Predicting of the Financial Crisis by Using the Financial Ratios and Presentation of Sufficient Prediction with Approach the Artificial Neural Networks and Fuzzy Nero

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Abstract: This study provide a comprehensive definition of financial crisis, using financial ratios and Artificial Intelligence techniques (Artificial Neural Network and Fuzzy Nero) model to predict the financial crisis of listed companies in Tehran Stock Exchange (automotive and parts manufacturing) are extracted. The aim of the present study and practical perspective on the nature and methods of causal and quasi-experimental research is considered. In this study, 126 companies-since the sample was taken and the required information was extracted from the financial statements of these companies. In this regard, MATLAB and SPSS Software was used to test hypotheses and build models . Findings indicate that the size of financial ratios to predict financial crises management is a significant relationship. Also Nrvfazy 85% confidence rule extracted from the model were estimated.

Key words: Financial crisis, financial ratios, artificial neural networks, models nrvfazy, extracted

INTRODUCTION

To achieve success, all business units, design and draw their operations toward their plans. Some of the units perform high risk operations to achieve but that leads to bankruptcy. These unexpected aspects of bankruptcy are so dangerous. However, the units that are not continuously active are not considered to be bankrupted, because some of them have achieved their goals despite the lack of continuity in their actions. Bankruptcy has a great impact on the management, shareholders, employees, creditors, customers and other stakeholders. Therefore, Bankruptcy challenges the countries both socially and economically (Altman, 1968, 1993). If bankruptcy is identified in its earlier stages, it possibly can be avoided with simpler solutions and economic and social consequences of it can be reduced or even prevented. But the factors that led to the bankruptcy of a company, do not emerge overnight. The signs of a financial crisis of a company appear much earlier than the final bankruptcy. However, Newton believes that the company is in decline in the stage of bankruptcy. Total debt exceeds the value of the company's assets and the company cannot avoid the stopping of the operations and the influx of creditors or other stakeholders who demand their collection of receivables. The financial crisis is a problematic condition in which the company is unable to gain sufficient financial sources to pursue its operations (Lensberg et al., 2006). In this situation the company is unable to encounter its obligations at maturity (Beaver, 1966). In this situation, the company is unable to produce enough liquidity to satisfy its needs such as payments to lenders (Jantadej, 2006). In the literature of finance, it is emphasized that the companies enter into the cycle of financial crisis many years before the bankruptcy and various economic events occur in the period before bankruptcy. For example, failure to pay debts or delays in payment of the loans occurs at least three years before the bankruptcy (Foster, 1985). In some cases, a company that has been in crisis may operate with these conditions for years. In other words, some companies face bankruptcy immediately after a severe crisis such as a great fraud. In some cases, the company's main stakeholders, including shareholders, lenders and managers may recognize that their interests are provided better in bankruptcy. Therefore, in some cases bankruptcy can be optional. Various factors including high costs, declining demand of costumers and poor financial management can cause financial crisis. Bankruptcy can be a consequence of financial crisis. Clearing accounts, dissolution, integration, restructuring and continuation of operations may occur as a result of the financial crisis (Lensberg et al., 2006). One of the ways that can help us to take advantage of suitable

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investment opportunities and also to avoid the wasting of resources, is the prediction of the financial crisis (Nia 2010. Prediction of the financial crisis, has long been regarded as one of the most important issues in the financial fields. Since in these models, the basic variable (dependent) is of a categorical type (financially distressed or healthy) we are faced with the problem of classification; thus, it is clear that in such studies, the statistical models, such as multiple discriminant analysis, logit analysis, Probit analysis are used. However, the credibility and effectiveness of the traditional statistical methods is related to some restrictive assumptions, such as linearity, normality, independence, predictive variables and the existence of a function of the predefined structure. These traditional methods, can solve problems if all or most of these assumptions are met. Recent studies in the field of Artificial Neural Networks (ANN) show that due to the non-linear, non-parametric and adaptive learning properties, ANNs are a powerful tool for identification and classification of patterns. ANN models are used to solve many financial problems, including financial distress prediction- this use is increasing. Many researchers have used the ANN to predict the financial crisis, they have concluded that the accuracy of prediction of ANN is significantly greater than traditional statistical techniques (Saeed, 2004). During the past decades, the success of artificial neural networks in prediction was observed. An artificial neural network, is a simplified model of a central system that models the structure of the human brain and includes a series of interconnected neurons; each of these neurons is called a layer. The role of neurons in neural networks, is data processing. This issue, in artificial neural networks is selected by the designer and through the same activation function which is a mathematical processor Based on the specific needs of a problem that is going to be solved by the neural network. The simplest form of network, has only two layers. The input and output layers of a network act like an input-output system and uses the neuron's input values to calculate the output values of neurons. Neural networks with hidden layers, have more capabilities than the two layer neural networks (Sayed, 2010). At the national level and in particular in the Tehran Stock Exchange's listed companies, there are companies that are experiencing financial crisis. For example, some of these companies are difficult to service their debt and do not have enough productivity to cover the costs; all these problems show that the company is engaged in financial crisis which would result in bankruptcy. That in general would have a negative impact on macro-economic indicators while the country is in desperate need of optimal allocation of resources and job creation (Nia 2010). One of the tools of

