

Application and Comparison of Altman and Ohlson Models to Predict Bankruptcy of Companies

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Abstract: Environment fluctuation and increasing competitiveness between corporations lead to make the achievement of proper benefit more difficult. Therefore, financial decision making received more attention compare to past few decades and it forces managers to apply novel techniques and methods in order to make excellent decisions. This study tries to investigate the application of Altman and Ohlson models as two of these techniques. To achieve this goal companies from Tehran Stock Exchange are chosen because there are standard financial statements for corporations in Tehran Stock Exchange and also the data is accessible.

Keywords: Altman model, bankruptcy, Ohlson model, Tehran stock exchange

INTRODUCTION

The most important and vital issues in financial management are investing and trust to investors for both real persons and legal persons in different levels of any business. A large number of studies about process of decision making in investment have been conducted in developed countries (Chen *et al.*, 2009). One of issues that could help organizations in order to have a superior decision making in their investment positions is using tools and models for evaluating financial situation of organizations. Because the investors cannot make a correct decision unless has a proper evaluation from its investment. One of these tools that used in corporations for decision making in their investments are models of bankruptcy prediction (Beaver, 1966).

Investors always intend to predict the possibility of bankruptcy of corporations and prevent to the risk of losing their investment. Hence, they are always looking for methods that could predict the possibility of bankruptcy of companies. Because in a case of bankruptcy the stock price decreases dramatically.

There are a variety of methods for predicting the bankruptcy but some of them are more famous and well-established. Therefore, based on the literature, between these methods, analysis of ratios and analysis of market risk are more valid. Analysis of market risk uses fluctuations in the market risk (such as variance of Rate of Return for a share and systematic risk) in order to estimate the possibility of bankruptcy of corporation. On the other hand, analysis of ratios estimates the possibility of bankruptcy by using a group of financial ratios that is chosen by experts.

The main goal of this study is to examine the prediction power of original Altman (1968) and Ohlson

(1980) models on the dataset of Iranian listed companies. In the Altman model (Z-score) for bankruptcy prediction analysis of ratios method is used. The model consists of five financial ratios that are coefficients by Discriminate Analysis Method and has been implemented as a function that financial ratios are as independent variables of it. Ohlson was a pioneer in introducing legit function to bankruptcy prediction in 1980 and a follow-up study was conducted by Zmijewski (1984) that is the first application of probity function.

Bankruptcy: Bankruptcy is a legal status of an insolvent person or an organization, that is, the one who cannot repay the debts that owes to creditors. In most jurisdictions, bankruptcy is imposed by a court order, often initiated by the debtor. When the amount of organization debts is higher than its value of existence assets bankruptcy is occurred (Gitman, 1996).

In Tehran Stock Exchange (TSE) Article, 141 Commercial Code states about the situation that a corporation count as a bankrupt corporation. This law says: If an organization loses at least half of its assets it is compulsory for Board of Director's to make an appointment and make a decision about the future of their corporation, whether they are going to decide to disbandment, the corporation or continue their activities (Soleimani *et al.*, 2003).

Generally, bankruptcy in corporations could happen in three different ways: financial, economical and legal (Chen *et al.*, 2009). In case of financial bankruptcy, corporation is not able to do its obligations before the deadline. Hence, it shows weaknesses in finance. One of the clues of financial weaknesses is absence of working capital. Lacks of working capital,

which itself is a sign that causes of weak capital structure by over current borrowing, high operational costs and other causes. Usually economic bankruptcy and financial and credit bankruptcy are different. Overall, economic bankruptcy is same as failure of trade, because the corporations could not achieve the same benefit that can be achieved elsewhere (Shumway, 2001). Based on laws, bankruptcy is not defined as inability of a company in payment of its obligations before the deadline. Regulations define the bankruptcy when the total assets are not sufficient to pay the total debt (Gholampour, 2009).

