# POLISH EARLY WARNING SYSTEMS IN PREDICTING RISK OF BANKRUPTCY OF WAWEL S.A IN THE YEARS 2013–2015

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## ABSTRACT

The always relevant issues of the assessment of bankruptcy risk for enterprises require that bankruptcy processes occurring in Poland are analysed on a continuous basis. This leads to verification of the existing theory on economics of bankruptcies and business failures on the one hand, and its further evolution on the other hand. For business practice, of significant importance in this area are methods for effective (pre-emptive) diagnosis of the signs of the deteriorating economic and financial situation of an enterprise, which can precede an enterprise's loss of the ability to pay and consequently permanent insolvency (bankruptcy). The traditional ex post indicator analysis has become by far insufficient. Thus, as it evolved, various science and research centres around the around, including in Poland, were undertaking efforts to create new early warning systems to ensure pre-emptive assessment of the bankruptcy risk level for economic entities. An early warning system is one of the elements designed to assess the economic and financial situation of a company. It allows us to identify the risk at an early stage and implement appropriate corrective processes.

Early identification of the signs of a pending crisis should thus be one of the basic tasks in the management of a company.

The aim of the paper is to assess the identification of bankruptcy risk for the company Wawel S.A, with the analysis covering the period from 2013 to 2015 in the company's operation. Moreover, the authors of the paper show the possibility of the application of Polish models for bankruptcy risk assessment by both internal and external stakeholders, who can use the information contained in financial statements and calculated financial indicators to assess whether a given economic entity is a healthy or sick entity. The research methods

used in the paper are: literature analysis, calculations by Polish early warning systems and analysis of the case study of the company Wawel S.A covering the period from 2013 to 2015.

The paper has been written based on the literature in the area of "economics of bankruptcies", accounting, financial analysis and auditing, provisions of law and financial statements of the company Wawel S.A.

The selection of the company Wawel S.A for analysis is to confirm the effectiveness of warning models-systems in predicting lack of bankruptcy risk for an economic entity, as the good economic and financial situation of the company analysed should be reflected in the fact that all the models show that Wawel S.A is a healthy company, i.e. no business continuity risk is identified.

## INTRODUCTION

One of the fundamental problems facing the managerial staff in a modern enterprise is to identify effective methods designed to assess the economic and financial situation of the enterprise and warn about business continuity risk. Decision-making in an enterprise and flexible reaction to changes is becoming increasingly complex. In the process of managing an enterprise, it is necessary to use tools that enable early identification of bankruptcy risk.

An early warning system is one of the components designed to assess the economic and financial situation of a company. It enables early recognition of risk and implementation of appropriate corrective processes. (Godlewska, 2008).

Early identification of the signs of a pending crisis should thus be one of the basic tasks in the management of a company.

The tasks of an early warning system include revealing the deteriorating economic and financial situation of an enterprise thanks to providing economic data e.g. in the form of financial indicators that allow subsequent decisions to be made to improve the company's economic and financial situation. An early warning system should be well-tried so that it can indicate the most probable threats. Therefore, it is important to test it in the long run with possibly unchanged factors of the environment. It is also important to define the moment of an enterprise's bankruptcy, as the occurrence of bankruptcy may vary in terms of time and meaning from country to country as a result of various factors of the environment. For the company at risk to have time to take corrective actions, the risk should be identified in advance so that the way to bankruptcy is a process spread over a period of time.

The aim of the paper is to verify the effectiveness of Polish models in predicting bankruptcy and assessing the economic and financial situation of the listed company Wawel S.A and to assess the identification of the bankruptcy risk for the company Wawel S.A, with the analysis covering the period from 2013 to 2015 of the company's operation.

The research methods used in the paper are: literature analysis, calculations by Polish models for the assessment of business continuity risk and analysis of the case study of the company Wawel S.A covering the period from 2013 to 2015.

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The selection of the company Wawel S.A for analysis is to confirm the effectiveness of warning models-systems in predicting lack of bankruptcy risk for an economic entity, as the good economic and financial situation of the analysed  company should be reflected in the fact that all the models show that Wawel S.A is a healthy company, i.e. no business continuity risk is identified.


THE IDEA OF AN EARLY WARNING SYSTEM

The current global economy forces companies to adapt to the changing environment. The fundamental characteristics of the competitive environment are risk and uncertainty. Therefore, companies have to be able to predict future, their own potential and possibilities. In enterprises that encounter difficulties in running business activity, objective remedial and bankruptcy processes occur (Tokarski, 2012).

An early warning system (EWS) is one of the components designed to assess a company's economic and financial situation. It allows us to recognise the risk at an early stage and implement appropriate corrective processes (Fliengier, 2013). Moreover, its aim is to both identify threats and indicate chances. For avoidance of misunderstanding connected with the meaning of the word "warning", these systems are sometimes called *early recognition systems.* They involve observation and analysis of risk factors inside a company. Thus, EWSs are a kind of barometer of changes that occur not only in the environment, but also in the organisation itself and which, from the perspective of the present day, are significant for the future operation of an enterprise (Cabała, 2008).

An early warning system appeared as a response to mass bankruptcies of enterprises during the Great Depression of 1929-1933, when managers, not knowing early signs of the dangers, were unable to predict the looming threat.  Currently, the vision of a company's failure is perceived as a threat or even heading for bankruptcy only by "amateurs in the field of management".

