Available online at http://ijdea.srbiau.ac.ir

Int. J. Data Envelopment Analysis (ISSN 2345-458X)

Vol.3, No.2, Year 2015 Article ID IJDEA-00326, 13 pages

Research Article

International Journal of Data Envelopment Analysis

Science and Research Branch (IAU)

A Study on the Financial Performance of Companies Using Data Envelopment Analysis Model and Zemijsky's Model and a Comparison of their Results.

Akbar rahimipoor[a*], masomeh tadress hasani[b]

(a) *young researchers club and elite, Sirjan Branch, Islamic azad university, sirjan, iran*

(b) *young researchers club and elite, Sirjan Branch, Islamic azad university, sirjan, iran*

Received 9 February 2015, Revised 15 May 2015, Accepted 27 June 2015

Abstract

Recent bankruptcy of big companies all over the world and fluctuations in Iran's stock market require that some methods be developed for the evaluation of companies' financial potential. Different models are used for the prediction of bankruptcy and the evaluation of organizational financial situation. Environmental changes and increasing competition among agencies led to companies' and organizations' limited access to expected profit. Thus, financial decision making is, nowadays, more and more important, forcing managers to apply modern control methods through sophisticated techniques. The present study aims to evaluate the performance of companies' situation. For this purpose, we use the two models of data envelopment analysis and Zemijsky and compare results derived from them. The research data were gathered from 10 accepted in stock market. Results from data envelopment analysis model indicated that only one company was in a proper financial situation while results from Zemijsky's model showed that there were two companies in good financial condition. We also managed to develop strategies for the improvement of financial situation in other companies using data envelopment analysis model.

Keywords: prediction of bankruptcy, evaluation of financial situation, data envelopment analysis model, Zemijsky model.

[*] Corresponding Author: akbarrazraz83@yahoo.com

1. Introduction

One of the most important issues in financial management is investment and investment trust. Appropriate tools and models not only help to evaluate organizational financial situation but also help with investment decision making. Environmental changes and stronger competition among agencies have limited expected profit. Quick and user-friendly tools are very important for investors and private companies, particularly those which are at the risk of bankruptcy, since they have to make a quick decision about their investment. These tools become more important when decision makers don't have analytical knowledge of their company's performance (Permacahndra, 20002).

Rapid technological advances and widespread environmental changes have accelerated economic changes. Increasing competition among economic agencies led to limited profit and higher risk of bankruptcy. Therefore, financial decision making is more strategic than the past. Financial decision making has never been free from risk and uncertainty. One way to help investors with such decisions is to provide predictive patterns about company's overall prospect; the more realistic predictions, the more correct basis for decision making (Mehrani et al. 2002). Bankruptcy forecasting models can be useful while making a decision in a particular company. Investors are interested to predict the possibility of a certain company's bankruptcy in order to minimize the risk of the loss of their capital. Accordingly, they are looking for some methods that can predict companies' financial bankruptcy (Mashayekhi et al. 2012).

2. The statement of the problem

The development of a prediction model has long been studied as an important issue in business and academic contexts. Bankruptcy forecasting can have a considerable effect on loan decisions and the profitability of financial agencies (Chin Yang et al. 2005). Since business failure in a company results in a big loss in related parties, failure prediction can be useful for businesses. It might even prevent bankruptcy (Pongstat et al. 2004). Therefore, most organizations are seeking for a model that can evaluated individual company's present financial situation and predict its future. For this purpose, in the present study we used these two models: data envelopment analysis and Zemijsky's model. The former is used to evaluate financial performance and the latter is used to evaluate bankruptcy risk. Then, we compare predictive results from the two models.

3. A review of the literature

3.1. bankruptcy forecasting model

A number of researches have been conducted to determine if models which consider financial ratios an independent variable are really able to predict bankruptcy. In the

following, we mention some of these researches.

