APPLYING FAHP AND COPRAS METHODS FOR EVALUATING FINANCIAL PERFORMANCE

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ABSTRACT

In a competitive environment, characterised by the scarcity of resources, performance evaluation and management play a crucial role. One of the main aspects of the organization performance is financial aspect which traditionally be attractive. Because profit is the main goal of many companies, financial performance and evaluation is very important. Most of the economical, industrial, financial or political decision problems are multi-criteria. The application of multi criteria decision making methods significantly improves the robustness of financial analysis and business decisions in general. In this study, based on six well-known financial performance measures, a multi criteria approach is used for evaluation of automobile parts manufacturer group of Tehran stock exchange (TSE). In this approach, Fuzzy analytic hierarchy process (FAHP) is applied to determine the weight of criterion then companies are ranked according to their financial performance by using Complex Proportional Assessment (COPRAS) method. The finding of this study can help companies identify the important financial measures for have a better recognition of their financial performance.

Keywords: *Fuzzy Analytic Hierarchy Process (FAHP), Complex Proportional Assessment (COPRAS), Financial performance.*

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1. INTRODUCTION

In a competitive environment, characterised by the scarcity of resources, performance measurement and management play a crucial role [1] so An accurate and appropriate performance evaluation is very critical. One of the main aspects of the organization performance is financial aspect which traditionally be attractive. Because profit is the main goal of many companies, financial performance and evaluation is very important. As financial performance indicators reflect the competitiveness of a company, they must be carefully identified in the evaluation process [2].

Most of the economical, industrial, financial or political decision problems are multi attribute. Multi Criteria Decision Making (MCDM) is an advanced field of operation research (OR). It provides decision makers and analysts with a wide range of methodologies, which are overviewed and well-suited to the complexity of economical decision problems [3]. The application of multi-criteria decision making methods significantly improves the robustness of financial analysis and business decisions in general [4].

In this study with help from the financial experts a multi criteria new model consists of Accounting measures criteria and Value based measures will be presented, also a hybrid approach of MCDM methods in Fuzzy environment for financial performance evaluation of TSE's company will be provided. At first FAHP will be used to determine the weight of main criteria and sub criteria, then COPRAS will be applied for ranking the automotive group's companies traded on TSE in 2002-2011.

2. Literature review

Several studies on financial performance evaluation are focused on ranking the alternatives according to their financial performance measures included in their comparison environments. Kung et al (2011) applied fuzzy MCDM methods to selecting the best company based on financial report analysis. They used FAHP to select weighting indicators and used the FTOPSIS method for outranking five major airlines [5]. Balzentis et al (2012) based on financial ratios used FTOPSIS, FVIKOR and FARAS methods for integrated assessment of Lithuanian economic in 2007-2010 periods [4]. Ergul& Seyfullahogullari (2012) for Ranking of Retail Companies Trading in ISE applied ELECTRE III based on financial performance in 2008-2010

[6]. Lee et al (2012) in a comparative study on financial positions of shipping companies in Taiwan and Korea used entropy and grey relation analysis. At first, they applied entropy to find the rela-tive weights of financial ratios of the four companies, and then they used grey relation analysis to rank the companies [7]. Yalcin et al (2012) constructed a hierarchical structure of the financial performance model for ISE's manufacturing company. They used FAHP, VIKOR and TOPSIS in their approach [2]. Bayrakdaroglu and Yalcin (2012) for strategic financial performance evaluation of ISE used FAHP for determining the weight of criteria and used VIKOR for best company selection [8]. Ignatus et al (2012) in their study survey financial performance of Iran's Automotive Sector based on PROMETHEE II [9]. Cheng et al (2012) developed an approach combining fuzzy integral with order weight average (OWA) method for evaluating financial performance in the semiconductor industry of Tiwan in 2008. In their study, cement firms are evaluated by taking into considering only some of the traditional accounting based measures [10].

3.financial performance measures

In this study six well-known financial performance measures that consisted of two traditional accounting based financial measures and four modern value based financial measures were selected for financial evaluation of TSE's companies. Table 1 shown selected financial measures whit their formulation.

Table 1. financial performance evaluation measures and their formulation.

