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Relationship Between ROA and Total Indebtedness by Threshold Regression Model

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ABSTRACT

The aim of this work is to examine the relationship between return on assets and total indebtedness of companies. Knowing this relationship allows for more effective business management. This relationship is analyzed on the basis of data from companies in the engineering (SK NACE 25, 28, 29, 30), electrical (SK NACE 26, 27), food (SK NACE 10, 11, 12) and spa industries in the Slovak Republic. To analyze the relationship between return on assets (ROA) and total indebtedness (TI) are used threshold regression models. Threshold regression models are a nonlinear extension of regression models and have a wide range of applications in economics. Tests show that in each sector we can consider regimes with different coefficients. We have shown the nonlinear character of ROA's dependence on total indebtedness. In the case of the engineering and electrical industry in the first regime, profitability increases with increasing indebtedness. However, after exceeding the limit value, profitability decreases. Food and spa industry show a decrease in profitability with increasing indebtedness throughout the course. However, the intensity of the decrease changes in the calculated threshold values. Knowing the coefficients and threshold values for individual industries can be used to optimize the debt policy of the company in the industry.

INTRODUCTION

The profitability of firms largely depends on the extent to which firms use debt and equity in their operations. A common factor included by researchers to determine firm profitability is capital structure. Min-Tsung Cheng (2009) tested the impact of capital structure on the firm's profitability. Result of the study shows that debt funding has significantly inversed impact on the firm's profitability. Andersson and Minnema (2018) examine the capital structure and profitability of 130 management consulting firms in Sweden during the years 2012-2016 by examining the relationship between leverage and profitability.

Muscettola and Naccarato (2016) examine the impact of debt on corporate profitability using a longitudinal sample of 7 370 Italian SMEs operating in the commerce sector during 2006-2010.

Study by Abu-Abbas, Alhmoud and Algazo (2019) tests the relationship between financial leverage and firm performance. Based on a sample from Amman Stock Exchange, the study finds that the financial leverage has a negative relationship with the firm performance proxies by ROA and EVA.

Table 1. Relationship between debt and profitability

Negative effect of debt on profitability	Olokoyo (2013), Quang and Xin (2014), Sheikh and Wang (2013), Mireku et al. (2014)
Positive effect of debt on profitability	Ramachandran and Candasamy (2011), Goyal (2013), Saeed et al. (2013), Nawaz et al. (2011)
Non-linear effect (inverse U-shaped relationship)	Cheng et al. (2010), Kebewar (2012)

Source: own processing

1. ENGINEERING, ELECTRICAL, FOOD AND SPA INDUSTRY IN SLOVAKIA

Slovakia has historically been and will continue to be an industrial state. According to the statistics of the European Union, the Slovak Republic is even the most industrialized state in the European area. Industrial production is a key element in ensuring the economic growth of Slovakia. *Engineering industry* in Slovakia is one of the main pilots of the Slovak economy. It has a strong historical background and maintains its stable position in the Slovak industry. In terms of representation in the industry ranking, the engineering industry in 2019 after the automotive industry (32.4%), accounted for almost 15.2%, compared to the electrical industry, which reached 9.2%. The engineering industry is generally defined as the sum of the divisions of industries according to the classification SK NACE Rev. 2:

25 Manufacture of metal products except machinery and equipment,
28 Manufacture of machinery and equipment,
29 Manufacture of motor vehicles, trailers and semi-trailers,
30 Manufacture of other transport equipment.

Due to the nature of production, part of the group of SK NACE 25 belong more to the metallurgical industry. Jencova (2018) evaluates competitiveness in industrial sectors by modeling volume of sales. From the branch of engineering industry, manufacture of machinery and equipment (SK NACE 28) is the most competitive during the period 2008-2019. The competitiveness coefficient is positive and the branch is the driving force in the ranking of the whole industry and industrial production of Slovakia. The manufacture of metal products except machinery and equipment (SK NACE 25), decreased from the second position in 2008 to the ninth position in 2013–2015. According to the Statistical Office of the Slovak Republic, 2 542.6 thousand people were employed in 2019 (94.2% of workers from the economically active population of the Slovak Republic), of which 696.7 thousand people worked in industry. At the end of the 1st quarter of 2020 it was 2 552.3 thousand people, of which worked in industry 708.5 thousand people. The engineering branch registered 2 100 companies, where were employed almost 104.2 thousand people before the coronary crisis.

