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Sectoral Determinants of Capital Structure in Slovak Firms: An Empirical Investigation

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Abstract

Background: Capital structure refers to the optimum mix of equity and debt that funds a firm's operations and investments. Determining the optimal capital structure is still one of the most basic challenges of corporate financial management.

Purpose: The primary objective of this study is to analyse the capital structure of Slovak companies, with particular emphasis on the role of sectoral affiliation and firm-level financial characteristics. It empirically examines three central hypotheses concerning the determinants of capital structure and indebtedness of Slovak companies.

Study design/methodology/approach: The study uses both descriptive and inferential statistical techniques like ANOVA, correlation analysis, and multiple linear regression incorporating eight explanatory variables to examine the determinants affecting companies´ capital structure. The relationship between financial leverage and return on equity (ROE) was explored both in the aggregate sample of firms and on sector level.

Findings/conclusions: Sectoral analysis reveals that firms in the tertiary and quaternary sectors exhibit higher average indebtedness than those in the primary and secondary sectors. The strongest negative predictors of indebtedness are the equity ratio and return on assets (ROA). Alternatively, sales volume shows a positive correlation, suggesting that larger firms employ more debt due to their broader capital needs. Combined results demonstrate that capital structure is determined by an intricate interaction among firm-specific attributes, namely profitability, internal capital availability, size, and industry factors. Empirical evidence derived from the Slovak context extends beyond national significance; it offers regionally representative insights that can inform strategic decision-making among firms, financial institutions, and policymakers throughout Central Europe.

Limitations/future research: Follow-up studies can be used to give an extension of the work by incorporating time-series data, distinguishing between short-term and long-term debt, or including ownership structure, firm age, and capital market access.

Keywords

Capital Structure, Equity Financing, Debt Financing, Return on Equity, Return on Assets, Indebtedness, Sector Affiliation

Introduction

Capital structure – alternatively, the mix of debt and equity used to finance corporate operations – is a leitmotiv of corporate finance practice and theory. Determination of the optimal capital structure, i.e., the mix that is cheapest to secure and best for firm value, has been the topic of decades' worth of theoretical debate and empirical investigation. After the pioneering foundations established by Modigliani and Miller (1958, 1963), later theories have endeavoured to account for real-world frictions such as taxation, risk of bankruptcy, information asymmetry, and agency costs.

Notwithstanding this extensive literature, capital structure decisions remain highly context specific. Differences in sectoral capital intensity, asset tangibility, market structure, and institutions mean that the validity of some capital structure theories may vary significantly by industry and country context. Emerging and post-transition economies may see these differences strengthened due to evolving financial institutions, regulatory regimes, and firm age.

This paper explores the determinants of capital structure decision for Slovak firms, with a focus on the part that sector membership and firm-level financial features play in explaining leverage. Slovakia is a high-quality empirical setting as an open, small post-socialist economy in the European Union (EU) yet still distinctively dissimilar in its institutions, ownership, and sectoral make-up. By combining sectoral analysis with firm-level financial data, this study offers a holistic view of capital structure tendencies that include industry-level and firm-level determinants.

This research makes the following contributions to the literature on capital structure:

- Contextual novelty: It offers fresh evidence from Slovakia, a less researched EU member with distinct financial and institutional features that contrast with mature Western economies.
- Integrated analytical approach: It combines sectoral affiliation and firm-level predictors under a unified regression framework, which enables nuanced recognition of capital structure heterogeneity.
- Theory refinement: By comparing empirical results for various industries, the study dispels the generalisability of traditional capital structure theories and accentuates the contingent nature of leverage–performance relationships.

These contributions are useful to financial decision-makers in emerging economies and foster more context-specific application of capital structure theories.

The theory of capital structure has developed over several paradigms, each seeking to identify how firms choose the optimal debt-equity ratio under different economic conditions. Early models envisioned perfect markets, while later paradigms envisioned real-world imperfections like taxes, information asymmetry, agency costs, and costs of financial distress. And yet, despite decades of evidence, capital structure determinants remain contested, and no theory is able to explain observed behaviour in any nation or sector. This research is therefore based on three leading theories that offer complementary descriptions of the capital structure decisions of firms operating in a post-transition economy such as Slovakia.

1. The Trade-Off Theory posits that firms balance the tax benefits of debt against the expected costs of financial distress (Kraus & Litzenberger, 1973). Firms with stable cash flows and tangible assets are expected to take on more debt, while riskier or less asset-intensive firms may avoid high leverage. This theory supports the assumption that sectoral differences – particularly in capital intensity – should influence the use of debt. Accordingly, Hypothesis 1 is grounded in Trade-Off Theory expectations about capital needs across industries.
2. The Pecking Order Theory (Myers & Majluf, 1984) emphasises information asymmetry between firm insiders and external investors. Firms tend to prioritize internal financing (retained earnings), followed by debt, and issue equity only as a last resort. As a result, more profitable firms are expected to rely less on external debt. This theory directly informs Hypothesis 3, which posits that profitability and internal capital availability are significant predictors of capital structure decisions at the firm level.
3. Agency Theory (Jensen & Meckling, 1976) focuses on manager-shareholder conflict, and debt serves as a disciplining device. The theory's relevance may vary by industry due to variation in managerial discretion and asset structure. While not directly tested, Agency Theory provides a rationale for including firm

size and structure-related variables in the regression model.

These three theories provide the foundation for the study's hypotheses. Hypothesis 1 reflects Trade-Off Theory expectations about sectoral capital needs. Hypothesis 2 draws on classical assumptions (including the Modigliani-Miller framework with taxes) about the positive relationship between leverage and ROE. Hypothesis 3 is based on the Pecking Order framework, incorporating firm-level financial indicators to predict indebtedness.

Although widely applied, these theories tend to make contradicting predictions, especially in emerging markets and transition economies where sectoral and institutional circumstances differ from theoretical assumptions. Therefore, this study follows a context-sensitive empirical approach: it uses well-established theoretical results as a point of departure but allows for heterogeneity in observed firm behaviour across Slovak sectors.

