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# Relationships Between the Beneish M-Score and Bankruptcy Models: Insights from Financial Models in Czech Manufacturing Firms\*

Jaroslav Svoboda<sup>1</sup>, Ilona Berková<sup>2</sup>, Jaroslava Pražáková<sup>3</sup>,  
Marie Vejsadová Dryjová<sup>4</sup>

## Abstract

Many well-known cases worldwide demonstrate that even if companies appear financially strong, their actual accounting reality may differ. Uncovering fraudulent behaviour is difficult, so auditors, financial authorities, stock exchanges, etc., must detect and eliminate it. This paper aims to determine the relationship between the Beneish M-score model and two bankruptcy models, Altman's Z-score and the Czech IN05 model. It verifies if there are significant differences in how these models classify firms, and whether the Beneish model aligns with them. The application part focuses on the 3,568 firms from the Czech manufacturing industry between 2015 and 2022, and uses the Bowker test for symmetry, working with paired data. The Beneish model showed that 34% of enterprises are at risk of fraud. The results of the analyses further confirmed the existence of systematic and statistically significant differences between the classifications of companies according to the Beneish model and the bankruptcy models Altman Z-Score and IN05. Therefore, if companies tend to go bankrupt, it is not possible to determine

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<sup>1</sup> Assistant Professor, Faculty of Economics, University of South Bohemia, Studentská 13, České Budějovice, Czech Republic. Scientific affiliation: accounting, auditing, IFRS. E-mail: [svoboda@ef.jcu.cz](mailto:svoboda@ef.jcu.cz) (Corresponding author).

<sup>2</sup> Assistant Professor, Faculty of Agriculture and Technology, University of South Bohemia, Studentská 1668, České Budějovice, Czech Republic. Scientific affiliation: corporate finance, data analysis. E-mail: [berkova@fzt.jcu.cz](mailto:berkova@fzt.jcu.cz).

<sup>3</sup> Assistant Professor, Faculty of Economics, University of South Bohemia, Studentská 1668, České Budějovice, Czech Republic. Scientific affiliation: corporate finance, auditing. E-mail: [smolaj@ef.jcu.cz](mailto:smolaj@ef.jcu.cz).

<sup>4</sup> Assistant Professor, Faculty of Economics, University of South Bohemia, Studentská 13, České Budějovice, Czech Republic. Scientific affiliation: accounting, auditing. E-mail: [maj.vejsadova@gmail.com](mailto:maj.vejsadova@gmail.com).

*whether they will tend to manipulate statements or not. Similarly, a tendency to manipulate financial statements cannot be demonstrated in companies with good financial health.*

**Keywords:** *Creative accounting, Beneish model, Altman model, IN model, Industrial enterprises*

**JEL classification:** *G33, M41, M42*

## 1. Introduction

The definition of fraudulent financial reporting is more or less uniform. The International Standards on Auditing describe fraud as an intentional act committed by one or more members of management, persons charged with the governance of an entity, or by one or more employees or third parties, in which deception is used to obtain an unfair or unlawful advantage.

Fraudulent financial reporting involves intentional misstatements, including the failure to disclose amounts or figures that should have been disclosed in the financial statements with the aim of misleading users of the financial statements. It may be caused by management's efforts to manipulate profits to affect their perception of the entity's performance and profitability. Such manipulation of profits can begin with minor measures or inappropriate adjustments to assumptions and changes in management's judgments. Pressures and motives can lead to such a number of interventions increasing to such an extent that fraudulent financial reporting arises. Such a situation may arise where, due to pressure to meet market demands or to maximise its remuneration based on performance, management deliberately takes positions that lead to fraudulent financial reporting caused by material misstatements in the financial statements. In some entities, management may be incentivized to significantly reduce (material) profits to minimize tax liability or increase profits to secure financing from the bank.

The study applies the Beneish M-score, a metric that employs financial variables to discern instances of profit manipulation by companies, in conjunction with the bankruptcy models of Altman Z-score and the Czech model IN 05.

## 2. Literature review

According to International Auditing and Assurance Standards Board (IAASB, n.d.), fraudulent financial reporting is, for example, the manipulation of accounting records or documents based on which the financial statements were prepared, the incorrect presentation of events, transactions or material information in the financial statements, or the failure to disclose them, or the intentional misapplication of accounting principles relating to amounts, classification, presentation or method

of disclosure. In addition, Schilit (2002) also includes the misuse of accounting principles, the procedures used to measure, identify, report, and disclose business transactions in fraudulent financial reporting. According to Zhou and Kapoor (2011), fraudulent financial reporting has unfortunately become a common economic and social problem with a rapidly growing negative impact not only on investors, but also on the stability of domestic and global economies.

