Business, Management and Education
ISSN 2029-7491 / eISSN 2029-6169
2018 Volume 16 Issue 1: 13–26
https://doi.org/10.3846/bme.2018.2482

# EVALUATION OF ENTERPRISE SURVIVAL: CASE OF LATVIAN ENTERPRISES

Natalia SCACUN[1], Irina VORONOVA[2, *]

[1, 2]*Department of Innovation and Business Management, Riga Technical University, Kalnciema street 6, Riga, Latvia*

Received 10 June 2018; accepted 11 June 2018

**Abstract.** Authors study the nature of insolvency both from the legal point of view and scientist position as well as updating tendencies of an insolvency of enterprises in recent years. The subject of the study has been selected company's survival potential that is analyzed with financial ratio analysis using bankruptcy prediction models. Considering research results, authors identify models that are applicable to a particular industry. Authors put primary metal industry (*NACE 24*) for the study. The aim of the paper is to investigate the survival potential of enterprises by testing existing parametric models of insolvency forecasting and assessing their potential for use in the economic conditions of Latvia. During the investigation has been reviewed the concept of the financially healthy company and its relation with the main success development factors.

**Keywords:** non-financial company distress, solvency forecasting models, parametric models, Latvian enterprises, metal industry, model validation.

**JEL Classification:** C5, C520.

## Introduction

The value of knowledge is the ability to apply it practically by predicting the situation and determining preventive actions. This paper is concentrated on scientist corporate bankruptcy prediction models to determine non-financial organization probability of bankruptcy. Company's financial stability prediction has always been a popular topic among scientists and researchers. Subject matter investigation became especially trendy when facing 2007–2009 financial crisis (Amini, Cont, & Minca, 2016). Authors believe that in the conditions of economic instability caused by political and crisis processes, each entity must evaluate its own risks. The inability of companies to conduct qualitative financial risk assessment meeting timely requirements and developing strategic goals could lead a company from insolvency process till legally recognized bankruptcy. Moreover, corporate financial distress could lead to domino effect affecting both stake–/ shareholders. The timely management of symptoms

*Corresponding author. E-mail: *irina.voronova@rtu.lv*

can help to avoid high costs (Keasey, Pindado, & Rodrigues, 2015). To prevent unfavourable internal and external costs, there is a necessity of implementing tools that could provide an accurate and timely manner reliable answers. The principle "the survival of the fittest" finds then its reflection in practice (Boratynska, 2016). Therefore, forceful financial failure prediction is crucial for entities to make the relevant decision.

Input variables, for instance, financial ratios and prediction techniques such as statistical and machine learning techniques affect the prediction performance. Financial ratios are identified as one of the most important factors that affect accuracy when developing bankruptcy prediction model (Liang, Lu, Tsai, & Shih, 2016). In this paper, authors want to focus on insolvency forecasting models from different authors based on financial ratios. This could be an effective tool for predicting organization insolvency because many researchers have tried to find out combinations of financial indicators that could be useful for predicting insolvency risk. Insolvency risk accurate assessment is prerequisite of future gain to an entity, therefore active risk management should be implemented (Buston, 2016).

The rest of this paper is organized as follows. Section 1 gives an overview of scientists and researchers definitions, shows dynamics tendencies using statistical data. Section 2 and 3 present research methodology and empirical results accordingly. Finally, the last Section gives a summary of the research and propose the implementation of models as well as gives recommendations how to improve research accuracy for the further researches.

## 1. Enterprise survival essence

### 1.1. Definition of enterprise solvency

The concept of solvency issues in Latvia appeared relatively recently, while the foreign practice has a long history. Bankruptcy concern has been studied by researchers from America, for example, A. E. Altman, L. A. Bernstein, J. J. Wild; from Great Britain – R. Taffler, H. Tisshaw; from Canada – D. A. Botheraas, J. G. Fulmer, G. L. V. Springate, from France – M. Golder, J. Konan; from Lithuania – J. Mackevichius and many others (Shneidere, 2009).

Various definitions of "insolvency" and "bankruptcy" are proposed by authors. A. E. Altman (1993) describes that "bankruptcy" may reflect a situation when company's net worth is negative or when a company has officially declared insolvency proceeding (Altman & Hotchkiss, 2006). R. Shneidere (2009) has defined that solvency refers to when a company is able to provide sufficient financial performance in order to cover all liabilities. The concept of insolvency is used to describe the counterpart of company's solvency (Shneidere, 2009). G. Savickaya defines that financially stable company is an entity that is able to face debt obligations and finance company's operations from operating funds and avoid financial crises (Savickaya, 2006). From the legal point of view, relying on Latvia Insolvency Law "The legal person's insolvency process is a set of legal measures, in which the claims of creditors are paid from debtor's property in order to facilitate the fulfilment of the debtor's obligations (1). The legal person's insolvency proceeding is commenced from the day when declared the insolvency proceeding and takes place until the day when the court takes a decision on the termination of insolvency proceeding (2)" (Maksātnespējas likums, n.d.). Authors could

conclude that scientist's definitions give priority to inability to cover their obligations while Law emphasizes the legal subject of the entity.