To ensure consistency between theoretical arguments and empirical testing, the explanatory variables used in the regression model are directly derived from the mechanisms proposed by the three theoretical frameworks discussed above. In particular, Trade-Off Theory motivates the inclusion of variables reflecting firm size and tax-related factors (sales, income tax), which proxy the potential benefits of debt tax shields and the capacity to sustain higher leverage. The Pecking Order framework justifies the use of profitability indicators such as return on assets (ROA) and equity levels, which capture the availability of internal funds and the preference for internal over external financing. Finally, Agency Theory provides the rationale for including firm size and structural variables such as the number of employees and equity capitalisation. Larger and more complex organisations are typically associated with greater separation between ownership and control, which may increase agency conflicts between managers and shareholders. In such cases, debt can function as a disciplinary mechanism that limits managerial discretion by imposing fixed payment obligations (Jensen & Meckling, 1976). Consequently, firm size proxies and capital structure indicators serve as empirical approximations of agency-related governance mechanisms within the regression framework.

The empirical literature further supports the theoretical expectations described above. Empirical studies have demonstrated that capital structure decisions are shaped by a wide array of factors. These include firm size, profitability, asset tangibility, growth opportunities, liquidity, earnings volatility, and institutional conditions. Table 1 summarizes key recent studies across various regions and industries.

Table 1 Overview of recent empirical studies on capital structure determinants

Authors	Key findings
Chen (2004)	This study on Chinese listed companies finds that firm size, profitability, and asset tangibility are key determinants of capital structure. It provides evidence supporting both trade-off and pecking order theories in an emerging market context. Institutional factors specific to China also play a significant role in shaping leverage decisions.
Jandik & Makhija (2005)	The study focuses on U.S. utility firms (1975–1994) finding unexpected positive links between earnings volatility and leverage.
Lim (2012)	Study conducted on Chinese financial firms (2005–2009) finds that profitability, size, earnings volatility, non-debt tax shields (NDTS), and institutional characteristics (e.g., state ownership) significantly shaped capital structure.
Acaravci (2014)	Growth opportunities had a positive effect; size, tangibility, and profitability negatively related to leverage. NDTS was insignificant.
Gomez et al. (2014)	The study examines Peruvian firms and finds that firm size, profitability, and growth opportunities are significant determinants of leverage. It provides evidence consistent with established capital structure theories. The findings also highlight the influence of emerging market characteristics on financing decisions.
Hussain & Miras (2015)	Profitability, size, and liquidity negatively affect leverage; only tangibility showed a positive, significant association. Growth was positive but not significant.
Al Ani & Al Amri (2015)	According to the study of 2008 – 2012 Omani industrial firms leverage is positively linked to risk and tangibility, but negatively to profitability and growth.
Alipour et al. (2015)	Study examining Iranian manufacturing firms (2003–2007) finds that size, profitability, liquidity, asset structure, risk, growth and state ownership affected leverage.
Burgstaller & Wagner (2015)	The study investigates the role of family ownership and founder management in SMEs and finds that these governance structures significantly influence leverage decisions and adjustment processes. Family-controlled firms tend to exhibit more conservative financing behaviour. The findings emphasise the importance of ownership characteristics in shaping capital structure dynamics.
Balios et al. (2016)	Focusing on SMEs during a severe economic crisis, the study finds that profitability and liquidity are negatively related to leverage, while risk factors tend to increase it. The results indicate that firms adjust their financing strategies under adverse macroeconomic conditions. This highlights the dynamic nature of capital structure determinants during periods of instability.
Kang & Ausloos (2017)	Positive leverage relationship with size, tangibility, and age; negative with board size, profitability, growth opportunity, NDTS. Profitability inversely related to debt (consistent with Pecking Order Theory).
Nemeth (2017)	The study explores human capital theory within organisational frameworks, emphasising its role in shaping firm performance and strategic decision-making. It suggests that human capital quality can indirectly influence financial policies, including capital structure decisions. The research contributes to understanding non-financial determinants of firm behaviour.
Dakalakis et al. (2017)	The research demonstrates that macroeconomic conditions significantly affect the behaviour of capital structure determinants in SMEs. It shows that firms adjust their leverage differently across economic cycles. The study highlights the importance of considering macro-level dynamics in capital structure analysis.

