

A New Integrated Approach for Evaluating Performance of Metals Industry in Tehran Stock Exchange

Mahdi Moradzadehfard¹, Mohammad Reza Fathi², Sadegh Tavakoli³, Sirous Azizollahi⁴

¹Assistant Professor, Faculty of Management and Accounting, Islamic Azad University, Karaj branch, Iran

²M.S. Candidate of Industrial Management, University of Tehran, Tehran, Iran

³M.S. Candidate of Finance, University of Tehran, Tehran, Iran

⁴M.S. Candidate of business Management, University of Tehran, Tehran, Iran

E-mail: reza.fathi@ut.ac.ir

Abstract: The aim of this study is applying a model to evaluate the performance of the firms by using financial ratios and at the same time, taking subjective judgments of decision makers into consideration. Proposed approach is based on Shannon's entropy and TOPSIS methods. Shannon's entropy method is used in determining the weights of the criteria and then rankings of the firms are determined by TOPSIS method. The proposed method is used for evaluating the performance of the five metal firms in the Tehran Stock Exchange by using their financial tables. Then the rankings of the firms are determined according to their results.

[Mahdi Moradzadehfard, Mohammad Reza Fathi, Sadegh Tavakoli, Sirous Azizollahi. A New Integrated Approach for Evaluating Performance of Metals Industry in Tehran Stock Exchange. N Y Sci J 2012;5(6):38-45]. (ISSN: 1554-0200). <http://www.sciencepub.net/newyork>. 6

Keywords: Multi-criteria decision making; TOPSIS; entropy; Performance evaluation; Metal sector.

Introduction

If we refer to effective symbol of market that can easily modify the stock status, undoubtedly, the basic metals industry, with 23 members, is considered most influential band among other in stock exchange. For example, national copper which is one of the most valuable companies in the market and Mobarakeh Steel, Khuzestan Steel and National Lead, zinc and aluminum are market leaders among others. Wang (2007) evaluated financial performance of domestic airlines in Taiwan with fuzzy TOPSIS method. Sekreter, Akyu^z, and C etin (2004) developed a model for determining the credibility of the Turkish firms in the food industry. Their model is based on AHP method and cluster analysis. Different from other studies in the literature, Shannon's entropy and TOPSIS methods are used together in this study. Shannon's entropy is utilized for determining the weights of the criteria. Then ranking of the firms is determined by the help of TOPSIS method. The remainder of this paper is organized as follows. In the second section the ratios that are used in the performance evaluation of the firms are briefly explained. In the third section Shannon's entropy is explained. In the fourth section, TOPSIS method is summarized. In the fifth section, an application in metals sector is given. And finally in section six, results of the application are presented.

Financial Ratios

Financial ratios are useful indicators of a firm's performance and financial situation. Financial ratios can be classified according to the information they provide. The following types of ratios are

frequently used and we have used these ratios in our application:

a) Liquidity ratios: Liquid asset is one that can be easily converted to cash at a fair market value and a firm's liquidity position deals with the question: Will the firm be able to meet its current obligations? (Weston & Brigham, 1993) A firm that intends to remain a viable business entity must have enough cash on hand to pay its bills as they come due. In other words, the firms must remain liquid. One way to determine whether this is the case is to examine the relationship between the firm's current assets and approaching obligations. Liquidity ratios are quick measures of a firm's ability to provide sufficient cash to conduct business over the next few months (Moyer, McGuigan, & Kretlow, 1992). Briefly, liquidity ratios provide information about a firm's ability to meet its short-term obligations. Three frequently used liquidity ratios are the current ratio, liquidity ratio and quick ratio.

1) Current ratio: The current ratio is the ratio of current assets to current liabilities. It is key measure in determining a firm's ability to pay current debts and is a good measure of the adequacy of working capital (Price, Haddock, & Brock, 1993). Current assets include the cash, a firm already has on hand in the bank, plus any assets that can be converted into cash within a normal operating period of 12 months, such as marketable securities held as short term investments, account receivable, inventories, and prepayments.