Bankruptcy usually caused by different reasons. One of the most important reasons in bankruptcy of corporations is mismanagement. The managerial failures, high costs, financial activities weakness, ineffective sales activities and high production costs or mixture of these reasons can be a warning for a company for bankruptcy. Economic activities could be the other reason of bankruptcy in organizations and corporations. Economic recession, changes in interest rates, rising inflation, raw material price fluctuations and international economic conditions, can be mentioned as economic reasons for bankruptcy of organizations. On the other hand, government decisions, natural and unwanted hazards and life-stage of organizations are also other reasons for the occurrence of bankruptcy (Goudie, 1987).

LITERATURE REVIEW

The first study in the field of bankruptcy prediction is conducted by Thomas Woodlock in early 1939. He was done a classic analysis in railway industry and published his work as an article under the name of "Percentage of operational costs to gross retained earnings" (Agarwal *et al.*, 2007). Edward Altman (1968) (in an article on financial ratios, discriminate analysis and bankruptcy prediction of institutions) presented a model for bankruptcy prediction, which is known as the Altman's Model. He implemented five financial ratios in this model whose accuracy was 95%. A few years later that, he introduced a modified version of his model called Z-score model. The Z-score model is still applied as a general practical tool for assessing the financial well-being of firms. Due to its characteristics, this model has been used for small samples of manufacturing firms as well as bankrupt and non-bankrupt firms with equal sizes (Grice and Ingram, 2001).

Altman selected 22 financial ratios and analyzed them by using multiple discriminate analysis method; he could produce the function Z which contained 5 financial ratios as independent variables and Z as dependent variable. Financial ratios in this model are as follows:

- Working capital to total assets
- Retained earnings to total assets
- Earnings before interest and taxes to total assets
- Market value of equity to total debt
- Sales to total assets (Duffie *et al.*, 2003)

After years of using model Z by researchers and different organizations, some criticisms were raised for the model. Financial analysts, accountants and even the companies believed that this model can be used only for institutions with a general business nature. Altman continued its research on bankruptcy prediction and improve its model and presented a new model, called model Z.

The most important amendment in Altman model is substituting equity book value and the market value and then changes the coefficients and limitations of bankruptcy. These two models were used mainly on manufacturing companies, usage of these models in non-manufacturing and service companies were not significant. Therefore, Altman continued his research to design a model named Model Z, in these model sales to total assets ratio variable is eliminated and the four-variable model provided specifically for non-manufacturing and service companies (Philosophov and Philosophov, 2002). In later years, many researchers study on bankruptcy prediction models and were able to design new models. Such as: the legit model by Ohlson (1980). Ohlson raised questions about the MDA model, particularly regarding the restrictive statistical requirements imposed by the model (Ohlson, 1980). To overcome the limitations, Ohlson (1980) employed logistic regression to predict company failure.

Some of the studies carried out on bankruptcy prediction models in Iran are as follows: Mehrani *et al.* (2005) studied the relationship between financial ratios and bankruptcy prediction. To examine research hypothesis and compute the financial ratios of interest from sample firms, the data related to one and two years before success or failure (bankruptcy) was collected for each participant group-successful and unsuccessful firms and the main research variables were computed including five financial ratios. The results of data analysis revealed that the obtained Z-score model correctly separated the sample firms and classified them in one of the successful or failed (bankrupt) groups without any error, indicating the ability of financial ratios in predicting success or failure (Mehrani *et al.*, 2005).

RESEARCH METHODOLOGY

In this study, using data extracted from financial statements of listed companies in Tehran Stock Exchange (TSE), the ratios calculated in the model and it's applying in the model, then the amount of Altman model for each company in each year of study is

determined. Statistical population of this study includes the companies in Tehran Stock Exchange which are a total of 90 companies. This study used data for a 4 year period from 2007 to 2010.

Altman model: Altman (1968) employs Multivariate Discriminate Analysis (MDA) on a list of financial ratios to identify those ratios that are statistically associated with future bankruptcy. Ohlson (1980) uses a legit model, which uses less restrictive assumptions than those taken by the MDA approach. Zmijewski (1984) adopts a probity approach that is also based on accounting data but uses a different set of independent variables. All of these approaches predict future bankruptcy based on accounting ratios drawn from firm's financial statements.

