International Journal of Scientific Management and Development ISSN:2345-3974
Vol.3 (6), 414-423 June (2015)

Research Paper

Evaluation and Prioritizing financial factors affecting price index in the stock market using fuzzy TODIM method

Jamal Rahmani[1], Kamal Ramoushjan[*2], Alireza Arshadikhamseh[3], Tayybeh Hatamimanesh[4]
1MA Student, Kharazmi University, Faculty of Engineering, Industrial Engineering Department, Tehran, Iran.
2MA Student, Kharazmi University, Faculty of Engineering, Industrial Engineering Department, Tehran, Iran.
3Assistant Professor, Kharazmi University, Faculty of Engineering, Industrial Engineering Department, Tehran, Iran.
4MA Student, Kharazmi University, Faculty of Engineering, Industrial Engineering Department, Tehran, Iran.

Available online at: www.IJSMD.Com
Received 22th February 2015, Revised 2th April 2015, Accepted 14th April 2015

Abstract
companies' dynamism and success depend upon assessing, counter posing, and identifying the pros and cons of their performance and it would be useful for managers, policy makers and stock market Investors as well as investors to compare companies operating in different domains of industries, yet the critical issue is to set appropriate criteria, indicators and models to do the rankings.
Since there are a variety of companies-ranking criteria in the stock market which affect and take effect, it is essential to make use of multi-indexes decision models to set priorities. Environment uncertainty is an important factor challenging decision-making which could severely confuse investors. No integrative, inclusive conceptual algorithm has so far been introduces to lessen this uncertainty. Taking this approach, In this paper try to apply the integrative approach as well as fuzzy theories and independent multi-indexes technique in uncertain conditions (known as TODIM) to identify uncertainty present in assessing criteria that influence price index of the stock market. The TODIM approach has been developed to support MCDA under uncertainty. This research is the first study in the ranking the factors of stock market. At the end. An illustrative example is also presented to show the efficiency of our model.
Keyword: : multi-indexes decisions, fuzzy theories, TODIM, stocks

Introduction

Nowadays, stocks, as a crucial tool in the capital market, play a significant role in the increased economy and lay the groundwork for economic prosperity through price setting, reducing risk, providing resources as well as optimal assets allocation. An index is a means to measure and compare phenomena that possess certain qualities and properties (pakdin, 2008).

The fiscal part of each country's economy is considered to supply financial resources needed for the expansion of true economic transactions generally including dollars and financial markets. The state of price index in the stock market is an important criterion to evaluate financial markets of countries which has been used as an important way in order to examine the stock market internal and external feedbacks and as a base for decisions made by investors.

The application of price index of shares is extensive and important for both investors to put money into private joint-stock sector and as economic index from macroeconomics' perspective, for shares of companies and manufacturing and economic sectors are exchanged in the stock market. For that matter and recognizing the importance macroeconomics policies and variables as well which can have a considerable effect in the capital market, the present paper, for the first time, attempts to prioritize financial factors influencing the stock market price index using fuzzy TODIM technique. The fuzzy property used here considerably increases managers and decision makers' capability of decision making in assessing each criterion so that opinions could get closer to reality. Strong mathematic foundation of this technique, on the other hand, as opposed to other methods in the area of MCDM has considerably increased its capability to support outcomes in validity and reliability. Next we review the literature. Then fuzzy TODIM method is introduced and last section will consider a case example, pointing out its numerical results.

Literature review

A lot of attention has been paid to factors influencing the stock market price index to identify and measure types of factors and their influence in today's complex, fast-changing environment. Therefore, making reference to the relevant theories, we present an integrative, exhaustive model. Investigating the short and long term relations between inflation rate and true nominal price index in the U.S. in a 132 month time period (1991-2003), Kim and In (2005) found the short-term relationship between the two variable is negative but the long-term relationship is the opposite. They concluded the relationship between inflation and price index is varying in time and depends on the time of investigation (kim and in, 2005). Gan et al (2006) examined the relationship between New Zeeland's stock market index with seven major economic variables through 1990-2003, indicating that there is a significant relationship between the stock market index and the independent variables during the term (Gan et al, 2006). Based on Bhanot (2006)'s theory, we take account of political factors as the criteria being considered. According to him, government's interventions impact on the stock market index, and unusual outcomes during the period would depend more on general activities from the government than its specific interventions. This is more n consistent with the impact of information than that of price pressure. Public ownership maintenance positively influences the stock market price performance (Bhanot, 2006). We adopted structural factors from Boardman and Claude's (2000) theory suggesting that firm's size has a negative impact on the stock market price performance (Boardman and Claude's, 2000). Amiri (2009), in his theory, argues that managerial factors and marketing can influence shares price. In other words, he explains that managerial factors play a role in the company's success or failure and, consequently, in shares price (Amiri, 2009). In their theory, Kevin and Vinod (2001) suggest Total

*Correspondent Author: Kamal Ramoushjan (ramooshjankamal@yahoo.com)
Manuscript No: IJSMD-KINA-2014-483