Kumar et al. (2017)	This review identifies profitability, firm size, and asset tangibility as the most consistent determinants of capital structure across studies. It also outlines gaps in the literature and suggests directions for future research. The study contributes to a more integrated understanding of capital structure theory.
Matias & Serrasqueiro (2017)	This empirical study of Portuguese SMEs finds that capital structure is influenced by both firm-specific characteristics and regional differences. The results suggest that local economic conditions and institutional environments matter. The study highlights the heterogeneity of SME financing behaviour.
Kaloudis & Tsolis (2018)	Study distinguishes between short-term and long-term debt and finds that their adjustment speeds differ: short-term debt increases faster, while long-term debt adjusts more slowly.
Amraoui et al. (2018)	The study analyses Moroccan firms and finds that capital structure decisions vary significantly across industries. Firm-specific factors such as profitability, size, and growth opportunities, along with industry characteristics, play a crucial role in financing choices. The results underline the importance of sectoral heterogeneity in capital structure theory.
Hang et al. (2018)	This meta-analysis shows that measurement methods significantly affect the observed relationships between capital structure determinants and leverage. The study highlights inconsistencies in empirical findings due to methodological differences. It calls for greater standardisation in future research.
Jedrzejczak-Gas (2018)	The study focuses on the TSL sector and finds that industry-specific factors significantly influence capital structure decisions. Firm size, profitability, and operational characteristics are key determinants. The research emphasises the importance of sectoral context in financial decision-making.
Moradi & Paulet (2019)	Empirical analysis of 1999–2015 European firms before and during the Euro crisis showed size, tangibility, non-debt tax shields, and earnings volatility exhibit positive and growth, profitability, tax shields negative leverage correlations.
Li & Islam (2019)	The study finds that both firm-specific and industry-level factors significantly determine capital structure in the Australian market. Variables such as profitability, size, and industry conditions play a crucial role. The research supports the relevance of multi-level analysis in financial decision-making.
Kedzior et al. (2020)	Analysing Polish technology firms, the study finds that growth opportunities, risk, and profitability are major drivers of capital structure. It highlights the unique financing patterns of high-tech firms. The results suggest that innovation-oriented firms may follow different leverage strategies.
Diantimala et al. (2021)	Study examining 1638 non-financial Indonesian firms finds that total asset as an indicator for firm size has a significant role in determining financing choice. Both capital structure and profitability are sensitive to firm size.
Stoiljković et al. (2021)	The study empirically examines small enterprises and finds that capital structure plays a significant role in explaining differences in financial performance. Results indicate that leverage levels influence profitability and efficiency, particularly in constrained financial environments. The findings suggest that optimal capital structure decisions are critical for enhancing firm competitiveness and sustainability.
Brendea et al. (2022)	Negative relationship between leverage and firm performance among firms in Central and Eastern Europe, contradicting the agency cost hypothesis. Evidence instead supports the franchise-value hypothesis, suggesting that more profitable firms tend to maintain lower debt levels.
Nguyen et al. (2022)	The study shows that stronger firm-level corporate governance is associated with higher leverage as a disciplinary mechanism for managers. However, this effect weakens in countries with higher national governance quality, where institutional environments reduce agency problems and the need for debt discipline.
Boateng et al. (2022)	This comprehensive review synthesises prior empirical studies and concludes that profitability, firm size, asset tangibility, and macroeconomic conditions are among the most robust determinants of capital structure decisions. The study highlights the evolution of theoretical perspectives and emphasises the role of institutional and market-specific factors. It also underlines the importance of integrating both firm-level and external determinants when analysing leverage behaviour.
Yeboah et al. (2022)	The study identifies both macroeconomic and firm-specific determinants of capital structure in listed firms in emerging markets. The results indicate that firm-level characteristics and macroeconomic conditions jointly influence financing decisions and the level of leverage.
Ogulo (2023)	The paper analyses the relationship between capital structure and the growth of construction companies. It suggests that financing decisions and the use of debt capital can affect firm growth, although the source is a working paper rather than a journal article.
Queiri et al. (2024)	Study conducted on Omani firms indicates positive associations between debt ratio and board size, board independence and multiple directorships but negative association with board meetings frequency.
Taherinia et al. (2024)	The paper examines the speed of adjustment toward target capital structure and shows that information asymmetry plays an important moderating role. The findings suggest that firms adjust their leverage at different speeds depending on market information conditions and expected returns.
Rocciolo et al. (2024)	The study shows that managerial characteristics, specifically CEO overcaution, affect capital structure choices. More cautious CEOs tend to adopt more conservative financing policies, which may reduce leverage and influence firms' debt decisions.
Olson & Bartholdy (2024)	The article investigates which factors are economically important in the capital structure decisions of European firms. The findings emphasise that selected firm-specific determinants have practical economic relevance for leverage decisions.
Chua et al. (2024)	The study finds heterogeneity in the speed of capital structure adjustment across industry sectors among Malaysian non-financial firms. This indicates that sectoral characteristics influence how quickly firms move toward their target leverage.
Musa et al. (2025)	Study finds a negative relationship between stock yield and leverage when using standard measures; however, adjusted leverage measures support the Modigliani–Miller irrelevance proposition under a stock-yield maximisation framework. Dividend yield is positively associated with leverage.
Vega-Gutiérrez et al. (2025)	Economic policy uncertainty (EPU) is positively associated with corporate leverage, with the relationship moderated by institutional quality, financial development, and cultural factors. Corporate diversification further strengthens this relationship and helps mitigate information asymmetry under high uncertainty.
Brendea et al. (2026)	The article examines optimal capital structure after the 2008 financial crisis using evidence from Romania. The results suggest that firms continue to target an optimal leverage level, but adjustment patterns may be affected by post-crisis financial conditions.

Source: the authors

Most findings suggest that larger firms tend to have higher leverage, while more profitable and liquid firms generally prefer lower debt levels – consistent with pecking order and trade-off logic. However, the strength and direction of these relationships often vary depending on market maturity, sector, and macroeconomic context (e.g., financial crises).

Table 2 summarizes the most frequently observed effects of key firm-level determinants based on prior empirical research. These findings guide the variable selection in our regression model.

Table 2 Summary of Determinant Effects

Determinant	Most frequent result
Firm Size	Positive - larger firms tend to have higher leverage, reflecting greater borrowing capacity.
Asset Tangibility	Positive - strong collateral leads to higher debt levels.
Profitability	Negative - more profitable → less debt.
Growth Opportunities	Mixed results.
NDTS (Non-Debt Tax Shields)	Negative or insignificant.
Earnings Volatility	Generally positive, but mixed.
State/Institutional Factors	Significant in emerging markets.
Liquidity / Cash Flow	Negative - internal funds reduce the need for debt.

Source: the authors

These findings confirm the view that capital structure is the result of a number of internal and external determinants and that one single theory cannot explain finance behaviour of firms and industries. As a result, hybrid theoretical frameworks and cross-country studies increasingly become prominent in recent studies.

1. Research Methodology

The primary objective of this study is to analyse the capital structure of Slovak companies, with particular emphasis on the role of sectoral affiliation and firm-level financial characteristics. Drawing on established theories and prior empirical studies, the following research questions (RQ) are posed:

RQ1: To what extent does sectoral classification influence Slovak firms' capital structure?

RQ2: Is there a consistent relationship between financial leverage and ROE across different economic sectors?

RQ3: What explains the degree of corporate leverage in Slovak companies among firm-level financial variables?