Xie and his colleagues (2011) have done a research on bankruptcy forecasting (financial distress) using supportive vector machine(SVM) and multiple distinguishing analysis(MDA) in manufacturing companies. Experimental results showed that SVM is a better predictive of bankruptcy than MDA. Then, Xie and his colleagues added internal governance and external market variables to predictive variables as macroeconomic variables and concluded that these variables are related to the bankruptcy of Chinese companies both in theory and in practice. . (xie and etal,2011)

Following Altman's studies, Springate(1978) used independent variables of these ratios: working capital to total asset, gains before taxes, taxes to total assets, gains before taxes to current debts and sales to total asset. Springate also developed a model that is 92.5% accurate. (cheeneebash and etal,2009)

Alfaro and his colleagues (2008) studied financial distress forecasting using Adaboost algorithm model and artificial neural networks. Adaboost algorithm can predict financial distress with 91.1 % accuracy. According to research findings, Adaboost algorithm has a better performance than artificial neural networks. (Alfaro and etal,2008)

Using neural networks, Wallace (2004) designed a model in which values of key financial ratios were applied. These values which had been reported as the best ratios in earlier bankruptcy studies include working capital to total asset, cash flows to total asset, net profit to total asset, total debts to total asset, current asset to current debts, quick asset to current asset. Wallace's model was 94% precise. Wallace managed to assess 65 different financial ratios of the previous studies. (Wallace,2004)

In a research conducted by Raei and his colleagues (2004), financial distress in 80 manufacturing companies was predicted by artificial neural networks. They also used a multiple variable distinguishing analysis model as a comparison model and concluded that artificial neural network model can more accurately predict financial distress than distinguishing model (Raei et al. 2004).

Firouziyan and his colleagues (2012) studied the application of genetic algorithm in predicting financial distress and compared it with Altman's Z model for accepted companies in Tehran stock market. Results showed that genetic algorithm model is more accurate for bankruptcy forecasting and consequently a more appropriate tool.(Firouziyan and etal,2012)

Fereydoun Rahnama Roudposhti and his colleagues (2000) conducted a study on the application of Altman's and Fulmers' bankruptcy forecasting models for accepted companies in Tehran stock market. They finally concluded that Altman's model is more conservative than Fulmer's model in predicting

bankruptcy. The number of companies which went bankrupt was higher in Altman's model than Fulmer's (Rahnama et al. 2010).

Zemijsky's model (1984) includes financial ratios, liquidity, performance and leverage. These ratios were not selected theoretically but were derived from his prior studies. Zemijsky's model was based on a sample consisting of 40 bankrupt companies and 800 efficient manufacturing companies. This model is one of the simplest models of bankruptcy forecasting in which the principle of the least number of independent variables is properly observed (Mehrani et al. 2006).

Ahmadi Kashani(2006) studied Altman's modified model in home appliances industry. According to the results, Altman's modified model can distinguish bankrupt and efficient companies with 90.7% precision.(Ahmadi Kashani,2006)

3.2. Data envelopment analysis model

Moravic and his colleagues (2013) did a research on forecasting the bankruptcy resulting from macroeconomics variables. In their study conducted over the period of 1993-2012, they analyzed the effect of GDP, financial debts of bankrupt companies, inflation and investment rate on some bankrupt companies . Lastly, they reached the conclusion that there is a strong correlation between these variables. (Moravic and etal,2012)

Varina and his colleagues (2013) developed a new financial approach to the classification of agricultural crops for trade purpose. They used 4 popular methods as non-challenging instruments of bankruptcy forecasting for today's complicated environment.

These methods include data envelopment analysis model, Lujit model, Z square model and financial forecasting model. Although they're not applied for financial department of organizations yet, their reliability was confirmed in this research. In addition, effective strategies were suggested for financial side of agricultural industry.(Varina and etal,2013)

In an study conducted by Musavi Shiri and his colleagues (2012), the role the efficiency of financial distress forecasting plays in companies was studied over a period of 10 years (2000-2010). They used DEA method on a sample of 60 manufacturing companies listed in Tehran stock market. They also applied multiple distinguishing analyses to confirm research findings. According to the findings, efficiency plays an important role in the prediction of companies' financial distress so that this variable can warn bankruptcy 2 years before bankruptcy happens. (Musavi Shiri and etal,2012)