analysis, are financial ratios; tools used to develop the prediction model are financial ratios derived from the financial statements (Nia, 2010). There are four categories of financial ratios that are used widely in predicting bankruptcy models. The four financial ratios include profitability ratios, capital structure ratios, liquidity ratios and performance ratios. These four groups compare simultaneously the characteristics of bankrupt financial companies and can affect the external and internal factors reflect on the possibility of bankruptcy (Altman, 1968, 1993). In Previous studies (Shin and Lee, 2002) proposed a method based on genetic algorithms to predict the financial crisis. They said that the rules caused by genetic algorithm are easier to understand and can be used like any other artificial intelligence systems. In this study, a genetic algorithm has been used to extract understandable rules for different users such as expert systems and is used to calculate the yield point for different variables in predicting bankruptcy. Also (McKee *et al.*, 2006) in a study entitled "Bankruptcy theory development and classification via genetic programming "used rough set theory and genetic algorithm to predict the financial crisis of US companies. McKay used the financial information of 291 companies between 1991 and 1997. He used two different methods and 4 variables out of the 11 variables. These variables included net income to total assets, firm size, current liquidity to current liabilities and current liquidity of investment to Net income. The results showed that the accuracy of the two methods is 80 and 67%. Also Chen and Du (2009) in a study entitled "Designing a model for the prediction of financial distress using neural networks and data mining techniques", used artificial neural networks and data mining techniques (DM) to predict the financial crisis in Taiwanese companies. They collected the information of 34 pair of healthy and in-crisis companies during 1999-2006. They analyzed 37 financial ratios that were obtained from similar studies using PCA (principal components analysis) and VARIMAX. The results suggest that DM provides better results than the neural network in the prediction of the financial crisis.

The present study has examined the ratios as dimensions of the study which were present in most financial reports and activity reports of Iranian companies. From the perspective of Amiri (2003), the ratios are: The ratio of current assets to current liabilities, the ratio of liquidity to current liabilities, the ratio of Quick assets to current liabilities, the ratio of total liabilities to total assets, the ratio of price per share to earnings per share and the ratio of working capital to sales. It should be noted that the above ratios are based on assessments of companies' conditions by financial analysts and creditors (Amiri,

2002). The main objective of this study is to predict the financial crisis, using financial ratios and providing a model of prediction with artificial neural networks and neuro-fuzzy approaches based on listed companies in Tehran Stock Exchange (automotive and construction parts).

MATERIALS AND METHODS

According to the literature review, a conceptual models based on the model of (Soleimani Amiri, 2002) is presented in Fig. 1.

The main hypothesis: The Consideration of the size of financial ratios to the predictability of financial crises has a significant impact

Secondary hypotheses:
- The size of Current Assets to Current Liabilities (CA /CL) has a significant impact on the predictability of financial crisis by management.
- The size of liquidity to current liabilities (L/C) has a significant impact on the predictability of financial crisis by management.