 Early warning systems are one of the elements of the process of assessing the economic and financial situation of an enterprise (Jędrzejewski, 2005). Their task is mainly to reveal the deteriorating overall economic and financial situation of the entity in question - principally to detect elements indicating the risk of bankruptcy (Karol, Prusak, 2009).

An early warning system is designed to distinguish between economic entities with a rather poor economic and financial situation and those not showing any bigger economic  or financial problems (Sikorski, 2006). This system is often equated with a bankruptcy forecast system whose task is to identify entities heading for collapse (Fraser, D.R, Fraser L.M).


CONDITIONS FOR PROPER FUNCTIONING OF EARLY WARNING SYSTEMS

An early warning system is in fact an element of a broader system, i.e. an information system in a company. A well-organised EWS ensures appropriate protection against

a possible crisis, as well as preparing resources to make the most of the opportunities (Tokarski, 2008).

For an early warning system to make sense, it has to fulfil three conditions, namely: (Zaleska, 2001)

- EWS has to be an effective system; it should indicate the risk of insolvency and bankruptcy with minimum number of wrong indications. Before a system can be regarded as effective, it has to be tested in practice in a relatively long period of time. Otherwise, such a system cannot be declared an effective one. In a short run, the system's indications can be correct by pure accident, e.g. due to the impact of seasonality on financial results of enterprises.
- the risk of insolvency and bankruptcy of a company should be detected well in advance so that the enterprise can take appropriate remedial or corrective actions. The development of a EWS makes sense only when bankruptcy is the result of a process spread over in time. Should this event be sudden, no system can be effective, as there will be no time to use the information delivered by it.
- as an early warning system can confirm its effectiveness only in the long run, the conditions under which it is tested should be relatively unchanged. In the Polish economy, which is characterised by high institutional changeability, this condition is very difficult to fulfil.

The form of an early warning system should depend on the specificity of the activities of the economic entity being analysed. A person developing an early warning system should in the first place take into account the following:  (Mioduchowska-Jaroszewicz, 2005)

- the size of an economic entity (large, medium-sized or small), which usually affects the factors listed below,
- sector, industry in which an economic entity operates, with a more detailed division than the classification into financial and non-financial activity, with the latter broken down into manufacturing, trade and services,
- type of ownership (private, state-owned, cooperative),
- legal form (for instance: companies constituted under commercial or civil law, natural persons engaged in a business),
- scope of accounting (full accounting system or simplified accounting, e.g. revenue and expense ledger, tax card, lump sum tax in the case of enterprises),
- geographical coverage of activities (international, national, local).

An early warning system is one of the elements of the process of assessing the economic and financial situation of an enterprise. It should show the deteriorating situation of an enterprise, in particular detect elements indicating the risk of bankruptcy. However, it does not provide hints on how the economic and financial situation of an enterprise can be improved. It is thus a preliminary analytical tool, which should be supported by a whole process of monitoring the economic and financial situation of an enterprise (Zaleska, 2002).

## EARLY WARNING SYSTEMS – EXAMINATION OF THE RISK BANKRUPTCY IN POLISH CONDITIONS

In the Polish economic reality, synthetic measures are increasingly used in forecasting financial difficulties. Most attempts rely on Z-score models, which were developed and tested in Western countries (Tokarski A, Tokarski M, 2006). In practice, the use of models that were created for economic conditions differing from Polish ones seems very limited. The data used in such models are often impossible to obtain in Polish companies (e.g. cumulative value of the retained profit). Economic practice and analysis of the available literature show that the use of published models for bankruptcy prediction should be limited in time and restricted to the country where the data used for their development is gathered (Korol, 2010). Polish bankruptcy prediction models should be developed on the basis of the financial data of Polish enterprises, verified and improved as the economic conditions change (Tokarski A, Tokarski M, 2006). In Poland, models using discriminant and logit methods were developed (Hołda, Micherda, 2007).

In the Polish conditions, it is not possible to use models developed and used in countries with a stable and developed market economy, therefore Polish economists have created Polish bankruptcy prediction models using a set of financial indicators and discriminant analysis (Kitowski, 2015).

Below shown the names of Polish early warning systems - models for assessment of business continuity risk for enterprises along with the names of their developers, names of the institutions where the models were developed, dates of model publication and effectiveness (efficiency) of the model for a research sample.

1. **Model by M. Pogodzińska and S. Sojak –** Faculty of Economic Sciences and Management, Nicolaus Copernicus University in Toruń

$$Z= 0{,}644741X_1 + 0{,}912304X_2$$

where:
$X_1$ – (current assets - inventory)/ current liabilities,
$X_2$ – gross profit / sales revenue
$Z > 0$ enterprise is not at risk of bankruptcy
$Z < 0$ enterprise is at risk of bankruptcy
$-0.254 \leq Z \leq 0.090$ poor financial condition of enterprises, the so-called informal economy

2. **Model by J. Gajdka and D. Stos –** University of Lodz

$$Z= 0{,}7732059 - 0{,}0856425X_1 + 0{,}0007747X_2 + 0{,}9220985X_3 + 0{,}6535995X_4 - 0{,}594687X_5$$

where:
$X_1$ – sales revenue /total assets
$X_2$ – (short-term liabilities / cost of production sold) * 360
$X_3$ – net profit /total assets
$X_4$ – gross profit / revenue from sales
$X_5$ – total liabilities /total assets
$Z > 0.45$ enterprise is not at risk of bankruptcy
$Z < 0.45$ enterprise is at risk of bankruptcy

