

## Applying discriminate analysis to predict prospects of corporate activities

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### Abstract

The paper reports on results of discriminate analysis applications, as regards predictions of prospects of a company's future economic developments – its success or default. Prediction accuracy impacts are qualified concerning the type and number of the distinguishing characteristics (discriminants), as well as the size of the files analysed.

**Key words:** economic forecasting, bankruptcy, prediction accuracy.

### Introduction

Analysing default economies of the Ostrava-Karvina collieries in the final year of their existence provided for the evidence that the same changes affected their capital structures. The obvious implication of the fact was a view that deficient capital circulation structures imply the default (Dvořáček, 2006). Envisaging a firm's economic prospects, it was subsequently proposed to employ a set of specific financial ratios to predict the insolvency by applying methods of discriminate analysis (Dvořáček, Sousedíková, 2006). At the same time it was highlighted that it was necessary to take into account several factors influencing the accuracy of the prediction concerning the economic success or failure. This especially concerned the size of the files analysed, and type as well as number of the financial ratios (discriminators) used for the discriminate analysis.

### Applying the discriminate analysis

Based on the knowledge of input data, the so-called discriminators, an objective of the practical applications of discriminate analysis is to identify a principal, standard by which it might be judged whether a firm develops its economies successfully in the future period of 1-2 years or a danger of default is looming.

The methods of discriminate analysis were applied both to files of default and sound companies at which point the size of these files was continually increasing. At the same time the discriminators in the ratio or index form or the combined ratio/index form were variously applied. The financial balance data, as to the 31-12 date, provided for the ratios which date was preceded by maximum of 12 months before the default announcement or 12 months before evaluating economies of the sound businesses. The equation,  $i = (t-1)/(t-2)$ , was used for calculating the indexes, at which point 31-12 balance data in time,  $(t-1)$ , preceded the default by 12 month maximum, and 31-12 balance data in time  $(t-2)$ , preceded the default by 24 month maximum. The sound business indexes were established analogically. The only difference was that the default dates were substituted by the dates of evaluation.

The application structure of the discriminate analysis was as follows:

- a) Ratio/index combinations:
  - o 31 sound firms, 31 defaults firms,
  - o 62 sound firms, 62 defaults firms.
- b) Ratios:
  - o 39 sound firms, 39 defaults firms,
  - o 62 sound firms, 62 defaults firms.
- c) Indexes:
  - o 32 sound firms, 32 defaults firms
  - o 62 sound firms, 62 defaults firms

Concerning industrial sectors and their shares in the files analysed, processing industries and service providers dominated being accompanied by mining industries.

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Ad a)

The following combination of discriminators was used for the first group:

- **Ratios:** Receivables/Current Assets; Reserves/Current assets; Equity Capital/Total Assets,
- **Indexes:** Fixed Assets Index, Current Assets Index, Receivables Index, Past Income Index, and Equity Index.

Ad b)

The second group concerned only the ratios as follows:

Receivables/Current Assets; Reserves/Current assets; Outside Capital/ Total Assets; Fixed Assets/Total Assets; Last Years' Income/Equity Capital; Liabilities/Outside Capital; Current Assets/Total Assets,

Ad c)

The third group involved only the indexes. The following discriminators we employed:

Receivables Index; Reserves Index; Outside Capital index; Fixed Assets Index; Last Years' Income Index; Liabilities Index; Current Assets Index.

From the point of view of a relation between the date of default (or for that matter sound business assessment) and the end of year,  $(t-1)$  or  $(t-2)$ , the indexes employ the 'oldest' value, whereas the ratios use the 'youngest' one. It has been assumed that such a differentiation might influence the prediction accuracy.

### Comparing files and results

The discriminate analysis considered the input data provided by files of varying size indexes, number of indexes, and periods since the dates of default announcements or assessment reports, respectively. That is why the results vary as to the analysed file the reclassifying accuracy concerning groups of successful businesses or those threatened by the default. Comparisons were made aiming at establishing the weights of individual factors vis-à-vis the prediction accuracy, which is essential for the usability of the results of discriminate analysis.

#### A comparison of the homogeneity of groups

Based on simple statistical assessments of variously large groups of the enterprises analysed, it has been established that larger groups, concerning both successful and failed firms, evidence a minor variability, i.e. the group is more homogenous. This fact is in favour of employing files of larger size as regards a firm's economic footing analysis and search for criteria of its future economic development. A comparison of the failed and successful enterprises evidences that the default firm assets are only a fraction of the assets of firms that operate successfully. The wobble-footing-firms are unable to expand or even reproduce their capital structures, operating beyond their income.

#### A comparison of the capital structures and resources

The capital structure and the resource evaluation was based on the total assets and liabilities of a relevant enterprise group in the period,  $(t-1)$ , i.e. 12 months before the default announcement or assessment report of successful firms.