Based on these research questions, the following hypotheses (H) are postulated to be tested empirically:

H1: Firms operating in the primary and secondary sectors exhibit higher levels of indebtedness compared to firms in the tertiary and quaternary sectors (Trade-Off Theory).

H2: There is a positive relationship between financial leverage and ROE, suggesting that increased debt usage may enhance ROE (Modigliani–Miller Theory with taxes).

H3: Corporate debt level (measured by the debt ratio) can be reliably predicted by employing firm-level indicators such as profitability, access to internal capital, and size of the firm (Pecking Order Theory).

This paper employs a cross-sectional, quantitative research design to analyse the capital structure decision of Slovak firms in four broad industries of the economy. Empirically, the study uses both descriptive and inferential statistical techniques like ANOVA, correlation analysis, and multiple linear regression.

1.1 Data Source and Sampling

Firm-level financial data were obtained from FinStat 2025 database, which offers standardized financial statements and classification codes for all Slovak registered firms. To ensure the sample is comparable and economically relevant, it was limited to active firms with revenues of over 2 million EUR annually.

Firms were categorized into four sectors based on their SK NACE classification as follows (for a detailed mapping of sector classifications, see Appendix A):

- Primary sector – It involves activities related to natural resource processing and extraction, e.g., mining, agriculture, fishing, and forestry. These industries typically supply raw materials to other sectors.
- Secondary sector – This encompasses building and industrial manufacturing. These firms typically require a large initial investment in technology and infrastructure and therefore, capital structure decision-making is particularly important.
- Tertiary sector – Mostly consisting of service activities such as trade, transport, finance, health, education, and tourism. Firms in this sector run comparatively less capital-intensive operations than their manufacturing industry counterparts.
- Quaternary sector – Representing the modern knowledge economy, this category includes firms involved in information technology, research and development, education, and consultancy services. Financing in this sector often focuses on intangible assets and human capital (Samuelson & Nordhaus, 2010).

Due to unequal representation across sectors, a stratified sampling approach was used:

- All 464 eligible firms from the primary sector were included.
- Random samples of 1 000 firms each were drawn from the secondary, tertiary, and quaternary sectors.

The final dataset comprised 3 464 firms, providing a robust representation of Slovakia's economic structure.

1.2Variables and Operationalisation

The selection of explanatory variables follows directly from the theoretical mechanisms identified in Trade-Off, Pecking Order, and Agency theories, ensuring that the empirical specification represents a measurable operationalisation of the underlying conceptual framework.

The third research hypothesis (H3) investigates whether a firm's level of indebtedness (measured by the debt ratio) can be effectively predicted using a set of firm-level and sectoral financial indicators. These variables are grounded in capital structure theory – particularly the Trade-Off and Pecking Order frameworks – and are also commonly employed in empirical corporate finance research.

Additionally, the variable ROE was included in the analysis of the second hypothesis (H2), which examined the relationship between financial leverage and profitability. Although ROE was not used in the regression model for the third hypothesis (H3), it played a central role in evaluating the effects of leverage on firm performance.

It is important to note that the relationship between financial leverage and ROE may involve potential endogeneity concerns, since ROE mechanically depends on equity levels and may therefore be simultaneously influenced by capital structure decisions. To mitigate this issue, ROE was not included as an explanatory variable in the regression model predicting the debt ratio (H3). Instead, it was analysed separately within the framework of Hypothesis 2 using correlation analysis. This approach allows us to explore the empirical association between leverage and shareholder returns while avoiding simultaneity bias in the regression specification. The analysis should therefore be interpreted as exploratory rather than causal, focusing on the direction and strength of the observed relationship rather than estimating a structural effect.

The whole set of variables used in the study appears below in Table 3. The table distinguishes between the dependent and explanatory variables, delineates their operational definitions, and indicates the direction of influence anticipated where appropriate.

Table 3 Overview of Variables Used in the Study

Variable	Description / Operationalisation	Role in Study	Expected Effect on Debt Ratio	Theoretical Rationale
Debt Ratio	Total liabilities / Total assets (in %) – measure of firm indebtedness	Dependent (H3)	–	Key indicator of leverage
Sector	Dummy variables for sectors 2, 3, and 4 (reference category: primary sector)	Independent (H1, H3)	Sec.: 0; Terc.: Negative; Quart.: Negative	Trade-Off Theory: asset tangibility, risk
Equity	Total equity (in EUR, standardized)	Independent (H3)	Negative	Trade-Off & Pecking Order Theories
ROA	Net income / Total assets (in %)	Independent (H3)	Negative	Pecking Order Theory: internal funding
Income Tax	Corporate income tax paid (in EUR, standardized)	Independent (H3)	Positive	Proxy for profitability; investment scale
Sales	Annual revenue (in EUR, standardized)	Independent (H3)	Positive	Trade-Off Theory: firm size & debt access
Number of Employees	Categorical size groups (proxy for firm size)	Independent (H3)	Mixed	Agency costs and scale economies
ROE	Net income / Equity (in %)	Test variable (H2)	–	Leverage effect

Source: the authors

All continuous financial variables used in the regression were standardized prior to estimation to ensure comparability. Sectoral affiliation was captured using dummy variables, allowing for comparisons relative to the primary sector.

The operationalisation enables systematic empirical investigation of the effects of firm-level and industry-level factors on the choice of capital structure, particularly in a small open economy such as Slovakia.

1.3Analytical Strategy

The analysis proceeds in three stages aligned with the three hypotheses:

- **Sectoral Differences in Leverage (H1):** A one-way ANOVA with Welch correction (due to unequal group variances) was used to test whether the average debt ratio differs significantly across sectors. Given the large sample sizes in each sector (≥ 500

observations), the central limit theorem ensures that the sampling distribution of the means is approximately normal, even when the underlying data are highly non-normal (Lumley et al., 2002), justifying the use of ANOVA. Post-hoc comparisons were conducted using the Games–Howell test.

