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Capital Structure under Systemic Shocks: How COVID-19 Reshaped SME Financing

Estructura de capital ante shocks sistémicos: cómo la COVID-19 reconfiguró la financiación de la PYME

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ABSTRACT

This study examines how the COVID-19 crisis reshaped the determinants of capital structure among Portuguese industrial small and medium-sized enterprises (SMEs). Using firm-level and macroeconomic data from 7,006 SMEs over 2016–2023, we estimated a fixed-effects panel model with robust standard errors. Before the pandemic, profitability, liquidity, and maturity were negatively associated with leverage, whereas size and asset tangibility increased debt financing, broadly supporting Pecking Order Theory. The findings show that the pandemic reshaped the determinants of SME financing rather than aggregate debt levels, revealing an adaptive response to systemic uncertainty. The study extends capital structure research in bank-based economies and provides implications for financial and regulatory policies supporting SMEs during systemic crises.

Keywords: Capital structure; SME financing; Financial constraints; Pecking Order Theory; Systemic shocks

JEL Code: G32, L25

RESUMEN

Este estudio analiza cómo la crisis de la COVID-19 reconfiguró los determinantes de la estructura de capital de las pequeñas y medianas empresas (pymes) industriales portuguesas. A partir de datos a nivel de empresa y macroeconómicos de 7.006 pymes correspondientes al periodo 2016-2023, se estimó un modelo de datos de panel de efectos fijos con errores estándar robustos. Antes de la pandemia, la rentabilidad, la liquidez y el vencimiento de la deuda presentaban una relación negativa con el apalancamiento, mientras que el tamaño y la tangibilidad de los activos favorecían la financiación mediante deuda, lo que respaldaba, en líneas generales, la teoría de la jerarquía financiera (*Pecking Order Theory*). Los resultados indican que la pandemia transformó los determinantes de la financiación de las pymes más que los niveles agregados de deuda, lo que evidencia una respuesta adaptativa ante la incertidumbre sistémica. El estudio amplía la investigación sobre la estructura de capital en economías basadas en la financiación bancaria y ofrece implicaciones para las políticas financieras y regulatorias de apoyo a las pymes durante crisis sistémicas.

Palabras clave: Estructura de capital; Financiación de la PYME; Restricciones financieras; Teoría de la jerarquía financiera; Choques sistémicos

Código JEL: G32, L25.

INTRODUCTION

Capital structure is a central theme in corporate finance, influencing a company's financial performance, risk profile, and long-term sustainability (Esposito et al., 2026; Jain et al., 2024; Modigliani & Miller, 1958; Nguyen, 2023). It reflects the mix of equity and debt used to finance business activities and shapes decisions related to investment, growth, and financial stability (Fedorova et al., 2024; Myers & Majluf, 1984; Vo et al., 2022). While debt-free firms may be financially sound, they may also underutilize growth opportunities. Conversely, excessive leverage increases the risk of distress and potential bankruptcy (Anh et al., 2023; Kraus & Litzenberger, 1973), making the search for an optimal capital structure an enduring issue in financial research. The literature has extensively studied several determinants, notably profitability, size, asset tangibility, liquidity, and firm age. However, findings remain inconsistent across studies, suggesting context-specific dynamics related to industry, geography, and macroeconomic conditions (Lisboa, 2019; Neves et al., 2020).

Among these contextual factors, the economic cycle plays a key role in influencing firms' access to capital and debt strategies (Duguleană et al., 2024). In boom periods, credit access and risk appetite tend to increase, whereas recessions restrict financing and raise borrowing costs (Jordà et al., 2011). Recent global disruptions, especially the COVID-19 pandemic, further amplified these dynamics. The pandemic created unprecedented economic uncertainty, disrupted operations, weakened cash flows, and intensified financial vulnerability, particularly among SMEs (Yang, 2022). Given their limited capacity to absorb shocks, SMEs in countries like Portugal were disproportionately affected, raising concerns over their financial resilience (Palminha et al., 2027; Matias & Serrasqueiro, 2017; Mota & Moreira, 2017).

This study investigates how the COVID-19 pandemic reshaped the determinants of capital structure in Portuguese industrial SMEs. Focusing on sectors under CAE codes 10 to 32, the analysis compares the pre-pandemic (2016–2019), COVID-19, and post-COVID (2020–2023) periods. In contrast to earlier studies, this research incorporates macroeconomic indicators –such as inflation, interest rates, and local unemployment growth– into the analysis, offering a broader understanding of external influences. Portugal is a good institutional setting for this research. The country has evidenced a strong recovery after the European sovereign-debt crisis, and the industrial landscape is heavily populated by SMEs. Additionally, Portugal is a bank-based economy, meaning that the findings may provide relevant insights for comparable bank-based Southern European economies.

