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Predicting corporate failure: how useful are multi-discriminant analysis models?

Abstract. The aim of the paper is to present how multi-discriminant models (MDA) perform in practice and to measure these models' effectiveness in bankruptcy prediction. For this purpose an ex-ante approach is adopted to emulate the way in which the models are used in practice. Thus two commercially applied models, Altman's and Datastream's, are presented and examined on independent samples of companies. The findings are that these two models have a very similar predictive ability and that the prior probability of failure is an important feature in determining this ability. The general conclusion of the paper is that the use of MDA models as predictors of bankruptcy can involve major understatement of classification errors. Therefore the robustness of these models as well as the acceptability of using the models as the sole means of assessing potential bankruptcy of companies could be doubtful. The paper fills a gap in the literature on independent testing of the developed MDA models. We stress the importance of shifting the threshold and consequently we show the impact of the choice of the threshold in a practical setting.

Keywords: multi-discriminant models, bankruptcy prediction.
JEL codes: G3, G33.

Much research has been undertaken into the development of muti-discriminant analysis (MDA) models over many years, for example Altman (1968, 1980), Marais (1980), Taffler (1982, 1984), Koh and Killough (1990) and C.Y. Shirata (1998)[1]. However, little attention has been paid to post-analysis checks on the reliability of these models in practice. Given that these models are extensively used in practice by, for example, credit rating agencies, banking institutions and other financial analysts it would seem essential that the reliability and validity of these models be

[1] For a comprehensive review of bankruptcy prediction models, mainly MDA models, one may refer to E. I. Altman and P. Narayanan (1997).

thoroughly evaluated. It is appropriate that the models are independently evaluated under ex-ante conditions, that is, as the models would be used in practice. This study fills a gap in the literature on this subject by testing MDA models as they would be used in practice.

One study by Piesse and Wood (1992) examined the existing MDA models. The study evaluated an independent sample of 261 companies conducting tests using both ex-post and ex-ante approaches. This study showed that the ex-post criterion yielded a high rate of misclassification. For example, 1 year prior to bankruptcy, for every one correct failure classification there were 20 incorrect classifications under the Altman model and 22 under the Taffler model. Under the ex-ante criterion there was a much higher rate of misclassification. For example, 1 year prior to bankruptcy, for every one correct failure classification there were 89 incorrect classifications under the Altman model and 78 under the Taffler model. Piesse and Wood conclude that:

"The matched sample, known outcome methodology, found to be convenient in model estimation, is unacceptable in evaluation and if used, produces an overwhelming bias in favour of model acceptance. The models investigated were descriptive of past events to some extent, but as predictors they performed poorly".

Piesse and Wood drew attention to the high level of Type I errors displayed by bankruptcy prediction models derived using multi-discriminant analysis.

1. The present study

The purpose of this study is to ascertain how well two MDA models perform in practice and to measure the models' effectiveness in bankruptcy prediction. The present study is designed to test for both Type I and Type II errors using established MDA models and an independent sample of companies[2]. An ex-ante approach is adopted as this is considered to be the way in which these models are used in practice, that is as predictors of potential bankruptcy. The objective of the study was to emulate as closely as possible the way in which these models would be used in practice.

As Piesse and Wood emphasise, testing MDA models is restricted by a lack of disclosed information about the coefficients used in most models. In selecting the models for testing in this study we considered a range of factors including the extent of usage of the model in practice and access to the full details of the model. Two models were selected based primarily on the above factors: Altman's original model and Datastream's model, both referred to as Z-Score models. Altman's

[2] Type I errors – Wrongly predicting a company will fail. Type II errors – Wrongly predicting a company will not fail.

pioneering work in this area is regarded as seminal and his model is extensively used throughout the world. Datastream is a commercial company that provides a range of statistical information of a macro and micro economic nature. The services that Datastream offer includes a Z-Score (based on their own MDA model) for selected companies.

