# THE USE OF BANKRUPTCY MODELS IN THE CONTEXT OF ASSESSING THE MACROECONOMIC BUSINESS ENVIRONMENT

Jakub Malik[1,a,*], Adela Poliakova[1,b] and Hana Bohusova[2,c]

[1]University of Zilina, Faculty of Operation and Economics of Transport and Communications, Univerzitna 1, 010 26 Zilina, Slovakia
[2]Ambis University, Department of Economics, Economy and Public Administration, Lindnerova 1, 108 00 Praha Liben, Czech Republic
[a]malik27@stud.uniza.sk, [b]adela.poliakova@uniza.sk, [c]hana.bohusova@ambis.cz
[*]Corresponding author

***Cite as:*** *Malik, J., Poliakova, A., Bohusova, H., (2024). The use of bankruptcy models in the context of assessing the macroeconomic business environment, Ekonomicko-manazerske spektrum, 18(2), 74-84.*

***Available at:*** *10.26552/ems.2024.2.74-84*

*Received: 4 September 2024; Received in revised form: 21October 2024; Accepted: 29 November 2024; Available online: 31 December 2024*

**Abstract:**
*Research background:* Predicting economic crises and assessing macroeconomic stability are among the most important challenges of the contemporary economy. Bankruptcy models, originally developed to assess the financial health of businesses, are increasingly being used for macroeconomic analysis
*Purpose of the article:* The aim of this paper is to analyse the impact of selected economic and institutional factors on the stability and efficiency of the business environment through discriminant analysis.
*Methods:* The model includes factors such as average quality of education, amount of R&D spending, education spending, financing of the judiciary, duration of litigation, market risk, number of venture capital investors, and government debt to GDP.
*Findings & Value added:* The results show that high education and judiciary spending, along with a higher number of venture capital investors, contribute significantly to the positive results of the model, indicating the need to support these areas to improve economic performance. Conversely, high R&D expenditures and lengthy judicial processes emerged as factors negatively impacting the efficiency of the business environment. The presence of venture capital has proved crucial for market dynamism and growth, while government debt has had only a minimal impact. The findings provide valuable information for policy makers and investors on optimising public spending and promoting key factors that have the potential to improve economic competitiveness and the stability of the business environment.

**Keywords:** discriminant analysis; macroeconomic environment; bankruptcy models

**JEL Classification:** C02; C38; C51

## 1. Introduction

Predicting economic crises and assessing macroeconomic stability are among the most important challenges of the contemporary economy. Bankruptcy models, originally developed to assess the financial health of businesses, are increasingly being used for macroeconomic

analysis (Athanasios et al. 2022). These models provide tools to quantitatively assess the risk of financial distress and thus potentially help to predict the possible bankruptcy or, conversely, the prosperity of specific economies. However, with the development of globally interconnected markets and the rising debt of many countries, the identification and prediction of sovereign bankruptcy is an issue that is increasingly resonating in both economics and political decision-making (Wang and Sun, 2006).

The aim of this paper is to propose a model that would allow to classify the economies of countries into one of two categories: prosperous and bankrupt states. This model is intended to serve as a tool for early recognition of macroeconomic risks and has the potential to provide objective information for economic policy makers and financial stability institutions. Forecasting models based on a combination of financial and non-financial indicators provide valuable information that can be used to assess economic stability and predict the risk of sovereign default, thus contributing to the stabilisation of the global economic environment.

Research on this issue is particularly important because of the increasing instability of the global financial system and the rise of sovereign default risk in the contemporary world. In an environment of high country indebtedness, political conflict and frequent economic shocks, understanding the factors leading to sovereign bankruptcy is essential for designing effective economic policies. In addition, accurate prediction of sovereign default risk can help to protect investors and increase confidence in international markets. The results of this research can provide insights that will enable improved assessment of countries' economic conditions and thus contribute to a more stable and predictable macroeconomic environment. This paper therefore makes a contribution not only to economic theory but also to the practice of international finance and macroeconomic policy.

