Corporate Debt Dynamics: Sectoral Clustering Analysis Using NACE Classification in Slovakia

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ABSTRACT

Research background: Many authors are currently exploring the impact of the industry on the financial structure of enterprises since there are statistically significant differences across various sectors, exposing the industry as a critical factor influencing corporate indebtedness. Clusters of sectors with homogeneous patterns of indebtedness and comparable levels of debt in various economic conditions may be determined, and, therefore, firms and their debt levels should be systematically examined and evaluated.

Purpose of the article: The main aim of this paper is to evaluate the level of debt in the Slovak environment on a sample of 19,480 firms from various sectors and to identify the relationships among them to identify sectors with homogeneous patterns of indebtedness and, consequently, comprehend which sectors are the most stable and independent.

Methods: Because NACE classification provides a framework for gathering and presenting statistical data based on many economic sectors, the number of input data was reduced based on cluster analysis. Using Ward's hierarchical clustering method using squared Euclidean distance, selected indebtedness ratios were used to define the sectors with comparable debt levels. To determine if there were statistically significant differences between the calculated debt ratios related to the economic sector, the Kruskal-Wallis test was performed. Subsequently, as the results indicated significant differences across various indebtedness ratios, a post hoc analysis was performed.

Findings & Value added: A group of NACE activities in which enterprises are sufficiently comparable that it is appropriate to evaluate their debt levels using the chosen indebtedness ratios are considered to be in sectors C, F, G and H, which included to tertiary sector, while the sectors K, R and S may also be grouped in one cluster, while form the secondary sector. The key relevance of our findings is the benchmarking of selected sectors about indebtedness, which may be used to further examine their growth in each of the V4 nations, which is an essential area for the evolution of the European economy as a whole. Studies considering a relatively significant amount of capital structure determinants may be beneficial to owners and managers, regulators, and financial institutions since debt policy affects firm performance, value, and survival.

INTRODUCTION

Many factors constantly influence the corporate financial situation and identifying them is necessary for the enterprise to maintain its long-term development. The assessment of the corporate financial situation contributes to identifying difficulties and critical circumstances in time and consequently preventing bankruptcy (Michalkova, 2023; Kostrzewski et al., 2023). Aman et al. (2023) argue that a corporation has to consider future financial development in addition to an appropriate financial nation if a firm wants to be successful in the market and compete in a continuously changing environment. In general, a financially healthy firm fulfils two requirements: (i) it is liquid over the long term, i.e., it can pay its obligations on time both now and in the future, as long-term liquidity is significantly influenced by the ratio of equity and debt financing in the overall capital structure of the company (Msomi, 2023); and (ii) it is profitable, i.e., it can generate enough profit to cover its costs through its business activities (Lehenchuk et al., 2022). The ratio between equity and debt, as reflected by the corporate financial structure, is a frequently discussed issue in financial research. The development of the corporate capital structure is a strategic decision, the consequences of which occur over several years. Therefore, it is necessary to consider several factors when developing it. Several studies have been conducted about the impact of particular factors on a corporate capital structure (Neykov et al., 2022; Kristofik & Medzihorsky, 2022; Kovacova et al., 2022). However, the capital structure is influenced by the sector in which the enterprise is operating. Enterprises in the same industry have specific characteristics, including the products they offer, the way their production expenses are structured, the technologies they utilize, and their profitability levels (Vojtekova & Kliestik, 2024), while these patterns additionally occur in the field of corporate capital structure. Kim (2023) state that the average total debt ratio differs by industry. It has been more than 50 years since Schwartz & Aronson (1967) introduced the relationship between industry affiliation and corporate capital structures in the United States. Empirical capital structure research nevertheless often includes the industry determinant. The main aim of this paper is to evaluate the level of debt in the Slovak environment on a sample of 19,480 firms from various sectors and to identify the relationships among them to identify sectors with homogeneous patterns of indebtedness and, consequently, comprehend which sectors are the most stable and independent. Due to different changes in specific countries caused by the disparate effects of the pandemic as well as other macroeconomic changes depending on the industrial orientation of national economies, one-country studies have become increasingly important.

The paper is divided into the following sections. The most recent and relevant research on the topic is included in the literature review. The methodology section notices the sample of analysed firms and the research methodological steps required for debt analysis implementation, focusing on industries with homogeneous patterns of indebtedness and the existence of statistically significant differences in debt indicators due to the NACE classification. The results and discussion section presents the findings from the statistical verification of selected debt indicators that were calculated previously. In the context of other international studies, these findings are discussed and debated. In addition to limits and challenges for future research, the conclusion section highlights the most important findings from the paper.

THEORETICAL BACKGROUND

In the dynamic and complex landscape of today's business environment, which is currently facing the most significant pressure in the last decade due to severe economic destabilization caused by the pandemic and other conflicts, enterprises must now more than ever fight for their market position or survival. As part of this process, every firm should engage in continuous evaluation of past procedures and decisions that have led the enterprise to its current state under these adverse circumstances. Firms that recognize the critical link between financial stability (Juracka et al., 2023) and overall business performance can swiftly and effectively adapt to turbulent times, even profiting from them (Valaskova et al., 2023). The emphasis on efficiency, in terms of overall company performance, has become a guiding principle for most successful stories in the modern business era. Furthermore, focusing on a retrospective analysis of the financial situation can help management learn from past mistakes and ensure ongoing improvement in corporate financial performance (Juracka & Rabe, 2023).

