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## THE APPLICABILITY OF THE EDMISTER MODEL FOR THE ASSESSMENT OF CREDIT RISK IN CROATIAN SMEs

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### **Abstract:**

In this paper the applicability of the Edmister model for the assessment of credit risk in small and medium sized enterprises (SMEs) was examined by testing the hypothesis that the Edmister model is applicable for predicting financial difficulties of SMEs in Croatia. Data from a data base of financial reports of SMEs in Croatia managed by FINA, as well as internal data and records of one of the major banks in Croatia were used. Data of 822 enterprises were collected and analysed. The Edmister Z-score was calculated for all 822 SMEs and finally only enterprises with the Edmister Z-score lower than 0.47 or higher than 0.53 (a total of 760 enterprises) were selected to the final research sample. A method of classification analysis and compliance measurement Cohen's Kappa were used for testing the research hypothesis. On the basis of the research results, it can be concluded that the Edmister model is not applicable for predicting financial difficulties of SMEs in Croatia.

*Keywords:* the Edmister model, credit risk analysis, Croatian SME's, financial difficulties, discriminant analysis, classification method, Cohen's Kappa.

*Jel Classification:* E51; G32

### **INTRODUCTION**

Majority of models that predict financial difficulties and estimate credit risk for enterprises, as the Beaver model (Beaver 1966), Altman model (Altman 1968), Deakin model (Deakin 1972.) or Ohlson model (Zenzerovic and Perusko 1980), have been developed on samples of large PLCs. An additional drawback of these models is the fact that the model variables are different financial ratios taken for a single time period; hence the models do not include trends of observing movemens. The Edmister model,

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applied in this research, is one of few credit risk models developed on SMEs and based on observing trends in financial ratios of individual enterprises compared to ratios of other companies operating in the same branch of activity. Namely, various studies has indicated that a business crises does not happen overnight, on the contrary, it is forebode for about four years prior to its manifestation, through a decrease in income or a continuous slowdown in profit compared to GDP (Osmanagic Bedenik 2009). In addition, the Edmister model has been developed on a sample of SMEs with a default status, i.e. in financial distress. Most other models are developed on models of enterprises which underwent bankruptcy, which is the worst case scenario and ultimate phase of financial distress, manifested at an earlier stage as problems with honouring payments in due date. For creditors it is crucial to spot warning signs indicating financial distress, in order to cut down potential loss resulting from business relations with enterprises in financial difficulties, by means of acceleration claims or other financial instrument.

The objective of this research is to examine the applicability of the Edmister model for evaluation of credit risk of SMEs in Croatia. We have tested the research hypothesis that the Edmister model is applicable for the prediction of financial difficulties in SMEs in Croatia – is. Since, as far as we know, the reliability of using the Edmister model in predicting financial difficulties has not been tested on a sample of Croatian enterprises, this research has an applicable value due to its contribution to the development of SMEs credit risk analysis in Croatia as well as fostering similar research in the region.

## **THEORETICAL FRAMEWORK**

Robert O. Edmister, was among the first to begin research of small enterprises (SE), as a part of his Doctoral thesis at Purdue University, Lafayette, Indiana (Edmister 1972). Prior to his scientific career Edmister worked in the banking industry as a senior credit analyst, which streamlines the focus of his thesis towards predicting failures of small enterprises based on analysis of financial ratios. He has proven that individual financial indicators, as well as relations between specific financial indicators, are not predictors of financial difficulties of small enterprises, it was necessary to calculate at least a three year trend of various financial ratios and groups of ratios in order to predict financial distress.

