Developing a Hybrid Approach to Credit Priority based on Accounting Variables (Using Analytical Network Process (ANP) and Multi-Criteria Decision-Making)

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Abstract

For the purpose of developing capital markets, performance evaluation is one of the most important debates for shareholders, creditors, governments and managers. Investors also are inclined how successful managers are in utilizing their capital. to know the progress process of managers in using their capital. Credit rating plays a crucial role in the money and capital markets and indicates an independent opinion on the company's ability to meet all the obligations in a timely and comprehensive manner. As most rating agencies do not disclose the method used and the methods provided for credit rating of companies in previous researches are mostly based on statistical methods and are relatively complex, in the present study, companies are ranked based on ratios regarding the information contained in financial statements, which are called accounting variables. These ratios are classified into 5 groups of profitability, growth and development, activity, leverage , liquidity, and the ratios related to each group. The survey results were collected using a questionnaire to evaluate the effective weights of each attribute with Analytical Network Process (ANP) and DEMATEL Technique and then the ranking of companies was conducted using the COPRAS technique with Expert Choice software.

Keywords: Credit Rating, Hybrid Method, Network Analysis, Financial Ratios, COPRAS and DEMATEL decision making technique

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1. Introduction

Stock exchange of each country, as a part of the capital market and economic environment, is considered as an indicator in determining the amount of public demand for information, and provides financing opportunities for the companies listed in these markets. It also enables investors to invest and achieve returns. On the other hand, it should be considered that investors perform extensive investigations to make investment decisions and buy and sell companies' shares as they convert their highly liquid assets into stocks. In the meantime, information institutions can help decision makers in make better decisions by providing timely, accurate, appropriate and relevant information.

Credit ratings play a crucial role in the money and capital markets. There are two types of credit ratings, including securities rating and corporate rating. The securities rating criterion is the probability of default or delay in the payment of securities, but corporate credit rating reflects an unbiased evaluation of the company's credit status and indicates an objective and independent opinion on the company's ability to perform obligations fully and timely (Wang et al., 2010).

Financial performance evaluation using traditional accounting criteria has many disadvantages. Traditional performance evaluation has been seriously criticized as it focuses only on accounting profit and does not take into account the cost of financing capital and is not considered an appropriate method. However, in value-based criteria, all financing costs are considered (Yahya Zadehfar et al., 2016). Hence, rating services is defined ranking companies based on ability, quality, efficiency and productivity. Doing such task is important not only for investors, but also for shareholders, financial creditors, etc. (Gholizadeh et al., 2016)

Regarding the fact that on the one hand, most of the methods presented for credit rating of companies in previous researches are based on statistical methods and are relatively complex, so solving problems by these methods is often time-consuming. On the other hand, rating agencies refuse to disclose the model used in the credit rating of companies and the rating performed by banks and credit institutions is mainly qualitative (Chen and Shih, 2006). In this study, to facilitate calculations and reduce costs of the data analysis and using advanced software, , we intend to identify effective financial ratios to perform credit ratings for companies, but we should also consider the possibility if a midtake made as the necessary element for big financial organizations including stock exchange . To do this, after identifying and weighing the effective accounting variables in this field, the financial data of listed companies (except banks, insurance companies and leasing companies) during 2013 to 2018 were collected, and then the corporate credit rating was conducted using multi-criteria decision-making techniques.

2. Experimental Literature

One of the consequences of the accounting evolution is using financial ratios to analyze financial statements. The formation of financial ratios dates back to the late nineteenth century. Since then analysts have developed ratios that are now widely applied. In 1993, Lu and Tiagarajan used ratios that financial analysts use in practice instead of using statistical models to select financial ratios. They selected 12 financial symbols and tested them via regression model and concluded that the basic symbols are related to stock returns (Anvari Rostami and Khatanloo, 2006).

