Predicting Bankruptcy: Evidence from Israel

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Abstract

In this study, we conducted an empirical investigation of whether it is possible to rely on two versions of the Altman Model (1968) to predict financial failure of publicly traded companies in Israel between 2000 and 2007. The findings of the study indicated that given the sample and the study term, the preferable model for predicting financial failure of Israeli companies is the Ingbar version of the Altman Model with a critical value of 1 and with the addition of the gray area. In particular, a survival index above 1 predicts a high likelihood of survival, while a lower index predicts low likelihood of survival. According to our study, the model is able to predict bankruptcy of companies with a 95% accuracy rate one year prior to bankruptcy and with an 85% accuracy rate two years prior to bankruptcy.

Keywords: Altman model, Bankruptcy prediction, Corporate failures, Financial ratios, Israel

1. Introduction

The ability to predict bankruptcy is critical for many users of financial statements. Such users include banks, investors, credit rating agencies, underwriters, auditors and regulators .During a period of financial and economic crisis, the importance of using a model to predict bankruptcy and flag warning signs as early as possible becomes increasingly important. Thus, for example, it is important for institutional investors who are buying corporate bonds to know the risk of bankruptcy inherent in said bonds, both prior and subsequent to their purchase.

One of the prominent models for forecasting bankruptcy is Edward Altman's Survival Model. Altman's studies (e.g., Altman, 1968; Altman, 1983) showed that poor management of a firm (as reflected in the financial ratios) and not necessarily fierce competition and economic recession is the main cause of bankruptcy. Using the model, it is possible to predict early warning signs of potential collapse. Altman compared two groups of firms: bankrupt and non-bankrupt firms. The model examined a large number of financial ratios to forecast the company's risk of financial failure, and the five best were selected to predict bankruptcy. Each ratio received a different weight based on its relative contribution to assessing the stability of the company. In 1968, the accuracy of the Altman Model in predicting bankrupt firms was estimated at 95% one year prior to bankruptcy and 72% two years prior to bankruptcy.

Yair Ingbar (1994) "converted" the Altman Index to publicly traded companies in Israel by using coefficients Altman found (1983) for private companies and determining different critical values. In his study, based on data from the 1980s, he achieved 93% accuracy in forecasting bankruptcy one year prior to collapse and 73% two years prior to it. These rates are very similar to the aforementioned rates of the Altman Index.

The research question in this study is: Is it possible to rely on the various versions of the Altman Model to predict financial failure of publicly traded companies in Israel today?

Previous studies in the Israeli context were based on data from the 1980s. It is important to reexamine this issue in recent years, in light of the major changes that have taken place both in the economy (particularly following the financial crisis that let many companies to experience liquidity problems) and in firm activity (in technology and financial terms).

This study contributes to a growing body of literature on the relationship between financial ratios and risk of bankruptcy in various countries. Most studies that have examined the predictive ability of the Altman Model were performed in developed countries such the US and UK. In contrast, our study focuses on a developing country, Israel, which like other developing countries is marked by a centralized capital market and significant government intervention. These characteristics may impact the way firms are managed (e.g. the financial strategy of said companies) which, in turn, may influence the financial ratios of said firms and their importance. Additionally, in light of the globalization and integration process in the capital markets, many foreign investors invest in the Israeli capital market, and thus, of 25 Israeli companies listed on the TA-25 Index, 6 of them were dual listed. As a reflection of this reality, foreign investor interest in the Israel capital market has increased in recent years, as has the analysis of the condition of publicly traded companies. For these reasons, it is critical to examine the predictive ability of the Altman Model in Israel today.

The structure of the article is as follows: Section 2 provides a review of some of the relevant literature and presents various versions of the Altman Index (different models). Section 3 sets out the hypotheses and describes the methodology and sample. As part of the study, the companies will be analyzed using two versions (models) of the Altman Index: (1) The original model proposed by Altman (1968) for public companies with a critical value of 2.675 - referred to hereafter as the original Altman Model, (2) The Ingbar Model and use of coefficients Altman (1983) found for private companies with a critical value of 1 and the addition of the gray area – hereinafter, the Ingbar Model. Section 4 contains an analysis of the findings, and Section 5 a conclusion.