The research included 19 most commonly used financial ratios for predicting financial difficulties at that time. The financial indicators/ratios used in the Edmister model have been shaded, since they proved to be statistically significant when predicting financial distress in small enterprises:

Short-term liabilities / Equity	Indebtedness
(Equity and Short-term liabilities) / Tangible assets	
Tangible assets / Equity	
Total liabilities / Equity	
Short-term assets / Total liabilities	Liquidity
(Short-term assets - Inventories) / Short-term liabilities	
Short-term assets / Short-term liabilities	
Inventories / Working capital	
Working capital / Total assets	Profitability
EBIT / Sales revenues	
EBIT / Total assets	
EBIT / Equity	Coverage
Cash flow <sup>a</sup> / Total liabilities	
Cash flow / Short-term liabilities	Turnover
Total assets / Sales revenues	
Tangible assets / Sales revenues	
Equity / Sales revenues	
Inventories / Sales revenues	
Working capital / Sales revenues	

<sup>a</sup> Cash flow = Gross profit (EBIT) + Depreciation

Edmister used two samples for his research, depending on the tested hypothesis, a one year sample of 562 small enterprises and a three year sample of 42 small enterprises. Namely, for the testing of predictive abilities of the trends in movement of financial indicators important for predicting financial difficulties, the sample had to fulfil the existence of a consecutive three year financial report criteria, which brought the initial number of 562 enterprises down to 42. Although this happened to be a relatively small sample for defining discriminant function, Edmister concluded that, while proving some research hypothesis which do not include a trend in movement of indicators the result was the same discriminant function on both samples, the samples were similar and therefore the discriminant function resulting from the three year sample can be used for testing other hypothesis and can be transferred to a larger sample.

The indicators were calculated for 562 small enterprises divided in the following major activity group: manufacturing 22%, trade 70%, services 8% of the sample. Furthermore, a calculation of average indicators for each group, led to a subdivision into 29 sub-groups, i.e. 29 activity branches. The resulting indicators were classified into 3 quartiles: first, median and third, with a purely statistic meaning, the lowest values belonging to the first, the medium values to the second and the highest values to the third quartile. Edmister defined the trend as changes in individual indicators in the same direction within a consecutive three year period. In the case an indicator demonstrated variety in direction of movement during a consecutive three year period, it was considered without a trend.

The following model was defined by means of a multivariate discriminant analysis on a three year sample:

$$Z_j = 0.951 - 0.423 X_{1j} - 0.293 X_{2j} - 0.482 X_{3j} + 0.277 X_{4j} - 0.452 X_{5j} - 0.352 X_{6j} - 0.924 X_{7j}$$

where:

- $Z_j$  – discriminant Z-score of discriminant function for object  $j$  of the discriminant function;
- $X_{1j}$  – independent variable 1 for object  $j$ ; if the *Cash flow / Short-term liabilities* ratio is in the first quartile (less than 0.05) it is coded 1, and 0 in other situations → very low coverage of short-term liabilities with cash flow can indicate financial distress;
- $X_{2j}$  – independent variable 2 for object  $j$ ; if the *Equity / Sales revenue* is in the first quartile (less than 0.07) it is coded 1, and 0 in other situations → financial distress is more likely in enterprises with a low percentage of equity in their sales revenues irrespective of their activity branches;
- $X_{3j}$  – independent variable 3 for object  $j$ ; if the ratio *Working capital / Sales revenue* compared to the ratio of the activity branch to which the enterprise belongs, is in the first quartile (less than -0.02) it is coded 1, and 0 in other situations → a relatively high turnover of working capital is more probable in enterprises in financial distress;
- $X_{4j}$  – independent variable 4 for object  $j$ ; if the three year average ratio *Short-term liabilities / Equity* compared to the ratio of the branch activity to which the enterprise belongs, is in the first quartile (less than 0.48) it is coded 1, and 0 in other situations → a low relation of debt and capital with respect to its branch activity, lowers the probability of distress;
- $X_{5j}$  – independent variable 5 for object  $j$ ; if the *Inventories / Sales revenue* ratio compared to the ratio of its branch activity shows an upward trend and is still in the first quartile (less than 0.04) it is coded 1, and 0 in other situations → an enterprise with a significantly high and decreasing inventory turnover regarding its branch activity will most likely suffer financial distress in the future;
- $X_{6j}$  – independent variable 6 for object  $j$ ; if the *Quick ratio*<sup>2</sup> compared to its branch activity ratio, is in the first quartile (less than 0.34) and shows a downward trend it is coded 1, and 0 in other situations → an enterprises with low and decreasing Quick ratio will more probably experience financial distress and;
- $X_{7j}$  – independent variable 7 for object  $j$ ; if the *Quick ratio* with respect to its branch activity ratio shows an upward trend it is coded 1, and 0 in other situations → increasing Quick ratio in relation to its branch activity can indicate a possibility of financial distress (this was an unexpected result compared to the common everyday belief, but could be explained by the fact that enterprises with a growing trend in Quick ratio compared to its branch activity ratio, can have issues with insufficient inventories to meet demand and consequently experience a loss in market share).

