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Financing strategies in mining industry across Europe

Introduction

Decisions regarding capital structure are one of the pivotal areas of corporate finance, attracting extensive attention in both practical and theoretical studies. The literature abounds with research exploring the various factors influencing capital structure formation. These determinants derive both from the external environment of companies and from companies' internal features inherent to the organizations themselves. The latter group of determinants exhibits a varied nature, influenced by the distinctive operational dynamics of entities across diverse sectors of the economy.

The conditions characterizing mining companies differ significantly from those operating in other manufacturing firms. This is because the specific nature of the mining process carried out in a mine differs significantly from the typical manufacturing process (Rosienkiewicz and Helman 2014). This has an impact on all management decisions in mining companies, including those related to capital structure formation. So far, the impact of capital structure factors has not been sufficiently examined with regard to individual sectors,

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including the mining industry. Only few studies on the factors influencing financial decisions can be found in this area. Moreover, the available analyses are only marginally cross-sectional, i.e. considering the differences between companies from various countries. The article aims to identify and assess the impact of capital structure factors of mining companies in Central and Eastern European (CEE) countries compared to Western European (WE) Union countries. In addition, the research attempts to establish whether the financial decisions of the analyzed entities align with the trade-off, pecking order, or agency costs theory. Given the limited studies on this subject, this article also seeks to address and contribute to the existing gap in this area.

The article comprises an introduction, five sections and a conclusion. The initial section delves into the mining industry's specific features in the context of capital structure formation. Subsequently, the second part outlines the financing strategies employed by mining companies within the framework of capital structure theories. This is followed by a review of mining companies' capital structure studies, accompanied by the presentation of a research hypothesis formulated based on the analyzed literature. The article's subsequent section is methodological, describing the data and research methods employed. The fifth part presents the research results and concludes with a summary.

1. The specific features of the mining industry in the context of capital structure

Mining companies are distinguished by unique features due to the specific nature of their operations. These characteristics exert a considerable influence on their financial decisions. Several factors come into play in this context, notably: high capital intensity, a substantial proportion of fixed assets in the asset structure, pronounced volatility in market prices of mineral resources, high operational risk, and long-term environmental impacts.

Significant capital expenditures are essential throughout the entire life cycle of mining companies. Consequently, whether initiating operations or making additional portions of the deposit available for exploitation, these entities experience increased demand for financial resources. At the same time, the initiation of each pit is regarded as a distinct investment project, requiring individual efficiency assessments. This is associated with increased risk owing to challenges in assessing geological and mining parameters (Jonek-Kowalska 2016). Capital expenditures are also incurred during the exploitation phase in the mining sector. This is related not only to the necessity of modernizing various fixed assets but also to operational activities, especially in the area of materials management. The operating conditions in a mine are exceptionally difficult, marked by high humidity, the presence of water, high temperatures and rugged terrain. As a result, mining machinery experiences frequent breakdowns, necessitating efficient materials management. The delivery of spare parts to their destination in the mine is complicated and time-consuming, as it involves multiple steps such as horizontal surface transport, vertical transport and, ultimately, horizontal

underground transport. Mining companies typically adopt a traditional approach to materials management, striving to maintain minimal inventories (Rosienkiewicz and Helman 2014). Nevertheless, such a policy may lead to losses stemming from disorganization in the mining process. Conversely, maintaining a substantial inventory of spare parts entails tying up a considerable amount of capital and incurring costs associated with preserving this inventory.

It is also worth noting that the mining industry faces a significant level of fixed costs due to the supporting processes, regardless of the level of extraction (Jonek-Kowalska 2016). This limits potential opportunities to reduce production costs, makes the cost side of efficiency inflexible, and prevents the effective use of cost management tools within the company.

Due to the aforementioned reasons, the capital-intensive nature of mineral exploitation results in a substantial demand for long-term external capital. Nevertheless, these entities are cautious in their use of capital generating interest-bearing liabilities, preferring to minimise liquidity risk by relying on equity capital as the primary source of financing for mining companies.

The high capital intensity of mining companies is reflected in their asset structure (Sierpińska 2021). Mining assets are classified on the balance sheet as either tangible or intangible assets. The former category includes items such as open-pit mines, pits, dams and reservoirs, machinery used for raw materials extraction, rails, shaft towers, etc. The latter category includes drilling rights, among other things (Jasiorska et al. 2020). The high proportion of fixed assets in the asset structure of mining companies allows for significant depreciation charges. This facilitates the generation of a higher cash surplus, consequently enhancing the ability to finance operations from internal funds. Moreover, the mining industry is strongly influenced by regulations related to climate policy and the energy transition, which forces changes in the asset structure and generates high capital expenditures related to the modernization of owned assets. The significant predominance of non-current assets in the asset structure of these entities primarily requires the involvement of equity capital to finance them.

The unique characteristics of the mining industry make it more susceptible to various financial and operational risks than many other sectors. This applies to the entire value creation chain, starting with the mining process, followed by mineral processing, logistics, finance, and, finally, sales and marketing, which are highly dependent on the market situation (Rymarczyk 2018). The main source of financial risk for mining companies is the high volatility in market prices of mineral resources. This results in significant fluctuations in operating profit, which affects the return on equity (ROE) and the entities' capacity to service debt (Sierpińska 2021). One approach to addressing this challenge is the implementation of risk control instruments, such as hedging. A slightly more favorable situation is observed in entities with diversified activities, i.e. those involved in the extraction of different types of mineral resources where market prices are not correlated with each other. Consequently, diversification of activity leads to profit smoothing and improves debt servicing capacity, thus reducing the level of financial risk. It is worth emphasizing, however, that in industries

characterized by substantial profit volatility due to market conditions, the primary source of financing is equity (Sierpińska 2021).