- **Leverage–Performance Relationship (H2):** Pearson's correlation coefficients were computed to assess the relationship between financial leverage and ROE, both across the whole sample and within individual sectors. This standardized measure of linear association was employed rather than a predictive regression model. This choice was motivated by the exploratory nature of the hypothesis, focusing on identifying the presence and direction of association rather than establishing causal inference or the effect magnitude.
- **Determinants of Indebtedness (H3):** A multiple linear regression model was estimated to determine whether key financial indicators significantly predict a firm's debt ratio. The model included the eight variables described above. Robustness checks were applied:
  - Outliers were removed using Cook's distance, Mahalanobis distance, and leverage diagnostics.
  - Multicollinearity was assessed using variance inflation factors (VIF < 5) and tolerance statistics (> 0.2).
  - Model residuals were examined for normality and homoscedasticity.

All statistical analyses were conducted using SPSS version 21.

2. Results and Discussion

This section presents the empirical findings in direct alignment with the three hypotheses set out earlier in the paper.

The results are structured into three main parts, each corresponding to one of the hypotheses: (1) an analysis of sectoral differences in corporate indebtedness to test whether firms in capital-intensive industries use more debt (H1), (2) an assessment of the relationship between financial leverage and ROE to evaluate the classical assumption of leverage-driven profitability (H2), and (3) a multivariate regression model that identifies the key firm-level and sectoral predictors of corporate indebtedness (H3). This structured approach allows for a comprehensive understanding of both industry-level and firm-level factors shaping capital structure decisions in Slovak companies.

2.1 Sectoral differences in indebtedness (H1)

H1: Firms operating in the primary and secondary sectors exhibit higher levels of indebtedness compared to firms in the tertiary and quaternary sectors.

Within the sample (n = 3 451), the mean indebtedness of firms was M = 64.16% (M = mean; hereafter M), the standard deviation was SD = 53.31 (SD = standard deviation; hereafter SD) and the median *total indebtedness* was Mdn = 64.47% (Mdn = median; hereafter Mdn). The results of the descriptive analysis are presented in Appendix B.

Descriptive statistics of total indebtedness across different economic sectors (see table 4) indicate significant variation in average indebtedness. Contrary to the a priori hypothesis, debt ratios were higher in the tertiary (M = 67.08%) and quaternary sectors (M = 70.95%) and considerably lower for the primary (M = 50.56%) and secondary sectors (M = 60.77%).

Table 4 Descriptive statistics of the indicator Total Indebtedness by economic sector

Sector	N	Average	Standard Deviation	Standard Error	95% Confidence Interval for the Mean		Minimum	Maximum
					Lower limit	Upper limit		
1	462	50.564	26.025	1.211	48.185	52.943	1.43	110.91
2	997	60.771	27.801	0.880	59.044	62,.99	6.50	255.04
3	996	67.081	32.180	1.020	65.081	69.082	0.03	589.70
4	996	70.952	87.052	2.758	65.539	76,.649	0.03	2 148.11
Together	3 451	64.164	53.308	0.907	62.385	65.943	0.03	2 148.11

Source: the authors

The assumption of normality was assessed using the Shapiro–Wilk and Kolmogorov–Smirnov tests, both of which indicated a significant deviation from normality. Given that the dataset (n = 3 451) is sufficiently large, the parametric One-Way ANOVA test can be applied despite the violation of the normality assumption. According to the Central Limit Theorem, when sample sizes are sufficiently large—typically ≥ 500 observations—the sampling distribution of the mean approaches normality, even when the underlying data distribution is substantially non-normal (Lumley et al., 2002).

One-way ANOVA with Welch's correction (due to unequal variances) confirmed that these are statistically significant differences: $F(3, 1643.67) = 40.941$, $p < 0.001$. However, the effect size was small ($\eta^2 = 0.015$), which implies that sectoral membership explains a small proportion - only about 1.5% of variation in indebtedness.

The results of Levene's statistic, Welch correction and Measures of Association are in Appendix C, D and E. The Games-Howell post-hoc test showed that all inter-sectoral differences were statistically significant in *Total Indebtedness* (Sig < 0.05), except between the tertiary and quaternary sectors (Sig = 0.553 > 0.05). The results of statistical significance are presented in Table 5.

Table 5 Games-Howell test results

Multiple Comparisons

Dependent variables: Total Indebtedness

	(I) Sector	(J) Sector	Difference in averages (I-J)	Standard deviation	Sig.	95% confidence interval	
						Lower limit	Upper limit
Games – Howell	1	2	-10.207*	1.497	0.000	-14.060	-6.355
		3	-16.517*	1.583	0.000	-20.590	-12.444
		4	-20.388*	3.012	0.000	-28.137	-12.639
	2	1	10.207*	1.497	0.000	6.355	14.060
		3	-6.310*	1.347	0.000	-9.774	-2.846
		4	-10.181*	2.895	0.003	-17.630	-2.732
	3	1	16.517*	1.583	0.000	12.444	20.590
		2	6.310*	1.347	0.000	2.846	9.774
		4	-3.871	2.941	0.553	-11.436	3.694
	4	1	20.388*	3.012	0.000	12.639	28.137
		2	10.181*	2.895	0.003	2.732	17.630
		3	3.871	2.941	0.553	-3.694	11.436

*. The difference in means is significant at the 0.05 level of significance.

Source: the authors

In Figure 1, the graph presents a visual depiction of the average *Total Indebtedness* values across the four economic sectors, showing that firms in the quaternary and tertiary sectors exhibit higher average debt levels compared to those in the primary and secondary sectors. This visual pattern complements the statistical results and highlights the sectoral differences observed.

