RELATIONSHIP BETWEEN PROFITABILITY AND DEBT: THE CASE OF THE SLOVAK ENERGY AND MINING SECTOR

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Abstract:
Research background: Knowing the financial situation of companies and the entire sector is very important in an increasingly competitive environment. Financial indicators are used to assess the financial situation, and it is important to examine the relationships between them. Managers can use this information for better decision-making and thus improve their position in the market.
Purpose of the article: The paper deals with modelling the relationship between profitability and debt of companies in the Energy and Mining sector of the Slovak Republic. The aim of this paper is to examine the relationship between return on equity and total indebtedness of companies in the Energy and Mining sector of the Slovak Republic.
Methods: A nonlinear regression model and a threshold regression model with one and two threshold values are used to model the relationship between profitability and debt. The models are used on the data of 1,219 companies from the Energy and Mining sector in the Slovak Republic for the year 2020. The analysis is focused on the year 2020, when the entire world was plagued by the COVID-19 pandemic and other negative events (price increases) appeared that had an impact on the sector. In the case of marginal models, total indebtedness is used as a threshold variable and total indebtedness, Debt/EBITDA, profit margin, EBITDA margin, Net Debt/*EBITDA* are used as mode variables.
Findings & Value added: We have shown the nonlinear relationship between return on equity and total indebtedness. Knowing the relationship between financial indicators allows for more effective business management. It can be used to optimize the debt policy of the company in the industry.

Keywords: energy and mining sector; modelling; profitability; debt

JEL Classification: C24; G32

1. Introduction

Slovak industry in 2020 was marked by resistance to the corona crisis. The year 2021 also tested its resilience to influences that do not have a direct impact, when energy and input prices

rose significantly in the second half of the year. In general, however, this year was an alternation of good and bad performance across all areas of industry. Until the next period, the industry in Slovakia has quite several obstacles that individual segments will have to deal with. High energy prices without government support will shut down and dampen more and more production in the country.

In 2020, the least construction raw materials were extracted in Slovakia since 2008. However, the entire segment is suffering from unfavorable market conditions. As many as seven of the ten largest mining companies in the Slovakia in 2020 showed a decline in sales. While in 2019 almost 30 thousand kilotons of raw materials were extracted in Slovakia, in 2020 it was almost a third less. The amount of coal and lignite mined fell by as much as a third year-on-year in 2020, to around one million tons. The planned volume of mining for 2021 and 2022 is at the level of 1.1 million tons (Mato, 2021a).

The growth trend of electricity production continued in 2020, but at a slower pace than in 2019. A total of 29 terawatt-hours (TWh) of electricity were produced in Slovakia in 2020, which is an increase of approximately one percent compared to 2019. As in previous years, the largest volume of electricity was produced from nuclear fuel (53.2 percent). Fossil fuels continued to account for the second largest share of electricity production (21.5 percent). While electricity production from natural gas increased by about a fifth in 2020, the share of coal and heavy fuel oil in production continued to decline. In 2020, a new type of fuel was introduced - liquids obtained from biomass, which accounted for almost a fifth of electricity production from renewable sources. They thus ranked as traditional green resources such as biomass, photovoltaics, and biogas. The total share of renewable sources in electricity production in 2020 was eight percent. The dominant electricity producer Slovenske elektrarne and its subsidiaries were able to report earnings before interest, taxes, depreciation, and amortization (EBITDA) of 363 million euros in 2020. By comparison, in 2019 it was 342 million euros. Net consolidated profit rose to 60 million euros from 23 million in 2019 (Mato, 2021b).

In contrast to electricity, the consumption of natural gas in Slovakia in 2020 increased slightly and reached a total of 52.1 TWh. However, the volume of natural gas transport decreased significantly in 2020. The level of 57 billion cubic meters is more than seventeen percent lower than in 2019, but at the same time closer to the average of previous years. 8.4 percent of this volume went to Slovak consumers. For the monopoly natural gas carrier in Slovakia, Eustream, revenues from the sale of services reached 748 million euros in 2020, which is six percent less year-on-year. The largest gas company Slovensky plynarensky priemysel (SPP) achieved the best economic result in history. Revenues from the sale of products and services reached 1.2 billion euros in 2020, which is an increase of 88 million compared to the previous year. The company's operating profit reached 6.6 million euros, while in 2019, state gas companies made a loss of 104 million euros (Mato, 2021b).

The total heat supply in 2020 amounted to approximately 14.3 terawatt-hours (TWh), which was a year-on-year decrease of almost three percent. Of the total heat supply, 32.5 percent was used for heating and domestic hot water in households. The consumption of the average Slovak household amounted to 6.2 gigawatt-hours (GWh), which is two percent more than in 2019. The average household's annual costs for heat and hot water amounted to 625 euros, which was an increase of 3.8 percent. In terms of fuels, up to 52 percent of heat was produced by burning natural gas. Renewable sources accounted for 16 percent of the total heat supply (Mato, 2021c).

