

# The Comparison Artificial Neural Networks and Multi Decimal Analysis Models for Forecasting Bankruptcy and Financial Distress

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*Abstract-One of the most important issues in the world of financial management is investment assurance for legal and rightful persons. The existence of suitable standards and instruments to evaluate financial conditions and companies situations can help investors to under take their decisions making. Financial corruption and bankruptcy bear extensive costs which cause lasting damages to country's economy. One of the ways to prevent financial corruption is to forecast financial distress. In this paper which uses the correlation research methodology employing Artificial Neural Networks (ANN), the financial corruption of the companies has been forecasted. The main aim of this research is to compare ANN and Multi Decimal Analysis (MDA) models in bankruptcy forecasting field. In order to study the effect of sampling differences on forecasting, the absolute validation method has been used. Dual Comparison Test was used to test three hypotheses introduced in this research. The results obtained from the models based on the data from 80 accepted companies in Tehran Stock Exchange show that in forecasting financial distress, the ANN model is more accurate than the MDA model.*

**Keywords:** Financial Distress (FD), Bankruptcy, Artificial Neural Networks, Multi Decimal Analysis.

## I. INTRODUCTION

On the national scale and considering the manufacturing companies -members of the Tehran Stock Exchange- we observe some companies which based on the definition presented in this study are among financially distressed companies. The point is revealed by observing these companies financial statements and auditors and legal inspectors' reports. Some of them, for example, are facing to problems in repaying their debts. Forecasting company distress has been known as a major subject of studies in the financial world. Some of the statistical models, MDA and Logit Analysis models are used in such studies. Due to some traits such as non-linearity, non-parametric and the adaptive learning of the ANN, they have become powerful tools to identify and classify existed patterns. The ANN has been used to solve many financial problems including

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forecasting financial distress, and this application is increasingly important. Many researchers using ANN to forecast the financial distress have come to the conclusion that the accuracy of the ANN is much more effective than the traditional statistical methods in a more meaningful degree. With regards to the stated comments, the ANN together with the MDA has been used in this study to forecast financial distress.

## II. LITERATURE REVIEW

Gordon (1971) in one of the first academic studies on the hypothesis of financial distress describes it as the company's profitability reduction factor which increases the possibility of company inability to pay off the interest and the capital debt. Whitaker describes financial distress as a situation where the company's cash flows are less than the total costs of interest on long term debt[1]. Using the analysis of the ratios goes back to 300BC, when Euclid used such analysis in his studies. The scientific usage of financial ratios started in 1870[2]. William Beaver states that analysis of ratios started in the early of 1900. The studies undertaken in 1930 show that the financial ratios in bankrupt companies are significantly different from financial ratios of non-bankrupt companies [3]. William Beaver was the first person who used statistical techniques and financial ratios for forecasting company bankruptcy, and Edward Altman is known as the first person who used the MDA to forecast bankruptcy. These researchers discovered that certain financial ratios change significantly when companies are on the verge of bankruptcy. Altman's first model initially introduced in 1968, was called the Z-Score. Altman's theory explained that quantitative models like the MDA could be used to distinguish between companies which face the possibility of bankruptcy[4].

Odom and Sharda in 1990 used a 3 layered pre-spent network[5]. In 1977 Cerano-Sinka used a Multi layered model; in the study the MLP was compared to MDA. The accuracy of forecasting with MDA and MLP was 86% and 94% respectively[6].Studies revealed that there are various financial data which can be useful in forecasting companies' distress, but there is no general agreement as to which one of the variations is more effective than others. The MDA method has been used more than other

models in forecasting company distress, but rapid trend of computer advancement has caused the increase of ANN applications.

### III. THE MDA AND ANN MODELS

The studies undertaken about the MDA and ANN forecasting models are presented in Tables 1 and 2.

**Table1. The MDA forecasting technique**

no.	Technique Title	Year	Objective	Researcher/s
1	Z-Score	1968	Distinguish Bankrupt	E.Altman
2	Merging Bior & Altman Models	1972	Forecast Bankruptcy	Dicken
3	Choosing Financial Ratios on the basis of Bior/Bloom/Altman Studies	1972	Forecast FD	R. Admister
4	Revision of Financial Ratios via classification into 3 separate groups	1974	Forecast FD	Mark Bloom
5	Revision of Altman Model & Deletion of Ratios of Market value of shares to debt book value and sales to total assets	1977	Forecast Bankruptcy	Moyer
6	Zeta(Revision of Financial Ratios & profitability Return	1977	Forecast Bankruptcy	Altman/Haldman/Narayana
7	Revision of Financial Ratios & Ratios related to cash flows	1985	Forecast Bankruptcy	Casey/Bartzak
8	Revision of Financial Ratios	1986	Forecast Bankruptcy	Lawrence/Bier
9	Revision of Cash Flows using Logit & Decimal Analysis technic	1988	Forecast Bankruptcy	Eziz/Emmanuel/Lassen
10	Z Zegon-Score	2000	Distinguish Bankrupt from non-bankrupt co's.	Altman
11	Revision of Altman's initial Z-Score	2001	Forecast Bankruptcy	Grice/Ingram

