THE Z MODELS: THE ANALYTICAL TOOLS FOR PREDICTING POTENTIAL COMPANY BANKRUPTCY

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Özet: Bu çalışma potensiyel şirket iflasının önceden tahmininde kullanılan araçlar olarak muhasebe-temelli Z Modellerinin faydalılığını incelemiştir. Z Modellerini kullanımının faydası, bu modellerin incelenen firmaların daha önceden iflas etmiş firmalarınkine benzeyen karakteristiklere ne derece sahip olduklarını belirlemesidir. Böylece, bu modeller yaklaşan finansal sıkıntıları çok önceden uygun bir şekilde ortaya çıkarmak için kullanılırlar. Makale aynı zamanda Z Modellerin yapısı ve kullanımında mevcut problemleri de ortaya koymuştur. Her ne kadar Z Modelleri istatistiki olarak eksiklikler içerse ve her zaman ve her şartlar altında uygulanamasa da, bu modellerin inkar edilemez tahmin etme gücüne sahip oldukları gözükmektedir.

I. Introduction

In making financial decisions and judgements about the financial situations of companies, published financial statements may be analysed to extract information. Motives leading different users of financial statements to make decisions actually are not the same, e.g., while lenders are interested in the credit-worthiness of the firm, share holders are more heavily involved with profits and dividends prospects. Whichever the motive for analysing financial statements, all decision makers will regard financial ratios as useful targets and projections. And particularly an ability to predict the likelihood of the failure of a company by means of financial ratios could be an invaluable benefit to shareholders, lenders, suppliers, managers, i.e., all interested parties who are naturally curious to know whether the company is a going concern or not. As a matter of fact , Robertson and Mills (1991) assert that, "since the 1920s there has been an interest by a number of researchers to try to identify those ratios or group of ratios which best predict failure".

The purpose of this article is to review and examine the 'Z models' that are utilised as valuable symptoms of potential company bankruptcy. The article is divided into five sections, including the introduction. The second section will sketch out the basic causes of company failure in a broader terms. The beginning of the third section will describe the financial signs and

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symptoms of potential bankruptcy situations, with the rest of the section devoted to the thorough understanding of the nature of the Z models. Firstly, the classical seminar study of Altman, the pioneering name in the field of using Z models, will be explored. Then the contributions of Taffler who is the leading name of the topic in the UK will be analysed. The fourth section will set out the pros and cons of the use of Z models in bankruptcy prediction studies. Finally the article will end by giving the general conclusions derived from the whole study.

II. The Causes of Corporate Bankruptcy

Nearly every book on corporate management includes a chapter about why firms fall into bankruptcy. Slatter (1984), for example, identified eleven factors as the principal causes of corporate decline. The first one is the poor management factor which may emerges as sheer incompetence or lack of interest in the top management. Apart from poor management, another major factor for corporate decline is the inadequate financial control which occurs in the absence of or inadequacy of cash-flow forecasts, costing systems and budgetary control. Other financial causes of decline are high gearing, conservative financial policies, the use of inappropriate financing sources, high cost structure, adverse movements in commodity prices and overtrading. In addition, competition between firms, irresponsiveness to market demand changes, lack of marketing effort, launching big projects without prior planning and not-properly-scrutinised acquisitions might potentially give rise to corporate failures as well.

Similarly, Samuels and etc. (1995) demonstrated the sequence of events leading to the typical failure in a step-wise approach as follows:

"1. Bad management: leads to
2. Poor management information (including poor accounting information): leads to
3. Mistakes: including one of the following
    (a) not responding to change in the market place, in technology or in society;
    (b) overtrading-rapid expansion;
    (c) the launch of big project or making a large acquisition-either the growth is too much for the management to handle, or the timing is wrong;
    (d) allowing financial gearing to rise-poor financial structure;

(e) overdependance on a small number of customers or suppliers.
Difficulties resulting from one of these policies leads to ;
4. Financial ratios deteriorating."

Within the context of bankruptcy-prediction studies, the published financial statements indicate that company has already begun to fall into the financial difficulties. Unless the deterioration does not reach to an irreversible point that make the initiation of the recovery actions useless, the financial ratio analysis may trigger the mechanisms to save the company from the edge of bankruptcy. As a matter of fact, there are many models that help to identify companies in financial difficulties using published financial statements as input. The study will explore the most outstanding and the famous ones of these models.