Financial performance indicators assess cash flow in addition to revenue and expenses (Wang et al., 2023) are often based on data gathered from the corporate balance sheet and profit and loss statement (Parlakkaya et al., 2020). Corporate activity (Serban et al., 2023), liquidity (Adusei, 2022), indebtedness (Gajdosikova et al., 2023), and overall performance (Guragai & Hutchison, 2020; Lazaroiu et al., 2023) may all be evaluated using financial indicators, while according to Jin et al. (2017) and Adu et al. (2023), the most crucial objectives are maximizing profit and enhancing the market value of the enterprise. Generally, a firm has to generate a profit to expand and invest (Durana et al., 2021). Because investors need to know the expected return on any investment made (Nasrallah and El Khoury, 2022) and return on sales, which is determined by operating profit as a percentage of sales, return on equity (Xu & Liu, 2021) is frequently used to monitor the achievement of this goal. According to Hwang et al. (2021), a firm may have cash flow problems even while it is profitable. Liquidity indicators assess the ability of the firm to meet its short-term financial obligations (Mihailovic et al., 2023). Current liquidity is one of the most well-known measures of liquidity because this indicator measures the ability of a firm to use current assets that may be transformed into cash to pay short-term debt that is due within a year (Novotna et al., 2023). A value higher than 1 is recommended, even if the monitoring of this financial indicator va-

ries depending on the industry in which the enterprise operates (Vukovic et al., 2022). If this indicator indicates a steadily declining trend or a lower value when compared to the industry average, the firm could be encountering problems with liquidity. On the contrary, a high ratio value indicates that additional revenue is not being used effectively (Buneta, 2021). The liquidity of the company is a precondition for its financial stability (Sliwinski, 2023), while if the liquidity is impacted, it might indicate corporate insolvency (Karas & Reznakova, 2023), which is directly related to indebtedness (Abinizano et al., 2023). Corporate indebtedness is the use of funds borrowed by a firm to finance its activities and assets (Wang, 2023). According to Mazanec (2023), a high debt ratio indicates that the firm significantly depends on debt to pay its long-term needs. Given the current state of the economy, several companies choose debt financing since they are unable to finance themselves solely through their own financial resources. According to Msomi (2023), an integral part of monitoring the corporate financial performance is precisely the debt level, which performs as an indicator of the amount of risk that the firm bears with a given ratio and structure of equity and debt financing. The level and volatility of corporate profits (Kim and Berger, 2008), the costs of financial difficulties (Alekneviciene & Stralkute, 2023), the impact of inflation (Khan, 2022), the effort to maintain ownership control of the firm (Abdullah & Tursoy, 2021), the dividend policy (Tayachi et al., 2023), the requirements for financial flexibility of the enterprise (Lei et al., 2021), and the type and intensity of taxation (Jacob, 2022) significantly impact the corporate indebtedness.

Another factor that David (2014) highlight as determining the level of corporate indebtedness is the industry affiliation of the firm. Harris & Raviv (1991) declare in their study that industry classification has a considerable impact on the average corporate debt level ratio. Moreover, Bradley et al. (1984) demonstrate that industry has a crucial role in determining leverage and that corporate leverage ratios differ more within sectors than within industries. The results concluded differences between industries as well as consistency within a specific sector. The industry in which small and medium-sized enterprises operate has an influence on them, according to Gaud et al. (2005). Generally, small and medium-sized enterprises in a given industry face comparable current conditions and frequently implement a similar financing pattern. Additionally, Hall et al. (2004) provided evidence of differences in agency costs between firms as well as inter-industry differences in debt across industries. According to La Rocca et al. (2011), industry-specific features influence the debt ratio through the importance of business risk, tangible assets, and growth possibilities. The capital structure of small and medium-sized enterprises may be impacted by industry-specific characteristics. Most research papers on the determinants influencing a corporate capital structure have used dummy variables or median industry variables to examine the influence of the industry, as demonstrated by the studies

conducted by De Jong et al. (2008) and Degryse et al. (2012). Nowadays, the impact of industry on corporate capital structures has been examined by many authors. The three industry-specific factors were utilized by Kayo & Kimura (2011) and Smith et al. (2015). According to La Rocca et al. (2011), enterprises operating in emerging economies require additional external financing to fulfil their investment potential since internal funding might not be sufficient to cover all future opportunities. A significant amount of the predictive power of industry affiliation on firm capital structure, according to Danso et al. (2020), is determined by the features of firms and the countries in which their shares are listed. Even after considering the impacts on both firms and countries, industry nonetheless plays an essential part in determining the differences in capital structure ratios.

Clusters of sectors with homogeneous patterns of indebtedness and comparable levels of capital intensity in various economic conditions may be determined, and, therefore, firms and their debt levels should be systematically examined and evaluated. Thus, the following hypothesis was set:

H1: In particular Slovak conditions, there is a significant occurrence of homogenous indebtedness patterns across industries.

Because of variations within nations, sectors, or the unique attributes of individual businesses, consensus has not been achieved in existing literature regarding the key factors influencing capital structure. Despite numerous theoretical frameworks, a comprehensive approach to crafting an ideal capital structure remains elusive. There is no universal formula where inputs lead to the optimal capital structure calculation. Success in resolving this issue hinges on a financial manager's ability to discern the factors influencing borrowing within the framework of corporate characteristics, which broadly shape perceptions of indebtedness. This discernment is just one of many competencies necessary for achieving a viable solution.

RESEARCH OBJECTIVE, METHODOLOGY AND DATA

The main aim of this paper is to evaluate the level of debt in the Slovak environment on a sample of 19,480 firms from various sectors and to identify the relationships among them to identify sectors with homogeneous patterns of indebtedness and, consequently, comprehend which sectors are the most stable and independent.

Financial parameters from the ORBIS database, regarded as a source of business and financial data on more than 400 million private and public firms operating worldwide, were required for a comprehensive debt analysis. The data on 30,130 enterprises operating in Slovakia during the monitored period 2018–2022 is contained in the database, which formed the basis for the debt analysis. The obtained data from a database were appropriately modified because not all enterprises met the criteria required to calculate the debt indicators. Enterprises that

did not provide the necessary input data for the debt analysis throughout the monitored period were removed. Outliers that might have diminished the significance of the realized financial analysis results were also eliminated using the Z-Score method. The firm-specific features for 19,480 Slovak firms, comprising firm size, legal form and ownership structure, firm age, and economic sector, are included in Table 1.