- The size of Quick Assets to Current Liabilities (QA /CL) has a significant impact on the predictability of financial crisis by management
- The size of Total Liabilities to Total Assets (TLTA) has a significant impact on the predictability of financial crisis by managemen.
- The Size of the Price per share to Earnings per Share (SP/EPS) has a significant impact on the predictability of financial crisis by management
- The size of Working Capital to Sales (WC/S) has a significant impact on the predictability of financial crisis by management
- The size of Working Capital to Total Assets (WC/TA) has a significant impact on the predictability of financial crisis by management
- The size of Earnings Before Interest and taxes to total assets (EBIT/TA) has a significant impact on the predictability of financial crisis by management
- The size of the ratio of Equity to Total Assets (E/ TA) has a significant impact on the predictability of financial crisis by management
- The size of Sales to Total Assets (S/TA) has a significant impact on the predictability of financial crisis by management
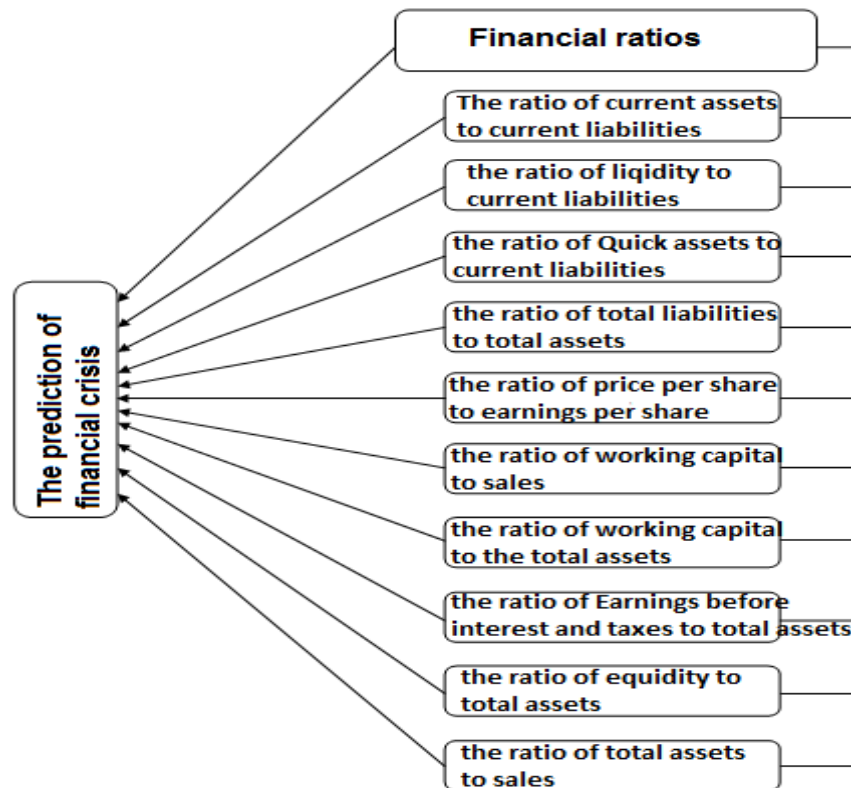

Fig. 1: The conceptual model derived from Soleimani Amiri (2002)

This research in terms of its objectives is an applied research and in terms of the nature and method of research is causal. The population of the study contains the companies related to the automotive industry and manufacturing parts listed in Tehran Stock Exchange (31 companies) which have presented their financial statements to the Tehran Stock Exchange from during 2005-2010. The Selection of companies related to automobile and parts listed in the Tehran Stock Exchange as the population of the study is due to the availability and reliability of information. Because these companies are accepted in exchange after some criteria that must be met. The removal method is used for sampling the study. Thus, out of the statistical population being all listed companies on Tehran Stock Exchange, only the following companies were selected:

- The companies whose fiscal year ends in March 20 (the end of Persian year) and has not been changed during the period of investigation
- The information required for the calculation of variables should be available during the period of investigation
- The companies which were in the range of research should have an ongoing presence in the Exchange

According to the above conditions, companies that could meet the criteria of the study were selected. Then they were categorized into two companies of healthy and in crisis. Thus, out of the 31 companies in the automotive and construction parts, 21 companies were selected as the samples of the study. Accordingly, given that six fiscal years is regarded in each company, the present study uses of 126 firm-year as samples. Information on financial ratios are collected from the financial statements of public archive of Stock Exchange, Stock Exchange's database and libraries. To analyze the data and predict the financial crisis, the integration algorithm of artificial intelligence and fuzzy methods were used. After data collection through review of financial statements of listed companies in Tehran Stock Exchange during 2005-2010, using the EXCEL spreadsheet we calculated the amount of financial ratios of this research and also separated the healthy and in crisis companies. Then, to identify appropriate financial ratios for modeling, SPSS 19 Software and regression tests were used. Then using MATLAB Software, predicting model of financial crisis was designed.