Mining is characterized by high operational risk. It is primarily associated with the occurrence of unpredictable natural hazards that pose a serious threat to the health and life of miners and the volatility of operating profits. These factors have a negative impact on economic added value (Jonek-Kowalska 2012). This parameter reaches its lowest values in periods when operational risk is highest. It is reflected in the cost of capital that increases along with the operational risk growth. Consequently, the capital structure also fluctuates as a result of changes in the availability of specific sources of financing.

The mining industry exerts a persistent and adverse long-term impact on the environment. The exploitation of mineral resources is accompanied by a range of hazards unparalleled in other sectors and eminently harmful to human life and health, destroying biodiversity and affecting the climate (Ahirwal and Maiti 2022). These include gas, dust, rock and gas explosion, radiation, climate, microbial, and many other threats, depending on the type of mineral being extracted (Keenan and Holcombe 2021). For example, the open-pit method causes soil degradation over vast areas of land, destroying local ecosystems. Deep mining, on the other hand, is associated with mining damage and water disruption. Companies specializing in metal ore extraction must also deal with the problem of toxic waste disposal. The environmental consequences of mining activities are very difficult to remove, and their time horizon extends well beyond the end of mining. Therefore, the scale of the financial needs in this area requires the search for all available funding sources.

Moreover, a key issue in this case is their complementary use and the effective application of financial mix. Instruments for financing revitalization include: public sources, especially EU funds, non-refundable foreign funds, loans from international financial institutions, government operational programs, national and regional funds, non-public sources, including mainly bank loans, bond issues, and private sector investments. Public-private partnerships also play an important role in this regard (Ryszko 2012).

2. Mining companies' financial strategies according to the capital structure theories

Decisions regarding the formation of capital structure are extensively analyzed, encompassing both empirical and theoretical perspectives. A number of theories explaining corporate financing patterns have emerged from these studies. In the context of examining the factors influencing the financing decisions of mining companies, three theories in particular are applicable: trade-off, pecking order and agency costs.

Trade-off and pecking order theories express opposing approaches to capital structure formation. At the core of the first concept is the thesis that the optimal capital structure of a company is the result of balancing tax interest benefits with the costs of financial distress (bankruptcy costs) together with agency costs relating to both equity and debt. Shaping the

capital structure at an optimal level leads to minimizing the weighted average cost of capital while maximising the company's market value (Kraus and Litzenberger 1973; Jensen and Meckling 1976; Myers 1977).

In turn, the pecking order theory explains firms' preferences for using particular sources of finance (Myers 1984, Myers and Majluf 1984). The order is as follows: internal sources, i.e., retained earnings, surplus cash, and short-term financial assets, are used first. Once these are exhausted, companies turn to external sources. Thus, they first use bank loans and credits, then decide to issue debt securities, then hybrid securities, and finally, shares. This theory does not set a target capital structure. A factor that has a key impact on the capital structure is the question of the preference order of the various sources of financing.

The last concept, the agency cost theory (Jensen and Meckling 1976), exposes the role of the agency costs that arise from the division of power in a company between its owners and managers. This situation leads to a conflict of interest between these stakeholders, resulting from the agency relationship. This relationship results from a contract between the owner and the manager, who undertakes to provide services on the owner's behalf. The owner must, therefore, delegate some of his decision-making powers to the hired manager. This relationship generates a disparity between the objectives of the owner and the manager, accompanied by an asymmetry of information. This disparity is because managers know more about the company's financial condition than other stakeholders, who do not have full access to information. Agency cost theory explains the formation of capital structure in the context of the conflict described, which affects the company's asset allocation.

The assumptions of the aforementioned capital structure theories emphasize the importance of various factors influencing corporate financial decisions. This study empirically verifies the impact of the tax burden, asset structure, liquidity, non-debt tax shield, profitability, working capital, growth opportunities, company risk and size, as well as the country of operation.

The literature emphasizes that tax benefits are a contributing factor leading to increased debt, especially during periods of high tax rates (Deng et al. 2020; Lee et al. 2023). Essentially, a higher tax rate on profits translates to greater advantages for the firm in terms of the tax shield. This results in a positive effect of tax burden on leverage, aligning with the premises of the trade-off theory.

Tangible assets, by serving as collateral for liabilities, enable the direct costs of bankruptcy, thereby encouraging firms to use more debt (Jensen and Meckling 1976; Myers 1977). Thus, the trade-off theory expects a positive relationship between asset structure and debt. On the contrary, according to the pecking order, firms with a high share of fixed assets are less prone to problems arising from information asymmetries. Therefore, their propensity to employ debt is lower. This implies a negative effect of the asset structure on firms' financing decisions.

In contrast, according to agency theory, the relationship between fixed assets and leverage can be either negative or positive. In the first case, companies predominantly finance their activities through short-term debt. Using these funds to finance fixed assets would

entail a high level of risk. Consequently, these entities prefer equity for financing fixed-asset investments (Doan 2020). In the second case, better collateralization of debt reduces the risk of agency costs for the lender, leading to increased leverage.