Slovak enterprises are categorized into four groups within the size representation: small (47.97%), medium-sized (43.78%), large (6.84%), and very large (1.40%). Most enterprises operate in category G – Wholesale and retail trade; repair of motor vehicles and motorcycles. This category got first place because the Slovak Republic is well-known for its automobile manufacturing sector. The production of cars is closely related to their subsequent sale and provision of service. On the contrary, the fewest firms in the sample belong to category O – Public administration and defence; compulsory social security.

Table 1: Firm-specific features of the sample

FIRM SIZE	
Small enterprise	47.97%
Medium sized enterprise	43.78%
Large enterprise	6.84%
Very large enterprise	1.40%
LEGAL FORM AND OWNERSHIP STRUCTURE	
Private limited companies	87.58%
Public limited companies	9.29%
Partnerships	3.02%
Other legal form	0.11%
FIRM AGE	
<10	2.10%
10-20	52.18%
20-30	28.46%
30-40	10.48%
>40	6.79%
ECONOMIC SECTOR (NACE CLASSIFICATION)	
A. Agriculture, forestry and fishing	5.27%
B. Mining and quarrying	0.24%
C. Manufacturing	15.62%
D. Electricity, gas, steam and air conditioning supply	0.83%
E. Water supply; sewerage, waste management, etc.	0.90%
F. Construction	8.17%
G. Wholesale and retail trade, repair of motor vehicles/motorcycles	28.24%
H. Transportation and storage	5.06%
I. Accommodation and food service activities	2.19%
J. Information and communication	3.81%
K. Financial and insurance activities	0.45%
L. Real estate activities	8.42%
M. Professional, scientific and service activities	11.23%
N. Administrative and support service activities	5.66%
O. Public administration and defence; compulsory social security	0.03%
P. Education	0.40%
Q. Human health and social work activities	2.24%
R. Arts, entertainment and recreation	0.81%
S. Other service activities	0.44%
TOTAL	100.00%

Source: own elaboration

According to the legal form, the most represented are private limited companies. While it is the most widespread type of legal form, it may be established simply (by an individual, but not by more than 50 individuals), requires a relatively low share of capital (5,000 euros), and has limited liability based only on the corporate assets or unpaid contributions by shareholders. A public limited company is the second most frequently encountered legal form in the dataset. A public limited company can be established by one legal entity or by two individuals with 25,000 euros of registered capital, while the liability is limited by the level of corporate assets. The last division is the firm age based on the number of years on the market. Enterprises with the shortest market operations (less than ten years) obviously have the lowest market share. Since the majority of firms have been on the market for more than ten years, it may be argued that these enterprises are sufficiently reliable to offer excellent data for the research.

Several methodological steps were used to conduct the financial analysis concerning the level of debt of enterprises operating in the Slovak environment. Six debt indicators were used to provide a comprehensive examination of Slovak corporate indebtedness from 2018 to 2022. Table 2 provides the formulas required for the following calculation.

Descriptive statistics, including average, median, standard deviation, minimum, maximum, and coefficient of variation, are compiled over a 5-year period in Table 3. The calculation of debt indicators was based on financial data (in thousands of euros).

Subsequently, to determine if a dataset is well-modelled by a normal distribution, normality tests were conducted. A statistical test of normality can be helpful since it can be difficult to determine whether the deviation from linearity is systematic or just the result of sample variation (Avdovic & Jevremovic, 2023). If the dataset is not well-modelled by a normal distribution, nonparametric methods might be needed.

Because NACE provides a framework for gathering and presenting statistical data based on many economic sectors, the number of input data (categories under investigation) is reduced through cluster analysis. The provided

Table 2: Summarized formulas of indebtedness indicators

Ratio	Algorithm
Total indebtedness ratio	Current and non-current liabilities to total assets
Self-financing ratio	Shareholders funds to total assets
Current indebtedness ratio	Current liabilities to total assets
Non-current indebtedness ratio	Non-current liabilities to total assets
Debt-to-equity ratio	Current and non-current liabilities to shareholders funds
Equity leverage ratio	Total assets to shareholders funds

Source: Gajdosikova et al. (2022)

Table 3: Descriptive statistics of financial data required to calculate indebtedness ratios

	avg.	med.	std. dev.	min.	max.	CV
TOAS	5,378.476	910.151	57,409.144	200.312	4,105,576.500	10.674
SHFD	2,724.311	403.369	33,995.715	−26,256.192	2,456,690.000	12.479
NCLI	559.958	20.380	10,560.599	−147.522	1,149,859.000	18.860
CULI	1,851.130	340.284	16,811.935	−220.857	1,268,792.200	9.082

Source: own elaboration

review and analysis of the indebtedness ratios was followed by cluster analysis to investigate the relationship between debt level and sectors of economic activity as defined by the NACE classification of Slovak enterprises, with an emphasis on the sector of economic activity in which the firm operates. Due to the heterogeneity of economic activity sectors, an attempt was made to categorize them into groups with similar assessments using cluster analysis. This method is known as interdependency analysis, which suggests that all of the variables included in the study are interconnected without being divided into independent (reasons) and dependent (effects) variables (Distefano et al., 2023). Hu et al. (2023) state that cluster analysis enables researchers to group objects into clusters. The cluster analysis was performed through the following methodological steps: (i) variable selection and adoption of the method to determine similarities between objects; (ii) method selection for grouping given objects into a homogenous group; (iii) selection of the number of clusters to identify; and (iv) evaluation and interpretation of observed clusters (Satre-Meloy et al., 2020; Crowther et al., 2021). The appropriate measuring technique must be selected based on the character of the application. In this paper, agglomerative hierarchical clustering was employed to group the economic sectors identified by the NACE classification of Slovak enterprises. According to Dalmaijer et al. (2020), hierarchical clustering begins with n clusters, where each observation forms a distinct homogeneous group and concludes with one cluster that contains all observations. The two closest observations, or observation clusters, are merged into a one new cluster at each step. The dendrogram is used to present a visual representation of the hierarchical clustering method, indicating the distances at which separate clusters (or observations) were merged. Clustering starts with a method to express the similarity (distance) of individual cases (Scutariu et al., 2022). When determining sectors with homogeneous patterns of indebtedness in the Slovak environment, a hierarchical method was computed using Ward's method, a hierarchical clustering technique based on the development of

