combines DEA (Data Envelopment Analysis) with improved GRA method to measure relative efficiencies, then determines the efficient and inefficient semiconductor companies, and lastly integrates the VIKOR, IGRA and the entropy weight methods to evaluate the operating performance of the efficient and inefficient groups, respectively.

2. Performance evaluation measures for IPOs

When considering the studies associated with measuring performance of IPOs in both the pre- and post-IPO periods, three traditional ABP measures, namely, return on assets (ROA), return on sales (ROS) and return on equity (ROE), are the most commonly employed measures (Jain, Kini 1994; Megginson *et al.* 1994; Mikkelson *et al.* 1997; Wang

2005). In addition to these three measures, cash flow to total assets (CF/TA) ratio is another one taken into consideration as a key measure of performance (Kaplan 1989; Jain, Kini 1994; Holthausen, Larcker 1996; Kim *et al.* 2004) since it provides an indication of the level of returns on total assets. These four traditional ABP measures are also used herein to evaluate ABP of IPOs in both the pre- and post-IPO periods. The definitions of four ABP measures are given in Table 1 and they are briefly explained as follows.

Table 1. Definitions of ABP measures

ABP measure	Definition
ROA	EBITDA*/Total Assets
ROE	Net Income/Stockholders' Equity
ROS	EBITDA*/Total Sales
CF/TA	Operation Cash Flow/Total Assets

Note: *EBITDA is earnings before interest, taxes, depreciation, and amortization.

ROA refers how profitable a company is relative to its total assets. This ratio shows the number of cents earned on each dollar of assets. If the return is higher, the management will be more efficient in utilizing its asset base, because the firm is earning more money on its assets (Palepu *et al.* 2000). ROE explains the amount of the company's return produced for its shareholders' investments into the firm. ROE, referred to be one of the most crucial financial ratios, is very sensitive to change in financial gearing (Chacko, Evans 2014). ROS indicates how much the management is able to operate the business with adequate success. Success in this context refers to recover the cost of the merchandise or services, the expenses of operating the business (including depreciation), and the cost of borrowed funds. The ratio substantially reflects the total cost/price effectiveness of the operation (Helfert 2001). Since operating cash flows (earnings before interest and tax or EBIT + depreciation) are a major component in net-present-value (NPV) calculations in valuing a firm, CF/TA is a convenient alternative measure of operating performance (Kim *et al.* 2004).

An appropriate measure of management and management strategy must consider the value of a company that can be measured in both book-value figures assessing its assets in place and market value-figures assessing the value of its competitive strategy (Bacidore *et al.* 1997). From this point of view, VBP measures that adequately reflect performance are proposed in order to assess the performance of companies such as; economic value added (EVA) by Stewart (1990, 1991), market value added (MVA) by Stewart (1990), cash flow return on investment (CFROI) by Young and O'Byrne (2001), cash value added (CVA) by Boston Consulting Group (2000) and refined economic value added (REVA) by Bacidore *et al.* (1997). In this paper, five VBP measures (EVA, MVA, CFROI, CVA and REVA) are used not only to evaluate VBP of IPOs but also to evaluate overall performance (OP) of IPOs in the post-IPO period. The definitions of these five VBP measures are given in Table 2 and they are briefly clarified as the following.

Table 2. Definitions of VBP measures

VBP Measure	Definition
EVA	Net Operating Profit After Taxes – (Weighted Average Cost of Capital × Total Invested Capital)
REVA	Net Operating Profit After Taxes – (Weighted Average Cost of Capital × Total Market Value)
MVA	Market Value – Invested Capital
CFROI	(Gross Cash Flow – Economic Depreciation)/Gross Investment
CVA	(Gross Cash Flow – Economic Depreciation) – Capital Charge

EVA is a value-based management technique developed by the Stern Stewart & Company consultant group. EVA depends upon the concept that shareholder value can only be created if a firm earns a return on its capital more than its cost of capital. The higher the value of EVA is, the more the total shareholder value increases (Erasmus 2008). EVA also indicates a firm's true performance because EVA reveals only incremental values added to a firm after considering cost of capital (Lee, Kim 2009). After the publication of the financial consultant Stern Stewart's MVA rankings in *Fortune* magazine in the United States, MVA has come into prominence. MVA is calculated as the difference between the market value of a company's debt and equity and the amount of capital invested (Copeland *et al.* 2000). The value of the MVA indicates the market's assessment a firm managers' efficiency in using the scarce resources (Cheng *et al.* 2007).

The CFROI refers to measure the expected return on an investment, using its cash flows and taking account of the time value of money. CFROI for a firm is compared to the cost of capital to pass judgments on whether a company's investments are good, neutral or poor investments. To enhance its value then, a firm should increase the spread between its CFROI and its cost of capital (Damodaran 1999). The CFROI valuation model creates a competitive lifecycle framework for analysing firms' past performance and forecasting future performance (Madden 2003). CVA calculates the excess cash flows generated over the capital cost. The value reflects all the benefits of EVA, while also attempting to improve on it by using cash flows instead of profit figures (Martin, Petty 2000). A firm's CVA is calculated by considering the operating cash flow instead of operating profit, and subtracting a gross capital charge. To convert NOPAT into the operating cash flow, depreciation and amortization are added back (Erasmus 2008). If shareholder value is positive, the CVA should exceed the real market cost of capital. Companies generating a cash premium over expected levels create value. Therefore, the company is able to resolve the problem of insolvency (Urbanczyk *et al.* 2005).

REVA stems partly from EVA's use of the economic book value of assets when the capital charge for the firm stems from a market-based WACC. Incremental shareholder value has been created only when REVA is positive. REVA is more convenient than EVA in measuring performance if the shareholders' view of the firm is taken into account. The firm's economic value is a prominent proof of invested capital from the standpoint of those below top management. REVA could be used to compensate senior management and EVA could be used to compensate divisional managers and those below them (Bacidore *et al.* 1997).

3. Research methodology

Multi-Criteria Decision Making (MCDM) is an advanced field of operation research that provides decision makers and analysts with a wide range of methodologies, which are overviewed and well-suited to the complexity of economical decision problems (Zavadskas, Turskis 2011). In a MCDM approach, first it is necessary to define the problem clearly, and then identify realistic alternatives. It is important to define the actors involved in the decision making, select the evaluation criteria, and evaluate each alternative according to the set of criteria. Next, an MCDM method is selected to aggregate the performance of each alternative (Turskis, Zavadskas 2010).

MCDM refers to screening, prioritizing, ranking, or selecting a set of alternatives under usually independent, incommensurate or conflicting criteria or attributes (Hwang, Yoon 1981). The application of multi-criteria methods depends on the calculation of criteria weights that have significance for alternatives to select, rank, etc. in many MCDM methods. Tzeng *et al.* (1998) classify weighting methods into objective or subjective, according to whether weights are indirectly computed from outcomes or directly obtained from decision makers. Wang *et al.* (2009) also propose the combination weighting methods as the third weighting method in addition to subjective and objective methods in their classification category within their scope of rank-order weighting methods. In general, the estimation of criteria weights is determined depending on the opinions of decision makers. Thus, weights obtained in this manner are subjective inputs in such analyses. These kinds of analyses are known to be as subjective weighting methods (e.g. Simple Multi-Attribute Rating Technique (SMART), SIMOS, Revised SIMOS, SWING, Analytic Hierarchy Process (AHP), pairwise comparison method, Delphi method, etc.) that determine weights only according to the preferences of decision makers. As criteria weights determined by the subjective weighting methods represent the subjective assessment of the decision maker, analytical results or rankings of alternatives based on the weights can be influenced by the decision maker due to his/her level of knowledge and experience in the relevant field (Ahn 2011). On the other hand, objective weighting methods (e.g. Entropy, CRiteria Importance Through Intercriteria Correlation (CRITIC), Mean Weight (MW), Standard Deviation (SD), Statistical Variance procedure, etc.) determine the weights by solving mathematical models without any consideration of the decision-maker's preferences.