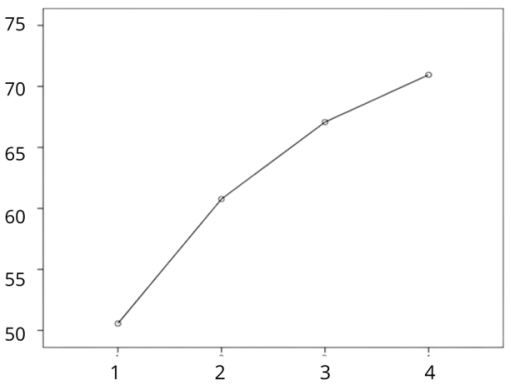

Figure 1 Sectoral averages for the indicator Total Indebtedness
Source: the authors

Conclusion for H1: Though sectoral difference is statistically significant, the trend discovered contradicts Hypothesis 1. Firms in the quaternary and tertiary sectors have significantly greater debt ratios than firms in the secondary and primary sectors. This contradicts the hypothesis of Trade-Off Theory that capital-intensive industries (e.g., manufacturing or agriculture) must be more leveraged since they are related to higher collateral value. The result shows that sectoral capital intensity in the Slovak context fails to capture leverage behaviour—firm age, size, or financial market access may be a more decisive factor.

2.2Financial leverage and ROE (H2)

H2: There exists a positive relationship between financial leverage and ROE, suggesting that increased debt usage may enhance ROE.

The aim of Hypothesis 2 (H2) was to examine the relationship between financial leverage and ROE, grounded in the Modigliani–Miller theorem with taxes, which posits that increased leverage enhances ROE through the tax shield effect. To test this hypothesis, Pearson's correlation coefficient was used instead of a predictive model, as the objective was to explore the relationship rather than to identify its causal mechanisms. The relationship was tested for statistical significance ($p < 0.05$) in order to ensure the robustness of the conclusions.

Prior to testing H2, we conducted a descriptive analysis of the *ROE* and *Financial Leverage* ratios. The number of valid observations in the *ROE* indicator was n = 3 347. The results of the descriptive analysis show that the mean value of *ROE* was M = -10.56 with standard deviation SD = 923.94. The median *ROE* was Mdn = 13.62. The notable discrepancy between the mean and median values indicates a highly skewed distribution with extreme outliers affecting the mean. The number of valid observations of the variable *Financial Leverage* reached n = 3 439. *Financial leverage* took a mean value of M = 10.35 with a standard deviation of SD = 952.909 with a median of Mdn = 2.60 in our sample of firms. Similar to ROE, the difference between mean and median reflects the presence of outliers and skewness in the data. These outliers were retained in the analysis to preserve the integrity of the dataset and to capture the full spectrum of firm financial behaviour, given the large sample size and the robustness of parametric methods applied. All the above values are recorded in Appendix F.

Given the large sample size (n > 3 300), the use of parametric methods, including Pearson correlation, is justified. According to the Central Limit Theorem, the sampling distribution of the mean approaches normality with sufficiently large samples, even when the underlying data are non-normal. Lumley et al. (2002) confirm that $n \geq 500$ is generally adequate for this approximation. In addition, Spearman's rank correlation, a non-parametric alternative, was also considered for robustness checks in case the assumption of linearity or normality was substantially violated.

We assessed the relationships between the *ROE* and *Financial Leverage* variables both within the full sample of firms and across the sectors. Contrary to theoretical predictions, the overall relation between financial leverage and ROE was weak and negative: $r = -0.111$, $p < 0.001$, as shown in Table 6. This indicates that, on average, higher leverage is not associated with higher ROE in Slovak firms.

Table 6 Correlation of ROE and Financial Leverage Ratios

Correlations		ROE	Financial Leverage
ROE	Pearson Correlation	1	-0.111**
	Sig. (2-tailed)	X	0.000
	N	3 347	3 347
Financial Leverage	Pearson Correlation	-0.111**	1
	Sig. (2-tailed)	0.000	X
	N	3 347	3 439

**. The correlation is significant at the 0.01 level of significance.

Source: the authors

Sectoral decompositions revealed further evidence of divergence:

- In the primary sector, the relationship was positive and significant (r = 0.569) according to classical financial theory.
- The correlation was negatively very strong in the secondary sector (r = -0.940).
- In the tertiary (r = 0.003) and quaternary (r = -0.099) sectors, correlations were weak or weakly negative.

The aforementioned values of the correlations of the *ROE* and *Financial Leverage* indicators for all four sectors are presented in Appendix G.

Conclusion for H_2: The expected positive relationship between financial leverage and ROE doesn't generally hold, but is only partially supported in the primary sector. The absent or negative correlations in the other sectors suggest that the expected enhancing effect of debt on shareholders' returns is highly industry setting, risk-firm, and profit-dependent. These findings challenge the relevance of conventional finance theory and emphasise the complexity of capital structure-performance relations in a post-transition economy in Slovakia.

2.3Firm-level determinants of indebtedness (H3)

H3: The level of corporate indebtedness (debt ratio) can be effectively predicted using a set of selected capital structure indicators.

A multiple linear regression with several predictors was employed to predict indebtedness (debt ratio). The regression model was conducted with following predictor variables: sector (dummies), number of employees (categorical), equity, income tax, ROA, and sales. The variables were standardized to ensure comparability of their relative predictive strength.

At the beginning of data preparation and the search for the optimal regression model, we performed data cleaning, elimination of nonsensical or incomplete values. We excluded all cases that had extreme influence on the model (as determined by indicators such as Leverage, Cook's distance, and Mahalanobis distance) if they had the following critical values:

- Leverage: we excluded cases with high leverage, which can have a large impact on the fit (quality) of the model. Based on the critical values, we identified cases with leverage values above 0.006 (suspicious cases) and 0.009 (highly suspicious cases).
- Cook's distance: we focused on cases with a value above 1, indicating a strong influence on the model. For each of the cases that had a Cook's distance higher than the critical values, we decided whether to exclude them from the set.
- Mahalanobis distance: we excluded cases that had values higher than the critical values for a given significance level ($p < 0.001$). Cases with high Mahalanobis distance may indicate outlier observations that may affect the overall model.