clusters with the highest possible internal homogeneity. The Ward's method is based on the analysis of variance, which identifies and merges clusters with a minimum sum of squares. This increase is a weighted squared distance between cluster centres (Dalmaijer et al., 2020). Firstly, all clusters are singletons (clusters containing a single point). A recursive algorithm under this objective function can be applied if the initial distance between individual objects is the squared Euclidean distance.

To determine if there are statistically significant deviations in an independent variable between two or more groups, the Kruskal-Wallis test was used (Kruskal & Wallis, 1952). The nonparametric Kruskal-Wallis test is applied when the assumptions for a normal distribution of each group with approximately equal variance in the scores are not met. The Kruskal-Wallis test, which measures median or mean equality (Bower et al., 2023), is a non-parametric method for comparing independent samples (Zimmermann et al., 2022). If a random sample of size from a large population consists of distinct groups or categories that are adequately represented in the sample, it is necessary to compare the groups of sizes with , in accordance with a continuous response variable . After determining the precise category assignment, the Kruskal-Wallis test is conducted by comparing the sum of the ranks for each group and ranking each observation independently. The Kruskal-Wallis test result, however, only indicates if there are differences in the medians of some of the groups but it does not identify which groups differ from each other.

To determine whether groups differ from one another, the Bonferroni adjustment can be used. Due to its simplicity, the Bonferroni correction is the method used for adjusting for multiplicity the most often (Francis & Thunell, 2021). However, this method is applied in research papers to adjust probability values while doing multiple statistical tests in any context, and it is typically associated with Dunn (1961). The Bonferroni correction was developed to address the issue that, as the number of tests increases, so does the probability of a type I error, assu-

ming there is an important distinction when it is not. Generally, the Bonferroni adjustment is applied to the probability values linked to each individual test to maintain a significance level of 0.05 for each test.

RESULTS AND DISCUSSION

The selected indebtedness ratios (total indebtedness ratio, self-financing ratio, current indebtedness ratio, non-current indebtedness ratio, debt-to-equity ratio, and equity leverage ratio) were computed over a 5-year horizon using the financial data of the examined enterprises, and their average values are summarized in Table 4.

Table 4: 5-year average values of indebtedness indicators

NACE	TI	SF	CI	NCI	DE	EL
A	0,516	0,484	0,416	0,100	1,740	2,847
B	0,433	0,567	0,337	0,096	1,153	2,214
C	0,508	0,492	0,426	0,082	1,695	2,936
D	0,556	0,444	0,439	0,117	1,762	2,823
E	0,499	0,501	0,395	0,104	1,674	2,896
F	0,542	0,458	0,476	0,066	1,854	3,052
G	0,515	0,485	0,458	0,057	1,794	3,122
H	0,556	0,444	0,458	0,098	1,984	3,249
I	0,537	0,463	0,457	0,080	1,637	2,752
J	0,465	0,535	0,416	0,049	1,353	2,556
K	0,328	0,672	0,284	0,044	1,349	2,657
L	0,446	0,554	0,375	0,071	1,439	2,486
M	0,451	0,549	0,398	0,053	1,479	2,666
N	0,481	0,519	0,424	0,057	1,613	2,804
O	0,499	0,501	0,455	0,044	1,568	2,702
P	0,422	0,578	0,387	0,035	1,211	2,278
Q	0,333	0,667	0,279	0,054	1,006	2,187
R	0,396	0,604	0,342	0,054	1,331	2,442
S	0,444	0,556	0,390	0,054	1,167	2,304

