ORIGINAL ARTICLE

Assessment applicability of selected models of multiple discriminant analyses to forecast financial situation of Polish wood sector enterprises

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Abstract

In the last three decades forecasting bankruptcy of enterprises has been an important and difficult problem, used as an impulse for many research projects (Ribeiro et al. 2012). At present many methods of bankruptcy prediction are available. In view of the specific character of economic activity in individual sectors, specialised methods adapted to a given branch of industry are being used increasingly often. For this reason an important scientific problem is related with the indication of an appropriate model or group of models to prepare forecasts for a given branch of industry. Thus research has been conducted to select an appropriate model of Multiple Discriminant Analysis (MDA), best adapted to forecasting changes in the wood industry. This study analyses 10 prediction models popular in Poland. Effectiveness of the model proposed by Jagiełło, developed for all industrial enterprises, may be labelled accidental. That model is not adapted to predict financial changes in wood sector companies in Poland.

The generally known Altman model showed the greatest effectiveness in the identification of enterprises at risk of bankruptcy. However, that model was burdened with one of the greatest errors in the classification of healthy enterprises as sick. The best effectiveness in the identification of enterprises not threatened with bankruptcy was found for forecasts prepared using the Prusak 2 model. However, forecasts based on those models were characterised by erroneous classification of sick companies as healthy. The model best fit to predict the financial situation of Polish wood sector companies was the Poznań model

$$Pz = 3.562 \cdot X_1 + 1.588 \cdot X_2 + 4.288 \cdot X_3 + 6.719 \cdot X_4) - 2.368$$

where:
X_1 – net income/total assets;
X_2 – (current assets – stock)/current liabilities;
X_3 – fixed capital/total assets
X_4 – income from sales/sales revenue).

INTRODUCTION

Globalisation and strong pressure imposed by market competition are trends observed in all branches of industry. This also pertains to the wood industry. Implementation of liberal market principles in Poland brought numerous positive economic and financial changes, accompanied at the same time by adverse phenomena, unfortunately also negative, resulting e.g. from overdue payment of receivables or impossibility of their recovery. Competitiveness of wood sector companies on the local, domestic or world markets to an increasing extent depends on the ability to supply customised ranges of products, individual products and services sufficiently efficiently and fast (Adamowicz et al. 2016). An additional element of good management is connected with access to reliable information. In economy we are observing increasing demand for information concerning bankruptcy in the wood sector. This presents an impulse for the scientific community to search for methods and mechanisms making it possible to monitor changes taking place on the timber market. This problem has gained in importance in relation with the recent economic crisis. Additionally, Brexit may have a negative effect on European markets.

Ribeiro et al. (2012) stated that in the last three decades prediction of enterprise bankruptcy has become an important and difficult task, thus becoming an impulse for many studies. This opinion has been shared by many other researchers e.g.: Abellán and Mantas (2014), Adamowicz and Noga (2014), Afik et al. (2016), Brezigar-Masten and Masten (2012), Chen et al. (2013), Delen et al. (2013), Ribeiro et al. (2012) and others.

Prediction of the financial situation of enterprises is crucial for managers, creditors and investors, since it makes it possible to make appropriate business decisions and reduce potential economic losses. Prediction of insolvency and rating predictions are essential in the world of finances. Inaccurate predictions may result in erroneous decisions and as a result lead to huge financial losses (Obermann & Waack, 2015). For this reason in practice systems forecasting the financial situation of enterprises are applied (Early Warning Systems – EWS). EWS is a system used to predict both the level of enterprise success and decline (Ozgulbas and Koyuncugil 2010). In practice there are many bankruptcy prediction models. Due to the specific character of

individual branches of industry not all EWSs may be successfully applied in practice. For this reason studies have been undertaken to indicate the most adequate EWS for Polish wood sector enterprises.

METHODS

Most models that are designed by financial institutions or by scholars to forecast corporate bankruptcy are usually built using a limited number of financial ratios that are measured once (Balcaen and Ooghe 2006). For this reason Multiple Discriminant Analysis (MDA) was the primary research method applied in this study. Failure models are usually designed using financial ratios calculated with data from balance sheets and income statements. The use of ratios is as much due to their predictive power as to their availability and standardization. They generally allow for good discrimination between failed and non-failed firms (Altman 1968), are easily available and are homogeneous, because they are calculated in the same way within a given regulatory framework (du Jardin 2016). In view of the above, forecasts based on discriminant models utilise prognostic properties of financial indexes. These indicators have been constructed based on reporting data from 142 Polish enterprises from the wood sector.