Based on data from the Statistical Office of the Slovak Republic, companies with 20 or more employees engaged in the supply of electricity, gas, and steam in 2020 achieved total sales of 12,053 million euros. Value added in this sector in 2020 was 2,747 million euros and earnings before tax (EBT) were 872 million euros. Companies with 20 or more employees engaged in

water collection, treatment, and supply in 2020 achieved revenues of 521 million euros. The value added in this sector in 2020 was 315 million euros and earnings before tax were 5 million euros.

Energy and mining sector is crucial for every economy, so this sector has been the subject of several studies, for example Horvathova et al. (2021), Melnychenko (2021), Stefko et al. (2021), Trzaska et al. (2021), Eljuri and Johnston (2014), Ghosh (2007) and Ogulata (2003).

At present, we can see increase in energy prices. The Energy and Mining sector is very important for households as well as for other industries. High energy prices without government support will shut down and dampen more and more production in the country. The corona crisis has also led to a decline in production, sales and profits in many sectors. For this reason, it is important to identify, assess and predict the financial situation in the Energy and Mining sector.

The paper deals with modelling the relationship between profitability and debt of companies in the Energy and Mining sector of the Slovak Republic. The aim of this paper is to examine the relationship between return on equity and total indebtedness of companies in the Energy and Mining sector of the Slovak Republic. A nonlinear regression model and a threshold regression model with one and two threshold values are used to model the relationship between profitability and debt. Table 1 provides an overview of the authors who dealt with the various effects of debt on profitability, while Table 2 provides an overview of studies in which a threshold and nonlinear regression models were used.

Table 1: Relationship between debt and profitability

Effect of debt on profitability	Author(s)
Negative effect	Zeitun and Tian (2007), King and Santor (2008), Pouraghajan and Malekian (2012), Olokoyo (2013), Mireku et al. (2014)
Positive effect	Ramachandran and Candasamy (2011), Goyal (2013)
Nonlinear effect	Wald (1999), Fama and French (2002), Berger and Bonaccorsi (2006), Margaritis and Psillaki (2007), Cheng et al. (2010), Ramadan and Aloqdeh (2011), Fozia et al. (2011), Kebewar (2012)

Source: own processing

Table 2: Use of threshold and nonlinear regression models

Author(s)	Object of study
Threshold regression models	
Samia et al. (2007)	plague outbreaks
Rezaei et al. (2019)	purchasing power parities in Iran using data on the *US* dollar, the British pound and the Japanese yen, which relate to the period 2001-2016.
Khemiri and Noubbigh (2020)	the relationship of the debt company regarding the size of the company in the period 2006-2016 in the countries of the sub-Saharan five
Wang and Wang (2021)	the non-linear effects of population aging on carbon emissions using data from 2002-2012 from 137 countries or regions
Nonlinear regression models	
Haug and Basher (2007)	long-run *PPP* using monthly data from the post-Bretton Woods era for G-10 countries
Sanchez-Vargas et al. (2013)	relationship between environmental regulation and manufacturing productivity in Mexico using a data set at the plant level
Omid and Jamil (2017)	the influence of inflation and operating cycle on the level of cash holding in 132 firms in the Tehran Stock exchange from 2007 to 2014
Ashrafi (2019)	how institutional investors and different types of them influence the firms' capital structure using a data including 240 the main market Iranian firms from 2012 to 2016

Source: own processing

2. Methodology

The paper deals with modelling the relationship between profitability and debt of companies in the Energy and Mining sector of the Slovak Republic. The aim of this paper is to examine

the relationship between return on equity and total indebtedness of companies in the Energy and Mining sector of the Slovak Republic. We can formulate hypothesis H1 as follows:
H1: *There are statistically significant threshold values of the total indebtedness variable in the relationship between the financial indicators and return on equity of non-financial corporations in the energy and mining sector of the Slovak Republic.*

2.1. Research sample

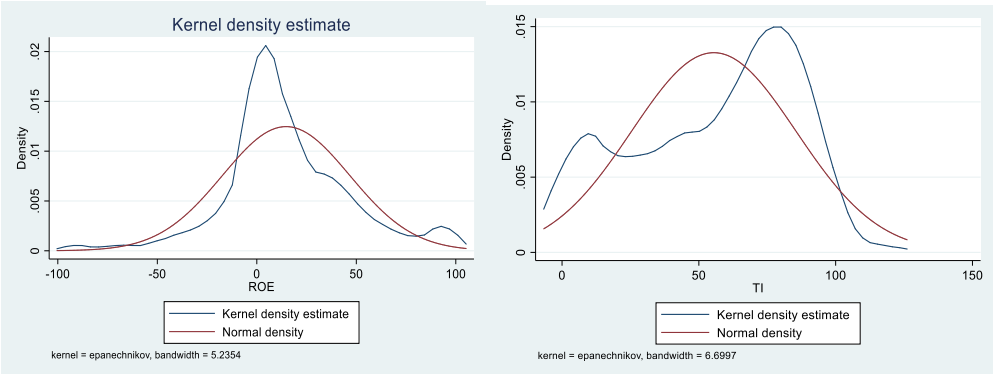
In the original database, the financial ratios of 1,520 Slovak companies in the energy and mining sector were included for the year 2020. The state indicators were obtained from the Financial Statements of the Slovak Republic and were calculated based on absolute indicators.