-Mocapadliyay and his colleagues (2012) developed a new method- a combination of DEA and multiple Perspetron layers- for the prediction of bankruptcy. They tried to suggest a new method which considers not only historic financial information of bankrupt companies but also companies which identify

which companies are resistant against bankruptcy and which ones are bankrupt. This performance evaluation is done by a multiple Perspetron larger model. Mocapadliyay and his colleagues suggested their new model for a better prediction of bankruptcy (Mocapadliyay and etal,2012)

Moradi and his colleagues (2012) studied the application of bankruptcy forecasting in Iran's machinery department. They attempted to examine the improvement of bankruptcy forecasting in two parts. In the first part, they introduced predictive variables while in the second part, they used two principle models of bankruptcy forecasting in big companies. Therefore, information about financial ratios and return big supportive companies in machinery industry into two bankruptcy forecasting models. Findings indicate that productivity variable leaves no change in the precision and accuracy of these models. Besides, they found that there wasn't a significant difference between the performance of the two machinery departments in multiple distinguishing model (Moradi et al. 2012).

Jinger and his colleagues (2011) conducted a research on bankruptcy forecasting and its advantages using experimental evidence from central departments of hospitals in France. Not only they presented a comprehensive history of bankruptcy forecasting but also they tried to answer these questions: how can we [predict bankruptcy in industries? To what extent are probabilities important in predicting bankruptcy and the risks of bankruptcy forecasting? How can we identify and use basic variables of bankruptcy forecasting? Jinger and his colleagues applied linear planning method to answer the questions above. Evidence from experimental studies support research results. In the last stage, they did a closer examination on results and analyzed the effect of each ratio on the model. (Jinger and et al, 2011)

Exo and his colleagues (2009) suggested bankruptcy forecasting model using efficiency as a predictive variable. They also used DEA as an instrument for the prediction of efficiency. The population of their study is accepted companies in Chinghai stock market so they selected a sample including 60 efficient and 60 bankrupt companies in a period of 1999-2005. Results from the three main models of bankruptcy forecasting (multiple distinguishing analysis, logistic regression, supporting vector machine) all prove that efficiency is an effective predictive variable. (Exo and etal,2009)

Sovashi and his colleagues (2009) showed that data envelopment analysis can predict bankruptcy faster and easier than logistic regression method. They used a sample of 50 bankrupt and 910 efficient companies between 1991 and 2004. Their study was based on 9 variables (2 output variables and 7 input variables). According to the results, LR method works well in internal samples while

DEA is more suitable for external samples. (Sovashi and etal,2009)

-Lopez and his colleagues (2008) used the methods of efficiency evaluation as a strategy for stock selection of stocks in Brazil stock market. The input variable of their study includes price to stock interest ratio, Beta ratio and stocks' return fluctuation while output variable involves stocks' revenue in 12, 36 and 60 months in a time period of 10 years or 102 months. They found out that portfolio based on efficiency evaluation methods had a better performance than two other indices of Brazil market. (Lopez and etal,2008)

-Chen (2008) conducted a study entitled" stock selection using quantitative patterns of efficiency evaluation" in Taiwan. They aimed to use data envelopment analysis for making a portfolio and comparing their return with market return rate. They wanted to discover if such a portfolio produces bigger return and if the strategy of size effect is a suitable strategy for stock selection. Input variables of this study included the variables of average equities' salary, average asset and sales cost, while output variables were income, working profit and net profit. Results showed that the strategy of size effect isn't a suitable strategy for stock selection in Taiwan's stock market. In addition, portfolio made from efficiency evaluation methods gives more returns than market index. (Chen ,2008)

