Ekonomicko-manazerske spektrum
2022, Volume 16, Issue 2, pp. 49-60

DEPENDENCE OF ROS ON FINANCIAL INDICATORS USING THRESHOLD REGRESSION MODELS

Marta Miškufová[1,a,*], Sylvia Jenčová[1,b] and Igor Petruška[1,c]

[1]Konštantínova 16, 080 01 Prešov, Slovakia
[a]marta.miskufova@unipo.sk, [b]sylvia.jencova@unipo.sk, [c]igor.petruska@unipo.sk
[*]Corresponding author

Cite as: *Miskufova, M., Jencova, S., Petruska, I. (2022). Dependence of ROS on financial indicators using threshold regression models, Ekonomicko-manazerske spektrum, 16(2), 49-60.*

Available at: *dx.doi.org/10.26552/ems.2022.2.49-60*

Received: 8 September 2022; Received in revised form: 17 November 2022; Accepted: 7 December 2022; Available online: 30 December 2022

Abstract:

Research background: The modern economy is characterized by extreme complexity, and in today's global world it is challenging to ensure financial stability and increase financial performance. Every enterprise tries to increase its financial performance and competitiveness. It therefore seems appropriate to look for applicable models, that can increase financial performance and competitiveness of companies.

Purpose of the article: The paper deals with modelling the relationship between financial indicator of profitability and financial indicators of activity, liquidity, and indebtedness. The aim of this article is to analyse the dependence of financial indicator of profitability (return of sales - *ROS*) on financial indicators of activity (turnover of assets – *TA*), indebtedness (total indebtedness - *TI*, financial leverage – *FL*), and liquidity (net working capital to assets ratio - *NWC/A*) of companies in the electrical engineering industry of the Slovak Republic.

Methods: The analysis was carried out using the financial indicators of 2,947 companies for the period 2017-2019. Statistica and Stata programs were used to analyse input data and develop threshold regression models. Input data analysis was performed using Kernel density estimation - Epanechnikov. Threshold regression models will be used for dependency analysis, where the threshold variables will be successively the indicators *TA, TI, FL, NWC/A.*

Findings & Value added: Knowing the relationship between financial indicator of profitability and financial indicators of activity, liquidity, and indebtedness enables more efficient business management. Knowing the coefficients and threshold values for individual industries can be used to optimize the company's debt policy in the relevant industry. The constructed models can be a starting point to improve financial health, prosperity, and competitiveness of analysed businesses. Our analysis is an important prerequisite for developing a realistic financial plan for companies operating in the electrical engineering industry in the Slovak Republic.

Keywords: Threshold regression model; electrical engineering industry; ROS; financial indicators.

JEL Classification: C24; G32.

1. Introduction

Capital structure varies between different industrial sectors and companies within the industrial sector, and a study by Modigliani and Miller (1958) was one of the studies on capital structure and its impact on the value of the company. In the last decade, there were several theories that illustrated capital structure for companies such as Pecking-order theory, The Static-order theory and the agency cost theory. Pecking-order theory states that the relationship between borrowing and profitability of the company is an inverse relationship so that the most profitable companies are less dependent on profits to finance their needs.

The profitability of firms largely depends on the extent to which firms use debt and equity in their operations (Miller and Modigliani, 1963). 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.

Muscettola and Naccarato (2016) examined the impact of debt on corporate profitability using a longitudinal sample of 7,370 Italian *SMEs* operating in the commerce sector during 2006-2010. Andersson and Minnema (2018) examined 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. Table 1 provides an overview of the authors who dealt with the various effects of debt on profitability.

Table 1: Relationship between profitability and debt.

Effect of debt on profitability	**Author(s)**
Negative effect	Rao et al. (2007), King and Santor (2008), Muritala (2012), Babalola (2012), Mohamad and Abdullah (2012)
Positive effect	Baum et al. (2006), Berger and Bonaccorsi (2006), David and Olorunfemi (2010)
Nonlinear effect (inverse U-shaped relationship)	Margaritis and Psillaki (2007), Ramadan and Aloqdeh (2011), Abdul (2014), Ramadan and Ramadan (2015), Petruska et al. (2021), Jencova et al. (2021)

Source: own processing

Threshold regression models have a wide range of applications in economics and have developed rapidly over the three decades since the seminal work of Tong (1983). Some later extensions of the model include the smooth transition threshold model (Chan, 1986), the functional-coefficient autoregressive model (Chen, 1993) and the nested threshold autoregressive model (Astatkie et al., 1997). Hansen (2000) developed a threshold model for nondynamic panels with individual fixed effects. Tsay (1998) and Gonzalo and Pitarakis (2002) studied models with multiple threshold values.