In the analysis of this study, MCDM approach including VIKOR is used to measure ABP of IPOs in the pre- and post-IPO periods, VBP of IPOs in the post-IPO period and overall performance (OP) of IPOs considering ABP and VBP measures together in the post-IPO period. The VIKOR method was first developed in 1990 by Serafim Opricovic and has been extensively studied by many researchers to date in many fields with its classical version (Hsu 2014; Kang, Park 2014; Büyüközkan, Görener 2015) or its extensions (Rostamzadeh *et al.* 2014; Liu *et al.* 2015; You *et al.* 2015). In very recently, a comprehensive review with a systematic approach has been conducted by Mardani *et al.* (2016) to identify VIKOR technique applications and methodologies, which have been developed to date. In the context of multi-criteria based decision making, VIKOR is advantageous, particularly in situations where the decision maker is not able, or does not know how he/she expresses

his/her preference at the early stage of system design (Kang, Park 2014). Moreover, the difficulty of reaching an agreement on the relative importance of the financial performance measures via a subjective weighting process with the multiplicity of the problem under a specific environment is increased in the absence of appropriate decision makers (Deng *et al.* 2000). Also if an unbiased ranking of alternatives (such as firms) is wanted, objective weights of importance are very useful (Diakoulaki *et al.* 1995). In line with this information, since crisp data of the performance measures to model the real life situations in our decision making problem is adequate, objective weighting methods that do not require any consideration of the decision maker's preferences are combined with VIKOR method. In the literature, VIKOR method is combined with the objective weighting methods in different fields such as supplier selection (Shemshadi *et al.* 2011), material selection (Liu *et al.* 2013), performance evaluation of women in the science and technology (Chou *et al.* 2014). The objective of this paper as mentioned above is to evaluate and rank the IPOs on the basis of ABP and VBP measures in the pre- and post-IPO periods by using the combined analytic approaches based on VIKOR and objective weighting methods (VIKOR-CRITIC and VIKOR-MW). The evaluation framework of the study based on these combined methods is shown in Figure 1. The detailed explanations of the objective weighting approaches and the VIKOR method are given in the following subsections.

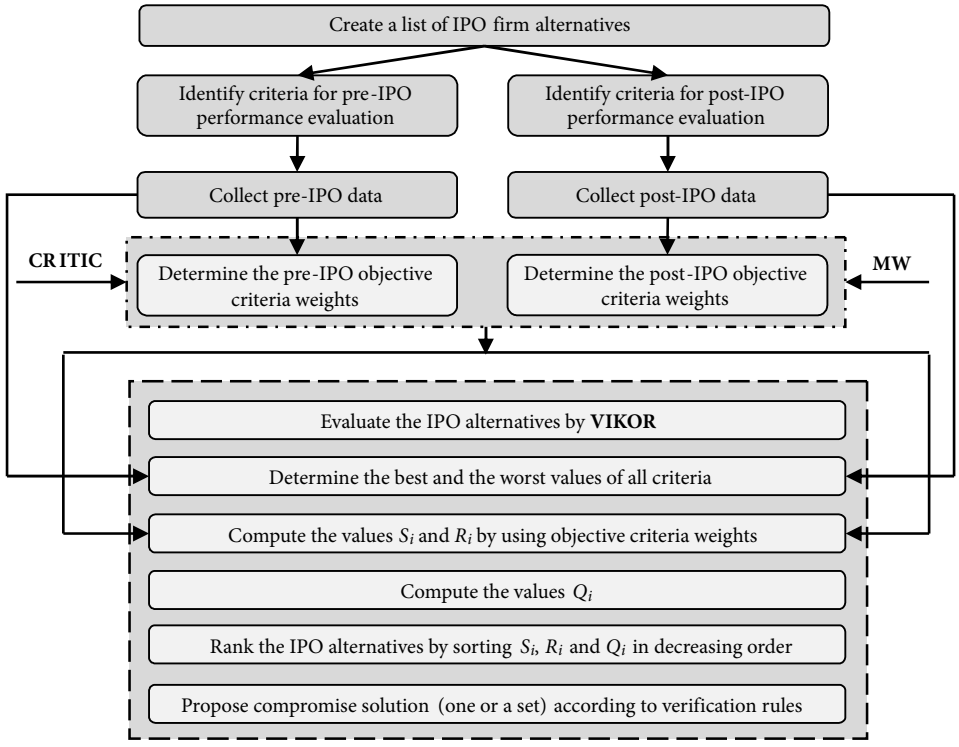

Fig. 1. The evaluation framework of the study

3.1. Objective weighting methods

The objective weighting methods obtain the weights only based on the known data of the problem and determine criteria weights by making use of the mathematical models (Aalianvari *et al.* 2012; Zardari *et al.* 2015). These kinds of methods may be particularly appropriate for situations when not only decision makers are non-existent but subjective weights obtained in the presence of decision makers are inconsistent as well.

The overall performance evaluation and ranking of competing firms is a complex process, in which multiple financial ratios (performance measures) that do not always move in the same direction (confliction signal) are required to be considered simultaneously (Deng *et al.* 2000). In such circumstances, using objective weighting process may be superior to determine conflicting criteria weights instead of subjective weighting process since it cannot be reached an agreement on the relative importance of the financial performance measures.

Accordingly, this paper presents two objective weighting methods, namely, CRITIC and MW, to derive the objective weights (relative importance) of the performance evaluation criteria about which VIKOR method requires preliminarily information. As the CRITIC method derives the objective weights by incorporating both contrast intensity and conflict that are contained in the structure of the decision problem (Diakoulaki *et al.* 1995), this method can be suggested to be more suitable for determining the weights of both traditional and modern performance measures used for measuring the performance of IPOs. In addition to the method CRITIC, for consistency in this research an equal weighting between the performance evaluation criteria may be considered appropriate. Therefore, the MW method is also used within the scope of the study. In the following, these two objective weighting methods are briefly summarized.

CRITIC Weighting Method: The method initially proposed by Diakoulaki *et al.* (1995) is used in obtaining criteria weights since it aims at the determination of objective weights of relative importance in MCDM problems. The developed method is based on the analytical investigation of the evaluation matrix for extracting all information contained in the evaluation criteria. In other words, objective weights are derived by quantifying the intrinsic information of each evaluation criterion. In this method, the determination process of criteria weights includes both standard deviation of the criterion and its correlation between other criteria.

Consider an initial decision matrix $X = \left[x_{ij} \right]_{m \times n}$ consisting of m alternatives and n criteria, where x_{ij} is the performance measure of ith alternative with respect to jth criterion. To obtain the weight of the jth criterion w_j, the following notations are used: c_j, is the quantity of information contained in jth criterion, σ_j is the standard deviation of the jth criterion, and ρ_{jk} is the correlation coefficient between the jth and kth criteria. Based on these notations, the calculation steps of the CRITIC method is given as follows (Jahan *et al.* 2012):

Step 1. Normalize the initial decision matrix using Eq. (1) for benefit criteria:

$$r_{ij} = \frac{x_{ij} - x_j^{\min}}{x_j^{\max} - x_j^{\min}}. \tag{1}$$

Step 2. Calculate the correlation between criteria pairs using Eq. (2):

$$\rho_{jk} = \frac{\sum_{i=1}^{m}(r_{ij} - \overline{r}_j)(r_{ik} - \overline{r}_k)}{\sqrt{\sum_{i=1}^{m}(r_{ij} - \overline{r}_j)^2 \sum_{i=1}^{m}(r_{ik} - \overline{r}_k)^2}}. \quad (2)$$

Step 3. Calculate weights of criteria using Eq. (3) and Eq. (4).

$$c_j = \sigma_j \sum_{k=1}^{n}(1 - \rho_{jk}); \quad (3)$$

$$w_j = c_j \Big/ \sum_{k=1}^{n} c_k, \quad (4)$$

where: $i = 1, 2, \ldots, m$; $j, k = 1, 2, \ldots, n$.