The meaning of the term *fraud* can vary depending on the situation and the person defining it. One main fact emerges from the diverse definitions of fraud, namely that, despite the obvious differences in the concept of fraud, fraud remains an act that is usually committed against a company or a person, by an individual or a group of individuals, for personal benefit or the benefit of their organization (Owusu et al., 2022). Wells (2013) divides fraudulent financial reporting into two subcategories, namely financial fraud and non-financial fraud, where the subcategory of financial fraud further includes overvaluation of assets or income in the form of accruals, fictitious income, concealment of liabilities and expenses, misdisclosure and mispricing of assets, and undervaluation of assets or income. Singleton and Singleton (2010) add that the most common type of fraud in financial statements is associated with the overestimation of revenues, where, in some cases, companies simply fabricate sales. Non-financial fraud is most often carried out through internal and external documents.

To prevent fraudulent conduct, it is essential to have an ethical corporate culture based on strong values, with management setting an example for employees through their own conduct. However, according to the results of the Brennan and McGrath (2007) investigation, in 71% of the cases examined, the CEO or chairman of the board was responsible for fraud. For this reason, the prevention of financial statement fraud must start at the top management level, according to the authors. The fact is also confirmed by Kasztelnik and Jermakowicz (2024), who state that the main perpetrators are CFOs and CEOs who aim to overestimate financial profitability and hide the actual theft.

Manipulation of financial statements, often associated with creative accounting, is a complex issue addressed in many professional articles. The topic of creative accounting has been monitored since the second half of the last century. Still, the boom of creative accounting is attributed to the period before the global financial crisis in 2007 (Savova, 2021). Creative accounting is generally perceived from a negative point of view, as the manipulation of financial statements to mislead the users of those statements, as reported by Murineanu (2024), Khaneja and Bhargava (2016), Khatri (2015), or Akpanuko and Umoren (2018). However, Strakova and Zvarikova (2021) concluded that creative accounting can also help in certain situations, such as avoiding bankruptcy by misleading users of financial statements. Iredele et al. (2022) also see a favourable aspect in creative accounting, namely that a company using creative accounting becomes more competitive in its operating

market. However, different geographies perceive creative accounting differently (Jones, 2021). It may be difficult, and sometimes impossible, for the parties involved to discern the reality and effect of accounting manipulation of financial statements, either due to insufficient knowledge and skills or an unwillingness to engage in detailed analysis. This assertion is supported by the findings of Brennan and McGrath (2007). The authors contend that identifying financial statement manipulation is challenging due to the numerous methods by which it can be executed.

The detection and manipulation of financial statements are complex processes involving various methods and models. These methods are tested on real cases, including modified accounting records to simulate creative accounting techniques or fraudulent behaviour (Kouřilová et al., 2018). The methods are often combined to increase efficiency in detecting manipulations in financial statements (Bina et al., 2023; Denich, 2021; Drábková, 2016; Durana et al., 2022; Blazek et al., 2020).

Detection of manipulation of financial statements is most often carried out using publicly available data from companies' financial statements, additionally, also through non-financial information from public sources using several tools, such as the use of analytical software, or mathematical and statistical methods in financial statements (Gee, 2014), or machine learning methods (Bolton & Hand, 2002). Detection models related to the detection of manipulation of financial information presented in financial statements are described by Yurt and Ergun (2015), Strakova (2020), and Bartov et al. (2000). Most of the detection models that make up the theory of accounting quality and earnings management focus on centre on accruals because accruals are easier to manage compared to earnings and cash flow (Yurt & Ergun, 2015; Strakova, 2020).

Techniques, goals, and motivations of creative accounting in the Czech Republic were investigated by, e.g., Honková and Myšková (2024). The results indicate that the predominant techniques employed are open accounting for additional sales, deferral of deliveries, recognition of revenues from partial deliveries, and a change in the value of inventories.

Common goals and motivations included reducing earnings volatility, supporting stock prices, increasing revenue or cash flow, and creating a consensus forecast for analysts' earnings.

Manipulative interference with the financial statements affects the financial health of the undertakings concerned to the benefit of the manipulator. In the standard evaluation of corporate financial health, there is a concerted effort to minimise subjectivity in selecting key indicators and their relative importance. In this context, specialised creditworthiness and bankruptcy models are employed. From this standpoint, it can be argued that creditworthiness and bankruptcy models

created by financial analysts on real data of specific companies in specific countries and times are more objective. It is posited that the models created can be used to predict whether the company is generating profit or whether it is on the verge of bankruptcy.