By bridging firm-level and macro-level perspectives, the study aims to contribute new insights into how crises affect capital structure decisions in SMEs. Specifically, it seeks to answer the following questions:

i) What are the key determinants of capital structure among Portuguese industrial SMEs?

ii) How did the COVID-19 pandemic alter the influence of these determinants?

This study contributes to capital structure literature in three main ways. First, theoretically, it extends the Pecking Order and Trade-Off frameworks by showing how systemic crises can alter the relative importance of firm-specific and macroeconomic determinants of SME financing decisions in a bank-based economy. Second, empirically, the study provides evidence from a balanced panel of 7,006 Portuguese industrial SMEs between 2016 and 2023, distinguishing between pre- and COVID-19 and post-COVID periods and between short- and long-term debt structures. The findings demonstrate that the COVID-19 crisis affected financing behavior and debt maturity choices more than overall leverage levels, while also increasing the relevance of macroeconomic conditions such as inflation, interest rates, and unemployment. Third, in terms of policy and managerial relevance, the results highlight the importance of financial flexibility, debt maturity management, and targeted public support mechanisms in strengthening SME resilience during periods of economic uncertainty.

The article proceeds as follows: Section 2 presents a literature review covering capital structure theories, the pandemic's economic effects, and key determinants. Section 3 describes the data, variables, and econometric model. Section 4 reports and discusses the results, and Section 5 concludes with implications, limitations, and suggestions for future research.

LITERATURE REVIEW

Capital structure theories

Modigliani and Miller (1958) established the foundational theory of capital structure, arguing that under perfect market conditions –without taxes, transaction costs, or asymmetries – capital structure has no impact on firm value. However, this framework was soon revised (Modigliani & Miller, 1963) to incorporate the tax shield benefit of debt, suggesting that leveraged firms enjoy a lower effective cost of capital. Miller (1977) further refined the view, noting that personal and corporate taxation could offset these benefits.

Myers (1977) introduced financial flexibility as a key consideration, explaining why firms do not maximize debt usage despite tax advantages. Firms with high investment potential may avoid excessive leverage to retain agility. The Trade-Off Theory (Kraus & Litzenberger, 1973) balances tax advantages against bankruptcy risks. In contrast, the Pecking Order

Theory (Myers & Majluf, 1984) emphasizes information asymmetry: firms prefer internal funding, resort to debt if necessary, and avoid equity to prevent negative market signaling.

Jensen and Meckling (1976) introduced agency theory to explain how conflicts between managers, shareholders, and creditors create costs that influence capital structure. High debt levels may incentivize risk-taking by shareholders, while also constraining managerial discretion. Jensen (1986) later argued that debt can act as a disciplining mechanism, promoting more efficient resource use. Although no theory fully explains capital structure choices, these perspectives underscore the relevance of internal firm dynamics (Jain et al., 2024).

The impact of COVID-19 on capital structure

Macroeconomic shocks like the COVID-19 pandemic substantially alter firm financing behavior. Crises elevate default risk and constrain credit supply, reinforcing conservative financial strategies. During such periods, firms tend to align with the Pecking Order Theory, prioritizing internal financing and liquidity preservation (Alhajjeah & Besim, 2024; Gao & Tsusaka, 2023).

Unlike the 2008 financial crisis, COVID-19 originated outside financial markets, yet its impact on capital structure was significant and multifaceted. Revenue losses and heightened uncertainty led many firms, especially SMEs, to reduce leverage or shift toward short-term debt (Deviyanti et al., 2023; Fedorova et al., 2024; Palminha et al., 2027). Some adopted proactive refinancing strategies, converting short-term liabilities into longer-term obligations to preserve liquidity (Shukla et al., 2024; Ahmed et al., 2024).

Responses varied by firm characteristics. Larger firms tended to deleverage more aggressively, while asset tangibility influenced long-term borrowing more than short-term (Jain et al., 2024; Vo et al., 2022). Over time, many firms revised earlier responses as markets stabilized, highlighting the need to examine both immediate and long-term effects of such crises.

For the purpose of this analysis, the study period is segmented into two distinct time intervals: the pre-pandemic period (2016–2019) and the post-pandemic period (2020–2023). The year 2020 is considered a turning point, as the first signs of an emerging global pandemic appeared in the early weeks of that year, culminating in the World Health Organization's official declaration of a pandemic on March 11, 2020.