Source: own elaboration

Financial indicators that indicate the extent to which business activities are covered by equity and debt are total indebtedness and the self-financing ratio. Jencova et al. (2021) claimed that it is essential for every firm to monitor the total indebtedness ratio, as it includes corporate total debt in the calculation. In their study, the authors state that the increase in the indicator value is associated with the risk of the inability of the enterprise to repay these debts. The higher the total indebtedness ratio, the higher the corporate debt level. The indicator of total indebtedness reaches an average value of 0.470, which indicates that 1 € of total corporate assets is covered by 0.470 € of debt in Slovak conditions. The highest level of indebtedness can be observed in sector H, where enterprises are indebted on average at 55.6%. On the contrary, firms operating in sector K prefer debt financing the least, where the average value of total indebtedness reaches 32.8%. Optimal indebtedness is generally defined as the one that minimizes the capital costs, thus maximizing the value of the company, and is set in deve-
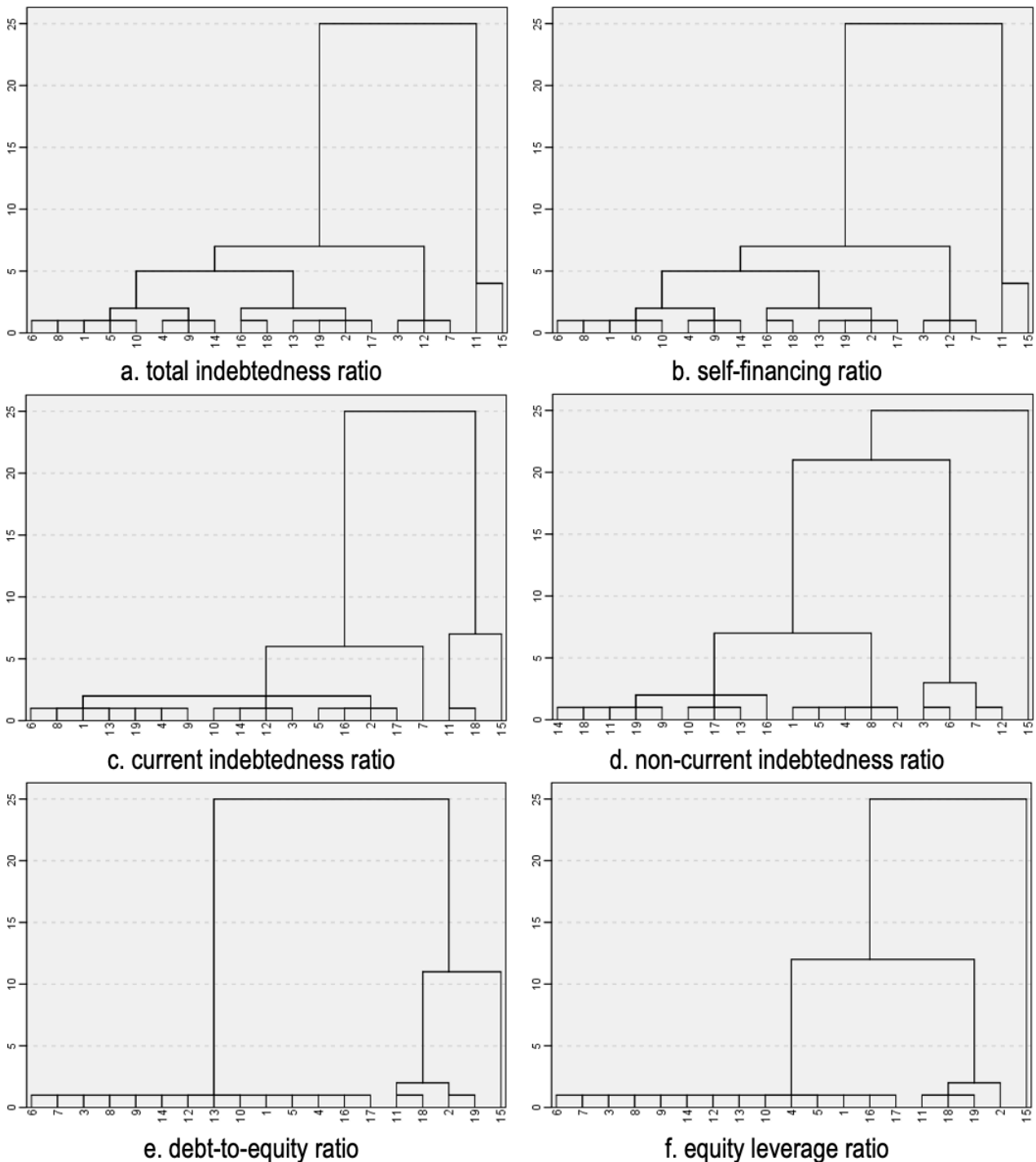
loped market economies in the range of 70–80% and in other economies in the range of 30–60% (Kellner & Runkel, 2023). In general, if the total indebtedness of the firm decreases, the self-financing ratio increases, and vice versa. Valaskova et al. (2019) concluded that the value of the given indicator should not fall below the level of 20–30%. In Slovakia, the average value of the self-financing ratio in all sectors reached the optimal value, as the lowest level of self-financing was achieved in companies operating in sector H, which confirms the optimal value determined by the authors. If the enterprise uses debt to finance its business activities, it is necessary to examine the corporate debt structure using the current and non-current indebtedness ratios. In the monitored period, Slovak enterprises preferred financing primarily using short-term debt in the range of 0.279 to 0.476. Sector Q has the lowest short-term debt, while 1 € of corporate assets is covered by 0.279 € of short-term debt. Conversely, enterprises in sector F, where the average value of the current indebtedness indicator reached 47.6%, employed the highest level of short-term debt. The non-current indebtedness ratio evaluates the corporate financial situation in the long term, including the ability of the firm to meet its financial obligations with a maturity of more than one year (Michalkova et al., 2021). In Slovak enterprises, the smallest share of long-term debt use is observed in sector P, where firms finance their corporate assets using 3.5% of long-term debt, while enterprises operating in sector D use an average of 11.7% for financing. The debt-to-equity ratio compares the total obligations of the enterprise to its equity to ascertain how much leverage a firm is using. The debt-to-equity ratio and the total indebtedness ratio efficiently depict the same thing because both increase as debts do, but the debt ratio increases exponentially while the total debt grows linearly. During the period under review, 1 € of shareholders funds was covered by 1.984 € of corporate debt in sector H, which reached the highest average value of the monitored indicator, and 1.006 € of corporate debt in sector Q, in which the lowest average value can be observed. A debt-to-equity ratio between 0.5 and 1.5 is regarded as optimal in most industries. The lower the ratio, the better, as a high value of the indicator is associated with increased risk (Lehenchuk et al., 2022). The significance of the observed ratio increases with the level of corporate debt. A value between 0 and 2.5 is optimal, but a higher value is unfavourable. In the Slovak business environment, the average indicator value is at the optimal level (Stefko et al., 2021). If enterprises use a combination of equity and debt to finance their business activities, it is crucial to monitor the equity leverage ratio. Even with equity leverage, there were significant differences in the monitored period due to the NACE classification of the firms. The equity leverage ratio reaches the lowest average value of 2.187 for companies operating in the sector Q, while 3.249 belongs to enterprises in the sector H, which can be considered the highest achieved average value among Slovak firms. However, it is essential for the enterprise to comprehend the appropriate level of the debt and the ability to repay it in a predetermined time. The

enterprise increases the ratio value if it increases the debt level. According to Stefko et al. (2021), value 4 is optimal when 75% of the business activities are financed by debt.