The first multivariate bankruptcy prediction model was developed by Altman in the late 1960s. The original Altman Z-Score model (based on Multiple Discriminant Analysis) has attracted the scientific community's attention since its inception. Its response to it has been to create countless competing models (Altman, 1968). Since then, Prof. Altman and his team have been intensively refining the original model through many modifications; for example, the ZETA® (Altman et al., 1977) or model utilized the non-financial indicators (Altman et al., 2016). Further, a great number of studies have focused on adapting or adjusting these models to the conditions and environment of the national economy. In addition to modifying the existing models, new models have been created. The first application of prediction models to the Czech environment was made by Neumaierová and Neumaier (2005), who determined four trustworthiness indices, i.e., IN95, IN99, IN01, and IN05.

### 3. Methodology and data

The paper aims to examine the interrelationship between the detection model of financial reporting manipulation and the evaluation of companies using bankruptcy models. The Albertina database, provided by Dun and Bradstreet (n.d.), was used for the selected analysis. In the time period 2015 to 2022, a field according to the NACE classification – section C, the manufacturing industry was chosen. This section includes the mechanical, physical, or chemical transformation of materials or components into new products (goods). The production process results in either finished products intended for use or consumption or semi-finished products intended for further processing (Český statistický úřad, n.d.). Financial statements were obtained from a stable sample of 3,568 enterprises (i.e., 24,976 records for the selected period). The theoretical basis consists of scientific publications and other sources listed in the list of sources.

The Beneish M-score was chosen as the selected model for detecting manipulation of financial reporting. It uses a set of financial variables to identify whether a company has manipulated its profits. The model was developed based on the assumption that there is a correlation between specific financial values and cases of financial fraud. This makes it possible to identify companies that engage in profit management practices. The initial model included five variables and was designed to evaluate the likelihood of profit manipulation between companies with a large discretionary temporal resolution (Beneish, 1997). Concerning the structure of the financial statements of Czech companies, where the type breakdown of the profit

and loss account is primarily reported, the evaluation was carried out using a model with 5 indicators.

$$M\text{-score} = -6.065 + 0.823 \times DSRI + 0.906 \times GMI + 0.593 \times AQI + 0.717 \times SGI + 0.107 \times DEPI \quad (1)$$

where:

DSRI = days' sales in receivables index; GMI = gross margin index; AQI = asset quality index; SGI = sales growth index; DEPI = depreciation index.

The M-score threshold is -2.22. If the calculated M-score for a given company is lower than the stated limit value, it is unlikely that the company would be a manipulator of accounting data. Otherwise, if the calculated M-score is higher than the stated limit value, the company is likely engaged in purposeful manipulations in its financial statements.

Regarding the bankruptcy models under consideration, the Z-score model (1983 edition) has been selected for its established global recognition and utilisation in academic and professional contexts. Altman (1983) established cut-off points for the interpretation of this variant of the Z'-score, which categorizes companies into three risk zones: the safe zone (Z'-score > 2.7), the grey zone (1.2 < the Z'-score < 2.7) and the distress zone (Z'-score < 1.2), in which companies with a Z-score of less than 1.2 are considered to be in financial distress and have a high probability of bankruptcy within the next two years.

IN 05 was chosen as a model presenting typical conditions for the Czech Republic (Neumaierová & Neumaier, 2005):

$$IN05 = 0.13 \times x_1 + 0.04 \times x_2 + 3.97 \times x_3 + 0.21 \times x_4 + 0.015 \times x_5 \quad (2)$$

where:

$x_1$  = assets / liabilities;  $x_2$  = EBIT = interests;  $x_3$  = EBIT / assets;  $x_4$  = revenue / asset;  $x_5$  = current assets / short-term liabilities and maximum value of variable  $x_2$  is 9.

If the resulting value of the IN 05 index is higher than 1.6, then the company creates value, and if it is lower than 0.9, the company does not create value but destroys it. A grey zone is defined between the limit values. This model is presented with a full calculation methodology due to its specificity in the conditions of the Czech Republic. Companies that either create value or are loss-making were selected for the analysis. Companies classified in the *grey zone* were excluded from further analysis.