The Z-score formula for predicting bankruptcy was published in 1968 by Edward I. The formula may be used to predict the probability that a firm will go into bankruptcy within two years. Z-scores are used to predict corporate defaults and an easy-to-calculate control measure for the financial distress status of companies in academic studies. The Z-score uses multiple corporate income and balance sheet values to measure the financial health of a company. In this study Z'-SCORE model of Altman is used. This model contains five financial ratios: Working capital to total assets (T_1), Retained earnings to total assets (T_2), Earnings before interest and taxes to total assets (T_3), Book value of equity to book value of debt (T_4), Sales to total assets (T_5). The model is shown in Eq. (1):

$$Z' = 0.717(T_1) + 0.847(T_2) + 3.1(T_3) + 0.42(T_4) + 0.998(T_5) \quad (1)$$

- $Z < 1.2$ State of complete bankruptcy
- State of between bankruptcy and non bankruptcy (Grey zone)
- $Z \geq 2.9$ State of perfect situation

Ohlson model: The econometric methodology of logistic analysis was chosen. The dependent variable is binomial and is defined as 1 if the firm is delisted and 0 if the firm is non-delisted firm. The same nine independent variables used by Ohlson (1980) are employed. The definitions of the nine independent variables are as follows:

- SIZE = Log (total assets/GNP price-level index). The index assumes a base value of 100 for 2003. The index year is as of the year prior to the year of the balance sheet date
- TLTA = Total liabilities divided by total assets
- WCTA = Working capital divided by total assets
- CLCA = Current liabilities divided by current assets
- OENEG = One if total liabilities exceeds total assets, zero otherwise

- NITA = Net income divided by total assets
- FUTL = Funds provided by operations divided by total liabilities
- INTWO = One if net income was negative for the last two years, zero otherwise
- CHIN = $(NIt - NIt-1) / (|NIt| + |NIt-1|)$, where NIt is net income for the most recent period

The denominator acts as a level indicator. The variable is thus intended to measure change in net income:

$$z_i = -1.32 - 0.407_{x1} - 6.03_{x2} - 1.43_{x3} - 0.0757_{x4} - 2.37_{x5} - 1.83_{x6} - 0.285_{x7} - 1.72_{x8} - 0.521_{x9} \quad (2)$$

Consistent with Ohlson, three sets of estimates were computed for the logistic model using the predictors previously described.

RESULT ANALYSIS

The sample is composed of 90 corporations with 45 firms in each of the two groups. The bankrupt group (group 1) is listed companies of Iran Stock Exchange that as per the Article No. 141 of Iran Commerce Code, their Retained Loss is more than twice of their capital. The second group (group 2) consists of a paired sample of listed firms chosen on a stratified random basis from the same database of Iran Stock Exchange.

With finding amount of variables and calculating the amount of 'Z and Ohlson model, Type I error rate (company is bankrupt, but it is predicted non-bankrupt companies) and type II errors (company is Non-bankrupt, but it is predicted as a bankrupt company) for each model is determined. Figure 1 shows a comparison of Altman model and Ohlson model regard with their accuracy in bankruptcy prediction.

Summary of examination of Altman bankruptcy prediction model for 1, 2 and 3 years before has been

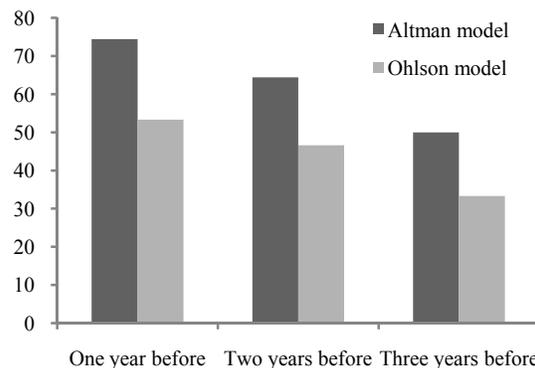


Fig. 1: A comparison of accuracy of Altman and Ohlson models

Table 1: Results of Altman model for 1, 2 and 3 years before

Year	Actual			Predicted			Accuracy	
	Group 1	Group 2	Total	Group 1 (bankrupt)	Group 2 (non-bankrupt)	Gray zone (critical)	Number correct	Percent correct
One year before	45	45	90	32	35	23	67	74.4
Two year before	45	45	90	28	30	32	58	64.4
Three year before	45	45	90	19	26	45	45	50
Total	135	135	270	89	91	100		