**Table2. The ANN forecasting model**

no.	Technique Title	Year	Objective	Researcher/s
1	3 Layered Pre-Earned Network	1990	Forecasting Bankruptcy	Adam/Sharda
2	Comparison of ANN with Logit Model	1992	Forecasting FD of Loan/Savings Inst.	Salchenberger/Sinar/Laesh
3	Using Financial Ratios	1991-2	Forecast FD	Kets/Fant
4	Comparing ANN with Linear Decimal Models & Regression	1992	Forecast Bankruptcy	Tom/Kiang
5	Comparing ANN with Logit Analysis & Recessive Division Lagorithm	1994	Forecast Bankruptcy	Nita ya Gastovat
6	ANN Grafting Model	1996	Forecast Bankruptcy	Lee/Haan/Quan
7	Multi Layered Perspetron	1997	Forecast Bankruptcy	Cerano/Sinka
8	Compare ANN with Logit Regression	1999	Forecast Bankruptcy	Xang/Ho/Patwa/Indora
9	Using Financial Ratios	2000	Forecast Bankruptcy	Shah/Morteza

#### IV. HYPOTHESIS

The overall accuracy of the ANN model is more than the MDA model in forecasting financial distress.

#### V. RESEARCH METHOD AND SAMPLING

The correlation research method has been used as the research methodology. In the method as a non-testing research method, the relationship between the variations based on the objective of the research is analyzed.

The field of study in this research includes the manufacturing companies as members of Tehran Stock Exchange. The used sample includes 120 selected manufacturing companies. The required data for this research were gathered by referring to the three years financial statements of the companies (available at the Tehran Stock Exchange Archives).

#### VI. DATA ANALYSIS

In order to summarize data, first the particular ratios were calculated by using the collected data related to each company. All the activities in summarization procedures were carried out using the Microsoft Excel 2003 along with coding by the Visual Basic Application.

After the data was summarized in such a way, first the statistical model i.e. MDA was considered. According to this purpose, statistics relating to each one of the variations in both groups were calculated firstly and subjected to the averages comparison test. At this time, the final decision about five main variations was made. From here on, the activities were continued using the five ratios which included: capital in flow/total assets, pre-financial expenses profit and tax/total assets, current assets/ current debts, pre-financial expenses profit and tax/net sales and total dues of the share owners/total debts. The ACT (averages comparison test) showed that there was a meaningful difference on the 5% level between the averages of all the variations in both groups. Of course it was at the 1% level for all the variations. Thenceforth, for each one of the secondary samples, a model was developed using MDA and SPSS 11.5 software which included:

For 1<sup>st</sup> sample:

$$FH = -0.99 + 0.101 X_1 + 0.462 X_2 + 5.415 X_3 + 0.916 X_4 - 0.334 X_5$$

For 2<sup>nd</sup> sample:

$$FH = -1.312 + 0.145 X_1 + 0.324 X_2 + 6.342 X_3 + 0.889 X_4 - 0.508 X_5$$

For 3<sup>rd</sup> sample:

$$FH = -0.061 - 1.128 X_1 + 4.479 X_2 + 2.37 X_3 + 1.004 X_4 + 4.902 X_5$$

For 4<sup>th</sup> sample:

$$FH = -1.105 + 0.103 X_1 + 0.561 X_2 + 5.056 X_3 + 1.201 X_4 - 0.319 X_5$$

Where:

$$\text{Current Ratio} = (CA - CL): X_1$$

$$\text{Pre-Financial Expenses Profit and Tax/ Net Sale} = (EBIT - NS): X_2$$

$$\text{Pre-Financial Expenses Profit and Tax/ Total Assets} = (EBIT - TA): X_3$$

$$\text{Total Dues of the Share Holders/ Total Debts} = (TE - TD): X_4$$

$$\text{Capital in Circulation to Total Assets} = (WC - TA): X_5$$

FH = Main Index

Decision making method about classification of samples into two groups of financially distressed and healthy companies is thus as follows: for each of the samples considering the coefficients obtained, the main index (FH) is calculated. If (FH) becomes negative, that sample will belong to the financial distressed group and, if it is positive, it will belong to the healthy group.