The first generation of threshold regression models developed inference under the assumption of exogenous or predetermined threshold variables. Recently, there is a growing interest in threshold regression models that accommodate endogenous threshold variables to identify the underlying mechanisms of such theories.

Generalized threshold regression models are employed in a wide range of different fields of application. The table 2 provides an overview of studies in which a threshold regression model was used.

Table 2: Use of threshold regression models.

Author(s)	**Object of study**
Yeh et al. (2017)	the effects of rising prices for cigarettes and tobacco products on cigarette consumption and tobacco tax revenues and smoking-related deaths in 28 *EU* countries during 2005-2014

Su Yi and An Xiao-li (2018)	examination of the impact of the regional level of technological innovation on regional sustainable development using the level of regional economic development of the 31 Chinese provinces from 2009 to 2015
Wang and Shao (2019)	the relationship between environmental regulations and ecological growth of the economy in the *G20* countries
Rosmah et al. (2020)	the impact of financial inclusion on the growth of production of 513 companies in selected *ASEAN* countries (Malaysia, Philippines, Vietnam)
Raza et al. (2020)	examines the non-linear relationship between financial development and renewable energy consumption in the countries with the highest renewable energy consumption over the years 1997-2017
Koyuncu et al. (2021)	the state of environmental quality in Turkey in the period of 1990-2015
Kansil (2021)	a study of threshold effects between foreign ownership and firm value of 408 Indian publicly listed companies over the period 2010-2018

Source: own processing

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). For example, the Self-Exciting Threshold Autoregressive Model (*SETAR*) (Tong, 1990) is very popular in nonlinear time series theory. 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).

The paper deals with modelling the relationship between financial indicator of profitability (return on sales – *ROS*) and financial indicators of activity (turnover of assets – *TA*), liquidity (net working capital to assets ratio – *NWC/A*), and indebtedness (financial leverage - *FL*, total indebtedness – *TI*) in the electrical engineering industry of the Slovak Republic. Threshold regression models will be used for dependency analysis, where the threshold variables will be successively the indicators *TA, TI, FL, NWC/A*. It is advisable to compare the obtained threshold values from the analysed models with the recommended values from the professional literature and practice. Knowing the relationship between financial indicator of profitability and financial indicators of activity, liquidity, and indebtedness enables more efficient business management. Knowing the coefficients and threshold values for individual industries can be used to optimize the company's debt policy in the relevant industry. The constructed models can be a starting point to improve financial health, prosperity, and competitiveness of analysed businesses. Our analysis is an important prerequisite for developing a realistic financial plan for companies operating in the electrical engineering industry in the Slovak Republic.

2. Methodology

The aim of this article is to analyse the dependence of financial indicator of profitability (return of sales - *ROS*) on financial indicators of activity (turnover of assets – *TA*), indebtedness (total indebtedness - *TI*, financial leverage – *FL*), and liquidity (net working capital to assets ratio - *NWC/A*) of companies in the electrical engineering industry of the Slovak Republic.

2.1 Research sample

In the initial database, we had at our disposal the financial indicators of 2,947 enterprises of the electrical engineering industry for the period 2017-2019. The research sample consists of a set of the largest non-financial corporations of the Slovak electrical engineering industry, whose ranking was obtained through the FinStat database. The absolute indicators were obtained from the financial statements, which are available in the Register of Financial Statements of the Slovak Republic. Financial indicators were calculated based on absolute indicators.

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.

Electrical engineering 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 engineering industry depends primarily on the automotive industry. The electrical engineering industry is considered as one of the main pillars of Slovak economy. Current situation on the market reflects both — traditional electronics manufacturing (power generators, telephones, radios, etc.) and new trends especially connected to the growing automotive industry in Slovakia (electric motors, microelectronics, sensors). Ongoing shift towards e-mobility is creating whole new opportunities for all electrical components' suppliers. The electrical engineering industry is one of the strongest contributors to the country's GDP, plays a significant role in the industrial output and is also one of the biggest employers in the country (SARIO, 2022).