Based on these findings from the literature, the following research hypothesis is formulated: *H1: The effect of the determinants on leverage levels changed in the COVID-19 and post-COVID period compared to the pre-pandemic period.*

Firm-specific determinants

Empirical research has identified several internal firm characteristics as key determinants of capital structure. Among these, profitability, size, asset tangibility, liquidity, and firm age are frequently studied.

Profitability

Most studies, especially on Portuguese SMEs, support a negative relationship between profitability and leverage, consistent with the Pecking Order Theory. Profitable firms prefer to use retained earnings rather than incur debt, thus preserving control and minimizing financial risk (Boumlik et al., 2025; Matias & Serrasqueiro, 2017; Nassim et al., 2025; Neves et al., 2020; Oliveira et al., 2026). However, some evidence shows profitability may be statistically insignificant under certain conditions (Lisboa, 2019; Neves et al., 2024), suggesting that context matters. Given the predominance of empirical evidence supporting the Pecking Order theory, the following hypothesis is proposed:

H2: Profitability is negatively related to the level of indebtedness.

Firm Size

Larger firms generally enjoy better credit access, lower information asymmetries, and higher credibility, encouraging greater use of debt—particularly long-term (Neves et al., 2020). This is consistent with both the Trade-Off and Pecking Order theories. However, some studies show a negative or insignificant relationship, especially for short-term debt (Lisboa, 2019), suggesting that larger firms may rely more on internal cash flows or face sector-specific dynamics.

In the empirical part of this study, in addition to considering total debt as the dependent variable, the hypothesis that the determinants may have different effects on short- and long-term debt will also be tested. Since the positive relationship is more prevalent among Portuguese SMEs, the following hypothesis is proposed:

H3: Firm size is positively related to the level of indebtedness.

Tangible assets serve as collateral, reducing creditor risk and enhancing debt capacity. Empirical evidence often shows a positive association between tangibility and long-term debt (Matias & Serrasqueiro, 2017; Neves et al., 2024), though some studies report a negative or insignificant effect, particularly for short-term debt (Singh et al., 2025). This may reflect creditor reluctance to accept fixed assets as short-term security (Psillaki & Daskalakis, 2009). The predominance of empirical evidence supporting the Trade-Off and Pecking Order theories leads to the formulation of the following hypothesis:

H4: Asset tangibility is positively related to the level of indebtedness.

Liquidity

Firms with high liquidity are less dependent on external financing, aligning with the Pecking Order Theory. While some research shows a clear negative correlation (Lisboa, 2017a), other studies – particularly those using Portuguese data – find mixed or insignificant results (Pacheco & Tavares, 2017). Notably, firms may maintain liquidity buffers while still using long-term debt for strategic investments (Lisboa, 2019). Thus, the following hypothesis is proposed:

H5: A company's liquidity is negatively related to the level of indebtedness.

Age

Older firms generally exhibit stronger reputations, internal reserves, and creditworthiness, which may reduce their reliance on debt. Several studies show that older firms assume more debt (e.g., Hovakimian et al., 2001; Sundaresan et al., 2015). For instance, Kieschnick and Moussawi (2018) find that the effects of firm age on how much debt a firm uses are primarily due to the interaction between firm age and its governance characteristics. However, empirical studies on Portuguese SMEs consistently show a negative relationship between firm age and total or short-term debt (Matias & Serrasqueiro, 2017; Serrasqueiro & Nunes, 2012), supporting conservative financial behavior as firms mature. Thus, the following hypothesis is proposed:

H6: A company's age is negatively related to the level of indebtedness.

Macroeconomic determinants

While firm-specific factors dominate most models, macroeconomic conditions significantly influence the availability and cost of financing. Variables such as inflation, interest rates, and unemployment shape firm behavior, especially during crises.

Inflation

The theoretical relationship between inflation and debt is ambiguous. On one hand, inflation may encourage borrowing by reducing the real cost of debt (Trade-Off Theory); on the other, it can signal instability and lead to deleveraging. Empirical findings are mixed: while some support a positive link (Frank & Goyal, 2009), others report negative or insignificant effects (Jõeveer, 2013; Neves et al., 2020). For Portuguese SMEs, inflation has generally been found to discourage long-term debt, possibly due to risk aversion and market volatility. Still, formulating the hypothesis in line with the Trade-Off and Pecking Order theories, we propose:

H7: Inflation is positively related to the level of indebtedness.