The average annual growth rate of costs determined by the geometric mean for the period 2008-2019 was 5.06% and the average annual growth rate of revenues determined by the geometric mean was 5.5%. Profit before tax (EBT) in 2018 was 1 177.09 thousand. €. It is an increase of 124.83% compared to 2008. In 2018, the median for the return on assets (ROA) within the group of companies SK NACE 28-Manufacture of machinery and equipment reached 3.88%, for the return on equity (ROE) almost 9.3%. The total indebtedness (TI) was 57%. The share of EBITDA in sales was 7.24%. Assets in this category sector turned 1.16 times per year, inventory turnover was 8 days, total liquidity has reached 1.61. Within the group of industry SK NACE 29 - Manufacture of motor vehicles, semi-trailers and trailers, the receivables turnover was 52.6 days and the inventory turnover was 13.28 days. One euro of equity invested in business accounted for two cents of net profit and one euro of sales generated almost three cents of EBITDA. The median value of newly created value in sales was 1.38%. Total liquidity reached 1.54. The median total indebtedness in the engineering group reached 58.04%. Within the group of in-

dustry SK NACE 30-Manufacture of other transport equipment, the receivables turnover was 132.64 days and the inventory turnover was 50 days. One euro of equity invested in business accounted for two cents of net profit and one euro of sales generated six cents of EBITDA. The median newly created value in sales was 1.31%. Total liquidity reached 1.85. The median total indebtedness in the engineering group reached 50%.

The engineering industry showed the most significant increase in sales by 2019. In 2020 due to the crisis caused by COVID-19 sales for the first quarter decreased by 18% compared to the previous period. The results of non-financial corporations in the engineering industry for 2019 may partially signal how the non-financial corporations were prepared to cope with the unfavorable situation and what the current development will do with their future management. Most engineering corporations have long-term system solutions for crisis situations, especially in the area of costs. Due to the corona crisis, on the one hand, there is a decline in demand from abroad, but on the other hand, companies are forced to respond by changing processes or procedures to be better prepared for unexpected adverse situations. They are looking for solutions that will help them become more efficient and productive. Engineering companies in connection with COVID-19 have begun to reform many of the processes using automation and information technology.

Electrical industry is generally defined as the sum of the divisions of the industries according to the classification SK NACE Rev. 2:

26 Manufacture of computer, electronic and optical products,
27 Manufacture of electrical equipment.

The development of the electrical industry depends primarily on the automotive industry. Companies covering this sector expect growth in demand every year. According to the Statistical Office of the Slovak Republic, the electrical branch registers 1 436 business entities in the SK NACE 26 and 1 628 business entities in the SK NACE 27. The branch employs 50.83 thousand people, which is representing almost 10% of total employment in Slovak industry. In terms of sales in 2017, the manufacture of electrical equipment (SK NACE 27) was the first in the industry of the Slovak Republic, the seventh place was the manufacture of computer, electronic and optical products (SK NACE 26). At present, it is a constantly evolving sector. It has the potential for significant development in connection with the introduction of Industry 4.0 and Smart technologies.

Profitability of the sector before the crisis in 2009 had a downward trend and the economic slowdown in its development should result in a further blow down. Despite the declining trend in most subsectors across electrical industry, in particular the production of consumer electronics has ensured an increase in profitability. The median return on assets (ROA) reached 6.28%, the operating profit margin 4.9%, and the share of value added in sales reached 27.82%. In the debt analysis, the median for the industry reached a total debt of 59.05%. The analysis of activity indicators show, that it is necessary to continue to monitor the turnover indicators of short-term trade receivables, where the median in the SK NACE 26 reached a positive decrease from 44.4 days in 2008 to 39 days in 2016 and in the SK NACE 27 from 23.55 days in 2008 to 18.79 days in 2016. In contrast, electrical companies pay their liabilities much earlier than they encash receivables (Jencova, 2018).