III. The Financial Symptoms of Corporate Bankruptcy

There are certain financial indicators that can be viewed as the crucial symptoms for predicting corporate failures. Walter (Quoted in Taffler, 1983) saw the exhaustion of the liquid assets as one of the symptoms. In his view, the probability of failure is higher:

- the smaller the size of the liquid asset,
- the smaller the funds flow from operations,
- the larger the claims on the resources by creditors,
- the greater the funds flow required for operations of the business and
- the more highly variable the inflows, outflows and claims on the business.

Similarly, Slatter (1984) put forward the following as the financial symptoms of company failure:

- Decreasing profitability,
- Decreasing sales volume at constant prices,
- Increase in debt,
- Decrease in liquidity,
- Restricted dividend policy,
- The use of unacceptable accounting practices and delays in publishing annual financial statements.

Nevertheless, the financial symptoms are not solely based on the analysis of the relative magnitude and trends of the accounts in the published financial statements. According to Barnes (1987), as one type of the positive use of ratios, researches in the statistical models have been employing the ratios

for mainly predictive purposes, including corporate failure. He asserted that the reason ratios are used is a mathematical one and is basically in order to facilitate comparison by adjusting for size.

A. The Univariate Approach of Beaver

Earlier research involving the analysis of financial ratios in a bankruptcy-prediction context focused upon using a single ratio to predict failure-the univariate approach-. As Pendlebury and Groves (1994) and Barnes (1987) state, perhaps the best known examples of the use of the univariate approach are in the earlier and original work by Beaver in 1966. Beaver matched a sample of failed with non-failed firms and for each of the pairs of companies calculated thirty of the more conventional financial ratios for each of the five years prior to the demise of the failed companies. The results revealed that compared to the non-failed companies, the mean ratios of the failed companies were substantially worse. As for ascertaining the predictive ability of ratios, Pendlebury and Grove (1994) indicate, Beaver assumed that for each pair of the companies, the one with the poorer ratios would be the one most likely to fail and made that the basis of his prediction. Observed evidence for five years prior to failure conclusively shown that the ratio analysis had high predictive ability. Beaver found that the ratio of the cash flows (net profits plus depreciation) to total debt was the best classifier among the ratios, followed by debt to total assets. (Barnes, 1987)

Taken in isolation, individual ratios can be misleading and inadequate; therefore, they need to be combined for presenting a composite picture of a firm. The first person that realised this within the context of company failure prediction is Edward I. Altman, an American researcher.

B.The First Z Model: Altman's Classical Study of 1968

In order to assess the quality of ratio analysis as an analytical technique, Edward I.Altman, in 1968 in his seminar study of the topic of "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy" used the prediction of corporate bankruptcy as an illustrative case. Limiting the data to the manufacturing corporations, Altman investigated a set of financial and economic ratios in a bankruptcy prediction context by employing a multiple discriminant analysis (MDA). Initially criticising the previous ratio analysis as inadequate because of inherent univariate

methodology in which emphasis was placed on individual signals of impending problems, Altman claimed that the ratio analysis presented in this fashion was susceptible to faulty interpretation and potentially confusing. In order to find answers to the questions of which ratios are important in detecting bankruptcy potential, what weights should be attached to those selected ratios, and how should the weights be objectively established, Altman used the statistical technique of MDA, which was designed to classify observations into distinct groupings (here failed and non-failed firms) depending on the characteristics of the observations. Altman indicated that, contrary to the univariate study, "the MDA technique has the advantage of considering an entire profile of characteristics common to the relevant firms...(and) perhaps the primary advantage of MDA in dealing with classification problems is the potential of analysing the entire variable profile of the object simultaneously rather than sequentially examining its individual characteristics." Sixty-six manufacturing companies with thirty-three firms in each of the solvent and insolvent groups constituted Altman's initial sample. Based on the "popularity in the literature and potential relevancy to the study" Altman initially compiled 22 potentially helpful ratios, including a few new ones initiated in the study. Following both the selection of final five ratios and numerous computer runs analysing different ratio profiles, the discriminant function of Altman emerged as following;

$$Z = .012X_1 + .014X_2 + .033X_3 + .006X_4 + .999X_5$$

Where X_1 = Working capital/Total assets

X_2 = Retained Earnings/Total assets

X_3 = Earnings before interest and taxes/Total assets

X_4 = Market value equity/Book value of total debt

X_5 = Sales/Total assets

Z = Overall Index

To gauge the predictive ability of his model, Altman applied the model to another samples other than the initial one and concluded that "the bankruptcy prediction is an accurate forecaster of failure up to two years prior to bankruptcy and that the accuracy diminishes as the lead time increases." What was certain from the application of the model was that all firms having a Z score of greater than 2.99 clearly fell into the "non-bankrupt" sector, while those firms having a Z below 1.81 were all bankrupt. The area between 1.81 and 2.99 which was called "zone of ignorance" was susceptible to error