Numerous global cases have shown that even when companies appear financially strong; their accounting reality can be significantly different. This discrepancy is at the core of the conflict between owners and managers (Wells, 2013), which is

described in detail in the Agency Theory<sup>1</sup>. Within this theory, managers exhibit a strong motivation to manipulate financial statements in order to meet targets set in bonus plans, secure additional financing, or prevent a decline in the company's market value. For this reason, our primary research question is the theoretical and empirical connection between earnings manipulation detection models (Beneish M-score) and bankruptcy prediction models (Altman Z-score and IN 05), aiming to increase the predictive power and complexity of financial analysis.

For statistical testing, the following null hypotheses have been formulated:

- *H01: The classification of enterprises according to the IN05 and Altman Z-score models is symmetrical, i.e., there are no systematic differences between the models in categorizing the companies.*
- *H02: The classification of enterprises according to the Beneish model and the IN05 model is symmetrical, i.e., there are no systematic differences in results between these models.*
- *H03: The classification of companies according to the Beneish model and the Altman model is symmetrical, i.e., there are no systematic inconsistencies in the classification of corporate risk.*

The rejection of any of the hypotheses mentioned above will be interpreted as evidence of the existence of a systematic difference between the classifications of the respective models. For statistical comparison, the hypotheses were adapted according to a more detailed specification of the set of enterprises, based on the key indicators: turnover, total assets, and debt percentage. Each indicator was then divided into four quartiles, thus enabling the consideration of companies' varying size and risk profiles in the multidimensional analysis.

Table 1: Descriptive statistics on variables used for classification

Variable	Average	Minimum	Maximum	Standard deviation
Assets (in ths. CZK)	501 971,76	3	82 486 364	2 095 505,86
Turnover (in ths. CZK)	660 192,21	0	167 734 155	3 217 301,26
Debt (%)	0,54	-15,98	558,99	3,78

Source: Author's calculations based on Albertina database (2015-2022)

<sup>1</sup> The basic idea comes from Smith's (1776) An inquiry into the nature and causes of the wealth of nations. W. Strahan and T. Cadell.

The Bowker symmetry test was selected to test the hypotheses, which is an extension of the McNemar test for paired data with more than two categories (Bowker, 1948). The test is suitable for paired categorical variables with the same set of values. It examines whether the transitions between categories in both models are symmetrical, i.e., whether the models do not systematically differ in how they are classified. In this study, the objective was to ascertain the existence of any potential interdependence between the outcomes of one model and those of another.

A chi-square test of independence was performed in addition to the Bowker test to compare the results of the Altman Z-score and IN05 models, which have the same category structure. This makes it possible to verify whether there is a statistically significant relationship between the classifications of farms according to these two models. At the same time, Cramer’s V was calculated to evaluate the strength of this dependence. All calculations were performed in RStudio.

#### 4. Results and discussion

When applying the standard M-score threshold (−2.22) to the studied sample of Czech companies, the model identified 34% of the monitored companies as likely financial reporting manipulators (i.e., companies with a high risk of fraud). The remaining 66% of the monitored companies were not identified by the model as suspected of manipulation and therefore fell into a low risk of fraud.

For a more detailed analysis of the relationship between the probability of accounting manipulation and the structural characteristics of firms, the firms were divided into quartiles according to the amount of debt, assets and turnover (quartile 1 depicts 25% of firms with the lowest values, quartile 4 depicts 25% of firms with the highest values). In each category, the frequency of observations classified as probable manipulators and unlikely manipulators according to the Beneish M-score was recorded. This situation is shown in Table 2.

Table 2: Categorization of M-score by company size

Quartile	Probability of manipulation		Probability of manipulation		Probability of manipulation	
	NO	YES	NO	YES	NO	YES
	Indebtedness		Assets		Turnover	
1	4 096 (66 %)	2 138 (34 %)	2 183 (35 %)	4 051 (65 %)	2 082 (33 %)	4 152 (67 %)
2	4 555 (73 %)	1 679 (27 %)	4 226 (68 %)	2 008 (32 %)	4 307 (69 %)	1 927 (31 %)
3	4 365 (70 %)	1 870 (30 %)	4 922 (79 %)	1 313 (21 %)	4 916 (79 %)	1 319 (21 %)
4	3 482 (56 %)	2 752 (44 %)	5 167 (83 %)	1 067 (17 %)	5 193 (83 %)	1 041 (17 %)

Source: Author’s calculations based on Albertina database (2015-2022)