The research process was conducted using data coming from enterprises solely from the region, where timber has been the basis for the production process. Classification of enterprises is consistent with the Polish Classification of Economic Activity. Analyses were based on source materials from sections: 16 – Production of wood products; 17 – Production of paper and paper products, and 31 – Production of furniture.

Experimental material

The primary criterion in the collection of source data was connected with availability of financial information. The opinion of Gruszczynski (2005), that a key element in the prediction of bankruptcy is related to the selection of the research sample, was followed in this study. Prior to empirical studies source data were accumulated and catalogued in order to construct a comprehensive, reliable and cohesive database of financial information for individual wood sector companies. Wood companies, for which a motion for bankruptcy and/or

a motion for the initiation of debt conciliation were filed, the co-called failed businesses (FB), were identified and catalogued. Information was also gathered on enterprises with a stable financial situation, the so-called healthy firms (HF). Following the recommendation by Hołda (2001), only companies publishing their complete financial statements were selected for analyses.

Financial statements of those enterprises came from Regional Courts and credit information agencies. For all enterprises in the analytical sample data were collected, based on which their financial and economic standing could be established. The primary criterion identifying a given enterprise as bankrupt was connected with the submission of a bankruptcy motion to a respective regional Economic Department of the National Court Register. Wood sector companies in an advantageous economic and financial situation were identified based on general financial information contained in balance sheets as well as profit and loss accounts, focusing primarily on total debt, profitability and liquidity indexes.

Gathered source materials were comprehensive and selected in terms of the organisational structure, considering the volume of financial assets of analysed companies. The sample of non-bankrupt enterprises comprised only those companies, which did not go bankrupt throughout the entire period of analysis.

Enterprises, which financial data were used in this study, came from all regions of Poland and represented varied legal forms of economic activity. They included stock corporations, limited liability companies, registered partnerships and cooperatives publishing financial statements.

Collected data were analysed to verify whether they have a normal distribution. As a result, the analytical sample comprised a total of 90 companies, which declared their bankruptcy in the years 2006–2012, as well as 52 enterprises, which during that period continued their economic activity. Potential explanatory variables were financial indexes applied in prediction models presented in the further part of this study. After collection and verification of required financial data the reliability of prediction was assessed for the selected multiple-branch models.

Prediction models

The following models were selected for tests: Altman (A), Gajdka and Stos (GS), Hadasik (Ha), Hołda (H), Jagiełło (J), Mączyńska (M), Poznań (Pz), Prusak 1 (P1), Prusak 2 (P2) and Wierzba (W). Selection of these models was connected with their earlier application in Poland.

In order to verify EWS applicability in forecasting of bankruptcy prediction in the wood sector, forecasts were made based on the enterprise classification matrix. Analyses were conducted on EWSs popular in Poland:

$$A = 0.717 \cdot X_1 + 0.847 \cdot X_2 + 3.107 \cdot X_3 + \\ + 0.420 \cdot X_4 + 0.998 \cdot X_5$$

where:
X_1 – working capital/total assets;
X_2 – retained profit/total assets;
X_3 – EBIT/total assets;
X_4 – equity/total debt;
X_5 – sales revenue/total assets.

$$GS = 0.7732059 - 0.0856425 \cdot X_1 + \\ + 0.0007747 \cdot X_2 + 0.9220985 \cdot X_3 + \\ + 0.6535995 \cdot X_4 - 0.594687 \cdot X_5$$

where:
X_1 – sales revenue/total assets (mean annual value);
X_2 – current liabilities x 360/costs of goods sold;
X_3 – net profit/total assets (mean annual value);
X_4 – gross profit/net sales revenue;
X_5 – total liabilities/total assets.

$$Ha = 2.36261 + 0.3654259 \cdot X_1 - 0.765526 \cdot X_2 + \\ - 2.40435 \cdot X_3 + 1.59079 \cdot X_4 - 0.00230258 \cdot X_5 + \\ - 0.0127826 \cdot X_6$$

where:
X_1 – current assets/current liabilities;
X_2 – current assets – stock/current liabilities;
X_3 – total liabilities/total assets;
X_4 – (current assets – current liabilities)/total liabilities;
X_5 – receivables/sales revenue;
X_6 – stock/sales revenue.