The energy and mining industry includes SK NACE 05 – Coal and lignite mining, SK NACE 06 – Oil and gas extraction, SK NACE 07 – Mining of metal ores, SK NACE 08 – Other mining and quarrying, SK NACE 09 – Auxiliary mining activities, SK NACE 35 - Supply of electricity, gas, steam and cold air, SK NACE 36 – Water collection, treatment and supply, SK NACE 37 – Wastewater treatment and disposal and SK NACE 38 – Collection, treatment and disposal of waste, recycling of materials.

The econometric software Stata 15.1 modules were used in the processing of this database: Kernel density estimation, Nonlinear regression and Threshold models. The financial ratios return on equity (ROE), total indebtedness (TI), Debt/EBITDA, profit margin, EBITDA Margin, Net Debt/EBITDA were used.

After omitting companies that did not have complete data (ROE, TI), 1,219 companies remained. As there were also outliers in the values of the indicators, the selection of enterprises according to the boundaries for ROE (-100; 100) and TI (0; 120) was narrowed. The omission of companies outside these limits meant that the number of companies analysed was reduced to 1,075. Kernel density estimation (Cox, 2005) was used for further data analysis. The representation of the Kernel density estimation for ROE and TI in the examined group is shown in Figure 1.

Figure 1: Kernel density estimation for ROE and TI



Source: own processing

The Kernel density estimate of ROE is far spicier than the normal distribution. The Kernel density estimate of TI has a considerably asymmetric shape with a mode slightly less than 100. The statistical parameters of the variables ROE and TI in the energy and mining sector are given in Table 3.

Table 3: Summary statistics for ROE and TI

Indicator	Observations	Mean	Std. dev.	Min	Max
ROE	1,075	15.64	31.95	-95.21	100.00
TI	1,075	55.46	30.06	0.00	119.44

Source: own processing

2.2. Nonlinear Regression Model

In the first step, we will use a nonlinear regression with a linear term and the square of the variable TI in the form:

$$ROE = cons + a.TI + b.TI^2 \quad (1)$$

2.3. Threshold Regression Model with Threshold and Mode Variable Total Indebtedness

We will use a threshold model (Stata, 2017) in which TI is a threshold and a mode variable:

$$ROE = (TI.\delta_1 + cons_1)I(-\infty < TI \leq \gamma) + (TI.\delta_2 + cons_2)I(\gamma < TI < \infty) + \varepsilon_t \quad (2)$$

where I is an indicator variable

ε_t is an *IID* error with mean value 0 and variance σ^2

$\delta_1, cons_1, \delta_2, cons_2, \gamma$ are the required model parameters

Our task is to determine the parameters β, δ_1, δ_2. Region 1 is defined as a subset of observations in which the value of TI is less than or equal to the threshold value γ. Similarly, Region 2 is defined as a subset of observations in which the value of TI is greater than the threshold value γ.

2.4. Threshold Regression Model with Threshold and Mode Variable Total Indebtedness and Other Mode Variables

To the ROE and TI indicators analysed so far, we have added other indicators: Debt/EBITDA, profit margin, EBITDA Margin, Net Debt/EBITDA.

After omitting companies where the values of indicators were missing, we were left with 605 companies. Following the analysis of Kernel density estimation, the following limits of indicators were determined: ROE (-100; 100), TI (0; 120), Debt/EBITDA (-25; 25), profit margin (-50; 100), EBITDA Margin (-50; 100) and Net Debt/EBITDA (-25; 25).

Therefore, other companies were omitted. The final state of the analysed companies is 466. Kernel density estimation for indicators with these limits is given in Figure 2.

The main statistical parameters of the variables ROE, TI, Debt/EBITDA, profit margin, EBITDA Margin, Net Debt/EBITDA in the Energy and Mining sector are shown in Table 4.

Table 4: Summary statistics for ROE, TI, Debt/EBITDA, profit margin, EBITDA Margin, Net Debt/EBITDA

Indicator	Observations	Mean	Std. dev.	Min	Max
ROE	466	17.298	29.695	-95.210	98.961
TI	466	65.590	22.176	1.586	116.49
Debt/EBITDA	466	2.655	3.151	-5.818	23.733
Profit margin	466	11.321	16.568	-48.865	59.717
EBITDA Margin	466	43.885	31.357	-40.758	109.397
Net Debt/EBITDA	466	1.5814	3.294	-17.582	21.227