Financial performance measures	Formula	Study
Return On Assets (ROA)	$ROA = \frac{Net\ income\ available\ to\ common\ stockholders}{Total\ assets}$	Yalcin et al. [2]
Return On Equity (ROE)	$ROE = \frac{Net\ income\ available\ to\ common\ stockholders}{Stockholder's\ equity}$	Yalcin et al. [2]

Financial performance measures	Formula	Study
Market Value Added (MVA)	$MVA = Total\ market\ value - Total\ capital\ employed$	Bayrakdaroglu and Yalcin [8]
Cash Value Added (CVA)	$CVA = Gross\ cash\ flows - Economic\ depreciation - Capital\ charge$	Yalcin et al. [2]
Refined Economic Value Added (REVA)	$REVA_t = NOPAT_t - WACC(Mcapital_{t-1})$	Hajiabbasi et al. [11]
Tobin's Q	$Tobin's\ Q = \frac{Mrket\ Value + Book\ Value\ of\ Liabilities}{Book\ Value\ of\ Assets}$	Jones et al. [12]

3. MCDM methods

MCDM is an advanced field of Operation Research; it provides decision makers and analysts with a wide range of methodologies, which are overviewed and well-suited to the complexity of economical decision problems [3]. In this study two fuzzy MCDM methods were used for evaluation of TSE's companies. At first FAHP was used to determine weight of main criteria and sub criteria then researcher used ARAS to ranking the companies based on best financial performance.

4.1. Fuzzy Analytic Hierarchy Process (FAHP)

In this study, the weights of the financial performance criteria are obtained by using extent FAHP method that is because of the computational easiness and efficiency [2]. Calculation of FAHP can be described as follow:

Assume that $O=\{o_1,o_2,o_3,...,o_n\}$ be an object set, and $G=\{g_1,g_2,g_3,...,g_m\}$ be a goal set. Each object is taken and extent analysis for each goal is performed, respectively. Therefore, *m* extent analysis values for each object can be obtained, with the following signs:

$$\tilde{Q}_{g_i}^1,...,\tilde{Q}_{g_i}^2,...,\tilde{Q}_{g_i}^m,\ i=1,2,...,\alpha,$$

where all the $\tilde{Q}_{g_i}^m$ (j = 1, 2, … , m) are triangular fuzzy numbers (TFNs).

The steps of extent FAHP can be given as in the following:

Step 1. The value of fuzzy synthetic extent with respect to the *i*th object is defined as

$$\tilde{S}_i=\sum_{j=1}^{m}\tilde{Q}_{g_i}^j\otimes\left[\sum_{i=1}^{n}\sum_{j=1}^{m}\tilde{Q}_{g_i}^j\right]^{-1} \quad (1)$$

To obtain $\sum_{j=1}^{m}\tilde{Q}_{g_i}^j$, perform the fuzzy addition operation of β extent analysis values for a particular matrix such that:

$$\sum_{j=1}^{m}\tilde{Q}_{g_i}^j=\left(\sum_{j=1}^{m}l_j,\sum_{j=1}^{m}m_j,\sum_{j=1}^{m}u_j\right) \quad (2)$$

and to obtain $\left[\sum_{i=1}^{n}\sum_{j=1}^{m}\tilde{Q}_{g_i}^j\right]^{-1}$, perform the fuzzy addition operation of $\tilde{Q}_{g_i}^j$ (j = 1, 2, … , β) values such that

$$\sum_{i=1}^{\alpha}\sum_{j=1}^{\beta}\tilde{Q}_{g_i}^j=\left(\sum_{i=1}^{\alpha}l_i,\sum_{i=1}^{\alpha}m_i,\sum_{i=1}^{\alpha}u_i\right) \quad (3)$$

and then the inverse of the vector above is computed:

$$\left[\sum_{i=1}^{\alpha}\sum_{j=1}^{\beta}\tilde{Q}_{g_i}^j\right]^{-1}=\left(\frac{1}{\sum_{i=1}^{\alpha}u_i},\frac{1}{\sum_{i=1}^{\alpha}m_i},\frac{1}{\sum_{i=1}^{\alpha}l_i}\right) \quad (4)$$