According to the Statistical Office of the Slovak Republic, the electrical engineering industry registers 1,436 business entities in the SK NACE 26 and 1,628 business entities in the SK NACE 27. The industry employs more than 42 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. In 2020 firms with SK NACE 27 reached the median of return on assets (*ROA*) 3.78 %, the operating profit margin was 3.80 %, return on equity (*ROE*) was 7.09 %, and the share of value added in sales reached 22.58 %. In the debt analysis, the median of total indebtedness reached 44.72 %. The analysis of activity indicators shows that the median of receivables turnover period reached 48.57 days, inventory turnover period was 0.04 days, liabilities turnover period reached 86.13 days, turnover of assets was 1.11. In the liquidity analysis, the median of liquidity of the 2nd degree reached 1.94, and liquidity of the 3rd degree was 2.21.

In 2020 firms with SK NACE 26 reached the median of return on assets (*ROA*) 2.54 %, the operating profit margin was 3.87 %, return on equity (*ROE*) was 4.74 %, and the share of value added in sales reached 21.48 %. In the debt analysis, the median of total indebtedness reached 35.35 %. The analysis of activity indicators shows that the median of receivables turnover period reached 46.95 days, liabilities turnover period reached 92.53 days, turnover of assets was 0.91. In the liquidity analysis, the median of liquidity of the 2nd degree reached 2.46, and liquidity of the 3rd degree was 2.76.

2.2 Kernel density estimation

Input data analysis was performed using Kernel density estimation - Epanechnikov. Kernel density estimation showed extreme properties that were very far from the normal distribution. Therefore, the range of analysed companies was reduced based on the financial indicators' values. Only companies that acquired the indicated values of the indicators were considered (Table 3).

Table 3: Financial indicators

Financial indicator	Formula	Borders
Return of Sales (ROS)	$Earnings\ before\ interest\ and\ taxes\ (EBIT)/Sales$	-0.5 – 0.9
Turnover of Assets (TA)	$Sales/Assets$	0.2 – 15
Total Indebtedness (TI)	$Total\ Debt/Total\ Assets$	0 – 1
Financial Leverage	$Assets/Equity$	1 – 10
Net Working Capital to Assets ratio (NWC/A)	$Net\ Working\ Capital/Assets$	-0.8 – 0.8

Source: own processing

Kernel density estimators approximate the density *f(x)* from observations on x. Histograms do this, too, and the histogram itself is a kind of kernel density estimate. The data are divided into nonoverlapping intervals, and counts are made of the number of data points within each interval. Histograms are bar graphs that depict these frequency counts - the bar is centred at the midpoint of each interval - and its height reflects the average number of data points in the interval. In more general kernel density estimates, the range is still divided into intervals, and estimates of the density at the centre of intervals are produced. One difference is that the intervals are allowed to overlap. We can think of sliding the interval - called a window - along the range of the data and collecting the centre-point density estimates. The second difference is that, rather than merely counting the number of observations in a window, a kernel density estimator assigns a weight between 0 and 1 - based on the distance from the centre of the window - and sums the weighted values. The function that determines these weights is called the kernel. Kernel density estimates have the advantages of being smooth and of being independent of the choice of origin (corresponding to the location of the bins in a histogram) (Stata, 2021, p. 3).

A kernel density estimate is formed by summing the weighted values calculated with the kernel function K, as in:

$$\hat{f}_K = \frac{1}{qh}\sum_{i=1}^{n} w_i K\left(\frac{x-X_i}{h}\right) \tag{1}$$

where $q = \sum_i w_i$ if weights are frequency weights (fweight) or analytic weights (aweight), and q = 1 if weights are importance weights (iweights). Analytic weights are rescaled so that $\sum_i w_i = n$. If weights are not used, then w_i = 1, for i = 1, . . ., n. If the window width h is not selected, it is calculated according to formula (2), where m is calculated using relation (3) (Stata, 2017):

$$h = \frac{0{,}9m}{n^{1/5}} \tag{2}$$

$$m = min\left(\sqrt{variance_x}, \frac{IQR_x}{1{,}349}\right) \tag{3}$$

where $IQR = Q_3 - Q_1$ (interquartile range, difference between the 75th and 25th percentiles). Several types of kernel functions can be used to illustrate a kernel density estimate: Biweight, Cosine, Epanechnikov, Epan2, Gaussian, Parzen, Rectangular, Triangular. The Epanechnikov is the default function if no other kernel is specified and is the most efficient in minimizing the mean integrated squared error.