Identifying sectors with homogeneous patterns of indebtedness and determining which are the most stable and independent are the main goals of a more comprehensive debt analysis of Slovak enterprises, as significant differences in average values can be observed based on the NACE classification of the firm when monitoring the calculated indebtedness indicators. The Shapiro-Wilk and Kolmogorov-Smirnov tests had to be used to confirm the normality of the dataset, even though the results rejected the hypothesis that the data had a normal distribution. After obtaining the descriptive statistics for each ratio, the cluster analysis was conducted to reduce the number of input data points. To detect and identify homogenous subgroups (clusters) of the monitored set of firms in various economic sectors (classified by NACE), hierarchical clustering of NACE categories was carried out based on specific descriptive characteristics (such as mean, median, standard deviation, minimum, and maximum) calculated for individual sectors. Sectors in various clusters have distinct debt ratios, while sectors within a cluster are often comparable based on a particular debt

Figure 1: Dendrograms of individual NACE categories for selected indebtedness ratios

a. total indebtedness ratio

b. self-financing ratio

c. current indebtedness ratio

d. non-current indebtedness ratio

e. debt-to-equity ratio

f. equity leverage ratio

Note: sectors are identified on the horizontal axis by numbers, i. e. 1 is for NACE A, 2 for B, 3 for C, 4 for D, 5 for E, 6 for F, 7 for G, 8 for H, 9 for I, 10 for J, 11 for K, 12 for L, 13 for M, 14 for N, 15 for O, 16 for P, 17 for Q, 18 for R, 19 for S

level. The clustering principle is derived from computing the distances between the objects. In this research paper, Ward´s method and squared Euclidean distance were used.

The cluster analysis results determined the sectors with comparable debt levels, as demonstrated by specific indebtedness ratios. For each indebtedness ratio, dendrograms depict the results of clustering 19 individual NACE categories, while the most comparable individual NACE categories within the clusters are those included in the monitored debt indicator. Conversely, economic sectors in other clusters are heterogeneous. The graph was separated at the fifth Euclidean distance, generating numerous main clusters (Figure 1a-1f).

Since total indebtedness and self-financing ratio are mutually complementary debt indicators, the economic sectors or clusters are also the same. Figure 1a–b presents the dendrogram that focuses on the developed clusters based on the NACE categories for these indicators. Table 5 summarizes the cluster analysis results, which were used to develop the four groups of economic sectors according to NACE categories. Most economic sectors are classified in Cluster 1 when considering the total indebtedness ratio and the self-financing ratio, whereas sectors B, M, P, Q, R, and S form Cluster 2. Cluster 3 is represented by sectors C, G, and L, and Cluster 4 consists of two economic sectors.

Table 5: Developed clusters of individual NACE categories for total indebtedness ratio and self–financing ratio

Cluster	1	2	3	4
Number of sectors	8	6	3	2
Economic sectors (NACE)	A, D, E, F, H, I, J, N	B, M, P, Q, R, S	C, G, L	K, O

Source: own elaboration

Four clusters were detected in the dendrogram depicted in Figure 1c, where economic sectors are categorized based on the current indebtedness ratio. To identify sectors with homogenous patterns of indebtedness while monitoring this debt indicator, Table 6 presents the findings of the cluster analysis. Based on the results, it can be concluded that Cluster 1, which consists of 15 economic sectors, is the most numerous homogenous unit. According to the dendrogram, sector G can be included in Cluster 2, sectors K and R contribute to Cluster 3, and Cluster 4 includes sector O.

Figure 1d provides an overview of the results of clustering NACE categories based on the non-current indebtedness ratio. Table 7 classifies the specific sectors of the four main clusters that emerged from the non-current indebtedness ratio monitoring. Cluster 1, composed of nine economic sectors, is the largest group, and Cluster 2 consists of five sectors. Sectors C, F, G, and L represent Cluster 3, and sector O can be included in Cluster 4 (which is comparable to the current indebtedness ratio).

Table 6: Developed clusters of individual NACE categories for current indebtedness ratio

Cluster	1	2	3	4
Number of sectors	15	1	2	1
Economic sectors (NACE)	A, B, C, D, E, F, H, I, J, L, M, N, P, Q, S	G	K, R	O

Source: own elaboration

Table 7: Developed clusters of individual NACE categories for non-current indebtedness ratio

Cluster	1	2	3	4
Number of sectors	9	5	4	1
Economic sectors (NACE)	I, J, K, M, N, P, Q, R, S	A, B, D, E, H	C, F, G, L	O

Source: own elaboration

By debt-to-equity ratio, the economic sector clusters in Slovak firms are represented in Figure 1e. Three main clusters were noticed, as Table 8 summarizes the cluster analysis results. Comparable to the current and non-current indebtedness ratios, the debt-to-equity dendrogram highlights most economic sectors identified in Cluster 1, which comprises 14 sectors. Sectors B, K, R, and S compose Cluster 2, and sector O is comprised of Cluster 3.

Table 8: Developed clusters of individual NACE categories for debt-to-equity ratio

Cluster	1	2	3
Number of sectors	14	4	1
Economic sectors (NACE)	A, C, D, E, F, G, H, I, J, L, M, N, P, Q	B, K, R, S	O

Source: own elaboration

Table 9: Developed clusters of individual NACE categories for equity leverage ratio

Cluster	1	2	3
Number of sectors	14	4	1
Economic sectors (NACE)	A, C, D, E, F, G, H, I, J, L, M, N, P, Q	B, K, R, S	O

Source: own elaboration

Figure 1f summarizes the results of the NACE categories clustering based on equity leverage ratio. Three main

clusters were formed, whose individual sectors are classified in Table 9, while they are identically included in the clusters as for the debt-to-equity ratio.