classification. At the end of his study, Altman suggested that investors would typically not have access to computer procedures and therefore attempted to extend the model for more general application by "selecting a "cut-off" point, or optimum Z value, which enables predictions without computer support". Therefore, Altman divided the zone of ignorance into 6 equal sub-ranges and found that the range of 2.67 and 2.68 had minimum number of misclassifications. Hence, the midpoint of this interval, the score of 2.675, was chosen as the Z value that discriminates best between the bankrupt and non-bankrupt firms.

In 1977, Altman developed and marketed a "second-generation" model called "Zeta analysis" which was essentially as the Z-score model, but took into account the changes in financial reporting standards (Barnes, 1987). This revised model which employed seven variables (namely, the return-on-assets ratio, the stability of earnings, the interest coverage ratio, the retained earnings/total-assets ratio, the current ratio, the equity/total capital ratio and the absolute size of the total assets) was found an even better predictor of bankruptcy up to five years in advance (Pendlebury and Groves, 1994 ; Samuels and etc., 1995).

C. The Leading Name in the UK: Taffler's Studies

From the inception of the idea in 1968 by Altman of using MDA to predict company failures on, various researches have been carried out using different versions of Z-score model. As Samuels and etc. (1995) assert, research in the UK in this area has been led by Richard Taffler. As the second prominent name of the field following Altman, Taffler produced a pair of Z-score models that have been operational in the UK for many years. His first model, Barnes (1987) puts forward, was completed in 1974 and made up of five ratios: earning before interest and tax/opening total assets, total liabilities/net capital employed, quick assets/total assets, working capital/net worth and stockturn. His second model which was developed in 1977 comprised four variables: profit before tax/current liabilities, current assets/total liabilities, current liabilities/total assets and no-credit interval that calculates the time for which the company can finance its continuing operations from its immediate assets if all other sources of short-term finance are cut off (Taffler and Tisshaw, 1977)

Taffler and Tisshaw (1977) said that to construct the latter model, a statistical technique known as "linear discriminant analysis" was applied to two groups of financial ratios. The bankrupt and solvent samples were represented

in the study with the equal numbers of 46 each. Following extensive statistical analysis, out of initial eighty different ratios, four ratios that were enumerated above were isolated as discriminating best between the two sets of firms. The application of the model revealed that it was able to predict with a near 100% accuracy subsequent company failures. The cut-off point of the model was zero; the companies with the z score of above zero were considered solvent whereas the ones with the negative score were deemed as potential insolvent.

Asserting that "a single 'at risk' reading for a company is not very useful for indicating the likelihood of imminent financial distress or the possibility of recovery", Taffler (1983,) originated a composite picture of underlying risk termed a "risk index" or "Z-score of Z-scores' results" by using three determining factors of ultimate financial distress: magnitude of latest z, number of years at risk and trend. The risk index appears to be operational utility and is measured on a 5 point scale, "with '1' indicating a relatively low probability of immediate financial distress and '5' a company usually beyond saving in its present form" (Taffler, 1983).

IV. The Pros and Cons of the Use of Z Models

As an answer to the question of "why these formulae (of Z-score) making use of conventional much-maligned historic accounting data as they do work so well", Taffler and Tisshaw (1977) and Taffler (1983) put forward primarily four reasons. In the first place, Taffler and Tisshaw (1977) claim, "because of the model's multivariate nature, they are able to explicitly take account of a number of crucial and distinct aspect of a company's financial structure simultaneously, these being optimally determined and appropriately weighted by the statistical methodology used." Further, they go on, "this multi-dimensional structure largely defeats such things as 'window dressing' and creative accounting generally, which usually show up elsewhere in the accounts and, as a result, can be trapped by the models."

Taffler (1983) expresses that the use of ratio constructs ensures that the effects of inflation are largely discounted by virtue of their numerators and denominators, both being affected, at least to a first approximation, in a similar way. Finally, and probably of most importance, Taffler (1983) asserts, "such a dramatic situation as impending solvency just can not be covered up however the accounts are stated, given that they can be correctly read in a multivariate way."