2. Literature Review with Emphasis on the Altman Model

Altman was the first to use multi-variable models to predict bankruptcy. In his influential 1968 research, he analyzed financial ratios of bankrupt and stable firms. He used a combination of financial ratios to predict bankruptcy. The inherent advantage of his model is a combination of the typical attributes of the relevant firm, while examining the common impacts of the variables, in contrast to Beaver's Model (Beaver, 1966), which examined each ratio separately.

Altman examined the various financial ratios related to liquidity, profitability, financial leverage, activity and solvency. He used a discriminate ratio model, where the dependent variable is classified in one of two groups - bankrupt firms and non-bankrupt firms, and the model provides coefficients for the explanatory variables, according to the discriminating ability of the variables. Of the numerous financial ratios examined, five (X_1 through X_5) that significantly contributed to forecasting. Each ratio is assigned a coefficient (weight) based on its relative contribution. The index - the Z-score - comprises the multiplication of each of the ratios by the appropriate coefficient and addition of the results. The model, which has become standard, showed high predictive power regarding which companies could face financial distress. The following is a listing of the ratios and coefficients:

Original Altman Model (Altman, 1968):

$$\mathbf{Z = 1.2(X_1) + 1.4(X_2) + 3.3(X_3) + 0.6(X_4) + 0.99(X_5)}$$

Where: $\mathbf{X_1}$ = working capital/total assets; $\mathbf{X_2}$ = retained earnings/total assets; $\mathbf{X_3}$ = earnings before interest and taxes/total assets; X4 = market value equity/ total debt; X5 = annual sales /total assets.

The Z-Score, which as aforementioned is a survival indicator, classifies companies based on their solvency. The higher the value is, the lower the risk of bankruptcy. A low or negative Z-Score indicates high likelihood of bankruptcy. Altman set critical values between companies based on the survivability indicator. He defined companies with a Z-Score lower than 1.81 as companies where bankruptcy is likely, companies with a Z-Score greater than 2.99 as stable companies where bankruptcy is unlikely to occur. Companies that have a score between 1.81 and 2.99 are in the gray area, meaning that bankruptcy is not easily predicted one way or the other.

Furthermore, he found that the value Z=2.675 maximizes the critical value between bankrupt companies and non-bankrupt companies.

In 1983, Altman revised his original 1968 model and established different coefficients to forecast bankruptcy in private companies (the capital in variable $\mathbf{X_4}$ is measured according to book value).

The Altman Model for Private Companies (Altman, 1983):

$$\mathbf{Z = 0.717(X_1) + 0.847(X_2) + 3.107(X_3) + 0.420(X_4) + 0.998(X_5)}$$

The following are the critical values of Z in private companies:

If the score is lower than 1.23, the likelihood of bankruptcy is high.

If the score is between 1.23 and 2.9, the company is in the gray area.

A score higher than 2.9 indicates it's a high likelihood of survival.

Over the past decade, the Z-score models were used as a proxy for bankruptcy risks in such areas as strategic planning (Calandro, 2007), investment decisions (Sudarsanam and Lai, 2001; Lawson, 2008), asset pricing (Griffin and Lemmon, 2002; Ferguson and Shockley, 2003), capital structure (Allayannis et al., 2003; Molina, 2005), credit risk pricing (Kao, 2000; Jayadev, 2006), distressed securities (Altman, 2002: ch. 22; Marchesini et al., 2004) and going-concern research (Citron and Taffler, 2004; Taffler et al., 2004).

As mentioned, Altman used Multivariate Discriminant Analysis (MDA) to predict corporate failures. Additional studies that use this approach include Blum (1974), Deakin (1977) and in more recent years: Beynon and Peel (2001), Neophytou et al. (2001) and Chung et al. (2008). Other researchers used logit regression techniques (Ohlson, 1980), recursive partitioning analysis (Frydman et al., 1985) and artificial neural network models (Trippi and Turban, 1996). According to Perez (2006), MDA is still one of the most popular approaches used for bankruptcy prediction. The traditional Z-Score method is still very accepted in financial statement analysis. It is described in the standard literature on the subject in detail, and its practical use is widespread among financial statement users (Agarwal and Taffler, 2007).