Given the size of the dataset (n > 3 000), we chose to test multiple models, monitoring the change in the adjusted coefficient of determination (Adj. R^2). We observed how the adjusted coefficient of determination changed over the course of ten iterations. We started with very low values and gradually observed an increase up to a value of 0.508. We found that the changes in Adj. R^2 stabilized after the eighth iteration. Based on the analysis, we decided that this model was optimal because after the eighth iteration, the value started to stabilize slowly and further growth was very small. This model offered a sufficient explanation of the variability without running the risk of overfitting the model to the data. This step was crucial for the model to be robust.

In order to assess multicollinearity between predictors, the following indicators were evaluated:

- Tolerance and VIF:
  - All predictors had a VIF < 5 (maximum 2.629 for SECTOR3), which is below the critical value;
  - Tolerance was > 0.2 for all variables, which is acceptable.
- Collinearity Diagnostics (Condition Index + Variance Proportions):
  - No dimension exceeded critical values simultaneously for multiple predictors (e.g., > 0.5 variance decomposition at CI > 15), so severe multicollinearity was not confirmed.

As shown in Table 7 and 8, the final model explained 48.5% of the variability in debt ratio (Adjusted R^2 = 0.485), and was statistically significant: $F(8, 2508) = 296.59$, $p < 0.001$. The magnitude of explained variance demonstrates strong substantive significance, reflecting a robust model fit. The Durbin-Watson statistic was 1.938, indicating no evidence of autocorrelation in the residuals, thus supporting the assumption of

independent errors and the validity of the regression model.

Table 7 Summary of the regression model

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin- Watson
1	0.697[a]	0.486	0.485	18.16%	1.938

a. Predictors: (Constant), Sales, ROA, SECTOR2, Number of_cat, SECTOR4, Ownership, Income tax, SECTOR3

b. dependent variable: debt ratio

Source: the authors

Table 8 ANOVA test

Model		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	782 716.681	8	97 839.585	296.594	0.000[b]
1	Residual	827 331.539	2 508	329.877	x	X
	Total	1 610 048.221	2 516	x	x	X

a. dependent variable: debt ratio

b. predictors: (Constant), Sales, ROA, SECTOR2, Number of_cat, SECTOR4, Ownership, Income tax, SECTOR3

Source: the authors

Key findings from the regression (see Table 9):

- Equity (β = -0.689) and ROA (β = -0.439) were the strongest negative predictors, consistent with the Pecking Order Theory.
- Sales (β = 0.322) and Income Tax (β = 0.179) had a positive impact, indicating that firm size and profitability lead to greater debt utilisation—confirming Trade-Off Theory.
- Sectoral dummy variables indicated that tertiary and quaternary sector companies possess considerably more debt than primary sector companies.
- Firm size (employees) had a negative influence on debt ratio, but was small in impact, possibly capturing structural conservatism or constraints on external finance.

Conclusion for H_3: The regression model strongly supports Hypothesis 3. Capital structure decisions are significantly shaped by a firm's financial profile and sectoral context. The contrasting roles of profitability, equity, and revenue confirm the complementary insights of both the Trade-Off and Pecking Order theories. The high explanatory power of the model (nearly 50%) affirms the robustness of the selected variables and the context-specific nature of capital structure determinants in the Slovak business environment.

Table 9 Regression model results

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Standard Error	Beta		
(Constant)	64.825	1.287	x	50.384	<0.001
SECTOR 2	13.759	1.273	0.245	10.812	<0.001
SECTOR 3	10.363	1.297	0.185	7.989	<0.001
SECTOR 4	16.076	1.202	0.283	13.370	<0.001
Number of employees	-0.600	0.144	-0.069	-4.167	<0.001
Equity	$-2.648*10^{-6}$	0.000	-0.689	-36.450	<0.001
Income tax	$1.512*10^{-5}$	0.000	0.179	8.481	<0.001
ROA	-1.167	0.049	-0.439	-23.740	<0.001
Sales	$3.475*10^{-7}$	0.000	0.322	16.212	<0.001

Source: the authors

Conclusion

This study explored the determinants of capital structure of firms in the Slovak Republic, with a focus on inter-sectoral differences. Using firm-level financial data and existing theoretical frameworks—namely, the Trade-Off Theory, Pecking Order Theory, and Agency Theory—we empirically tested three hypotheses to examine the influence of sectoral affiliation and financial measures on firms' leverage decisions.

The first hypothesis, that firms in the primary and secondary industries would be more leveraged with greater capital intensity, was not confirmed. Contrary to theoretical expectation, firms in the tertiary and quaternary industries were significantly more leveraged. Sectoral variations were statistically significant but not extremely explanatory. This finding rejects the assumption that leverage is driven by capital needs only and suggests that institutional or market-specific factors—such as access to credit from banks or firm age—may play a stronger role in a developing economy such as Slovakia.

The second hypothesis, that it would find a positive relationship between ROE and financial leverage, was also not supported in the pooled data. The pooled correlation was weakly negative, and sectoral analyses had highly disparate patterns—between a very strong positive correlation in the primary sector and a very strong negative correlation in the secondary sector. These variations highlight that the influence of debt on performance is not the same and can be contingent on firm strategy, risk appetite, or cost of capital by industry.

The third hypothesis was firmly supported. A multiple linear regression model with sector affiliation, profitability, equity, firm size, sales, and tax payment explained nearly half of corporate leverage variation (Adjusted $R^2 = 0.485$). The most significant negative predictors were equity and ROA, consistent with Pecking Order Theory, while sales and income tax were positively associated with higher leverage under Trade-Off Theory dynamics. Industry dummies also confirmed that firms in service industries are more leveraged, highlighting the need for a context-specific capital structure analysis.