Companies with high liquidity prefer internal sources of financing, thereby reducing debt. Consequently, in line with the pecking order theory, higher liquidity is associated with lower leverage. Conversely, according to the trade-off theory, the relationship is positive. As highly liquid companies enjoy a robust ability to service and repay their obligations, they are inclined to use debt (Dakua 2019).

The impact of the non-debt tax shield on leverage is negative according to both the trade-off and pecking order theory. In the first case, this factor is a substitute for the interest tax shield, resulting in a negative relationship with debt. In the second case, entities that raise funds through depreciation have less need for debt, as they can rely on internal financing (Gregova et al. 2018). Conversely, the positive relationship between the non-debt tax shield and leverage can be explained on the grounds of the agency theory. Companies try to counteract the potentially irrational use of free cash flow resulting from increased depreciation by managers. Therefore, they increase their debt level (Harris and Raviv 1991).

According to the trade-off theory, the relationship between working capital and debt is positive. In order to finance the needs in this area, firms increase debt (Flannery and Öztekin 2019). Conversely, according to the pecking order theory, firms seek to optimize the size of working capital in order to improve liquidity and reduce external financing (Afza and Nazir 2008).

According to the trade-off theory, the relationship between profitability and leverage is positive. This is because profitable companies have lower financial distress costs and seek to benefit from the interest tax shield. Therefore, a profitable company should use more debt to reduce its tax burden. Also, agency theory indicates that a higher level of debt is more favorable for highly profitable entities, as this alleviates the problem of excess free cash. In contrast, according to the pecking order theory, highly profitable firms generally use less debt because they prefer internal financing (Harris and Raviv 1991).

Trade-off and agency theories assume a negative relationship between growth opportunities and debt. According to the first concept, the realization of growth opportunities is usually associated with high risk and an increase in the expected cost of financial difficulties, which consequently reduces debt. The agency theory suggests that fast-growth companies finance riskier projects, making the cost of debt higher for them (Harris and Raviv 1991). Conversely, according to the pecking order theory, the relationship between growth and leverage is positive. The information asymmetry between managers and investors, coupled with the need to minimize information costs, prompts companies to initially resort to internal financing, turn to debt once internal sources are exhausted, and only consider issuing shares as a last resort (Nguyen and Tran 2020).

The negative impact of risk on the amount of debt is consistent with both the trade-off and the pecking order theories. According to the first concept, high-risk companies should be cautious with leverage due to the increased costs of financial distress and the likelihood of

bankruptcy. Conversely, in line with the pecking order theory, entities with high volatility of operating profits first use their accumulated internal financial resources and only then turn to debt (Dakua 2019).

The positive impact of company size on debt levels can be explained on the grounds of the trade-off, agency, and pecking order theories. From the point of view of the first concept, as large companies are more diversified, they face lower bankruptcy risk. According to the agency theory, large companies that have been in operation longer than their smaller counterparts are more established and enjoy a higher level of recognition. Consequently, their reputation leads to a lower cost of raising debt. In contrast, according to the pecking order, the lower risk profile of large companies reduces information asymmetry, thereby lowering the cost of debt relative to other sources of finance.

Consequently, large firms take on more debt than smaller ones (Nguyen and Tran 2020). The pecking order theory can also explain a negative relationship between debt and firm size. In this case, the lower level of information asymmetry in large entities encourages equity issuance because its cost is lower than that of issuing debt. Therefore, large firms prefer to issue equity rather than debt capital (Myers and Majluf 1984).

3. Empirical studies on the capital structure of mining companies and hypotheses development

Numerous studies in the literature have explored capital structure, but the impact of capital structure factors is observed to vary based on the industrial specificity of individual entities. Consequently, this influence has not been adequately examined in companies within certain sectors, including the mining industry. Only a limited number of studies exist in this area, with a substantial portion serving as contributions to future research, primarily attributable to either the limited number of entities analyzed or the relatively brief period of analysis. Moreover, few analyses verify both the direction and strength of the influence of capital structure factors, thus enabling the identification of criteria that guide mining companies in their decision-making processes regarding the selection of financing sources. Moreover, only a few of these studies are cross-sectional in nature, as they rarely include comparisons between companies from different countries. Barburski and Hołda (2023) conducted a comparative analysis of capital structure factors for companies in the mining and energy sectors across both the “old” EU member states, namely Germany, France, the United Kingdom, Spain, Italy and Sweden, and the subsequent entrants, including Poland, the Czech Republic, Slovakia, Hungary, Romania, and Bulgaria, spanning the period from 2012 to 2020. The authors note that the level of debt in both sectors is comparatively lower than that observed in other industries. Working capital had a statistically significant positive impact on the total debt of mining companies in all countries analyzed. A negative impact of asset structure and profitability on leverage was also diagnosed in this industry, although its statistical significance was only observed in some countries.

Škuláňová (2020) analyzed the impact of five factors on the capital structure of mining companies from eight CEE countries and three industry leaders from non-European countries between 2009 and 2017. The author showed that entities that used debt in previous periods try to reduce their debt levels in subsequent years. In addition, the statistically significant determinants of debt in the analyzed countries turned out to be profitability, asset structure, non-debt tax shield, GDP growth, and inflation.

Islam and Khandaker (2015) analyzed the factors influencing the financial decisions of 1620 listed Australian companies between 2000 and 2012. The sample was divided into companies from mining and other sectors. The authors highlight the existence of fundamental differences in financial patterns across entities in the two groups. For mining companies, profitability, and asset structure were found to be statistically significant determinants of capital structure. In the other sectors, these determinants proved irrelevant to financial decisions.