A 5-parameter model was used for the evaluation. Czech accounting standards primarily allow for the reporting of costs and revenues in the income statement according to type. Alternative purpose-based reporting is permitted. However, this approach requires internal classification of costs based on management accounting, which is then transferred to financial accounting for reporting purposes. This is reflected here in the SGAI indicator, which captures administrative costs. The current state of purpose-based reporting is, therefore, voluntary and is practiced by companies only in very exceptional cases. It can only be found in large companies that report according to IFRS. It is mandatory only for companies listed on public markets. A similar topic was also addressed by Dimitrijević and Danilović (2017), for example. The disparities in outcomes between the 5-parameter and 8-parameter models are addressed in the research by Durana et al. (2022) or Srebro et al. (2021). In this study, Durana's findings are evaluated concerning alternate perspectives, as outlined in the works of Wiszniowski (2020) and Timofte et al. (2021). The choice of a suitable model depends on several factors, such as time series, number of companies, sectors, but also the propensity of the environment to tax evasion.

Companies with the highest indebtedness are more likely to have accounting manipulation, though this is also true of companies with lower indebtedness. This could be due to management pressure on highly indebted companies to report better results, while low-debt companies might do better to obtain more bank loans. In companies classified by assets and turnover, the probability of accounting manipulation decreases with increasing size.

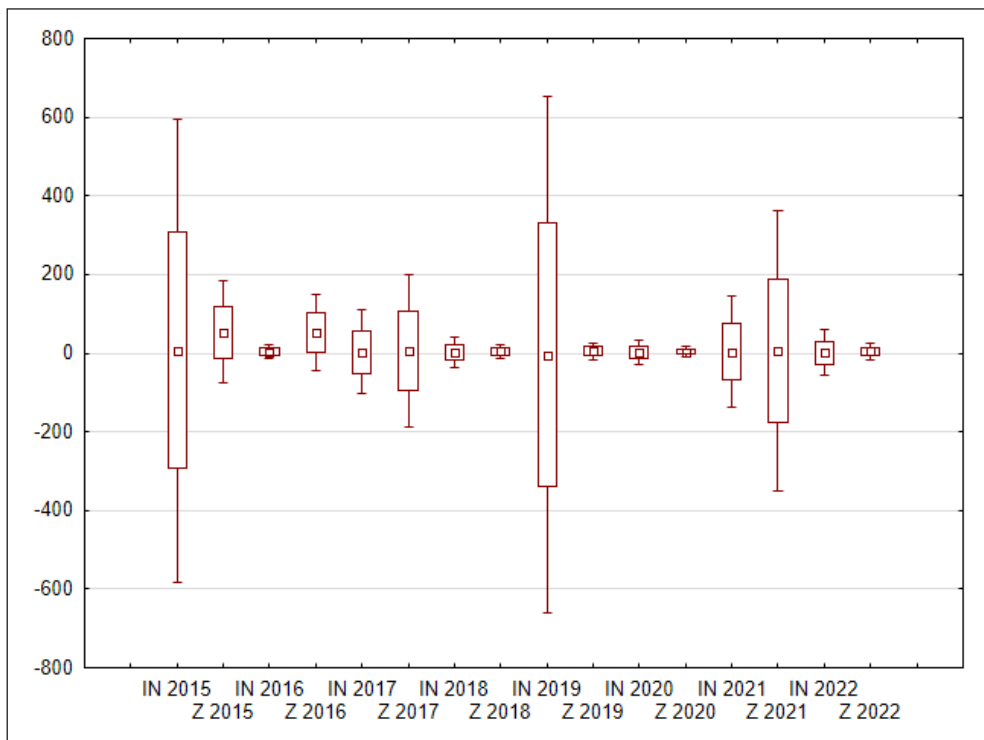
Although there are a number of models suitable for identifying creative accounting, the Beneish model is one of the most widely used worldwide. Its effectiveness is confirmed by a study by Shakouri et al. (2021), according to which it achieved a success rate of up to 73% in detecting fraudulent behaviour. The calculations performed in the study by Srebro et al. (2021) only exceptionally exceed the 40% threshold for the possibility of fraud. Švábová et al. (2020) adjusted the Beneish M-score and created their model for detecting fraudulent behaviour, with a success rate of 32.7% for identifying manipulative behaviour, while that of non-manipulative behaviour was 38.4%.

Consistent with the abovementioned papers, Bína et al. (2023) indicate a higher risk of using creative accounting methods for credit-burdened enterprises. The study, which relies on the outputs of the prevailing model, identifies that the manipulation of financial statements is predominantly observed in firms facing bank credit constraints. This group of enterprises may also be more inclined to engage in creative accounting practices. Concerning the tested bankruptcy models, they state that the IN05 and Z-score models primarily concern themselves with liquidity, debt, and profitability ratios. Enterprises with a high proportion of assets that are also indebted do not perform well in terms of liquidity and at the same time only achieve a low return on assets, which worsens the enterprise's overall performance.