3. **Model by E. Mączyńska –** Institute of Economic Sciences of the Polish Academy of Sciences in Warsaw; SGH Warsaw School of Economics

$$W = 1{,}51X_1 + 0{,}08X_2 + 10{,}00X_3 + 5{,}00X_4 + 0{,}30X_5 + 0{,}10X_6$$

where:

$X_1$ – amortization+ net profit/liability

$X_2$ – balance sheet/liability

$X_3$ – pre-tax profit /balance sheet total

$X_4$ – pre-tax profit / revenue from sales

$X_5$ – inventory / revenue from sales

 $X_6$ – revenue from sales / balance sheet total

$W < 0$ enterprise at risk of bankruptcy (sick enterprise)

$W = 0$ limit value

$W > 0$ enterprise not at risk of bankruptcy (healthy enterprise)

$0 \leq W < 1$ poor financial situation of enterprises (the so-called informal economy)

4. **Model by A. Hołda –** Cracow University of Economics

$$Z_H = 0{,}605 + 0{,}681 \times 10^{-1}\, PWP - 1{,}96 \times 10^{-2}\, SZ + 9{,}69 \times 10^{-3}\, ZM + 6{,}72 \times 10^{-}\, WOZ + 1{,}57 \times 10^{-1}\, RM$$

where:

PWP = current assets / short-term liabilities

SZ = total liabilities / balance sheet total

ZM = net financial result / annual average total assets

WOZ = average short-term liabilities / (operating expenses - other operating expenses

RM = total revenue / yearly average total assets

$Z_H > 0$ enterprise not at risk of bankruptcy

$Z_H < 0$ enterprise at risk of bankruptcy

5. **Model by D. Hadasik –** Poznan University of Economics and Business

$$D(W) = 0{,}365425\, X_1 - 0{,}765526\, X_2 - 2{,}40435\, X_3 + 1{,}59079\, X_4 + 0{,}00230258\, X_5 - 0{,}0127826\, X_6 + 2{,}36261$$

where:

$X_1$ = current assets / current liabilities

$X_2$ = (current assets – inventory)/current liabilities

$X_3$ = total liabilities /total assets

$X_4$ = working capital/total liabilities

$X_5$ = receivables x 365 days / net sales revenue

$X_6$ = inventory *365 days / net sales revenue

$D(W) > 0$ enterprises not at risk of bankruptcy

$D(W) < 0$ bankrupted enterprises

6. **Model by D. Wierzba –** Warsaw School of Computer and Economic Science)

$$Z = 3{,}26\, X_1 + 2{,}16\, X_2 + 0{,}69\, X_3 + 0{,}3\, X_4$$

where:

$X_1$ =(operating income– amortization)/balance sheet total

$X_2$ = (operating income- amortization)/net sales revenue

$X_3$ = working capital /balance sheet total

$X_4$ = total assets / liabilities
Z > 0 enterprise not at risk of bankruptcy
Z < 0 enterprise at risk of bankruptcy

7. **Model by A. Pogorzelski** –Institute of Economics of the Polish Academy of Sciences in Warsaw; Warsaw University of Technology

$$Y= 0,893 X_1 – 0,0975 X_2 – 0,8412X_3 + 0,8974 X_4 + 0,2711$$

where:
$X_1$ = operating result / total assets
$X_2$ = outside capital  total assets
$X_3$ = =( outside capital-cash)/ revenue from sales
$X_4$ = (operating profit amortization / short-term liabilities
Y > 0 enterprise not at risk of bankruptcy
Y < 0 enterprise at risk of bankruptcy

8. **Model by J. Janek and M. Żuchowski** – Warsaw University of Technology

$$Z= 3,247X_1 – 2,778 X_2 – 1,834 X_3 + 2, 141 X_4$$

where:
$X_1$ = operating result / total assets
$X_2$ = inventory / revenue from sales
$X_3$ =( outside capital-cash)/ revenue from sales
$X_4$ = change in sales revenue (current period revenue - previous period revenues)
Z > - 0.509 enterprise not at risk of bankruptcy
Z < - 0.509 enterprise at risk of bankruptcy

9. **Model by B. Prusak** – Gdańsk University of Technology

$$Z= 6,5245X_1 + 0,1480 X_2 + 0,4061 X_3 + 2,1754 X_4 – 1,5685$$

where:
$X_1$ = operating result / average value of balance sheet total
$X_2$ = operating expenses - short-term liabilities
$X_3$ = current assets / short-term liabilities
$X_4$ = Operating result/ revenue from sales
Z > -0.13 enterprise not at risk of bankruptcy
Z < -0.13 enterprise at risk of bankruptcy
–0.13 ≤ W < 0.65 poor financial situation of enterprises (the so-called informal economy)

10. **Model by M. Hamrol, B. Czajka and M. Piechocki** –Poznań University of Economics and Business

$$FD = 3,562W_1 + 1,588W_2 + 4,288W_3 + 6,719W_4 - 2,368$$

where:
$W_1$ = net financial result/total assets (balance sheet total
$W_2$ = (current assets - inventories)/short-term liabilities
$W_3$ = fixed capital/ total assets
$W_4$ = financial result on sales / sales revenue