In spite of the advantages in the usage of financial ratios in predicting company failures, many criticisms have been directed towards it. The problems about the use of Z-score in particular, as Robertson and Mills (1991) indicates, lies in meeting the strict mathematical standards:

- It is not valid for a model derived for industry group to be used to evaluate other industry groups,

- It is not valid to use the model to observe trends,

- It is not valid arbitrarily to change the cut-off.

- It is not valid to change the specifications of any of the ratios contained in the model.

Robertson and Mills clearly display that the practice shows great deviations from these standards. Instead of limiting the application of the models to a narrow section of companies for which they were derived, it is assumed that the models can transcend industries. Additionally, in the application of the models, the resultant Z scores should be compared against a specific cut-off point. Therefore, comparision of the yearly changes in the ratio values can not be accepted as a valid procedure. As for arbitrarily changing both the cut-off point and specifications of any of the ratios of a model, the authors cogently argue that there are abundant examples of these practices in the literature, too. Robertson and Mills (1991) assert that "the main reason for wanting to change the specification of a ratio has centred on ratio X_4 in Altman's 1968 model". Being stated as market value of equity divided by the book value of debt, this ratio restricted the use of the model merely to those companies that were quoted on a stock exchange. For the sake of applying the model to a wide spectrum of companies, in the following studies the market value of equity in the ratio was replaced by the book value of eqiity, but at the expense of producing substantial changes in the weights of assigned to other ratios.

Both Pinches and Eisenbeis (Quoted in Barnes, 1987) identified a number of difficulties arising from the statistical assumptions made in the application of the MDA studies which researchers did not usually address. These include: the assumptions of multivariate normality in the distribution of the sample groups, the equality of the group dispersion matrices, addressing the problems of determining the relative importance of individual variables, reducing the number of variables that do not significantly contribute to the

overall discriminating model, the selection of prior probabilities and costs of misclassification, and the classification error rates.

As among the problems of Z-score models, the question of the stationarity of the model and ratios over time attracts paramount importance. Pendlebury and Groves (1994) asserted that due to the environmental changes some changes occur in the financial ratios. Levels of profitability and liquidity, for example, will tend to be lower during the downturn of the trade cycle. Thus lower ratios for a nevertheless successful company, when fed into the predictive model, could cause an erroneous prediction of failure, if the prediction model has been based on ratios achieved by companies during better economic times. Therefore. in case of instability of underlying relationships and parameters over time, the model will only be valid for the sample period and it can not be extrapolated into a subsequent period with the same expected performance.

In spite of all these shortcomings, relevance of financial ratios, particularly of Z-score models can be best succinctly captured in terms of Taffler's remarks (1991) as follows:

"The Z-score model is not a black box; rather it is an additional analytical resource to be used only by the skilled financial analyst. It is in no way able to replace the analyst's judgement and experience. It is also necessary to emphasise that just because of its statistical origins, the Z-score technique should not be looked on as principally a portent of doom but as a constructive business tool that can also be used positively to identify recovery situations and uncover other business opportunities."

V. Conclusion

Over several years a number of researchers has been involved with identifying the best group of financial ratios that predicts company failure. The initial methods using individual financial ratios finally gave way to the wide-spread use of a statistical method known as discriminant analysis to develop Z models. Basically, Z models, which are constructed by using the last set of accounts of both failed and on-going companies just prior to demise of the former ones, produce a single Z score. It is this Z score that is used as a yardstick in singling out the firms in financial crisis. If the resultant score of the firms for which the model is applied is less than the Z score, these firms are considered showing the serious warning signs of impending collapse.

With the differences emerging in the selection of ratios and industries, all varying types of Z models constructed to now have been based upon the classical study of Edward 1.Altman in 1968. The prominent name of the UK in this field is R.J.Tafler.

In fact, both the construction and the application of Z models have drawn severe criticism particularly regarding the satisfaction of the strict mathematical standards. However, availability of commercial services such as DataStream in the UK, which among other information provides a Z score service, can be cited as a proof of the usefulness of the models.

Summary: The study evaluated the nature and usefulness of the accounting-based Z models as the predictive tools for identifying potential company bankruptcy. The benefit of using Z models is that they indicate the extent to which the company under concern has characteristics showing resemblance to those of previous failed ones. Therefore, the models can be appropriately used to highlight far in advance the impending financial distress so that recovery action could be initiated. The article also mentioned the principal problems embodied in the Z models. Although the Z models are subject to statistical shortcomings and can never be applicable at all times and under all circumstances, the indication is that they appear to have undeniable predictive ability.

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