In 2000, Petrovsky performed a study "Using financial statement information to distinguish successful Companies from unsuccessful Companies. The main question of the researcher was "Can we achieve high return using the basic analysis based on accounting of the companies with a higher book value to market value? In another study by Mohnram (2004), financial ratios were used

to separate successful companies from unsuccessful ones. The results of both studies indicate that companies with high book value to market value ratio have higher returns on average. These ratios have been used extensively in various studies as basic factors in determining the value of companies and separating successful and best companies from unsuccessful companies (Mehrani et al., 2010).

Using Analytical Hierarchy Process (AHP) method, some researchers prioritized the effective variables on the company's value and determined the following criteria as general topics in decision-making hierarchy (Gholizadeh, 2010).

Operational efficiency: Some variables are defined to explain the operational dimension of the company. This variable mostly focuses on the operational part of the company's profit and loss statement, i.e. the value belonging to profit before tax and interest and includes fixed operating costs, cost of goods sold, total assets, duration of activity or company age, etc.

Financial efficiency: This criterion actually considers the company's return from different views and includes dividend policy, net profit, earnings per share etc.

Risk: The wealth of shareholders depends on two factors: "risk" and "return". Risk means the probability of the difference of the real value from the value expected by investors. The variables of this criterion include the investment risk degree, systematic risk, etc.

Management performance: Indeed, these variables indicate the context of activity (opportunities and limitations) and the performance of the manager (strengths and weaknesses) and its variables include: sales, sale growth, market value -added, stock supply and demand, etc.

Corporate performance evaluation attributes are divided into two groups: traditional and value-based criteria. Using traditional performance evaluation criteria was common in the capital market for a long time until value-based criteria were developed. Financial statement analysis often begins with the use of financial ratios based on balance sheet information, profit and loss statements, and cash flow statements. Financial ratios indicate the strengths or weaknesses of companies compared to other companies in the same industry, pioneer companies, and last year's performance of the same company (Malhotra et al., 2008).

Financial ratios are the most useful indicator for the performance and financial status of the company (Ortoghrol and Ghargash Oghli, 2014). Financial ratios are calculated easily, but their interpretation is often difficult and challenging, especially when two or more ratios show opposite signs to each other. The main disadvantage to the ratio analysis of financial statements is that each financial ratio evaluates one dimension of an organization's financial performance in such a way that some of them have liquidity capability, some have profitability ability, others have growth capability, and finally the last group evaluates the organization's operation method (Khajavi et al., 2014).

One way to compare two or more companies (especially when these companies have different sizes) is to use their financial ratios and examine the relationships between the various components of the financial statements. In general, in financial statements analysis and comparing companies, the above method is used with five types of ratios:

Short-term financial ability ratios (or liquidity ratios)
Long-term financial ability ratios (or leverage ratios)
Asset turnover ratios
Profitability ratios
Market value ratios

In a study, the effective indicators on the decision-making of investors in companies listed on Tehran Stock Exchange have been divided into several important groups (Asgharizadeh, 2016). Financial, liquidity, leverage, profitability, market value, manufacturing indicators, productivity indicators, indicators of economic significance and management indicators are among the most important of these indicators. These indicators include: gross profit to sales, Net profit ratio to return on asset

(ROA), Earnings per share, Price to Price Ratio (P / E), Dividend payout ratio (DPR), Cash earnings per share, Net profit to sale, Net profit to average assets after deducting design and development assets, quick ratio, asset turnover, increase in production compared to the previous year and financial expenses coverage.

Financial ratios are the most useful indicators for the company's performance and financial status (Ortogrol, 2014). Ranking is performed only by using multi-criteria decision models by considering several criteria, each of which with a special position. In these methods, different indicators are used according to the type of ranking. Therefore, by using five financial ratios as indicators and by applying multi-criteria decision-making methods, companies that are listed in the stock exchange can be financially evaluated and ranked (Moradzadehfard et al., 2016).

Financial ratio analysis is a very important and appropriate technique for financial analysis, with the following advantages:

1) Financial ratios can be used to measure performance and determine performance standards.

2) Financial ratios can be used to focus on areas that need improvement or to focus on areas that have the highest potential for future progress.

3) They enable the external sectors of the organization (creditors, banks, etc.) to evaluate the profitability and credit value of the organization.