Malhotra and his colleagues (2007) used data envelopment analysis model in order to evaluate bonds. They used 2 financial ratios (long-term debts to total asset and total debts to total asset) as inputs and 6 financial ratios (the times of interest coverage, profit before interest and taxes, profit before interest, taxes and depreciation of tangible and intangible assets, free cash flows to total debts, net cash flows to total asset, capital return and profit to sales) as outputs. The criterion for using these output and input ratios was that researchers believed these ratios can more accurately show borrower's financial ability for paying debts and interests. There were 34 decision-making units in this study. According to the results of the study, 8 units could pay debts and interests more efficiently. (Malhotra and etal,2007)

Mohseni and his colleagues (2013) predicted financial distress and used efficiency as a predictive variable. They applied data envelopment analysis for calculating efficiency index in accepted companies of Tehran stock market in a period of 2005-2009. The result of efficiency index was used as a variable for financial distress forecasting. Results indicated that the variable of efficiency meaningfully increases the precision of prediction. (Mohseni and etal,2013)

Kazemi and his colleagues (2012) integrated data envelopment analysis and perfectionist planning for the study of stock selection in Tehran stock market. They gathered data from 6 industries – 250 companies in total- in the year 2009. They determined relative efficiency of companies and the most efficient company

in each industry. On the next stage, after they collected data about investment criteria for efficient companies, they used linear planning for determining perfectionist level of investment. To make sure objectives of lower priority are achieved, they entered modified results into perfectionist planning model. On the last stage, they used perfectionist planning and provided some suggestions for investment decision- making; suggestions that suit investors' preferences and goals. Results showed that the objectives of Betha, return, Di and liquidity rank were completely achieved while risk objective was partially achieved. On the other hand, Ci objective had a positive deviation by 2.27. Kazemi and his colleagues could make a portfolio including 8 different shares out of 250 shares. (Kazemi and etal,2012)

Sinayi and his colleagues (2012) studied companies' relative performance and efficiency in order to form a stock basket. For this purpose, they used data envelopment analysis. They used the variable of size effect to compare the performance of basket. They wanted to know if a portfolio of small companies had a better performance than overage industry. They also applied input- and output- oriented patterns relative to fixed measure of CCR and variable measure of BCC when the company under study had returns. According to their findings, the return of portfolio is equal to that of average market when CCR method is used whereas the figure exceeds the return of average market when BCC method is applied. Thus, it can be concluded that a portfolio of smaller companies had higher return than average marker return and a better performance. It should be noted that these researchers used William Sharp's criteria for the measurement of portfolio's performance. (Sinayi and etal,2012)

Mahmoudabadi and his colleagues (2011) attempted to conduct credit ranking in terms of the solvency of debts and interests. They aimed to determine credit ranking of accepted companies in Tehran Stock market. For this purpose, they used data envelopment analysis model and two inputs. They also gave each company a rank of AAA to D. AAA rank stands for the highest solvency while D rank means the lowest solvency. Therefore, solvency decreases when companies approach that D rank and increases when they approach AAA. Their findings were confirmed by traditional analysis of ratios. .(Mahmoudabadi and etal,2011) And many other studies.

4. Research methodology

The method used in this research is correctional survey. We also used historical dat. Research data were collected from financial statements of selected companies such as balance sheet, income statement and cash flow statement. In addition, we used other information gathered from companies which are accepted in stock market. Some theoretical

information was collected from books, journals and accounting hypotheses.

Research questions and hypotheses

This research tries to answer the following questions:

-Based on data envelopment analysis model, which companies are efficient and which ones are inefficient?

-Based on Zemijsky's model, which companies are efficient and which ones are inefficient?

-Is there a meaningful difference between results from Zemijsky's model and data envelopment analysis model?

-Which one of these models enables us to provide strategies for the improvement of companies' financial situation?

The following hypothesis is developed for the present study:

There is not a significant difference between results from the two models (i.e. Zemijsky's model and data envelopment analysis model) in terms of the evaluation and prediction of companies' financial situation.