Mean Weight (MW) Method: In Mean Weight (MW), the weights are derived objectively by using the equation (Deng *et al.* 2000):

$$w_j = \frac{1}{n}, \quad (5)$$

where: $j = 1, 2, \ldots, n$.

This method is based on the assumption that all criteria are of equal importance, and thus weights are assigned to criteria equally via this method. MW method is used in MCDM when the there is no information from decision maker or information is not sufficient to reach a decision (Jahan *et al.* 2012). The method applied in many decision making problems requires minimal knowledge of the decision maker's priorities and minimal input from decision maker (Wang *et al.* 2009).

3.2. VIKOR method

One of the applicable MCDM methods is the VIKOR method, which has been developed by Opricovic (1998) for solving multi-criteria optimization problems of complex systems. Since the Serbian name of VIKOR (VIsekriterijumska optimizacija optimizacija i KOmpromisno Resenje) means multi-criteria optimization and compromise solution, the other name of this method is compromise ranking method. The fundamental principle of VIKOR is to focus on ranking and selecting from a set of alternatives in the presence of conflicting criteria (Opricovic 2011). The ranking could be performed by comparing the measure of closeness to the ideal alternatives. It determines the compromise ranking-list, the compromise solution, and the weight stability intervals for preference stability of the compromise solution obtained with the given weights (Opricovic, Tzeng 2004).

In the VIKOR method, the multi-criteria measure for compromise ranking has been developed from the L_p – *metric* used as an aggregating function in a compromise programming method (Yu 1973; Zeleny 1982). The various I alternatives are denoted as a_1, a_2, …, a_I. For alternative a_i, the rating of the jth aspect is denoted by f_{ij}, i.e. f_{ij} is the value of jth criterion function for the alternative a_i; n is the number of criteria.

The development of this method based on L_p – *metric* as shown in Eq. (6):

$$L_{p,i} = \left\{ \sum_{j=1}^{n} \left[w_j (f_j^* - f_{ij}) \Big/ (f_j^* - f_j^-) \right]^p \right\}^{1/p}, \quad (6)$$

where: $1 \le p \le \infty$; $i = 1, 2, \ldots, I$. $L_{1,i}$ (as S_i in Eq. (8)) and $L_{\infty,i}$ (as R_i in Eq. (9)) are used to formulate the ranking measures. The solution obtained by $\min_i S_i$ is with a maximum group utility ("majority" rule), and the solution obtained by $\min_i R_i$ is with a minimum individual regret of the "opponent". The compromise ranking algorithm VIKOR has the following steps (Opricovic, Tzeng 2004):

Step 1. Determine the best f_j^* and the worst f_j^- values of all criterion functions, $j = 1, 2, \ldots, n$. If the jth function represents a benefit then:

$$f_j^* = \max_i f_{ij} \quad f_j^- = \min_i f_{ij}. \quad (7)$$

Step 2. Compute the values S_i and R_i; $i = 1, 2, \ldots, m$, by the relations:

$$S_i = \sum_{j=1}^{n} w_j (f_j^* - f_{ij}) \Big/ (f_j^* - f_j^-); \quad (8)$$

$$R_i = \max_j \left[w_j (f_j^* - f_{ij}) \Big/ (f_j^* - f_j^-) \right], \quad (9)$$

where, S_i and R_i represent the utility measure and regret measure, respectively, and w_j is the weight (relative importance) of the jth criterion.

Step 3. Compute the values Q_i, $i = 1, 2, \ldots, m$, by the relation:

$$Q_i = v(S_i - S^*) \Big/ (S^- - S^*) + (1 - v)(R_i - R^*) \Big/ (R^- - R^*), \quad (10)$$

where, $S^* = \min_i S_i$, $S^- = \max_i S_i$ and $R^* = \min_i R_i$, $R^- = \max_i R_i$ and v is the weight of the strategy of *maximum group utility*, whereas $(1 - v)$ is the weight of the *individual regret*, usually $v = 0.50$. Here, when v is larger than 0.50, the index of Q_i follows majority rule.

Step 4. Rank the alternatives, sorting by the values S_i, R_i and Q_i, in decreasing order as three ranking lists.

Step 5. Propose as a compromise solution, for given criteria weights. If the two conditions given below are satisfied, the alternative a' is the best ranked by the measure Q:

C1. Acceptable advantage: $Q(a'') - Q(a') \ge DQ$, where a'' is the second best alternative in the ranking list by Q; $DQ = 1/(m - 1)$; where m is the number of alternatives.

C2. Acceptable stability in decision making: alternative a' must also be the best ranked by S (R) and this must be higher than the second ranked S (R).

If one of the above-mentioned conditions is not satisfied, then we can get the compromised solution that includes the following two judge rules: (1) The first ranked alternative is the best alternative when the first and second ranked alternatives satisfy both above conditions and (2) The first and second ranked alternatives are the best alternatives simultaneously when the first and second ranked alternatives only fail to satisfy the condition C2. If the condition C1 is not satisfied alternatives a', a'', …, $a^{(k)}$, $a^{(k)}$ is determined by the relation $Q(a^{(k)}) - Q(a') \approx DQ$, the positions of these alternatives are "in closeness".

4. Implementation of the combined methods for performance evaluations of IPOs

4.1. Sample and data

This study depends on the data related to 16 Turkish IPO firms going public in 2011. Given the difficulty in obtaining earlier data, it is necessary to use a one-year period prior to the IPOs (pre-IPO period) for the pre-IPO measure of traditional performance. Thus, the original data which belongs to 16 Turkish IPO firms in this research includes the values of ABP measures for one-year pre-IPO period (for the year 2010) and one-year post-IPO period (for the year 2012), and the values of VBP measures for one-year post-IPO period (for the year 2012).

Financial statements for calculating ABP and VBP measures are obtained from the official web site of Public Disclosure Platform (2015). To calculate a firm's weighted-average cost of capital (WACC), the following variables are operationalized. The annual compound reference Treasury bill rates (Treasury bill rates are converted into monthly) are obtained from the official website of the Republic of Turkey Prime Ministry Undersecretariat of Treasury (2015). Turkish Development Bank's medium term investment annual interest rates are considered as a cost of borrowing for estimating weighted-average cost of capital. The capital asset pricing model (CAPM) is used to calculate a firm's cost of equity. The BIST-100 index is used as the index return. Stock returns and index return are extracted from the official website of the Borsa İstanbul abbreviated as BIST (2015). The proposed studies, which are mentioned in the literature review of this study, analysing the performance of IPOs with respect to pre- and post-IPO periods in the literature put forward that ABP of IPOs deteriorates following going public. In this respect, the data for ABP measures of 16 Turkish IPO firms are compared whether there is deterioration between the two IPO periods or not. As seen in Table 3, there is a sharp drop in the ABP measures of IPOs from the pre-IPO to post-IPO period.