2. Altman's model[3]

Altman's model is derived from a sample of 66 manufacturing companies. The sample consists of 33 failed and 33 non-failed companies, matched by size and industry and selected on a stratified random basis. The construction of the model follows the normal matched-pair methodology common to MDA analysis. The model consists of the following variables:

Variables:

X_1 = Working capital / total assets
X_2 = Retained earnings / total assets
X_3 = Earnings before interest and taxation / total assets
X_4 = Market value of equity / book value of total debt
X_5 = Sales / total assets

3. Datasteam's model

Datastream's model is a classification model developed by Marais (1979). It is based on a sample of 100 UK companies consisting of 50 failed and 50 non-failed companies. Although limited information is available on the model construction, the type of variables used is known. The model consists of four variables that measure distinct aspects of company performance.

Variables:

X_1 = measures profitability,
X_2 = measures liquidity,
X_3 = measures gearing,
X_4 = measures stock turnover.

[3] For the modification of the Z-score model see: J.B. Caouette, E.I. Altman and P. Narayanan (1998).

4. Data

The sample of companies selected for this study consists of all quoted companies, both on the full London Stock Exchange and on the Alternative Investment Market (AIM), the secondary investment market in London, with registered addresses in the county of Yorkshire in April 1997. The Yorkshire region provides a wide diversity of businesses, including manufacturing, retailing and distribution. This study contrasts with Piesse and Woods mainly in respect to the sample of companies. Piesse and Wood's sample consists of one narrowly defined industrial sector, the UK motor components sector. For the present study a total of 140 companies form the sample.

The progress of the companies forming the sample was reviewed annually, over a five-year period from 1997 to 2001 inclusive.

5. Results

The results of the study are shown on Table1. From Table 1 it can be seen that one year prior to 2001, for the two correct failure classification there are 25 incorrect classifications under the Altman model and for the two correct classifications under the Datastream model there are 23 incorrect classifications. Three years prior to 2001 shows similar results.

Table 1. Ex-ante classification accuracy

	Altman		Datastream	
Years prior to event	1	3	1	3
Correct classification				
Survivor	112	109	114	113
Failure	2	1	2	2
Incorrect classification				
Type I errors	25	28	23	24
Type II errors	1	2	1	1
Total	140	140	140	140

Altman's model was developed more than a quarter of a century ago from the US company data. Consequently, it is debatable whether this model is applicable to a European environment at the turn of the 20th to the 21st century. One might expect that, a priori, Altman's model would be a poorer predictor of bankruptcy

than the Datastream model, developed far more recently and from the UK data. However, as can be seen from Table 1, there is little difference in the predictive ability of either of the two models.

In building MDA models for the purposes of predicting corporate failure it is normally difficult to establish a precise cut-off value showing a clear distinction between the two samples of companies, failed and non-failed. Often, a range of overlap exists between the two samples and consequently there is some degree of flexibility on exactly where the cut-off value should rest within this 'grey zone' range. It has been debated whether moving the cut-off value would affect the accuracy of the predictive ability of the model. For example, repeating the tests using a cut-off value based on the lowest decile of Z-Scores improves the accuracy of failure prediction and reduces Type I errors significantly. Table 2 shows the impact of moving to the lowest decile. Type I errors are reduced from 29 to 8 in the case of Altman's model and from 25 to 16 in the case of Datastream's model. It is also useful to illustrate the distribution of data graphically and to show the impact of moving the cut-off value. Figure 1 shows the distribution of companies around Altman's cut-off of 2.675. Similarly, Figure 2 shows the distribution of companies around the Datastream model cut-off of 0.