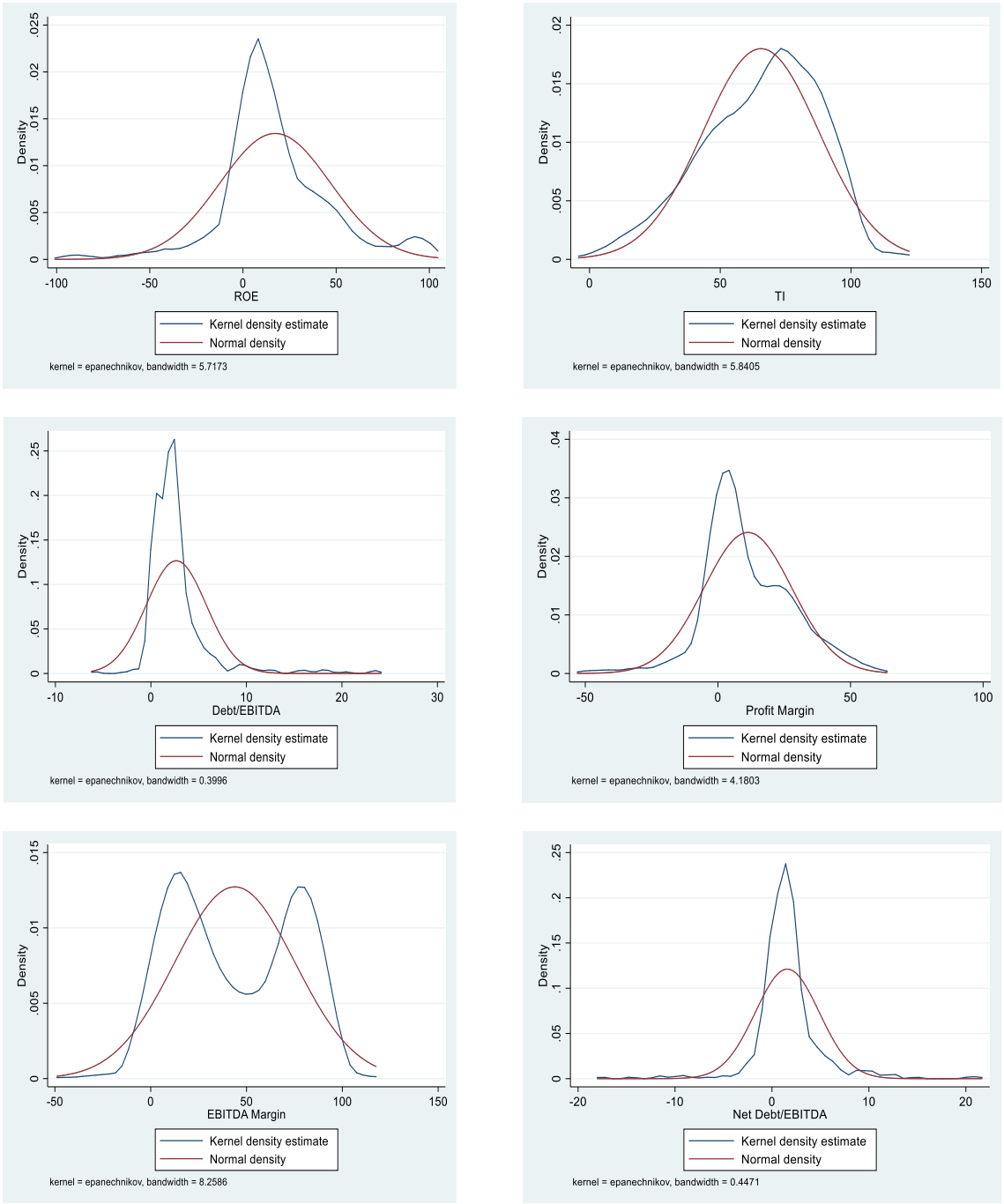
Source: own processing

3. Results

3.1. Nonlinear Regression Model

Estimates of nonlinear regression model coefficients and their significance and standardized coefficients (β) are given in Table 5.

Figure 2: Kernel density estimation for ROE, TI, Debt/EBITDA, Profit margin, EBITDA margin, Net Debt/EBITDA



Source: own processing

Table 5: Nonlinear regression model

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ROE	Coef.	Std. Err.	t	P>|t	β
TI	0.443993	0.1206719	3.68	0.000	0.4178
TI^2	-0.00296	0.0011697	-2.53	0.011	-0.2876
Cons	2.810577	2.7050110	1.04	0.299	

Source: own processing

The standardized nonlinear regression coefficients are comparable. The coefficients for TI and TI^2 are significant, in addition, the coefficient for TI^2 is negative. So, we can talk about the effect of inverted U. If we derive ROE according to TI we get:

$$\frac{dROE}{dTI} = 0.44399 - 0.00296 \cdot TI \quad (3)$$

We are looking for an extreme, so we set the derivative equal to zero.

$$0.44399 - 0.00296.TI = 0 \quad (4)$$

$$TI = 74.99 \quad (5)$$

This point, where TI acquires the value of 74.99, is called the "turning point", because in it the derivative changes from a positive value to a negative one.

3.2. Threshold Regression Model with Threshold and Mode Variable Total Indebtedness

The parameters of the threshold regression model with one threshold value (TI = 90.36) are given in Table 6.