Interest Rates

Higher interest rates increase the cost of borrowing and tend to reduce leverage, aligning with the Trade-Off Theory. Studies show a negative correlation between interest rates and debt

levels (Hatzinikolaou et al., 2002; Ramli et al., 2019). However, the relationship may vary with credit availability and economic outlook. For example, some firms may still take on debt in high-rate environments if future growth expectations are strong (Savvakis et al., 2021). Following the prediction of the Trade-Off theory, the following hypothesis is formulated:
H8: Interest rates are negatively related to the level of indebtedness.

Unemployment
Though less commonly studied, unemployment influences corporate risk assessments and investment strategies. Rising unemployment can signal economic deterioration, reducing firms' willingness to borrow. Some studies suggest a negative correlation between unemployment and leverage (Vega-Gutierrez et al., 2021), while others find no clear pattern. Importantly, this study uses municipal-level unemployment data to capture regional differences, providing a more granular understanding of localized credit conditions. Based on the evidence presented, the following research hypothesis is formulated:
H9: Unemployment is negatively related to the level of indebtedness.

All these hypotheses will also be studied in terms of whether the COVID-19 pandemic strengthened or weakened the influence of the different variables on leverage.

METHODOLOGY

Variables, data and sample
This study investigates how the determinants of capital structure in Portuguese industrial SMEs evolved during the COVID-19 period. The dependent variable is total indebtedness, calculated as the ratio of total liabilities to total assets (here referred to as TD). To distinguish debt profiles, long-term debt (non-current liabilities to total assets) and short-term debt (current liabilities to total assets) are also analyzed, defined as LTD and STD, respectively.

Independent variables fall into two categories: firm-specific determinants (profitability, size, tangibility, liquidity, and age) and macroeconomic indicators (inflation, interest rates, and municipal unemployment growth). These variables correspond to hypotheses derived from prior literature and are summarized in Table 1.

Table 1
Independent Variables

Hipothesis	Acronym	Independent variable	Formula	Expected sign
H2	PRO	Profitability	$\frac{\text{EBIT}}{\text{Total Asssets}}$	–
H3	SIZ	Size	Ln (Total Assets)	+
H4	TANG	Tangibility	$\frac{\text{Tangible Fixed Assets}}{\text{Total Assets}}$	+
H5	LIQ	Liquidity	$\frac{\text{Current Assets}}{\text{Current Liabilities}}$	–
H6	AGE	Age	Ln (Year – Year of Foundation)	–
H7	INF	Inflation	Inflation rate	+
H8	IR	Interest rates	Interest rate for new loan operations	–
H9	UNE	Growth in the municipality registered unemployment	$\frac{\Delta \text{ Registered unemployment in the Municipality}}{\text{Registered unemployment in the Municipality}}$	–

Source: Own elaboration.

Table 2
Distribution of firms by CAE

CAE	DESCRIPTION	N	%
10	Food	712	10.2%
11	Beverages	161	2.3%
12	Tobacco	0	0.0%
13	Textiles	461	6.6%
14	Wearing apparel	808	11.5%
15	Leather and related products	415	5.9%
16	Wood and products of wood and cork	381	5.4%
17	Paper and paper products	123	1.8%
18	Printing and reproduction of recorded media	213	3.0%
19	Refined petroleum	5	0.1%
20	Chemicals and man-made fibers	151	2.2%
21	Pharmaceutical products	26	0.4%
22	Rubber and plastic products	350	5.0%
23	Other non-metallic mineral products	510	7.3%
24	Basic metals	65	0.9%
25	Fabricated metal products	1328	19.0%
26	Computer, communication and electronic equip.	45	0.6%
27	Electrical equipment	122	1.7%
28	Machinery and equipment	357	5.1%
29	Motor vehicles, trailers and parts	108	1.5%
30	Other transport equipment	33	0.5%
31	Furniture	470	6.7%
32	Other manufacturing activities	162	2.3%
	Total	7,006	100%

Source: Own elaboration.

The analysis covers 2016–2023. The final sample includes 7,006 active SMEs in mainland Portugal, operating in industrial sectors under CAE codes 10 to 32. Table 2 presents the distribution of firms by CAE. Firms were selected from the ORBIS database and met the

EU's SME criteria. We retained only firms with consistently positive values for key financial indicators across the period, resulting in a balanced panel of 56,048 observations. Macroeconomic variables were sourced from PORDATA and the Bank of Portugal, matched to firms by their municipality.