The cluster analysis results may be considered to have verified that several sectors have considerable similarities in their debt levels. To summarize the findings in reply to the research question, the cluster analysis results demonstrate comparable patterns of indebtedness across sectors in the Slovak environment. To summarize the reply to the research question, the cluster analysis results demonstrate comparable patterns of indebtedness across sectors in the Slovak environment. The NACE activities in sectors C – Manufacturing, F – Construction, G – Wholesale and retail trade, repair of motor vehicles/motorcycles and H – Transportation and storage are considered to be sufficiently comparable amongst their debt level evaluations using the chosen indebtedness ratios. The tertiary sector, which offers services to people, governments, and other industries, is composed of almost all these sectors. The sectors K – Financial and insurance activities, R – Arts, entertainment and recreation, and S – Other service activities can also be included in the tertiary sector. Based on the cluster analysis results, these sectors are all grouped into the same cluster when considering the debt-to-equity ratio, equity leverage ratio, and non-current indebtedness ratio. The primary sector has always had a significant role in the rural economy, but its significance in terms of GDP and as a provider of employment for rural regions has been decreasing (Loizou et al., 2019). The number of tertiary sector firms has exceeded that of primary industry companies in recent decades (Hu et al., 2023; Ticau et al., 2023). According to Kwok et al. (2018), the tertiary sector is one of the sectors with the greatest economic significance due to its share of the production and operation areas, its role in producing employment, and its contribution to the GDP of the nation. Sakk et al. (2013) examined financial indicators in firms with a focus on the sector in which they operate, and their findings demonstrated that, as is typical in a recession, current liabilities and debt increased more quickly than sales. Net profit declined for enterprises in the secondary and tertiary sectors, but if this trend persists and debt levels rise, firms may become financially unstable. A firm with sufficient capital, regular sales, and a positive net income is more financially stable, according to Tsoutsos et al. (2017). Sector O – Public administration and defence; compulsory social security is always grouped in a particular cluster according to the clustering of NACE categories based on the level of the selected indebtedness ratio (except for the total indebtedness and self-financing ratio when the cluster forms together with sector K – Financial and insurance activities). To determine if there are statistically significant differences between the calculated debt ratios related to the economic sector, the Kruskal-Wallis test was performed after the number of input data points in the clusters was reduced. The results of the Kruskal-Wallis test, which examined statistically significant distinctions in debt ratios concerning NACE categories, are summari-

zed in Table 10. All of the indebtedness indicators reveal statistically significant differences based on the results. Subsequently, as the results indicated significant differences across various indebtedness ratios, a post hoc analysis was performed. The results of the pairwise comparison of economic sectors are provided in Table 11. All clusters of sectors differ statistically significantly from each other based on the pairwise comparison. The exception is cluster 4, which does not differ from the others when monitoring the non-current indebtedness ratio, and cluster 3, whose level of sector indebtedness is similar to that of the remaining clusters when monitoring the debt-to-equity and equity leverage ratio.

Table 10: The output of the Kruskal-Wallis test concerning the NACE categories

	TI	SF	CI	NCI	DE	EL
Kruskal-Wallis H	217.93	217.93	128.87	611.53	34.94	31.07
df	3	3	2	3	2	2
Asymp. Sig.	0.000	0.000	0.000	0.000	0.000	0.000

Source: own elaboration

According to Ross et al. (2016), it is still challenging to explain the significant differences in average leverage ratios among industries. Numerous factors that influence the leverage decisions of publicly listed corporations were explored by Li & Stathis (2017), who also evaluated whether these factors are consistently significant. The relationship between these factors and the leverage decision was assessed using multiple linear panel regressions. The authors identified eight characteristics that are consistently relevant in influencing capital structure, including profitability, log of assets, median industry leverage, industry growth, market-to-book ratio, tangibility, capital expenditure, and investment tax credits. Using an extensive sample of enterprises from 13 different countries, Kedzior (2012) conducted a comparative analysis of capital structure and its determinants across new and existing EU member states and demonstrated that macroeconomic and institutional factors, such as economic growth, inflation rates, corporate income taxes, the evolution of the banking industry and capital markets, and national legal frameworks, impact capital structure in addition to the traditional determinants associated with a business entity, such as industry, profitability, size, and growth potential. Additionally, Chen & Chen (2011), Sohrabi & Movaghari (2020), Boateng et al. (2022), Reddy et al. (2022) and Marlina et al. (2023) examined the impact of industry leverage on corporate financial performance. Degryse et al. (2012) evaluated the influence of corporate and industry characteristics on the capital structure of small enterprises. The authors claimed that profit explicitly reduces short-term debt, while growth increases long-term debt. Because average debt levels differ within sectors, they concluded that industry effects are crucial to take into account when considering the corporate capital structure. Furthermore, there is a significant level of