Begley et al. (1996) used the original Altman Model of 1968, while revising the coefficients. The study showed that revising the coefficients negatively impacted on the forecasting ability compared to the original model.

Aziz and Dar (2006) reviewed 89 studies on prediction of bankruptcy between 1968-2003. They found that the multi-variable models (Z-Score) and logit were the most popular in the 89 studies. Chung et al. (2008) examined the insolvency predictive ability of different financial ratios for ten failed finance companies during 2006-2007 in New Zealand. They found that four of the five Altman (1968) ratios, one year prior to failure, were superior to other financial ratios for predicting corporate insolvency.

In 1994, in Israel, Ingbar conducted a study on the financial statements of 40 publicly traded Israeli companies, some profit and stable and others not profitable or undergoing recovery processes in 1982-1990. The results of the study, published in his book *Analysis of Financial Statements*, indicated that application of the Altman Model yields good results both for stable and bankrupt companies. In terms of the bankrupt companies, warning signs could be identified two and even three years prior to the onset of the crisis at the company.

Ingbar found that companies in Israel operate with less working capital and higher financial leverage than American companies, explaining why he made the criteria more flexible. He changed the limits of the critical values of Z for public companies in Israel:

A Z value greater than 2.50 indicates a stable and healthy company.

When the Z value is lower than 1.00, it indicates a weak company where bankruptcy is likely.

When the Z value is between 1.00 and 2.50, the company is in the gray area and bankruptcy is not easily predicted one way or another. Ingbar calculated equity according to its book value.

In his book, Ingbar also compares 15 companies that went bankrupt and 15 stable companies, selected randomly from the list of companies that were traded on the Tel Aviv Stock Exchange during the period in which the bankruptcies of the first 15 companies occurred. All the ratios were calculated using the Altman Model for private companies. It proves that in virtually all the bankrupt companies, the crisis could be predicted three years earlier. Using Altman's survival indicators, only with respect to three of the 15 companies was it impossible to predict bankruptcy three years earlier, and only with respect to one of the 15 companies did the model fail to predict bankruptcy one year prior to collapse. Ingbar notes that these success rates are in line with the accuracy level of the Altman indicators, at 90%-95%.

Studies conducted following Ingbar's also indicate the applicability of Altman indicators and their importance in predicting bankruptcy, both in the Altman Model for private companies and Altman's original model for public companies. Thus, for example, Ben-Horin (1996) demonstrates this with Adacom, which collapsed in 1994, based on the quarterly data of the indicator for 1992-1994. A later study conducted by Eden and Meir (2007) demonstrates this on Shamir Salads, which collapsed in 2005, according to data for 2003 and 2004. Both studies prove that the Altman indicators clearly show that the companies are in financial distress.

3. Research Hypotheses, Methodology and Sample

3.1 Research hypotheses

Based on the findings in the international and domestic literature, we will set out seven hypotheses below. The hypotheses relate to the question of whether in recent years in Israel it has been possible to predict bankruptcy of companies using the accepted Altman models.

In **the two first hypotheses**, we propose that the ability to predict bankruptcy with the Altman Model for publicly traded companies in Israel in recent years will be good, as proven in studies that included samples of companies about 20 or more years ago.

Hypothesis 1: The Altman Model will predict bankruptcy in companies that actually went bankrupt with at least 80% accuracy.

Hypothesis 2: The Altman Model will predict stability in stable companies with at least 80% accuracy.

The third hypothesis assumes that the model's predictive ability increases the closer the date of bankruptcy.

Hypothesis 3: The closer the date of bankruptcy, the higher the accuracy of predicting **bankruptcy** according to the Altman Model.

The fourth, fifth and sixth hypotheses refer to the Ingbar Model (1994), and the definition of two critical values, while adding the gray area (Z greater than 1) to the upper range. The hypotheses examine whether the Ingbar model, adjusted for Israeli companies, improves the predictive ability, compared to the results in the examination of Hypothesis 1 through 3 (above).