Table 3. Comparison of ABP measures of IPOs in the pre- and post-IPO periods

ABP measures	N	Mean before	Mean after	Mean change	Median before	Median after	Median change	t-statistic	z-statistic
ROA	16	0.096	–0.009	0.105	0.083	0.015	0.067	–1.329 (0.097)*	–1.655 (0.049)**
ROS	16	0.151	–0.047	0.198	0.066	0.028	0.034	–0.521 (0.303)	–0.983 (0.163)
CF/TA	16	0.117	0.009	0.108	0.091	0.033	0.058	–2.073 (0.023)**	–2.017 (0.022)**
ROE	16	0.838	0.003	0.835	0.172	0.033	0.139	–0.107 (0.458)	–0.588 (0.278)

Note: For each variable, it is calculated as change of the mean and median values from pre-IPO to post-IPO period. Wilcoxon signed rank test (z-statistic) is used as the test for significance for the change in median values, while the standard t-statistic is used for the mean change test. Probability values of z-statistic and t-statistics are in parentheses. ** and * denote significance at the 5%, and 10% levels, respectively, for two-tailed tests.

According to Table 3, both the mean and median values deteriorate entire ABP measures. The mean (median) value of ROA has fallen significantly from 9% to 0%, which is a fantastic drop of roughly 110%. Similarly, the mean value of CF/TA has significantly dropped approximately by 92%. The changes in ROS and ROE are statistically insignificant according to the Wilcoxon test and t-test, although the mean (median) arithmetically changes 19% (3%) and 83% (13%), respectively. Overall, findings show that the ABP of IPOs deteriorates following going public, which are consistent with the aforementioned literature.

4.2. Determining the objective weights of the performance evaluation criteria

As it is mentioned above, two different objective weighting methods, CRITIC and MW, are used to determine the weights of performance measures in the combined methods. According to the aforementioned explanations pertaining to the calculation processes of both these methods, the objective weights of the criteria with respect to each related performance measurement are calculated by each weighting approach and the obtained results are illustrated in Table 4 to use in VIKOR steps later.

Table 4. Objective weights of the evaluation criteria

Objective weights of ABP measures					
Method/IPO period	CF/TA	ROA	ROS	ROE	
CRITIC/pre	0.180	0.188	0.329	0.303	
MW/pre	0.250	0.250	0.250	0.250	
CRITIC/post	0.181	0.185	0.230	0.404	
MW/post	0.250	0.250	0.250	0.250	
Objective weights of VBP measures					
Method/IPO period	CFROI	CVA	REVA	MVA	EVA
CRITIC/post	0.223	0.245	0.220	0.157	0.155
MW/post	0.200	0.200	0.200	0.200	0.200
Objective weights of OP measures					
Method/IPO period	CF/TA	ROA	ROS	ROE	
CRITIC/post	0.081	0.083	0.081	0.082	
MW/post	0.111	0.111	0.111	0.111	
	CFROI	CVA	REVA	MVA	EVA
CRITIC/post	0.158	0.156	0.174	0.086	0.099
MW/post	0.111	0.111	0.111	0.111	0.111

4.3. Performance evaluations of IPOs using VIKOR with objective weights

After determining the weights of the evaluation criteria, the VIKOR method is applied for evaluating the performance of the IPOs. Thus, the rankings of IPOs with respect to ABP in the pre-IPO period, ABP in the post-IPO period, VBP in the post-IPO period and overall

performance (OP) in the post-IPO period are obtained. The decision making problem of this study has 16 alternatives and 9 criteria including four ABP and five VBP measures. The best (f_j^*) and the worst (f_j^-) values for all criteria with respect to three performance evaluations are obtained from the original data using Eq. (7). Thus, the normalized data for each performance evaluation of IPOs are calculated by using the related best and worst values.

As the two objective weighting methods are used to derive the criteria weights in this study, the calculation results of the three performance evaluations (ABP in the pre-IPO, ABP in the post-IPO, and VBP in the post-IPO periods) obtained by using the combined VIKOR-CRITIC and VIKOR-MW methods are presented in Table 5 and Table 6, respectively. In these tables, the values of S_i and R_i using Eqs. (8–9) and Q_i using Eq. (10) are calculated, and then three ranking lists of alternatives are determined, sorting by the values S_i, R_i and Q_i (for $v = 0.50$) in decreasing order.

Table 5. The results of the combined VIKOR-CRITIC method ($v = 0.50$)

ABP in the pre-IPO period						
IPOs	S_j	Rank	R_j	Rank	Q_j	Rank
ADESE	0.819	12	0.283	6	0.794	11
ATAÇ	0.181	1	0.087	1	0.000	1
AVOD	0.773	8	0.283	5	0.766	8
BERKOSAN	0.874	14	0.295	14	0.852	14
BİLİCİ	0.658	5	0.285	8	0.700	4
BİMEKS	0.786	9	0.290	13	0.790	9
BİZİM	0.656	4	0.288	11	0.706	5
DAGİ	0.722	7	0.285	9	0.739	7
ERİCOM	0.699	6	0.279	4	0.714	6
KRON	0.201	2	0.201	2	0.249	2
LOKMAN	0.818	11	0.286	10	0.800	12
MEPET	0.952	15	0.307	15	0.925	15
ÖZBAL	0.811	10	0.284	7	0.791	10
SARAY	0.845	13	0.290	12	0.824	13
UTOPYA	1.000	16	0.329	16	1.000	16
YAPRAK	0.375	3	0.274	3	0.505	3
ABP in the post-IPO period						
IPOs	S_j	Rank	R_j	Rank	Q_j	Rank
ADESE	0.203	4	0.065	2	0.107	3
ATAÇ	0.750	15	0.404	16	0.936	16
AVOD	0.268	6	0.152	8	0.273	7
BERKOSAN	0.313	10	0.157	9	0.309	10
BİLİCİ	0.288	9	0.145	6	0.275	8
BİMEKS	0.284	8	0.158	10	0.292	9

End of Table 5

ABP in the post-IPO period						
IPOs	S_j	Rank	R_j	Rank	Q_j	Rank
BİZİM	0.055	1	0.055	1	0.000	1
DAGİ	0.276	7	0.122	5	0.235	5
ERİCOM	0.479	14	0.194	13	0.466	13
KRON	0.852	16	0.256	14	0.788	15
LOKMAN	0.145	2	0.082	3	0.096	2
MEPET	0.363	12	0.177	12	0.368	12
ÖZBAL	0.460	13	0.267	15	0.558	14
SARAY	0.268	5	0.145	7	0.263	6
UTOPYA	0.180	3	0.104	4	0.150	4
YAPRAK	0.348	11	0.159	11	0.333	11
VBP in the post-IPO period						
IPOs	S_j	Rank	R_j	Rank	Q_j	Rank
ADESE	0.410	13	0.190	14	0.640	13
ATAÇ	0.537	16	0.180	12	0.799	15
AVOD	0.225	3	0.115	2	0.134	2
BERKOSAN	0.256	6	0.133	6	0.236	6
BİLİCİ	0.321	11	0.180	13	0.478	11
BİMEKS	0.374	12	0.158	10	0.490	12
BİZİM	0.447	14	0.223	15	0.796	14
DAGİ	0.291	9	0.175	11	0.417	10
ERİCOM	0.203	1	0.082	1	0.000	1
KRON	0.304	10	0.151	9	0.363	9
LOKMAN	0.229	4	0.121	3	0.160	3
MEPET	0.520	15	0.245	16	0.975	16
ÖZBAL	0.2450	5	0.131	5	0.212	5
SARAY	0.223	2	0.129	4	0.173	4
UTOPYA	0.262	8	0.137	7	0.256	8
YAPRAK	0.257	7	0.138	8	0.251	7

The ranking results of the three performance evaluations obtained by VIKOR-CRITIC are presented in Table 5 and explained as follows. In the first evaluation results (ABP in the pre-IPO period), ATAÇ is the best ranked firm, and it can be assigned as a compromise solution since it meets the two conditions C1 (Acceptable advantage: according to the result of $Q_{[2]} - Q_{[1]} = 0.2489 \geq DQ = 0.0667$) and C2 (Acceptable stability: according to the result of the best ranked in S_j and R_j). In the second evaluation results (ABP in the post-IPO period), BİZİM is the best ranked firm, and it can be assigned as a compromise solution since it meets the two conditions. In the third evaluation results (VBP in the post-IPO period), ERİCOM is the best ranked firm, and it can be assigned as a compromise solution since it meets the two conditions.