By calculating the discriminant function described above, Edmister came to the following conclusions:

- Enterprises with a Z-score less than 0.47 were enterprises with default status;
- Enterprises with a Z-score higher than 0.53 were enterprises with sound performance;

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<sup>2</sup> (Short-term assets – Inventories) / Short-term liabilities

- Within the previously mentioned two values is a grey zone requiring additional analysis, extra effort and credit analysis skills. Therefore, quality information related to the management quality, market position, competitive strategy and all other important elements necessary for acquiring an overall performance assessment of a company should be taken into account.

## DATA AND METHODOLOGY

### Research sample

Data from an internal data base of one of the largest banks in Croatia have been used for this research. Bank client data was compared to other enterprises in the same activity branch using the data base of FINA (Financial agency). Firstly, 1895 SMEs were selected due to their credit exposure in 2010 out of the bank data base (they have been granted a loan in 2010 or in the years prior to 2010). Secondly, 107 enterprises, which had been given a default status/NPL<sup>3</sup> in 2010 (payments delayed over 90 days), were selected from the bank data base on loan repayments out of 1895 SMEs.

For the analysis of the feasibility of the Edmister model on SMEs in Croatia it was necessary to make a 3 consecutive year analyses of financial reports prior to the year when the enterprise was given a default/NPL status. For the years 2007 to 2009 a sample of 1895 enterprises was compared to FINA's data base for 2007, 2008 and 2009. Finally, a sample of 822 enterprises with three consecutive year financial reports was extracted. However, 35 enterprises were given a default/NPL status in 2010 and 787 enterprises repaid their loans regularly in 2010, and the bank had no reserves for them between 2007 and 2009.

Representativeness of the defined sample, from the statistics point of view and the hypothesis testing point of view, has been proven by means of a specialized web application<sup>4</sup> based on the: total number of SMEs that have reported their annual financial reports for 2009 – 4550, number of SMEs in the banks research sample – 760, portion of SMEs with the default status/NPL within the SME bank clients sample – 4.26% and the required level of reliability – 95%.

### Data analysis

FINA's data were analysed as follows:

1. All data from financial reports necessary for calculating variables, i.e. financial indicators according to the Edmister model – Short-term assets, Inventories, Short-term liabilities, Equity, Sales revenue, Depreciation and Gross profit were extracted for enterprises from FINA's data base for the years 2007, 2008 and 2009. Subsequently all ratios according to the Edmister model were calculated:

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<sup>3</sup> NPL – Nonperforming loan

<sup>4</sup> <http://www.surveysystem.com/sscalc.htm>; web application used in scientific article Zenzerovic 2009, 1–16.

Cash flow/Short-term liabilities, Equity/Sales revenue, Working capital/Sales revenue, Short-term liabilities/Equity, Inventories/Sales revenue as well as the Quick ratio.

2. It was not necessary to calculate the average value regarding the activity branches for the first two ratios according to the Edmister model, only the value of the first quartile for 2009 which was expressed in the following way:  
 First quartile (Free cash flow/Short-term liabilities 2009) = 0.0487501  
 First quartile (Equity/Sales revenue/Turnover 2009) = 0.073629;
3. For all other ratios of the Edmister model, average values were calculated for each branch of activity respectively, for 2007, 2008 and 2009, except the ratio for Working capital/ Sales revenue which was calculated only for 2009, for each branch of activity, as defined in the model itself;
4. Individual ratios of enterprises from FINA's data base were divided by the average ratio for each branch of activity respectively and the first quartiles were calculated:  
 First quartile (*Working capital/Sales revenue* for 2009) = -0.22008  
 First quartile (*Inventories /Sales revenue* for 2009) = 0.125877  
 First quartile (*Quick ratio* for 2009) = 0.657274  
 First quartile (three year average value of *Short-term liabilities/Equity*) = 0.3155.