Current liabilities include financial obligations expected to fall due within next year, such as

accounts payables, and various accruals such as taxes and wages due (Moyer et al., 1992).

Current Ratio = Current Assets / Current Liabilities

2) Quick ratio (Acid test ratio): Although the current ratio measures a firm's ability to meet current liabilities out of existing current assets, it is not a measure of immediate liquidity (Price et al., 1993). Immediate liquidity is measured by quick ratio. This ratio is a more stringent measure

of liquidity than the current ratio. It recognizes that a firm's inventories are often one of its least liquid current assets (Moyer et al., 1992). This ratio is calculated by deducting inventories from current assets and dividing the remainder by current liabilities.

Quick Ratio = (Current Assets – Inventories) / Current Liabilities

3) Cash ratio: Cash ratio is the most conservative liquidity ratio. The cash ratio is an indication of the firm's ability to pay off its current liabilities if for some reason immediate payment were demanded. This ratio excludes all current assets except the most liquid ones such as; cash and cash equivalents. The cash ratio is defined as

Cash Ratio = (Cash + Marketable Securities) / Current Liabilities

b) Financial leverage ratios: Financial leverage ratios indicate a firm's capacity to meet short- and long-term debt obligations. These ratios provide evidence on the extent to which non-equity capital is used in a firm and the long term ability of a firm to meet payments to non-equity suppliers of capital (Foster, 1978). Unlike liquidity ratios that are concerned with short term assets and liabilities, financial leverage ratios measure the extent to which the firm is using long term debt.

1) Debt ratio: Debt ratio indicates what proportion of the firm's assets is being financed through debt. Debt encompasses all short term liabilities and long term borrowings. A ratio under 1 means a majority of assets are financed through equity, above 1 means they are financed more by debt.

Debt Ratio = Total Debt / Total Assets

2) Long term debt to equity: this ratio is obtain as follow

Long term debt to equity = long term debt / equity

3) Total debt to equity: this ratio is obtain as follow

Total debt to equity = total debt / equity

c) Activity ratios (Asset turnover ratios): One objective of financial management is to determine how a firm's resources best can be distributed among the various asset accounts. Activity ratios indicate

how much a firm has invested in a particular type of asset relative to the revenue the asset is producing. By comparing activity ratios for the various asset accounts of a firm with established industry norms, the analyst can determine how efficiently the firm is allocating its resources (Moyer et al., 1992).

1) Account receivable turnover: This ratio shows the number of times accounts receivable are paid and reestablished during the accounting period. The higher the turnover, the faster the business is collecting its receivables and the more cash the client generally has on hand.

Accounts Receivable Turnover = Total Net Sales / Accounts Receivables

2) Total asset turnover ratio: This ratio indicates how effectively a firm uses its total resources to generate sales and is a summary measure influenced by each of the activity ratios.

Total Asset Turnover Ratio = Sales / Total Assets

d) Profitability ratios: Profitability refers to the ability of a firm to generate revenues in excess of expenses (Foster, 1978). Profitability ratios offer several different measures of the success of the firm generating profits. A firm's profits demonstrate how well the firm is making investment and financing decisions. If a firm is unable to provide adequate returns in the form of dividends and share price appreciation to investors, it may be unable to maintain its asset base. Anyone whose economic interests are tied to the long term survival of a firm will be interested in profitability ratios (Moyer et al., 1992).

1) Net profit margin ratio: This ratio measures how profitable a firm's sales are after all expenses, including taxes and interest, have been deducted.

Net Profit Margin Ratio = Earnings after taxes / Sales

2) Return on equity ratio: This ratio measures the rate of return on the ownership interest of the common stock owners. Return on equity is viewed as one of the most important financial ratios. It measures a firm's efficiency at generating profits from every dollar of net assets, and shows how well a company uses investment dollars to generate earnings growth. It is equal to a fiscal year's net income (after preferred stock dividends but before common stock dividends) divided by total equity (excluding preferred shares), expressed as a percentage.