Hypothesis 4: The Ingbar Model improves the predictive ability for bankrupt companies.

Hypothesis 5: The Ingbar Model improves the predictive ability for stable companies.

Hypothesis 6: The closer the date of bankruptcy, the better the accuracy of predicting **bankruptcy** according to the Ingbar Model.

Hypothesis 7 assumes that the Ingbar Model has an advantage over the Altman Model and is based on the good results of Ingbar's study on Israeli companies in the 1980s.

Hypothesis 7: The Ingbar Model improved the overall predictive ability compared to the Altman Model.

3.2 Methodology

The results of the study will be examined according to the original model developed by Altman in 1968 and according to the Ingbar Model.

Examination of the hypotheses will be done by calculating the Z-Score.

- Examination of Hypotheses 1 and 2 will be done by rating Z for both critical values: The first category - Z-Scores greater than 2.675, second category - Z-Scores below 2.675. Altman (1968) found that this value discriminates best between bankrupt and non-bankrupt companies. Companies in the first category will be classified as stable, while companies in the second category will be classified as being at risk for bankruptcy. Then, the percentage of companies correctly classified and the percentage of companies incorrectly classified will be calculated. The percentage of correctly classified companies will reflect the predictive accuracy of the Altman Model.
- Examination of Hypothesis 3 will be done by comparing the percentage of correctly classified companies (classified according to the critical values determined by Altman in his original 1968 model) over three years.
- Examination of Hypotheses 4 and 5 will be conducted according to the Ingbar Model, similar to the examination of Hypotheses 1 and 2 with two critical values: The first category - Z-Scores greater than 1.00, second category - Z-Scores below 1.00.
- Examination of Hypotheses 6 and 7 will be done by comparing the percentage of companies classified correctly (classified according to the Ingbar Model) over three years.

3.3 Sample and data

The sample includes 40 companies publicly traded on the Tel-Aviv Stock Exchange between 2000 and 2007, 20 companies that were in suspension, liquidation or receivership (failed companies) and 20 matched stable (non-failed) companies.

The failed group, including all failed public companies with full financial data, resulted in 20 companies which include the vast majority of bankrupt public companies during the aforementioned period.

The control group includes 20 stable companies that were matched with the failed companies in the sample for asset size and industry. For the sake of comparison, only stable companies not lacking data over the years examined were included.

As in similar studies conducted in Israel in the past (Ingbar, 1994), let us note that the small number of publicly traded bankrupt companies in Israel is a limitation in the study. Therefore, to address part of this problem, firms from different sectors were included in the sample.

Financial data of the companies was taken from the MAYA site and Yifat Hon Database.

4. Results

Hypotheses 1-3: Table 1 in the Appendix and the corresponding diagram display the companies classified correctly and incorrectly within the ranges of the original Altman Model, with a critical value of 2.675. If we examine the overall predictive ability - both of stable companies and bankrupt companies, we will find that the accuracy rate of prediction for the overall Altman Model ranges between 63% and 68%. In contrast, with respect to bankrupt companies, the accuracy rate of prediction of the Altman Model in the two years prior to the date of bankruptcy is 100%. In other words, the model clearly identifies bankrupt companies. In contrast, the model indicates that a stable company is a bankrupt company in most cases.

Hypotheses 4 - 7: Table 2 in the Appendix and the following diagram present the prediction accuracy according to the Ingbar Model, when the critical value is 1.00 and with the addition of the gray area.

The important finding from Table 2 is improved accuracy of prediction of stable companies compared to previous examinations. That said, compared to the previous analysis, when dealing with bankrupt companies, the accuracy of the Ingbar model is lower. Additionally, it can also be seen that the overall accuracy of prediction improved compared to the previous analysis and ranges between 73% and 80%.

The following is a more detailed examination of the individual hypotheses:

Hypothesis 1 was verified: The original Altman Model for public companies predicted bankruptcy with over 80% accuracy. Three years prior to bankruptcy, the accuracy rate is 95% and two years and one year prior to bankruptcy, the predictive ability reaches 100%.