### 1.2. Insolvency signs detection

In today's economic environment company faces severe market competition. As a result, many companies are becoming more sensitive to environmental changes. To remain competitiveness, organizations need to increase the efficiency of their business, therefore financial resources needed to maintain competitiveness and retain solvency. American energy enterprise ENRON that six consecutive years were acknowledged as an American most innovative company by Fortune opinion became bankrupt on December 21st, 2001 has confirmed the fact that even multinational companies must keep track of their financial situation and analyze financial stability (Ventura, 2008).

Understanding economic conditions, identifying insolvency factors could be an effective analytical tool that will help to manage company's crisis when generating forecasts and decision making. There is need to evaluate organization stability considering quantitative models that refer on financial data and includes a variation of coefficients as well as qualitative models, for instance, Delphi method, brainstorm, SWOT matrix, McKinsey and other (Baykina, 2010).

In this work, authors will review quantitative models as they are based on publicly available information, namely, annual reports that could be used to calculate financial indicators. Even though today's accounting system is governed by generally accepted international norms and rules developed based on accounting theory and practice, the financial quality of the reports is questionable (Januška, 2004).

Economical and scientific researches suggest that using financial ratios in different combinations can predict the company's insolvency. Currently, there are many insolvency forecasting models that are already in use, but some are still in the development phase. The diversity of models could be explained by the fact that the specifics of the industry and the economic environment in which the company operates is unstable, therefore, it is necessary to seek out the most precise models and to study their application (Nelson, 1981). Currently, the insolvency models of E. Altman and V. Beaver are widely used by foreign companies, who have proved themselves in practice (Tereshchenko, 2000). However, authors want to study and pilot 20 insolvency models that could be useful in Latvian economic conditions.

Laakso (2010) has created "healthy firm triangle" including three factors that are generally defined as insolvency factors: profitability, solvency and liquidity. Laakso believes that profitability is a precondition for all successful companies continuing with the fact that profitability has a positive effect on liquidity because it is wise to show sufficient cash flow to reduce the need for short-term liabilities thereby reducing insolvency risk (Laakso, Laitinen, & Vento, 2010). Petersen and Plenborg (2012) point out that without liquidity, the entity cannot meet short – term liabilities because liquidity risk affects the company's ability to generate positive net cash in short– /long–term. The risk of insolvency relates to the company's ability to fulfil its financial obligations (Petersen & Plenborg, 2012).

### 1.3. Business demography character

The environmental characteristics are essential in order to carry out a qualitative analysis of the company's insolvency, therefore necessary to understand what external factors affect the company's operations and how their changes can affect the company's economic activity. The country is interested in positive business climate as the number of registered companies will increase, tax payments will be higher in the state budget as well as increase market motivation mechanism – a competition that will contribute to economic growth rates.

Figure 1 shows that there is a decline in the dynamics of registered companies. Moreover, in mid – 2017 number of dead companies exceeded active that indicates unfavourable business demography conditions.

One of the most important indicators that characterize the country's economic development and economic growth rates is a gross domestic product (GDP). One component of GDP is exports that increase the competitiveness of the country. Figure 2 shows metal industry (NACE 24) export and import dynamics.

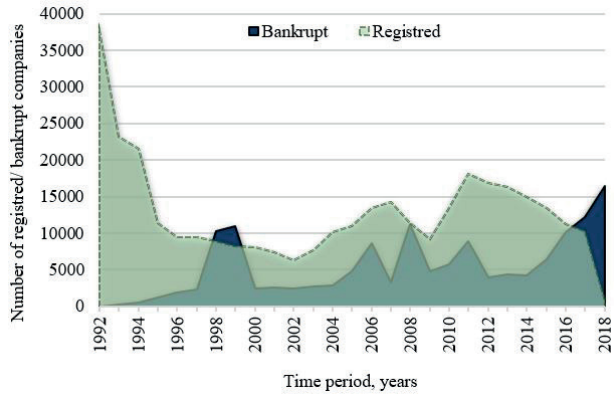


Figure 1. Dynamics of Latvian registered bankrupt companies in 1992–2018 years

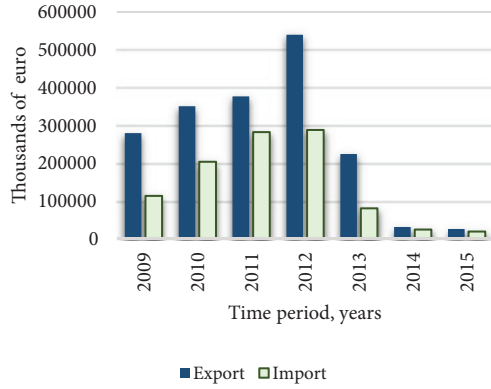


Figure 2. Metal export and import dynamics (NACE 24)