Due to the limitation of the range of values, the number of analysed enterprises decreased to 1,807. Statistica and Stata programs were used to analyse input data and develop threshold regression models.

2.3 Threshold regression model

The threshold regression model extends linear regression by allowing different coefficients for individual regions (Hansen, 2000, 2011). 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:

$$y_t = x_t\beta + z_t\delta_1 + \varepsilon_t \ \ if - \infty\langle q_t \leq \gamma \tag{4}$$

$$y_t = x_t\beta + z_t\delta_2 + \varepsilon_t \ if \ \gamma\langle q_t \ \langle\infty \tag{5}$$

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 x 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 β, δ_1, δ_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 value γ. Similarly, Region 2 is defined as a subset of observations in which the value of q_t is greater than the threshold value 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):

$$y_t = x_t\beta + z_t\delta_1 I(-\infty\langle q_t \leq \gamma) + z_t\delta_2 I(\gamma\langle q_t\langle\infty) + \varepsilon_t \tag{6}$$

where I is indicator function for a sequence of T' values in qt, 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:

$$\gamma^{'} = arg\ min_{\gamma\in\Gamma}\ S_{T'(\gamma)} \tag{7}$$

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

$$S_{T'(\gamma)} = \sum_{t=1}^{T'}\{y_t - x_t\beta + z_t\delta_1 I(-\infty\langle q_t \leq \gamma) + z_t\delta_2 I(\gamma\langle q_t\langle\infty)\}^2 \quad (8)$$

The statistical software Stata 15.1 was used to calculate the coefficients and threshold values. The work deals with the non-linear effect (inverse U-shaped relationship) between the financial indicator of profitability (*ROS*) and financial indicators of activity (*TA*), liquidity (*NWC/A*), and indebtedness (*FL, TI*) using a threshold regression model.

3. Results and Discussion

Threshold models with the dependent variable *ROS* were successively compiled. The independent variables were *TI, FL, NWC/A* and *TA*. These independent variables entered the regression models as regional (regime, mode) variables. The threshold variables were successively considered: *TA, TI, FL, NWC/A*. The parameters of the threshold regression model with one threshold value (*TA* = 1.2832) are given in Table 4.

Table 4: Threshold variable TA

	ROS	**Coef.**	**Std. Err.**	**z**	**P> |z|**
Region 1	TI	-0.0377	0.0533	-0.71	0.479
	FL	-0.0059	0.0071	-0.833	0.405
	NWC/A	0.0691	0.0242	2.85	0.004
	TA	0.0242	0.0231	1.05	0.295
	cons	0.1399	0.0277	5.05	0.000
Region 2	TI	-0.131	0.0371	-3.54	0.000
	FL	-0.0035	0.0043	-0.81	0.415
	NWC/A	0.01754	0.0205	0.86	0.392
	TA	-0.0022	0.0015	-1.45	0.146
	cons	0.1613	0.0170	9.49	0.000

Source: own processing

In this model, the coefficients are significant for *NWC/A* in the first region and *TI* in the second region. The influence of *NWC/A* on *ROS* is positive in the first region and the influence of *TI* on *ROS* is negative in the second region. If the value of *TA* is less than 1.2832 (Region 1), then with the increase of *NWC/A* there is an increase in *ROS* with coefficient of 0.0691. If the value of *TA* is greater than 1.2832, then with the increase of *TI* there is a decrease in *ROS* with coefficient of -0.131. The parameters of the threshold regression model with one threshold value (*TI* = 0.2343) are given in Table 5.