5. Data analysis

5.1. Zemijsky model

In his model, Zemijsky used leverage, performance and liquidity financial ratios in order to provide a proper pattern. The ratios were not selected theoretically but they were more based on his experience from his prior studies. Zemijsky's model was originally developed from a sample consisting of 40 bankrupt companies and 800 efficient companies. His model was 98.2% precise. In the following, Zemijsky's model (Zemijsky, 1984) is shown:

Table1. Equation1:zemijsky model

Z: total index
χ_1 : the ratio of net profit to total asset
χ_2 : the ratio of total debts to total asset
χ_3 : the ratio of current revenue to current debts

Table2. Z value limits

Z range	Bankruptcy risk
$Z \leq 0.5$	Bankrupt
$Z>0.5$	Efficient

6. Data envelopment analysis

In order to evaluate units, we used output-orientation BBC envelopment model.

This model has several outputs and one input and aims to maximize Theta for the highest level of output. Equation number (1) shows an overall view of this model. In this model, the number of units under study must be relative to the number of evaluated units. The number of outputs and inputs must be three times bigger than total number of outputs and inputs. Because there are 3 variables in our study, the number of total units must be at least 9.

In this article used Excel software top analyze data from financial statements. First, we categorized information in the two groups of fiscal year and company and entered information about financial ratios in

Table 3. Equation2:DEA model

$Minz = \theta$	
$st:$ $\sum_{j=1}^{n} \lambda_j x_{ij} \le x_{i0}$	(i=1,2,……m)
$\sum_{j=1}^{n} \lambda_j y_{rj} \le \theta y_{r0}$	(r=1,2,…….s)
$\sum_{j=1}^{n} \lambda_j = 1$	(j=1,2,……...n)
$\lambda_j \ge 0$	(j=1,2,……...n)
θ free sign	

Zemijsky's model. Then, we determined Z values for each company. Next, financial ratios were computed based on the average information over 6 fiscal years and reentered in Zemijsky's model. Z value was determined again for each company. After we determined financial ratios in Zemijsky's model, we identified output and input variables for data envelopment analysis model according to financial experts' opinions. Finally, we managed to develop a model consisting of one input and two outputs. This model is comparable to Zemijsky's original model. We applied two Wilcoxon's ranking marker tests (Binomial statistical method) in order to determine if there's a significant difference between results from the two models.

In addition, we used dependent pair t in order to develop a more conservative model. In these tests, we assume that null hypothesis means the lack of a meaningful difference between the two models, while the research hypothesis tries to confirm such a meaningful difference. If output value of the test is bigger than 0.05, then research hypothesis will be rejected and null hypothesis will be accepted. Conversely, if this value is smaller than 0.05, then research hypothesis will be confirmed.

7. Results from hypothesis solving

Results from Zemijsky's model indicate that only 2 companies out of 10 possess a good financial situation. This means that other 8companies are bankrupt. Similarly, results from data envelopment analysis model show that only out of 10 companies are efficient and other 9 companies are bankrupt. Research results for the first two research questions are shown in Table 2. Results for the third research question confirm research hypothesis. These results which were derived from willcoxon's tests (independent pair t test) indicate that there's no meaningful difference between results from the two models. It should be noted that since our data were qualitative, we assigned number 1 to bankrupt companies and zero to efficient companies. By doing so, we obtained some qualitative data which can be used in statistical equations. Results from t test are shown in Table 3. In order to answer the fourth question, we should refer to results from data envelopment analysis model. In

table 4, some strategies are mentioned for bankrupt companies to turn into efficiency. For example, decision making unit no.1 needs to reach to the value of 0.342 from 0.672 in the first financial index and reach the value of 1.859 from 0.936 in the third financial index in order to become financially efficient. As can be seen in the table, there's only one decision-making unit (unit no.7) which possesses optimal financial performance in data envelopment analysis model.