## 2. Literature review

The process of globalisation has helped the concept of competitiveness to move from the corporate level to the international level. However, the concept of competitiveness is not clearly and precisely defined. Ceptureanu (2016) says that competitiveness is a complex concept that is closely related to factors such as sustainable development, standard of living, productivity and economic growth. He presents a new methodological and theoretical approach to this issue, pointing to the development of competitiveness as a separate field of economics with its own tools and concepts. According to a study by Rajnoha and Lesnikova (2022), higher competitiveness of a country leads to GDP growth, which positively affects sustainability and quality of life. They proposed a mechanism for sustainable competitiveness that includes investment in research, technology and ecology for long-term growth and well-being. At the macroeconomic level, Balkyte and Tvaronaviciene (2010) point to new trends in competitiveness theory, especially in the context of global challenges such as sustainable development. According to the authors, there is a need to develop a concept of 'sustainable competitiveness' that considers economic dynamism, social progress and environmental sustainability. Ketels and Porter (2021) examine why Europe has not made more progress in increasing competitiveness despite numerous EU initiatives, identifying the main problem as the inability to adapt policy approaches to changing conditions. They propose a new role for the EU to support Member States and regions to increase their competitiveness in line with current challenges.

Aranguren and Margo (2020) examine the role of academic institutions in the competitiveness policy-making process. They argue that these organisations can play a key role in the process of adaptive implementation where they serve as founding institutions. Hrabinova

(2011) discusses the concept of the knowledge economy and its impact on competitiveness. She argues that in the current environment where information and communication technologies play a key role, information and knowledge are key drivers of competitive advantage. However, the knowledge economy can also lead to differentiation, particularly in terms of income, which can have a negative impact on social cohesion. Xu (2015) conducted a similar study, analysing the relationship between knowledge competitiveness and industry economic competitiveness, and argues that knowledge competitiveness is a key factor influencing a country's economic competitiveness.

Ruzekova et al. (2020) analyse the impact of the institutional environment on the competitiveness of the national economy, using export performance as a key indicator. Their research showed that export performance is not a universal indicator of competitiveness, suggesting the need to use multi-factor indicators to measure competitiveness more accurately. Therefore, Androniceanu et al. (2020) focused on the multidimensional assessment of competitiveness, welfare, innovation and concluded that there is a direct and strong relationship between competitiveness, innovation and welfare. Governments and organisations that invested more in research in the sense of innovation to increase the competitiveness of their products and services had higher GDP growth and higher levels of well-being of the population. Cieslik and Michalek (2018) identified the following factors increasing welfare, prosperity and economic growth: population growth, working time, technology, specialization, capital, labour and productivity, as well as various institutional factors such as the political system, economic freedom and development. Bencsik and Trunkos (2009), in turn, examined the impact of lifelong learning on quality of life and concluded that in several Western European countries, such as Denmark, Germany and Sweden, where adult education has a long tradition, a high level and quality of adult education is a determinant of quality of life. Sebo and Sebova (2010) approach competitiveness assessment from the perspective of product competitiveness. They propose the use of statistical methods, particularly multicriteria evaluation, as a tool for assessing different aspects of product competitiveness.

Climate change and global warming have forced economists and scientists to broaden the concept of competitiveness to include an environmental aspect. Recently, the term "eco-innovation" has also been used, Loucanova et al. (2017) associate this term with organizational innovations, innovative products or processes that aim to reduce environmental costs, increase social acceptance and ultimately achieve sustainable development. Xie et al. (2019) analysed 209 enterprises belonging to "polluting industries", concluding that green product innovation also has a positive impact on the financial performance of the enterprise. In contrast, Dechezlepretre and Sato (2017) argue that environmental regulations can lead to statistically significant adverse effects on trade, employment, plant location, and productivity in the short run, especially in a well-identified subset of pollution- and energy-intensive industries, because the resulting benefits do not appear to be large enough to outweigh the costs of the regulated entities. Ketels and Porter (2021) published a similar study, concluding that environmental regulation unnecessarily increases costs and thus retards environmental progress. In particular, costs increased due to the need to comply with regulations, neglecting the benefits created by innovation, and this affected the competitiveness of the industry.