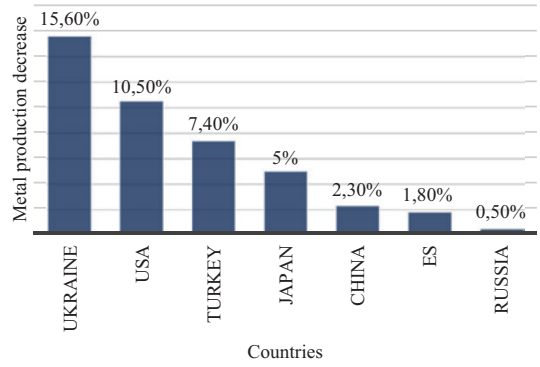


Figure 3. Metal production decline in 2015

Currently could be seen metal market stagnation. This could be explained due to the fact that Liepaja's Metalurgs – one of the largest metal producers in Latvia, encountered financial problems and metal production has been interrupted that affected export and import by a sharp decrease. Authors could also assume that export and import slowdown relates to World Metallurgical Crisis. Many researchers attribute the crisis to the fact that the metal is no longer needed in its pure form, as new alloys appear which are in high demand on the market. According to World Steel Association (WSA) statistical data, in 2015 there has been a sharp decline in metal production since 2009. The main factors mentioned by WSA is metal overproduction and protectionist policy (World Steel Association, 2015).

From Figure 3 could be seen that most rapid collapse of production was in Ukraine, USA, Turkey, Japan, China, the European Union and Russia by 15.60%; 10.50%; 7.40%; 5%; 2.30%, 1.80% and 0.50% reduction of metal production volume respectively.

## 2. Evaluation of enterprise survival

### 2.1. Insolvency forecasting approach

There is a huge amount of bankruptcy prediction methods. The subject of the study has been selected company's insolvency forecasting models. Plenty of models have been created, however, relatively small number of existing models suits market and economic conditions of the Latvia Republic. According to the Figure 1, the number of death companies has increased dramatically. Authors could mention several reasons for such situation. Firstly, current market conditions significantly differ from preceding, secondly, the business environment is highly turbulent, thirdly, small and medium enterprise (SME) quantitative domination and inappropriate Insolvency Law in Latvia to prevent Insolvency Proceedings for SME, consequently, insolvency detection on the 1st organization symptoms.

Bankruptcy models could be generally categorized as 2 major groups: parametric and non –parametric. Parametric models depend on rational criteria, consequently, known parameters to make decisions, whereas non – parametric techniques assume a model with

unknown parameters – distribution free (Gepp, Kumar, & Bhattacharya, 2010). Non – parametric techniques have been favourably applied in recent studies, therefore authors assume, that models have a potential for development. As per all analyzed insolvency forecasting models, they are parametric and could be classified four groups: multiplicative discriminant analysis (MDA); logarithmic regression; valuation approach, rating (I. Mavlutova, Zalitis, A. Mavlutova, B. Mavlutov, & 2014). Authors suggest for research models compiled in Table 1 that were obtained using author's original papers as well as taken from researchers practical assessment of theoretical and empirical studies of insolvency forecasting models.

Table 1. Insolvency forecasting models taken for analysis (Altman and Hotchkiss (2006); Arasu, Balaji, Kumar, and Thamizhselvi (2014); Shneidere (2009); Kanapickiene & Marcinkevicius (2014); Berzkalne & Zelgalve (2013); Ginoglou, Agorastos, & Hatzigagios (2002); Singh & Mishra (2016); Pitrova (2001); Gruszczynski (2015); Joo-Ha & Taehong (2000); Shneidere (2009); Singh & Mishra (2016); Savickaya (2006), Tereshchenko (2000); Alferov & Khudyakova (2017))

| Model group | Model |
|---|---|
| MDA | E. Altman Z" (1993);<br>E. Altman Z (1968);<br>E. Altman's Z' (1983);<br>G. Springeits (1978);<br>R. Shorin, I. Voronova (1998);<br>R. Taffler, H. Tisshaw (1977);<br>Lis (1972);<br>E. Altman (1968);<br>Fulmer (1984);<br>Konan, Golder (1979). |
| Logarithmic regression | Ginoglou, Agorastos (2002);<br>Lin, Piesse (2004);<br>Altman, Sabato (2007);<br>Chesser (1974);<br>Gruszczynski (2003);<br>Joo-Ha, Taehong (2000);<br>Voronova, Genriha (2009);<br>Begley, Ming, Watts (1996);<br>D. Ohlson (1980). |
| Valuation approach | M. Zmijewski (1984);<br>G. Savickaya (2007);<br>Irkutsk scientists (1998);<br>Durand (1941). |
| Rating | Saifulin, Kadikova (1996) |

## 2.2. Methodology of the research

Financial data is input information; therefore, it should be reliable. For this purpose, authors have used Lursoft database, research was held by authors in May 2016. 21 companies were selected for primary research: 12 companies are active (solvent) and 9 companies have been liquidated (bankrupt). All companies were selected from one industry – manifesting of

metals and metal products – NACE 24 classification. When extracting input date for 5 last years, 4 companies annual reports were considered as invaluable for research because many accounting items lines were absent that could cause errors approbating models.