$$H = 0.605 + (6.81 \cdot 10 - 1) \cdot X_1 + \\ - (1.96 \cdot 10 - 2) \cdot X_2 + (1.57 \cdot 10 - 1) \cdot X_3 + \\ + (9.69 \cdot 10 - 3) \cdot X_4 + (6.72 \cdot 10 - 4) \cdot X_5$$

where:
X_1 – operating assets/current liabilities;

X_2 – total liabilities x 100/total property;

X_3 – total revenue/mean annual total property;

X_4 – net profit (loss) x 100/average total property;

X_5 – average current liabilities x 360/costs of sold products, goods and materials.

$$J = -1.8603 + 12.296 \cdot X_1 + 0.1675 \cdot X_2 + 1.399 \cdot X_3$$

where:

X_1 – gross income from sales/costs of operating activity;

X_2 – total income/total assets;

X_3 – equity/total liabilities.

$$M = 1.5 \cdot X_1 + 0.08 \cdot X_2 + 10.0 \cdot X_3 + 5.0 \cdot X_4 + 0.3 \cdot X_5 + 0.1 \cdot X_6$$

where:

X_1 – (gross profit + depreciation)/total liabilities;

X_2 – balance sheet total/total liabilities;

X_3 – gross profit/balance sheet total;

X_4 – Gross profit/sales revenue;

X_5 – Stock/sales revenue – inventory turnover index;

X_6 – Sales revenue/balance sheet total – asset turnover index

$$Pz = 3.562 \cdot X_1 + 1.588 \cdot X_2 + 4.288 \cdot X_3 + 6.719 \cdot X_4 - 2.368$$

where:

X_1 – net income/total assets;

X_2 – (current assets – stock)/current liabilities;

X_3 – fixed capital/total assets

X_4 – income from sales/sales revenue

$$P1 = 6.524 \cdot X_1 + 0.148 \cdot X_2 + 0.406 \cdot X_3 + 2.176 \cdot X_4 - 1.568$$

where:

X_1 – operating profit/balance sheet total;

X_2 – operating cost/current liabilities;

X_3 – operating assets/current liabilities;

X_4 – operating profit/sales revenue

$$P2 = 1.438 \cdot X_1 + 0.188 \cdot X_2 + 5.023 \cdot X_3 - 1.871$$

where:

X_1 – (net income + depreciation)/total liabilities;

X_2 – operating cost/mean short-term liabilities;

X_3 – profit from sales/balance sheet total

$$W = 3.26 \cdot X_1 + 2.16 \cdot X_2 + 0.3 \cdot X_3 + 0.69 \cdot X_4$$

where:

X_1 – (profit from operating activity – depreciation)/total assets;

X_2 – (profit from operating activity – depreciation)/sales of products;

X_3 – operating assets/total liabilities;

X_4 – operating capital/total assets.

In literature on the subject we may find e.g. the GS model presented by Godlewska 2010.

Selection of companies

Using the above-mentioned MDAs forecasts were prepared, which were next verified with the actual economic situation. Analyses were performed based on financial data for the population of healthy firms, i.e. HF, and failed businesses (FB). Forecasts were based on the collected retrospective data from the period of 1-, 2- and 3-year periods preceding the year of forecast, which was at the same time the year of its verification. The use of data from FB and HF in the analyses was connected with the search for a method facilitating an effective prediction of bankruptcy of enterprises under typical economic conditions, in which successful companies operate next to companies going bankrupt.

After forecasts had been made, they were verified with the actual financial situation of the analysed enterprises. Forecast of bankruptcy was conducted separately for 1 year before, for 2 years before and for 3 years before bankruptcy of that firm.

It needs to be stressed that some multi-branch models assume an interval of the explained variable, within which we may not definitely verify the financial situation of a firm (the so-called grey zone). For the needs of this study this area was eliminated by dividing the interval of values corresponding to the grey zone into halves. In the interpretation of the obtained empirical values using the multi-branch models assuming the existence of a grey zone, i.e. A, H, P1, P2 and M, it was assumed that values found in the lower half of the grey zone interval correspond to enterprises at risk of bankruptcy, while values from the upper half – healthy companies. In the other models boundary values were retained in the original form. This approach made possible a direct comparison of individual models.

General economic efficiency indexes as well as type I and type II errors were used in order to assess applicability of individual forecasts prepared using the analysed models in the assessment of wood sector enterprises.