Quality Management (TQM) has effect on shares price and that TQM could bring wealth to the organization. Based on all said above, marketing and managerial factors can be adopted from the extant theories (Kevin and Vinod, 2001). Bartram (2007) considered how shares price as opposed to currency and inflation rates was affected, demonstrating amongst all economic variables, market interest rate and currency rate has the main effect on shares price index (Bartram, 2007). Amiri (2009) came to conclusion that disclosure of financial inventories, as a financial factor, influences shares price index (Amiri,2009). In his research, Jamshidi (1988) concludes the ratio of price on income impacts on shares price index. Examining the effect of mental factors from past variation in shares price on tendency to shares purchasing and price index, Huddart et al (2006) confirmed such effect exists. Scholars have found that the extent of transactions matters more, both in terms of statistics and economy, when the current prices exceed the prices of last year. The past highest price acts as a reference for investors to decide whether or not to purchase shares (Huddart et al, 2006). We have concluded that past variation in shares influence investors' decision as to whether to purchase shares. Investigating effect of various factors on shares prices, Boardman and Claude (2000) confirmed such an effect and identified such factors as government, gold share, type of industry, and time periods (Boardman and Claude, 2000). Examining the relationship between a company's shares price and the average price of other companies' shares, Heins and Allison (1996) concluded that changes in a company's shares price is contingent on numerous factors rather than the average stock of shares in the market which is not considered here. Considering the relationship between a company's shares price with the average price of other firms' shares, they found that the average price of other firms' shares has no effect on variations in a company's shares price and that its shares price is dependent on other variables and factors and is independent of the average price of other companies' shares (Heins and Allison, 1996). In their study, Kalev, Liu and Pham (2002) found an increase in the extent of transaction, price variations, and news coming to the market in the beginning and ending of each day's transaction suggest positive inter-relationships between these variables (Kalev, liu and pham, 2002). Based on the theory of effective markets, Ivsia (2001), of MIT, examined the financial behaviors of shareholders in the U.S. NASDAQ stock market in relation to the ways in which they make decisions over the shares of high tech companies; results showed that shareholders' decisions over such shares aren't in accord with the extant theories of financial management, and in spite of low gains and low EPS of such companies, their shares are increasingly on demand, because of shareholders' expectations of bright future of these companies (Ivais, 2001). Epstein (1994) points to firms' annual fiscal reports as invaluable and insignificant factor on investors' decisions.

The fuzzy TODIM

Combining fuzzy set theory and TODIM is a novel approach. TODIM is a Crete multi criteria method founded on prospect theory (Kahraman et al, 2003) The TODIM method has been successfully used and empirically validated in different applications (Gomez et al,1992; Tzeng et al,2002). This method is based on a description, proved empirically, of how people make effective decisions when faced with risk. Although not all multi criteria problems address risk, the shape of the value function of TODIM is identical to prospect theory's gain and loss function TODIM's multi criteria value function is composed in parts whose mathematical descriptions reproduce the gain and loss function The global multi criteria value function of TODIM then aggregates all measures of gains and losses by considering all criteria. Introducing expressions of losses and gains in the multi criteria function is incorporated into the TODIM formulation. Gomes et al (2009) apply TODIM to investigate and recommend options for upstream projects for the natural gas reserves recently discovered in the Mexilhão field in the Santos Basin, Brazil. In addition Gomes and Rangel (Gomez et al, 2009) presented an evaluation of residential properties with real estate agents in Brazil and define a reference value for the rents of these properties' characteristics using the TODIM method of multi criteria decision. This approach can assist professionals in the real estate market to evaluate alternatives clearly using the criteria defined by specialists. In general, TODIM can be used for qualitative and quantitative criteria. Verbal scales of qualitative criteria are converted into cardinal scales, and both types of scales are normalized. The relative measure of dominance of one alternative over another alternative is determined for each pair of alternatives. This measure is computed as the sum of all criteria of relative gain and loss values for these alternatives. The parts of this sum will be a gain, a loss, or a zero, depending on the performance of each alternative with respect to each criterion.

Because the TODIM evaluation criteria are subjective, qualitative and described with linguistic information (Gomez et al, 1992) fuzzy set theory provides a more desirable evaluation tool to assist managers This theory helps to address the vagueness of human thought and expression in decision making. In particular, fuzzy set theory tackles the ambiguities involved in the process of linguistic estimation and provides a beneficial method for converting these linguistic terms into triangular fuzzy numbers (TFNs) due to the defuzzification operations in process. The defuzzification captures the importance of the criteria based on decision-makers' opinions (Triantaphilo, 1996; Tseng et al, 2008; Zhang and Zhai, 2011). However, no study has jointly considered the fuzzy set theory and TODIM. By proposing a hybrid fuzzy set and TODIM approach, this study enables the qualitative measures in linguistic terms to be presented by TFNs and to be defuzzified subsequently into a crisp value for analysis. TODIM will then be applied to **z** the alternatives using gain and loss function.

Method

This study focused on Stoke Price Index and their relevant associations as described below. The definitions of TFNs, perspective theory TODIM and the procedures of the proposed approach are also briefly discussed.

A fuzzy set Ã in a universe of discourse X is characterized by the membership function $\mu_{\tilde{A}}\sim(x)$ that assigns each element x in X a real number in the interval [0;1]. The numerical value $\mu_{\tilde{A}} \sim (x)$ stands for the grade of membership of x in A (Leong and Cao, 2000; Kuo et al, 2002; Mikhailov and Tsvetiov, 2004).

Table 1 presents the corresponding interval-valued TFNs with linguistic preferences.

Table 1.Corresponding TFNs to linguistic preferences

Linguistic preferences	Interval – valued TFNs
Very poor	[(0,0),0,(1,1.5)]
Poor	[(0,0.5),1,(2.5,3.5)]
Medium poor	[(0,1.5),3,(4.5,5.5)]
Medium	[(2.5,3.5),5,(6.5,7.5)]
Medium good	[(4.5,5.5),7,(8,9.5)]
Good	[(5.5,7.5),9,(9.5,10)]
Very good	[(8.5,9.50,10,(10,10)]

Definition 1. A TFN $\tilde{a}$ is defined by a triangular $\tilde{a} = (a_1, a_2, a_3)$ with

$$\mu_{\tilde{a}}(x) = \begin{cases} 0 & x < a_1 \\ \frac{x - a_1}{a_2 - a_1} & a_2 \geq x \geq a_1 \\ \frac{a_3 - x}{a_3 - a_2} & a_3 \geq x \geq a_2 \\ 0 & OW \end{cases} \quad (1)$$

Definition 2. Let $\tilde{a} = (a_1, a_2, a_3)$ and $\tilde{b} = (b_1, b_2, b_3)$ be two TFNs, where $a_1 \leq a_2 \leq a_3$, and $b_1 \leq b_2 \leq b_3$. The distance between $\tilde{a}$ and $\tilde{b}$ is

$$\delta(\tilde{a}, \tilde{b}) = \sqrt{\frac{1}{3}[(a_1 - b_1) + (a_2 - b_2) + (a_3 - b_3)} \quad (2)$$

The TFN is based on a three-value judgment: the minimum possible.