## 3. Methodology

Discriminant analysis is a parametric method for determining which weights of quantitative variables or predictors most effectively discriminate between two or more groups of cases better than random selection (Cramer, 2003). This analysis produces a discriminant function that is a

linear combination of the weights and scores of those variables. Discriminant analysis is a frequently used statistical method in many scientific fields, especially in natural and socio-economic disciplines (Kral et al., 2009). Discriminant functions are linear combinations of variables that contribute most to the resolution of *k* groups within multivariate observations. Their goal is to identify a subset of variables that can discriminate groups almost as efficiently as the total set of original variables. After selecting the variables with the highest ability to discriminate between groups, the next step is to order these variables according to their contribution to group separation (Rencher and Christensen, 2012). According to Hair et al. (2014), discriminant analysis encounters a classification problem in which two or more groups are known in advance, and individual observations are classified into one of these groups based on the measured values. Linear discriminant analysis can be said to be a dimensionality reduction method, and its main goal is to project the data into a space of lower dimensionality characterized by higher separability between groups.

First, it is necessary to establish the objective of the analysis, which is to distinguish countries on the basis of the quality of their business environment and to develop a classification rule to correctly assign them to one of two groups: countries with developed business environments (code 0) and countries with underdeveloped business environments (code 1). Data on the countries is then collected, identifying variables describing the business environment, Based on the studies already carried out, the following variables have been identified as relevant for describing the business environment: average quality of education (X1), amount of expenditure on research and development (X2), expenditure on education (X3), expenditure on the judiciary (X4), average number of days to process a civil dispute (X5), market risk (X6), number of venture capital investors (X7), government debt to GDP (X8). These data are prepared for analysis, which involves standardising the values and checking the completeness and accuracy of the records. Table 1 summarises selected data.

*Table 1: Summary of selected data*

| Countries | Country code | X1 | X2 | X3 | X4 | X5 | X6 | X7 | X8 |
|---|---|---|---|---|---|---|---|---|---|
| Netherlands | 0 | 502.33 | 2.2 | 5.20% | 0.27% | 127 | 0.00% | 0.2 | 52.4 |
| Denmark | 0 | 501.00 | 2.9 | 7.80% | 0.17% | 190 | 0.00% | 0.3 | 36.7 |
| Sweden | 0 | 502.33 | 3.4 | 7.60% | 0.27% | 161 | 0.00% | 0.2 | 36.7 |
| Ireland | 0 | 504.67 | 1.2 | 3.50% | 0.30% | 118 | 0.84% | 0.2 | 56 |
| Luxembourg | 0 | 476.67 | 1.2 | 3.60% | 0.17% | 161 | 0.00% | 1.2 | 24.4 |
| Finland | 0 | 516.33 | 2.8 | 6.40% | 0.19% | 300 | 0.39% | 0.2 | 65.8 |
| Germany | 0 | 500.33 | 3.2 | 4.90% | 0.35% | 237 | 0.00% | 0.1 | 69.3 |
| Austria | 0 | 491.00 | 3.2 | 5.40% | 0.32% | 156 | 0.39% | 0.1 | 82.8 |
| Belgium | 0 | 500.00 | 2.9 | 6.40% | 0.22% | 399 | 0.60% | 0.1 | 108.2 |
| Estonia | 0 | 525.33 | 1.6 | 5% | 0.26% | 135 | 0.70% | 0.4 | 18.1 |
| France | 0 | 493.67 | 2.2 | 5.50% | 0.21% | 637 | 0.49% | 0.2 | 112.9 |
| Czech Republic | 0 | 495.33 | 1.9 | 3.90% | 0.32% | 165 | 0.60% | 0.0 | 41.9 |
| Lithuania | 0 | 479.67 | 1 | 3.80% | 0.27% | 117 | 0.84% | 0.1 | 44.3 |
| Cyprus | 1 | 438.00 | 0.6 | 5.80% | 0.27% | 617 | 2.47% | 0.1 | 103.6 |
| Spain | 1 | 482.67 | 1.2 | 4.20% | 0.37% | 468 | 1.58% | 0.0 | 118.4 |
| Portugal | 1 | 492.00 | 1.4 | 5% | 0.30% | 280 | 1.88% | 0.1 | 127.4 |
| Latvia | 1 | 487.33 | 0.6 | 4.40% | 0.37% | 239 | 1.19% | 0.1 | 44.8 |
| Slovenia | 1 | 503.67 | 2 | 4.80% | 0.45% | 350 | 1.19% | 0.0 | 74.7 |
| Poland | 1 | 513.00 | 1.3 | 4.60% | 0.30% | 317 | 0.84% | 0.0 | 53.8 |
| Italy | 1 | 477.00 | 1.4 | 4% | 0.30% | 674 | 2.18% | 0.0 | 150.8 |
| Hungary | 1 | 479.33 | 1.5 | 4.70% | 0.40% | 165 | 1.88% | 0.0 | 76.8 |
| Bulgaria | 1 | 426.67 | 0.8 | 4.10% | 0.61% | 660 | 1.58% | 0.0 | 34.4 |
| Romania | 1 | 428.00 | 0.5 | 3.10% | 0.44% | 168 | 2.18% | 0.0 | 48.8 |
| Slovak Republic | 1 | 469.33 | 0.8 | 3.90% | 0.43% | 204 | 0.84% | 0.0 | 63.1 |
| Greece | 1 | 453.33 | 1.3 | 3.70% | 0.29% | 551 | 3.56% | 0.0 | 193.3 |
| Croatia | 1 | 471.67 | 1.1 | 3.90% | 0.53% | 665 | 2.47% | 0.0 | 79.8 |