Enterprise Classification Matrix

In order to determine which model to a greater degree identifies the risk of bankruptcy for wood sector firms, a test verifying the accuracy of the assessments was performed, i.e. Enterprise Classification Matrix (ECM). ECM is a tool, using which the accuracy of indications of an estimated model is assessed (Card 1982). Using ECM the effectiveness of appropriate classification of enterprises to one of the two groups (healthy vs. failing companies) was evaluated.

Following the recommendations of Prusak (2004), measurement results were interpreted using type I (EI) and type II errors (EII) as well as general efficiency index (SP).

Type I error, which defines what percentage of bankrupt companies was erroneously classified as healthy companies, was calculated using the following formula: $EI = NP1/(P1 + NP1) \times 100\%$, where: $P1$ – forecasted number of bankrupt companies correctly classified to the population of failed businesses; $NP1$ – forecasted number of non-bankrupt companies erroneously classified to the population of failed businesses.

Type II error, based on which it was determined what percentage of enterprises with a stable financial situation was erroneously classified as bankrupt companies, was calculated according to the following formula:

$$EII = NP2/(P2 + NP2) \cdot 100\%$$

where:

$P2$ – forecasted number of non-bankrupt firms correctly classified to the population of non-bankrupt firms;
$NP2$ – forecasted number of bankrupt companies erroneously classified to the population of non-bankrupt firms.

The general efficiency index, using which the relative size of correctly classified enterprises was established, was calculated using the formula:

$$SP = (P1 + P2)/(P1 + NP1 + P2 + NP2) \cdot 100\%.$$

Symbols were applied as in the previous formulas.

Low values of EI and EII and high SP values indicate considerable applicability of a given model in forecasting the economic situation of a company.

Results

In accordance with the assumed objectives of the study and the developed methodology it was attempted to assess the effectiveness of prediction based on the selected multi-branch models. First of all it was confirmed in this study that data obtained in the prediction analyses had Gaussian distributions. Next, in order to verify the applicability of multi-branch models to assess the financial situation of Polish wood sector enterprises changes in the financial situation of those firms were forecasted using selected theoretical methods. In accordance with the adopted methodology, effectiveness of forecasts provided by individual models was assessed using general efficiency indexes and prognostic type I and II errors were determined. Forecasts were verified with the actual economic situation of this group of enterprises, which in reality went bankrupt and those, which continued their operations. In each test group we used data from 15 HF and 15 FB. Forecasts were prepared based on the accumulated data from 1-year, 2- and 3-year periods preceding the year of forecast, which was also the year of their verification.

Based on the analyses concerning the effectiveness of classification of wood sector enterprises to the categories of companies at risk and those at no risk of bankruptcy it was found that mean SP of forecasts obtained from all the methods was 74%, while for 1-year forecasts it was 77%, 2-year forecasts it was 70% and for 3-year forecasts – 75%, respectively. Averaged EI was 33%, while for 1-year forecasts it was 23%, 2-year forecasts it was 42% and for 3-year forecasts it was 33%. Averaged EII was 19%, with that for 1-year forecasts amounting to 22%, for 2-year forecasts 42% and for 3-year forecasts – 33%, respectively. The highest general efficiency was found for the prediction obtained using the Pz model. It needs to be stressed that averaged (1-, 2- and 3-year forecasted) SP in that model amounted to 82% and errors EI to 20% and EII to 15%. In this model SP was greater than mean values, while errors were smaller. At the same time it was the only model,

which averaged SP exceeded 80%. The lowest averaged SP was obtained for forecasts prepared using the J model J (54%). When applying that model EI (29%) was lower than the averaged value, but EII reached the record value of 62%.

In view of 1-, 2- and 3-year forecasts it was found that in all the cases the highest SP was obtained at the application of the Pz model, while it was lowest for the J model. SP for the Pz model was 86% for 1-year forecasts, while EI was 6% and EII – 20%, for 2-year forecasts SP was 76%, EI – 33% and EII – 13%, for 3-year forecasts SP was 83%, EI – 20% and EII – 13%, respectively. For comparison, in the model considered the worst, i.e. the J model, these values were as follows: 1-year forecasts SP – 56%, EI – 33%, EII – 53%, 2-year forecasts SP – 53%, EI – 33%, EII – 60% and 3-year forecasts SP – 53%, EI – 20% and EII – 73% (tab. 1). It needs to be stated that the forecast prepared using that model was comparable to random classification.