Food industry is generally defined as the sum of the divisions of the industries according to the classification SK NACE Rev. 2:

10 Food production,
11 Beverage production,
12 Manufacture of tobacco products.

The food industry is closely connected with agriculture. The food industry registers 3 900 companies, the number of employed persons in 2017 was 37.021 thousand in food production and 5.25 thousand in beverage production. Jencova (2018) evaluates competitiveness in industrial sectors by modeling volume of sales. The food, beverages and tobacco industry acquired a negative competitiveness coefficient in 2008 and 2010, and was included in the group of less competitive ones. In recent years, the competitiveness coefficient has developed positively, which has made it possible to place the sector in the group of competitive ones. Multi-criteria evaluation of food businesses, based on the financial statements of

non-financial corporations in the food industry for the period 2015 - 2018 taken from the Register of Financial Statements, shows that the majority of food businesses have similar results in different economic times. Rajo, Inc., Bratislava, Plzensky Prazdroj Slovakia, Inc., Velky Saris, Cheese factory Bel Slovakia, Inc., Michalovce, Ryba (Fish) Zilina, Ltd., Zilina, Heineken Slovakia Malthouse, Inc., Hurbanovo, Hubert J.E., Ltd., Sered, Mondelez SR Production, Ltd., Bratislava, Dr.Oetker, Ltd., Bratislava, Wineries Topolcianky, Ltd., Topolcianky and Hydina (Poultry) SK, Ltd., Kezmarok achieved the same order in terms of multicriteria methods in selected years. The financial indicators of food companies in 2019 were influenced by a number of determinants, mainly legislative changes, investments in modernization of production, expansion of capacities, increasing purchase prices, food imports and many others, whether positive or negative. The current situation associated with COVID-19 has affected the Slovak economy in all areas.

Thanks to its tradition, the Slovak *spa industry* is successful and is increasingly participating in the development of tourism in the Slovak Republic. The Slovak spa industry is a cultural and historical phenomenon in Central Europe. In the Slovak Republic, we record 21 spa companies, which in 2018 employed 3 750 people and the annual turnover was 155 313 thousand €. The largest spa companies include Slovak Health Spa Piestany, Inc., Slovak Health Spa Rajecke Teplice, Inc., Bardejov spa, Inc., Slovak Health Spa Turcianske Teplice, Inc., Spa Trencianske Teplice, Inc. According to the Statistical Office of the Slovak Republic, the Slovak spa employs almost 4 000 people. In the first place in terms of employment (908 employees), added value (23 737 mil. €), the volume of completed sales (36 782 mil. €), by the number of guests (44 898) and the number of beds (2 400) are classified Slovak Health Spa Piestany, Inc. Spa Bojnice, Inc. can be unambiguously included among the spa companies with higher profitability, where one euro of equity generated eight cents of net profit in 2018. On the contrary, Natural Iodine Spa Cíz, Inc., PIENINY RESORT, Ltd., Spa Brusno, Inc., which are already in restructuring, show a long-term loss. Negative equity in recent years shows Spa Kovacova, Ltd. (Stefko et al., 2020).