Table 5: Threshold variable TI

	ROS	**Coef.**	**Std. Err.**	**z**	**P> |z|**
Region 1	TI	0.9096	0.3478	2.62	0.009
	FL	-0.4264	0.2307	-1.85	0.065
	NWC/A	0.1598	0.0378	4.22	0.000
	TA	-0.0065	0.0037	-1.74	0.082
	cons	0.4685	0.2336	2.01	0.045
Region 2	TI	-0.0910	0.0446	-2.04	0.042
	FL	-0.0063	0.0043	-1.48	0.139
	NWC/A	0.0078	0.0174	0.45	0.653
	TA	-0.0065	0.0015	-4.36	0.000
	cons	0.1757	0.0191	9.20	0.000

Source: own processing

The model with the threshold variable *TI* already has more significant coefficients - *TI, NWC/A, TA*. In the first region (with a value of *TI* up to 0.2343), the influence of *TI* on *ROS* is positive, in the second region (with a value of *TI* above 0.2343), the influence of *TI* on *ROS* is negative. If the value of *TI* is less than 0.2343 (Region 1), then with the increase of *TI* there is an increase in *ROS* with coefficient of 0.9096. If the value of *TI* is greater than 0.2343, then with the increase of *TI* there is a decrease in *ROS* with coefficient of -0.0910. *NWC/A* has a positive effect in the first region and *TA* has a negative effect in the second region. If the value of *TI* is less than 0.2343 (Region 1), then with the increase of *NWC/A* there is an increase in *ROS* with coefficient of 0.1598. If the value of *TI* is greater than 0.2343, then with the increase of *TA* there is a decrease in *ROS* with coefficient of -0.0065. The parameters of the threshold regression model with one threshold value (*FL* = 1.468) are given in Table 6.

Table 6: Threshold variable FL

	ROS	**Coef.**	**Std. Err.**	**z**	**P> |z|**
	TI	2.1893	0.5627	3.89	0.000
	FL	-1.4559	0.3721	-3.91	0.000
Region 1	NWC/A	0.1463	0.0303	4.82	0.000
	TA	0.0041	0.0026	-1.57	0.115
	cons	1.4973	0.3627	4.12	0.000
	TI	-0.0519	0.0560	-0.93	0.353
	FL	-0.0095	0.0047	-1.99	0.047
Region 2	NWC/A	-0.0061	0.0183	-0.33	0.738
	TA	-0.0078	0.0016	-4.78	0.000
	cons	0.1675	0.0243	6.87	0.000

Source: own processing

TI has a strong positive influence on *ROS* in the first region, but this influence disappears in the second region. If the value of *FL* is less than 1.468 (Region 1), then with the increase of *TI* there is an increase in *ROS* with coefficient of 2.1893. The coefficient for *FL* is significant in both regions and is negative. However, in the second region, the influence of *FL* on *ROS* is significantly reduced. If the value of *FL* is less than 1.468 (Region 1), then with the increase of *FL* there is a decrease in *ROS* with coefficient of -1.4559. If the value of *FL* is greater than 1.468, then with the increase of *FL* there is a decrease in *ROS* with coefficient of -0.0095. As in the previous two cases, the effect of *NWC/A* on *ROS* is positive, but only in the first region. If the value of *FL* is less than 1.468 (Region 1), then with the increase of *NWC/A* there is an increase in *ROS* with coefficient of 0.1463. *TA* has a negative effect in the second region. If the value of *FL* is greater than 1.468, then with the increase of *TA* there is a decrease in *ROS* with coefficient of -0.0078. The parameters of the threshold regression model with one threshold value (*NWC/A* = 0.4345) are given in Table 7.

Table 7: Threshold variable NWC/A

	ROS	**Coef.**	**Std. Err.**	**z**	**P> |z|**
	TI	0.0171	0.0386	0.44	0.657
	FL	-0.0135	0.0041	-3.26	0.001
Region 1	NWC/A	-0.0058	0.0235	-0.25	0.804
	TA	-0.0057	0.0018	-3.14	0.002
	cons	0.1306	0.0158	8.22	0.000
	TI	-0.2229	0.0668	-3.33	0.001
	FL	0.0008	0.0142	0.06	0.955
Region 2	NWC/A	0.0102	0.0615	0.17	0.868
	TA	-0.0080	0.0021	-3.71	0.000
	cons	0.2326	0.0431	5.39	0.000