Return on Equity = Net Profit before Taxes / Net worth

3) Return on asset: An indicator of how profitable a company is relative to its total assets. ROA gives an idea as to how efficient management is at using its asset to generate earnings. The formula for return on asset is:

Return on asset = Net income / Total asset

Shannon's Entropy

As we know, entropy theory is another important theory to study the problem of uncertainty. Entropy weight is a parameter that describes how much different alternatives approach one another in respect to a certain attribute. The greater the value of the entropy, the smaller the entropy weight, then the smaller the differences of different alternatives in this specific attribute, and the less information the specific attribute provides, and the less important this attribute becomes in the decision making process. So for calculating weight, we will use the following steps:

Step1: Normalize the decision matrix.

Set: for $x_{ij} > 0 \rightarrow P_{ij} = \frac{x_{ij}}{\max_{j=1} x_{ij}}$

for $x_{ij} \leq 0 \rightarrow P_{ij} = \frac{x_{ij}}{\min_{j=1} x_{ij}}$

The raw data are normalized to eliminate anomalies with different measurement units and scales. This process transforms different scales and units among various criteria into common measurable units to allow for comparisons of different criteria.

Step2: Compute entropy h_i as

$$h_i = -h_0 \sum_{j=1}^m p_{ij} \cdot \ln p_{ij} \quad i=1,2,\dots,n$$

where h_0 is the entropy constant and is equal to $(\ln m)^{-1}$ and $p_{ij} \cdot \ln p_{ij}$ is defined as 0 if $p_{ij} = 0$

Step 3: Set $d_i = 1 - h_i$, $i = 1, 2, \dots, n$ as the degree of diversification.

Step 4: Set $w_i = \frac{d_i}{\sum_{s=1}^n d_s}$ $i=1,2,\dots,n$ as the degree of importance of attribute i .

TOPSIS

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is one of the useful MADM techniques to manage real-world problems (Yoon & Hwang, 1985). TOPSIS method was firstly proposed by Hwang and Yoon (1981). According to this technique, the best alternative would be the one that is nearest to the positive ideal solution and farthest from the negative ideal solution (Benitez, Martin, & Roman, 2007). The positive ideal solution is a solution that maximizes the benefit criteria and minimizes the cost criteria, whereas the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria (Wang & Elhag, 2006). In short, the positive ideal solution is composed of all

best values attainable of criteria, whereas the negative ideal solution consists of all worst values attainable of criteria (Wang, 2007).

The TOPSIS method consists of the following steps:

Step 1: Calculate the normalized decision matrix. The normalized value r_{ij} is calculated as

Step 2: Calculate the weighted normalized decision matrix. The weighted normalized value v_{ij} is calculated as

$$r_{ij} = X_{ij} / \sqrt{\sum_{i=1}^n X_{ij}^2}, \forall i, j \tag{1}$$

Where w_j is the weight of the j th criterion, and $\sum_{j=1}^m w_j = 1$

$$v_{ij} = w_j \cdot r_{ij}, \forall i, j \tag{2}$$

Step 3: Determine the ideal and negative-ideal solution.

$$A^* = \{v_1^*, \dots, v_m^*\} = \{(\max_i v_{ij} | j \in C_b), (\min_i v_{ij} | j \in C_c)\}$$

$$A^- = \{v_1^-, \dots, v_m^-\} = \{(\min_i v_{ij} | j \in C_b), (\max_i v_{ij} | j \in C_c)\}$$

where C_b is associated with benefit criteria and C_c is associated with cost criteria.

Step 4: Calculate the separation measures, using the m -dimensional Euclidean distance. The separation of each alternative from the ideal solution is given as

$$S_i^* = \sqrt{\sum_{j=1}^m (v_{ij} - v_j^*)^2}, \forall i$$

Similarity, the separation from the negative-ideal solution is given as

$$S_i^- = \sqrt{\sum_{j=1}^m (v_{ij} - v_j^-)^2}, \forall i$$

Step 5: Calculate the relative closeness to the ideal solution. The relative closeness of the alternative A_i with respect to A^* is defined as

$$CC_i^* = \frac{S_i^-}{S_i^* + S_i^-}, \forall i$$

Step 6: Rank the preference order.