Table 6: Threshold regression model with one threshold value (TI = 90.36)

	ROE	Coef.	Std. Err.	z	P > |z|	95 % Conf. Interval	
Region 1	TI	0.1910	0.0353	5.40	0.000	0.1217	0.2602
	Cons.	5.5794	2.0499	2.72	0.006	1.5616	9.5971
Region 2	TI	-3.1690	0.4292	-7.38	0.000	-4.0104	-2.3276
	Cons.	324.069	41.402	7.82	0.000	242.28	405.3101

Source: own processing

The values of the information criteria were as follows: AIC = 7372.88; BIC = 7392.80; HQIC = 7380.42. All coefficients are significant and there is no intersection of confidence intervals. The coefficient at TI for Region 1 is positive 0.191 and the coefficient at TI for Region 2 is negative -3.169. If the value of TI is less than 90.36 (Region 1), then with the increase of TI there is an increase in ROE with coefficient of 0.191. If the value of TI is greater than 90.36, then with the increase of TI there is a decrease in ROE with coefficient of -3.169.

When analysing the model with two threshold values, the values of the information criteria were achieved: AIC = 7376.88; BIC = 7406.76; HQIC = 7388.19. The values of the information criteria are therefore slightly higher than in the case of the model with one threshold value. All coefficients of the model are significant (Table 7). The sign of the coefficient already changes at the value of the threshold variable (TI = 76.79). The intersection of the confidence intervals of the regression coefficients for Region 2 and Region 3 is non-zero. The differences between Region 2 and Region 3 are therefore small.

Table 7: Threshold regression model with two threshold values (TI = 76.79 and 90.36)

	ROE	Coef.	Std. Err.	z	P > |z|	95 % Conf. Interval	
Region 1	TI	0.14268	.0449	3.17	0.002	0.0545	0.2307
	Cons.	6.6525	2.169	3.07	0.002	2.399	10.9056
Region 2	TI	-1.8693	0.5310	-3.52	0.000	-2.9102	-0.8284
	Cons.	180.5351	44.3124	4.07	0.000	93.6842	267.3858

Region 3	TI	-3.1690	0.4258	-7.44	0.000	-4.0037	-2.3343
	Cons.	324.0692	41.1193	7.88	0.000	243.4767	404.6616

Source: own processing

The first threshold value for the three-region model is 76.79. This value is very similar to the turning point (74.99), which we obtained from the nonlinear regression model. For Region 1 with a TI less than 76.79, the coefficient of the model is positive (0.14268). If the value of TI is less than 76.79 (Region 1), then with the increase of TI there is an increase in ROE with coefficient of 0.14268. For Region 2 with TI from 76.79 to 90.36, the coefficient is negative (-1.8693). If the value of *TI* is from 76.79 to 90.36, then with the increase of *TI* there is a decrease in *ROE* with coefficient of -1.8693. For Region 3 with *TI* above 90.36 profitability decreases much faster (-3.169). If the value of *TI* is greater than 90.36, then with the increase of *TI* there is a decrease in *ROE* with coefficient of -3.169. Due to the overlap of confidence intervals and the value of information criteria, we prefer a model with one threshold value.

3.3. Threshold Regression Model with Threshold and Mode Variable Total Indebtedness and Other Mode Variables

The correlation matrix shows acceptable values except for the correlation between Debt/EBITDA and Net Debt/EBITDA (Table 8).

Table 8: Correlation matrix

	ROE	**TI**	**Debt/EBITDA**	**Profit margin**	**EBITDA Margin**	**Net Debt/EBITDA**
ROE	1					
TI	0.191	1				
Debt/EBITDA	-0.149	0.262	1			
Profit margin	0.467	-0.031	-0.168	1		
EBITDA Margin	0.203	0.084	-0.051	0.639	1	
Net ebt/EBITDA	-0.111	0.292	0.775	-0.1328	0.077	1

Source: own processing

In further analysis, we will omit the Net Debt/EBITDA indicator and test the possibilities of using the threshold model for the threshold variable TI and the mode variables TI, Debt/EBITDA, profit margin, EBITDA Margin for one or two threshold values. When selecting a suitable model, we will use information criteria (AIC, BIC, HQIC), significance of coefficients and their confidence intervals. Estimates of the coefficients of the model with one threshold value are given in Table 9. The corresponding values of the information criteria are as follows: AIC = 2860.37; BIC = 2901.814 and HQIC = 2876.682.