DISCUSSION

Discussions and assessment of effectiveness of prognostic models focused on the identification of risk of bankruptcy have been conducted by researchers for a long time. Relationships and research trends in the prediction of business failure were discussed in detail e.g. by Dimitras et al. (1996). While since the 1980s the use of MDA has decreased it still remains a generally accepted standard method and it is frequently used as a baseline method for comparative studies (Altman and Narayanan 1997). MDA has been replaced by less demanding statistical techniques such as logit analysis, probit analysis and linear probability modelling (Balcaen and Ooghe 2006). Nevertheless, MDA may be used to predict bankruptcy of enterprises.

There is a need to adapt prognostic models to current domestic conditions, dependent on political and economic changes as well as the modified concept of enterprise management (Juszczyk and Balina 2014). Stawicki and Sojak (2001) as well as Juszczyk and Balina (2014) stressed the need to conduct studies for specific branches of the economy. Variation and dynamics of economic processes and their multifaceted character are so high that it is difficult to consider all

significant factors affecting operations of individual economic entities within one model. This proposal may be met by construction of new models or indication of an appropriate model from among those already existing.

Economic forecasting makes it possible to predict the course of trends for free-market economy. However, we need to remember of the selection of an appropriate prediction method. It is crucial that even at the application of adequate methodology economic forecasts may not be treated as the only indicator when making economic decisions (Kocel 2010). However, it does not mean that scientific forecasts of market changes e.g. connected with the number of prospective customers fulfilling their liabilities, is not an important issue in the management process in all sectors, including the wood sector. Prediction of bankruptcy for industrial enterprises in the wood sector is fundamental in view of the multifaceted risk of financial insolvency in free-market economy. It may be an important element supporting the decision making process.

Obviously making decisions in all enterprises is closely connected with the adopted strategy within the framework of the profile of company operations. Adequately effective models (in terms of the accuracy of forecasted market changes) support the decision making process, which makes it possible to reduce the risk of loss of receivables, resulting from the previously executed commercial transactions. We need to agree with the opinion by Kocel (2010) that forecasts should be as accurate as it is possible, particularly in view of the potential financial losses incurred in the case of erroneous forecasts, thus it is advisable to conduct studies indicating appropriate methods to predict bankruptcy in wood sector companies. An additional argument suggesting an urgent need to undertake studies aiming at the identification of an appropriate prediction method for the financial situation of enterprises was connected with an increasing impact of bankruptcy of wood sector companies. This problem affected both manufacturing and commercial enterprises.

Despite the currently stable financial situation in Polish forestry, companies are going bankrupt in the associated wood sector. It seems that deficit of timber assortments in the market of round wood is one of the causes for such a situation. When analysing problems with access to the Polish raw material base it needs to

be stressed that demand on the timber market is a consequence of demand for timber-derived products and it depends on the buying power of households as well as related sectors, e.g. construction industry. Additionally, the current situation in the wood sector is influenced, similarly as the entire economy, by the conditions for operating on the common European market. It pertains first of all to the open market of goods and services as well the labour market, transfer of subsidies, influx of foreign capital in direct foreign investments. They coincide with globalisation processes and business trends in world economy, particularly crisis in financial markets and collapse of major economies both in Europe and worldwide at the end of 2008 and in 2009, followed by the decline and unstable political and economic situation in Greece and Italy in 2011, as well as the current consequences of Brexit.

Analyses of literature on the subject of bankruptcy of firms in the wood sector provide grounds for a thesis on the necessity to search for economic instruments supporting the decision making process in the performance of marketing objectives. One of such instruments is provided by models predicting bankruptcy of enterprises. Their practical importance is considerable due to the potential adoption of appropriate prevention measures based on these forecasts. It needs to be remembered that preventive actions make it possible to avoid negative financial consequences connected with the erroneous selection of contractors. Obviously indication of an appropriate prediction model based on sector predictors is of importance both for science and commercial practice. A sector-based bankruptcy prediction model should be applied both in the decision-making system of forest administration supplying timber for industry and in enterprises converting timber. This model may be particularly important for listed companies. Economic forecast is a basic tool in the assessment of the future financial standing of an enterprise, which affects quotations of a given company. Discriminant models may be a source of information for market contractors concerning the future financial situation and potential bankruptcy of enterprises. Accurate economic inferences based on results of prediction analyses may be made only thanks to selecting an appropriate prediction model for a given sector.

In order to satisfy the formulated thesis on the necessity to construct a prognostic sector-based model and estimate theoretical models, studies were undertaken to identify this problem in the wood sector. When conducting the research process presented in this study the currently existing prediction models for company bankruptcy were also considered.