Consequently, the research calculation part is based on the financial statements of 17 companies over a period of last 5 years, of which 7 companies are bankrupt, and 10 are solvent. The approbation of the model includes the principle of recognition of bankrupt/ solvent organization. Authors have analyzed models from the aspect – which model could faster alert the company, namely, 5; 4; 3; 2 and 1 years before bankruptcy. The methodology for determining the accuracy of models is as follows: firstly, it is necessary to select the correct sum of the estimates, that is, how much they recognize or do not recognize bankrupt or solvent. Bankrupt and solvent number of companies will be in the column total forecasts. Secondly, the precision of models is determined by dividing the amount of the assessment with the number of existing bankrupt/ solvent companies (total forecasts). Thirdly, the number of unrecognized companies is entered in the column with the wrong sum of classification, and its value is divided by the number of existing bankrupt/ solvent companies when mathematical calculating an error. Based on the accuracy and error values, the top 3 models for multiplicative discriminant analysis, logarithmic regression, valuation approach and rating models selected 5; 4; 3; 2 and 1 year before bankruptcy. When forecasting probabilities were calculated, authors have done a comparative analysis of models to detect 3 models for determining the company's bankruptcy. Consequently, active enterprises could in a timely manner make prudent decisions to maintain the company's solvency.

Continuously changing environment is precondition of necessity to determine valuable insolvency prediction model to protect and support business decision making. Therefore, authors put forward hypothesis – it is useful to use at least three insolvency models from different classes, predicting the company's potential bankruptcy in the economic environment of Latvia.

## 3. Results

### 3.1. Financial ratio correlation

In analyzed insolvency forecasting models the most frequent ratio used is liquidity ratio working capital / total assets. This ratio shows whether an organization has enough active value to finance its liabilities (Swedbank, 2016). The 2$^{nd}$ most repeated ratio is efficiency ratio Asset Turnover Ratio (ATR) – net turnover/ total assets. The analysis of net turnover dynamics is important for the organization as its reduction may indicate a decrease in demand that could be caused by inadequate business processes that should be improved. ATR measures revenues generated to the value of assets (Saksonova, 2006).

According to Table 2 authors could conclude that financial coefficient correlation corresponds to the Laakso "healthy firm triangle" (Laakso et al., 2010) as insolvency models mostly include profitability, liquidity and solvency ratios.

Table 2. Correlation of financial ratios in insolvency forecasting models (source: own research)

| Financial ratio | Count |
|---|---|
| Working Capital / Total Assets | 11 |
| Net Turnover / Total Assets | 10 |
| Gross profit or loss / Total Assets | 7 |
| Retained earnings / Total Assets | 6 |
| Net profit or loss / Total Assets | 6 |
| Account Payable / Total Assets | 6 |
| Own capital / Account Payable | 5 |
| Profit or loss before tax and interest payments / Total Assets | 3 |
| Current assets / Current liabilities | 3 |

### 3.2. Test of insolvency forecasting models

Relying on the Table 3 results, the author could conclude that model of E. Altman Z" (1993) better forecasts insolvency 1, 2, 3 years before bankruptcy, the accuracy is 77.78%, 64.71% and 70.59% respectively. 4 years before bankruptcy with accuracy 70.59 % is generated by two models G. Springate (1978), R. Taffler, H. Tisshaw (1977). 5 years before bankruptcy, R. Taffler, H. Tisshaw (1977) creates the same precision, namely, predicting bankruptcy 4 years before with accuracy of 70.59%.

The worst prediction dynamics of 1, 2, 3 and 4 years before the bankruptcy is generated by Konan, Golder (1979) model with an accuracy of 22.22%, 47.06%, 29.41% and 41.18% respectively. 5 years before bankruptcy has changed the trend, and this model is 5$^{th}$ out of 10 MDA models. The worst forecast 5 years before the bankruptcy is Lis (1972). Even though the model among the British is considered to be precise and practical, this is not applicable in predicting the probability of insolvency for metal producing companies.