Table 9: Threshold regression model with one threshold value (TI = 90.01)

	ROE	**Coef.**	**Std. Err.**	**z**	**P > |z|**	**95 % Conf. Interval**	
Region 1	Debt/EBITDA	-1.340	0.391	-3.42	0.001	-2.108	-0.572
	Profit margin	1.038	0.084	12.26	0.000	0.872	1.204
	EBITDA Margin	-0.200	0.045	-4.40	0.000	-0.289	-0.112
	TI	0.368	0.056	6.54	0.000	0.258	0.478
	Cons.	-6.891	3.645	-1.89	0.059	-14.035	0.253
Region 2	Debt/EBITDA	-1.784	0.617	-2.89	0.004	-2.995	-0.574
	Profit margin	1.945	0.233	8.33	0.000	1.487	2.402
	EBITDA Margin	-0.116	0.103	-1.13	0.258	-0.318	0.085
	TI	-5.827	0.469	-12.41	0.000	-6.747	-4.907
	Cons.	582.29	44.859	12.98	0.000	494.369	670.215

Source: own processing

The coefficients are in the vast majority significant, but only in two cases there is no penetration of confidence intervals (TI and Profit margin). TI shows the same properties as in

previous cases. The coefficient at TI Region 1 is positive 0.368 and the coefficient at TI for Region 2 is negative -5.827. If the value of TI is less than 90.01 (Region 1), then with the increase of TI there is an increase in ROE with coefficient of 0.368. If the value of TI is greater than 90.01, then with the increase of TI there is a decrease in ROE with coefficient of -5.827. The profit margin has a greater impact on the return on equity in the Region 2 (TI is above 90.01).

The values of the information criteria for the two threshold values (73.458 and 90.01) are higher than in the previous cases: AIC = 2870.37; BIC = 2932.535 and HQIC = 2894.837. The parameters of this model are given in Table 10.

Table 10: Threshold regression model with two threshold values (TI = 73.458 and 90.01)

	ROE	Coef.	Std. Err.	z	P > |z|	95 % Conf. Interval	
Region 1	Debt/EBITDA	-1.283	0.4988	-2.57	0.010	-2.261	-0.3060
	Profit margin	0.7760	0.1016	7.63	0.000	0.5767	0.9753
	EBITDA Margin	-0.1587	0.0543	-2.92	0.003	-0.2652	-0.0522
	TI	0.2494	0.0821	3.04	0.002	0.0883	0.4104
	Cons.	-0.5477	4.1414	-0.13	0.895	-8.6648	7.5692
Region 2	Debt/EBITDA	-1.3180	0.5948	-2.22	0.027	-2.4839	-1.5207
	Profit margin	1.5163	0.1408	10.76	0.000	1.2401	1.7924
	EBITDA Margin	-0.2224	0.0793	-2.80	0.005	-0.3778	-0.0669
	TI	0.9659	0.3816	2.53	0.011	0.2178	1.7139
	Cons.	-57.435	31.2706	-1.84	0.066	-118.7249	3.8539
Region 3	Debt/EBITDA	-1.3180	0.5948	-2.22	0.027	-2.4839	-1.5207
	Profit margin	1.5163	0.1408	10.76	0.000	1.2401	1.7924
	EBITDA Margin	-0.2224	0.0793	-2.80	0.005	-0.3778	-0.0669
	TI	0.9659	0.3816	2.53	0.011	0.2178	1.7139
	Cons.	-57.435	31.2706	-1.84	0.066	-118.7249	3.8539

Source: own processing

Again, most of the coefficients are significant, but the confidence intervals of the model coefficients in each region overlap for each variable. Due to this fact and the higher values of the information criteria, we will choose a model with one threshold value.

4. Discussion

In the first stage, the relationship between return on equity and total indebtedness was solved using a nonlinear regression model. Nonlinearity is sought using an inverted U-shaped model. In nonlinear regression model, the turning point for the return on equity of the company is the value of total indebtedness of 74.99.

When using the threshold regression model, one (TI=90.36) or two threshold values (TI=76.79 and 90.36) come into play. In the threshold regression model with one threshold value, if the value of total indebtedness is less than 90.36 (Region 1), then with the increase of total indebtedness there is an increase in return on equity with coefficient of 0.191. If the value of total indebtedness is greater than 90.36, then with the increase of total indebtedness there is a decrease in return on equity with coefficient of -3.169.

If we consider a model with two threshold values, the first threshold value for the three-region model is 76.79. This value is very similar to the turning point (74.99), which we obtained from the nonlinear regression model. The sign of the coefficient already changes at the value of the threshold variable (TI=76.79). The intersection of the confidence intervals of the regression coefficients for Region 2 and Region 3 is non-zero. The differences between Region 2 and Region 3 are therefore small. Due to the overlap of confidence intervals and the value of information criteria, we can say that a model with one threshold value is more appropriate in this case.

To the return on equity and total indebtedness indicators analysed so far, we have added other indicators: Debt/EBITDA, profit margin, EBITDA Margin, Net Debt/EBITDA. We tested the possibilities of using the threshold regression model for the threshold variable total indebtedness and the mode variables total indebtedness, Debt/EBITDA, profit margin, EBITDA Margin for one or two threshold values. Threshold values close to those of previous models
(TI = 73.458 and 90.01) were calculated. The coefficients are in the vast majority significant, but only in two cases is there no penetration of confidence intervals (total indebtedness and profit margin). Total indebtedness shows the same properties as in previous cases. The profit margin has a greater impact on the return on equity in the Region 2 (TI is above 90.01). By comparing the values of the information criteria and the confidence intervals, we can say that a model with one threshold value is more appropriate in this case. Therefore, we confirm hypothesis 1.