Value a_1, the mean possible value a_2 and the maximum possible value a_3. The criteria values depend on linguistic preferences.

The weight vector $w = (w_1, w_2, w_3)$ of the criteria is unknown but satisfies $w_j \geq 0\ j = 0,1,2,..,n$, with $\sum_{j=1}^{n} w_j = 1$. Suppose that the criterion C_j is denoted $\tilde{c}_{ij}$. Then, $\tilde{C} = [\tilde{c}_{ij}]_{m \times n}$ is a fuzzy decision matrix. In Fig. 1, $\tilde{c}_{ij}$ is expressed in an interval-valued TFN:

$$\tilde{C} = \begin{cases} a_1, a_2, a_3 \\ a_1, a_2, a_3 \end{cases} \quad (3)$$

Then, $\tilde{c} = [(a_1, a_1'); a_2; (a_3', a_3)]$. The normalized decision matrix $\tilde{R}$ can thus be calculated. Given $\tilde{C}_{ij} = [(a_{ij}, a_{ij}'); a_{ij}; (a_{ij}', a_{ij})]$, the normalized performance rating is

$$\tilde{r}_{ij} = \left[\left(\frac{a_{ij}}{d_j^+}, \frac{a_{ij}'}{d_j^+}\right); \frac{b_{ij}}{d_j^+}; \left(\frac{a_{ij}'}{d_j^+}, \frac{a_{ij}}{d_j^+}\right)\right], \quad i = 1,2,\ldots,m \quad ; \quad j = 1,2,\ldots,n \qquad for \quad j \in I \quad (4)$$

$$\tilde{r}_{ij} = \left[\left(\frac{a_j^-}{a_{ij}}, \frac{a_j^-}{a_{ij}'}\right); \frac{a_j^-}{a_{ij}}; \left(\frac{a_j^-}{a_{ij}'}, \frac{a_j^-}{a_{ij}}\right)\right], \quad i = 1,2,\ldots,m; \quad j = 1,2,\ldots,n \ for \quad j \in I \quad (5)$$

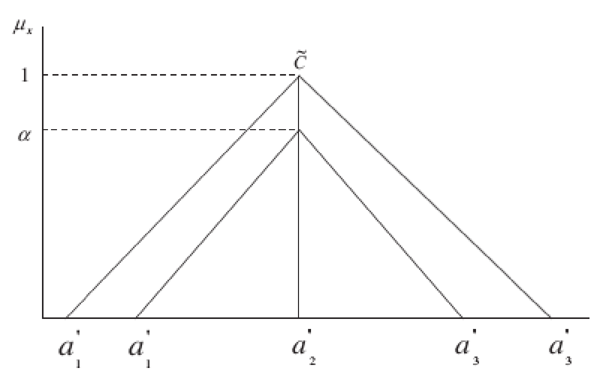

Fig 1. An interval-valued TFNs (from Zhang et al,2011)

Where $d_j^+ = max_i\{c_{ij}, i = 1, \ldots, m\}$, and $d_j^- = min_i\{a_{ij}, i = 1, \ldots, m\}$. Given that $\tilde{r}_{ij} = [(l_{ij}, l'_{ij}); m_{ij}; (u_{ij}, u'_{iij})]$, $\tilde{R} = [r_{ij}]_{m\times n}$ can be obtained and $R_0 = (r_{01}, r_{01}, \ldots, r_{0n}) = ([(1,1); 1; (1,1)], [(1,1); 1; (1,1)], \ldots, [(1,1); 1; (1,1)])$.

The distance between the reference value and each comparison value can be calculated using Definition 2:

$$\delta_{ij}^{(1)} = \sqrt{\frac{1}{3}\left[\left(l'_{ij} - 1\right) + \left(m_{ij} - 1\right) + \left(u'_{ij} - 1\right)^2\right]} \qquad (6)$$

$$\delta_{ij}^{(2)} = \sqrt{\frac{1}{3}\left[\left(l_{ij} - 1\right) + \left(m_{ij} - 1\right) + \left(u_{ij} - 1\right)^2\right]}$$

This calculation is used to determine the distance between the reference value and the comparison value in the interval $\delta_{ij} = \left[\delta_{ij}^{(1)}, \delta_{ij}^{(2)}\right]$. Hence, this study uses a formula to determine the criteria weight (Zhang and Zhai, 2011)

$$w_j = \frac{\sum_{i=1}^{m}(\delta_{ij}^{(1)} + \delta_{ij}^{(2)})}{\sum_{i=1}^{m}\sum_{j=1}^{n}(\delta_{ij}^{(1)} + \delta_{ij}^{(2)})} \qquad (7)$$

The weight vector of the criteria is applied to decision matrix A. The reference series and the comparison series constitute the interval

value $\delta_{ij} = \left[\delta_{ij}^{(1)}, \delta_{ij}^{(2)}\right]$.

The concept of a linguistic preference is useful to address uncertainties, i.e., for description in conventional linguistic expressions. Table 1 indicates how the interval-valued triangular fuzzy membership functions can accommodate the qualitative data while the evaluators process the evaluation in the form of linguistic information.