The literature highlights the low level of leverage in the mining sector. Urbina and Valdivieso (2007) have shown that mining companies in Peru actually have lower levels of debt compared to optimal leverage. This implies that these entities prefer to reduce debt instead of taking advantage of the opportunity to maximize the firm's value as a result of substituting equity with cheaper debt in the capital structure, which would allow the weighted average cost of capital to be optimized. Ranoz (2017) analyzed mining companies' financing structure based on case studies of selected Polish and foreign entities. The author showed that the level of debt in their financing structure most often ranged between 10 and 35% but did not exceed 45%. Similar conclusions were reached by Sierpińska (2021), who emphasizes that the assets of mining companies are mainly financed with equity, followed by the entities' use of short-term liabilities, while they usually avoid interest-bearing liabilities. Moreover, the financing structure of Polish and global mining companies is similar. It is worth noting that during an economic slowdown, mining companies have increased the shares of their equity capital in their general sources of financing. Additionally, these entities largely abandon bank loans in favor of issuing bonds, which appears to be a more flexible source of financing (Sierpińska and Bąk 2012).

The aforementioned specificity of companies operating in the mining industry is likely to make their functioning similar regardless of the country or size class. Consequently, it is reasonable to assume that the capital structure of mining firms and the determinants of leverage are also predominantly influenced by the industry effect. This leads to the formulation of the following research hypotheses:

- H1: The capital structure of mining companies is similar across Western and Central-East EU countries.
- H2: The impact of capital structure determinants on debt is similar across Western and Central-East EU countries.

4. Data and methods

The data utilized for the analytical section of this study originates from the BACH database (BACH 2023) issued by the European Committee of Central Balance Sheet Data Offices (ECCBSO). This database presents standardized annual account statistics for non-financial enterprises across twelve EU countries. It encompasses consolidated details pertaining to company financial statements, specific financial ratios, and information on company size and industrial categorization.

The analysis in this study encompasses the mining and quarrying industry, categorized under section C according to the NACE classification, across eight Western EU member states (Austria, Belgium, Germany, Spain, France, Italy, Luxembourg, and Portugal) and four Central-Eastern EU countries (the Czech Republic, Croatia, Poland, and Slovakia), and within three size classes (S – small, M – medium, and L – large) over the period from 2000 to 2020. The structure of the analyzed data is three-dimensional, with each dimension

Table 1. Definition of variables

Tabela 1. Definicja zmiennych

Variable character	Symbol	Ratio	Formula
Dependent variables	TTD	Total debt ratio	Total debt/Assets
	LTD	Long-term debt ratio	Non-current debt/Assets
	STD	Short-term debt ratio	Current debt/Assets
Explanatory variables	TAX	Tax burden	Tax on profit/Earnings before tax
	COL	Collateral	Tangible fixed assets/Assets
	LIQ	Financial liquidity	Cash and bank/Assets
	NDS	Non-debt tax shield	Depreciation and amortization of fixed assets/Net turnover
	ROE	Return on equity	Net profit or loss for the period/Equity
	WCR	Working capital ratio	Operating working capital/Net turnover
	GRT	Firm growth	$(\text{Assets of year } n + 1 - \text{Assets of year } n) / \text{Assets of year } n$
	VOL	Earnings volatility (risk)	$(\text{Net profit or loss of the year } n + 1 - \text{Net profit or loss of the year } n) / \text{Net profit or loss of the year } n$
	SIZE	Size dummies	Dummy variables for size groups: S, M, L
	CT	Country dummies	Dummy variables for size countries: AT, BE, CZ, DE, ES, FR, HR, IT, LU, PL, PT, SK
	YEAR	Year dummies	2000, 2001, ..., 2021

Source: authors' own compilation based on BACH (2023).

corresponding to the three size classes of firms, 12 countries, and 21 years. Owing to data release delays, the latest available year as of 2023 is 2020. Multiple dependent and explanatory variables were calculated for each entity defined by these three dimensions. The construction of these ratios is defined in Table 1.

The selection of explanatory variables aligns with the factors typically examined as the key determinants of capital structure by other studies in the field discussed in the previous section.

The methods applied in the study align with the primary goal, which is to examine the consistency of factors influencing capital structure decisions in mining companies across WE and CEE EU countries.

Given the potential variability in debt structures among mining companies depending on the firm size, the research hypotheses formulated in the previous section (H1 and H2) relating to financial structures' and their determinants' East-West variation will be verified separately for each size group. Similarly, as three distinct debt measures are employed, the validation of hypotheses will take the debt maturity into account.

The initial stage of the analysis involved examining basic descriptive statistics for mining companies across different country and size classifications. For testing the first hypothesis (H1), a one-way analysis of variance was conducted with the three debt ratios as dependent variables and the classification of countries into either CEE or WE as the qualitative factor. The second hypothesis (H2) was evaluated using panel data regression results conducted separately for the two groups of EU countries. The model is specified by formula (1):

$$D_{cst} = \beta_0 + \beta_1 TAX_{cst} + \beta_2 COL_{cst} + \beta_3 LIQ_{cst} + \beta_4 NDS_{cst} + \beta_5 ROE_{cst} + \quad (1)$$

$$+ \beta_6 WCR_{cst} + \beta_7 GRT_{cst} + \beta_8 VOL_{cst} + \gamma_s SIZE + \alpha_c CT + \rho_t YEAR + \xi_{cst}$$

- ↩ D_{cst} – one of the three debt measures (TTD, LTD, STD) in c country of firm size s in year t ,
- CT – dummy variables representing countries, $c = 1, \dots, 11$,
- $SIZE$ – dummy variables representing size classes, $s = S, M$,
- $YEAR$ – dummy variables representing years, $t = 1, \dots, 21$,
- $\beta, \gamma, \alpha, \rho$ – coefficients,
- ξ – random factor,
- other variables as specified in Table 1.