Our results could be generalized to the V4 countries (Poland, the Czech Republic and Hungary). These countries, like Slovakia, do not have a developed capital market and for this reason our results are comparable to the Energy and Mining sectors in these countries.

In study by Cheng et al. (2010), they use panel threshold regression model to test the panel threshold effect of debt ratio on firm value. The results confirm that a triple-threshold effect does exist and show an inverted U-correlation between leverage and firm value. Ramadan and Ramadan (2015) confirmed an inverse relationship between capital structure and return on assets in a sample of the Jordanian industrial enterprises listed at Amman Stock Exchange. Other authors who have investigated the relationships between financial indicators include Lyocsa et al. (2022) and Svabova et al. (2020). Gajdosikova et al. (2024) and Valaskova et al. (2021) also dealt with the capital structure and debt.

5. Conclusions

The paper dealt with modelling the relationship between profitability and debt of companies in the Energy and Mining sector of the Slovak Republic. The aim of this paper was to examine the relationship between return on equity and total indebtedness of companies in the Energy and Mining sector of the Slovak Republic.

A nonlinear regression model and a threshold regression model with one and two threshold values were used to model the relationship between profitability and debt. The models were used on the data of 1,219 companies from the Energy and Mining sector in the Slovak Republic for the year 2020. In the case of marginal models, total indebtedness was used as a threshold variable and total indebtedness, Debt/EBITDA, Profit margin, EBITDA Margin, Net Debt/EBITDA were used as mode variables.

This paper has several limitations. First, we did not consider all companies from Energy and Mining sector of the Slovak Republic, and we analysed only one year. Therefore, it would be interesting to repeat the analysis with more companies or for different years. Secondly, we did not use qualitative data in the analysis (size of the company, location, owners, etc.). Thirdly, it would be appropriate in further research to use other statistical methods to investigate the relationships between financial indicators.

We have shown the nonlinear relationship between return on equity and total indebtedness. Knowing the relationship between financial indicators allows for more effective business management. It can be used to optimize the debt policy of the company in the industry.

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References

Ashrafi, M. (2019). Nonlinear relationship between institutional investors´ ownership and capital structure: evidence from Iranian firms. *International Journal of Managerial and Financial Accounting*, *11*(1), 1-19.

Berger, A. N., & Bonacrossi, E. (2006). Capital structure and firm performance: A new approach to testing agency theory and an application to the banking industry. *Journal of Banking and Finance, 30*(4), 1065-1102.

Cox, N. J. (2005). Speaking Stata: Density probability plots. *Stata Journal*. *5*(2), 259–273.

Eljuri, E., & Johnston, D. (2014). Mexico´s energy sector reform. *Journal of World Energy & Law Business*, *7*(2), 168-170.

Fama, E. F., & French, K. R. (2002). Testing trade-off and pecking order predictions about dividends and debt. *The Review of Financial Studies*. *15*, 1-33.

Fozia, M., Niaz, A. B., & Ghulam, A. (2011). Capital Structure and Firm Performance: A Case of Textile Sector of Pakistan. *Asian Journal of Business and Management Sciences*, *1*(9), 9-15.

Gajdosikova, D., Valaskova, K., & Lazaroiu, G. (2024). The Relevance of Sectoral Clustering in Corporate Debt Policy: The Case Study of Slovak Enterprises. *Administrative Sciences, 14*(2), 26.

Ghosh, S. (2007). Investment opportunities in Indian energy sector. *International Journal of Indian Culture and Business Management*, *1*(1-2), 64-82.

Goyal, A. M. (2013). Impact of capital structure on performance of listed public sector banks in India. *International Journal of Business and Management Invention*, *2*(10), 35-43.

Haug, A. A., & Basher, S. A. (2007). Linear or Nonlinear Cointegration in the Purchasing Power Parity Relationship? *Applied Economics*, *43*(2), 185-196.

Horvathova, J., Mokrisova, M., & Vrablikova, M. (2021). Benchmarking-A Way of Finding Risk Factors in Business Performance. *Journal of Risk and Financial Management*, *14*(5), 221.

Cheng, Y. S., Liu, Y. P., & Chien, Ch. Y. (2010). Capital structure and firm value in China: A panel threshold regression analysis. *African Journal of Business Management*, *4*(12), 2500-2507.

Kebewar, M. (2012). The effect of debt on corporate profitability – evidence from French service sector. *SSRN Electronic Journal.*

Khemiri, W., & Noubbigh, H. (2020). Size-threshold effect in debt-firm performance nexus in the sub-Saharan region: A Panel Smooth Transition Regression approach. *Quarterly Review of Economics and Finance*, *76*, 335-344.

King, M., & Santor, E. (2008). Family values: Ownership structure, performance, and capital structure of Canadian firms. *Journal of Banking and Finance*, *32*(11), 2423–2432.

Lyocsa, S., Vasanicova, P., Misheva, B. H., & Vateha, M. D. (2022). Default or profit scoring credit systems? Evidence from European and US peer-to-peer lending markets. *Financial Innovation*, *8*(1), 32.