RESULTS AND DISCUSSION

To implement neuro-fuzzy models and neural networks, regarding the number of cycles of delays (p)

inputs and outputs must first be defined. The number of delayed cycles of P indicates that the prediction of the financial crisis should be done for the next several periods. The periods in this study contain 12 months. For example, if $p = 1$ then the financial crisis would be predicted for the next year. Or if $p = 2$, then the financial crisis would be predicted for the next two years. It should be noted that the connection between the financial crisis and all financial ratios are not necessarily a direct linear relationship; it can be considered a non-linear relationship. The Trainlm algorithm is used to study the impact of network performance among the existing algorithms suitable for teaching the neural network. There is access to these algorithms in MATLAB.

According to the values in the Table 1, 10 neural networks will be applicable, of which the best network is selected with the lowest MAPE error. ANFIS model is presented to predict the financial crisis. Here the process of ANFIS implementation is provided in four stages. First phase of input variables and establishment of rules using MATLAB Software genfis2 code has been conducted. First the fuzziness of input variables and the establishment of rules have been conducted using genfis2 code of MATLAB Software. After the establishment of the fuzziness of data through subtraction clustering and genfis2 techniques, the second stage concerns the forming of fuzzy rule's base for ANFIS. Then the existing rules observed in the rule base of Step 2, make a system of fuzzy inference and after being trained i.e., obtaining the coefficients of f1 to f3 are turned into another fuzzy inference system called ANFIS. The training of ANFIS is conducted by MATLAB software. Then the models were validated and authentication. Time delay of p is considered with the one and two values of time periods and the results of any amount is analyzed to see what the best value of p is. In other words, it is better to predict the financial crisis should be done for the current year or for subsequent years should be made. In other words, it is better to predict the financial crisis for the current year or for subsequent years. In the case of existing models for the prediction and estimation of the financial crisis, including ANFIS and Neural Networks; their error results are compared with each other. In comparison, 30% of all available observations are considered to test the model and calculate the errors of the model. As described earlier, the error index, is that of MAPE. Table 2 compares the results of procedures and testing of the data. The results show that the error of models are decreased when predictions are done for a one-year period. The error results of testing both Neuro-Fuzzy (ANFIS) and Neural

Table 1: Different parameters and different levels of neural network

The type of data	Training algorithm	The transfer function of the hidden layer	The number of hidden layer's neurons	The type of preprocessing	The way of selecting the test	Test percent
Training	Trainlm	tansig, logsig	Min = 2, Max = 10	Mapminmax	Dividerand	30%

Table 2: Predicted error of different models with one year and two-years periods

Input variables	p-valuw	The number of observations	ANFIS	ANN
The first ratio-earnings before interest and taxes to assets				
The second ratio-equity to assets				
The fifth ration-quick assets to current liabilities	1	105	15	17
The first ratio-earnings before interest and taxes to assets				
The second ratio-equity to assets				
The fifth ration-quick assets to current liabilities	2	84	16	17

Networks (ANN) models are very close together. However ANFIS Model can be considered acceptable. The following reasons can be cited for the preferring of ANFIS Model:

- This model provides the ability to model the fuzzy variables and uncertainty in the environment is modeled appropriately
- The model has shown a good ability to estimate and predict the financial crisis such that the error in some cases has decreased to 15%
- Despite the prediction of the financial crisis, the neuro-fuzzy model, produces a fuzzy database and this database in different modelling spaces, shows the complex relationship between financial ratios and financial crisis in the form of simple linear models. Transparency of the financial crisis in this model is one of the benefits of this neural network model

According to the results, the neuro-fuzzy model is the best model to predict the financial crisis; when the financial crisis is to be considered for the next year the first three aspect of ratios-Earnings before interest and taxes to property, the second-the equity to asset and fifth quick assets to current liabilities are used as inputs of the model Table 2. In the following, the results of the primary and secondary hypotheses are presented.