Prospect theory

The value function used in the prospect theory is described in form of a power law expressed as

$$v(x) = \begin{cases} x^{\alpha} & if\ x \geq \\ -\theta(-x)^{\beta} & if\ x < 0 \end{cases}, \qquad (8)$$

where α and β are parameters related to gains and losses, respectively. The parameter θ represents a characteristic that is steeper for losses than for gains when considering cases for which risk aversion $\theta > 1$. Fig. 2 shows a prospect value function with a concave and a convex S=shaped for gains and losses, respectively. Kahneman and Tversky (1979) determined the values of $\alpha = \beta = 0.88$ and $\theta = 2.25$, both of which values are consistent with empirical data. The study also suggested that θ is between 2.0 and 2.5. In addition, Abdellaoui (2000) suggested the values α = 0.89 and β = 0.92 (see Fig. 2).

TODIM

The TODIM method uses paired comparisons between the criteria by using technically simple resources to eliminate occasional inconsistencies resulting from these comparisons. TODIM allows value judgments to be performed on a verbal scale using a criteria hierarchy, fuzzy value judgments and interdependence relationships among the alternatives. The decision matrix consists of alternatives and criteria. The alternatives $(A_1, A_2, \ldots, A_M)$ are viable alternative, $c_1, c_2, \ldots, c_n$ are represented criteria, and x_{ij} indicates the rating of the alternative A_{ij} according to the criteria c_j. The weight vector $w = (w_1, w_2, \ldots, w_n)$ comprises the individual Weights w_j $(j = 1,2, \ldots, n)$ for each criterion c_j satisfying $\sum_i^n w_j = 1$.

The data of the decision matrix A originate from different sources. The matrix is required to normalize it to transform it into a dimensionless matrix and allows various criteria to be compared. This study uses the normalized decision matrix $R = [r_{ij}]_{m\times n}$, with $i = 1, \ldots, m$, and $j = 1, \ldots, n$.

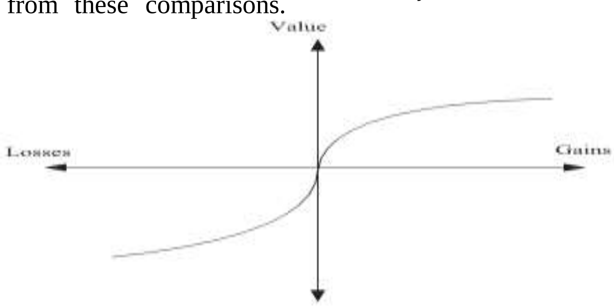

Fig 2. Value function of the TODIM method

$$A = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix} \quad (9)$$

TODIM then calculates the partial dominance matrices and the final dominance matrix. The first calculation that the decision makers must define is a reference criterion (typically the criterion with the greatest importance weight). Therefore, w_{rc} indicates the weight of the criterion c divided by the reference criteria r. TODIM is expressed by the following equations (Gomez et al, 1992). The dominance of each alternative over each alternative is

$$\delta(A_i, A_j) = \sum_{c=1}^{m} \varphi_c(A_i, A_j)_{\forall(i.j)} \quad (10)$$

Where

$$\varphi(A_i, A_j) = \begin{cases} \sqrt{\dfrac{w_{rc}(x_{ic} - x_{jc})}{\sum_{c=1}^{m} w_{rc}}} & if\ (x_{ic} - x_{jc}) > 0 \\ 0 & if\ (x_{ic} - x_{jc}) = 0 \\ \dfrac{-1}{\theta}\sqrt{\dfrac{(\sum_{c=1}^{m} w_{rc})(x_{jc} - x_{ic})}{w_{rc}}} & if\ (x_{ic} - x_{jc}) < 0 \end{cases} \quad (11)$$

The term$\emptyset_c(A_i, A_j)$ represents the contribution of criterion $c\ (c = 1,2,..,m)$ to the function $\emptyset_c(A_i, A_j)$ when comparing alternative i with alternative j. The parameter θ r represents the attenuation factor of the losses, whose mitigation depends on the specific problem. A positive$(x_{ij} - x_{jc})$ represents a gain, whereas a nil or a negative $(x_{ij} - x_{jc})$ represents a loss. The final matrix of dominance is obtained by summing the partial matrices of dominance for each criterion. The global value of the alternative i is determined by normalizing the final matrix of dominance according to the following expression:

$$\xi_i = \frac{\sum \delta(i.j) - min \sum \delta(i,j)}{mzx \sum \delta(i,j) - min \sum \delta(i,j)} \quad (12)$$

Ordering the values ξ_i provides the rank of each alternative, and better alternatives have higher values of ξ_i . The use of numerical values in rating alternatives may be limited in their capacity to address uncertainties. Therefore, an extension of TODIM is proposed to solve problems with decision making with uncertain data resulting in fuzzy TODIM. In practical applications, the triangular shape of the membership function is often used to represent fuzzy numbers. Fuzzy models using TFNs proved highly effective for solving decision-making problems for which the available information is imprecise. Hence, this study provides some basic definitions of fuzzy set theory (Tseng et ai, 2008).

Proposed approach

This study attempts to apply fuzzy set theory and TODIM to incorporate 16 stoke price index evaluation criteria. The objective is to analyze how the proposed hybrid method can be used to determine the criteria and the alternatives. The expert group applies the proposed approach using the following four step:

1. The relevant information from a literature review and expert opinions is required to confirm stoke price index reliability. Compose the measures on a qualitative scale, and confirm reliable criteria The definition of TFN is presented in Eqs. (1) and (2).

2. Interpret the linguistic preferences for the interval-valued TFNs. Use linguistic preferences to convert the interval-valued TFNs into crisp values, and then perform fuzzy assessments according to Eqs. (3)–(6) to remove the fuzziness and to aggregate the measures into a crisp value(w_j).

3. Use Eq. (7) to determine the initial interval-valued TFNs decision Matrix A. The term $\emptyset_c = (\tilde{A}_i, \tilde{A}_j)$ represents the contribution of the criterion c to the function $\delta(\tilde{A}_i, \tilde{A}_j)$ when comparing alternative i with alternative j using Eqs. (10) and (11). The final matrix of dominance is obtained by summing the partial matrices of dominance for each criterion.