### 4.1. Comparison of models for assessing financial health: Altman Z-Score and IN05

The course of the financial health of the analysed companies within the monitored period is shown in Figure 1. The individual boxes show the results achieved by the IN05 model and Altman Z-Score in the individual monitored years. The graph clearly shows differences in the values achieved, where IN 05 achieves larger ranges between the maximum and minimum values, while Z-Score is more consistent. When evaluating the mean values (in our case, it is the median), IN 05 shows more balanced results. In the Z-Score, it is possible to identify higher median values achieved in 2015 and 2016, corresponding to a higher proportion of enterprises classified as financially healthy. Overall, the most balanced values of bankruptcy models were reported in 2020, identically for both models used.

Figure 1: Financial health according to Altman Z-score and IN05



Source: Author's calculations based on Albertina database (2015-2022)

Furthermore, it was tested whether the classification of models according to Altman and IN05 is symmetrical, i.e., there are no systematic differences between these two models in classifying enterprises into individual categories. For a better overview, the division of companies in our group into individual categories is shown in Table 3.

Table 3: Categorization of companies according to Altman Z-score and IN05

Classification	Altman Z-Score		IN05	
Tendency to bankruptcy	1 621	6.5%	5 405	21.7%
No tendency to bankruptcy	16 475	66.1%	11 923	47.8%
Grey Zone	6 841	27.4%	7 609	30.5%
On the whole	24 937	100%	24 937	100%

Source: Own calculations based on Albertina database (2015-2022)

The chi-square of the independence test was used to determine the degree of agreement between the classifications of enterprises according to Altman Z-score and the Czech IN05 model. This test evaluated the data as a whole, comparing the aggregate values of individual classifications. A chi-square independence test was used to determine the agreement between enterprise classifications according to Altman Z-score and the Czech IN05 model. This test evaluated data as a whole, comparing the aggregate values of individual classifications. The results (test statistics ( $\chi^2$ ): 2808.42, degree of freedom [df]: 2, p-value: <0.001) rejected the hypothesis of no systematic differences between classifications, proving a connection between the IN05 model and Altman Z-score. Cramer's coefficient  $V = 0.237$  indicates the relationship's weak to medium strength, showing models are not interchangeable.

The relationship between the IN05 and Altman Z-score models was also analysed through paired comparison. The results of the Bowker symmetry test ( $\chi^2$  test statistics = 784.907; degrees of freedom = 2; p-value < 0.001) led to the rejection of the H01 null hypothesis. This result points to statistically significant and systematic differences between the classifications of enterprises according to both models.

Both models operate within the ratio analysis framework, utilising sales and EBIT to total assets as key performance indicators. However, a distinguishing aspect of each model lies in the distinct variables employed to calculate liquidity and indebtedness. Another factor to consider is the width of the grey zone interval, while for the IN05 model, this interval is more than half as narrow. It is also necessary to consider the conditions under which the model was created. IN05 is directly applicable to the Czech economic and accounting requirements. Consequently, the result of this model should be accorded greater weight than Altman Z-score, which is a foreign product (Bína et al., 2023).

## 4.2. Comparison of the Beneish model and IN05

An overview of the distribution of companies into individual categories was created in Table 4 to test another hypothesis. This hypothesis examined whether there are differences between the Beneish model and IN05.

Table 4: Categorization of companies according to IN05 and Beneish

Classification	Unlikely manipulation	Probable manipulation
Tendency to bankruptcy	2 044 (12%)	3 361 (19%)
No tendency to bankruptcy	4 097 (24%)	7 826 (45%)

Source: Author’s calculations, Albertina database (2015-2022)

Based on the performed Bowker symmetry test for all enterprises (without their classification) according to the Beneish model and the IN05 model, excluding the grey zone, the following results were obtained:  $X^2 = 72.63$ ,  $df = 1$ ,  $p < 0.001$ . The p-value obtained is significantly lower than the commonly used significance levels, which means the H2 null hypothesis is rejected. This result suggests the existence of statistically significant and systematic differences between the classifications of enterprises according to the Beneish model and the IN05 model. Therefore, if companies tend to go bankrupt (31% of companies), it is impossible to determine whether they will tend to manipulate statements. Similarly, a tendency to manipulate financial statements cannot be demonstrated in companies with good financial health (69%).