Table 4. results from Zemijsky's model and data envelopment analysis model

Companies	**Zemijsky's model**	**Data envelopment analysis model**
	number	number
Bankrupt (inefficient)	8	9
Efficient	2	1

Table5. Results from Willcoxon's tests

Test	**Sig**	**Test value**	**The hypothesis under study**
Willcoxon	0.056	-5.77	Hypothesis is confirmed

8. Conclusions and suggestions

As mentioned earlier, performance evaluation and organizational financial forecasting is crucial in today's changing and complicated environment. Organizational managers need to seek for some methods in order to understand their organization's current situation. Meanwhile, they need to predict and plan their future organizational goals. Such methods as data envelopment analysis and bankruptcy forecasting models can open the way for managers. Our research findings show that only one or two companies out of 10 companies have optimum performance. This means that other companies lack a satisfactory financial situation. According to these findings, it seems that data envelopment analysis model provides a more conservative evaluation than Zemijsky's model. However, this finding need to be studied in future researches. Thus, we suggest that future researches try to find out if data envelopment

Table 6. some strategies for the improvement of data envelopment analysis model

company	**Index 1**	**Index 2**	**Index 3**
1	0.342 to 0.679	0.692 to 0.692	1.859 to 0.936
2	9.194 to 14.801	18.62 to 18.62	50.034 to 36.5
3	0.438 to 0.767	0.887 to 0.887	2.382 to 1.021
4	0.299 to 0.732	0.605 to 0.605	1.627 to 0.903
5	0.241 to 0.265	0.488 to 0.323	1.312 to 1.312
6	0.349 to 0.591	0.706 to 0.706	1.898 to 1.256
7	0.411 to 0.411	0.832 to 0.832	2.235 to 2.235
8	71.169 to 26.837	34.771 to 34.771	93.436 to 73.544
9	0.355 to 0.629	0.719 to 0.719	1.932 to 1.24
10	0.378 to 0.737	0.766 to 0.766	2.06 to 1.128

analysis model is more conservative than Zemijsky's model. We hope our research findings and strategies will be useful for the managers of organizations under study.

Acknowledgment

We do appreciate all friends who helped me conduct this research successfully. We must add that "the present study was fully funded by Young Researchers and Elite Club of Islamic Azad University, Sirjan branch".

References

[1] Afshar Kazemi M.,.Ali, Khalili Iraqi., Maryam, Sadat Kiyayi, Ahmad.(2012). stock selection in Tehran stock market using data envelopment analysis and perfectionist planning, *financial knowledge of stocks analysis*, Iranian quarterly of science and research, 13(2), 46-63.

[2] Ahmadi Kashani., Seyyed abbas,(2005).a model of bankruptcy forecasting for home appliances industry, *M.A thesis, Islamic Azad University*, Central faculty of Economics and Accounting.

[3] Alfaro.,e,Garcia,n.(2008). bankruptcy forcasting:an empirical comparison of adaboost and neural networks,*international adrances in economic research* ,14(2),110-122.

[4] Cheeneebash., J, K.B., Lallmamode, & A, Gopaul. (2009). Predicting Bankruptcy using Tabu Search in the Mauritian Context World Academy of Science, *Engineering and Technology,.58(4),* 866-875.

[5] Chen., H.H, (2008). Stock selection using data envelopment analysis, *Industrial Management & Data Systems*, 108(9, 1255-1268.

[6] Firouziyan., Mahmoud, Javidi., Daryoush, Najm Aldini., Narges.(2011). Genetic algorithm in bankruptcy forecasting and a comparison of this algorithm with Altman's Z model in accepted companies in Tehran Stock market, *accounting and editing studies, is18(60)*, 99-114.

[7] Janer.,jpseph, Bankruptcy Prediction and its advantages.(2011).Master's Thesis, *Department of Economics Copenhagen Business School*.

[8] Lopes., A, Lanzer., E, Lima, M. and DaCosta, N. (2008). DEA investment strategy in the Brazilian stock market, *Economics Bulletin*, 13(2), 31-10.

[9] Mehrani., Sasan, Mehrani., kaveh, Monsefi., Yashar, Karami ,Gholamreza. (2005). An assessment on the application of Zemsky's and Shirata bankruptcy patterns for accepted companies in Tehran Stock market, *accounting and editing studies,12(4*),105-131.

[10] Mehrgan., Mohammad Reza.(2008). qualitative models for organizational evaluation ,second edition, *Tehran Administration Faculty Publication.*

[11] Mohseni., Reza, Aghababaei., Reza, Mohammad Bagheri., Vahid.(1923).Financial distresspublication using efficiency as a predictive variable, quarterly *of researches and economic policies, 21(656)*, 123-146.