Table 6. The results of the combined VIKOR-MW method (v = 0.50)

ABP in the pre-IPO period						
IPOs	S_j	Rank	R_j	Rank	Q_j	Rank
ADESE	0.810	12	0.215	3	0.790	8
ATAÇ	0.199	2	0.072	1	0.027	1
AVOD	0.758	9	0.233	7	0.809	9
BERKOSAN	0.863	14	0.243	14	0.899	14
BİLİCİ	0.638	5	0.235	9	0.743	6
BİMEKS	0.749	8	0.240	13	0.821	10
BİZİM	0.581	4	0.219	4	0.666	4
DAGİ	0.682	7	0.235	10	0.769	7
ERİCOM	0.640	6	0.220	5	0.702	5
KRON	0.153	1	0.153	2	0.228	2
LOKMAN	0.797	11	0.235	11	0.839	12
MEPET	0.952	15	0.250	15	0.971	15
ÖZBAL	0.788	10	0.234	8	0.829	11
SARAY	0.823	13	0.239	12	0.864	13
UTOPYA	1.000	16	0.250	16	1.000	16
YAPRAK	0.339	3	0.226	6	0.541	3
ABP in the post-IPO period						
IPOs	S_j	Rank	R_j	Rank	Q_j	Rank
ADESE	0.214	4	0.059	3	0.113	4
ATAÇ	0.674	15	0.250	15	0.862	15
AVOD	0.242	5	0.094	8	0.216	7
BERKOSAN	0.294	10	0.097	9	0.255	10
BİLİCİ	0.271	9	0.090	6	0.222	8
BİMEKS	0.255	7	0.098	10	0.233	9
BİZİM	0.059	1	0.059	2	0.022	1
DAGİ	0.270	8	0.075	5	0.186	5
ERİCOM	0.481	14	0.129	13	0.446	13
KRON	0.909	16	0.250	16	1.000	16
LOKMAN	0.128	2	0.051	1	0.040	2
MEPET	0.345	12	0.110	12	0.316	12
ÖZBAL	0.409	13	0.165	14	0.494	14
SARAY	0.244	6	0.090	7	0.207	6
UTOPYA	0.168	3	0.064	4	0.099	3
YAPRAK	0.336	11	0.098	11	0.282	11
VBP in the post-IPO period						
IPOs	S_j	Rank	R_j	Rank	Q_j	Rank
ADESE	0.396	13	0.155	13	0.518	13
ATAÇ	0.601	16	0.200	14	1.000	16
AVOD	0.222	3	0.102	3	0.036	3

End of Table 6

	VBP in the post-IPO period					
IPOs	S_j	Rank	R_j	Rank	Q_j	Rank
BERKOSAN	0.250	6	0.109	6	0.105	6
BİLİCİ	0.307	11	0.147	12	0.367	12
BİMEKS	0.364	12	0.129	10	0.350	11
BİZİM	0.405	14	0.200	15	0.752	14
DAGİ	0.285	9	0.143	11	0.318	10
ERİCOM	0.206	1	0.099	1	0.000	1
KRON	0.292	10	0.123	9	0.231	9
LOKMAN	0.227	4	0.100	2	0.034	2
MEPET	0.479	15	0.200	16	0.845	15
ÖZBAL	0.244	5	0.107	5	0.088	5
SARAY	0.221	2	0.105	4	0.052	4
UTOPYA	0.264	8	0.122	8	0.188	8
YAPRAK	0.251	7	0.112	7	0.124	7

The ranking results of the three performance evaluations obtained by VIKOR-MW are also given in Table 6 and explained as follows. In the first evaluation results (ABP in the pre-IPO period), ATAÇ is the best ranked firm, and it can be assigned as a compromise solution since it meets the two conditions. In the second evaluation results (ABP in the post-IPO period), BİZİM is the best ranked firm, but it cannot be assigned as a compromise solution since it doesn't meet the condition C1. Therefore, a set of compromise solutions is identified as the best ranked firms that are LOKMAN, BİZİM, ADESE and UTOPYA. In the third evaluation results (VBP in the post-IPO period), ERİCOM is the best ranked firm, but it cannot be assigned as a compromise solution since it doesn't meet the condition C1, and thus a set of compromise solutions is identified as the best ranked firms including ERİCOM, LOKMAN, AVOD and SARAY.

Since the parameter v is introduced as the weight of the strategy of *maximum group utility*, the ranking of alternatives for the three performance evaluations in both Table 5 and Table 6 can also be calculated according to the value of the weight v between 0 and 1. Thus, a sensitivity analysis can be carried out by setting v systematically to the values of the mentioned interval, and the changes in the rankings can be tracked. The results of such an analysis are summarized in Table 7.

According to Table 7, the results of the sensitivity analysis for the three performance evaluations obtained from the two combined methods can be explained as follows. In the first evaluation results (ABP in the pre-IPO period), both combined methods present the same results since ATAÇ is the best ranked firm in the most replacements in spite of the different value of v. In the second evaluation results, BİZİM is the best ranked firm for all values of v and is the only compromise solution in the most replacements in the VIKOR-CRITIC method. Also, BİZİM is the best ranked firm in the most replacements in the VIKOR-MW method for the different value of v. Lastly, in the third evaluation results

(VBP in the post-IPO period), ERİCOM is the best ranked firm for all values of v and is the only compromise solution in the most replacements in the VIKOR-CRITIC method. According to the CRITIC-MW method, ERİCOM is the best ranked firm and four IPOs (ERİCOM, LOKMAN, AVOD and SARAY) is a set of compromise solutions for all values of v.

Table 7. Solutions for different values of v for ABP and VBP of IPOs

ABP (pre-IPO period)		
v	VIKOR-CRITIC	VIKOR-MW
0.00	ATAÇ	ATAÇ
0.25	ATAÇ	ATAÇ
0.50	ATAÇ	ATAÇ
0.75	ATAÇ	ATAÇ
1.00	ATAÇ, KRON	KRON, ATAÇ
ABP (post-IPO period)		
v	VIKOR-CRITIC	VIKOR-MW
0.00	BİZİM, ADESE	BİZİM
0.25	BİZİM	BIZIM, LOKMAN
0.50	BİZİM	LOKMAN, BIZIM, ADESE, UTOPYA
0.75	BİZİM	BIZIM, LOKMAN
1.00	BİZİM	BIZIM
VBP (post-IPO period)		
v	VIKOR-CRITIC	VIKOR-MW
0.00	ERİCOM	ERICOM, LOKMAN, AVOD, SARAY
0.25	ERİCOM	ERICOM, LOKMAN, AVOD, SARAY
0.50	ERİCOM	ERICOM, LOKMAN, AVOD, SARAY
0.75	ERİCOM	ERICOM, AVOD, LOKMAN, SARAY
1.00	ERİCOM, SARAY,AVOD	ERICOM, SARAY, AVOD, LOKMAN

The implications of the results depicted in Table 7 can also be discussed as follows. The results of the sensitivity analysis for both combined methods are mostly same with respect to the ABP of IPOs in the pre-IPO period in spite of the objective weighting methods used in here and also the different values of v. On the other hand, the results of the sensitivity analysis for both combined methods differ from each other with respect to both ABP and VBP of IPOs in the post-IPO period. While the VIKOR-CRITIC method mostly proposes a compromise solution, the VIKOR-MW method mostly proposes a set of compromise solutions. The main difference of the solutions obtained from both combined methods stems from the values of S_i and R_i calculated depending on the criteria weights since these obtained values are used to calculate the value of Q_i to determine the rank index for each alternative. Thus, the weights of criteria derived from the CRITIC method, which calculates the weights by extracting all information contained in the evaluation criteria as does not

in the MW method, can be considered as more realistic in terms of reflecting the intrinsic information of each criterion. Accordingly, the results obtained by VIKOR-CRITIC can be more meaningful for investors to make more profitable investment decisions. Moreover, it is remarkable that the value of the index rank of each alternative largely depends on the value of the v (usually it is taken as 0.50 for consensus).