FD > 0 enterprises not at risk of bankruptcy
FD < 0 bankrupted enterprises

### 11. Model by P. Stępień and T. Strąk – University of Szczecin

$$Y = -11 X_1 + 6 X_2 - 40X_3 + 19X_4 - 19$$

where:
$X_1$ = outside capital /total capital
$X_2$ = (total current assets- inventory)/ short-term liabilities
$X_3$ = net profit / total capital
$X_4$ = revenue from sales/ operating expenses
Y > 0 enterprise not at risk of bankruptcy
Y < 0 enterprise at risk of bankruptcy

### 12. Model by E. Mączyńska and M. Zawadzki – Institute of Economics of the Polish Academy of Sciences in Warsaw

$$Z = 9,498X_1 + 3,566X_2 + 2,903 X_3 + 0,452 X_4 - 1,498$$

where:
$X_1$ = operating result / balance sheet total
$X_2$ = equity / total assets
$X_3$ = (Net profit + depreciation)/total liability
$X_4$ = current assets /short-term liabilities
Z > 0 enterprise not at risk of bankruptcy
Z < 0 enterprise at risk of bankruptcy

### 13. Model by D. Appenzeller and K. Szarzec – Poznań University of Economics and Business

$$Z = 1,286X_1 - 1,305X_2 - 0,226X_3 + 3,015X_4 - 0,005X_5 - 0,009X_6 - 0,661$$

where:
$X_1$ =current assets/short-term liabilities
$X_2$ = (current assets - inventory short-term receivables)/short-term liabilities
$X_3$ = gross result/ revenue from sales
$X_4$ = net result/average value of assets
$X_5$ = (average value inventory /revenue from sales*number of days
$X_6$ = liabilities and provisions for liabilities/(operating result + amortization) * (12 / accounting period)
Z > 0 enterprise not at risk of bankruptcy
Z < 0 enterprise at risk of bankruptcy

### 14. Model by S. Sojak and J. Stawick – Faculty of Economic Sciences and Management, Nicolaus Copernicus University in Toruń

$$Enterprise_{poor} = - 0,1144X_1 + 0,5178X_2 - 20,4475X_3 - 0,0661X_4 + 0,0663X_5 - 50,4610X_6 + 1,8358 X_7 - -11,6499$$

$$\text{Enterprise}_{good} = -0,0153X_1 + 2,0482X_2 + 9,6370X_3 + 0,1714X_4 - 0,0091X_5 - 15,7800X_6 - 0,0018X_7 - 5,9920$$

$$\text{Enterprise}_{average} = -0,0586X_1 - 3,3608X_2 + 10,7088X_3 + 0,1455X_4 - 0,0660X_5 + 4,5837X_6 + 0,2,4329X_7 - 2,3393$$

where:

$X_1 =$ (net profit / average value of current assets) * 100

$X_2 =$ (current assets - inventories - accrued expenses) / short-term liabilities

$X_3 =$ average working capital / average value of balance sheet total

$X_4 =$ (net profit /average equity) * 100

$X_5 =$ (net profit / average value of non-current assets) * 100

$X_6 =$ (net income + interest on outside capital - income tax) /average balance sheet value

$X_7 =$ current assets/short-term liabilities

The biggest positive value indicates the type of an enterprise in the analysis of a given year.

Due to a large number of indicators used to assess the economic and financial situation of an enterprise, different models can be created and exist, with different sets of variables and weighting factors, which allows users to apply a number of models rather than only one (Mączyńska, 2004).

E. Mączyńska, M. Zawadzki think that there is no single and only correct model for bankruptcy risk assessment in Poland. The large number of indicators used to assess the prediction of bankruptcy justifies the development of models differing in terms of the set of variables and weighting factors but showing similar classification capability. As a result, users of such models, including investors, creditors, analysts and auditors, can apply different models to suit the specificity of their activity and analytical needs (Mączyńska, Zawadzki, 2004).

## THE USE OF POLISH EARLY WARNING SYSTEMS IN THE EXAMINATION OF BANKRUPTCY RISK OF WAWEL S.A IN THE YEARS 2013-2015

Table 1 presents necessary financial data needed to determine financial indicators in systems for early warning about an enterprise's bankruptcy risk, while  contains calculation formulas of the specific models.

Table 1. Data from the financial statements used in the assessment of bankruptcy risk for Wawel S.A in the years 2013-2015

| Item | Specification | 2013 | 2014 | 2015 |
|------|---------------|------|------|------|
| 1. | Current assets | 302,859,000 | 341,748,000 | 376,253,000 |
| 2. | Total Current assets | 302,859,000 | 341,748,000 | 376,253,000 |
| 3. | Total assets | 510,542,000 | 554,904,000 | 634,521,000 |
| 4. | Amortization | 14,316,000 | 15,458,000 | 19,643,000 |
| 5. | Fixed capital | 372,258,000 | 446,191,000 | 510,840,000 |
| 6. | Outside capital | 138,370,00 | 125,548,000 | 142,943,000 |
| 7. | Working capital | 189,761,000 | 233,593,000 | 253,150,000 |
| 8. | Operating expenses | 342,573,000 | 329,104,000 | 636,230,000 |