Carrying out these calculations for the testing collection, year (t-1) and year (t-2), forecasting of group membership was undertaken by the model. And comparing it to the real membership of the samples, the function of models was achieved. It is interesting to note that during the development of the model, '0' and '1' were considered for financially distressed and healthy companies respectively.

To classify the samples, of course, one can also use the environs which the SPSS software offers for each one of the groups, the results of which will not be different to these results. Through this method, for each one of the samples, using the environs related to each group, the main index is calculated and the sample would belong to the group with higher main index.

The main function of the MDA model appears in the submitted report by the SPSS software under the title of DFCC (Discriminate Function Coefficients Canonical) and the environs of each group titled as CFC (Classification Function Coefficients).

At the next stage, the forecasting of financial distress was carried out by the ANN. All the functions relating to this part were carried out by the (Subject Software) and using Neural Network Toolbox available in that environment along with coding. As was described earlier, at his stage, the final network topology for each of the four secondary samples was chosen following several tests, the length of them was in total 100 hours. Considering that the final output of the numeral network was zero or one, the samples with output less than 0.5 were classified as financially distressed companies, and those with output greater than 0.5 were classified as healthy companies.

To calculate the final output of the network for the testing sets of the (t) year, the achieved scales of the first and the middle layers were used. The final classification of these samples, both in the case of the MDA and the ANN, was carried out using the Excel software. The function of the Neural Network was then calculated by comparing the forecast results and reality.

At the last stage, to test the hypothesis introduced in this research, the Dual Comparison Test was used. This was undertaken for the year (t).

H0: At the year (t), the total accuracy of forecasting of the ANN is less or equal to the MDA.

H1: At the year (t), the total accuracy of forecasting of the ANN is greater than the MDA.

Tables 3 and 4 shows the results of the Dual Comparison Test for the year (t).

**Table 3. Forecast results for year (t)**

ANN				MDA				
Sub 2	Sub 1	Sub 2	Sub 1	Sub 2	Sub 1	Sub 2	Sub 1	
15	15	15	15	15	15	15	15	Bankruptcy
0.9	0.9	0.85	0.85	0.85	0.72	0.852	0.852	
15	15	15	15	15	15	15	15	Healthy
0.923	0.9144	0.908	0.92	0.90	0.89	0.889	0.861	
30	30	30	30	30	30	30	30	Total
0.91	0.905	0.888	0.879	0.872	0.81	0.87	0.86	

**Table 4. The results of the ACT for the year (t)**

	ANN	MDA
Mean	0.895	0.853
t	5.132	
P – value	0.014	

Table 4 shows the results of the DCT for the year (1).As it is clear from the figures and numbers in the table; the average difference of both groups is meaningful at 5% level. This means that H1 is proofed and we can conclude that in the year (t) the accuracy of the ANN was greater than the MDA. This test was conducted in a dual way; therefore in this condition the differences between the averages are meaningful.

#### VII. CONCLUSION AND ANALYSIS

Forecasting FD and bankruptcy of the companies is an interesting and important subject in the financial world. Forecasting FD, and finding the reason of the problem and solving it, satisfactory results would be achieved. In this research, the forecasting of the FD in sampled companies was undertaken using ANN and MDA.

In this research, the Sectional Evaluation technique has been used to evaluate the ANN classification power. A good model is one which maintains its power regarding to different samples or during the different time periods. Results obtained from the ANN show that, this model is highly powerful to forecast the companies FD. The ANN and the MDA results were compared and the mentioned hypothesis was confirmed in all cases, so it can be said that:" in a meaningful manner, the accuracy of the ANN in forecasting FD is greater than the MDA ".It means that ANN has a higher ability than the MDA to correct FD forecasting of the companies. This result is important from the view that the correct forecasting of the FD companies is far more significant than precision forecasting for healthy companies in general, it must be said that using the results of this research, as the first step, the FD and bankruptcy of the companies and also its consequences can be avoided in a proper way. Of course, this result is depended on identifying and correcting causes following the forecast method implementation.

#### VIII. SUGGESTION FOR FEUTURE RESEARCHERS

- Comparison of the ANN with other statistical models,
- Using other topologies in ANN for extracting model,
- Using neural-based networks to extract the model, and
- Using Genetic Algorithm in model extraction.

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