Using all three selected classifications (i.e., assets, turnover, indebtedness), the resulting values were identical to the analysis of the unsorted set. Only the results for companies in the second quartile by turnover appeared to be interesting. It was revealed that the models do not show systematic differences in results (at a significance level of 1%). The resulting values in this case were:  $X^2 = 5.69$ ,  $df = 1$ ,  $p = 0.017$ .

## 4.3. Comparison of the Beneish model and Altman Z-score

The next step investigated whether there are systematic differences between the Beneish model and the Altman model. The results (test statistics  $X^2 = 3,549.00$ ,  $df = 1$ ,  $p < 0.001$ ) rejected the null H3 hypothesis in favour of the alternative, i.e., that there are statistically significant and systematic differences between the classifications of enterprises according to the Beneish model and the Altman model. There are, therefore, consistent discrepancies in the classification of enterprises into risk categories. The division of companies into individual categories is shown in Table 5.

Table 5: Categorization of companies according to Altman Z-score and Beneish

Classification	Unlikely manipulation	Probable manipulation
Tendency to bankruptcy	834 (5%)	787 (4%)
No tendency to bankruptcy	5 509 (30%)	10 966 (61%)

Source: Author’s calculations based on Albertina database (2015-2022)

The rejection of the H3 hypothesis suggests the presence of consistent discrepancies between the Beneish model and Altman Z-score model in classifying enterprises into risk categories. Consequently, it is not feasible to ascertain, based on financial health, whether a company will have a propensity to manipulate financial statements. Following the findings of this study, Agustia et al. (2020) suggest that there is an absence of a relationship between bankruptcy risk and profit-management behaviour when firms implement one of two business strategies involving cost management differentiation, thereby mitigating the risk of bankruptcy. However, it should be noted that the risk of bankruptcy is subject to change throughout a company’s lifecycle (Khanh & Thu, 2019), and the manipulation of profits can be more significant during the initiation and decline phase (Hussain et al., 2020). In contrast, a study conducted in the V4 countries demonstrates that profit manipulation is prevalent in companies experiencing financial distress and in the grey zone (as defined by Altman Z score), where the financial future of a company is impossible to predict (Valášková et al., 2021).

The present study did not identify any correlation between companies experiencing financial distress and the presence of links. Valášková et al., 2021 have stated that the Beneish M-score was combined with Altman Z-score in two models based on discrimination analysis. These models were applied to a sample of 11,105 business relationships, revealing significant relationships between these financial situations. It has been demonstrated that businesses confronted with financial challenges, or those operating within the so-called *grey zone*, tend to manipulate profit. Another similar analysis was conducted by Parikh (2024), who selected five Indian pharmaceutical companies as a sample. The results indicated minimal risk of financial manipulation in most companies, with one company showing sporadic high-risk years, which raises some concerns but does not significantly threaten its overall financial stability. In contrast, Rossi et al. (2020) found the opposite dependence. The findings from the case study indicate that financial instability is a predictor of bankruptcy. However, it is also a factor that hinders effective profit management.

## 5. Conclusion

The analysis of the detection of possible manipulation of financial statements was carried out in a sample of more than 3.5 thousand Czech industrial companies over

a seven-year period. The Beneish model showed that the risk of fraud could be identified for 34% of the companies in the total set of enterprises. If the analysis was extended to include a more detailed classification of companies, then in terms of the amount of assets and turnover, the trend is such that the probability of manipulation with accounting data decreases with the company's increasing size. In the case of sorting by indebtedness, the companies with the highest indebtedness and the companies with the lowest indebtedness have the highest probability of manipulating accounting.

The Bowker symmetry test was used to evaluate the relationship between the Beneish model and the bankruptcy models (Altman Z-Score, IN05), which indicated the existence of statistically significant and systematic differences between the classifications of companies according to the Beneish model and the Altman Z-Score and IN05 models. Therefore, if companies tend to go bankrupt, it is impossible to determine whether they will tend to manipulate statements. Similarly, a tendency to manipulate financial statements cannot be demonstrated in companies with good financial health. Therefore, it is not possible to determine on the basis of financial health whether the company will tend to manipulate financial statements. The rejection of the hypotheses indicates consistent discrepancies between the IN05 and Altman Z-score models in classifying enterprises into risk categories. This discrepancy may be due to the different constructions and orientations of the two models – IN05 is a model developed for the Czech business environment, which emphasizes specific financial indicators relevant to the local market; The Altman Z-score is an internationally recognized model that uses a combination of several financial ratios to predict bankruptcy, but may have limited accuracy when applied to different economies or industries.