4. Calculate the global value of the alternatives by normalizing the final matrix of dominance using Eq. (12). Ordering the values ξ_i provides the rank of each alternative. The best alternatives are

those that have the highest ξ_i. The function $\emptyset_c = (\tilde{A}_i, \tilde{A}_j)$ permits the data to be adjusted to prospect theory's value function. Hence, this study further explains the aversion and the propensity to risk. This function assumes the shape ''S'', displayed in Fig. 1. The concave curve represents the gains function, and the convex curve below the horizontal axis represents the losses function. The concave part reflects the aversion to risk in the face of gains, and the convex part reflects the propensity to risk in the face of losses.

Case Study

Using fuzzy TODIM model, we, here, present a practical example of criteria influencing the stock market price index to assess and prioritize them. The results are also indicated. The section is comprised of two parts; part 1 generally explains the example and its conditions, and part 2 provides the numerical results.

Example explanation: Tehran Stock Market, as the most important stock market in Iran, has been investigated in this study. To assess criteria influencing stocks price index, all influencing factors were examined and 16 general and influencing criteria were selected; also, we determined 5 choices influencing stocks price index as the general model is offered in table 2. We show general stock price index whit A_i .

Table 2: criteria influencing stocks price index

Stock price index	Internal Factors	Management(A_1)	1. Gain of each share(C_1)
			2. Disclosure of financial inventories(C_2)
		Marketing (A_2)	3. Historical trend of shares price(C_3)
			4. Return rate of assets(C_4)
			5. Ratio of price on income(C_5)
		Structural (A_3)	6. Financial risks(C_6)
			7. Shares value(C_7)
			8. Number of shares transacted(C_8)
			9. Current value(C_9)
			10. Profit margin(C_{10})
	External factors	Political (A_4)	11. Size of the company(C_{11})
			12. Ratio of circulation capital on the whole property(C_{12})
			13. Circulation of the total asset(C_{13})
		Economic (A_5)	14. Variations in gold price(C_{14})
			15. Variations in oil price(C_{15})
			16. Variations in currency rate(C_{16})

Considering the 16 criteria (C_i), we want to determine which choice has the greatest effect on stock price index using fuzzy TODIM technique.

Expert opinions are obtained from a group composed of five professors and six senior management staff members, all of whom had extensive consulting experience before this study.

1. Table 3 presents the qualitative scales that require translation into interval-valued TFNs (see Table 1). The matrix presents sixteen criteria and four alternatives that were measured in the TFNs, and the defuzzification process is employed in Eq. (7).

The TFNs were applied to transform the total weighted matrices into interval performance matrices. The linguistic preferences were used to convert measures into TFNs, to remove the fuzziness and to aggregate the measures into a crisp value (w_j), shown in Table 2. The TFNs were converted into crisp value shown in Table 4.

Table 3: Interval – value TFNs decision matrix

	A_1	A_4	A_3	A_4	A_5
C_1	[(5.5,7.5),9,(9.5,10)]	[(4.5,5.5),7,(8,9.5)]	[(4.5,5.5),7,(8,9.5)]	[(8.5,9.5),10,(10,10)]	[(2.5,3.5),5,(6.5,7.5)]
C_2	[(5.5,7.5),9,(9.5,10)]	[(8.5,9.5),10,(10,10)]	[(0,1.5),3,(4.5,5.5)]	[(4.5,5.5),7,(8,9.5)]	[(2.5,3.5),5,(6.5,7.5)]
C_3	[(5.5,7.5),9,(9.5,10)]	[(2.5,3.5),5,(6.5,7.5)]	[(4.5,5.5),7,(8,9.5)]	[(8.5,9.5),10,(10,10)]	[(4.5,5.5),7,(8,9.5)]
C_4	[(5.5,7.5),9,(9.5,10)]	[(8.5,9.5),10,(10,10)]	[(2.5,3.5),5,(6.5,7.5)]	[(8.5,9.5),10,(10,10)]	[(4.5,5.5),7,(8,9.5)]
C_5	[(5.5,7.5),9,(9.5,10)]	[(4.5,5.5),7,(8,9.5)]	[(4.5,5.5),7,(8,9.5)]	[(8.5,9.5),10,(10,10)]	[(2.5,3.5),5,(6.5,7.5)]
C_6	[(5.5,7.5),9,(9.5,10)]	[(4.5,5.5),7,(8,9.5)]	[(4.5,5.5),7,(8,9.5)]	[(8.5,9.5),10,(10,10)]	[(2.5,3.5),5,(6.5,7.5)]
C_7	[(2.5,3.5),5,(6.5,7.5)]	[(8.5,9.5),10,(10,10)]	[(4.5,5.5),7,(8,9.5)]	[(4.5,5.5),7,(8,9.5)]	[(4.5,5.5),7,(8,9.5)]
C_8	[(4.5,5.5),7,(8,9.5)]	[(4.5,5.5),7,(8,9.5)]	[(8.5,9.5),10,(10,10)]	[(5.5,7.5),9,(9.5,10)]	[(2.5,3.5),5,(6.5,7.5)]
C_9	[(4.5,5.5),7,(8,9.5)]	[(5.5,7.5),9,(9.5,10)]	[(4.5,5.5),7,(8,9.5)]	[(8.5,9.5),10,(10,10)]	[(2.5,3.5),5,(6.5,7.5)]
C_{10}	[(2.5,3.5),5,(6.5,7.5)]	[(5.5,7.5),9,(9.5,10)]	[(4.5,5.5),7,(8,9.5)]	[(4.5,5.5),7,(8,9.5)]	[(2.5,3.5),5,(6.5,7.5)]
C_{11}	[(5.5,7.5),9,(9.5,10)]	[(0,1.5),3,(4.5,5.5)]	[(4.5,5.5),7,(8,9.5)]	[(4.5,5.5),7,(8,9.5)]	[(4.5,5.5),7,(8,9.5)]
C_{12}	[(5.5,7.5),9,(9.5,10)]	[(4.5,5.5),7,(8,9.5)]	[(4.5,5.5),7,(8,9.5)]	[(4.5,5.5),7,(8,9.5)]	[(2.5,3.5),5,(6.5,7.5)]
C_{13}	[(5.5,7.5),9,(9.5,10)]	[(8.5,9.5),10,(10,10)]	[(4.5,5.5),7,(8,9.5)]	[(4.5,5.5),7,(8,9.5)]	[(2.5,3.5),5,(6.5,7.5)]
C_{14}	[(5.5,7.5),9,(9.5,10)]	[(8.5,9.5),10,(10,10)]	[(4.5,5.5),7,(8,9.5)]	[(4.5,5.5),7,(8,9.5)]	[(8.5,9.5),10,(10,10)]
C_{15}	[(5.5,7.5),9,(9.5,10)]	[(2.5,3.5),5,(6.5,7.5)]	[(8.5,9.5),10,(10,10)]	[(4.5,5.5),7,(8,9.5)]	[(2.5,3.5),5,(6.5,7.5)]
C_{16}	[(4.5,5.5),7,(8,9.5)]	[(4.5,5.5),7,(8,9.5)]	[(8.5,9.5),10,(10,10)]	[(4.5,5.5),7,(8,9.5)]	[(2.5,3.5),5,(6.5,7.5)]