The average value of specific ratios according to the activity branches are presented in the table 1.

**Table 1.** Average value of ratios in the Edmister model according to the activity branches

Activity branches	Working capital/ Sales 2009	Short-term liab/ Equity 2007	Short-term liab/ Equity 2008	Short-term liab/ Equity 2009	Inventories/ Sales 2007	Inventories/ Sales 2008	Inventories/ Sales 2009	Quick ratio 2007	Quick ratio 2008	Quick ratio 2009
Manufacture of food products and beverages	8%	73%	88%	89%	22%	22%	23%	0.85	0.73	0.72
Manufacture of wood and wooden products	15%	73%	83%	72%	23%	25%	28%	0.79	0.75	0.71
Manufacture of textiles and leather	14%	65%	80%	72%	26%	26%	25%	0.82	0.76	0.74
Manufacture of petroleum, chemical and other non-metallic products	16%	58%	68%	73%	17%	17%	18%	1.10	0.99	0.96
Manufacture of metal, electrical and electronic products including motor vehicles	9%	95%	118%	113%	18%	16%	18%	0.89	0.82	0.82
Other manufacturing	17%	47%	18%	20%	12%	14%	14%	1.47	1.34	1.08
Electricity, water supply, sewerage and waste management	5%	30%	38%	39%	5%	4%	4%	1.11	1.02	1.00

**Table 1.** (continued)

Activity branches	Working capital/Sales 2009	Short-term liab/Equity 2007	Short-term liab/Equity 2008	Short-term liab/Equity 2009	Inventories/Sales 2007	Inventories/Sales 2008	Inventories/Sales 2009	Quick ratio 2007	Quick ratio 2008	Quick ratio 2009
Construction	12%	16%	23%	23%	18%	23%	23%	0.79	0.79	0.81
Trade of motor vehicles	6%	116%	142%	125%	12%	14%	15%	0.69	0.62	0.71
Wholesale trade, except of motor vehicles	11%	149%	154%	150%	13%	14%	14%	0.95	0.89	0.90
Retail trade, except of motor vehicles	2%	144%	177%	163%	14%	15%	16%	0.71	0.68	0.66
Transportation and storage	-1%	65%	74%	73%	6%	6%	6%	0.93	0.91	0.86
Accommodation, food and beverage service activities	-34%	25%	30%	36%	4%	4%	8%	0.60	0.59	0.48
Information and communication	16%	88%	108%	86%	7%	10%	11%	1.19	1.09	1.15
Professional, scientific and technical activities	35%	56%	61%	62%	10%	10%	12%	1.50	1.28	1.35
Other service activities	35%	100%	135%	121%	8%	9%	7%	1.16	1.18	1.35

Bank clients sample was selected from a given data base of enterprises with all ratios calculated. Additionally, enterprises from the bank client sample along with their name, registration and type of activity, were accompanied with additional variable — default/NPL status for 2010, to which variable 1 was attached if the client received this status in 2010; a 0 was attached if the client was creditworthy/non-default. Then the following ratios were calculated with respect to the average branch activity ratio for analysed samples obtained from the banks internal records data base:

- Working capital/Sales revenue for 2009,
- Short-term liabilities/Equity for 2007, 2008 and 2009 as well as the average value for the three year period,
- Inventories/ Sales revenue for 2007, 2008 and 2009,
- Quick ratio for 2007, 2008 and 2009.