The main hypothesis is: The Consideration of the size of financial ratios to the predictability of financial crises has a significant impact. According to the results, we can say that this hypothesis is valid. Because the significance of neuro-fuzzy models is conducted in different spaces of the financial ratios. Results showed that the confidence in the sector is very close to 100% and the models are significant. This result means that we can predict the financial crisis based on financial ratios. Of course, this model refers to the three financial ratios namely, first, second and fifth ratios. In other words, we can say that, the consideration of the size of financial ratios has an impact on the ability to predict the financial crisis.

The secondary hypotheses are:
- The size of Current Assets to Current Liabilities (CA/CL) has a significant impact on the predictability of financial crisis by management
- The size of liquidity to Current Liabilities (L/C) has a significant impact on the predictability of financial crisis by management
- The size of Quick Assets to Current Liabilities (QA/CL) has a significant impact on the predictability of financial crisis by management
- The size of Total Liabilities to Total Assets (TLTA) has a significant impact on the predictability of financial crisis by management
- The Size of the Price per Share to Earnings per Share (SP/EPS) has a significant impact on the predictability of financial crisis by management
- The size of Working Capital to Sales (WC/S) has a significant impact on the predictability of financial crisis by management
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- The size of Earnings Before Interest and Taxes to Total assets (EBIT/TA) has a significant impact on the predictability of financial crisis by management
- The size of the ratio of Equity to Total Assets (E/TA) has a significant impact on the predictability of financial crisis by management
- The size of Sales to Total Assets (S/TA) has a significant impact on the predictability of financial crisis by management

In this study, the negative working capital is considered as a sign of the financial crisis. Thus, the output variable of the model is the ratio of the working capital to the total assets. Working capital is defined as the difference between Current assets minus current liabilities; therefore, in modeling the financial crisis, the significance and effectiveness of the financial ratio of current assets to current liabilities is clear and doesn't need to be investigated. Also, the ratio of working capital

to sales and working capital to total assets is significant and has an obvious impact because the numerator is the same as the definition of the financial crisis; thus the number of ratios that are required to be tested in terms of their effectiveness, are decreased to 7 financial ratio. In this study, the testing of the secondary hypotheses was conducted in two stages. As previously mentioned, the third step of the proposed algorithm, analyzes the impact of the financial ratios on financial crisis. The impact of financial ratios on the financial crisis is shown in two stages:

The analysis of the coefficients of the variables in fuzzy rules and II) the effect of elimination of variables of neuro-fuzzy model: The results showed that among seven studied financial ratios, the first, second and fifth ratios of ratios are significant and have a significant positive impact on the ability to predict the financial crisis; Thus among the secondary hypothesis of 1-7, hypotheses 1, 2 and 5 are significant and the significance of other hypotheses cannot be assured. The results of hypotheses 3, 4, 5 and 6 are consistent with the results of Kazemi Nia (2010). Kazemi Nia also quoted in his study of Mervin, in stating that the ratio of working asset to total assets is the best criterion for the final stop and inability to continue the activities. The results of hypotheses 1, 2, 5 and 7 are in consistent with the results of Soleimani Amiri in 2002 and 2003. Neuro-fuzzy model for predicting the financial crisis in the next year, is trained and the results of this training is presented in the following. One of the most efficient ways of showing the relationship between different variables is the use of a three-dimensional graphical display. Figure 2 regards the relationship

between first ratios (earnings before interest and taxes to assets) and second (equity to assets) with the financial crisis in the next year. In the right diagram, the normalized variable of the financial crisis is shown on z axis. When the normalized variable of financial crisis is <0.5 it indicates that the main variable i.e. the ratio of working capital to assets is negative and there exists the financial crisis. In the left chart which is the pseudo color of the right one, the financial crisis <0.5 are highlighted with blue. According to the charts, the financial crisis is most likely when the first financial ratio (earnings before interest and tax to assets) is <0.5 and the second financial ratio (equity to assets) is <0.4. In this case, the normalized variable of financial crisis will be <0.5; this indicates that the main variable i.e. the ratio of working capital to assets is negative.

Figure 3 regards the relationship between first ratios (earnings before interest and taxes to assets) and the fifth (quick assets to current liabilities) with the financial crisis in the next year. In this chart the financial crisis <0.5 are highlighted with blue as well. According to the charts, the financial crisis is most likely when the first financial ratio (earnings before interest and tax to assets) is <0.55 and the fifth financial ratio (quick assets to current liabilities) is <0.4. In this case, the normalized variable of financial crisis will be <0.5; this indicate that the main variable i.e. the ratio of working capital to assets is negative.