Table 4. Matrix of alternatives scores again criteria

	A_1	A_4	A_3	A_4	A_5
C_1	0.178	0.214	0.165	0.189	0.254
C_2	0.144	0.341	0.237	0.168	0.109
C_3	0.275	0.128	0.203	0.177	0.217
C_4	0.189	0.144	0.225	0.244	0.198
C_5	0.256	0.175	0.109	0.208	0.252
C_6	0.175	0.225	0.153	0.276	0.171
C_7	0.265	0.131	0.186	0.181	0.237
C_8	0.207	0.195	0.342	0.141	0.115
C_9	0.317	0.214	0.212	0.155	0.102
C_{10}	0.174	0.174	0.224	0.255	0.132
C_{11}	0.225	0.225	0.214	0.106	0.221
C_{12}	0.194	0.214	0.274	0.175	0.143
C_{13}	0.198	0.215	0.135	0.265	0.187
C_{14}	0.221	0.178	0.216	0.272	0.113
C_{15}	0.296	0.186	0.099	0.254	0.165
C_{16}	0.185	0.277	0.109	0.254	0.175

2. Using Eq. (9) to determine the initial interval-valued TFNs decision matrix, the computations demonstrate how to determine the dominance measurements (A_1, A_2), which are presented The computations represent the values of the measurements of dominance after the implementation of the mathematical formulation of the fuzzy TODIM method.

3. Eq. (10) determines the values of the dominance measures, and $\delta(A_2, A_3)$ is obtained for the different values of $\delta(A_2, A_3)$ for all criteria. The following computational processes are determined using Eq. (11). For instance, if $\theta = 1$,$w_{rc} = 1.0$, and $w_{rc} = 0.65$, then

$$P_{21} - P_{31} > 0 \text{ (indicating a gain), and } \emptyset(A_2, A_3) = \sqrt{\frac{w_{rc}(x_{ic} - x_{jc})}{\sum_{j=1}^{m} w_{rc}}} = \sqrt{\frac{\left(\frac{0.65}{0.65}\right)(0.214 - 0.165)}{8}} = 0.078,$$

Similarly, if $\theta = 1$,$w_{rc} = 1.0$, and $w_{rc} = 0.65$, then $P_{24} - P_{34} > 0$ (indicating a loss), and

$$\emptyset(A_2, A_3) = -1/\theta\sqrt{(\textstyle\sum_{C=1}^{M} w_{rc})(x_{jc} - x_{ic})/w_{rc}} = \qquad \emptyset(A_2, A_3) = -1/1\sqrt{(8)(0.144 - 0.225)/8} = -0.309$$

4. Eq. (12) calculates the overall value of the alternatives by normalizing the corresponding dominance measurements. The rank of each alternative derives from ordering the alternatives respective values. The global measures computed the complete rank ordering of all alternatives. In addition, a sensitivity analysis should then be applied to verify the stability of the results based on the decision makers' preferences. The results are presented in Table 5.

$$\xi_i = \frac{\sum \delta(i.j) - min \sum \delta(i,j)}{mzx \sum \delta(i,j) - min \sum \delta(i,j)} = \frac{0.388 - (-0.309)}{0.108 - (-0.309)} = 1.671$$

The normalized ξ_i from Eq. (12) is then used to calculate the overall criteria priority weights in Table 5.$WC = (c_1, \dots, c_{16})$ =(0.0637, 0.0650, 0.0586, 0.0661, 0.0589, 0.0693, 0.0765, 0.0551, 0.0660 , 0.0610, 0.0570, 0.0768, 0.0644, 0.0535, 0.0533, 0.0548).

The overall values of the alternatives obtained from normalizing the corresponding dominance measurements are presented in Table 6, along with each alternative's rank. This study obtained its results by implementing the classification and the interval-valued fuzzy TODIM methods. A sensitivity analysis was performed, varying the weighting assigned to the alternatives of greatest importance to the decision makers when $\theta = 1$ using interval-valued Fuzzy TODIM.