Hypothesis 2 was not verified: The original Altman Model did not forecast stability in stable companies with an accuracy rate of 80% or higher. The highest accuracy rate achieved was only 35%. In other words, the Altman Model does not identify most of the companies as stable and has a high type I error rate, or gives many "false alarms".

Hypothesis 3 was verified: The closer the date of bankruptcy, the higher the predictive accuracy of the original Altman Model. As mentioned above, three years prior to bankruptcy, the predictive accuracy was 95%, and two years prior to bankruptcy, accuracy increased to 100%.

Hypothesis 4 was not verified: The Ingbar Model had poorer results than the Altman Model with respect to bankrupt companies. However, the Ingbar Model's ability to predict bankruptcy is very high and reached 85% two years prior to bankruptcy and 95% one year prior to bankruptcy.

Hypothesis 5 was verified: The Ingbar Model predicted stable companies with greater accuracy. According to the Altman Model, the highest level of accuracy reached 35%; under the Ingbar Model, the highest accuracy rate is 70%.

Hypothesis 6 was verified: The Ingbar Model demonstrated greater accuracy in predicting companies facing financial distress the closer the date of bankruptcy.

Hypothesis 7 was verified: The better predictive ability of the Ingbar Method for stable companies has an impact on the overall predictive ability and on the preference for the Ingbar Method in the sample of Israeli companies.

5. Summary and Conclusions

In this study, which includes a sample of 40 publicly traded companies in Israel, we examined the applicability of the Altman Model and the Ingbar Model for forecasting bankruptcies between 2000 - 2007. Previous studies published in Israel were conducted on a single company or in a different economic environment, and therefore we felt it was important to re-examine the issue on a sample of companies and during a later period.

Our study shows that the predictive ability of the original Altman Model for publicly traded companies is very high with respect to bankrupt companies. However, the model is less efficient in predicting stable companies and gives many "false alarms". Use of the Ingbar Model improves the predictive ability for stable companies and, as a result, the overall predictive ability of the model.

In light of our study, and considering the sample and period of the study, the recommended model for predicting bankruptcy in Israel (between the two examined) is the Ingbar Model, with a critical value of 1.00 and the addition of the gray area to the upper range A score higher than 1.00 indicates that bankruptcy is unlikely to occur, and a score below 1.00 predicts that bankruptcy is likely. Between the two models examined, this model achieves the best results when predicting stable companies (a rate of 65%-70%). According to our study, the Ingbar Model is able to predict bankrupt companies with an accuracy rate of 95% one year prior to bankruptcy, while two years prior to bankruptcy it has an accuracy rate of 85%.

We should note that the Altman Model (all versions) is only a single tool in evaluating the risk of bankruptcy for companies and therefore other information, both qualitative and quantitative, must be used to evaluate the solvency of companies. This is done in the banking industry as part of managing and controlling credit risks. That said, the results of the study are encouraging because even today the Inbar Model can be used to predict financial failure of companies in Israel, even two years prior to bankruptcy. This issue has been very important over the past year, following the liquidity distress many Israeli and global companies have faced.

The most important advantage of the model compared to more advanced ones is its simplicity and the low cost of its application. Using an objective, quantitative indicator represented by a single number, the credit risk can be estimated. We believe the issue to be of great importance now, in light of the significant growth in recent years in the amount of information companies include in financial statements. The model allows users to focus attention on a single number in an era when we are "flooded" with financial information, when we “cannot see the forest for the trees."

It is important to note two limitations of the study. First, given the small number of publicly traded companies in Israel that have gone bankrupt compared to the United States, our sample is limited (similar to other samples taken in Israel). This constitutes a certain limitation and therefore the relatively good results of the study must be looked at with a critical eye, and which are sensitive to the sample and to the period reviewed. Second, as part of the study, we examined publicly traded companies in various industries, and therefore we cannot rush to draw conclusions regarding private companies. Therefore, there is certainly room for a future study that will include a wider sample of companies (following the financial crisis) and, if possible, the study would also examine private companies separately. In the future, as financial reporting is established under IFRS and the transition to fair value accounting, there will also be room to re-examine the models.

Acknowledgement

We thank Anna Basov for computational assistance.