Table 3. Percentage accuracy of bankruptcy based on MDA models (source: own research)

| Model | Years before bankruptcy | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| E. Altman (1968) | 56 | 59 | 59 | 59 | 59 |
| E. Altman Z (1968) | 72 | 59 | 71 | 47 | 41 |
| E. Altman Z' (1983) | 72 | 59 | 71 | 47 | 47 |
| E. Altman Z" (1993) | 78 | 65 | 71 | 59 | 35 |
| Fulmer (1984) | 56 | 59 | 53 | 47 | 41 |
| G. Springate (1978) | 72 | 65 | 71 | 71 | 65 |
| Konan, Golder (1979) | 22 | 47 | 29 | 41 | 53 |
| Lis (1972) | 61 | 53 | 65 | 47 | 29 |
| R. Shorin, I. Voronova (1998) | 67 | 65 | 71 | 59 | 41 |
| R. Taffler, H. Tisshaw (1977) | 63 | 63 | 69 | 71 | 71 |

Analyzing results of logarithmic regression models (see Table 4), could be concluded that Ginglou, Agorastos (2002) model is applicable in determining probability 1, 3 years before bankruptcy, their accuracy is 88.89% and 88.24% respectively. Lin, Piesse (2004) model is effective in predicting the unfavourable financial situation 2 years before bankruptcy, its accuracy is 76.47%, 4 and 5 years before bankruptcy – Altman, Sabato (2007), the accuracy is 70.59% and 64.71% respectively.

Table 4. Percentage accuracy of bankruptcy based on logarithmic regression models (source: own research)

| Model | Years before bankruptcy | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Altman, Sabato (2007) | 72 | 53 | 65 | 71 | 65 |
| Begley, Ming, Watts (1996) | 33 | 41 | 41 | 35 | 41 |
| Chesser (1974) | 67 | 53 | 59 | 47 | 47 |
| D. Ohlson (1980) | 17 | 29 | 35 | 41 | 41 |
| Ginoglou, Agorastos (2002) | 89 | 71 | 88 | 65 | 53 |
| Gruszczynski (2003) | 61 | 53 | 59 | 47 | 41 |
| Joo-Ha, Taehong (2000) | 50 | 47 | 35 | 35 | 24 |
| Lin, Piesse (2004) | 83 | 76 | 71 | 47 | 47 |
| Genriha et al. (2009) | 44 | 47 | 41 | 47 | 47 |

The worst results for 1, 2, 3 years before bankruptcy are due to the D. Ohlson (1980) model, their error is 83.33%, 70.59% and 64.71% respectively; 4, 5 years before bankruptcy best result generate Joo–Ha, Taehong (2000) model.

From the Table 5, the author noticed that 1, 2 and 3 years before the bankruptcy assessment approach and rating models did not show an error higher than 50%. This may be caused due to the fact that existing models are quite precise. Predicting the situation 1, 2 and 3 years before bankruptcy, the highest accuracy of 83.33%, 70.59% and 76.47% respectively show the model of M. Zmijewski (1984). The model of G. Savickaya (2007) gives the highest accuracy 4 and 5 years before bankruptcy – 64,71%, 70.59% respectively. Durand model has worst result 1, 2, 3, 4 and 5 years before bankruptcy.

Table 5. Percentage accuracy of bankruptcy based on assessment approach and rating models (source: own research)

| Model | Years before bankruptcy | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| G. Savickaya (2007) | 72 | 71 | 65 | 65 | 71 |
| Irkutsk scientists (1998) | 67 | 59 | 71 | 59 | 59 |
| M. Zmijewski (1984) | 83 | 71 | 76 | 59 | 53 |
| Saifulin, Kadikova (1996) | 72 | 71 | 71 | 53 | 53 |
| Durand (1941) | 67 | 53 | 59 | 41 | 35 |

Analyzing forecasting models results, they provide different accuracy level, therefore, authors conclude that any company evaluating its financial situation, should take at least 3 models from different model classes.

Table 6. Highest percentage accuracy of bankruptcy prediction models (source: own research)

| Model | Years before bankruptcy | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| E. Altman Z (1968) | | | 70,59 | | |
| E. Altman Z' (1983) | | | 70,59 | | |
| E. Altman Z" (1993) | 77,78 | 64,71 | 70,59 | | |
| G. Springate (1978) | | | 70,59 | 70,59 | |
| R. Shorin, I. Voronova (1998) | | | 70,59 | | |
| R. Taffler, H. Tisshaw (1977) | | | | 70,59 | 70,59 |
| Ginoglou, Agorastos (2002) | 88,89 | | 88,24 | | |
| Lin, Piesse (2004) | | 76,47 | | | |
| Altman, Sabato (2007) | | | | 70,59 | 64,71 |
| M. Zmijewski (1984) | 83,33 | 70,59 | 76,47 | | |
| G. Savickaya (2007) | | 70,59 | | 64,71 | 70,59 |

From Table 6 could be seen that for analysis of 1 year before bankruptcy is useful to use E. Altman Z" (1993), Ginoglou, Agorastos (2002) and M. Zmijewski (1984). 2 years before bankruptcy is worth using E. Altman Z" (1993), Lin, Piesse (2004) and M. Zmievskis (1984) or G. Savickaya (2007) models. When calculating the result 3 years before bankruptcy, it is worthwhile to use the following MDA models: E. Altman Z" (1993), E. Altman Z (1968), E. Altmans Z' (1983), G. Springate (1978), R. Shorin, I. Voronova (1998), since these 5 models show the same precision 70.59%. From logarithmic regression models – Ginoglou, Agorastos (2002), from valuation approach, rating models – M. Zmijewski (1984).

