



EFFECTIVENESS OF POLISH AND FOREIGN DISCRIMINANT MODELS

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ABSTRACT

This article focuses on a study whose thesis was to ascertain whether current bankruptcy forecasting models are effective in relation to companies involved in international commercial road transport. In the case of the international commercial road transport sector, the best foreign model – in terms of overall performance – was the Altman III model with 80% accuracy, followed by the Altman II model with a performance rating of 77.5% for this sector. These results, in effective identification of bankrupt and solvent companies by the use of foreign discriminant models, indicate limited accuracy in their application under the structural and legal conditions in Poland. During research regarding the effectiveness of contemporary models, it was observed that there are Polish discriminant models that are based on multiple tests (with regard to commercial entities), which can be utilized in assessing bankruptcy risk in the considered sector. The best Polish models for assessing bankruptcy risk in the commercial road transport sector were the Poznan (Hamrol and others) models and the Hadasik IV model which had a performance assessment of 82.5%. In the case of other models, their performance ran at lower percentages and therefore could not be considered for analyzing commercial entities in the studied sector.

Keywords: bankruptcy, bankruptcy forecast, discriminant analysis

RANGE AND RESEARCH METHODOLOGY

The study encompassed 60 corporate entities in the international road transport industry in the years 2007 to 2010, incorporated in the Polish Republic as limited liability companies, using their balances and profit and loss accounts. The sample selection was governed by purposive-random format. For the two phase study, sixty companies were selected wherein for the first phase, 20 ‘bankrupted in 2009’ companies were randomly chosen. A further 20 were chosen having continuous activity; and for this determinant model construction phase, the data from 40 companies for 2007 and 2008 was examined; two full ‘pre-bankruptcy’ accounting periods were scrutinized. The commonalities of these 40 companies were utilized in examining the effectiveness of foreign and domestic determinant models. For the second phase of the study, another 20 companies, which were declared bankrupt in 2011, were randomly chosen. The same ‘continual activity’ group of the first phase was utilized but with the change that the data of both bankrupt and operating companies now pertained to 2009 and 2010. The collated data was used to verify the determinant model for a specific industry. The study took into account bankrupt companies which issued annual financial reports for at least

3 full accounting periods in *Monitor Polski B* (a Polish government daily regarding finances, reports, etc.) before petitioning a court to declare bankruptcy, and also were characterized by deficit spending (negative net worth) and financial losses. The contrasted side, those companies which were operational in 2011 since at least January 1, 2005, had comparable asset values to the bankrupt group with differentials no greater than 500,000. PLN. In 2009, Poland had 51 international transport companies declare bankruptcy; solvent - 529 companies.

The established bankrupt group was then organized ascending, according to their National Court Register number, and twenty companies were chosen at random. Every second company was chosen beginning with the company in fifth position. The 'in operation' group was randomly established, also in that after being ordered by registration number, every twenty-sixth company was chosen beginning with the company in fourth position. In 2011, there were 49 companies in the international commercial road transport industry which declared bankruptcy; of these, once organized in ascending order, every second company was drawn beginning with the fifth position. To assess accuracy of company classification, an assessment accuracy matrix was applied to the discriminant model, a tool which presents summaries pertaining to index accuracy (see, among others [Card 1992, pp. 431-439], [Congalton 1991, pp. 35-46], [Li, Racine 2007, p. 240]). This accuracy tool is the square 'k x k' matrix where 'k' equals the number of deciding classes. Matrix rows reflect correct decision classification, and the matrix column represents the determinant model estimates. The general matrix classification scheme, utilizing discriminant analysis to assess the accuracy of a prediction model to foresee bankruptcy, is shown in Table 1.

Table 1. Assessment Matrix for Discriminant Model Accuracy

Factual Company Classification	Anticipated Model-Based Classification	
	Bankruptcy Risk	No Bankruptcy Risk
Bankruptcy Risk	Correct Classification	Incorrect Classification
No Bankruptcy risk	Incorrect Classification	Correct Classification

Source: original on the basis of Altman E. I., (1996), Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy, *Journal of Finance*, No 4, Vol. XXIII, pp. 598-599.