| 9. | Manufacturing costs of products sold | 339,148,000 | 328,154,000 | 362,093,00 |
|---|---|---|---|---|
| 10. | Total property | 510,542,000 | 554,904,000 | 634,521,000 |
| 11. | Receivables | 191,995,000 | 190,430,000 | 197,288,000 |
| 13. | Other operating expenses | 3,425,000 | 950,000 | 1,137,000 |
| 14. | Average value of equity | 342,465,000 | 400,764,000 | 460,467,000 |
| 15. | Average value of balance sheet total | 474,083,000 | 532,723,000 | 594,712,000 |
| 16. | Average working capital | 165,342,000 | 211,677,000 | 243,371,000 |
| 17. | Average short-term liabilities | 107,977,000 | 110,626,000 | 115,629,000 |
| 18. | Average value of fixed assets | 200,764,000 | 208,451,000 | 235,712,000 |
| 19. | Net income from sales | 595,645,000 | 594,161,000 | 631,188,000 |
| 20. | Revenue from sales | 595,645,000 | 594,161,000 | 631,188,000 |
| 21. | Balance sheet total | 510,542,000 | 554,904,000 | 634,521,000 |
| 22. | Average annual property | 474,083,000 | 532,723,000 | 594,712,000 |
| 23. | Cash | 67,538,000 | 108,189,000 | 130,598,000 |
| 24. | Net financial result | 80.467.000 | 88.035.000 | 92.868.000 |
| 25. | Income from operations | 96,011,000 | 102,922,000 | 107,843,000 |
| 26. | Inventory | 42,948,000 | 42,772,000 | 47,639,000 |
| 27. | Change in revenue from sales | 39,748,000 | – 1,484,000 | 37,027,000 |
| 28. | Total liabilities | 138,370,000 | 125,548,000 | 142,943,000 |
| 29. | Current liabilities | 113,098,000 | 108,155,000 | 123,103,000 |
| 30. | Short-term liabilities | 113,098,000 | 108,155,000 | 123,103,000 |
| 31. | Gross profit | 99,804,000 | 108,683,000 | 114,994,000 |
| 32. | Net profit | 80,467,000 | 88,035,000 | 92,868,000 |
| 33. | Operating profit | 96,011,000 | 102,922,000 | 107,843,000 |
| 34. | Pre-tax profit | 99,804,000 | 108,683,000 | 114,994,000 |
| 35. | Financial results from sales | 228,521,000 | 242,918,000 | 251,106,000 |
| 36. | Total capital | 510,542,000 | 554,904,000 | 634,521,000 |
| 37. | Equity | 372,172,000 | 429,356,000 | 491,578,000 |
| 38. | Average value of inventory | 40,783,000 | 42,860,000 | 45,205,000 |
| 39. | Liabilities and provisions for liabilities | 138,370,000 | 125,548,000 | 142,943,000 |
| 40. | Average value of current assets | 273,319,000 | 322,303,000 | 359,000,000 |
| 41. | Deferred charges | 378,000 | 357,000 | 728,000 |
| 42. | Income tax | 19,337,000 | 20,648,000 | 22,126,000 |

Source: own work based on financial statements 2013-2015 Wawel S.A.

Calculation formulas and values of financial indicators used in Polish models for assessment of business continuity risk for Wawel S.A. in the years 2013 – 2015.

1. **Model by M. Pogodzińska and S. Sojak –** Faculty of Economic Sciences and Management, Nicolaus Copernicus University in Toruń

$Z_{2013} = 0.644741 \times 2.30 + 0.912304 \times 0.17 = 1.64$

$Z_{2014} = 0.644741 \times 2.76 + 0.912304 \times 0.18 = 1.94$

$Z_{2015} = 0.644741 \times 2.67 + 0.912304 \times 0.18 = 1.88$

According to the assessment by this model, in the period from 2013 to 2015 the enterprise was not at risk of bankruptcy and was not in the informal economy.

2. **Model by J. Gajdka and D. Stos –** University of Lodz

$Z_{2013} = 0.7732059 - 0.0856425 \times 1.17 + 0.0007747 \times 120.05 + 0.9220985 \times 0.16 + 0.6535995 \times 0.17 - 0.594687 \times 0.27 = 0.48$

$Z_{2014} = 0.7732059 - 0.0856425 \times 1.07 + 0.0007747 \times 118.65 + 0.9220985 \times 0.16 + 0.6535995 \times 0.18 - 0.594687 \times 0.23 = 0.46$

$Z_{2015} = 0.7732059 - 0.0856425 \times 0.99 + 0.0007747 \times 122.39 + 0.9220985 \times 0.15 + 0.6535995 \times 0.18 - 0.594687 \times 0.23 = 0.48$

According to the assessment by this model, the enterprise was not at risk of bankruptcy in the years 2013-2015

3. **Model by E. Mączyńska –** Institute of Economic Sciences of the Polish Academy of Sciences in Warsaw; SGH Warsaw School of Economics

$W_{2013} = 1.51 \times 0.68 + 0.08 \times 3.69 + 10.00 \times 0.20 + 5.00 \times 0.17 + 0.30 \times 0.07 + 0.10 \times 1.17 = 4.32$

$W_{2014} = 1.51 \times 0.82 + 0.08 \times 4.01 + 10.00 \times 0.20 + 5.00 \times 0.18 + 0.30 \times 0.08 + 0.10 \times 1.07 = 4.59$

$W_{2015} = 1.51 \times 0.79 + 0.08 \times 4.44 + 10.00 \times 0.19 + 5.00 \times 0.18 + 0.30 \times 0.08 + 0.10 \times 0.99 = 4.47$

According to the assessment by this model, the enterprise was not at risk of bankruptcy in the years 2013-2015 and was not in the informal economy

4. **Model by A. Hołda –** Cracow University of Economics

$Z_{2013} = 0.605 + 0.681 \times 10^{-1} \times 2.68 - 1.96 \times 10^{-2} \times 0.27 + 9.69 \times 10^{-3} \times 0.17 + 6.72 \times 10^{-4} \times 0.32 + 1.57 \times 10^{-1} \times 1.26 = 1.15$