4) With these ratios, a criterion is obtained for comparing the activities of the company in a time period and also the calculated ratios can be compared with an average industry.

If the analysis based method of these ratios is integrated with other methods such as econometrics, these ratios can play a crucial role in the evaluation process and judgment (Gharib et al., 2014).

Based on the criteria identified based on the literature review, in various studies including Amiri (2013), Moradzadehfard (2015) , financial ratios have been used in five main categories including profitability cluster, growth, activity, leverage and liquidity for corporate credit ratings. Also, Edirising et al. (2008) used financial ratios in 6 categories including profitability criteria (including return on capital, return on assets, net profit margin and earnings per share), operational efficiency criteria (including receivables turnover, inventory turnover, asset turnover), liquidity criteria (including current ratio, quick ratio and debt to equity ratio), leverage criteria (including total debt to total assets ratio, total debt to equity ratio), company vision criteria (including price to income ratio, and market to book value ratio) and growth criteria (including revenue growth rate, net profit growth rate, and earnings per share growth rate) to select corporate stocks.

Based on the existing literature review, the following financial ratios have been used in five categories for credit ratings of the companies listed on the Iranian Stock Exchange as shown in Table 1:

Credit ratings by credit ratings institutions are determined based on the publicly available information such as financial statements and explanatory notes and other publicly issued reports and sometimes confidential information provided by the company to institutions. The factors that are considered in the process of determining the company's ratings, although not completely transparent, generally include both quantitative factors such as financial ratios and quality factors, such as management quality, industry characteristics, competitive position of the company, etc. Considering the quantitative factors alone can indicate a significant change in the credit rating of companies, but the rating is not based on merely quantitative factors. To obtain a correct ranking, all available quantitative and qualitative factors should be taken into consideration (Gary et al., 2006).

Table 1:   Indicators and sub-indicators used in the research

Calculation method	Sub-indicator	Main indicators
Curretn ratio $= \dfrac{current\ assets}{current\ debts}$	Current ratio	**Liquidity**
Quick ratio$= \dfrac{Current\ asset - Non - quick\ current\ asset}{Current\ debts}$	Quick ratio	**ratios**
Cash ratio $= \dfrac{Cash + Shortterm\ investment}{Current\ debt}$	Cash ratio	

Lack of direct access to qualitative information has caused researchers to rely only on financial ratios, as these ratios can be easily calculated based on the financial statements and the financial statements are offered to the public. This procedure is less problematic for researches conducted in the world, because the result obtained is compared with the rankings declared by credit rating agencies and this shows the effective factors on rank and not the determining factors of rating.

3. Research methodology

The present study is an applied research in terms of purpose, and its results can be used by banks and credit institutions, financing companies, investors, financial analysts, and other stakeholders of Stock Exchange Organization and various companies. This study is theoretically survey, inductive, and ex post facto in terms of study type. Here, the researcher examines the research variables by selecting a sample that represents the community.

This research is performed based on the following steps:

- Identify effective financial ratios

- Implementation of ANP hierarchical analysis methods

- Data collection

- Ranking using multi-criteria decision making technique (DEMATEL, COPRAS)

- Data analysis

Theoretical basics and research background was provided based on books, articles, dissertations and databases of universities and Internet sites were used and by organizational documents such as audited financial statements and information available in the stock exchange, as well as information software available in the library of Stock Exchange, the data required for the ranking of companies were collected. As the audited financial statements have been approved by the Stock Exchange Organization, the data collected in this study had the acceptable reliability and validity.