The index values of CC_i^* lie between 0 and 1. The larger index value means the closer to ideal solution for alternatives.

Application

The aim of this study is to evaluate the performance of five metal firms in Tehran Stock Exchange, with the help of financial ratios. Firstly financial ratios are calculated for each firm. Shannon’s entropy is utilized for determining the weights of main and sub-criteria. Finally, TOPSIS method is proposed for evaluating the performance of the metal firms, considering financial ratios and weights of the criteria. By this way, the ranking of the firms according to their general performance is obtained.

The ratios in Fig. 1 are used for evaluating the metal firms. Here, the ratio that forms each sub-criterion has different preference degree. During the formation of the model, the places of the numerator and denominator are changed for the small value preferences. By this way big values gain a more preferable situation in this ratio. For instance, ratio of Total Debt/Assets is preferred to take small value. So, numerator and denominator change their place while

this ratio is calculated. Preference degree changes from one decision maker to another. In this condition, these ratios are revised according to the decision maker’s preference. Because different groups inside and outside the firm have varying objectives and expectations, they approach financial analysis from different perspectives (Moyer et al., 1992). So, financial ratios have different level of significance for different users. For instance, managers of firms are especially interested in activity and growth ratios. While investors and shareholders focus on profitability ratios, creditors concerned with financial leverage ratios (Sekreter et al., 2004). For this reason, three decision makers are selected from different areas and these decision makers evaluate the criteria. The first decision maker is a creditor, the second one is investment consultant, and the last one is shareholder.

According to Shannon method, first of all we normalize the decision matrix that is shown in Table 1.