The results of our analysis are presented in the following section.

5. Results and discussion

The initial phase of the analysis focused on comparing debt levels, which entailed assessing basic descriptive statistical data for mining companies in various country and size categories. The examination of mean debt values in the examined industry across the two EU macro-regions, as shown in Figure 1, reveals that there are no significant differences between the compared groups.

The average values of debt metrics across different size groups of firms, as shown in Figure 2, exhibit slightly more variation compared to the geographical breakdown. On average, the total debt ratio of small firms is significantly greater than that of large and particularly medium enterprises. Furthermore, small businesses display a considerably higher proportion of short-term debt compared to their larger counterparts. Additionally, the level of long-term debt tends to rise along with the firm size.

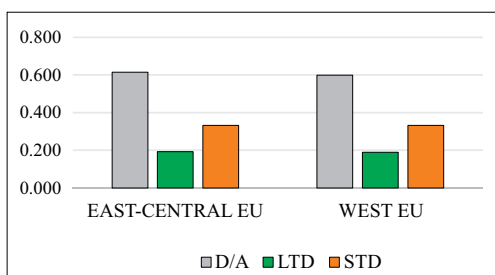


Fig. 1. Mean values of debt ratios in the mining industry for CEE and WE countries. The mean values are calculated for all size groups of firms (small, medium and large) and for all years available for all countries in the region in the period 2000–2020. Source: authors' calculations based on (BACH 2023)

Rys. 1. Średnie wartości wskaźników zadłużenia w górnictwie dla krajów EŚW i WE

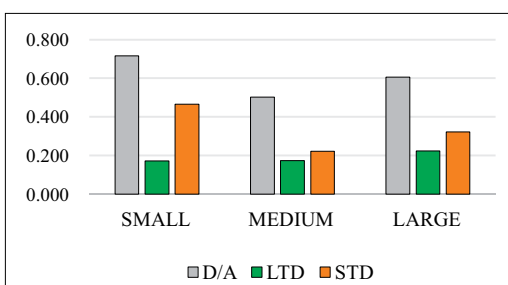


Fig. 2. Mean values of debt ratios in mining industry across size groups of firms. The mean values are calculated for 12 countries (AT, BE, CZ, DE, ES, FR, HR, IT, LU, PL, PT, SK) and for all years available for a given country in the period 2000–2020. Source: authors' calculations based on (BACH 2023)

Rys. 2. Średnie wartości wskaźników zadłużenia górnictwa w poszczególnych grupach wielkościowych przedsiębiorstw

The conclusions from the graphical exhibits can be supported by the analysis of variance (Table 2) performed for the two predictors: geographical location and firm size.

Table 2. One-way ANOVA results; values of F statistics and p value in parentheses

Tabela 2. Wyniki jednoczynnikowej analizy ANOVA; wartości statystyki F i wartości p w nawiasach

Size or region	Grouping factor	Dependent variable		
		TTD	LTD	STD
SMALL	CEE vs. WE	0.32 (0.574)	0.75 (0.387)	1.511 (0.220)
MEDIUM		5.27 (0.000)	0.95 (0.331)	0.341 (0.560)
LARGE		23.27 (0.000)	1.02 (0.313)	1.28 (0.259)
All size groups		2.17 (0.141)	0.08 (0.779)	0.00 (0.979)
WE	size	146.0 (0.000)	17.19 (0.000)	201.3 (0.000)
CEE		99.5 (0.000)	11.4 (0.000)	93.6 (0.000)
All countries		217.4 (0.000)	27.85 (0.000)	293.0 (0.000)

The values of F statistics were **bolded** for $p < 0.1$.

Source: authors' calculations based on (BACH 2023).

The table reveals that while firm size has proven to be a significant factor in differentiating financing policies within the mining sector, irrespective of debt maturity, the influence of a firm's location (CEE vs. WE) on its debt structure only exhibits slight variations depending on the size of the firm and the type of debt. Significant cross-regional differences in financing patterns are observed primarily for medium and large firms, specifically in the case of the total debt ratio. The lack of a significant impact of location on other types of debt and for other size classes can be attributed to the operational specificity within the industry, which predominantly determines financing strategies irrespective of country-specific features. These findings provide robust support for H1 concerning long-term and short-term debt across all size classes and limited support concerning the total debt.

To verify the second research hypothesis (H2) concerning the cross-regional similarity of factors affecting leverage in the mining industry, the panel data regression models were estimated separately for the two groups of EU countries. Tables 3 and 4 display the results.

Both tables provide grounds for a detailed comparison of the influence of various variables on distinct debt measures between WE and CEE countries. Analyzing the findings reveals that the factors responsible for shaping financing strategies in these two macro-regions are only slightly different.