It is important to note that logarithmic regression and valuation approach, rating models 1, 2 and 3 years before bankruptcy enters higher accuracy than MDA models. The best results 4 years before bankruptcy are presented by G. Springate (1978); R. Taffler, H. Tisshaw (1977) MDA models with the same accuracy of 70.59%. With the same precision, it is worth using a logarithmic regression model Altman, Sabato (2007), in turn from the valuation approach, rating models G. Savickaya (2007). Calculating probability 5 years before bankruptcy, the models do not differ 4 years before bankruptcy. The difference is that G. Springate (1978) get lower by 5.88%, Altman, Sabato (2007), and G. Savickaya (2007) increased by 5.88 %. When evaluating all three groups, the author can conclude that logarithmic regression models are the most accurate, followed by valuation approach, rating models and MDA. Such situation authors could explain by the mathematical differences between models. MDA models in construction of a linear function, logarithmic regression functions have a small bend also called "tails". Valuation approach, rating models are MDA and logarithmic regression combinations.

### 3.3. Results application

Despite the results obtained, authors also wanted to test the accuracy based on real company. Primary company was selected – Liepājas Metalurgs AS that entercounted financial difficulties and in 2013 started insolvency process. As shown in Table 7, not all models with a high degree of precision prove themselves to be in practice.

Models E. Altman Z (1968), E. Altman Z' (1983), E. Altmann Z" (1993), G. Springate (1978), R. Shorin, I. Voronova (1998), Ginoglou, Agorastos ( 2002) Lin, Piesse (2004) confirms the results obtained, that is, identifies the bankrupt business. M. Zmijewski (1984) model showed bankruptcy only when the company started insolvency proceedings. R. Taffler, H. Tisshaw (1977), Altman, Sabato (2007), G. Savicka (2007) did not reflect the empirical data. This situation allows us to conclude and prove hypothesis that the company must use at least 3 models from each group to verify the quality of the data obtained.

Table 7. Models with highest percentage accuracy based on Liepājas Metalurgs AS data (source: own reserch)

| Model | 2014 | 2013 | 2012 | 2011 | 2010 |
|---|---|---|---|---|---|
| E. Altman Z (1968) | 1 | 1 | 1 | 1 | 1 |
| E. Altman Z' (1983) | 1 | 1 | 1 | 1 | 1 |
| E. Altman Z" (1993) | 1 | 1 | 1 | 1 | 1 |
| G. Springate (1978) | 1 | 1 | 1 | 1 | 1 |
| R. Shorin, I. Voronova (1998) | 1 | 1 | 1 | 1 | 1 |
| R. Taffler, H. Tisshaw (1977) | 0 | 0 | 0 | 0 | 0 |
| Ginoglou, Agorastos (2002) | 1 | 1 | 1 | 0 | 1 |
| Lin, Piesse (2004) | 1 | 1 | 1 | 0 | 0 |
| Altman, Sabato (2007) | 1 | 1 | 0 | 0 | 0 |
| M. Zmijewski (1984) | 1 | 1 | 0 | 0 | 0 |
| G. Savickaya (2007) | 1 | 0 | 0 | 0 | 0 |

* 1 – bankrupt; 0 – solvent

Models E. Altman Z (1968), E. Altman Z' (1983), E. Altmann Z" (1993), G. Springate (1978), R. Shorin, I. Voronova (1998), Ginoglou, Agorastos ( 2002) Lin, Piesse (2004) confirms the results obtained, that is, identifies the bankrupt business. M. Zmijewski (1984) model showed bankruptcy only when the company started insolvency proceedings. R. Taffler, H. Tisshaw (1977), Altman, Sabato (2007), G. Savicka (2007) did not reflect the empirical data. This situation allows us to conclude and prove hypothesis that the company must use at least 3 models from each group to verify the quality of the data obtained.

Looking at Table 7, authors have noticed that MDA models more accurately describe the current situation than the other models, which in this case indicates that they are most applicable in the economic conditions of Latvia, despite the conclusion made by the authors regarding the accuracy of the group, based on the data, in order to facilitate more accurate results should be used larger number of companies. Moreover, viewed models do not include external environmental factors, therefore influence results.