*Source: own elaboration*

Countries will be divided into two groups based on the International Institute for Management Development's competitiveness rankings. Discriminant analysis is applied to the data, which is carried out in the statistical software SPSS. The model calculates discriminant functions which are linear combinations of the independent variables. The significance of the individual variables is verified using Wilks' lambda and p-values. Those variables that show statistical significance are considered as key variables.

Next, the assumptions of the discriminant analysis are tested, in particular the equality of covariance matrices between groups, which is verified by the Box test. If the assumptions are met, the discriminatory ability of the model is assessed using canonical correlation and statistical tests. On the basis of the discriminant functions developed, a classification rule is constructed which allows countries to be assigned to groups based on their discriminant scores.

Finally, the model is validated using a test sample or cross-validation methods to verify its accuracy and reliability. The results of the analysis are interpreted in terms of the ability to distinguish between groups, key variables are identified and the applicability of the model to other data is assessed.

## 4. Results

After collecting all the data in SPSS statistics, we build the model via Analyse-Classify-Discriminant, next we consider the output of the program (Table 1).

*Table 2: Comparison of the significance of input variables*

| | Wilks' Lambda | F | df1 | df2 | Sig-value |
|---|---|---|---|---|---|
| Average quality of education | 0.681 | 11.249 | 1 | 24 | 0.003 |
| Expenditure on research and development | 0.550 | 19.649 | 1 | 24 | 0.000 |
| Education expenditure (% of GDP) | 0.827 | 5.022 | 1 | 24 | 0.035 |
| Judicial expenditure (% of GDP) | 0.590 | 16.693 | 1 | 24 | 0.000 |
| Number of days to process a civil dispute | 0.763 | 7.448 | 1 | 24 | 0.012 |
| Market risk | 0.375 | 39.946 | 1 | 24 | 0.000 |
| Venture capital investors | 0.763 | 7.448 | 1 | 24 | 0.012 |
| Government debt to GDP | 0.843 | 4.455 | 1 | 24 | 0.045 |

*Source: own elaboration*

To assess the significance of the input variables, we will compare the last column called sig-value. Before assessing the significance of the input variables, we will set the null and alternative hypothesis at significance level at 5 %:

H0: The input variable is statistically insignificant.

H1: The input variable is statistically significant.

By comparing the individual sig-values with the significance level, we concluded that all variables are statistically significant. The observed parameters are clearly different in countries with developed and countries with underdeveloped business environments.

This is followed by Box's test of the goodness of fit of the covariance matrices. The Box test shows that the covariance matrices can be identical. The log determinants of the covariance-covariance matrices of each group are identical.

*Table 3: Box test for equality of covariance matrices*

| Country development | Rank | Log determinants |
|---|---|---|
| 0 | 8 | 5.146 |
| 1 | 8 | 5.064 |
| Grouped within groups | 8 | 10.075 |

The order and natural logarithms of the determinants are from the group covariance matrices.