Jencova (2018) constructed a competitiveness indicator, which is based on items of the financial statements of the entity (sales, personnel costs and assets of the company). In the period 2013-2018 the Slovak spa industry is competitive, while the most competitive were Slovak Health Spa Rajecke Teplice, Inc., Slovak Health Spa Turcianske Teplice, Inc., Spa Bojnice, Inc.. Among the less competitive companies belong Spa Sliac, Inc. and among the uncompetitive we can include the Specialized Medical Institute Marina. Jencova et al. (2019) in their work analyzed the financial and economic position of spa companies in space through the methods of multicriteria evaluation for the period 2013-2017. The authors chose for criteria the ratio financial metrics ROA, ROS (return on sales), the share of personnel costs in net turnover and the share of value added in sales. According to the financial analysis by applying four methods of multicriteria evaluation (ranking method, scoring method, normalized variable, distance from a fictitious object), the results showed that the Spa Bojnice, Spa Lucky, Spa Dudince, Bardejov spa and Slovak Health Spa Piestany were the best in the ranking. The least competitive in 2017 were Spa Stos, Inc., Natural Health Spa, Cerveny Klastor Pieniny Resort, Ltd., Natural Iodine Spa Ciz, Inc., Spa Brusno, Inc.. Stefko et al. (2018) also deal with the issue of spas and health care in Slovakia. According to data from the National Center of Health Care in 2018, 179 213 patients completed medical stay in spa treatment facilities. It is an increase of 7%. The average length of stay was 12.8 days. At present, all spa companies in Slovakia are financially affected as a result of the coronary crisis.

2. DATA AND METHODOLOGY

The analysis used financial ratios of companies obtained from the year-end financial statements of companies in the Slovak Republic in the following sectors:

- Engineering industry – 1 139 findings for the period 2014-2018
- Electrical industry - 749 companies in 2017
- Food industry - 374 findings 2013-2018
- Spa - 125 findings - 2013-2018

Threshold models have a wide range of applications in economics and have developed rapidly over the three decades. The first generation of threshold regression models developed inference under the

assumption of exogenous or predeteremined threshold variables. Recently, there is a growing interest in threshold regression models that accommodate endogenous threshold variables in order to identify the underlying mechanisms of such theories. Generalized threshold regression models are employed in a wide range of different fields of application.

Threshold models are often applied to time-series data. The threshold can be a time. Or the threshold can be in terms of another variable (Stata, 2020). Threshold models occur as special cases of more complex statistical procedures such as mixture models, switching models, Markov switching (MSW) and Smooth Transition Autoregressive (STAR) (Arlt and Arltova, 2003).

Table 2. Use of generalized threshold regression models

Lee et al. (2011)	Finance, sociology and biostatistics
Lee et al. (2017)	Explain relationship between public debt and median real GDP growth
Huang, Hwang and Yang (2008)	Explain the non-linear relationship between energy consumption growth and economic growth

Source: own processing

The threshold regression model extends linear regression by allowing different coefficients for individual regions. These areas are identified by whether the values of the threshold variable are below or above the threshold value. The model can have multiple threshold values. The number of model limits is determined based on information criteria: Bayesian information criterion (BIC), Akaike information criterion (AIC), or Hannan – Quinn information criterion (HQIC). Consider a threshold regression with two regimes (regions) (Stata, 2017) determined by γ :

$$y_t = x_t\beta + z_t\delta_1 + \varepsilon_t \quad if \quad -\infty < q_t \leq \gamma$$
$$y_t = x_t\beta + z_t\delta_2 + \varepsilon_t \quad if \quad \gamma < q_t < \infty$$

where y_t is a dependent variable, x_t is a vector of variables that can also contain lagging values of y_t, β is $k \times 1$ vector of regionally invariant parameters, ε_t is IID error with mean value 0 and variance σ^2, z_t is vector of variables with regionally specific vectors coefficients δ_1 and δ_2, q_t is a threshold variable, which can be one of the variables x_t or z_t.