[12] Mahmoud abadi., Hamid, ghayuri Moghaddam., Ali.(2012). Credit ranking in terms of solvency of main debts and interests using data envelopment analysis (the case of accepted companies in TehranStock market, *accounting journal, 2(2),*125-145.

[13] Mashayekhi., Bita, Khaleghi Tabar., Susan.(2011). a comparison of bankruptcy forecasting models for accepted companies in Tehran Stock Market using optimization algorithms of neural networks, *M.A thesis in accounting, Administration Faculty,* Tehran University.

[14] Moravec., Tomáš. (2013).the bancruptcy in the czech republic influence of macroeconomic variables,136-145.

[15] Mosavi Shiri.,M. & M., Salehi. (2012). Prediction of Financial Distress in Tehran Stock Exchange Using DEA Approach, *Indian Journal of Science and Technology,* 5(10),, 3461-3473.

[16] Mukhopadhyay.,Ayan, Tiwari.,Suman, Narsaria,Ankit., Roy Karmaker., Bhaskar. (2012). New Approach to Predicting Bankruptcy: Combining DEA and Multi-Layer.

[17] Moradi., Mohsen, Shafiee Sardasht., Morteza, Ebrahimpour., Maliheh. (2012). An Application of Support Vector Machines inBankruptcy Prediction; Evidence from Iran, *World Applied Sciences Journal 17* (6), 710-717.

[18] Malhotra., R. Malhotra., D.K. and Yeh., C.H. (2007).Using data envelopment analysis to rate bonds. *Proceeding of the Northeast Business Association,* 4,420-408.

Perceptron, *IJCSI International Journal of Computer Science Issue*s, -

[19] Pongsatat Surapol., Judy Ramage ,& Howard,. Lawrence. (2004) .Bankruptcy Prediction for Large and Small Firms in Asia: A Comparison of Ohlson and Altman,*Journal of Accounting and Croporate Governance,* 1(2), 1-13.

[20] Premachandra, (2009), DEA as a tool for bankruptcy assessment, *European journal of operational Research,* 9(4),71-76. .

[21] Rahnama Roudposhti., Fereydoun, Alikhani., Raziyeh, Maran Jouri., Mahdi.(2009). an assessment of the application of Altman's and Fahlmer's bankruptcy forecasting models in the accepted companies in Tehran Stock market, *quarterly of accounting and editing studies,55*, 19-34.

[22] Raei., Reza and Saeed., Falahpour. (2004). Financial distress prediction of companies by Artificial Neural Networks technique, *Journalof Financial Research. 17,*. 39-69.

[23] Sinayi .,Hassan Ali, Gashtasbi Maharlouy.,i Rasoul.(2012), Efficiency evaluation and companies' relative performance for stock selection using data envelopment analysis, *accounting knowledge journal, 3(11),* 105-132.

[24] Sueyoshi.,Toshiyuki, & Mika .,Goto. (2009.DEA-DA for Bankruptcy-Based Performanc Assessment: Misclassification of

Japanese Construction Industry", *European Journal of Operational Research,* 199(5), 576-594.

[25] Vavřina., Jan, Hampel., David, Janova., Jitka. (2013). new approaches for the financial distress classification in agribusiness, *acta universitatis agriculturae et silviculturae mendelianae brunensis*, vol lxi(4).

[26] Wallace Wanda A.,(2004), Risk Assessment By Internal Auditors Using Past Research On Bankruptcy Applying Bankruptcy Model..

[27] Xu.,Xiaoyan, & Wang, Yu. (2009).Financial Failure Prediction Using Efficiency as a

Predictor, *Presented at Expert Syst,* , 366-373.

[28] Xie., Chi, Changqing .,Luo, & Xiang,Yu. (2011).*Financial distress prediction based on SVM and MDA methods: the case of Chinese listed companies*, 45(10),671-686.