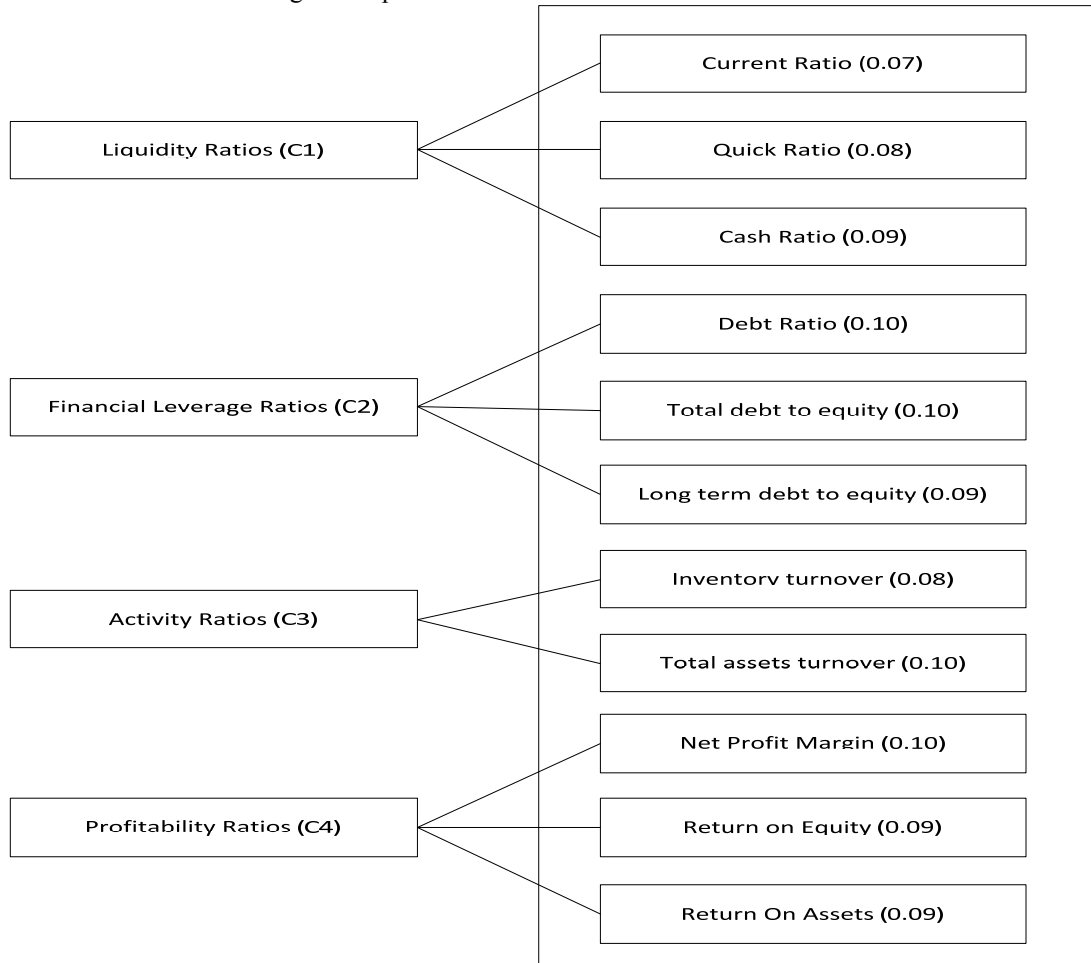


Fig 1. Hierarchical structure of model in application

Table 1. Normalize decision matrix

| | Profitability | | | Liquidity | | | Activity | | Financial leverage | | |
|--------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|--------------------|-----------------|-----------------|
| | C ₁ | C ₂ | C ₃ | C ₄ | C ₅ | C ₆ | C ₇ | C ₈ | C ₉ | C ₁₀ | C ₁₁ |
| calcimine | 43.13 | 31.97 | 48.12 | 1.62 | -1.16 | 0.5 | 135.3 | 1.62 | 0.34 | 0.5 | 0.08 |
| NICICOI* | 29.34 | 20.56 | 58.3 | 1.16 | -0.84 | 0.19 | 161 | 1.08 | 0.65 | 1.84 | 0.26 |
| khorestan steel co | 3.71 | 2.78 | 10.77 | 0.73 | -0.38 | 0.09 | 129.97 | 1.64 | 0.74 | 2.87 | 0.44 |
| Khuzestan steel co | -13.82 | -6.82 | 36.45 | 0.42 | -0.21 | 0 | 138.53 | 1.1 | 1.19 | -6.35 | -0.6 |
| NIZL | 0.4 | 0.35 | 0.77 | 0.7 | -0.16 | 0.06 | 100.45 | 2.73 | 0.55 | 1.2 | 0.2 |
| max | 43.13 | 31.97 | 58.3 | 1.62 | -0.16 | 0.5 | 161 | 2.73 | 1.19 | 2.87 | 0.44 |
| min | -13.82 | -6.82 | 0.77 | 0.42 | -1.16 | 0 | 100.45 | 1.08 | 0.34 | -6.35 | -0.6 |

* NICICOI is abbreviation of national Iranian copper industries company and NIZL is abbreviation of national Iranian zinc and lead.

Then, according to step 2, 3 and 4, we compute h_i , d_i and w_i that are shown in Table 2.

Table 2. h_i , d_i and w_i for each criteria

| | Profitability | | | Liquidity | | | Activity | | Financial leverage | | |
|--------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|--------------------|-----------------|-----------------|
| | C ₁ | C ₂ | C ₃ | C ₄ | C ₅ | C ₆ | C ₇ | C ₈ | C ₉ | C ₁₀ | C ₁₁ |
| calcimine | 1 | 1 | 0.83 | 1 | 1 | 1 | 0.84 | 0.59 | 0.29 | 0.17 | 0.18 |
| NICICOI | 0.68 | 0.64 | 1 | 0.72 | 0.72 | 0.38 | 1 | 0.4 | 0.55 | 0.64 | 0.59 |
| khorestan steel co | 0.09 | 0.09 | 0.18 | 0.45 | 0.33 | 0.18 | 0.81 | 0.6 | 0.62 | 1 | 1 |
| Khuzestan steel co | 1 | 1 | 0.63 | 0.26 | 0.18 | 0 | 0.86 | 0.4 | 1 | 1 | 1 |
| NIZL | 0.01 | 0.01 | 0.01 | 0.43 | 0.14 | 0.12 | 0.62 | 1 | 0.46 | 0.42 | 0.45 |
| E | -0.32 | -0.34 | -0.51 | -0.81 | -0.73 | -0.59 | -0.46 | -0.84 | -0.83 | -0.59 | -0.61 |
| d | 1.32 | 1.34 | 1.51 | 1.81 | 1.73 | 1.59 | 1.46 | 1.84 | 1.83 | 1.59 | 1.61 |