Our task is to determine the parameters $\beta, \delta_1, \delta_2$. Region 1 is defined as a subset of observations in which the value of q_t is less than or equal to the threshold γ. Similarly, Region 2 is defined as a subset of observations in which the value of q_t is greater than the threshold γ. Conclusions about the "nuisance" parameter γ are complicated due to its non-standard asymptotic distribution (Hansen, 2000). Threshold uses conditional least squares to estimate the parameters of the threshold regression model. The threshold value is estimated by minimizing the sum of squared errors *(SSE)* obtained for all tentative thresholds. The estimated threshold γ' is one of the values in the threshold variable q_t . To estimate the threshold, we minimize the least squares of the following regression with T observations and two regions (Stata 2017):

$$y_t = x_t\beta + z_t\delta_1 I(-\infty < q_t \leq \gamma) + z_t\delta_2 I(\gamma < q_t < \infty) + \varepsilon_t$$

where I is indicator function for a sequence of T' values in q_t, where $T' < T$. The default trimming percentage is set to 10%, which implies that T´corresponds to the number of observations between the 10th and the 90th percentile of q_t . The estimator for the threshold is:

$$\gamma' = arg\ min_{\gamma \epsilon \Gamma} S_{T'(\gamma)}$$

where $\Gamma = (-\infty, \infty)$

$$S_{T'(\gamma)} = \sum_{t=1}^{T'} \{yt - xt\beta + zt\delta 1 I(-\infty < qt \leq \gamma) + zt\delta 2 I(\gamma < qt < \infty)\}^2$$

The statistical software Stata 15.1 was used to calculate the coefficients and treshold values. The work deals with the non-linear effect (inverse U-shaped relationship) between ROA and Total Indebtedness using a threshold regression model.

Return on assets (ROA)

$$ROA = EBIT / Total\ Asset \times 100$$

The return on asset (ROA) is generally applied to measure profitability (Ahmadinia, Afrasiabishani and Hesami, 2012). Return on Assets defines the efficient management of a firm's asset to generate profits. It is an indicator which explains how profitable a firm is in relation to its total assets.

Total Indebtedness (TI)

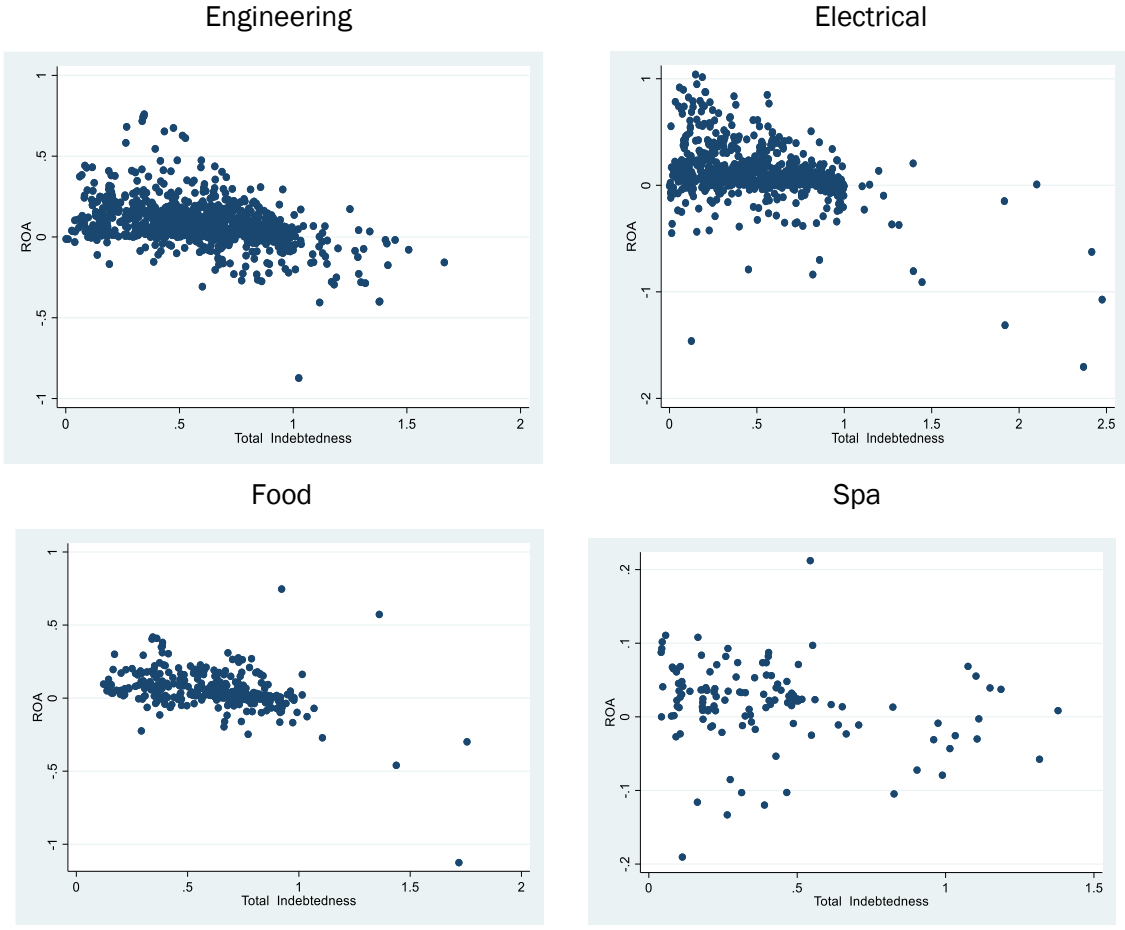
$$TI = Total\ Debt / Total\ Assets \times 100$$