Source: own processing

TA is significant in both regions. However, its impact on *ROS* is negative. If the value of *NWC/A* is less than 0.4345 (Region 1), then with the increase of *TA* there is a decrease in *ROS* with coefficient of -0.0057. If the value of *NWC/A* is greater than 0.4345, then with the increase of *TA* there is a decrease in *ROS* with coefficient of -0.0080. *FL* has a negative effect in the first region and *TI* has a negative effect on *ROS* in the second region. If the value of *NWC/A* is less than 0.4345 (Region 1), then with the increase of *FL* there is a decrease in *ROS* with coefficient of -0.0135. If the value of *NWC/A* is greater than 0.4345, then with the increase of *TI* there is a decrease in *ROS* with coefficient of -0.2229. Table 8 compares the limits of the analysed financial indicators data, the recommended values for the financial indicators and the threshold values that were determined by individual models. We can state the proximity of the recommended values of the indicators and the limit values from the obtained models.

Table 8: Limits of financial indicators

Financial indicators	**Analysed data**		**Recommended values**		**Model threshold value**
	Lower limit	**Upper limit**	**Lower limit**	**Upper limit**	
TA	0.2	15	1.2		1.283
TI	0	1	0.3	0.5	0.234
FL	1	10	1	1.5	1.468
NWC/A	-0.8	0.8			0.434

Source: own processing

We can compare our results with several existing studies, which used threshold regression models for analysing the relationship between profitability and other financial indicators. Ramadan and Ramadan (2015) showed that there is statistically significant inverse effect of capital structure on the return on assets (*ROA*) of the Jordanian industrial companies listed at Amman Stock Exchange. Jencova et al. (2021) used threshold regression models to analyse the relationship between return on assets (*ROA*) and total indebtedness (*TI*). In the case of the engineering and electrical industries in the Region 1, profitability (*ROA*) increases with increasing indebtedness (*TI*). However, after exceeding the threshold value, profitability (*ROA*) decreases. Food and spa industries show a decrease in profitability (*ROA*) with increasing indebtedness (*TI*) throughout the course. However, the intensity of the decrease changes in the calculated threshold values. Petruska et al. (2021) examined the relationship between return on sales (*ROS*) and total indebtedness (*TI*) using threshold regression models in construction industry. Authors applied three models (with one, two and three threshold values). They found that the model with one threshold value is the most appropriate. In the Region 1, profitability (*ROS*) increases with increasing indebtedness (*TI*). However, after exceeding the threshold value, profitability (*ROS*) decreases. Other authors (Berger and Bonacrossi, 2006; Margaritis and Psillaki, 2007; Min-tsung Cheng, 2009; Muscettola and Naccarato, 2016; Andersson and Minnema, 2018) used other methods (quantile regression, panel regression, data envelopment analysis) for examining the relationship between profitability and other financial indicators.

4. Conclusions

The paper dealt with modelling the relationship between financial indicator of profitability and financial indicators of activity, liquidity, and indebtedness of companies from the electrical engineering industry in the Slovak Republic. The aim of this article was to analyse the dependence of financial indicator of profitability (return of sales - *ROS*) on financial indicators of activity (turnover of assets – *TA*), indebtedness (total indebtedness - *TI*, financial leverage – *FL*), and liquidity (net working capital to assets ratio - *NWC/A*) of companies in the electrical engineering industry of the Slovak Republic.

Knowing the relationship between financial indicator of profitability and financial indicators of activity, liquidity, and indebtedness enables more efficient business management. Threshold models were used for dependency analysis of *ROS* on financial indicators of liquidity, activity, and indebtedness, where the threshold variables will be successively the indicators *TA, TI, FL, NWC/A*. Knowing the coefficients and threshold values for individual industries can be used to optimize the company's debt policy in the relevant industry.

We can state the proximity of the recommended values of the financial indicators and the threshold values from the obtained models. The constructed models can be a starting point to improve financial health, prosperity, and competitiveness of analysed businesses. Our analysis is an important prerequisite for developing a realistic financial plan for companies operating in the electrical engineering industry in the Slovak Republic.