## Conclusions

Research was mainly based on the metal products industry. Analyzing the tendencies of the steel market, since 2013 in Latvia has been a sharp decrease in export and import volumes. The main reason mentioned by WSA is metal market stagnation that caused sharp decrease in export and import volumes. Correlation analysis of used forecasting model financial ratio correspond to Laakso healthy firm triangle as mostly models include profitability, liquidity and solvency ratios that overall contribute to the financial stability of the company.

Authors explored and piloted 20 insolvency forecasting models and their potential as a predictor 1, 2, 3, 4, 5 years before of bankruptcy. According to the authors empirical results, 1 year before the bankruptcy, it is useful to use models of E. Altman Z", Ginoglou, Agorastos and M. Zmijewski; 2 years before bankruptcy it is worth using E. Altman Z"; Lin, Piesse and M. Zmijewski or G. Savickaya models; 3 before bankruptcy – E. Altman Z; E. Altman Z'; E. Altmana Z"; G. Springate; R. Shorina, I. Voronova; 4 years before bankruptcy G. Springate or R.Taffler and H. Tisshaw; Altman, Sabato; G. Savickaya; 5 years before bankruptcy R. Taffler, H. Tisshaw; Altman, Sabato; G. Savickaya. Some of mentioned models show the same percentage accuracy and error, so person who will use these models can choose the appropriate one based the author's research results.

Relying on the empirical data, authors conclude that logarithmic regression models are the most accurate, followed by valuation approach, rating models and multiplicative discriminant analysis models respectively. The result may be explained by model's mathematical differences.

Authors suggest that for several models, prediction error could arise due to the fact that active companies were facing financial difficulties due to metal market stagnation.

In order to verify the reliability of the models, the company Liepājas Metalurgs AS was taken as the base for approbation. Most of the models were able to determine if company entercounted finansial difficulties, however, M. Zmijewski (1984), R. Taffler, H. Tisshaw, Altman, Sabato, G. Savickaya did not reflect the empirical data. Additionaly, MDA models were more precise in determining bankruptcy of the company despite the fact that empirical research showed logarithmic regression higher agree of accuracy. This allow authors to prove hypothesis that company should use at least three models, predicting bankruptcy from different model classes.

Considering the abovementioned factors, authors believe that approbation of models in the economic conditions of Latvia should be continued increasing the reliability of the models by analyzing larger number of enterprises that will allow to make qualitative conclusions about an organization future development scenario. Authors believe that implementation of solvency forecasting models in organization require financial specialists continuously follow models as changes in external environment can reduce the reliability of the models that can lead to incorrect interpretation of company's financial position.

Author's research is in demand because liquidated enterprises rapidly increased in recent years as well as have reduced the number of registred companies. Due to this situation, smaller amounts of taxes are transferred to the state budget, consequently, development of the Latvian economy diminishing.

In order to ensure a viable business environment, predictive models could be an effective financial risk tool that would be useful both for company's management by taking preventive actions to improve existing financial position and the state in order to improve monitor function of bankrupt firms that could cause global problems to the country.

Financial crisis causes could be classified as external and internal that depend on problem context (Ventura, 2008). Taking into account empirical evidence, insolvency forecasting models could be an effective predictors of business failure.

## References


Altman, E. I., & Hotchkiss, E. (2006). *Corporate financial distress and bankruptcy: predict and avoid bankruptcy, analyze and invest in distressed debt.* Wiley Finance.

Altman, E. I. (1993). *Corporate financial distress and bankruptcy*. John Wiley & Sons.

Amini, H., Cont, R., & Minca, A. (2016). Resilience to contagion in financial networks. *Mathematical Finance*, 329-365. https://doi.org/10.1111/mafi.12051

Arasu, R., Balaji, C. D., Kumar, S. P., & Thamizhselvi, N. (2014). Applicability of Fulmer and Springate Models for predicting financial distress of firms in the finance sector – an emperical analysis. *Journal of Finance and Risk Management, 4*(1), 1-9.

Alferov, V. N., & Khudyakova V. V. (2017). Monitoring kreditosposobnosti zayomshikov kak mehanizm atikrizisknogo upravlenija. *Strategii biznesa, 36*(4), 1-11. Retrieved from https://goo.gl/vhNeq2

Baykina, S. (2010). *Uchet i analiz bankrotstva.* Moskva: Dashkov i Ko.

Berzkalne, I. & Zelgalve, E. (2013). Bankruptcy prediction models: a comparative study of the Baltic listed companies. *Journal of Business Management*, *7*(1), 72-82.