Figure 4 regards the relationship between the second ratios (Equity to assets) and the fifth (quick assets to current liabilities) with the financial crisis in the next year. In this Chart the financial crisis <0.5 are highlighted with blue as well. According to the charts, the financial crisis is most likely when the second financial ratio (Equity to
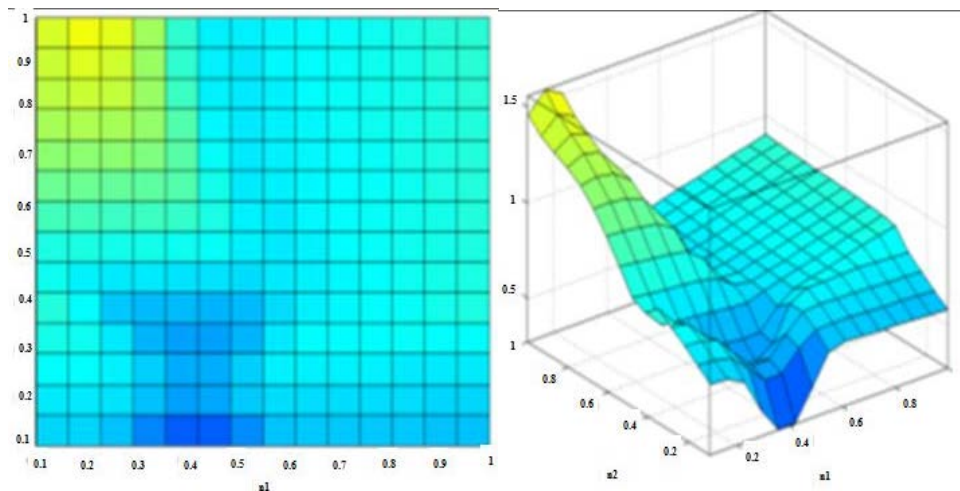

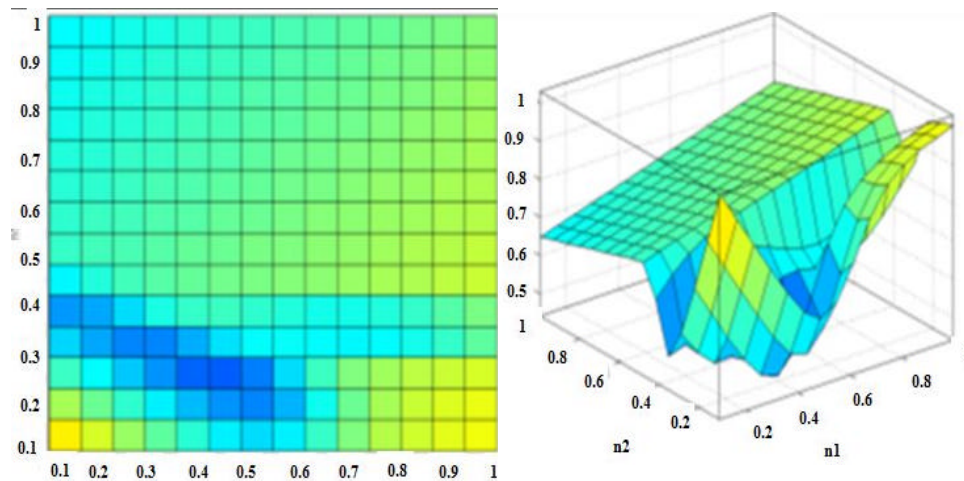Fig. 2: The first and second ratios associated with the financial crisis