$Z_{2014} = 0.605 + 0.681 \times 10^{-1} \times 3.16 - 1.96 \times 10^{-2} \times 0.23 + 9.69 \times 10^{-3} \times 0.17 + 6.72 \times 10^{-4} \times 0.34 + 1.57 \times 10^{-1} \times 1.12 = 0.99$

$Z_{2015} = 0.605 + 0.681 \times 10^{-1} \times 3.06 - 1.96 \times 10^{-2} \times 0.23 + 9.69 \times 10^{-3} \times 0.16 + 6.72 \times 10^{-4} \times 0.32 + 1.57 \times 10^{-1} \times 1.06 = 0.98$

According to the assessment by this model, the enterprise was not at risk of bankruptcy in the years 2013-2015

5. **Model by D. Hadasik –** Poznan University of Economics and Business

$D(W)_{2013} = 0.365425 \times 2.68 - 0.765526 \times 2.30 - 2.40435 \times 0.27 + 1.59079 \times 0.37 + 0.00230258 \times 117.65 - 0.0127826 \times 26.32 + 2.36261 = 1.45$

$D(W)_{2014} = 0.365425 \times 3.16 - 0.765526 \times 2.76 - 2.40435 \times 0.23 + 1.59079 \times 0.42 + 0.00230258 \times 116.98 - 0.0127826 \times 26.26 + 2.36261 = 1.45$

$D(W)_{2015} = = 0.365425 \times 3.06 - 0.765526 \times 2.67 - 2.40435 \times 0.23 + 1.59079 \times 0.40 + 0.00230258 \times 114.09 - 0.0127826 \times 27.55 + 2.36261 = 1.44$

According to the assessment by this model, the enterprise was not at risk of bankruptcy in the years 2013-2015

6. **Model by D. Wierzba –** Warsaw School of Computer and Economic Science)
$Z_{2013} = 3.26 \times 0.16 + 2.16 \times 0.14 + 0.69 \times 0.37 + 0.3 \times 2.19 = 1.74$
$Z_{2014} = 3.26 \times 0.16 + 2.16 \times 0.15 + 0.69 \times 0.42 + 0.3 \times 2.72 = 1.94$
$Z_{2015} = 3.26 \times 0.14 + 2.16 \times 0.14 + 0.69 \times 0.40 + 0.3 \times 2.63 = 1.83$

According to the assessment by this model, the enterprise was not at risk of bankruptcy in the years 2013-2015

7. **Model by A. Pogorzelski** –Institute of Economics of the Polish Academy of Sciences in Warsaw; Warsaw University of Technology
$Y_{2013} = 0.893 \times 0.19 - 0.0975 \times 0.27 - 0.8412 \times 0.12 + 0.8974 \times 0.98 + 0.2711 = 1.19$
$Y_{2014} = 0.893 \times 0.19 - 0.0975 \times 0.23 - 0.8412 \times 0.03 + 0.8974 \times 1.09 + 0.2711 = 1.37$
$Y_{2015} = 0.893 \times 0.17 - 0.0975 \times 0.23 - 0.8412 \times 0.02 + 0.8974 \times 1.04 + 0.2711 = 1.31$

According to the assessment by this model, the enterprise was not at risk of bankruptcy in the years 2013-2015

8. **Model by J. Janek and M. Żuchowski –** Warsaw University of Technology
$Z_{2013} = 3.247 \times 0.19 - 2.778 \times 0.07 - 1.834 \times 0.12 + 2.141 \times 39748 = 85\ 100.68$
$Z_{2014} = 3.247 \times 0.19 - 2.778 \times 0.07 - 1.834 \times 0.03 + 2.141 \times (- 1484) = - 3\ 176.87$
$Z_{2015} = 3.247 \times 0.17 - 2.778 \times 0.08 - 1.834 \times 0.02 + 2.141 \times 37027 = 79\ 275.09$

According to the assessment by this model, the enterprise was not at risk of bankruptcy in the years 2013-2015

9. **Model by B. Prusak –** Gdańsk University of Technology
$Z_{2013} = 6.5245 \times 0.20 + 0.1480 \times 3.03 + 0.4061 \times 2.68 + 2.1754 \times 0.16 - 1.5685 = 3.29$
$Z_{2014} = 6.5245 \times 0.19 + 0.1480 \times 3.04 + 0.4061 \times 3.16 + 2.1754 \times 0.17 - 1.5685 = 1.77$
$Z_{2015} = 6.5245 \times 0.18 + 0.1480 \times 2.95 + 0.4061 \times 3.06 + 2.1754 \times 0.17 - 1.5685 = 1.65.$

According to the assessment by this model, the enterprise was not at risk of bankruptcy in the years 2013-2015

10. **Model by M. Hamrol, B. Czajka and M. Piechocki –**Poznań University of Economics and Business
$FD_{2013} = 3.562 \times 0.16 + 1.588 \times 2.30 + 4.288 \times 0.73 + 6.719 \times 0.38 - 2.368 = 7.53$
$FD_{2014} = 3.562 \times 0.16 + 1.588 \times 2.76 + 4.288 \times 0.80 + 6.719 \times 0.41 - 2.368 = 8.76$
$FD_{2015} = 3.562 \times 0.15 + 1.588 \times 2.67 + 4.288 \times 0.81 + 6719 \times 0.40 - 2.368 = 5.32$