After determining the weights of the criteria with Shannon method, financial ratios are calculated. Firstly, financial tables of the metal firms are obtained from the web site of Tehran Stock Exchange. Then the liquidity, financial leverage,

activity and profitability that are used in the performance evaluation process are calculated separately for each firm. These ratios are indicated from Tables 3–6.

Table 3. Financial leverage ratios for the metal firms

| | Financial leverage ratios | | |
|--------------------|---------------------------|----------------------|--------------------------|
| | Debt ratio | Total debt to equity | Long term debt to equity |
| calcimine | 0.34 | 0.5 | 0.08 |
| NICICOI | 0.65 | 1.84 | 0.26 |
| khorestan steel co | 0.74 | 2.87 | 0.44 |
| Khuzestan steel co | 1.19 | -6.35 | -0.6 |
| NIZL | 0.55 | 1.2 | 0.2 |

Table 4. Activity ratios for the metal firms

| | Activity ratios | |
|--------------------|--------------------|-----------------------|
| | Inventory turnover | Total assets turnover |
| calcimine | 135.3 | 1.62 |
| NICICOI | 161 | 1.08 |
| khorasan steel co | 129.97 | 1.64 |
| Khuzestan steel co | 138.53 | 1.1 |
| NIZL | 100.45 | 2.73 |

Table 5. Liquidity ratios for the metal firms

| | Financial leverage ratios | | |
|--------------------|---------------------------|-------------|------------|
| | Current ratio | Quick ratio | Cash ratio |
| calcimine | 1.62 | -1.16 | 0.5 |
| NICICOI | 1.16 | -0.84 | 0.19 |
| khorasan steel co | 0.73 | -0.38 | 0.09 |
| Khuzestan steel co | 0.42 | -0.21 | 0 |
| NIZL | 0.7 | -0.16 | 0.06 |

Table 6. Profitability ratios for the metal firms

| | profitability ratios | | |
|--------------------|----------------------|-------|-------|
| | Net profit margin | ROA | ROE |
| calcimine | 43.13 | 31.97 | 48.12 |
| NICICOI | 29.34 | 20.56 | 58.3 |
| khorasan steel co | 3.71 | 2.78 | 10.77 |
| Khuzestan steel co | -13.82 | -6.82 | 36.45 |
| NIZL | 0.4 | 0.35 | 0.77 |

After the financial ratios are calculated, normalization of these values is made. Then, weighted normalized matrix is formed by multiplying

each value with their weights. All weighted values that form each sub-criterion are aggregated to form Table 7. Then, the values in Table 7 and the weights of each main criterion are multiplied to form Table 8.

Table 7. Total values of main criteria

| | Profitability | | | Liquidity | | | Activity | | Financial leverage | | |
|--------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|--------------------|-----------------|-----------------|
| | C ₁ | C ₂ | C ₃ | C ₄ | C ₅ | C ₆ | C ₇ | C ₈ | C ₉ | C ₁₀ | C ₁₁ |
| calcimine | 0.8 | 0.83 | 0.57 | 0.71 | -0.77 | 0.92 | 0.45 | 0.42 | 0.2 | 0.07 | 0.1 |
| NICICOI | 0.54 | 0.53 | 0.69 | 0.51 | -0.56 | 0.35 | 0.54 | 0.28 | 0.39 | 0.25 | 0.32 |
| khorasan steel co | 0.07 | 0.07 | 0.13 | 0.32 | 0.25 | 0.16 | 0.43 | 0.42 | 0.44 | 0.39 | 0.54 |
| Khuzestan steel co | -0.26 | -0.18 | 0.43 | 0.18 | -0.14 | 0 | 0.46 | 0.28 | 0.71 | -0.87 | -0.73 |
| NIZL | 0.01 | 0.01 | 0.01 | 0.31 | -0.11 | 0.11 | 0.33 | 0.7 | 0.33 | 0.16 | 0.24 |