The present research adopts an innovative approach to examining the interrelationships between models. This approach facilitates the evaluation of agreement or the incompatibility of classifications at the individual companies' level. This is in contrast to other research based on data aggregations, which can create biases. The methodology employed in this study is the Bowker test, which functions with paired data, i.e., classifications of a specific company according to different models, while each unit is analysed separately in all periods.

The main limitation of our study is the use of the five-parameter Beneish model rather than the more comprehensive eight-parameter version. This choice was necessary to ensure the robustness and representativeness of the sample, as it allowed us to analyse a set of more than 3,500 companies, most of which are not publicly listed – an analysis that would not have been feasible using the eight-parameter model. Importantly, prior research has shown that the five-parameter model exhibits similar trends comparable to the eight-parameter model (see, e.g., Srebro et al., 2021; Durana et al., 2022). We also recognize that Beneish's model was originally developed within the US GAAP accounting environment.

Nevertheless, several previous studies have successfully applied it in other accounting systems, including the European environment. Although differences between US GAAP and Czech accounting regulations may affect the absolute values of individual indicators, they are unlikely to affect their mutual relationships, which are central to the objectives of this analysis.

One of the main directions for further research would be an international or cross-sector comparison of the results obtained using Beneish's model. Such a comparison would make it possible to assess the extent to which the model's informative value differs in different accounting, institutional, and sectoral conditions.

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## Odnosi između Beneishovog M-rezultata i modela bankrota: Primjeri financijskih modela u češkim proizvodnim poduzećima

Jaroslav Svoboda<sup>1</sup>, Ilona Berková<sup>2</sup>, Jaroslava Pražáková<sup>3</sup>,  
Marie Vejsadová Dryjová<sup>4</sup>

### Sažetak

Mnogo je poznatih slučajeva diljem svijeta koji pokazuju da čak i tvrtke koje izgledaju financijski jake, njihova računovodstvena stvarnost može biti drugačija. Teško je otkriti manipulativno ponašanje, pa ga revizori, financijske vlasti, burze itd. moraju detektirati i eliminirati. Ovaj rad ima za cilj utvrditi odnos između Beneishovog M-rezultata i dvaju modela stečaja, Altmanovog Z-rezultata i češkog IN05 modela. Provjerava se da li postoje značajne razlike u načinu na koji ovi modeli klasificiraju tvrtke i je li Beneishov model usklađen s njima. Aplikacijski dio fokusira se na 3568 tvrtki iz češke prerađivačke industrije između 2015. i 2022. godine te koristi Bowkerov test simetrije, radeći s uparenim podacima. Beneishev model pokazao je da je 34% poduzeća u riziku od prijevare. Rezultati analiza dodatno su potvrdili postojanje sustavnih i statistički značajnih razlika između klasifikacija tvrtki prema Beneishevom modelu i modelima stečaja Alman Z-Score i IN05. Stoga, ako tvrtke imaju tendenciju bankrota, nije moguće utvrditi hoće li biti sklone manipuliranju izvještajima ili ne. Slično tome, tendencija manipuliranja financijskim izvještajima ne može se pokazati u tvrtkama s dobrim financijskim zdravljem.

**Ključne riječi:** kreativno računovodstvo, Beneishev model, Altmanov model, IN model, industrijska poduzeća.

**JEL klasifikacija:** G33, M41, M42

<sup>1</sup> Docent, Faculty of Economics, University of South Bohemia, Studentská 13, České Budějovice, Republika Češka. Znanstveni interes: računovodstvo, revizija, IFRS. E-mail: svoboda@ef.jcu.cz (Autor za korespondenciju).

<sup>2</sup> Docent, Faculty of Agriculture and Technology, University of South Bohemia, Studentská 1668, České Budějovice, Republika Češka. Znanstveni interes: korporativne financije, analiza podataka. E-mail: berkova@fzt.jcu.cz.

<sup>3</sup> Docent, Faculty of Economics, University of South Bohemia, Studentská 1668, České Budějovice, Republika Češka. Znanstveni interes: korporativne financije, revizija. E-mail: smolaj@ef.jcu.cz.

<sup>4</sup> Docent, Faculty of Economics, University of South Bohemia, Studentská 13, České Budějovice, Republika Češka. Znanstveni interes: računovodstvo, revizija. E-mail: maj.vejsadova@gmail.com.