A significant element affecting reliability of forecasts prepared using early warning models is their static nature. This problem was indicated e.g. by Grice and Dugan (2001) and Balcaen and Ooghe (2006). They stated that static values used in calculation of specified financial indexes investigated in a given period do not consider a dynamic approach to company bankruptcy. This problem has become increasingly important especially recently. For this reason in this study in order to include the dynamics of changes taking place in the timber market in terms of enterprise bankruptcies, we adopted the principle of performing analyses in a step-wise system and the prepared forecasts (1-, 2- and 3-year) were compared with actual market events occurring in the successive years. Thanks to such an approach we could consider the dynamics of occurring economic changes in our investigations.

The next element taken into consideration in this study was the period of analysis. Based on a review of literature it was found that a frequent objection to models forecasting enterprise bankruptcy is their becoming obsolete as well as an insufficient period of analysis, thus producing an inadequately small number of data. This has prevented a reliable interpretation of the situation of enterprises or bankruptcy forecasting. As it was indicated by Matuszyk (2003) and Agarwal and Taffler (2007), testing of efficiency of a prognostic model should cover a period from four to six years. Taking into consideration the above observations this study was based on financial data from the period of 2006–2012.

Within this study we identified wood sector companies threatened with bankruptcy. It was established that the effectiveness of forecasts obtained from individual models varied. Averaged general efficiency of these forecasts ranged from 54% (the J model) to 82% (the Pz model). Taking into consideration the classification of companies to the populations of healthy and failed enterprises it was stated that the Pz model was best adapted to the Polish wood sector. Forecasts provided by this model were characterised by the highest SP. However, other models had lower errors EI (model A) or EII (models P2, GS, H and P1) (tab.1.) Forecasts prepared using

model A classified the lowest number of FB to the class of healthy companies, but as many as 35% HF were incorrectly classified as FB. A worse result was obtained only using the J model.

As it was mentioned earlier, a lower error of classification of HF to FB was observed for forecasts prepared using the P2, GS, H and P1 models. A particularly low EII was recorded in models P2, GS and H. In two former models, i.e. GS and H, in 2- and 3-year forecasts no enterprise with a stable financial situation was incorrectly classified. Unfortunately, FB were also classified to the HF group (a high EI). On average in the P2 model 55% and in both the GS and the H model 40% firms which went bankrupt were classified in the forecasts as companies with a good financial standing. This means that although these models did not identify HF as FB, they identified FB as HF. Forecasts prepared using this model classified a vast majority of firms as not threatened with bankruptcy even if it was not the case. For this reason the authors of this study are of an opinion that these models need to be rejected in forecasting financial changes in wood sector enterprises.

It needs to be stressed that the greatest stability of obtained forecast results based on 1-, 2- and 3-year data was obtained when applying the P2 model. Prediction using this model in each of the three analysed periods of source data collection (1-, 2- and 3-year) was characterised by a uniform SP amounting to 70%. However, apart from the J model, this result was one of the worst. For this reason, despite stability of this model, in the opinion of the authors it should not be applied in the wood sector.

It needs to be stressed that the J model was constructed for the needs of small and medium-sized enterprises in the industrial sector. Thus it would seem that this model should be best adapted to the evaluation of wood sector companies. In reality the accuracy of a forecast prepared using this model was very low.

Testing of prediction models under Polish economic conditions was the first attempt at the search for adequate forecasting methods for financial changes in the wood sector. The authors hope that in view of the specific character of the sector and the specific nature of economic changes taking place in individual countries, applicability of individual models will be verified by researchers from other countries.

CONCLUSIONS

1. When assessing effectiveness of estimated theoretical prognostic models the highest SP values in the identification of bankruptcy threat were observed for forecasts in the Pz model.
2. Effectiveness of the J model, which was developed for the total population of commercial enterprises, needs to be considered accidental. This model is not suited for the prediction of financial changes in wood sector companies in Poland.
3. The lowest EI level, and thus the lowest effectiveness in the identification of enterprises at risk of bankruptcy were found for forecasts prepared using the A model. However, this model had one of the greatest errors of classification of HF as FB.
4. The lowest EII and thus the lowest effectiveness in the identification of enterprises not threatened by bankruptcy were found in relation to forecasts prepared using models P2, GS and H. However, forecasts made using those models exhibited the highest EI, i.e. erroneous classification of a FB as a HF.
5. The Pz model was best adapted to predict the financial situation of Polish wood sector companies.

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