Margaritis, D., & Psillaki, M. (2007). Capital structure and firm efficiency. *Journal of Business Finance and Accounting*, *34*(9-10), 1447-1469.

Mato, V. (2021a). TOP v priemysle: Ticho na stavbach sa vlani rozsirilo aj do kamenolomov. *Trend*. Available online: https://www.trend.sk/trend-archiv/ticho-stavbach-vlani-rozsirilo-aj-kamenolomov.

Mato, V. (2021b). Top v priemysle: Energetikom sa darilo. Investovali a zvratili straty. *Trend*. Available online: https://www.trend.sk/trend-archiv/energetikom-darilo-investovali-zvratili-straty.

Mato, V. (2021c). Top v priemysle: Kym teplarom priala zima, vodarom k rastu vlani chybal odber. *Trend*. Available online: https://www.trend.sk/trend-archiv/kym-teplarom-priala-zima-vodarom-rastu-vlani-chybal-odber.

Melnychenko, O. (2021). Energy Losses Due to Imperfect Payment Infrastructure and Payment Instruments. *Energies*, *14*(24), 8213.

Mireku, K., Mensah, S., & Ogoe, E. (2014). The relationship between capital structure measures and financial performance: Evidence from Ghana. *International Journal of Business and Management*, *9*(6), 151–160.

Ogulata, R. T. (2003). Energy sector and wind energy potential in Turkey. *Renewable and Sustainable Energy Reviews*, *7*(6), 469-484.

Olokoyo, F. O. (2013). Capital structure and corporate performance of Nigerian quoted firms: A panel data approach. *African Development Review*, *25*(3), 358–369.

Omid, A. M., & Jamil, E. (2017). Linear and Nonlinear Relationship between Inflation, Operating Cycle and Cash Holdings: Evidence from Iran. *International Journal of Asian Social Science*, *7*(4), 300-310.

Pouraghajan, A., & Malekian, E. (2012). The relationship between capital structure and firm performance evaluation measures: Evidence from the Tehran stock exchange. *International Journal of Business and Commerce*, *1*(9), 166–181.

Ramadan, I., & Aloqdeh, S. (2011). The Determinants of Capital Structure-Evidence from Jordan. *Jordan Journal of Business Administration*, *7*(2), 228-245.

Ramadan, Z. S., & Ramadan, I. Z. (2015). Capital Structure and Firm´s Performance of Jordanian Manufacturing Sector. *International Journal of Economics and Finance*, *7*(6), 279-284.

Ramachandran, A., & Candasamy, G. (2011). The impact of capital structure on profitability with special reference to IT industry in India vs. domestic products. *Managing Global Transitions*, *9*(4), 371–392.

Rezaei, A. A., Raeisipour, A., Zayandehroodi, M., & Esfandabadi, S. A. J. (2019). Survey Purchasing Power Equity in Iran: The Approach of a Bayesian Threshold Auto Regression Model. *International Journal of Contemporary Economics and Administrative Sciences*. *9*(1), 135-+.

Samia, N., Chan, K., & Stenseth, N. (2007). A generalized threshold mixed model for analyzing nonnormal nonlinear time series, with application to plague in Kazakhstan. *Biometrika*, *94*(1), 101–118.

Sanchez-Vargas, A., Mansilla-Sanchez, R., & Aguilar-Ibarra, A. (2013). An empirical analysis of the nonlinear relationship between environmental regulation and manufacturing productivity. *Journal of Applied Economics*, *16*(2), 357-372.

Stata. (2017). *Statistic Data Analysis – Threshold regression*. Available online: stata.com

Svabova, L., Valaskova, K., Durana, P., & Kliestik, T. (2020). Dependency Analysis Between Various Profit Measures and Coporate Total Assets for Visegrad Group´s Business Entities. *Organizacija*, *53*(1), 80-90.

Stefko, R., Horvathova, J., & Mokrisova, M. (2021). The Application of Graphic Methods and the DEA in Predicting the Risk of Bankruptcy. *Journal of Risk and Financial Management*, *14*(5), 220.

Trzaska, R., Sulich, A., Organa, M., Niemczyk, J., & Jasinski, B. (2021). Digitalization Business Strategies in Energy Sector: Solving Problems with Uncertainty under Industry 4.0 Conditions. *Energies*, *14*(23), 7997.

Valaskova, K., Kliestik, T., & Gajdosikova, D. (2021). Distinctive determinants of financial indebtedness: evidence from Slovak and Czech enterprises. *Equilibrium-Quarterly Journal of Economics Policy*, *16*(3), 639-659.

Wald, J. K. (1999). How firm characteristics affect capital structure: An international comparison. *Journal of Financial Research*, *22*(2), 161-187.

Wang, Q., & Wang, L. (2021). The nonlinear effects of population aging, industrial structure, and urbanization on carbon emissions: A panel threshold regression analysis of 137 countries. *Journal of Cleaner Production*, 287.

Zeitun, R., & Tian, G. G. (2007). Capital structure and corporate performance: Evidence from Jordan. *Australasian Accounting Business and Finance Journal*, *1*(4), 3.