In order to calculate Edmister's Z-score, it was necessary to calculate values for 7 binary variables, marked as  $x_1, x_2, \dots, x_7$  and with the following meaning:

- $x_1$  becomes 1 if Cash flow/Short-term liabilities ratio in 2009 is in the first quartile, i.e. less than 0.0487501, otherwise the value is 0;
- $x_2$  becomes 1 if Equity/Sales revenue ratio in 2009 is in the first quartile, i.e. less than 0.073629, otherwise the value is 0;
- $x_3$  becomes 1 if Working capital/Sales revenue ratio in 2009 in relation to Working capital/Sales revenue ratio of its activity branch is in the first quartile, i.e. less than -0.22008, otherwise the value is 0;

- $x_4$  becomes 1 if the average three year ratio of Short-term liabilities/Equity in relation to Short-term liabilities/Equity of its activity branch is in the first quartile, i.e. less than -0.3155, otherwise the value is 0;
- $x_5$  becomes 1 if the Inventories/Sales revenue ratio in relation to the Inventories/Sales revenue ratio of its activity branch has had an upward trend in the last three years, and in 2009 was in the first quartile, i.e. less than 0.125877, otherwise the value is 0;
- $x_6$  becomes 1 if the Quick ratio in relation to the Quick ratio of its activity branch has had a downward trend in the last 3 years, and in 2009 was in the first quartile, i.e. less than 0.657274, otherwise the value is 0;
- $x_7$  becomes 1 if the Quick ratio in relation to the Quick ratio of its activity branch has had an upward trend in the last 3 years.

Edmister Z-score for the analysed enterprises was calculated using the obtained variables  $x_1, x_2, \dots, x_7$  and the equation previously mentioned.

## RESEARCH RESULTS

The obtained values of Edmister Z-score have the following meaning:

- Enterprises with Z-scores less than 0.47 were classified as default/NPL enterprises;
- Enterprises with Z-score higher than 0.53 were classified as financially stable enterprises;
- Between the two presented values there is a grey zone.

Edmister himself pointed out that the grey zone required additional analyses, what was explained in the part 2 of this paper. Hence, enterprises with Edmister Z-score between 0.47 and 0.53 were excluded from further research. There were 62 enterprises in total which fulfilled the given criteria, with 3 of them not honouring payment to the bank for over 90 days, i.e. with the default/ NPL status, and 59 regular/non-default bank clients. Hence the research sample was cut to 760 enterprises with 32 being in default.

In developing a model for predicting crises, it is necessary to obtain a percentage of precisely classified enterprises, i.e. take into account the number of correctly classified enterprises with the default/NPL status and the number of correctly classified enterprises with non-default/regular status. This is exactly how the applicability of the Edmister model on SMEs in Croatia was analysed.

The obtained parameters were tested further through applicability analysis of the Edmister model using classification analysis. Interpretation of parameters for predicting financial distress can lead to two main types of errors when classifying enterprises (White and Sondhi 1994):

1. *Type I error* occurs when a specific enterprise is classified as non-default, but in reality it has been given a default/NPL status;
2. *Type II error* occurs when a specific enterprise is classified as default and in reality is a non-default client.

In both cases, a misevaluation took place and consequently a wrong decision is made. From the point of view of the enterprise's creditor, in the first case loss occurs



due to a risky loan which cannot be repaid by the client. Real loss depends on collateral, and is definitely a situation which creditors try to avoid by additionally enhancing their risk assessment competences. In the second case, an opportunity loss in income arises due to the fact that an enterprise with full capability of payment and positive credit rating is misevaluated by the creditor. Consequently, it can lead to loss in market share since the enterprise will most definitely try to make a credit arrangement with a different creditor who has more developed risk assessment competences and a more accurate evaluation of SMEs.

By means of classification analysis of the obtained Edmister Z-score values of bank clients, the following results were revealed:

**Table 2.** Results of the classification analysis of Edmister Z-score

		Edmister Z-score		
		Default	Non-default	Total
Bank	Default	25	7	<b>32</b>
	Non-default	382	346	<b>728</b>
	<b>Total</b>	<b>407</b>	<b>353</b>	<b>760</b>
	% Default	78.13%	21.88%	100.00%
	% Non-default	52.47%	47.53%	100.00%

On the basis of presented data, type I error and type II error are calculated and the following results are reached:

Error type I =  $7/760 = 0.92\%$ ;

Error type II =  $382/760 = 50.26\%$ .