*Source: own elaboration*

*Table 4: Result of the Box test*

| **Box's M** | | 119.272 |
|---|---|---|
| F | Estimate | 2.094 |
| | df1 | 36 |
| | df2 | 1,938.156 |
| | Sig-value | 0.000 |
| Tests of the null hypothesis of equal population covariance matrices. | | |

*Source: own elaboration*

In the next section of the deliverables, we evaluate the canonical correlation of the discriminant function and its statistical significance. These correlations are used to assess the resulting quality of the model, and thus whether the canonical discriminant functions clearly distinguish (discriminate) the groups formed. We identify two groups of countries, i. e., one discriminant function. Table 6 shows the values of the correlation coefficients between the discriminant function and each of the explanatory variables; these are also used to assess which variables have the greatest discriminatory ability. Results indicates that the correlation between the discriminant function and the explanatory variables is statistically significant (Sig. $<\alpha$ (0.05)), the resulting canonical correlation is 0.930, i.e. very high. The absolute values of the standardized coefficients of the canonical discriminant function provided us with information about the discriminant property of the selected variables (Table 5).

*Table 5: Canonical correlation of the discriminant function*

| **Eigenvalues** | | | | |
|---|---|---|---|---|
| **Function** | **Eigenvalue** | **Deviation %** | **Cumulative %** | **Canonical correlation** |
| 1 | 6.374[a] | 100 | 100 | 0.930 |
| [a]1 canonical discrimination function was used in the analysis. | | | | |

*Source: own elaboration*

*Table 6: Test of statistical significance*

| **Wilks' Lambda** | | | | |
|---|---|---|---|---|
| **Chi-square** | **Wilks' Lambda** | **Chi-square** | **df** | **Sig-value** |
| 1 | 0.136 | 39.959 | 8 | 0.000 |

*Source: own elaboration*

Table 7 shows that the relationship between the discrimination function and market risk and judicial spending is moderately strong. Further, the dependence between the discriminant function and the number of days to process civil litigation and the amount of government debt is weak.

*Table 7: Coefficients of the discriminant function*

| | **Function** |
|---|---|
| | **1** |
| Average quality of education | 0.400 |
| Expenditure on research and development | -1.791 |
| Education expenditure (% of GDP) | 1.474 |
| Judicial expenditure (% of GDP) | 1.657 |
| Number of days to process a civil dispute | -0.469 |
| Market risk | 0.176 |
| Venture capital investors | 0.303 |
| Government debt to GDP | 1.563 |

*Source: own elaboration*

The table shows that coefficients close to zero have a low impact on the discriminant function; at the same time, negative values of the coefficients rank countries towards alternative group membership. The indicators with the highest discriminatory power are judicial expenditure, government debt to GDP and education expenditure.

*Table 8: Assessment of the strength of dependence of the coefficients*

| | **Function** |
|---|---|
| | **1** |
| Market risk | 0.511 |
| Research and development expenditure | -0.358 |
| Judicial expenditure (% of GDP) | 0.33 |
| Average quality of education | -0.271 |
| Venture capital investors | -0.221 |
| Number of days to process civil litigation | 0.221 |
| Education expenditure (% of GDP) | -0.181 |
| Government debt to GDP | 0.171 |
| Pooled within-group correlations between discriminant variables and standardized canonical discriminant functions<br>Variables sorted by absolute magnitude of correlation within the function. | |

*Source: own elaboration*

Through the non-standardized coefficients of the canonical discriminant function, the resulting discriminant equation of the prediction model for EU countries can be written, it takes the form:

$$y_M = -19{,}901 + 0{,}019 \cdot X_1 - 2{,}663 \cdot X_2 + 1{,}1316 \cdot X_3 + 19{,}844 \cdot X_4 - 0{,}003 \cdot X_5 + 0{,}299 \cdot X_6 + 1{,}404 \cdot X_7 + 0{,}04 \cdot X_8 \quad (1)$$

Discrimination scores (Z-scores) for each country can be computed through the non-standardized coefficients of the canonical discriminant function. On the basis of its comparison with the centroids, a decision can be made to classify a country into the group with a developed business environment or with the remaining business environment.