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Appendix

Table 1. The Predictive Ability of the Altman model

Year	Company Type	N1/N2	correct		% error
			number	%	
One year before bankruptcy	Bankrupt	20	20	100%	0%
	Stable	20	5	25%	75%
	Total	40	25	62.5%	37.5%
Two years before bankruptcy	Bankrupt	20	20	100%	0%
	Stable	20	7	35%	65%
	Total	40	27	67.5%	32.5%
Three years before bankruptcy	Bankrupt	20	19	95%	5%
	Stable	20	6	30%	70%
	Total	40	25	62.5%	37.5%

Table 2. The Predictive Ability of the Ingbar Model

Year	Company Type	N1/N2	correct		% error
			number	%	
One year before bankruptcy	Bankrupt	20	19	95%	5%
	Stable	20	13	65%	35%
	Total	40	32	80%	20%
Two years before bankruptcy	Bankrupt	20	17	85%	15%
	Stable	20	13	65%	35%
	Total	40	30	75%	25%
Three years before bankruptcy	Bankrupt	20	15	75%	25%
	Stable	20	14	70%	30%
	Total	40	29	72.5%	27.5%

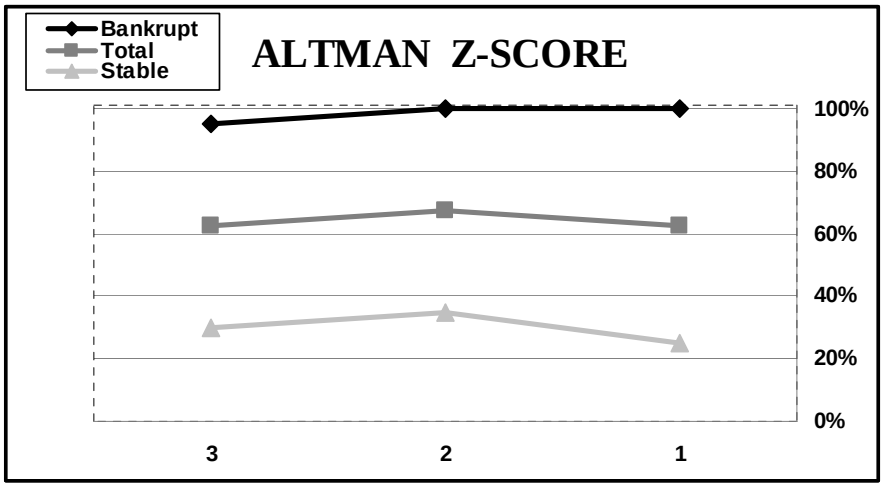

Diagram 1. The Predictive Ability of the Altman model

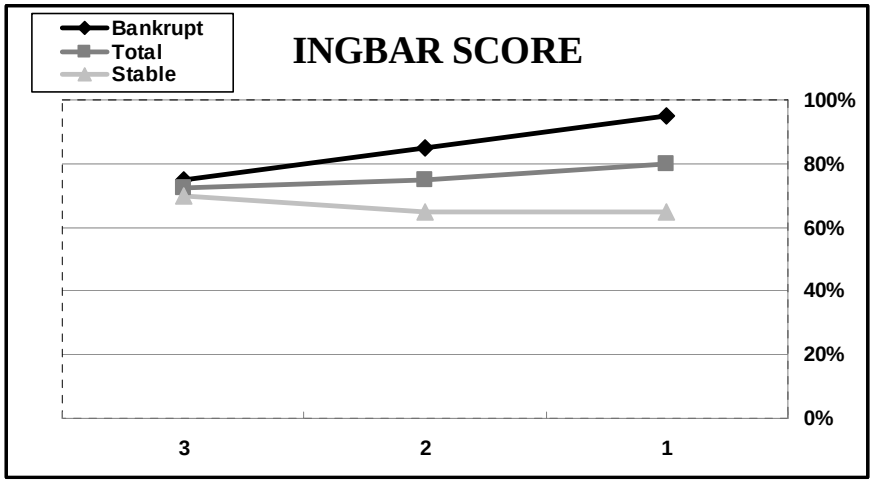

Diagram 2. The Predictive Ability of the Ingbar Model