Table 5. Final weights and ranking

	Weight	Global weights	Ranking
C_1	1.671	0.0637	8
C_2	1.707	0.0650	6
C_3	1.538	0.0586	11
C_4	1.735	0.0661	4
C_5	1.545	0.0589	10
C_6	1.819	0.0693	3
C_7	2.008	0.0765	2
C_8	1.447	0.0551	13
C_9	1.732	0.0660	5
C_{10}	1.600	0.0610	6
C_{11}	1.495	0.0570	12
C_{12}	2.015	0.0768	1
C_{13}	1.689	0.0644	7
C_{14}	1.404	0.0535	15
C_{15}	1.398	0.0533	16
C_{16}	1.434	0.0548	14

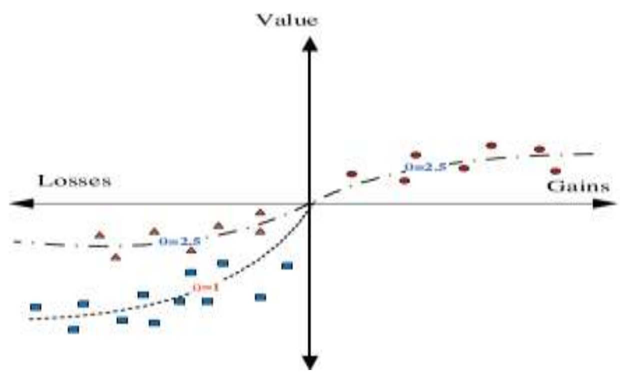

Fig 3. Gains and losses chart

The classical TODIM and the fuzzy TODIM (θ=2.5) ranked the alternatives identically. This analysis was performed by varying the value of θ, the attenuation factor of losses. In the first implementation, θ was set to 1. In the sensitivity analysis, θ was changed to 2.5. With this change in the value of the attenuation index of gains and losses, the only change in the order of the alternatives was a reversal in the order of A_2 and A_3. In this particular application, the decision makers believed that sensitivity analyses should be conducted exclusively on the weight of the reference criterion and the value of θ.

Fig. 3 presents the result from applying two aversions of attenuation to gains and losses (θ=1 and θ=2.5) with equal correlations For different degrees of aversion, despite increases in the aversion, the preferences remain approximately constant. The segments of the value function are in the positive and the negative quadrant when θ=2.5. Therefore, both values of θ describe the gain and the loss of the value function equally well. However, θ=1 indicates the loss function is appropriate. Table 6 presents a comparative table of the ranking obtained with the fuzzy TODIM method (θ=1) compared with the classical evaluation methodology currently used by the firm. The information obtained from the location problem evaluation criteria.

Table 6. Ranking of alternatives

Classical TODIM		Fuzzy TODIM	
		$\theta = 1$	$\theta = 2.5$
A_1	1	1	1
A_2	5	2	5
A_3	2	5	2
A_4	3	3	3
A_5	4	4	4

The application of the classical TODIM assumed that the significant weight of the life cycle assessment had an important effect on the inverted positioning, compared with the fuzzy TODIM method of alternatives 2 and 3. Comparing the rank order of the alternatives (A_2 and A_3) obtained from the fuzzy TODIM with the classical TODIM for decision making shows significant changes in ranking suppliers for two particular alternatives. Specifically, A_2 is ranked 5th by classical TODIM but 2nd by fuzzy TODIM (θ=1) in the loss function; and A_3 is ranked 2nd by classical TODIM and 5th by fuzzy TODIM (θ=1) in the loss function. This inverted positioning, or change in rank order, is caused by the life cycle assessment. However the fuzzy TODIM θ=2.5 in the gain and the loss functions is ranks as classical TODIM. A_1 is the first choice among different approaches

Conclusion

The paper focused on assessing criteria which influence stocks price index. As it is evident, all the criteria are qualitative by nature and were assessed with the aid of fuzzy theories approach; as each data was partly uncertain and ambiguous, but this uncertainty could be reduced by using fuzzy numbers.

The proposed hybrid fuzzy TODIM decision model enables an evaluator to translate qualitative criteria, such as linguistic expressions, into crisp values. This study employed TFNs to represent linguistic variables in addressing subjective judgments by decision makers, thus reducing the evaluator's cognitive burden during evaluations.

Classical TODIM methods are generally well suited to decision making problems in which information is presented as crisp values but often performs poorly when the information is subject to uncertainty. In the hybrid fuzzy TODIM approach, the quantitative and the qualitative information are represented by interval-valued TFNs. To determine the criteria weights based on different assumptions from classical TODIM, this study uses sensitivity analysis to improve the results from prospect theory (with respect to the loss and the gain functions). In addition, this study uses the likelihood degree of comparing interval numbers to rank the alternatives and to select the optimal alternative. Thus, the proposed hybrid approach in study is important for developing and enriching theories and methods for decision making In addition, in some actual decision making processes, determining the specific values for the lower and the upper bounds of TFN is challenging. If the values' range is relatively straightforward to determine, then it is appropriate to define lower and upper bounds values as an interval. Hence, it can not only avoid information loss but also express the decision making information more precisely. The linguistic variables were converted into interval-valued triangular fuzzy numbers in some studies. The defuzzification method developed by Triantaphyllou and Lin and Zhang and Zhai (2011) are effective for the final weighting of each criterion by various evaluators. The proposed model incorporates a set of STOK PRICE INDEX criteria with a fuzzy measure and is an effective method for weighting candidate criteria with subjectivejudgment.Moreover, this proposed model can accommodate criteria easily and effectively with gain and loss functions.

This study does not presume that a perfect mathematical multicriteria decision support method exists independent of the peculiarities of the case studied. For each decision type, several methods, if understood and used appropriately, may produce equally beneficial adjustments that are aligned with the paradigms on which they are based..

References

Abdellaoui, M. (2000). Parameter-free elicitation of utility and probability weighting functions. Management Science, 46, 1497–1512.

Amiri, A.A. et al, (2009).The Investigation and Explanation of Local Model of Effective Internal Factors on Stock Price Index in Tehran Stock Exchange with Fuzzy Approach, J ApplSci 9(2): 258-267.

Asprem, M. (1989), " Stock Prices, Asset Portfolios and Macro economic Variables in ten European Countries " , Journal of Banking and Finance, Vol. 13, PP. 589-612.