The statistical population of this research (identification and weighting of effective accounting variables) is all credit managers, experts in the credit field in the first phase. Due to the limited number of study population and as only special people with the required information can respond the questionnaire, the purposive (judgment) sampling method was used. Also, the statistical population of this research in the second phase of the research (credit rating of companies) is the financial information of companies listed on the stock exchange, except banks and financial and credit institutions, insurance companies and investment companies during 2013 to 2018. In order to determine

Equity to total assets ratio$= \dfrac{Equity}{Total\ assets}$	Equity to asset ratio
Fixed assets to equity ratio$= \dfrac{Fixed\ assets}{Equity}$	Fixed assets to equity ratio
Fixed assets to long term debts ratio$= \dfrac{Fixed\ assets}{Longterm\ debts}$	Fixed assets to long term debts ratio
Debt ratio$= \dfrac{Total\ debt}{Total\ assets}$	Debt ratio
Inventory turnover$= \dfrac{Cost\ of\ goods\ sold}{Average\ inveotyr\ during\ year}$	Inventory turnover
Current assets turnover rate$= \dfrac{Net\ sale}{Current\ asset}$	Current assets turnover
Total assets turnover $= \dfrac{Net\ sale}{Total\ assets}$	Total assets turnover
Accounts payable turnover$= \dfrac{Credit\ purchase}{Average\ payables\ during\ \ ayear}$	Accounts payable turnover
Receivables turnover$= \dfrac{Net\ sale}{Recieved\ accounts}$	Receivables turnover
Net margin rate $= \dfrac{Profit\ after\ tax}{Sale}$	Net margin
Capital return rate$= \dfrac{Profit\ before\ tax}{Equity}$	Capital return
Operating profit growth$= \dfrac{Operatingprofitofcurrentyear - Operatingprofitofpreviousyear}{Operatingprofitofprevious\ year}$ $\times 100$	Operating profit growth
Equity growth $= \dfrac{Equity\ of\ current\ year\ - Equity\ of\ previous\ year}{Equity\ of\ previous\ year}$ $\times 100$	Equity growth
Asset growth $= \dfrac{Curretn\ year\ asset - Previous\ year\ asset}{Previous\ year\ sale} \times 100$	Asset growth
Sale growth$= \dfrac{Current\ year\ sale - Previous\ year\ sale}{Previous\ year\ sale} \times 100$	Sale growth

Leverage ratios (rows 1–4)

Activity ratios (rows 5–9)

Profitability ratios (rows 10–11)

Growth ratios (rows 12–15)

the population size, almost 100 companies listed on the stock exchange were selected using screening method. To do this, 4 criteria were chosen and if the company met all the criteria, it was selected as the research population and the rest was removed. The financial statements of these companies were obtained using the Kodal site and then the companies were analyzed and ranked. Conventional multi-criteria decision making techniques including COPRAS and DEMATEL were used to analyze the data for corporate ratings.

In decision-making science, in which choosing a solution from among the existing solutions or the prioritization of solutions is discussed, Multiple Attribute Decision Making (MADM) methods have been developed for several years. In such models, the decision maker intends to select the best option from the pre-existing alternatives according to the purpose of the problem and considering the branches. These models with extensive applications in ranking issues, are called rating models. (Akbari and Zahedi Keyvan, 2008).

The two main types of different methods of information processing in a MADM problem include:

a. Non-compensatory models: they include methods in which trade-off between attributes is not permitted. Therefore, each attribute in these methods is presented separately and attribute to attribute comparisons are made.

b. Compensatory model: They include methods in which the trade-off of attributes is allowed and any change (possibly little) in one attribute can be compensated by an opposite change in another attribute (or attributes). Some of these models are: ELECTRE, MDS, COPRAS, TOPSIS, SAWLINEAR ASSLGNMENT, etc. (Asgharpour, 1999).

Analytical Network Process (ANP) was extended in 1996 by Saaty. To solve problems by ANP method, a network is considered that the nodes in this network are equivalent to the goal, criteria and alternatives according to our needs and the directional vectors that connect these nodes are also equivalent to the direction and the effect of nodes on each other. Like AHP method, in ANP, the weight of the criteria and the desirability of the alternatives are obtained directly by receiving individual judgments and using pairwise comparisons.

ANP method is presented based on human brain analysis for complex and fuzzy problems with non-hierarchical structure and is proposed to modify AHP method. In this method, after setting up a non- hierarchical structure and determining the logical relationship between different levels of decision, the existing structure is divided into N subset $(S_1.S_2..S_N)$ and then judgment matrix is constructed for the feedback system through pairwise comparisons. For this purpose, at first it is necessary to form pairwise comparisons matrix by comparing the criteria and sub-criteria two by two.