This paper has several limitations because we do not consider all companies from electrical engineering industry in the Slovak Republic, and we analyse only three years. Therefore, it would be interesting to repeat the analysis with more companies or for different years. A prerequisite for follow-up research is to estimate model for longer time series. Besides that, we can consider the regional segmentation of companies and other qualitative data. We could also consider the size of firms in the regression model. In further research, we could divide the sample of enterprises into small, medium, and large and find differences in the results. Moreover, in addition to threshold regression, we suggest using data enveloped analysis, quantile regression or panel regression. The presented results are the basis for further modelling, and at the same time a source of stimulus for further discussion.

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

Funding: “This research received no external funding.”

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

Acknowledgments: “This research was funded by the Scientific Grant Agency of the Ministry of Education, Science, Research, and Sport of the Slovak Republic and the Slovak Academy of Sciences, grant numbers VEGA 1/0741/20 and KEGA 001PU-4/2022”.

Conflicts of Interest: “The authors declare no conflict of interest.”

References

Abdul, J. T. (2014). The impact of capital structure on the performance of the Jordanian public shareholding industrial companies. *The Journal of Jordan in Business Administration*. *12*(3).

Andersson, A., & Minnema, J. (2018). The relationship between leverage and profitability. Available from: http://www.divaportal.org/smash/get/diva2:1234028/FULLTEXT01.pdf

Astatkie, T., Watts, D.G., & Watt, W.E. (1997). Nested Threshold Autoregressive (NeTAR) Models. *International Journal of Forecasting, 13*(1), 105-116. https://doi.org/10.1016/S0169-2070(96)00716-9

Arlt, J., & Arltova, M. (2003). *Finanční časové řady*. Praha: Grada Publishing.

Babalola, Y.S. (2012). The Effects of Optimal Capital Structure on Firms’ Performances in Nigeria. *Journal of Emerging Trends in Economics and Management Sciences*. *3*(2), 131-133.

Baum, C.F., Schafer, D., & Talavera, O. (2006). The effects of short-term liabilities on profitability: a comparison of German and US firms. Working paper, No. 636. Boston: Boston College Department of Economics.

Berger, A., & 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. https://doi.org/10.1016/j.jbankfin.2005.05.015

David, D.F., & Olorunfemi, S. (2010). Capital Structure and Corporate Performance in Nigeria Petroleum Industry: Panel Data Analysis. *Journal of Mathematics and Statistics*. *6*(2), 168-173.

Gonzalo, J., & Pitarakis, J. (2002). Estimation and Model Selection Based Inference in Single and Multiple Threshold Models. *Journal of Econometrics. 110*(2), 319-352. https://doi.org/10.1016/S0304-4076(02)00098-2

Hansen, B.E. (2000). Sample splitting and threshold estimation. *Econometrica*, *68*(3), 575-603. https://ezproxy.pulib.sk:2350/10.1111/1468-0262.00124

Hansen, B.E. (2011). Threshold autoregression in economics. *Statistics and Its Interface*. *4*(2), 123–127.

Chan, K.S., & Tong, H. (1986). On Estimating Thresholds in Autoregressive Models. *Journal of Time Series Analysis*. *7*(3), 179-190.

Chen, R., & Tsay, S. (1993). Functional-coefficient Autoregressive Models. *Journal of the American Statistical Association*. *88*(421), 298-308. https://doi.org/10.2307/2290725

Jencova, S. (2018). *Aplikácia pokročilých metód vo finančno-ekonomickej analýze elektrotechnického odvetvia Slovenskej republiky*. SAEI, vol. 54. Ostrava: VSB–TU Ostrava. ISBN 978–80–248–4219–6.

Jencova, S., Petruska, I., & Lukacova, M. (2021). Relationship between ROA and total indebtedness by threshold regression model. *Montenegrin Journal of Economics*. *17*(2), 37-46.

Kansil, R. (2021). Relation between foreign ownership and firm value - Fixed-effect panel threshold regression analysis. *World Journal of Science Technology and Sustainable Development. 18*(2), 109-129. https://doi.org/10.1108/WJSTSD-11-2020-0095

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. https://doi.org/10.1016/j.jbankfin.2008.02.002

Koyuncu, T., Beser, M. K. & Alola, A. A. (2021). Environmental sustainability statement of economic regimes with energy intensity and urbanization in Turkey: a threshold regression approach. *Environmental science and pollution research*. *28*(31), 42533-42546.