The total error is 51.18% therefore, on the basis of the classification analysis, it can be concluded that the Edmister model deviates significantly in evaluation of the credit risk in SMEs in Croatia, i.e. there is only 48.82% probability that the model will predict financial difficulties correctly. Hence, it can be concluded that the Edmister model cannot be applied for predicting financial failure in SMEs in Croatia. The analysis has shown that the least deviation of the Edmister model from the bank sample according to activity branches was in the wood manufacturing with 33% of total error, while the largest deviation was in transport and storage with 80% and other manufacturing with 75%. Detailed presentation of deviations according to activity branches is shown in the table 3.

**Table 3.** Deviation of the Edmister model according to the activity branches

Activity branches	Type I error	Type II error	Total	Bank sample	Total error
Manufacture of food products and beverages	1	32	33	65	50.77%
Manufacture of wood and wooden products	0	6	6	18	33.33%
Manufacture of textiles and leather	0	6	6	15	40.00%
Manufacture of petroleum, chemical and other non-metallic products	0	14	14	32	43.75%
Manufacture of metal, electrical and electronic products including motor vehicles	0	31	31	68	45.59%
Other manufacturing	0	9	9	12	75.00%
Electricity, water supply, sewerage and waste management	0	15	15	31	48.39%

**Table 3.** (continued)

Activity branches	Type I error	Type II error	Total	Bank sample	Total error
Construction	3	35	38	83	45.78%
Trade of motor vehicles	2	19	21	36	58.33%
Wholesale trade, except motor vehicles	0	99	99	208	47.60%
Retail trade, except motor vehicles	0	41	41	68	60.29%
Transportation and storage	1	23	24	30	80.00%
Accommodation, food and beverage service activities	0	7	7	16	43.75%
Information and communication	0	11	11	20	55.00%
Professional, scientific and technical activities	0	18	18	35	51.43%
Other service activities	0	16	16	23	69.57%
<b>Total</b>	<b>7</b>	<b>382</b>	<b>389</b>	<b>760</b>	<b>51.18%</b>

Analysis of reliability based on a statistic measurement better known as Cohen's Kappa is normally used for verifying how well a certain model functions in reality, i.e. how reliable it is. Namely, this method compares the difference between results obtained on the basis of the tested model and real results. The results of Cohen's Kappa can be assorted into six categories, with the following meaning (Landis and Koch 1977):

< 0	Very small compliance
0.0 – 0.20	Small compliance
0.21 – 0.40	Acceptable compliance
0.41 – 0.60	Medium strong compliance
0.61 – 0.80	Significant compliance
0.81 – 1.00	Almost perfect compliance

In this paper, the compatibility of predictions of enterprises' financial status is analysed, according to the bank data analysed over a three year period and data obtained by calculating Edmister Z-score. For the Edmister model to be applicable to SMEs in Croatia, and for the results obtained in this manner to be reliable, the Kappa value should be higher than 0.81.

Kappa is calculated according to the following formula (Howell 1997):

$$\kappa = \frac{\sum f_o - \sum f_E}{N - \sum f_E},$$

where:

- o  $f_o$  – obtained frequency in compliance of the two models (number of coincidences/compliances of the two models – numbers on the diagonal);
- o  $f_E$  – expected frequency of compliance of the two models (expected number of coincidences/compliances of the two models);
- o  $N$  – total number of observations in the sample.

The table of compliance and inconsistency between Edmister model and the bank samples, along with the expected compliance frequency (in brackets) is shown diagonally in the table 4.