Table 11: The output of the pairwise comparison concerning the NACE categories

TI	Test Stat.	Std. Error	Std. Test Stat.	Sig.	Adj. Sig.
Cluster 1-Cluster 2	1,696.274	125.159	13.553	0.000	0.000
Cluster 1-Cluster 3	300.606	90.535	3.32	0.001	0.005
Cluster 1-Cluster 4	3,321.179	587.483	5.653	0.000	0.000
Cluster 2-Cluster 3	-1,395.669	116.953	-11.934	0.000	0.000
Cluster 2-Cluster 4	1,624.905	592.130	2.744	0.006	0.036
Cluster 3-Cluster 4	3,020.574	585.790	5.156	0.000	0.000
SF	**Test Stat.**	**Std. Error**	**Std. Test Stat.**	**Sig.**	**Adj. Sig.**
Cluster 1-Cluster 2	-1,696.274	125.159	-13.553	0.000	0.000
Cluster 1-Cluster 3	-300.606	90.535	-3.32	0.001	0.005
Cluster 1-Cluster 4	-3,321.179	587.483	-5.653	0.000	0.000
Cluster 2-Cluster 3	1,395.669	116.953	11.934	0.000	0.000
Cluster 2-Cluster 4	-1,624.905	592.130	-2.744	0.006	0.036
Cluster 3-Cluster 4	-3,020.574	585.790	-5.156	0.000	0.000
CI	**Test Stat.**	**Std. Error**	**Std. Test Stat.**	**Sig.**	**Adj. Sig.**
Cluster 1-Cluster 2	-878.953	89.729	-9.796	0.000	0.000
Cluster 1-Cluster 3	1,802.368	358.888	5.022	0.000	0.000
Cluster 2-Cluster 3	2,681.321	363.654	7.373	0.000	0.000
NCI	**Test Stat.**	**Std. Error**	**Std. Test Stat.**	**Sig.**	**Adj. Sig.**
Cluster 1-Cluster 2	-3,418.548	138.355	-24.708	0.000	0.000
Cluster 1-Cluster 3	-985.744	92.968	-10.603	0.000	0.000
Cluster 1-Cluster 4	-1,870.530	2,515.083	-0.744	0.457	1.000
Cluster 2-Cluster 3	2,432.803	125.959	19.314	0.000	0.000
Cluster 2-Cluster 4	1,548.018	2,516.518	0.615	0.538	1.000
Cluster 3-Cluster 4	-884.785	2,514.431	-0.352	0.725	1.000
DE	**Test Stat.**	**Std. Error**	**Std. Test Stat.**	**Sig.**	**Adj. Sig.**
Cluster 1-Cluster 2	1,709.019	292.472	5.843	0.000	0.000
Cluster 1-Cluster 3	-2,215.794	2,515.251	-0.881	0.378	1.000
Cluster 2-Cluster 3	-3,924.813	2,531.544	-1.550	0.121	0.363
EL	**Test Stat.**	**Std. Error**	**Std. Test Stat.**	**Sig.**	**Adj. Sig.**
Cluster 1-Cluster 2	1,614.638	292.472	5.521	0.000	0.000
Cluster 1-Cluster 3	-1,907.941	2,515.251	-0.759	0.448	1.000
Cluster 2-Cluster 3	-3,522.579	2,531.544	-1.391	0.164	0.492

Source: own elaboration

intra-industry heterogeneity, which indicates that the level of industry competitiveness and the variety of technologies used are significant determinants of capital structure. Even Ohman & Yazdanfar (2017) concluded that there are different levels of correlation between industry affiliation and small and medium-sized business lending policies. Therefore, it is not unexpected that the literature has extensively explored the influence of capital structure determinants. However, the majority of these studies have either examined one sector or have used basic industry dummies from several industries. In cases where single industries have not been examined, such as manufacturing (Liu et al., 2022), tourism (Fabris, 2023), financial (Meng & Xiao, 2023) and non-financial sector (Klazar & Slintakova, 2019), studies have concentrated on the sign and the statistical and economic significance of estimated coefficients but not on the reasons for the difference in leverage.

CONCLUSION

Many authors are currently exploring the impact of the industry classification on the financial structure of enterprises since there are statistically significant differences across various sectors, revealing the industry as a critical factor influencing corporate indebtedness. This fact is further supported by the results of the research paper, which demonstrate that significant differences in the financial structures of companies in different industries exist. Therefore, it can be concluded that the industry has an essential impact on the capital structure decision.

Thus, the main aim of this paper was to determine the debt level in the Slovak environment on a sample of 19,480 enterprises from different sectors and recognize relationships between them in order to identify sectors with homogeneous patterns of indebtedness and to understand which sectors are the most stable and independent. Selected indebtedness ratios were used to define

the sectors with comparable debt levels, which were then identified using Ward's hierarchical clustering method using squared Euclidean distance. The results of the cluster analysis indicate similar patterns of indebtedness across sectors in Slovakia, which summarizes the findings in response to the research question. A group of NACE activities in which enterprises are sufficiently comparable that it is appropriate to evaluate their debt levels using the chosen indebtedness ratios are considered to be Sectors C – Manufacturing, F – Construction, G – Wholesale and retail trade, repair of motor vehicles/ motorcycles and H – Transportation and storage. As part of the tertiary sector, most sectors provide services to people, governments, and other industries. According to the clustering of NACE categories according to the level of the selected indebtedness ratio, the sectors K – Financial and insurance activities, R – Arts, entertainment and recreation, and S – Other service activities may also be grouped in one cluster, which form the secondary sector (except for the current indebtedness ratio and the interest burden ratio). Except for the total indebtedness and self-financing ratio when the cluster forms together with sector O – Public administration and defence; compulsory social security is always grouped in a particular group according to the clustering of NACE categories based on the level of the selected indebtedness ratio. The statistical relevance of the differences between all indicators of indebtedness related to the NACE categories was verified by the Kruskal-Wallis test after the reduction of the input data to the clusters. In the Slovak business environment, the research results determined which industries had the highest and lowest debt levels. The key relevance of our findings is the benchmarking of selected sectors about indebtedness, which may be used to further examine their growth in each of the V4 nations, which we believe is an essential area for the evolution of the European economy as a whole. Studies considering a relatively significant amount of capital structure determinants may be beneficial to owners and managers, regulators, and financial institutions since debt policy affects firm performance, value, and survival.

The following limitations should be noted, despite the contribution of the paper to the existing literature. Because the paper focuses only on one national economy in Slovakia, its scope limits how relevant the conclusions may be. Future research should examine this phenomenon in all areas of Slovakia's national economy or over a longer time horizon than that which was allowed for this research in order to ascertain whether the results will change and to enable broader generality and application.

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