Boratynska, K. (2016). Corporate bankruptcy and survival on the market: lessons from evolutionary economics. *Oeconomia Copernicana, 7*(1), 107-129. https://doi.org/10.12775/OeC.2016.008

Buston, C. (2016). Active risk management and banking stability. *Journal of Banking and Finance*, 203-215. https://doi.org/10.1016/j.jbankfin.2015.02.004

Gepp, A., Kumar, K., & Bhattacharya, S. (2010). Business failure prediction using decision trees. *Journal of Forecasting, 29*(6), 536-555. https://doi.org/10.1002/for.1153

Ginoglou, D., Agorastos, K., & Hatzigagios, T. (2002). Predicting corporate failure of problematic firms in Greece with LPM logit probit and discriminant analysis models. *Journal of Financial Management & Analysis, 15*(1), 1-15.

Gruszczynski, M. (2015). Issues in modelling the financial distress and bankruptcy of companies. *Quantitative Methods in Economics, 16*(1), 96-107. https://doi.org/10.2139/ssrn.2880146

Januška, M. (2004). *Mūsdienu prasības bilances kontu uzskaitei un analīzei*. Rīga: Merkūrijs.

Joo-Ha, N., & Taehong, J. (2000). Bankruptcy prediction: evidence from Korean listed companies during the IMF crisis. *Journal of International Financial Management and Accounting, 11*(3), 178-197. https://doi.org/10.1111/1467-646X.00061

Kanapickiene, R., & Marcinkevicius, R. (2014). Possibilities to apply classical bankruptcy prediction models in the construction sector in Lithuania. *Economics and Management, 19*(4), 317-332. Retrieved from https://goo.gl/unAWsB

Keasey, K., Pindado, J., & Rodrigues, L. (2015). The determinants of the costs of financial distress in SMEs. *International Small Business Journal, 33*(8), 862-881. https://doi.org/10.1177/0266242614529317

Krusinskas, R., Lakstutiene, A., & Stankeviciene, J. (2014). The research of reliability of bankruptcy prediction models in Lithuanian companies. *Transformations in Business and Economics, 13*(2), 102-123. Retrieved from https://goo.gl/QX6ovf

Laakso, T., Laitinen, E., & Vento, H. (2010). *Threat of insolvency and successful company reorganization.* Helsinki: Talentum Media Oy.

Liang, D., Lu, C.-C., Tsai, C.-F., & Shih, G.-A. (2016). Financial ratios and corporate governance indicators in bankruptcy prediction: a comprehensive study. *European Journal of Operational Research, 252*, 561-572. https://doi.org/10.1016/j.ejor.2016.01.012

Lursoft. (n.d.). *Uzņēmumu datu bāzes*. Retrieved from https://doi.org/10.1016/j.ejor.2016.01.012

Maksātnespējas likums. (n.d.). Retrieved from https://goo.gl/cdW3yY

Mavlutova, I., Zalitis, U., Mavlutova, A., & Mavlutov, B. (2014). Evaluation of enterprise solvency in lending practice of commercial banks: evidence from Latvia. *RISEBA*, 90-108. Retrieved from https://goo.gl/E8VxKG

Nelson, P. B. (1981). *Corporations in crisis: behavioral observations for bankruptcy policy.* United States: Praeger.

Petersen, C., & Plenborg, T. (2012). *Financial statement analysis: valuation, credit analysis and executive compensation*. England: Pearson Education Limited.

Pitrova, K. (2001). Possibilities of the Altman Zeta Model Application to Czeck Firms. *E* & *M* Ekonomie a Management, *3*, 66-76. Retrieved from https://goo.gl/CMhULZ

Saksonova, S. (2006). *Uzņēmuma finanšu vadības praktiskās metodes*. Rīga: Merkūrijs LAT.

Singh, B. P., & Mishra, A. K. (2016). Re-estimation and comparisons of alternative accounting based bankruptcy prediction models for Indian companies. *Financial Innovation, UNSP, 2*(6). https://doi.org/10.1186/s40854-016-0026-9

Shneidere, R. (2009). *Finanšu analīzes metodes uzņēmuma maksātnespējas prognozēšanai*. Rīga: Lietišķās informācijas dienests izdevniecība.

Swedbank. (2016). *Kā saprast, vai mans uzņēmums strādā ienesīgi?* Retrieved from https://goo.gl/jsVFy4

Savickaya, G. V. (2006). *Metodika kompleksnogo analiza hozyajstvennoj deyatelnosti*. Moskva: Infra-M.

Tereshchenko, A. (2000). *Finansovaya sanaciya i bankrotstvo predpriyatij.* Kiev: KNEU.

Ventura, J. (2008). *The bankruptcy handbook: everything you need to know to avoid bankruptcy, get rid of debt, and rebuild your credit*. United Kingdom: Kaplan Publishing.

Waszkowski, A. (2011). Methods of classification models. *Oeconomia*, 95-106. Retrieved from https://goo.gl/qZnc87

World Steel Association. (2015). Retrieved from https://goo.gl/yTKG4h