Table 8. Solutions for different values of v for OP of IPOs

OP (post-IPO period)		
v	VIKOR-CRITIC	VIKOR-MW
0.00	ERİCOM	LOKMAN, AVOD, ERİCOM, SARAY
0.25	ERİCOM	LOKMAN, AVOD, SARAY
0.50	LOKMAN, ERİCOM, AVOD, SARAY	LOKMAN, AVOD
0.75	LOKMAN, AVOD	LOKMAN
1.00	LOKMAN	LOKMAN

Finally, overall performance (OP) evaluation of IPOs in the post-IPO period with the 9 evaluation criteria including ABP and VBP measures together is also analysed in this study by using both combined methods. The rankings of IPOs with respect to OP obtained using both combined methods are carried out by considering the different values of v in the interval [0, 1] such a sensitivity analysis. The results of this analysis are presented in Table 8. As can be seen from the final solutions of the sensitivity analysis, while ERİCOM is the best ranked firm for $v < 0.50$ and LOKMAN is the best ranked firm for $v \geq 0.50$ in VIKOR-CRITIC, LOKMAN is the best ranked firm in the most replacements in VIKOR-MW in spite of the different value of v. When comparing the results with respect to the value of v, both methods propose similar results for $v > 0.50$, but they propose different results for $v < 0.50$. It is notable that the changes in these results mostly depend on the objective criteria weights derived from the method CRITIC, which extracts all information contained in the evaluation criteria as mentioned above. Consequently, since the differences between the obtained results by both combined methods for the same values of v are extremely dependent on the weights of evaluation criteria, the results obtained by VIKOR-CRITIC can be more preferable than VIKOR-MW for investors in making more profitable investment decisions before leaping into any investment decision.

Conclusions

The main objective of this study is to analyse the performance of IPO firms for their pre- and post-IPO periods in an environment with multi-dimensional measures to more logically verify the performance measurement. Since the decision problem of this study depends on multi-criteria decision analysis, the VIKOR method, which is among many famous MCDM methods, is used as a MCDM tool for evaluating and ranking the IPO firms in the present study. This method applied to determine compromise solution of a MCDM problem with non-commensurable and conflicting criteria is a practical and useful tech-

nique for ranking and selection of a number of possible alternatives. In addition, criteria weights are explicitly defined with the appropriate questions posed to the decision maker for eliciting information from them. In this direction, objective weights are determined to be much more appropriate than subjective weights as conveying the rationality and veracity of criteria weights. Therefore, it is believed that the objective weights of the criteria obtained from objective methods (CRITIC and MW used in this study) can be seen as the appropriate interpretation of criteria weights to enhance the quality of the results obtained from the VIKOR method. Thus, the final rankings of IPOs are obtained with respect to not only ABP in the pre-IPO period but also ABP, VBP and OP in the post-IPO period through the combined VIKOR-CRITIC and VIKOR-MW methods.

The findings of this study have several significant theoretical and methodological aspects as follows. In terms of theoretical perspective, this study makes important contributions to the literature on performance evaluation of IPOs. While many contributing authors has long examined various aspects of the performance of IPOs, this study is unique with regard to the performance evaluation of IPOs with respect to not only traditional performance measures but also modern performance measures by considering multiple criteria explicitly and structuring complex problem well. In addition, in terms of methodological perspective, the objective weights obtained from two different objective methods are incorporated into the VIKOR method for evaluating performance of IPOs. Since the compromise solution (one or a set) proposed by VIKOR depends substantially on criteria weights in terms of both combined methods used in this study, the VIKOR-CRITIC can show more realistic results because of the differential weights assigned to criteria by the method CRITIC.

In addition, the findings of the study may also have managerial implications on decisions with regard to importance of ABP and VBP measures to evaluate more logically. This study offers investors suggestions for their investment strategies. First, this paper provides a systematic overview of performance evaluation of IPOs with its multi-dimensional perspective to guide investors in their efforts to make profitable investment. Second, this study shows at a glance which IPO firm is more profitable to co-invest and an important guideline for investors to look at the performances of IPO firms in perspective.

In a further research, some other ranking MCDM tools such as TOPSIS, COPRAS, and MOORA etc. can be alternatively used instead of VIKOR and made comparison of the results obtained in this paper with the ones from the other methods. Lastly, a further research may be the application of subjective methods for obtaining subjective criteria weights depending on the preference of decision makers in a fuzzy environment.

Acknowledgements

We would like to thank the anonymous reviewers for their helpful and constructive comments that greatly contributed to improving the final version of the paper.

References

Aalianvari, A.; Katibeh, H.; Sharifzadeh, M. 2012. Application of fuzzy Delphi AHP method for the estimation and classification of Ghomrud tunnel from groundwater flow hazard, *Arab Journal of Geosciences* 5(2): 275–284. https://doi.org/10.1007/s12517-010-0172-8

Aggarwal, R.; Leal, R.; Hernandez, L. 1993. The aftermarket performance of initial public offerings in Latin America, *Financial Management* 22(1): 42–53. https://doi.org/10.2307/3665964

Ahn, B. S. 2011. Compatible weighting method with rank order centroid: maximum entropy ordered weighted averaging approach, *European Journal of Operational Research* 212(3): 552–559. https://doi.org/10.1016/j.ejor.2011.02.017

Alanazi, A. S.; Liu, B. 2013. *IPO financial and operating performance: evidence from the six countries of the GCC*. Discussion paper series in finance. Australia: Griffith University.

Alanazi, A. S.; Liu, B.; Forster, J. 2011. The financial performance of Saudi Arabian IPOs, *International Journal of Islamic and Middle-Eastern Finance and Management* 4(2): 146–157. https://doi.org/10.1108/17538391111144533

Bacidore, J. M.; Boquist, J. A.; Milbourn, T. T.; Thakor, A. V. 1997. The search for the best financial performance measure, *Financial Analysts Journal* 53(3): 11–20. https://doi.org/10.2469/faj.v53.n3.2081

Baležentis, A.; Baležentis, T.; Misiunas, A. 2012. An integrated assessment of Lithuanian economic sectors based on financial ratios and fuzzy MCDM methods, *Technological and Economic Development of Economy* 18(1): 34–53. https://doi.org/10.3846/20294913.2012.656151

Bayrakdaroğlu, A.; Yalçın, N. 2012. Strategic financial performance evaluation of the Turkish Companies Traded on ISE, *Ege Academic Review* 12(4): 529–539. https://doi.org/10.21121/eab.2012419514

Borsa İstanbul. 2015. [online], [cited 20 January 2015]. Available from Internet: http://www.borsaistanbul.com

Boston Consulting Group. 2000. *New perspectives on value creation: a study of the worlds' top performers* [online], [cited 15 January 2015]. Available from Internet: https://www.bcg.com

Bulgurcu, B. 2013. Financial performance ranking of the automotive industry firms in Turkey: evidence from an entropy-weighted technique, *International Journal of Economics and Financial Issues* 4(3): 844–851.