The empirical findings of this study are broadly consistent with the existing literature on capital structure determinants, while also revealing context-specific deviations. The observed negative relationship between profitability (ROA) and leverage supports the Pecking Order Theory and is in line with prior studies (e.g., Hussain & Miras, 2015; Kang & Ausloos, 2017), which emphasise the preference for internal financing among more profitable firms. Simultaneously, the positive association between firm size (proxied by sales) and leverage confirms Trade-Off Theory predictions and corresponds with evidence reported by Chen (2004) and Gomez et al. (2014). However, the absence of a stable positive relationship between financial leverage and ROE contradicts the classical Modigliani–Miller proposition and rather aligns with more recent empirical findings highlighting the conditional and sector-dependent nature of this relationship (e.g., Brendea et al., 2022). Overall, the results suggest that capital structure decisions in the Slovak context cannot be fully explained by a single theoretical framework, but rather reflect a combination of firm-level characteristics and sector-specific factors.

In general, the findings of this study contribute to the literature on empirical capital structure by underscoring the sectoral and firm-specific nuances influencing financing decisions in a small post-transition economy. While classical theory provides useful points of reference, these theories are not capable of explaining observed action in the Slovak economy. Instead, our evidence is compatible with a hybrid explanation, in which financial metrics at the firm level mesh with sectoral patterns and institutional limitations.

For policy-makers and financial decision-makers, they suggest that, for one-size-fits-all solutions to capital structure optimisation, perhaps they are not enough. Strategic financial choice needs to consider not only theoretical best practice but institutional setting, firm-specific risk, and industry-specific features.

A key limitation of this study is that it is based on a single-year cross-section of firm-level data. This design was chosen deliberately, as the primary focus of the study is on cross-sectoral differences rather than temporal dynamics. We acknowledge that panel or time-series analyses could strengthen the robustness of the findings and provide additional insights into changes over time.

Follow-up studies can be therefore used to give an extension of the work by incorporating time-series data, distinguishing between short-term and long-term debt, or including ownership structure, firm age, and capital market access. Intertemporal analysis with other Central and Eastern European

economies can also permit generalisation or comparison with the results of this study.

Declarations

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Appendix A: Sectors of the Slovak economy

Sector	Division	SK NACE sections marked with letters
primary	1 to 3	A – Agriculture, forestry and fishing
primary	5 to 9	B – Mining and quarrying
secondary	10 to 33	C – Manufacturing
secondary	35	D – Electricity, gas, steam and air conditioning supply
secondary	36 to 39	E – Water supply, sewage treatment and disposal, waste and refuse disposal services
secondary	41 to 43	F – Construction
tertiary	45 to 47	G – Wholesale and retail trade; repair of motor vehicles and motorcycles
tertiary	49 to 53	H – Transport and storage
tertiary	55 and 56	I – Accommodation and food service activities
quaternary	58 to 63	J – Information and communication
quaternary	64 to 66	K – Financial and insurance activities
tertiary	68	L – Real estate activities
quaternary	69 to 75	M – Professional, scientific and technical activities
quaternary	77 to 82	N – Administrative and support services
tertiary	84	O – Public administration and defence; compulsory social security
quaternary	85	P – Education
quaternary	86 to 88	Q – Health and social work
tertiary	90 to 93	R – Arts, entertainment and recreation
tertiary	94 to 96	S – Other activities
tertiary	97 and 98	T – Activities of households as employers
tertiary	99	U – Activities of extraterritorial organizations and associations

Source: the authors, based on the Statistical Classification of Economic Activities SK NACE Rev. 2, 2007

Appendix B: Descriptive Statistics of the Indicator Total Indebtedness

Total Indebtedness		
n	valid values	3 451
	missing values	13
Diameter (M)		64.164
Median (Mdn)		64.468
Standard deviation (SD)		53.308
Minimum		0.03
Maximum		2 148.11

Source: the authors

Appendix C: Results of Levene's Statistic for Total Indebtedness

Test of Homogeneity of Variances			
Levene's statistics	df1	df2	Sig.
5.823	3	3 447	0.001

Source: the authors

Appendix D: Results of Welch Correction for Total Indebtedness

Robust Tests of Equality of Means				
	Statistic[a]	df1	df2	Sig.
Welch	40.941	3	1 643.670	0.000
a. asymptotically distributed.				

Source: the authors

Appendix E: Measures of Association of the Indicator Total Indebtedness between Sectors

Measures of Association		
	Eta	Eta Squared
Total Indebtedness * sector	0.124	0.015

Source: the authors

Appendix F: Descriptive statistics of ROE and Financial Leverage

		ROE	Financial Leverage
N	valid values	3 347	3 439
	missing values	117	25
Diameter (M)		-10.560	10.348
Median (Mdn)		13.615	2.599
Standard deviation (SD)		923.943	952.909
Minimum		-4 2811.56	-50 789.885
Maximum		2 773.80	20 622.238

Source: the authors

Appendix G: Correlations of ROE and Financial Leverage for all Sectors

Sector			ROE	Financial Leverage
1	ROE	Pearson Correlation	1	0.569**
		Sig. (2-tailed)	X	0.000
		N	462	462
	Financial Leverage	Pearson Correlation	0.569**	1
		Sig. (2-tailed)	0.000	X
		N	462	464
2	ROE	Pearson Correlation	1	-0.940**
		Sig. (2-tailed)	X	0.000
		N	970	970
	Financial Leverage	Pearson Correlation	-0.940**	1
		Sig. (2-tailed)	0.000	X
		N	970	996
3	ROE	Pearson Correlation	1	0.003
		Sig. (2-tailed)	X	0.923
		N	964	964
	Financial Leverage	Pearson Correlation	0.003	1
		Sig. (2-tailed)	0.923	X
		N	964	994
4	ROE	Pearson Correlation	1	-0.099**
		Sig. (2-tailed)	X	0.002
		N	951	951
	Financial Leverage	Pearson Correlation	-0.099**	1
		Sig. (2-tailed)	0.002	X
		N	951	985
**. Correlation is significant at the 0.01 level				

Source: the authors