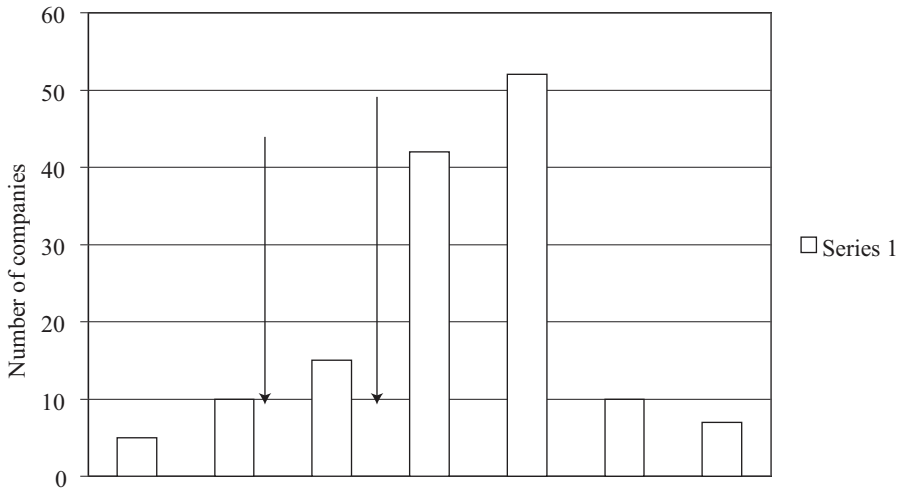

Figure 1. Altman's model – ex-*ante* classification. One year prior to event

It is worthy of note that classification of all companies in this study as non-bankrupt would be correct in 137 of the 140 cases (97.9%).

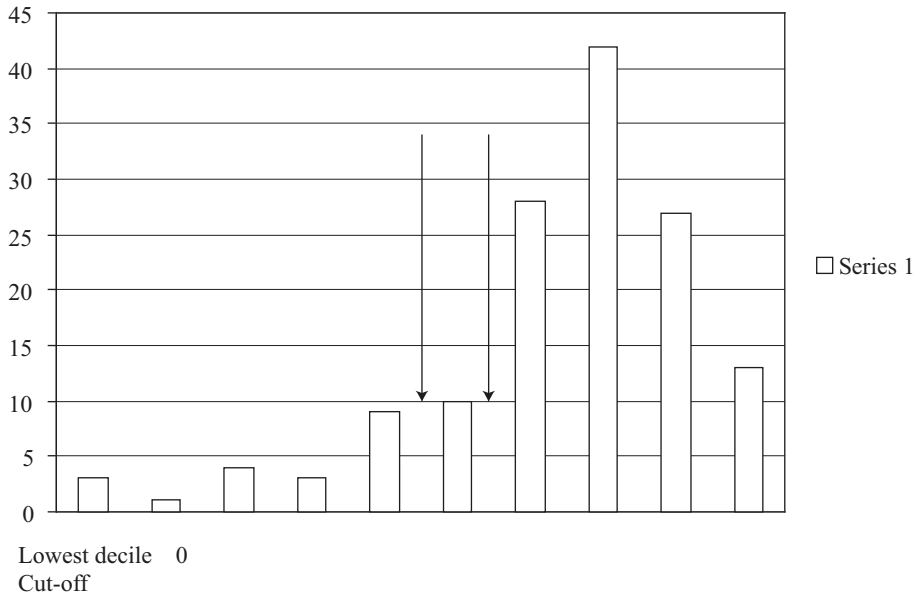

Figure 2. Datastream model – *ex-ante* classification. One year prior to event

Table 2. Ex-ante classification accuracy at the lowest decile cut-off

	Altman		Datastream	
Years prior to event	1	3	1	3
Correct classification				
Survivor	123	122	121	118
Failure	1	2	2	2
Incorrect classification				
Type I errors	14	15	16	19
Type II errors	2	1	1	1
Total	140	140	140	140

Therefore, the prior probability of failure is an important feature in determining a model's predictive ability.

The overall pattern of errors associated with classification accuracy depends on the frequency of failure relative to survival. In the long run the probability of failure is low as shown by the following three sources: Dun and Bradstreet (1982) report failures running at less than 0.75% of the US quoted companies since 1934. Altman (1977) suggest a prior failure rate of 2%. The long run failure rate of companies in England and Wales is 0.85%[4].

[4] Corporate failure data supplied by Dun and Bradstreet (UK) 2002.

The failure rate recorded in the sample used for this study of 2.1% is marginally higher than the long run average of 0.75% but is in line with Altman's suggested prior failure rate.

6. Conclusion

The results of this study demonstrate that the use of MDA models as predictors of bankruptcy can involve major understatement of classification errors and therefore raises doubts about the robustness of these models AND about the acceptability of using these models as the sole mean of assessing potential bankruptcy of companies.

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