One method of calculations in ANP method is to place the weights obtained by performing pairwise comparisons in a matrix called supermatrix. Supermatrix is a matrix of relationships between network components that is obtained from the special vectors of these relationships. Supermatrix can be divided into different blocks. Each block represents the weight obtained from a pairwise comparison of rows (e.g. attributes) with respect to columns (e.g. alternatives or attributes).

After the creation of the initial supermatrix, which is called unweighted supermatrix, if necessary, the columns of this matrix are normalized and a weighted or normal supermatrix is obtained (Figure 1). Using probabilistic matrices and Markov chains, Saaty proved that the final weight of the elements is obtained as:

$$W = \lim_{k \to \infty} W^{2k+1} \qquad\qquad (1)$$

Where k is an odd figure. The final matrix or limited matrix is obtained by solving the above

Equation. This matrix is a matrix in which all the numbers in each row are equal to each other and equal to the standard weight in the same row.
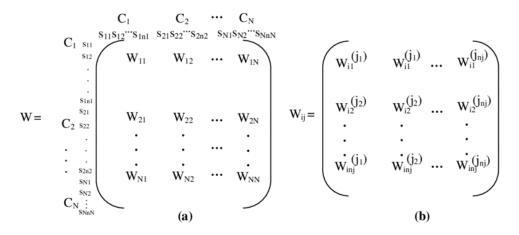

Figure 1: Normalized matrix and weighted supermatrix

The necessary steps to perform analytical network process (ANP) method are as follows:

Step 1 : Define the network structure

Step 2 : Making a questionnaire using a completely scientific method

Step 3 : Explain the structure of the initial supermatrix

Step 4 : Perform the necessary pairwise comparisons based on the designed questionnaire

Step 5 : Formation of the initial supermatrix

Step 6 : Obtain all the weights related to the network structure matrices

Step 7 : Form an unweighted supermatrix

Step 8 : Calculate weighted supermatrix

Step 9 : Calculate limited supermatrix

DEMATEL technique is the short form of Decision Making Trial And Evaluation. DEMATEL technique was introduced by Fonetla and Gabus in 1971. DEMATEL technique, which is one type of decision-making methods based on pairwise comparison, presents a hierarchy structure of the existing factors in the system with the mutual effect relationship using the experts' judgment in extraction of the factors of a system and systematic structuring to them using the graphs theory principles. DEMATEL technique is based on diagrams that can divide the factors involved into two groups of cause and effect and make the relationship between them as perceived structural model.

The network analysis questionnaire, which includes a pairwise comparison of attributes (financial ratios) with each other, was responded by this group of experts using a range of 1 to 5 according to Table 2 (defined by Saaty). Thus, while comparing each financial ratio with other ratios, the opinions of different people were taken into account in the ranking of companies. After pairwise comparisons of financial ratios by decision-making experts, the weights of the criteria (major and minor financial ratios) are calculated according to the conceptual model procedure. After normalization using the

following formula (Equation 2), the initial decision matrices are multiplied by the weights obtained from the fuzzy networks analysis and the normal weighted (initial) matrix is formed.

$$K = \frac{1}{max \sum_{j=1}^{n} a_{ij}} \qquad (2)$$

From the weighted sum of the sub-indicators values of each main criterion (18 financial ratios totally), the value of the main indicators (5 main ratios) is calculated and the final decision matrix is created. This matrix is also multiplied by the relevant weights and the final rating of the companies is obtained according to the final normal weight matrix and according to the procedure of the conceptual research model.

Table 2: A Five-point Likert evaluation

Neutral	Moderately important	Important	Very important	Extremely important
1	2	3	4	5

In this research, companies are ranked based on ratios, which are called research variables. These ratios are classified into 5 groups: profitability, growth and development, activity, leverage , liquidity, and ratios for each group:

The description and explanation of attributes are shown in Table 3.