On average, the successful ratio of fixed and current assets was constant reaching the value of 49 %. 55 % of these assets were covered by the internal capital resources, 45 % came from the external sources. The failed firms' average ratio of fixed assets was 67 %, the current assets ratio was 32 %, and the equity value was -72 % of the total liabilities. The external capital resources reached the value of 161 %, the difference from the total given by the remaining liabilities. The capital structures and resources of default firms are defined and conditioned by:

Higher ratios of fixed assets:

- Influence of impaired negotiability of fixed assets (location, specificity, etc.),
- Influence of technological process necessity,
- Influence of longer depreciation periods and the implication of the balance higher residual prices.

Lower ratios of current assets:

- Influence of decreased production rates, and the implied stock decreases concerning both input and output,
- Influence of decreased sales rates, and the implied receivables decreases, and lower cash-flows causing a set-back of short-term financial capital.

Negative equity capital:

- Influence of in-the-red current operations,
- Influence of in-the-red past year operations as accumulated losses,
- Influence of reserve depletion.

Outside capital dominance:

- Primarily influence of increasing liabilities implied by cash-flow difficulties.

#### A comparison of prediction accuracy

Based on the feedback of the criterion values established by discriminate analysis, the enterprises analysed were newly structured, and the new files were compared with the original ones. This provided for a percentage qualification of the prediction accuracy that represents a key factor for practical applications of the method. The following Tab.1 comprises the results of the discriminate analysis applications:

Tab. 1.

Distinguishing characteristics	Number of firms	Prediction accuracy [%]	
		Successful firms	Default firms
8 characteristics: combination of financial ratios and indexes	31 + 31	100	77
	62 + 62	92	79
7 characteristics: Financial ratios only	39 + 39	90	74
	62 + 62	82	76
7 characteristics: Indexes only	32 + 32	81	78
	62 + 62	92	68

The prediction accuracy arithmetic average is 90 % for successful firms, and 75 % for those enterprises that failed. Less accurate predictions of failure can be attributed to the fact that the bankruptcy petition for some firms was rather induced by a speculation than a sheer economic necessity – creditors believed to get some minor sums of money or there was an interest involved to get the related firms' property, etc.

Concerning the prediction accuracy, it is possible to assume that the discriminate analysis predicts a firm's future economic footing as based on a quantitative criterion that has been calculated from concrete values of financial ratios and indexes of related firms. From the point of view of mathematics, it means that if any mistaken criterion has occurred, it must be implied by concrete values of input variables (discriminators). The discriminator values of mistakenly classified corporate bodies should differ from the values of the firms that are classified correctly. To verify this hypothesis, the same size file of 62 was used to compare the successful and failed businesses. The combination of distinguishing characteristics – financial ratio and indexes – was employed for the task as this provided for the relatively highest prediction accuracy results: the 92 % success, and the 79 % failure.

Arithmetical averages of discriminator values of correctly classified enterprises were calculated for both files, as well as upper and bottom limits of the 95 % confidence interval of discriminator values of correctly classified businesses. These arithmetical averages and the upper and bottom limits were compared with the discriminator values of mistakenly classified firms. In all cases, the arithmetical values of correctly and wrongly classified enterprises differed markedly. Concerning the default and successful firm groups, three discriminators differed with a statistical significance. The linear discriminate function value is calculated from the files of both successful and default firms. The discriminator limiting values, e.g. the 95 % accuracy of correctly classified firms, can be employed for qualifying the prediction value of a firm's future economic footing.

#### Conclusion

The results for applications of discriminate analysis, as regards the predictions of the future economic development of corporate activities, can be summarised as follows:

- Larger size files are more homogenous,
- Capital structures and resources of failed businesses corroborate the hypothesis that disturbed capital structures imply a bankruptcy,
- Prediction is more accurate for successful firms than for their counterparts which testifies to non-economic reasons for filing of bankruptcy petitions,
- Greater prediction accuracies are related to greater numbers of distinguishing characteristics – discriminators,
- Greater prediction accuracies are related to combinations of financial ratios and indexes.

Predictions of firms' future economic footing, which are based on applications of discriminate analysis, start with lists (files) of successful and failed firms. After quantifying criteria are set, the firms are classified putting them into the two groups mentioned, and by comparing their performance with the situation before the evaluation, a prediction accuracy is qualified. The correct classification files provide for establishing of upper and lower limits, e.g. the 95 % reliability interval of discriminator values. Predicting the economic developments of new firms, these concrete discriminant values can be compared with the discriminant value limits of correctly classified corporate bodies. If the values of all discriminants are within the reliability interval limits, the firms' future economic developments can be qualified. If at least the value of a single discriminator is outside of these limits, the related prediction is less accurate accordingly. The latter would be in analogy to the so called 'gray zone' of Altman's classical models (Altman, 1968) that do not provide for unequivocal predictions.

The proposed method of prediction for a firms' future economic footing should be considered as a pilot project which needs a further verification and elaborating. For that reason no concrete form of any discriminate function or criterion value is presented. Elaborating the prediction method, options of classifying firms along with their industrial branch relevance or their size or assessments of their file distribution are all at hand. On the other side, the 100 % accuracy predictions can hardly be expected as reasons for filing of bankruptcy petitions which are not always purely economically based.

#### *Acknowledgements*

*This contribution's project has been funded by the Grant Agency of the Czech Republic under the registration number, GA 105/05/0515, and the authors want to thank the Agency for the assistance provided.*

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