Büyüközkan, G.; Görener, A. 2015. Evaluation of product development partners using an integrated AHP-VIKOR model, *Kybernetes* 44(2): 220–237. https://doi.org/10.1108/K-01-2014-0019

Chacko, G.; Evans, C. L. 2014. *Valuation-methods and models in applied corporate finance*. New Jersey: Pearson Education Inc. Press.

Chen, G. M.; Firth, M.; Kim, J.-B. 2000. The post-issue market performance of initial public offerings in China's new stock markets, *Review of Quantitative Finance and Accounting* 14(4): 319–339. https://doi.org/10.1023/A:1008358609204

Cheng, J. M. S.; Tsao, S. M.; Tsai, W. H.; Tu, H. H. 2007. Will eChannel additions increase the financial performance of the firm?—The evidence from Taiwan, *Industrial Marketing Management* 36(1): 50–57. https://doi.org/10.1016/j.indmarman.2006.06.011

Chou, Y. C.; Yen, H. Y.; Sun, Y. Y. 2014. An integrate method for performance of women in science and technology based on entropy measure for objective weighting, *Quality and Quantity* 48(1): 157–172. https://doi.org/10.1007/s11135-012-9756-6

Copeland, T.; Koller, T.; Murin, J. 2000. *Valuation: measuring and managing the value of companies*. New York: John Wiley & Sons.

Damodaran, A. 1999. *Value creation and enhancement: back to the future*. Working paper. New York: New York University Stern School of Business.

Deng, H.; Yeh, C.-H.; Willis, R. J. 2000. Inter-company comparison using modified TOPSIS with objective weights, *Computers and Operations Research* 27(10): 963–973. https://doi.org/10.1016/S0305-0548(99)00069-6

Diakoulaki, D.; Mavrotas, G.; Papayannakis, L. 1995. Determining objective weights in multiple criteria problems: the CRITIC method, *Computers and Operations Research* 22(7): 763–770. https://doi.org/10.1016/0305-0548(94)00059-H

Erasmus, P. D. 2008. Evaluating value based financial performance measures: PhD thesis. Stellenbosch, Western Cape, South Africa, Stellenbosch University.

Ergul, N.; Seyfullahogullari, C. A. 2012. The ranking of retail companies trading in ISE, *European Journal of Scientific Research* 70(1): 29–37.

Ertuğrul, İ.; Karakaşoğlu, N. 2009. Performance evaluation of Turkish cement firms with fuzzy analytic hierarchy process and TOPSIS methods, *Expert Systems with Application* 36(1): 702–715. https://doi.org/10.1016/j.eswa.2007.10.014

Gallizo, J. L.; Salvador, M. 2003. Understanding the behavior of financial ratios: the adjustment process, *Journal of Economics and Business* 55(3): 267–283. https://doi.org/10.1016/S0148-6195(03)00022-5

Ginevičius, R.; Podvezko, V. 2006. Assessing the financial state of construction enterprises, *Technological and Economic Development of Economy* 12(3): 188–194.

Goergen, M.; Renneboog, L. D. R. 2003. *Insider retention and long-run performance in German and UK IPO's*. Discussion paper. Tilburg, Netherlands: Tilburg University, Tilburg Law and Economic Center.

Helfert, E. A. 2001. *Financial analysis tools and techniques*. USA: McGraw-Hill Press.

Holthausen, R. W.; Larcker, D. F. 1996. The financial performance of reverse leveraged buyouts, *Journal of Financial Economics* 42(3): 293–332. https://doi.org/10.1016/0304-405X(96)00884-7

Hsu, L.-C. 2014. A hybrid multiple criteria decision-making model for investment decision making, *Journal of Business Economics and Management* 15(3): 509–529. https://doi.org/10.3846/16111699.2012.722563

Hsu, L.-C. 2015. Using a decision-making process to evaluate efficiency and operating performance for listed semiconductor companies, *Technological and Economic Development of Economy* 21(2): 301–331. https://doi.org/10.3846/20294913.2013.876689

Hwang, C.-L.; Yoon, K. 1981. *Multiple attribute decision making – methods and applications: a state-of-the-art survey*. New York: Springer-Verlag. https://doi.org/10.1007/978-3-642-48318-9

Ignatius, J.; Behzadian, M.; Malekan, H. S.; Lalitha, D. 2012. Financial performance of Iran's automotive sector based on PROMETHEE II, in *2012 IEEE International Conference on Management of Innovation and Technology (ICMIT)*, 11–13 June 2012, Bali, Indonesia. https://doi.org/10.1109/ICMIT.2012.6225775

Jahan, A.; Mustapha, F.; Sapuan, S. M.; Ismail, M. Y.; Bahraminasab, M. 2012. A framework for weighting of criteria in ranking stage of material selection process, *The International Journal of Advanced Manufacturing Technology* 58(1–4): 411–420. https://doi.org/10.1007/s00170-011-3366-7

Jain, B. A.; Kini, O. 1994. The post-issue operating performance of IPO firms, *The Journal of Finance* 49(5): 1699–1726. https://doi.org/10.1111/j.1540-6261.1994.tb04778.x

Kang, D.; Park, Y. 2014. Review-based measurement of customer satisfaction in mobile service: sentiment analysis and VIKOR approach, *Expert Systems with Applications* 41(4): 1041–1050. https://doi.org/10.1016/j.eswa.2013.07.101

Kaplan, S. 1989. The effects of management buyouts on operating performance and value, *Journal of Financial Economics* 24(2): 217–254. https://doi.org/10.1016/0304-405X(89)90047-0

Kazan H.; Özdemir, Ö. 2014. Financial performance assessment of large scale conglomerates via TOPSIS and critic methods, *Journal of Management and Sustainability* 3(4): 203–224.

Kim, K. A.; Kitsabunnarat, P.; Nofsinger, J. R. 2004. Ownership and operating performance in an emerging market: evidence from Thai IPO firms, *Journal of Corporate Finance* 10(3): 355–381. https://doi.org/10.1016/S0929-1199(02)00019-6

Lee, S.; Kim, W. G. 2009. EVA, refined EVA, MVA, or traditional performance measures for the hospitality industry?, *International Journal of Hospitality Management* 28(3): 439–445. https://doi.org/10.1016/j.ijhm.2009.01.004

Liu, H. C.; You, J. X.; You, X. Y.; Shan, M. M. 2015. A novel approach for failure mode and effects analysis using combination weighting and fuzzy VIKOR method, *Applied Soft Computing* 28: 579–588. https://doi.org/10.1016/j.asoc.2014.11.036

Liu, H.-C.; Liu, L.; Wu, J. 2013. Material selection using an interval 2-tuple linguistic VIKOR method considering subjective and objective weights, *Materials and Design* 52: 158–167. https://doi.org/10.1016/j.matdes.2013.05.054

Loughran, T.; Ritter, J. R. 1995. The new issues puzzle, *The Journal of Finance* 50(1): 23–51. https://doi.org/10.1111/j.1540-6261.1995.tb05166.x

Lye, A. C. L. 1999. *The long- run operating performance of IPO firms in Australia*: Honours thesis. Australia, The University of Queensland.

Madden, B. J. 2003. *Cash Flow Return On Investment (CFROI) valuation: a total system approach to valuing the firm*. Burlington, England: Butterworth-Heinemann.

Mardani, A.; Zavadskas, E. K.; Govindan, K.; Amat Senin, A.; Jusoh, A. 2016. VIKOR technique: a systematic review of the state of the art literature on methodologies and applications, *Sustainability* 8(1): 1–38. https://doi.org/10.3390/su8010037

Martin, J. D.; Petty, J. W. 2000. *Value based management: the corporate response to the shareholder revolution*. Boston: Harvard Business School Press.