According to the assessment by this model, the enterprise was not at risk of bankruptcy in the years 2013-2015

**11. Model by P. Stępień and T. Strąk –** University of Szczecin

$Y_{2013} = -11 \times 0.27 + 6 \times 2.30 - 40 \times 0.16 + 19 \times 1.74 - 19 = 18.49$

$Y_{2014} = -11 \times 0.23 + 6 \times 2.76 - 40 \times 0.16 + 19 \times 1.81 - 19 = 23.02$

$Y_{2015} = -11 \times 0.23 + 6 \times 2.67 - 40 \times 0.15 + 19 \times 1.74 - 19 = 51.55$

According to the assessment by this model, the enterprise was not at risk of bankruptcy in the years 2013-2015

**12. Model by E. Mączyńska and M. Zawadzki –** Institute of Economics of the Polish Academy of Sciences in Warsaw

$Z_{2013} = 9.498 \times 0.19 + 3.566 \times 0.73 + 2.903 \times 0.68 + 0.452 \times 2.68 - 1.498 = 6.08$

$Z_{2014} = 9.498 \times 0.19 + 3.566 \times 0.77 + 2.903 \times 0.82 + 0.452 \times 3.16 - 1.498 = 6.86$

$Z_{2015} = 9.498 \times 0.17 + 3.566 \times 0.77 + 2.903 \times 0.79 + 0.452 \times 3.06 - 1.498 = 6.53$

According to assessment by this mode, in the years 2013-2015 the enterprise was not at risk of bankruptcy

**13. Model by D. Appenzeller and K. Szarzec –** Poznań University of Economics and Business

$Z_{2013} = 1.286 \times 2.68 - 1.305 \times 0.60 - 0.226 \times 0.17 + 3.015 \times 0.40 - 0.005 \times 24.99 - 0.009 \times 1.25 - 0.661 = 3.05$

$Z_{2014} = 1.286 \times 3.16 - 1.305 \times 1.00 - 0.226 \times 0.18 + 3.015 \times 0.42 - 0.005 \times 26.33 - 0.009 \times 1.06 - 0.661 = 3.18$

$Z_{2015} = 1.286 \times 3.06 - 1.305 \times 1.07 - 0.226 \times 0.18 + 3.015 \times 0.39 - 0.005 \times 26.14 - 0.009 \times 1.12 - 0.661 = 2.88$

According to the assessment by this model, the enterprise was not at risk of bankruptcy in the years 2013-2015

**14. Model by S. Sojak and J. Stawick –** Faculty of Economic Sciences and Management, Nicolaus Copernicus University in Toruń

$Enterprise_{poor} = -0.1144X_1 + 0.5178X_2 - 20.4475X_3 - 0.0661X_4 + 0.0663X_5 - 50.4610X_6 + 1.8358 X_7 - 11.6499$

$Enterprise_{good} = -0.0153X_1 + 2.0482X_2 + 9.6370X_3 + 0.1714X_4 - 0.0091X_5 - 15.7800X_6 - 0.0018X_7 - 5.9920$

$Enterprise_{average} = -0.0586X_1 - 3.3608X_2 + 10.7088X_3 + 0.1455X_4 - 0.0660X_5 + 4.5837X_6 + 0.24329X_7 - 2.3393$

$Enterprise_{poor\ 2013} = -0.1144 \times 29.44 + 0.5178 \times 2.29 - 20.4475 \times 0.35 - 0.0661 \times 23.50 + 0.0663 \times 40.08 - 50.4610 \times 0.13 + 1.8358 \times 2.68 - 11.6499 = -21.52$

$Enterprise_{good2013} = -0.0153 \times 29.44 + 2.0482 \times 2.29 + 9.6370 \times 0.35 + 0.1714 \times 23.50 - 0.0091 \times 40.08 - 15.7800 \times 0.13 - 0.0018 \times 2.68 - 5.9920 = 3.23$

$Enterprise_{medium2013} = -0.0586 \times 29.44 - 3.3608 \times 2.29 + 10.7088 \times 0.35 + 0.1455 \times 23.50 - 0.0660 \times 40.08 + 4.5837 \times 0.13 + 0.24329 \times 2.68 - 2.3393 = -6.00$

$Enterprise_{bad\ 2014} = -0.1144 \times 27.31 + 0.5178 \times 2.76 - 20.4475 \times 0.40 - 0.0661 \times 21.97 + 0.0663 \times 42.23 - 50.4610 \times 0.13 + 1.8358 \times 3.16 - 11.6499 = -20.93$

$Enterprise_{good2014} = -\,0.0153 \times 27.31 + 2.0482 \times 2.76 + 9.6370 \times 0.40 + 0.1714 \times 21.97 - 0.0091 \times 42.23 - 15.7800 \times 0.13 - 0.0018 \times 2.76 - 5.9920 = 4.42$

$Enterprise_{average2014} = -\,0.0586 \times 27.31 - 3.3608 \times 2.76 + 10.7088 \times 0.40 + 0.1455 \times 21.97 - 0.0660 \times 42.23 + 4.5837 \times 0.13 + 0.24329 \times 2.76 - 2.3393 = -\,7.16$

$Enterprise_{bad\ 2015} = -\,0.1144 \times 25.87 + 0.5178 \times 2.66 - 20.4475 \times 0.41 - 0.0661 \times 20.17 + 0.0663 \times 39.40 - 50.4610 \times 0.13 + 1.8358 \times 3.06 - 11.6499 = -\,20.93$