Margaritis, D., & Psillaki, M. (2007). Capital structure and firm efficiency. *Journal of Business Finance and Accounting*. *34*(9-10), 1447-1469. https://ezproxy.pulib.sk:2350/10.1111/j.1468-5957.2007.02056.x

Miller, M., & Modigliani, F. (1963). Corporate income taxes and the cost of capital: a correction. *American Economic Review*. *53*(3), 443–453.

Min-tsung Cheng, (2009). Relative effects of debt and equity on corporate operating performance: A quantile regression study. *International Journal of Management*. *26*(1).

Modigliani, F., & Miller, M. H. (1958). The cost of capital, corporate finance, and the theory of investment. *American Economic Review. 48*, 261-297.

Mohamad, N.E., & Abdullah, F.N. (2012). Reviewing Relationship between Capital Structure and Firm's Performance in Malaysia. *International Journal of Advances in Management and Economics*. *1*(4), 151-156.

Muritala, T.A. (2012). An empirical analysis of capital structure on firms' performance in Nigeria. *International Journal of Advances in Management and Economics*. *1*(5), 116-124.

Muscettola, M., & Naccarato, F. (2016). The Casual Relationship Between Debt and Profitability: The Case of Italy. *Athens Journal of Business and Economics*. *2*(1), 17-32.

Petruska, I., Horvathova, J., & Mokrisova, M. (2021). Analýza vzájomných vzťahov medzi ukazovateľmi pri hodnotení finančného zdravia podnikov. *Financie, uctovnictvo, matematicke metody: analyzy a trendy*. 140-152.

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.

Rao, N.V., Al-yahyaee, K.H.M., & Syed, L.A.M. (2007). Capital structure and financial performance: evidence from Oman. *Indian Journal of Economics and Business*. *7*, 1-14.

Raza, S. A., Shah, N., Qureshi, M.A., Qaiser, S., Ali, R. & Ahmed, F. (2020). Non–linear threshold effect of financial development on renewable energy consumption: evidence from panel smooth transition regression approach. *Environmental Science and Pollution Research*. *27*(25), 32034–32047.

Rosmah, N., Zulkefly, A.K., Tamat, S. & Aisyah, A.R. (2020). Financial Inclusion and Firms Growth in Manufacturing Sector: A Threshold Regression Analysis in Selected Asean Countries. *Economies*. *8*(4), 80. https://doi.org/10.3390/economies8040080

SARIO, (2022). *Electronics & Electrical Components Industry in SLOVAKIA*. Bratislava: Slovak Investment and Trade Development Agency.

Stata, (2017). Statistic Data Analysis – Threshold regression. Available from: stata.com.

Stata, (2020). Threshold regression. Available from: https://www.stata.com/features/overview/threshold-regression/

Su, Y., & An, X. (2018). Application of threshold regression analysis to study the impact of regional technological innovation level on sustainable development. *Renewable & Sustainable Energy Reviews*. *89*, 27-32. https://doi.org/10.1016/j.rser.2018.03.005

Tong, H. (1983). *Threshold Models in Nonlinear Time Series Analysis: Lecture Notes.* Statistics 21. Berlin: Springer.

Tong, H. (1990). Non-Linear Time Series: A Dynamical System Approach. *Oxford University Press*.

Tsay, R.S. (1998). Testing and Modelling Multivariate Threshold Models. *Journal of the American Statistical Association*. *93*(443), 1188-1202. https://doi.org/10.1080/01621459.1998.10473779

Wang, X. & Shao, Q. (2019). Non–linear effects of heterogeneous environmental regulations on green growth in G20 countries: Evidence from panel threshold regression. *Science of the Total Environment*. *660*, 1346–1354. https://doi.org/10.1016/j.scitotenv.2019.01.094

Yeh, CH. Y., Schafferer, CH., Lee, J. M., Ho, L. M., & Hsieh, C. J. (2017). The effects of a rise in cigarette price on cigarette consumption, tobacco taxation revenues, and of smoking-related deaths in 28 EU countries- applying threshold regression modelling. *BMC Public Health*. *17*, 676.