Table 3: Final criteria extracted by experts

Main attribute	Minor attribute
Current ratio (D1)	
Quick ratio (D2)	Liquidity ratio s(C1)
Cash ratio (D3)	
Equity to asset ratio (D4)	
Fixed assets to equity ratio(D5)	
Fixed assets to long-term debts ratio (D6)	Leverage ratios (C2)
Debt ratio(D7)	
Inventory turnover (D8)	
Current Assets Turnover (D9)	
Total Asset Turnover (D10)	Activity ratios (C3)
Accounts Payable turnover (D11)	
Accounts receivable turnover (D12)	
Net profit margin (D13)	Profitability ratios (C4)
Return on Capital (D14)	
Equity growth (D16)	
Asset Growth (D17)	Profitability ratios (C5)
Sales growth (D18)	

In the next step, the results of elite judgments of the importance of each financial ratio, by considering the geometric mean of experts' judgments, were analyzed in Expert Choice v11.0 software. The table of pairwise comparisons matrix was provided from the geometric mean of the judgments of 10 experts. The main research question in prioritizing the top companies was as follows:

"For appropriate prioritization the top companies in the stock market, how much superior is each of the above attributes compared to the other ones?" The scores obtained from the questionnaire

were normalized using the above formula (Saaty, 2007). After entering the data obtained from the pairwise comparison questionnaire into the special decisions software, the ranked results and assigned weights were achieved.

In recent years, COPRAS method has become common as one of the multi-criteria decision-making methods due to the easy calculation, complete ranking of alternatives and consideration of positive and negative criteria. In multi-criteria decision models, the goal is either to weight the criteria or to rank the alternatives. This method also considers the second goal, which is to rank the alternatives. COPRAS is one of the multi-criteria decision making (MCDM) methods that is the best option among a set of practical alternatives (Kaklauskas and Zavadskas, 1996). This method has been applied by various researchers to solve decision problems. In this method, we first use the following formula (Equation 3) to normalize the matrix obtained in the previous step:

$$d_{ij} = \frac{q^i}{\sum_{j=1}^n x_{ij}} x_{ij} \qquad (3)$$

Then, the sum of the normal values of the positive criteria should be separated and the negative criteria should be calculated using 4 separate equations for each alternative.

$$Sj^+ = \sum_{zi=+} d_{ij}$$

$$Sj^- = \sum_{zi=-} d_{ij} \qquad (4)$$

Finally, we rank the alternatives according to the following equation (Equation 5), which is the calculation of the COPRAS index. The higher the value of Qj, the better the ranking of the alternative in prioritization. The alternative with the highest value is the ideal alternative.

$$Q_j = Sj^+ + \frac{S_{\bar{min}} \sum_{j=1}^n S_{\bar{j}} x}{S_{\bar{j}} \sum_{j=1}^n \frac{S_{\bar{min}}}{S_{\bar{j}}}} \qquad (5)$$

4. Research findings

In network analysis, after obtaining the opinions of experts and university professors, the consistency of pairwise comparisons should be ensured. For this purpose, the consistency of 200 matrices of pairwise comparison related to ANP technique was evaluated using this method (Gous, 1998) and 136 matrices with CR less than 0.1 had the acceptable consistency and were combined with each other and the cumulative matrix of expert opinions were obtained. After proving the consistency of the comparisons, the priority vector of each of the cumulative matrices of pairwise comparison is calculated.

Then, according to the opinions of experts, the unweighted matrix of pairwise comparisons is obtained. Then, according to the mentioned items and DANP method, by combining the unweighted supramatrix and the supermatrix, the final effect obtained from the DEMATEL method is ACHIEVED, and by raising this supermatrix, the limited supermatrix is obtained in which the final and main weights of indicators and sub-indicators are extracted as shown in Table 4.