**Table 4.** Compliance of the Edmister model with the bank sample in the default status categorisation

		Edmister Z-score		
		Default	Non-default	Total
Bank	Default	25 (17.14) <sup>a</sup>	7	<b>32</b>
	Non-default	382	346 (338.14)	<b>728</b>
	Total	<b>407</b>	<b>353</b>	<b>760</b>

<sup>a</sup> Expected frequency status default = probable status default according to Edmister x probable status default according to bank sample x N = (407/760) x (32/760) x 760

Based on the values obtained the following Kappa value was calculated:

$$k = \frac{25 + 346 - 17.14 - 338.14}{760 - 17.14 - 338.14} = 0.04$$

The measured reliability of the Edmister model for predicting financial failures of SMEs is 0.04, meaning that there is very little compliance between predicting financial difficulties according to Edmister and the real bank sample. Consequently, it can be concluded that, according to the calculated indicators, the Edmister model is not a reliable model for predicting financial distress of SMEs in Croatia.

## CONCLUSION

The possibility of applying the Edmister model for evaluating credit risk was examined in this paper. The hypothesis that the Edmister model is applicable for predicting financial difficulties of SME's in Croatia was tested. Data from a data base of financial reports of SMEs in Croatia managed by FINA, as well as internal data and records of one of the major banks in Croatia, with information on the loan repayment status of SME clients of that bank were used for confirming or dismissing this hypothesis. The final research sample contained 822 enterprises whose 3 year financial results could be accessed.

Edmister Z-score was calculated for all 822 SMEs and finally only enterprises with Edmister Z-score lower than 0.47 or higher than 0.53 (a total of 760 enterprises) were selected for the final research sample. In fact, between these two numbers there is a grey zone, for which Edmister pointed out the need for additional analyses, further effort and credit analyses skills, as well as taking into account qualitative information related to the quality of management, position in the market, competition strategy and other important elements necessary for evaluating the overall business performance of the enterprise. A method of classification analysis and compliance measurement Cohen's Kappa were used for hypothesis testing.

The method of classification analysis has shown that Edmister model can predict the probability of financial difficulties of SMEs in Croatia by 49% accuracy, which is well below the levels of acceptability. Furthermore, the Edmister model has a higher level of precision when evaluating the status default of SMEs compared to non-default status. On a sample of clients with a default status, 7 out of 32 clients were misclassified i.e. 22%, while on the sample of non-default clients 382 out of 728 clients were

misevaluated, i.e. 52%, which is more than double error rate. The measurement of compliance of Cohen's Kappa indicated reliability of the Edmister model for predicting financial failure of SMEs of 0.04, suggesting very small compliance of the Edmister model and the original bank sample. Taking into consideration the results of the research, it can be concluded that the Edmister model is not applicable for predicting financial difficulties of SMEs in Croatia.

## REFERENCE

- Altman, Edward I. 1968. Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *Journal of Finance* 23 (4): 589–609.
- Beaver, William H. 1966. Financial Ratios as Predictors of Failure. In *Empirical Research in Accounting: Selected Studies*. *Journal of Accounting Research* 4: 71–111.
- Deakin, Edward B. 1972. A Discriminant Analysis of Predictors of Business Failure. *Journal of Accounting Research* 10 (1): 167–179.
- Edmister, Robert O. 1972. An Empirical Test of Financial Ratio Analysis for Small Business Failure Prediction. *Journal of Financial and Quantitative Analysis* 7 (2): 1477–1493.
- Howell, David C. 1997. *Statistical Methods for Psychology*. Belmont, SAD: Wadsworth Publishing Company.
- Landis, Richard J., and Gary G. Koch. 1977. The Measurement of Observer Agreement for Categorical Data. *Biometrics* 33 (1): 159–174.
- Osmanagic Bedenik, Nidzara. 2009. Bilancni pokazatelji ranog upozorenja poslovne krize [Balance Sheet Early Warning Indicators]. *Racunovodstvo, revizija i financije* 19 (6): 79–83.
- White, Gerald I., and Ashwinpaul C. Sondhi. 1994. *The Analysis of Financial Statements*. John Wiley and Sons Inc.
- Zenzerovic, Robert, and Ticijan Perusko. 2006. Kratki osvrt na modele za predvidjanje stečaja. *Ekonomski istrazivanja* 19 (2): 132–151.
- Zenzerovic, Robert. 2009. Business' Financial Problems Prediction: Croatian experience. *Ekonomski istrazivanja* 22 (4): 1–16.