Table 2: Results of Ohlson model for 1, 2 and 3 years before

Year	Actual			Predicted			Accuracy	
	Group 1	Group 2	Total	Group 1 (bankrupt)	Group 2 (non-bankrupt)	Gray zone (critical)	Number correct	Percent correct
One year before	45	45	90	20	28	0	48	53.3
Two year before	45	45	90	19	23	0	42	46.6
Three year before	45	45	90	12	18	0	30	33.3
Total	135	135	270	51	69	0		

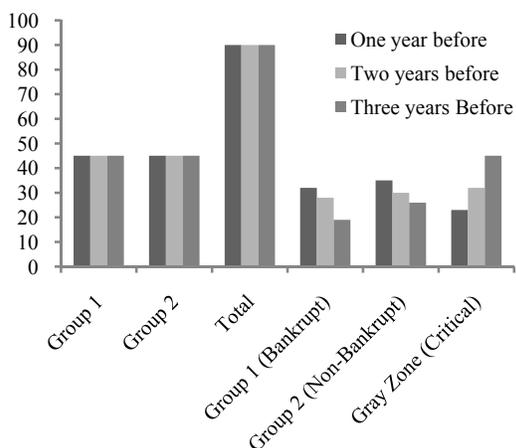


Fig. 2: Results of Altman model for 1, 2 and 3 years before

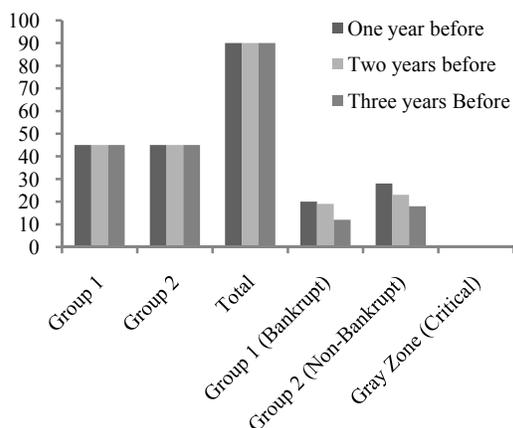


Fig. 3: Results of Ohlson model for 1, 2 and 3 years before

presented in Table 1. Table 1 shows Altman model in on year before is more accurate compare to two or three years before. Therefore, the most accurate prediction is for one year before with 74.4% of correct predictions and the worse one is 3 year before with 50%. Summary

of examination of Ohlson bankruptcy prediction model for the past 1, 2 and 3 years has been presented in Table 2.

As Table 2 shows none of the predictions are in the grey area. Figure 2 demonstrates the results of Altman model for one, two and three years before. Accordingly, Fig. 3 depicts the results for Ohlson model for one, two and three years before. As is mentioned in Table 2 there is no records for gray zone.

CONCLUSION

Considering the results original Altman (1968) bankruptcy prediction model, without any modification made in the independent variables and coefficients, can predict bankruptcy issue of Iranian listed companies with the accuracy of 74.4, 64.4 and 50%, respectively for 1, 2 and 3 years before and original Ohlson (1980) bankruptcy prediction model, without any modification made in the independent variables and coefficients, can predict bankruptcy issue of Iranian listed companies with the accuracy of 53.3, 46.6 and 33.3%, respectively for 1, 2 and 3 years before. A comparison between Altman and Ohlson model shows in all three situations Altman works better and it could be suggested to investors in order to predict bankruptcy of companies. For further research other bankruptcy prediction models can be applied and compare the results and also application of Neural network models is suggested for future research.

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