This presentation of the results pertaining to forecast accuracy allows the determination of the model's effectiveness. In the case of determinant analysis, three types of effectiveness and incorrect classification. In the case of 'model effectiveness', we see [Prusak 2004, p. 6]:

Effectiveness - First Degree (SP_1) establishes the percent of accurately classified companies at risk of bankruptcy, determined according to the formula –

$$SP_1 = \frac{P_1}{P_1 + NP_1} \cdot 100\%$$

Effectiveness – Second Degree (SP_2) establishes what percent of all analyzed companies as not-at-risk of bankruptcy were identified accurately, based on the formula –

$$SP_2 = \frac{P_2}{P_2 + NP_2} \cdot 100\%$$

Overall Effectiveness (SP_0) – demonstrates what percent of all companies analyzed were classified correctly by the model. The formula enabling effectiveness determination is –

$$SP_0 = \frac{P_1 + P_2}{P_1 + NP_1 + P_2 + NP_2} \cdot 100\%$$

Where the formulae use these symbols:

- P_1 – anticipated number of bankrupted companies classified as ‘at risk’,
- P_2 – anticipated number of operational companies classified as ‘not at risk’,
- NP_1 – number of operational companies classified as ‘at risk’,
- NP_2 – number of bankrupted companies classified as ‘not at risk’.

Determining the validity of the model and its forecast degree of error, in the test group and the group used for formulating the model, enabled model assessment with regard to practical applicability.

STUDY RESULTS

Research regarding performance assessment of constructed discriminant models, both those for the Polish and foreign markets, was an issue of interest for many researchers, among them Stasiewski [1996, *Rachunkowość* nr 12], Gasza [1997, *Bank i Kredyt* nr 3], Rogowski [1997, *Bank i Kredyt* nr 6], Koralun-Bereźnicka [2006, *ZN-KZ i F* nr 69] and many others. They indicated a need to develop a discriminant model specifically for Polish conditions where the imminent bankruptcy discriminant models for highly developed economies showed low accuracy in anticipating bankruptcy of Polish enterprises.

It bears noting that the Polish discriminant models were formulated over a period of ‘a couple’ of decades, during which time many significant changes occurred in the methods of corporate management; the commercial milieu has changed and the Polish market continues to transform. These transformations signaled the need for application verification of models for forecasting, or anticipation of, imminent bankruptcy (see [Grice, Dugan, 2001, p. 122], [Sojak, Stawicki, 2001, pp. 45-52]). Accuracy assessment of discriminant models for Polish market conditions have been undertaken, among others, by Kisielińska [2010, pp. 17-31], Waszkowski [2011, pp. 96-106], Czapiewski [2009, pp. 118-128], Stefański i Sabuhoro [2006, pp. 225-246], Grzegorzewska i Runowski [2008, pp. 83-90], Juszczuk [2010, pp. 572-584], Balina [2009, pp. 161-174; 2012a, pp. 225-263; 2012b, 231-238], Dec [2008, p. 129], and their results have indicated lowered accuracy -- shortly after their introduction -- in differentiating potential fiscal failures and solvent enterprises. Accuracy verification was undertaken on the basis of varied companies in a given industry profile. It bears mentioning that rarely is there a Polish discriminant model available to indicate potential bankruptcy for a specific industry profile. An exception is the research carried out by Stefanski [2011, pp. 131-139], who examined the applicability of Polish discriminant models to assess bankruptcy potential for Polish securities banks listed by the Warsaw Stock Exchange, as well as Juszczuk¹, who carried out effectiveness verification for Polish and foreign determinant bankruptcy models for the transport sector. Resulting from the current trend for bankruptcy analysis from a particular industrial perspective [Sojak, Stawicki, 2001, pp. 89-102], it would seem appropriate to verify Polish and foreign bankruptcy models for corporate entities in three distinctly different industries.

¹ For more see [Juszczuk, 2010, pp. 572-584].

As the authors have put to use financial data of limited liability companies, further examination will exclude models constructed for publicly owned (joint stock) or other lawful incorporation. The parameters pertaining to this current study have restricted the number of bankruptcy prognostic models that can be examined, and verification of foreign bankruptcy prognosticating models has been restricted to Altman II, Altman III, Springete, Legault and van Frederikslust I models.

Concurrently the applicability of Polish models for predicting corporate bankruptcy in the above mentioned industry was undertaken maintaining the given parameters. The qualifying models were: Pogodziński and Sojak, Gajdki and Stos I, Gajdki and Stos II, Hadasik I, Hadasik II, Hadasik III, Hadasik IV, Wierzba, Stępień and Strąk I, Stępień and Strąk II, Stępień and Strąk III, Stępień and Strąk IV, Hołda, INE PAN (Mączyński and Zawadzki) I, INE PAN (Mączyński and Zawadzki) II, INE PAN (Mączyński and Zawadzki) III, INE PAN (Mączyński and Zawadzki) IV, INE PAN (Mączyński and Zawadzki) V, INE PAN (Mączyński and Zawadzki) VI, INE PAN (Mączyński and Zawadzki) VII, Appenzeller and Szarzec I, Appenzeller and Szarzec II, Poznański, Prusak I, Prusak II, Prusak IV oraz Juszczak.