*Table 9: Centroids for a general model for assessing the business environment of countries*

| **Landscape development** | **Function** |
|---|---|
| | **1** |
| 0 | -2.426 |
| 1 | 2.426 |
| Unstandardized canonical discriminant functions evaluated at group means | |

*Source: own elaboration*

SPSS also uses the model constant to calculate the centroids, thus making a targeted correction so that the weighted average of the centroids (weighted by the number of countries in each group) is zero. Comparing the Z-score values with zero then determines the outcome, a positive value indicates a developed business environment and a negative value indicates a backward business environment.

*Table 10: Classification table*

| | | **Landscape development** | **Expected group membership** | | **Total** |
|---|---|---|---|---|---|
| | | | **0** | **1** | |
| Original | Count | 0 | 13 | 0 | 13 |
| | | 1 | 1 | 12 | 13 |
| | % | 0 | 100 | 0.0 | 100.0 |
| | | 1 | 7.7 | 92.3 | 100.0 |
| 96.2 % of the original merged cases are correctly classified. | | | | | |

*Source: own elaboration*

Considering the reported results, it can be summarized that the model for countries with developed business environments has 100 % classification ability. And the model for countries with underdeveloped business environment has 92.3 % classification ability. However, caution should be exercised because if the model is validated on the same data on which the model was built, its classification ability is overestimated.

## 5. Discussion

The results of the discriminant analysis suggest a number of interesting conclusions that are consistent or contrast with the existing literature. The average quality of education (X1) has a moderately positive effect on the observed outcome, suggesting that education plays an important role. This conclusion is supported by Ponomarenko et al. (2022) who emphasize the need to implement total quality management (TQM) philosophy in educational institutions in order to increase their competitiveness. Similarly, Iatagan (2015) highlights the importance of quality assurance and international cooperation in higher education to improve the competitiveness of universities.

On the other hand, the negative impact of R&D spending (X2) contrasts with the findings of Ravselj and Aristovnik (2019), who have shown long-run positive effects of R&D on firm performance. This difference may be explained by regional specificities or the short-run nature of the data analysed. However, Sofrankova et al. (2018) points out that in the V4 countries, higher R&D expenditures contribute to the development of innovation activities and improved competitiveness, suggesting that the effectiveness of these investments may depend on their regional and sectoral context.

The positive impact of spending on education (X3) and a quality judiciary (X4) on the outcome is consistent with the findings of Kirovska et al. (2022), who identify positive associations between the efficient functioning of the judicial system and foreign investment inflows. Conti and Valentini (2018), in turn, emphasize that an independent judiciary promotes entrepreneurship and lowers barriers to entry. Thus, judicial support is a key factor to increase economic stability and competitiveness.

Market risk (X6) and the number of venture capital investors (X7) show a significant positive impact on the result, suggesting that a dynamic business environment can support economic growth. This conclusion is in line with the work of Bobakova and Cepelova (2014), who highlight the low level of venture capital use in Slovakia and its potential as a key factor for financing innovation. Moreover, Hnoievyi et al. (2022) stress that the development of venture capital is essential for enhancing innovation performance and economic growth. The slightly positive impact of government debt (X8) suggests that as long as debt is manageable, it may not be a major obstacle to economic growth. The findings of Kiselakova et al. (2018) show that effective public financial management and increasing R&D spending in the education sector can contribute significantly to improving the competitiveness of CEE countries.

Finally, Lysokon et al. (2024) emphasise the importance of strategic management of education and continuous improvement of the quality of the teaching process, and this comprehensive approach can inspire policies aimed at the efficient use of public resources. Habermeier (2007) points to the key role of education and technological innovation in building the macroeconomic strength of countries, reinforcing the need for investment in education quality and the promotion of innovation.

On the basis of the above, it is recommended to focus on increasing the efficiency of public spending, supporting venture capital and the judiciary, and optimising R&D spending in the long term. Future research could analyse the links between macroeconomic factors and long-term competitiveness trends at the global level.