Megginson, W. L.; Nash, R. C.; Randenborgh, M. V. 1994. The financial and operating performance of newly privatized firms: an international empirical analysis, *The Journal of Finance* 49(2): 403–452. https://doi.org/10.1111/j.1540-6261.1994.tb05147.x

Mikkelson, W. H.; Partch, M. M.; Shah, K. 1997. Ownership and operating performance of companies that go public, *Journal of Financial Economics* 44(3): 281–307. https://doi.org/10.1016/S0304-405X(97)00006-8

Opricovic, S. 1998. Multi-criteria optimization of civil engineering systems: PhD dissertation. Belgrade, Faculty of Civil Engineering.

Opricovic, S. 2011. Fuzzy VIKOR with an application to water resources planning, *Expert Systems with Applications* 38(10): 12983–12990. https://doi.org/10.1016/j.eswa.2011.04.097

Opricovic, S.; Tzeng, G. H. 2004. Compromise solution by MCDM methods: a comparative analysis of VIKOR and TOPSIS, *European Journal of Operational Research* 156(2): 445–455. https://doi.org/10.1016/S0377-2217(03)00020-1

Palepu, K. G.; Healy, P. M.; Bernard, V. L. 2000. *Business analysis and valuation: using financial statements*. Cincinnati, Ohio: South-Western College Publishing.

Public Disclosure Platform. 2015. [online], [cited 10 January 2015]. Available from Internet: https://www.kap.org.tr/

Rekik, Y. M.; Boujelbene, Y. 2013. Tunisian IPOs underpricing and long-run underperformance: highlight and explanation, *Journal of Business Management and Economics* 4(4): 93–104.

Republic of Turkey Prime Ministry Undersecretariat of Treasury. 2015. [online], [cited 10 January 2015]. Available from Internet: http://www.treasury.gov.tr

Rezaie, K.; Ramiyani, S. S.; Nazari-Shirkouhi, S.; Badizadeh, A. 2014. Evaluating performance of Iranian cement firms using an integrated fuzzy AHP–VIKOR method, *Applied Mathematical Modelling* 38(21–22): 5033–5046. https://doi.org/10.1016/j.apm.2014.04.003

Ritter, J. R. 1991. The long-run performance of initial public offerings, *The Journal of Finance* 46(1): 3–27. https://doi.org/10.1111/j.1540-6261.1991.tb03743.x

Rostamzadeh, R.; Ismail, K.; Zavadskas, E. K. 2014. Multi criteria decision making for assisting business angels in investments, *Technological and Economic Development of Economy* 20(4): 696–720. https://doi.org/10.3846/20294913.2014.984364

Safaei Ghadikolaei, A.; Khalili Esbouei, S.; Antucheviciene, J. 2014. Applying fuzzy MCDM for financial performance evaluation of Iranian companies, *Technological and Economic Development of Economy* 20(2): 274–291. https://doi.org/10.3846/20294913.2014.913274

Shemshadi, A.; Shirazi, H.; Toreihi, M.; Tarokh, M. J. 2011. A fuzzy VIKOR method for supplier selection based on entropy measure for objective weighting, *Expert Systems with Applications* 38(10): 12160–12167. https://doi.org/10.1016/j.eswa.2011.03.027

Stewart, G. B. 1990. *The quest for value: the EVA management guide*. New York: Harper Business.

Stewart, G. B. 1991. *The quest for value: a guide for senior managers*. New York: Harper Business.

Turskis, Z.; Zavadskas, E. K. 2010. A novel method for multiple criteria analysis: Grey Additive Ratio Assessment (ARAS-G) method, *Informatica* 21(4): 597–610.

Tzeng, G. H.; Chen, T. Y.; Wang, J. C. 1998. A weight-assessing method with habitual domains, *European Journal of Operational Research* 110(2): 342–367. https://doi.org/10.1016/S0377-2217(97)00246-4

Urbanczyk, E.; Midoduchowska-Jaroszewicz, E.; Szczesna-Urbaniak, A. 2005. Economic value added versus cash value added: the case of companies in transitional economy, Poland, *International Journal of Banking and Finance* 3(1): 107–117.

Wang, C. 2005. Ownership and operating performance of Chinese IPOs, *Journal of Banking and Finance* 29(7): 1835–1856. https://doi.org/10.1016/j.jbankfin.2004.07.003

Wang, J. J.; Jing, Y. Y.; Zhang, C. F.; Zhao, J. H. 2009. Review on multi-criteria decision aid in sustainable energy decision-making, *Renewable and Sustainable Energy Reviews* 13(9): 2263–2278. https://doi.org/10.1016/j.rser.2009.06.021

Wang, Y. J. 2014. The evaluation of financial performance for Taiwan container shipping companies by fuzzy TOPSIS, *Applied Soft Computing* 22: 28–35. https://doi.org/10.1016/j.asoc.2014.03.021

Wang, Y. J.; Lee, H. S. 2010. Evaluating financial performance of Taiwan container shipping companies by strength and weakness indices, *International Journal of Computer Mathematics* 87(1): 38–52. https://doi.org/10.1080/00405000701489412

Yalama, A.; Ünlü, U. 2010. The calendar anomalies in IPO returns: evidence from Turkey, *Journal of Economics Business and Finance* 25(286): 89–109.

Yalçın, N.; Bayrakdaroglu, A.; Kahraman, C. 2012. Application of fuzzy multi-criteria decision making methods for financial performance evaluation of Turkish manufacturing industries, *Expert Systems with Applications* 39(1): 350–364. https://doi.org/10.1016/j.eswa.2011.07.024

You, X. Y.; You, J. X.; Liu, H. C.; Zhen, L. 2015. Group multi-criteria supplier selection using an extended VIKOR method with interval 2-tuple linguistic information, *Expert Systems with Applications* 42(4): 1906–1916. https://doi.org/10.1016/j.eswa.2014.10.004

Young, S. D.; O'Byrne, S. F. 2001. *EVA and value-based management: a practical guide to implementation*. New York: McGraw-Hill.

Yu, P. L. 1973. A class of solutions for group decision problems, *Management Science* 19(8): 936–946. https://doi.org/10.1287/mnsc.19.8.936

Yurdakul, M.; İç, Y. T. 2003. An illustrative study aimed to measure and rank performance of Turkish automotive companies using TOPSIS, *Journal of the Faculty of Engineering and Architecture of Gazi University* 18(1): 1–18.

Zardari, N. H.; Ahmed, K.; Shirazi, S. M.; Yusop, Z. B. 2015. *Weighting methods and their effects on multi-criteria decision making model outcomes in water resources management*. Springer Briefs in Water Science and Technology, Springer International Publishing.

Zavadskas, E. K.; Turskis, Z. 2011. Multiple criteria decision making (MCDM) methods in economics: an overview, *Technological and Economic Development of Economy* 17(2): 397–427. https://doi.org/10.3846/20294913.2011.593291

Zeleny, M. 1982. *Multiple criteria decision making*. New York: McGraw-Hill.

Neşe YALÇIN. She is Associate Professor of Quantitative Methods, Department of Business Administration, Nevşehir Hacı Bektaş Veli University, Turkey. She received her PhD in Production Management from Erciyes University, Turkey. Her articles have appeared in journals such as *Human and Ecological Risk Assessment*, *Utilities Policy*, *Expert Systems with Applications*, *International Journal of Production Research* and *The International Journal of Advanced Manufacturing Technology*. Her research interests include operations research, multiple criteria decision analysis, application of fuzzy sets and systems, (fuzzy) performance evaluation, finance, production management and assembly line balancing.

Ulaş ÜNLÜ. He received the Master degree in Finance, Anadolu University, Turkey and the PhD degree in accounting and finance, Erciyes University, Turkey. He is currently Associate Professor in Nevşehir Hacı Bektaş Veli University, Turkey. His main research interests are asset pricing, initial public offering and value based management.