This metric contains information about the financial structure of company as measured by the proportion of foreign resources to seed assets (Lesakova, 2007).

3. RESULTS AND DISCUSSION

We analyzed the possibility of one or two thresholds model in sectors: Engineering, Electrical, Food, Spa. We first clearly showed the obtained values in Fig. 1.

Figure 1. Graphical representation of the detected values



Source: own processing

An overview of the calculated treshold values is given in Tab.3. In the case of the electrical industry, we have chosen two thresholds as the most appropriate option.

Table 3. Overview of calculated limit values

Industry	*Engineering*	*Electrical*	*Food*	*Spa*
Number of observations	1 139	749	374	125
Treshold – TI	0.3448	0.2069 0.8601	0.8753	0.1636
Sum of squared residuals	14.8216	36.8027	4.7657	0.3236

Source: own processing

In the following, we will analyze the results for individual sectors in more detail.

Engineering industry

The most suitable option is one threshold value: 0.3448. The coefficient at TI Region1 is positive 0.312 and the coefficient at TI for Region2 is negative -0.2262. This means that at a TI of less than 34.4%, the ROA increases with a coefficient of 0.312. After exceeding this limit, the ROA decreases with a coefficient of - 0.2262. Statistical tests show that all coefficients (even in absolute terms) are significant and different for individual regions (Tab.4).

Table 4. Parameters of the treshold regression model for Engineering industry

Engineering	*ROA*	*Coef.*	*Std.Err.*	*z*	*P > |z|*	*95% Conf.Interval*	
Region1	Total Indbt	**0.3120**	0.0919	3.40	**0.001**	0.1319	0.4922
	Cons	**0.0809**	0.0205	3.93	**0.000**	0.0406	0.1213
Region2	Total Indbt	**-0.2262**	0.0180	-12.53	**0.000**	-0.2615	-0.1908
	Cons	**0.2183**	0.0129	16.92	**0.000**	0.1929	0.2435

Source: own processing

Electrical industry

When comparing the results of the model with one or two threshold values, it shows a better possibility to use two treshold values (0.2069 and 0.8601). For the Region1 with a TI less than 20.69%, the linear coefficient of the model is positive (1.1999). For the Region2 with TI from 20.69% to 86.01%, the linear coefficient is negative (- 0.2495). For the Region3 with TI above 86.01% profitability decreases much faster (-0.6844) (Tab.5).