ACCURACY ASSESSMENT OF SELECTED FOREIGN DISCRIMINANT MODELS

The accuracy verification of the foreign models as the pertained to the analyzed industry was begun with judgment of applicability in the context of anticipating bankruptcy. The effectiveness of Altman's models (I, II, III), Springete's, Legault's, and van Fredrikslust's models are shown in Table 2.

Table 2 – Accuracy of Foreign Models in Forecasting Bankruptcy Risk for Companies in the International Transport Sector [%]

Model	SP ₁	SP ₂	SP ₀
Altman II	85.0	70.0	77.5
Altman III	60.0	100.0	80.0
Springete	70.0	25.0	47.5
Legault	35.0	100.0	67.5
van Fredrikslust I	100.0	0.0	50.0

Source: own research.

For companies involved in international commercial road transport, the highest accuracy was found in Altman's III model (80%), followed by Altman's II model (77.5%), and Legault's model (67.5%). It should be noted that these results deviate from Altman's indicated general accuracy in his own studies [1968, pp. 589-609; 1983, pp. 89-102]. If the model is to be judged as useful, its general accuracy should be greater than 80% [Korol, Prusak 2005, pp. 19-34]. Therefore, applying foreign models to international transport companies which have their headquarters in Poland should be undertaken with caution since the error risk is at least 20% - a relatively high level.

ACCURACY ASSESSMENT OF POLISH COMMERCIAL SECTOR DETERMINANT MODELS

To uncover company bankruptcy risk factors in the studied commercial branches, an examination of models developed in Poland was undertaken for accuracy. The results of that rating are presented in Table 3.

Table 3 – Accuracy of Polish Models in Forecasting Bankruptcy for International Road Transport Companies [%]

Model	SP ₁	SP ₂	SP ₀	Model	SP ₁	SP ₂	SP ₀	
Pogodzińska i Sojak	85.0	5.0	45.0	INE PAN I	100.0	10.0	55.0	
Gajdki i Stos I	50.0	50.0	50.0	INE PAN II	85.0	45.0	65.0	
Gajdki i Stos II	30.0	90.0	60.0	INE PAN III	85.0	45.0	65.0	
Hadasik I	95.0	60.0	77.5	INE PAN IV	90.0	50.0	70.0	
Hadasik II	80.0	70.0	75.0	INE PAN V	95.0	30.0	62.5	
Hadasik III	80.0	80.0	80.0	INE PAN VI	80.0	50.0	65.0	
Hadasik IV	65.0	100.0	82.5	INE PAN VII	70.0	85.0	77.5	
Wierzba	75.0	65.0	70.0	Appenzeller Szarzec I	and	80.0	50.0	65.0
Stępień and Strąk I	80.0	65.0	72.5	Appenzeller Szarzec II	and	80.0	45.0	62.5
Stępień and Strąk II	60.0	95.0	77.5	Poznański		80.0	85.0	82.5
Stępień and Strąk III	90.0	0.0	45.0	Prusak I		50.0	90.0	70.0
Stępień and Strąk IV	45.0	95.0	70.0	Prusak III		40.0	85.0	62.5
Hołda	100.0	0.0	50.0	Prusak IV		80.0	20.0	50.0
Juszczuk	60.0	80.0	70.0					

Source: own research.

In the case of international commercial road transport, the highest accuracy (82.5%) was seen in two models: Poznański and Hadasik IV.

In the case of twenty out twenty-seven Polish models examined with regard to forecasting potential bankruptcies and solid operations, significant variation was observed between the first and second orders tests, which in effect limit their use in predicting bankruptcy in the given commercial branch.

Noted should be that the Polish models, and foreign as well, gave varying results oscillating between 76.7% (Altman III), and 49.2% (Stępień and Strąk III). This indicates a significant potential for confusion and incorrect readings regarding potential bankruptcy or solvent operation occurring from availability of models and their various indications.

The construction of a highly accurate determinant model for the international commercial road transport companies with headquarters in Poland was undertaken as a result of the major inadequacy of most Polish and foreign models in assessing bankruptcy risk.

CONCLUSIONS AND RECOMMENDATIONS

In the case of the international commercial road transport sector, the best foreign model – in terms of overall performance – was the Altman III model with 80% accuracy, followed by the Altman II model with a performance rating of 77.5% for this sector. These results, in effective identification of bankrupt and solvent companies by the use of foreign discriminant models, indicate limited accuracy in their application under the structural and legal conditions in Poland.

During research regarding the effectiveness of contemporary models, it was observed that there are Polish discriminant models that are based on multiple tests (with regard to commercial entities), which can be utilized in assessing bankruptcy risk in the considered sector. The best Polish models for assessing bankruptcy risk in the commercial road transport sector were the Poznan (Hamrol and others) models and the Hadasik IV model which had a performance assessment of 82.5%. In the case of other models, their performance ran at lower percentages and therefore could not be considered for analyzing commercial entities in the studied sector.

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