## 6. Conclusions

Discriminant analysis has proven its effectiveness in distinguishing countries with developed business environments from those with underdeveloped business environments. The main findings suggest that all selected variables have a statistically significant effect on intergroup

discrimination. The most significant variables included spending on the judiciary, government debt to GDP, and spending on education, with these factors playing a key role in the quality of the business environment. The model showed high classification accuracy, with countries with developed business environments correctly classified with 100% accuracy and countries with underdeveloped environments correctly classified with 92.3% accuracy. The overall classification ability of the model was 96.2%. The canonical correlation between the discriminant function and the explanatory variables was 0.930, indicating a very strong ability of the model to discriminate between groups. This study contributes to the theory of business environment assessment by identifying the key factors influencing the quality of the business environment. The use of discriminant analysis demonstrates how statistical methods can be used to effectively differentiate countries based on their economic and institutional characteristics. The results support the importance of investments in education, judicial efficiency and public financial management in improving the business environment. For policy makers, these findings provide concrete recommendations for improving the business environment. Emphasis should be placed on increasing spending on education and research, reducing the time taken to resolve legal disputes and managing public debt efficiently. The model can be used to regularly assess countries and identify areas for improvement.

Although the model showed high accuracy, it should be noted that it was validated on the same data that were used to build it. This may lead to an overestimation of the classification ability of the model. In addition, the data used for the analysis is limited to a specific time frame, which may affect its generalizability to other periods or regions. The choice of variables was also influenced by data availability, which may mean that some important factors may have been omitted. Future research should aim to broaden the data base and include a wider range of variables that may influence the business environment. Validation of the model should be carried out on an independent test sample or through cross-validation. Another challenge is to examine dynamic changes in the business environment over time in order to track trends and impacts of policy decisions. Future research could also apply discriminant analysis in combination with other methods, such as machine learning or Bayesian models, to improve prediction ability and classification accuracy.

In conclusion, this analysis provides valuable insights into the factors influencing the business environment and provides a solid basis for further research and policy implementation aimed at improving countries' economic and institutional environments.

**Author contributions:** All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

**Funding:** This paper is an output of the project 006ŽU-4/2022 Improving the quality of education through the synergy of accounting theory and practice in the field of study economics and management.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.

**Conflicts of Interest:** The authors declare no conflict of interest.

## References

Androniceanu, A. M., Kinnunen, J., Georgescu, I., & Androniceanu, A. (2020). A Multidimensional Approach to Competitiveness, Innovation and Well-Being in the EU Using Canonical Correlation Analysis. *Journal of Competitiveness*, *12*(4), 5-21.

Aranguren, M. J., & Magro, E. (2020). How can universities contribute to regional competitiveness policy-making? *Competitiveness Review: An International Business Journal*, *30*(2), 101-117.

Athanasios, A., Charalampos, K., & Eleni, K. (2022). Assessing the effectiveness of tax administration in macroeconomic stability: evidence from 26 European Countries. *Economic Change and Restructuring*, *55*(4), 2237-2261.

Balkyte, A., & Tvaronaviciene, M. (2010). Perception of competitiveness in the context of sustainable development: facets of "sustainable competitiveness". *Journal of business economics and management*, *11*(2), 341-365.

Bencsik, A., & Trunkos, I. (2009). Economic changes demand to move from lifelong learning to life wide learning. *Problems of Education in the 21st Century*, *15*, 20-28.

Bobakova, V., & Cepelova, A. (2014). Venture capital as an alternative source of funding and its use in the Slovak Republic. In *Vision 2020: Sustainable Growth, Economic Development, and Global Competitiveness* (Vols. 1–5, pp. 128–138).

Ceptureanu, E. G. (2016). Considerations on competitiveness. *Quality-Access to Success*, *17*(155), 125–128.

Cieslik, A., & Michalek, J. J. (2018). Firm-level determinants of direct and indirect exports: empirical evidence for CEE and MENA countries. *Economic Research-Ekonomska Istrazivanja*, *31*(1), 982-992.

Cramer, D. (2003). *Advanced quantitative data analysis*. McGraw-Hill Education (UK).

Conti, R., & Valentini, G. (2018). Super partes? Assessing the effect of judicial independence on entry. *Management Science*, *64*(8), 3517-3535.

Dechezlepretre, A., & Sato, M. (2017). The impacts of environmental regulations on competitiveness. *Review of environmental economics and policy*, *11*(2), 183-206.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2014) *Multivariate Data Analysis*. 7th Edition, Pearson Education, Upper Saddle River.

Habermeier, H. U. (2007). Education and economy – An analysis of statistical data. In *Proceedings of the Symposium and Forum Education in Materials Science, Technology and Engineering* (pp. 55–66).