Step 2. As $\tilde{Q}_1=(l_1,m_1,u_1)$ and $\tilde{Q}_2=(l_2,m_2,u_2)$ are two triangular fuzzy numbers, the degree of possibility of $\tilde{Q}_2\geq\tilde{Q}_1$ defined as:

$$V\left(\tilde{Q}_2 \geq \tilde{Q}_1\right) = \sup_{y \geq x}\left[\min\left(\mu_{\tilde{Q}_1}(x), \mu_{\tilde{Q}_2}(y)\right)\right] \quad (5)$$

and can be equivalently expressed as follows:

$$V\left(\tilde{Q}_2 \geq \tilde{Q}_1\right) = hgt\left(\tilde{Q}_1 \cap \tilde{Q}_2\right) = \mu_{\tilde{Q}_2}(d) = \begin{cases} 1, & if\ \ m_2 \geq m_1 \\ 0, & if\ \ l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & O.W \end{cases} \quad (6)$$

where d is the ordinate of the highest intersection point D between $\mu_{\tilde{Q}_1}$ and $\mu_{\tilde{Q}_2}$ (see Figure 1). To compare $\tilde{Q}_1$ and $\tilde{Q}_2$, we need both values of $V\left(\tilde{Q}_1 \geq \tilde{Q}_2\right)$ and $V\left(\tilde{Q}_2 \geq \tilde{Q}_1\right)$.

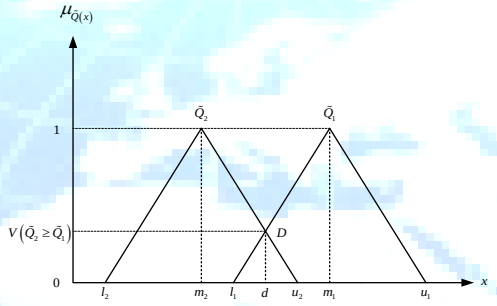

figure 1: The intersection between $\tilde{Q}_1$ and $\tilde{Q}_2$.

Step 3. The degree possibility for a convex fuzzy number to be greater than k convex fuzzy $\tilde{Q}_i$ (i = 1, 2, … , k) numbers can be defined by

$$V\left(\tilde{Q} \geq \tilde{Q}_1, \tilde{Q}_2, ..., \tilde{Q}_k\right) = V\left[\left(\tilde{Q} \geq \tilde{Q}_1\right)\ and\ \left(\tilde{Q} \geq \tilde{Q}_2\right)\ ...\ and\ \left(\tilde{Q} \geq \tilde{Q}_k\right)\right] = \min V\left(\tilde{Q} \geq \tilde{Q}_1\right),$$
$$i = 1, 2, 3, ..., k. \quad (7)$$

Assume that $d'(P_i) = \min V\left(S_i \geq S_k\right)$ for $k = 1, 2, ..., n;\ k \neq i$. Then the weight vector is given by

$$W' = \left(d'(P_1), d'(P_2), ..., d'(P_n)\right)^T \quad (8)$$

where $P_i\left(i = 1, 2, ..., n\right)$ are n elements.

Step 4. Via normalization, the normalized weight vectors are

$$W = \left(d(P_1), d(P_2), ..., d(P_n)\right)^T \quad (9)$$

where W is a non-fuzzy number.

4.2. Complex Proportional Assessment (COPRAS)

COPRAS method was first put forward by Zavadskas et al. in 2008, is used to prioritize the alternatives on the basis of several criteria along with the associated criteria weights [13]. This method works on a stepwise ranking and evaluation procedure of the alternatives in terms of their significance and utility degree. Due to its simplicity this method has been successfully applied in the field of construction and materials selection, contractor selection and etc [14].

Let us assume the fuzzy decision making matrix $X = x_{ij}$, where $i = 1, 2, ..., m$ and $j = 1, 2, ..., n$ represent the number of alternatives and criteria respectively. In this study, m =10 and n = 6. Also each jth criterion is assigned with respective coefficient of significance w_j that it obtained by FAHP, in this study. Benefit criteria are members of set B while cost criteria are members of respective set C.

With above, calculation of COPRAS can be described as follow:

Step 1. Normalize the values of x_{ij} by using the following formula

$$\bar{x}_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \quad j = 1, 2, ..., n \quad (10)$$

Step 2. Determine the weighted normalized decision matrix.

$$\hat{x}_{ij} = \bar{x}_{ij} \times w_j, \ \forall j, i \quad (11)$$

where $\bar{x}_{ij}$ is the normalized performance value of ith alternative on jth criteria and w_j is the associated weight of the jth criteria.