Table 5. Parameters of the treshold regression model for Electrical industry

Electrical	*ROA*	*Coef.*	*Std.Err.*	*Z*	*P > |z|*	*95% Conf.Interval*	
	TotalIndbt	**1.1999**	0.3054	3.93	**0.000**	0.6012	1.7986
Region1	Cons	**0.0866**	0.0371	2.33	**0.020**	0.0137	0.1594
	TotalIndbt	**-0.2495**	0.0550	-4.53	**0.000**	-0.3547	-0.1416
Region2	Cons	**0.2543**	0.0306	8.29	**0.000**	0.1942	0.3143
	TotalIndbt	**-0.6844**	-0.688	-9.95	**0.000**	-0.8193	-0.5496
Region3	Cons	**0.6501**	0.0727	8.94	**0.000**	0.5075	0.7927

Source: own processing

Statistical tests show that all coefficients (even in constants) are significant and different for individual regions. The model for the Electrical industry shows similar behavior as the model for Engineering industry even at two limit values, first followed by the growth of ROA and then a decrease with the increase of TI.

Food industry

The threshold regression model for the Food industry shows different properties. First a slight decrease in ROA (-0.1394) and then a stronger decrease (-0.6844) with an increase in TI. (Tab. 6). The threshold for TI is quite high (87.53%).

Table 6. Parameters of the treshold regression model for Food industry

Food	*ROA*	*Coef.*	*Std.Err.*	*z*	*P > |z|*	*95% Conf.Interval*	
Region1	Total Indbt	**-0.1376**	0.0299	-4.59	**0.000**	-0.1964	-0.07892
	Cons	**0.1394**	0.0183	7.58	**0.000**	0.1033	0.1754
Region2	Total Indbt	**-0.6485**	0.0899	-7.22	**0.000**	-0.8245	-0.4725
	cons	**0.6095**	0.0928	6.57	**0.000**	0.4278	0.7913

Source: own processing

The coefficients are significant and different for each mode.

Spa industry

In this case, we have the smallest number of measurements. The model indicates a strong decrease (-1.1165) to the TI threshold (16.36%), followed by a very slight decrease to the significance threshold (-0.0336).

Table 7. Parameters of the treshold regression model for Spa

Spa	*ROA*	*Coef.*	*Std.Err.*	*z*	*P > |z|*	*95% Conf.Interval*	
Region1	Total Indbt	**-1.1165**	0.3400	-3.28	**0.001**	-1.7830	-0.4500
	Cons	**0.1276**	0,0323	3.95	**0.000**	0.0642	0.1910
Region2	Total Indbt	**-0.0365**	0.0177	-2.06	**0,040**	-0.0713	-0.0017
	Cons	**0.0336**	0.0098	3.40	**0.001**	0.0142	0.0530

Source: own processing

As in the previous cases, the coefficients are significant and different for each mode.

Finally, we present the division of the number of enterprises into individual regimes by industry (Tab.8).

Table 8. The number of enterprises belonging to various modes

Industry	*Region1*	*Treshold 1*	*Region 2*	*Treshold2*	*Region 3*
Engineering	199	0.3448	940		
Electrical	159	0.2069	467	0.8601	123
Food	333	0.8753	41		
Spa	27	0.1636	98		

Source: own processing

Electrical shows the most homogeneous division of companies into individual regimes.

CONCLUSION

In this work, we analyzed the dependence of the financial ratio of the return on assets (ROA) on the total indebtedness (TI) of the company for the engineering, electrical, food and spa industries in Slovakia. We have shown the nonlinear character of ROA's dependence on total indebtedness in each industry. We used threshold regression models to examine the relationship between ROA and total indebtedness. For each industry, a threshold value of the total indebtedness was found in which the linear relationship changes. In the case of the electrical industry (SK NACE 26, 27), it is appropriate to use up to two limit values. In the case of the engineering (SK NACE 25, 28, 29, 30) and electrical sector in the first regime (Region1), profitability increases with increasing indebtedness. However, after exceeding the limit value, profitability decreases (Region2). Food (SK NACE 10, 11, 12) and spa industry shows a decrease in profitability with increasing indebtedness throughout the course. However, the intensity of the decrease changes in the calculated threshold values. All calculated model coefficients are significant and different for individual regions. The determination of model coefficients and threshold values for individual industries can be used to optimize the debt policy of the company in the relevant industry.

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