Fig. 3: The first and fifth ratios associated with the financial crisis
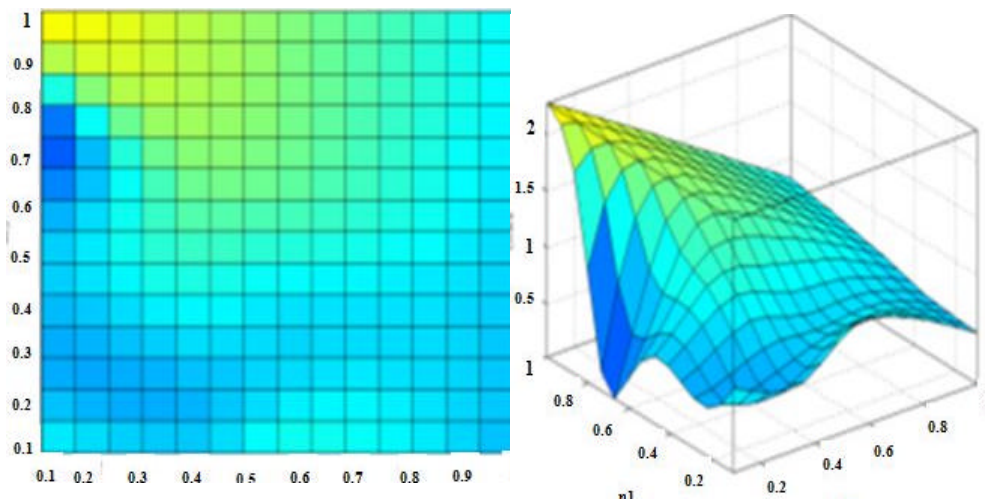

Fig. 4: Third and fifth ratios associated with the financial crisis

assets) is <0.2 and the fifth financial ratio (quick assets to current liabilities) is between 0.6 and 0.8. In this case, the normalized variable of financial crisis will be <0.5; this indicates that the main variable i.e. the ratio of working capital to assets is negative. From the analysis of all three of these charts it can be generally concluded that the financial crisis is most likely when:

- The first financial ratio is <0.5 and the second financial ratio is <0.4
- The first financial ratio is <0.55 and the fifth financial ratio is <0.4
- The second financial ratio is <0.2 and the second financial ratio is between 0.6-0.8

In summing up all above, we can conclude that: The financial crisis is most likely when: the normalized value of the first financial ratio is <0.5, the second financial ratio is <0.2 and the fifth financial ratio is <0.4. Of course, these values are about the normalized variables. If we define the results with the original values of financial ratios, we can say: The ratio of working asset to the next year's asset is negative if the first ratio being earnings before interest and taxes to assets is <0.1 and the second ratio being equity to assets is <0.14 and the fifth ratio being quick asset to the current liabilities is <1.2.

CONCLUSION

In the current situation that the crisis has become an integral part of normal life of the today's organizations, beneficiaries and stakeholders are increasingly in need of information, analysis and logical inference from the data. More great crises that have made many of the giant economies of the world to be faced with bankruptcy were crises that have had pre-specified symptoms. Some of these signs are clearly reflected in the financial statements; thus, the use of the results of the analysis of financial statements and the use of other sources of information, states the overview of the current financial situation facing the company. Prediction of the financial crisis and the bankruptcy of companies is one of the interesting and important studies in the field of finance. By predicting the financial crisis and the reasons of the problem and its solution, satisfactory results can be achieved. In this study, the prediction of the financial crisis of companies was performed using Neuro-Fuzzy techniques (ANFIS). Statistical models only in some circumstances respond well (when their statistical assumptions are available). Taking into account the actual conditions and complexes of non-linear spaces, ANFIS is a great alternative for statistical models in solving the issues such as the prediction of the financial crisis. In addition, the ANFIS can be used to solve many financial problems and given the excellent results that are achieved, it is expected that the use of ANFIS is increased dramatically in the financial sphere. In this study, the Artificial Neural Networks (ANN) were used to evaluate the potential of neuro-fuzzy techniques in modeling; According to the literature, ANN as the most powerful method, taking into account the actual conditions and regardless of the statistical assumptions, is known in modeling of the financial crisis and bankruptcy. The results show the superiority of the ANN technique to ANFIS. The use of neuro-fuzzy techniques, showed that this model is capable of predicting financial crisis of the company and can be used with high confidence. Of course, it is natural that the moving away from the financial crisis, reduces the predictive power of the model. Using the results and the model presented in this study, as a first step, we can prevent the company from bankruptcy and financial crisis and its consequences, appropriately. After the prediction, the reasons should be investigated in order to manage the crises better. In addition, the ability to model predictions indicate that by moving away from the time of financial crisis the predictive ability of the Model is also reduced. This has been due to the reduction of the clarity of financial indicators in terms of the accounting information. Future research could predict the ability of the model according to longer time periods (5 year or more).

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