Table 3. Panel regression results for WE countries (AT, BE, DE, ES, FR, IT, LU, PT)

Tabela 3. Wyniki regresji panelowej dla krajów WE (AT, BE, DE, ES, FR, IT, LU, PT)

Variable	Model (1) ^{FE} (TTD)		Model (2) ^{FE} (LTD)		Model (3) ^{FE} (STD)	
	Estimate	Std. error	Estimate	Std. error	Estimate	Std. error
const.	0.866***	0.031	0.159***	0.013	0.647**	0.020
COL	-0.275***	0.044			-0.319***	0.030
LIQ	-0.818***	0.265	-0.651***	0.174	-0.427***	0.125
NDS			0.620***	0.210	-1.090***	0.173
WCR	-0,129***	0,027				
SIZE	M***, L***		M*, L***		M***, L***	
CT	No		BE*, IT**		IT**	
YEAR	2001*, 2005**, 2007**		2019**		2007***	
No. obs.	474		474		474	
R ²	0.550		0.344		0.779	
Adj. R ²	0.541		0.327		0.776	
AIC	-907.2		-691.0		-1160.3	
Hausman test	114.3 [0.000]		4.3 [0.039]		98.1 [0.000]	
Joint significance robust F test						
Size	30.3 [0.000]		15.6 [0.000]		91.8 [0.000]	
Country	n/a		4.5 [0.020]		5.5 [0.029]	
Year	4.4 [0.009]		5.6 [0.030]		9.3 [0.006]	

FE – the model was estimated as a fixed effects model; interpretation of parameters in relation to small firms, Austria, and the year 2000.

* – significant at the 10% level, ** – 5%, *** – 1%.

Source: authors' calculations based on (BACH 2023).

In terms of tax burden, both WE and CEE EU countries exhibit a statistically insignificant impact on all debt measures, suggesting that tax burden does not play a significant role in shaping the debt structures of mining companies in either region. Moving to asset tangibility, also referred to as collateral, and financial liquidity, both regions display similar relationships. The variables have a significantly negative impact on total and short-term debt across both WE and CEE countries. This suggests a fairly consistent influence of collateral and financial liquidity on these debt measures, irrespective of geographical location.

The negative direction of the effect of asset structure on leverage is consistent with both the pecking order and agency theory. In the first case, the low debt propensity of mining companies is explained by low vulnerability to problems arising from information asymmetry.

Table 4. Panel regression results for CEE countries (CZ, HR, PL, SK)

Tabela 4. Wyniki regresji panelowej dla krajów CEE (CZ, HR, PL, SK)

Variable	Model (1) ^{RE} (TTD)		Model (2) ^{FE} (LTD)		Model (3) ^{FE} (STD)	
	Estimate	Std. error	Estimate	Std. error	Estimate	Std. error
const.	0.627**	0.118	0.18***1	0.023	0.527***	0.037
COL	−0.512***	0.100			−0.312***	0.048
LIQ	−1.114*	0.605	−1.239***	0.366		
NDS	1.252***	0.363	1.301**	0.176	−0.686**	0.222
ROE					0.315*	0.153
WCR					0.145**	0.049
GRT	0.028***	0.008	0.011**	0.004		
VOL	0.002**	0.001	0.005***	0.001	−0.003*	0.002
SIZE	M***, L*		M**, L***		M***, L***	
CT	SK***		HR***		SK***	
YEAR	2006–2019***,**		No		2015**	
No. obs.	94		94		94	
R ²	n/a		0.641		0.862	
Adj. R ²	n/a		0.612		0.847	
AIC	−222.8		−269.5		−288.1	
Hausman test	4.2 [0.238]		19.8 [0.001]		59.8 [0.000]	
Joint significance robust F test						
Size	13.1 [0.000]		8.5 [0.008]		147.0 [0.000]	
Country	21.4 [0.000]		14.7 [0.004]		30.6 [0.000]	
Year	1.2 · 10 ¹³ [0.000]		n/a		5.7 [0.041]	

FE – the model was estimated as fixed effects model.

RE – the model was estimated as random effects model; interpretation of parameters in relation to small firms, the Czech Republic and the year 2000.

* – significant at the 10% level, ** – 5%, *** – 1%.

Source: authors' calculations based on (BACH 2023).

In the second case, the diagnosed relationship should be explained primarily with regard to debt maturity. As financing fixed assets with short-term debt would lead to an increased risk, mining companies prefer equity to finance them. This conclusion is consistent with previous studies of capital structure factors in the analyzed sector (Urbina and Valdivieso 2007; Ranosz 2017; Barburski and Hołda 2023; Sierpińska 2021). The negative impact of liquidity on leverage in mining companies aligns with the pecking order theory. This relationship indicates a preference for internal sources of financing, thereby reducing debt. The findings confirm the earlier conclusion about the fundamental importance of equity in financing the operations of mining companies.

In terms of non-debt tax shields, proxied by depreciation, WE countries exhibit an insignificant impact on total debt but a significantly positive impact on long-term debt. In contrast, CEE countries show a significantly positive impact on both total and long-term debt and a significantly negative impact on short-term debt. The positive impact of the non-debt tax shield can be explained by the agency theory. The increase in debt, in this case, is to counteract the irrational use of free cash arising from depreciation allowances. Debt is thus regarded as a tool for disciplining managers.

Examining profitability, as defined by the return on equity, reveals an insignificant impact on all debt measures, except for CEE countries, where it exerts a statistically significant positive influence on short-term debt. This suggests that profitability may have varying implications for short-term debt in the CEE context. The positive effect of profitability on debt is consistent with both trade-off and agency theory. However, in the case of mining companies, the relationship reflects, as in the case of the non-debt tax shield, a tendency to mitigate problems arising from the irrational use of free cash.