Table 8. Total weighted values of main criteria

| | Profitability | | | Liquidity | | | Activity | | Financial leverage | | |
|--------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|--------------------|-----------------|-----------------|
| | C ₁ | C ₂ | C ₃ | C ₄ | C ₅ | C ₆ | C ₇ | C ₈ | C ₉ | C ₁₀ | C ₁₁ |
| calcimine | 0.06 | 0.06 | 0.05 | 0.07 | -0.08 | 0.08 | 0.04 | 0.04 | 0.02 | 0.01 | 0.01 |
| NICICOI | 0.04 | 0.04 | 0.06 | 0.05 | -0.05 | 0.03 | 0.04 | 0.03 | 0.04 | 0.02 | 0.03 |
| khurasan steel co | 0.01 | 0.01 | 0.01 | 0.03 | -0.02 | 0.01 | 0.04 | 0.04 | 0.05 | 0.04 | 0.05 |
| Khuzestan steel co | -0.01 | -0.01 | 0.04 | 0.02 | -0.01 | 0.00 | 0.04 | 0.03 | 0.07 | -0.08 | -0.07 |
| NIZL | 0.00 | 0.00 | 0.00 | 0.03 | -0.01 | 0.01 | 0.03 | 0.07 | 0.03 | 0.01 | 0.02 |

Positive and negative ideal solution is determined by taking the maximum and minimum values for each criterion. Then the distance of each firm from PIS and NIS with respect to each criterion are calculated with the help of Eq. (5) and (6). Then closeness coefficient of each firm is calculated by using Eq. (7) and the ranking of the firms are determined according to these values. The ranking of the metal firms are shown in Table 9. After the performance evaluation of the Iranian metal firms in Tehran Stock Exchange by taking financial ratios into consideration, the order of the firms are found as in Table 9. Besides the financial ratios, the decision makers' priorities also affected the ranking of the firms. If there will be a difference in the priority of the decision makers, the ranking may change. For this reason decision maker should know his priority properly and then determine the weights of the criteria.

Table 9. Rankings of metal firms according to CC_i values

| firms | CC _i | Ranking |
|--------------------|-----------------|---------|
| calcimine | 0.69 | 1 |
| NICICOI | 0.66 | 2 |
| khurasan steel co | 0.58 | 3 |
| Khuzestan steel co | 0.24 | 5 |
| NIZL | 0.53 | 4 |

Conclusion

In today's competitive environment evaluating firms' performance properly, is an important issue not only for investors and creditors but also for the firms that are in the same sector. Determining the competitiveness of the firms and evaluating the financial performance of them is also crucial for the sector's development. In this study, an objective evaluation system is developed for evaluating the performance of firms by using the financial tables. The proposed method is used in determining the ranking of the firms in the same sector by comparing the firms according to the criteria determined. Financial tables of the firms are used for performance evaluation and the subjective judgments of the decision makers incorporated into the evaluation process. Different from other studies in the literature, in this study Shannon's entropy and TOPSIS

methods are used together. Shannon's entropy is utilized for determining the weights of the criteria and TOPSIS method is used for determining the ranking of the firms. In the application, ranking result of the Metal firms is reached by considering the performance of the firms. As the weights of criteria are determined by the decision makers from different areas, the result indicates an overall performance ranking.

Corresponding Author:

Mohammad Reza Fathi
M.S. Candidate of Industrial Management, University of Tehran, Tehran, Iran
E-mail: reza.fathi@ut.ac.ir

Acknowledgement

The authors wish to thank an anonymous referee for the valuable suggestions which considerably improve the quality of the paper.

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5/1/2012