$Enterprise_{good2015} = -\,0.0153 \times 25.87 + 2.0482 \times 2.66 + 9.6370 \times 0.41 + 0.1714 \times 20.17 - 0.0091 \times 39.40 - 15.7800 \times 0.13 - 0.0018 \times 3.06 - 5.9920 = 4.05$

$Enterprise_{average2015} = -\,0.0586 \times 25.87 - 3.3608 \times 2.66 + 10.7088 \times 0.41 + 0.1455 \times 20.17 - 0.0660 \times 39.40 + 4.5837 \times 0.13 + 0.24329 \times 2.06 - 2.3393 = -\,6.74$

The biggest positive value indicates the type of an enterprise in the analysis of a given year

Table 2 presents the result of the classification of the identification of predicted bankruptcy risk for the enterprise being analysed.

The analysis of the data contained in table 2 shows that the Company was not at risk of bankruptcy during the analysis period, as in the period 2013-2014 fourteen Polish models-systems for early warning against bankruptcy indicated that the enterprise was not at risk of bankruptcy.

 The analysis of Polish warning system models reveals that there is no single, only correct and best model for assessment of bankruptcy risk for an enterprise and that such models are useful tools in the assessment of the economic and financial situation of an enterprise.


SUMMARY

Early recognition of an emerging bankruptcy risk is a necessary condition for taking fast corrective actions and avoiding bankruptcy. Early warning models enable early detection (Pierzchalska, 2014).

Decision-making in an enterprise and flexible response to changes is increasingly complicated. In the process of managing an enterprise, it is necessary to use tools designed to identify the risk of bankruptcy at an early stage.

A well-functioning market economy provides possibilities of comparable operation conditions to all economic agents in the country. However, not every entity has sufficient skills to use them appropriately.  Therefore, as a result of wrong decisions taken by managerial staff many entities may find themselves in crisis that puts their existence in jeopardy. Often, such situation results from the managerial staff's inability to predict future phenomena that  bring about changes in the market, and consequently the emergence of a real threat to the functioning of a given entity may appear. The problem of the possibilities and capabilities of predicting how the conditions of the operation on the market will be transformed, with the market's increasing complexity and pace of development, makes it necessary to search for tools that can effectively identify business continuity risks.

Table 2. Identification of bankruptcy risk for the enterprise Wawel S.A. based on Polish early warning systems in the period from 2013 to 2015

| Item | Name of the model | Enterprise not at risk of bankruptcy | | | Enterprise at risk of bankruptcy | | |
|---|---|---|---|---|---|---|---|
| | | 2013 | 2014 | 2015 | 2013 | 2014 | 2015 |
| 1. | Model by M. Pogodzińska and S. Sojak | X | X | X | | | |
| 2. | Model by J. Gajdek and D. Stos | X | X | X | | | |
| 3. | Model by E. Mączyńska | X | X | X | | | |
| 4. | Model by A. Hołda | X | X | X | | | |
| 5. | Model by D. Hadasik | X | X | X | | | |
| 6. | Model by D. Wierzba | X | X | X | | | |
| 7. | Model by A. Pogorzelski | X | X | X | | | |
| 8. | Model by J. Janek and M. Żuchowski | X | X | X | | | |
| 9. | Model by B. Prusak | X | X | X | | | |
| 10. | Model by M. Hamrol, B. Czajka and M. Piechocki | X | X | X | | | |
| 11. | Model by P. Stępień and T. Strąk | X | X | X | | | |
| 12. | Model by E. Mączyńska and M. Zawadzki | X | X | X | | | |
| 13. | Model by D. Appenzeller and K. Szarzec | X | X | X | | | |
| 14. | Model by S. Sojak and J. Stawicki | X | X | X | | | |

Source: own work.

Research methods, as proven by economic theory and practice, enable identification of risk signs that are relevant to business continuity of an economic entity. Constantly improved and enriched with new proposals and concepts, they become indispensable in supporting decision-making processes, in particular as components of extended early warning systems (EWS) (Rutkowska, 2006).

The aim of this paper was to present models created by Polish researchers to identify business continuity risk for a business entity and to verify the effectiveness of Polish models which are based on discriminant analysis and are designed to predict bankruptcy and assess the economic and financial situation of the listed company Wawel S.A. 14 most common and most often used models in the conditions of the Polish economy were selected.

The aim of the paper was not to create a new early warning model-system for assessment of business continuity risk, but to indicate the possibility, purpose and justness of the use of the available, especially Polish models for assessment of business

continuity risk to prove the thesis that they are useful in assessment of bankruptcy risk, as they constitute an important complementary element in the comprehensive assessment of the economic and financial situation of an economic entity in the conditions of the Polish economy. Otherwise, it would have been necessary to ask what the point of creating early warning models-systems is and for whom they are created.

The research conducted showed that the analysed forecasting models are of high predictive value. As well as being used to predict bankruptcy, they also enable, in a fast and simple way, without significant costs, examination of the overall economic and financial situation of an economic entity conducting business activity in Poland.

The selection of the company Wawel S.A for analysis confirmed the effectiveness of warning models-systems in predicting lack of bankruptcy risk for an economic entity, as the good economic and financial situation of the analysed company was reflected in the fact that all the results produced by the models showed that Wawel S.A is a healthy company, i.e. no business continuity risk was identified in the analysis period.

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