Step 3. The sums S_i^+ and S_i^- of weighted normalized values are calculated for both beneficial and non-beneficial criteria respectively. For benefit criteria, higher value is better and for cost criteria, lower value is better for the attainment of goal. S_i^+ and S_i^- are calculated using the following equations:

$$S_i^+ = \sum_{j=1}^{k} d_{ij} \quad \forall j \in B \quad (12)$$

$$S_i^- = \sum_{j=K+1}^{k} d_{ij} \quad \forall j \in C \quad (13)$$

Step 4. Determine the relative importance or priorities of the candidate alternative *Qi* by the following equation:

$$Q_i = S_i^+ + \frac{\sum_{i=1}^{m} S_i^-}{S_i^- \sum_{i=1}^{m} \frac{1}{S_i^-}} \quad (14)$$

The relative importance Q_i of an alternative shows the extent of satisfaction attained by that alternative. Among the alternatives, one with the highest Q_i value is the best alternative.

Step 5. Calculate the performance index (PI_i) of each alternative as,

$$PI_i = \frac{Q_i}{Q_{\max}} \times 100\% \quad (15)$$

where $Q_{\max}$ is the maximum relative importance value. PI_i value is utilized to get complete ranking of the alternatives.

4. Applications of the proposed approach

The aim of this study is to present a multi criteria approach to evaluate the financial performance of the companies in the Iran traded on TSE by using both accounting based measures and value based measures together. This approach was applied for evaluation of automobile parts manufacturer group of TSE in 2002-2011 (ten years). For this period of the research, annual financial statements of companies which pass away independent external auditing are considered. With respect to the TSE's Database and Rahavard Novin software, data were gathered. At the end, ten companies were selected for this study.

The weights of the criteria are first determined by using FAHP. The pair-wise comparison scores have been carried out by financial experts. Experts are asked to make pair-wise comparisons for all evaluation criteria based on table 2.

Table 2. Triangular fuzzy conversion scale [2].

Linguistic scale for importance and successful degrees	Triangular fuzzy scale	Triangular fuzzy reciprocal scale

Linguistic scale for importance and successful degrees	Triangular fuzzy scale	Triangular fuzzy reciprocal scale
Equally important/successful	(1/2, 1, 3/2)	(2/3, 1, 2)
Weakly more important/successful	(1, 3/2, 2)	(1/2, 2/3, 1)
Strongly more important/successful	(3/2, 2, 5/2)	(2/5, 1/2, 2/3)
Very strongly more important/successful	(2, 5/2, 3)	(1/3, 2/5, 1/2)
Absolutely more important/successful	(5/2, 3, 7/2)	(2/7, 1/3, 2/5)

After computing the result of each evaluator's assessment, Lin (2010) approach was used to obtain the consistency ratio of pare wise matrix. Consistency ratio values are less than the acceptable threshold value (i.e., CR < 0.1) [15].

With respect to the results Value based measures are more important than Accounting measures in financial performance evaluation of TSE's companies. Table 3 shows the weights of the sub criteria were obtained by FAHP. CVA, REVA and MVA have highest weight among criteria, respectively, so TSE's companies should pay special attention to these measures about their financial performance.

Table 3. Weights of sub criteria obtained from FAHP.

Sub criteria	Weight	Rank
ROA	0.0499	5
ROE	0.0292	6
MVA	0.2431	3
CVA	0.2556	1
REVA	0.2446	2
Tobin's Q	0.1776	4

COPRAS have been used for ranking the companies based on financial performance. Table 4 Shows the results have been obtained from COPRAS based on mean value of each criterion. With respect to *Q* and *PI* values among the evaluated companies, GHAT had best financial performance in 2002-2011.

Table 4. Ranking the companies.

Company	Q	PI	Rank
RADI	0.0948	81.25	6
RTIR	0.0975	83.55	4
RINM	0.0934	80.06	9
ZMYD	0.1074	92.05	3
SZPO	0.1149	98.51	2
AZIN	0.0934	80.10	8
RIIR	0.0948	81.29	5
KFAN	0.0941	80.65	7

Company	Q	PI	Rank
FNAR	0.0930	79.71	10
GHAT	0.1167	100.00	1

5. Conclusion

Financial ratios provide useful quantitative financial information about company performance. In this context, this study used six well-known financial measures for performance evaluation of the ten automobile parts manufacturer companies traded on TSE in 2002-2011.