Table 4:   Final weights of indicators and sub-indicators

Total	Factor Weight	Weight in sub-	Sub-indicators	Rank	Normal Weight	Total Weight	Indication
1	0.037253	0.17199	Current ratio(D1)	1	0.30136	0.14165	Liquidity
9	0.010446	0.04823	Quick ratio(D2)				
10	0.009481	0.04377	Cash ratio(D3)				
5	0.01736	0.08015	Equity to asset ratio(D4)	2	0.20946	0.098453	Leverage
7	0.013739	0.06343	Fixed assets to equity ratio(D5)				
12	0.007528	0.03475	Fixed assets to long-term debts ratio(D6)				
8	0.013504	0.06234	Debt ratio(D7)				
4	0.017551	0.08103	Inventory turnover (D8)	5	0.14744	0.069303	Activity
6	0.014983	0.06917	Current Assets Turnover (D9)				
11	0.00891	0.04113					
18	0.001552	0.00717	Total Asset Turnover (D10)				
17	0.003207	0.01481	Accounts payable turnover (D11)				
2	0.021839	0.10082	Net profit margin (D13)	4	0.15707	0.073829	Profitability
14	0.00554	0.02558	Return on capital (D14)				
3	0.019045	0.08793	Operating profit growth (D15)	3	0.18467	0.086802	Growth
13	0.006192	0.02859	Equity growth (D16)				
15	0.005112	0.0236	Asset Growth (D17)				
16	0.003363	0.01553	Sales growth (D18)				

Now, by using the weights obtained and COPRAS method, the credit rating of the companies listed on the Tehran Stock Exchange is obtained. Due to the high volume of information, the following is a brief summary of the results of this model for the required sample.

The statistical population of the study includes companies listed on the Tehran Stock Exchange. Indeed, the research population does not include financial and investment companies. The research period is during April 2013 to the end of March 2018. Finally, 100 companies were selected as the study sample by random sampling method. According to the 6-year period, 600 companies were ranked using the mode presented in this study. The output rating tables of the research model during the 6-year period indicate the correct trend of decreasing or increasing the credit rating of

companies based on the financial information provided by them, debt condition, the stock price trend in the market and the liquidity status during this period. . In the following, we analyze the output of the model with other available criteria.

5. Conclusion

According to the problem and purpose proposed, in this study, we attempt to achieve a ranking model using multi-criteria decision-making methods, and in particular, the hybrid DANP and CO-PRAS methods. Also, investigating the output of this method and its consistency to reality is among the other issues in this section. The output of the proposed model is consistent with the results of the models presented in previous studies. In this study, it was found that the quick ratio (D1), equity to assets ratio (D4), inventory turnover (D8), net profit margin (D13) and operating profit growth (D15) had the highest weight compared to other sub-indicators. Thus, these sub-indicators can be considered as the most important and effective financial ratios in the sample companies ranking.

Since in Iran the credit rating topic has not yet found a proper status and in general rating agencies refuse to disclose the model used for credit rating, there is no comprehensive criterion for comparing the results of this study with the results of the existing methods for evaluating the model accuracy. However, in order to find out that the results of this method are correct and consistent with reality, first the common results between the output of the research model are compared with reports provided by licensed rating agencies and they are in good matching with each other. On the other hand, it should be noted that normally which indicator is considered by stakeholders and investors in investment. The rate of return on capital and net profit margin are the most important indicators used in the credit rating of companies and securities selection, so that two indicators have achieved the highest weight importance via the DANP method. In this method, companies were ranked according to financial ratios, their weight and COPRAS method, in which the rank of each company was defined in each each fiscal year. Also, since Article 141 of the Commercial Code considers the credit evaluation of all banks, credit institutions and financing companies as an important issue, according to the studies and referring to the financial information of companies included in the article 141 of the Commercial Code Amendment, it was observed that during the period of research, this approach, on average, has successfully predicted the financial distress of more than 96% of Iranian companies. Therefore, all the above results indicate that the method used in this study is in good matching with reality and choosing this method can appropriately reveal the real status of the companies due to its available, limited data (financial ratios) and its simple computational method.

Also, the results of this study and the inconsistency of all financial ratios, show that the widely used criterion of earnings per share, which is generally used by investors and shareholders to evaluate companies, is not a suitable criterion alone and it is proposed that the multi-criteria model should be replaced by separate evaluation methods.

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