Beckwith, j. (2001), Stock Selection in Six Major Non –U.S. Markets. Journal of Investing. 9(2),37-44,.

Bhanot, K., (2006). Anatomy of a government interventions in index stocks: Price pressure or information effects?, Journal of business,(79)(2) , pp. 963-986.

Boardman, A. E. & Claude, L., (2000). Factors affecting the stock price performance of share issued privatizations, Applied Economics,(32)(11(.

E. Triantaphyllou, C.T. Lin.(1996). Development and evaluation of five fuzzy multi-attribute decision-making method., International Journal of Approximate Reasoning 14 pp:281–310.

Erman, E. and Okuyan, H. and Kadioglu,O. (2009), " Real Macro Economic Variables and Stock Prices: Test of Proxy Hypothesis in Turkey", Journal of Managerial Finance, Vol. 35, No. 12, PP. 999-1010.

Fama, E.F. (1981), " Stock Prices, Real Activity, Inflation and Money ", Journal of American Economic Review, Vol.71, PP. 545-65.

Gallagher, B. Taylor, T. W. (2004), "On stock market returns and monetary policy", Journal of Finance, Vol. 52, PP. 635-53.

Gerhard, O. F. (2004), " CausalRlations Among Stock Returns and Macroeconomic Variables in a Small Open Economy ", Journal of International Financial Markets, Institutions and Money, Vol. 9 , PP 61-74.

Gomes, L.F.A.M., & Lima, M.M.P.P. (1992). TODIM: Basics and application to multicriteriarankingof projects with environmental impacts. Foundations of Computing and Decision Sciences, 16 (4), 113–127.

Gomes, L.F.A.M., & Rangel, L.A.D. (2009). An application of the TODIM method to the multicriteria rental evaluation of residential properties. European Journal of Operational Research 193, 204–211.

Howe, L. Ch. And Maysami, R. C. and Hamzah, M. A. (2004), " Relationship Between Macroeconomic Variables and Stock Market Indices: Cointegration Evidence from Stock Exchange of Singapores All-S Sector Indices ", JurnalPengurusan, Vol. 24 , PP. 47-77.

Huddart et al, (2006). Psychological factors, stock price paths, and trading volume, Management science, Article in press.

Jorjensen, N. F. Roll, R. and Ross, S. (2006), "Economic forces and the stock market" , Journal of Business, Vol. 59, PP. 383-403.

Kahraman, C., D. Ruan and I. Dogan. (2003). Fuzzy group decision-making for facility location selection. Inform. Sci., 157 pp: 135-153.

Kalev, Liu and Pham, (2002). the Dynamic Relationship Between Stock Returns and Trading Volume: Domestic and Cross-Country Evidence; Journal of Banking and Finance, Vol. 26, pp. 51-78

Kevin B. Hendricks, Vinod R. Singhal.,(2001) The Long-Run Stock Price Performance of Firms with Effective TQM Programs, Management Science, Vol. 47, No. 3, pp. 359-368.

Kim, S. and In, F. (2005) "The Relationship Between Stock Returns ad Inflation: New Evidence From Wavelet Analysis",Journal of Empirical Finance, Vol. 12, PP. 435 - 444.

Kuo, R.J., S.C. Chi and S.S. Kao. (2002). A decision support system for selecting convenience store location through integration of fuzzy AHP and artificial neural network. Comput. Ind.,47(2) pp:199-214.

L.F.A.M. Gomes, L.A.D. Rangel, F.J.C. Maranhao,(2009), Multicriteria analysis of natural gas destination in Brazil: an application of the TODIM method, Mathematical and Computer Modeling 50 92–100.

Leung, L. and D. Cao. (2000). On consistency and ranking alternatives in fuzzy AHP. Euro. J. Oper. Res.,124(1) pp: 102-113.

M.L. Tseng, Y.H. Lin, A.S.F. Chiu, C.H. Liao. (2008). Using FANP approach on selection of competitive priorities based on cleaner production implementation: a case study in PCB manufacturer Taiwan. Clean Technology and Environmental Policy 10 (1) pp: 17–29

Madsen, F. (2002), "Cointegration and causality between macroeconomic variables and stock market returns",Global Finance Journal, Vol. 10 No. 1, PP. 71-81.

Mikhailov, L. and P. Tsvetinov. (2004). Evaluation of services using a fuzzy analytic hierarchy process, .Appl. Soft Comput., 5(1): 23-33.

Ming-Lang Tseng and KimHua Tan and Ru-Jen Lin and Yong Geng.(2012), " Multicriteria analysis of green supply chain management using interval-valued fuzzy TODIM", journal of Elsevier.

Robert D. and Gay, J. (2008), " Effect of Macroeconomic Variables on Stock Market Returns For Four Emerging Economies: Brazil, Russia, India, And China ", International Business & Economics Research Journal , Vol. 7, No. 31 , PP. 1-8.

S. Zhang, S. Liu, R. Zhai. (2011). An extended GRA method for MCDM with interval valued triangular fuzzy assessment and unknown weights. Computers and Industrial Engineering 61 pp: 1336–1341.

SadegVaziri, Boroskeh (1385). Survey the Effect of croeconomics Variable on Tehran Stock Price Index , M.A. Dissertation, Alzahra University.

Sorayaei, Ali; PakdinAmiri, Alireza, (2008). A Study of Manpower Productivity Status in Mazandaran (North of Iran) Province Payamnor University, The International Conference On Management Sciences and Arts, GurukulKangri university, Haridwar, Uttarakhand, India.

Tzeng, G.H., M.H. Teng, J.J. Chen and S. Opricovic. (2002). Multi criteria selection for a restaurant location in Taipei. Int. J. Hospit. Manage., 21(2) pp: 171-187.

Wen-Shiung Lee, (2008), Combined MCDM techniques for exploring stock selection based on Gordon model, Expert Systems with Applications