Turning to the working capital ratio, a markedly different impact is observed between WE and CEE countries. WE countries exhibit a significantly negative influence on both total and short-term debt, while CEE countries demonstrate a significantly positive impact on short-term debt. The negative relationship between these two variables is in line with the pecking order theory. It implies actions to improve liquidity and reduce the volume of external financing. An inverse relationship was diagnosed in the CEE countries, suggesting that mining companies in this region finance their working capital needs by increasing short-term debt.

When considering growth and risk, the impact on debt measures varies across the regions. While growth remains insignificant in WE countries, it has a significantly positive impact on total and long-term debt in CEE countries. Risk, on the other hand, is insignificant in WE countries but shows significant impacts in CEE countries, with a positive effect on total and long-term debt and a negative effect on short-term debt. These distinctions constitute a few examples of varying effects on debt structures across the two regions. The positive relationship between debt and growth opportunities is in line with the pecking order theory. In this context, mining companies seek to reduce the costs of information asymmetry between managers and investors by reaching for internal financing first. The negative relationship between risk and short-term debt is consistent with both the trade-off and pecking

order theories. In contrast, the positive relationship diagnosed for total debt and long-term debt and risk in CEE countries is somewhat surprising. It is presumed that the reasons for this lie in the interventionist policies of the EU and the Member States regarding mining companies, which affect their financial performance. However, this problem requires further research.

Finally, the analysis of size, country, and year effects reveals consistent patterns in both WE and CEE countries. As for the size effects, these were found significant for all debt ratios in both regions, meaning that the capital structure of both medium and large firms differs significantly from the reference size group of small firms. The country effect appears much weaker, with only one or two countries demonstrating significantly different capital structures from the reference countries of Austria and the Czech Republic, respectively. Similar conclusions can be drawn with regard to the year effects, indicating that the capital structure of the examined population remains relatively consistent across different years. A concise summary of the findings concerning the (dis)similarity of the impact of capital structure determinants on debt between the compared groups of countries can be found in Table 5.

Table 5. Comparison of the impact of variables on capital structure between CEE and WE EU countries

Tabela 5. Porównanie wpływu zmiennych na strukturę kapitału pomiędzy krajami UE CEE i WE

Debt ratio	Impact on capital structure										
	TAX	COL	LIQ	NDS	ROE	WCR	GRT	VOL	SIZE	CT	YEAR
TTD	S	S	S	SD	S	SD	SD	SD	S	D	S
LTD	S	S	S	S	S	S	SD	SD	S	S	S
STD	S	S	SD	S	SD	SD	S	SD	S	S	S

S – similar impact; SD – slightly different impact; D – different impact.

If a variable had the same sign and significance or was insignificant in both regions, it was interpreted as a similar impact. If the impact was significant in one region but insignificant in the other one, it was interpreted as a slightly different impact. If the impact of a variable was significant for both regions but in opposite directions, it was interpreted as a different impact. Regarding the size, country, and year effect, the impact was interpreted as similar, depending on whether the effect was significant or insignificant in both regions. The effect was considered different if the significance differed between the two regions.

Source: authors' own compilation.

In conclusion, the relatively small differences in terms of relevance and direction observed in the impact of variables on debt measures between WE and CEE countries can be attributed to the industry specificity of mining companies, highlighting the importance of considering sector-specific circumstances in understanding financing decisions.

Conclusions

In line with the primary aim of this article, which is to identify and assess the impact of capital structure factors within the context of mining companies in CEE countries compared to their counterparts in WE EU countries, the conclusions drawn from the analysis can be summarised in Tables 6 and 7. The tables provide synthetic information about the level of support for research hypotheses regarding the similarity of capital structure across the CEE and WE countries and the similarity of the impact of various factors on debt.

Table 6, dedicated to the verification of research hypothesis H1, reveals the degree of similarity in capital structure among mining firms across the CEE and WE countries. The comprehensive examination of debt ratios, namely total, long-term and short-term, across all size classes reveals substantial support for the hypothesis. The findings suggest a consistent pattern of similarity in capital structure, indicating that mining companies in the two compared macro-regions exhibit comparable debt structures. The only distinctions observed, specifically in the case of total debt for medium and large firms, constitute an exception from the general tendency of mining companies to adopt similar financing strategies regardless of their geographical location.

Table 6. The verification of research hypothesis H1 concerning the similarity of capital structure of mining companies across Western and Central-East EU countries

Tabela 6. Weryfikacja hipotezy badawczej H1 dotyczącej podobieństwa struktury kapitałowej spółek górniczych w krajach UE Zachodniej i Środkowo-Wschodniej

Debt ratio	Size class of mining firms			
	All sizes	Small	Medium	Large
TTD	Yes	Yes	No	No
LTD	Yes	Yes	Yes	Yes
STD	Yes	Yes	Yes	Yes

“Yes” – indicates support found based on the lack of significant differences between a given debt ratio’s mean across WE and CEE countries; “No” – means that no support was found for a given factor, as their mean values differed significantly between the compared regions.

Source: authors’ own compilation.

Turning to Table 7, which summarised the support for the second research hypothesis (H2), the analysis provides a detailed comparison of the impact of various factors on debt across the CEE and WE countries. While there is robust support for the impact of several independent variables on debt across both regions, such as tax burden, collateral, liquidity, non-debt tax shields, profitability, size effect, and year effect, the presence of only weaker

support in some instances suggests that the impact may not be entirely uniform. Specifically, factors like working capital, growth, risk, and country effect exhibit weak or no support, indicating some variations in their influence on debt between the two regions. Moreover, considering the direction of the influence of individual variables on debt, it can be concluded that the financing decisions of mining companies in both CEE and WE countries align with the pecking order and agency theories. This implies a preference for internal financing, with debt primarily regarded as a disciplinary tool for managerial control.