Hnoievyi, V. H., Koren, O. M., & Kviatkovska, L. A. (2022). Realization of venture capital in providing an innovative model of economic development. *Academy Review*, (1), 35-41.

Hrabinova, R. (2011). Competitiveness vs. knowledge economy. In *Aktualne pohlady na konkurencieschopnost a podnikanie – nove vyzvy: International Conference on Business and Competitiveness of Companies* (pp. 162–166). Bratislava: University of Economics Bratislava, Faculty of Business Management.

Iatagan, M. (2015). Quality of education – A guarantee of institutional competitiveness. In *21st International Conference on The Knowledge-Based Organization (KBO)* (Vol. 21, pp. 592–599).

Ketels, C., & Porter, M. E. (2021). Rethinking the role of the EU in enhancing European competitiveness. *Competitiveness Review: An International Business Journal*, *31*(2), 189-207.

Kirovska, Z., Gjozinska, B., & Jadrovska, L. T. (2022). The Impact of the Efficiency of the Judicial System in Attracting Foreign Direct Investments in the Republic of North Macedonia. *Zagreb International Review of Economics & Business*, *25*(1), 21-32.

Kiselakova, D., Sofrankova, B., Cabinova, V., Onuferova, E., & Soltesova, J. (2018). The impact of R&D expenditure on the development of global competitiveness within the CEE EU countries. *Journal of competitiveness*, *10*(3), 34-50.

Kral, P., Kanderova, M., Kascakova, A., Nedelova, G., & Bojdova, V. (2009). *Viacrozmerne statisticke metody so zameranim na riesenie problemov ekonomickej praxe*.

Loucanova, E. et al. (2017). Aspekty podnikatelskych subjektov realizujucich inovacny proces eko-inovacii. *In: Eko-inovacie ako nástroj konkurencieschopnosti*.

Lysokon, I., Vasyliuk, T., Barulina, Y., Razmolodchykova, I., & Zakharova, H. (2024). Educational management in higher education institutions: strategies for quality and competitiveness management. *Cadernos Educacao Tecnolagia E Sociedade*, *17*, 73-84.

Ponomarenko, N., Polyansky, P., Shkurat, I., Romanenko, M., & Tolochko, S. (2022). Quality management of higher education for increasing the competitiveness of labour resources. *International Journal for Quality Research*, *3*(16), 817-830.

Rajnoha, R., & Lesnikova, P. (2022). Sustainable competitiveness: How does global competitiveness index relate to economic performance accompanied by the sustainable development? *Journal of competitiveness*, *14*(1), 136-154.

Ravselj, D., & Aristovnik, A. (2019). The impact of R&D expenditures on corporate performance: The case of world R&D companies. In *Proceedings of FEB Zagreb 10th International Odyssey Conference on Economics and Business* (Vol. 1, No. 1, pp. 658–667).

Rencher, A. C., & Christensen, W. F. (2012). *Methods of multivariate analysis*. John Wiley & Sons.

Ruzekova, V., Kittova, Z., & Steinhauser, D. (2020). Export performance as a measurement of competitiveness. *Journal of Competitiveness*, *12*(1), 145-160.

Sebo, J., & Sebova, M. (2010). Measuring competitiveness using multi-criteria evaluation. *Journal of Competitiveness*, (1), 33–40.

Sofrankova, B., Kiselakova, D., Cabinova, V., & Onuferova, E. (2018). R&D expenditure as a factor of the competitiveness and innovation activity development within the V4 countries. In *Innovation management and education excellence through Vision 2020* (Vols. I–XI, pp. 4811–4821).

Xie, X., Huo, J., & Zou, H. (2019). Green process innovation, green product innovation, and corporate financial performance: A content analysis method. *Journal of business research*, *101*, 697-706.

Xu, F. (2015). Industry Knowledge Competitiveness Advances Economic Competitiveness. In *Proceedings of the 2012 3rd International Conference on E-Business and E-Government-Volume 04* (pp. 29-35).

Wang, L., & Sun, C. (2006). Cluster analysis of national growth competitiveness. In *Proceedings of the 1st International Conference on Product Innovation Management* (pp. 242–246).