In the proposed approach, at first FAHP has been utilized to determine the weights criteria. Then COPRAS have been used for ranking the companies based on financial performance.

In today's world economy, good financial situations provide company's competitive advantage. Many studies in the literature involving MCDM procedures use only the traditional financial ratios. Results shown value based measures are more important than accounting based measures for TSE's companies evaluation, also for show better performance evaluation, companies should pay more attention to CVA, REVA, MVA and etc respectively.

Further study can include some other value based measures like shareholder value added (SVA), equity economic value added (EEVA) and… for performance measures. In addition to the proposed methods in this study, some other MCDM methods such as COPRAS, ORESTE and MULTIMOORA can be used for financial performance evaluation.

REFERENCES

[1] Amado, C., A., F., Santos, S., P., Marques, P., M., (2012). Integrating the Data Envelopment Analysis and the Balanced Scorecard approach for enhanced performance assessment. *Omega*, 40, 390-403.

[2] Yalcin, N., Bayrakderaglu, 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, 350-364.

[3] Zavadskas, E., & K., Turskis, Z., (2011), Multiple criteria decision making (MCDM) methods in economics, *Technological and Economic Development of Economy*, 17 (2), 397-427.

[4] Balzentis, A., Balzentis, T., Misiunas, A.. (2012), An integrated assessment of lithuanian economoc sectors based on financial ratios and fuzzy MCDM methods.Technological and Economic Development of Economy, 18 (1), 34-53.

[5] Kung, J.,Y., Chuang, T., N., Ky, C., M., (2011). A Fuzzy MCDM Method to Select The Best Company Based on Financial Report Analysis. *IEEE International Conference on Fuzzy Systems June 27-30*, Taipei, Taiwan, 2013-2017.

[6] Ergul, N. & Seyfullahogullari, C., A., (2012). The Ranking of Retail Companies Trading in ISE. *European Journal of Scientific Research*, 70 (1), 29-37.

[7] Lee, P., T., W., Lin, C., W., Shin, S., H., (2012). A comparative study on financial positions of shipping companies in Taiwan and Korea using entropy and grey relation analysis. *Expert Systems with Applications*, 39, 5649-5657.

[8] Bayrakdaroglu, A. & Yalcin, N., (2012). Strategic Financial Performance Evaluation of the Turkish Companies Traded on ISE. *EGE ACADEMIC REVIEW*, 12 (4), 529-539.

[9] Ignatius, J., Behzadian, M., Malekan, H., S., Lalitha, D., (2012). Financial Performance of Iran's Automotive Sector based on PROMETHEE II. *Proceeding of the 2012 IEEE ICMIT*, 35-38.

[10] Cheng, C., H., Chen, C., T., Huang, S., F., (2012). Combining fuzzy integral with order weight average (OWA) method for evaluating financial performance in the semiconductor industry. *African Journal of Business Management*, 6 (21), 6358-6368.

[11] Hajiabasi, M., Kaviani, M.,Samadi Largani, M., Samadi Largani, M., Montazeri, H., (2012). Comparison of information content value creation measures(EVA, REVA, MVA, SVA, CSV

and CVA) and accounting measures (ROA, ROE, EPS, CFO) in predicting the Shareholder Return (SR) Evidence from Iran Stock Exchange. *ARPN Journal of Science and Technology*, 2 (5), 517-521.

[12] Jones, J., S., Miller, S., A. & Yeager, T., J., (2011) .Charter value, Tobin's Q and bank risk during the subprime financial crisis. *Journal of Economics and Business*, 63, 372-391.

[13] Zavadskas, E., K., Kaklauskas, A., Turskis, Z., Tamošaitien, J. (2008). Selection of the effective dwelling house walls by applying attributes values determined at intervals. *Civil Eng Manage*, 14 , 85–93.

[14] Das, M., C., Sarkar, B., Ray, S., (2012). A framework to measure relative performance of Indian technical institutions using integrated fuzzy AHP and COPRAS methodology .*Socio-Economic Planning Sciences*, 46, 230-241.

[15] Lin, H., F., (2010). An application of Fuzzy AHP for evaluating course website quality. *Computers & Education*, 54(4). 877-888.