Table 7. The summary of support for research hypothesis H2 concerning the similar impact of various factors on debt between the CEE and WE countries

Tabela 7. Podsumowanie poparcia hipotezy badawczej H2 dotyczącej podobnego wpływu różnych czynników na zadłużenie pomiędzy krajami EŚW i WE

Debt ratio	Independent variables										
	TAX	COL	LIQ	NDS	ROE	WCR	GRT	VOL	SIZE	CT	YEAR
TTD	yes	yes	yes	weak	yes	weak	weak	weak	yes	no	yes
LTD	yes	yes	yes	yes	yes	yes	weak	weak	yes	yes	yes
STD	yes	yes	weak	yes	weak	weak	yes	weak	yes	yes	yes

“Yes” – indicates support found based on the similar impact of a given factor on debt in terms of significance and direction; “No” – means that no support was found for a given factor, as their impact was different in terms of sign for firm specific variables or in terms of relevance for dummy variables; “Weak” indicates that only partial support was found for a given factor, whose impact was different only in terms of significance.

Source: authors' own compilation.

In conclusion, the outcomes of this study contribute significantly to the fulfillment of the article's aim by offering a comprehensive evaluation of capital structure factors in the European mining industry. The identified similarities and variations in debt structures and the impact of diverse factors provide a foundation for informed decision-making among mining companies, policymakers, and investors operating in both CEE and WE EU countries. This research not only enhances our understanding of corporate financing strategies in the mining sector but also highlights the importance of contextual factors, such as industrial specifics, in shaping capital structure across diverse European regions.

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FINANCING STRATEGIES IN MINING INDUSTRY ACROSS EUROPE

Keywords

mining industry, capital structure, pecking order theory, leverage, agency costs theory

Abstract

This article aims to identify and assess the impact of capital structure factors on financing strategies of mining industry enterprises in Central and Eastern European (CEE) countries in comparison to Western European (WE) Union countries. The research contributes to determining which of the main theories of capital structure best describes the financial strategies employed in the examined sector. The analysis encompasses mining companies from eight WE and four CEE countries, utilising panel data models with information spanning from 2000 to 2020. The study covers various firm-specific variables commonly employed in similar research, along with the effects of country and year.

The main findings indicate a significant similarity in both the capital structure and the influence of the analysed factors on leverage across the two regions. This homogeneity is attributed to the industrial specificity of the mining sector, which appears to supersede country-specific or firm-size specific features. Moreover, examining the impact of variables on capital structure considering different debt maturity terms reveals that the financial strategies of the analysed companies align with the pecking order and agency theory of capital structure. This suggests that mining companies predominantly rely on internal financing, viewing debt primarily as a tool to discipline managers. Due to data limitations in the employed BACH database, the study does not encompass all EU countries, highlighting the potential for further research incorporating other regions. The identified similarities in capital structure, along with the impact of various factors, provide insights for financial decision-makers in mining firms, and investors operating in both CEE and WE EU countries.

STRATEGIE FINANSOWANIA W PRZEMYSŁE WYDOBYWCZYM W EUROPIE

Słowa kluczowe

struktura kapitału, dźwignia finansowa, przemysł wydobywczy,
teoria hierarchii finansowania, teoria kosztów agencji

Streszczenie

Celem artykułu jest identyfikacja i ocena wpływu czynników struktury kapitału na strategie finansowania przedsiębiorstw wydobywczych w krajach Europy Środkowo-Wschodniej w porównaniu z krajami Europy Zachodniej UE. Badanie umożliwia określenie, która z teorii struktury kapitału najlepiej opisuje strategie finansowe stosowane w badanym sektorze. W analizie obejmującej przedsiębiorstwa wydobywcze z ośmiu krajów Europy Zachodniej i czterech krajów Europy Środkowo-Wschodniej, zastosowano modelowanie danych panelowych z okresu 2000–2020. W badaniu uwzględniono wpływ różnych zmiennych charakterystycznych dla firm, a także efekt kraju i roku. Główne wyniki wskazują na znaczne podobieństwo struktury kapitału i wpływu analizowanych czynników na dźwignię finansową w obu regionach. Jednorodność tę można przypisywać specyfice przemysłowej sektora wydobywczego, która wydaje się przeważać nad specyfiką kraju czy wielkości firmy. Co więcej, badanie wpływu zmiennych na strukturę kapitału z uwzględnieniem różnych terminów zapadalności długu ujawnia, że strategie finansowe analizowanych spółek są zgodne z teorią hierarchii finansowania i teorią agencji. Oznacza to, że firmy wydobywcze polegają głównie na finansowaniu wewnętrznym, postrzegając dług przede wszystkim jako narzędzie dyscyplinujące menedżerów. Ze względu na zakres danych dostępnych w wykorzystanej bazie danych BACH, analiza nie obejmuje wszystkich krajów UE, nakreślając kierunek ewentualnych dalszych badań w tym obszarze obejmujących inne regiony. Zidentyfikowane podobieństwa w strukturze kapitału, wraz z wpływem różnych czynników, pogłębiają dotychczasową wiedzę z zakresu podejmowania decyzji finansowych przez firmy wydobywcze. Wyniki mogą się okazać przydatne dla decydentów i inwestorów działających w analizowanych krajach.