To assess the relationship between capital structure and its determinants, panel data models were estimated for total, long-term, and short-term debt. The models include both firm-level and macroeconomic variables and were estimated using a Fixed Effects Model (FEM) based on F, Breusch-Pagan, and Hausman tests. Robust standard errors (HAC) were used due to evidence of heteroscedasticity and autocorrelation. Accordingly, three regressions were estimated, one for each dependent variable. These variables include total debt ($TD_{i,t}$), long-term debt ($LTD_{i,t}$) and short-term debt ($STD_{i,t}$), with the following base specification:

$$TD_{i,t} = \beta_1 + \beta_2 PRO_{i,t} + \beta_3 SIZ_{i,t} + \beta_4 TANG_{i,t} + \beta_5 LIQ_{i,t} + \beta_6 AGE_{i,t} + \beta_7 INF_{i,t} + \beta_8 IR_{i,t} + \beta_9 UNE_{i,t} + \varepsilon_{i,t} \quad (1)$$

where independent variables are profitability ($PRO_{i,t}$), size ($SIZ_{i,t}$), tangibility ($TANG_{i,t}$), liquidity ($LIQ_{i,t}$), age ($AGE_{i,t}$), inflation ($INF_{i,t}$), interest rate ($IR_{i,t}$), and the growth in the municipality's unemployment ($UNE_{i,t}$). i represents individual firms, t is the year in the analysis, β corresponds to the estimated coefficients, and $\varepsilon_{i,t}$ is the idiosyncratic error, which changes between firms and during the period.

Separate regressions were conducted for pre-pandemic (2016–2019) and COVID-19 and post-COVID (2020–2023) periods to compare structural changes. A dummy variable was introduced in the full-period model to isolate the COVID-19 context. Additional diagnostics included Pearson correlation matrices, variance inflation factors (VIFs), the Modified Wald test, and the Wooldridge test to ensure statistical validity. All analyses were performed using STATA 18.5.

RESULTS

Descriptive statistics

Table 3 presents summary statistics for the dependent and independent variables across the full sample and the pre- and COVID-19 and post-COVID subperiods. On average, total debt across firms was 53.76%, with a decrease from 55.12% pre-pandemic to 52.40% COVID-19 and post-COVID. While long-term debt slightly increased (17.02% to 17.86%), short-term debt declined more notably (38.10% to 34.54%), suggesting a shift toward longer-term financing.

Table 3
Descriptive Statistics

Variable	Period	Average	s.d.	Minimum	Maximum
	Pre-Pandemic	0.55120	0.21754	0.01014	0.99971
TD	COVID-19 and post-COVID	0.52400	0.22168	0.00598	0.99994
	Total	0.53760	0.22004	0.00598	0.99994
	Pre-Pandemic	0.17019	0.16913	0.00000	0.99493
LTD	COVID-19 and post-COVID	0.17860	0.16733	0.00000	0.91414
	Total	0.17439	0.16828	0.00000	0.99493
	Pre-Pandemic	0.38102	0.19266	0.00050	0.99971
STD	COVID-19 and post-COVID	0.34540	0.17872	0.00020	0.99668
	Total	0.36321	0.18667	0.00020	0.99971
	Pre-Pandemic	0.06620	0.09521	-6.02505	1.18606
PRO	COVID-19 and post-COVID	0.05793	0.09126	-0.99151	0.83671
	Total	0.06206	0.09335	-6.02505	1.18606
	Pre-Pandemic	7.37636	1.31191	0.95618	11.90141
SIZ	COVID-19 and post-COVID	7.68060	1.28104	3.56370	11.46195
	Total	7.52848	1.30544	0.95618	11.90141
	Pre-Pandemic	0.30520	0.20077	0.00000	0.99737
TANG	COVID-19 and post-COVID	0.30163	0.19511	0.00000	0.99360
	Total	0.30342	0.19797	0.00000	0.99737
	Pre-Pandemic	2.51781	6.05431	0.01121	733.0018
LIQ	COVID-19 and post-COVID	2.74262	3.52458	0.05330	286.8400
	Total	2.63022	4.95488	0.01121	733.0018
	Pre-Pandemic	2.92750	0.77951	0.00000	5.71703
AGE	COVID-19 and post-COVID	3.17110	0.58485	1.60944	5.73010
	Total	3.04930	0.69976	0.00000	5.73010
	Pre-Pandemic	0.00825	0.00415	0.00300	0.01400
INF	COVID-19 and post-COVID	0.03350	0.03005	0.00000	0.07800
	Total	0.02088	0.02489	0.00000	0.07800
	Pre-Pandemic	0.02634	0.00352	0.02236	0.03159
IR	COVID-19 and post-COVID	0.02978	0.01386	0.01977	0.05338
	Total	0.02806	0.01025	0.01977	0.05338
	Pre-Pandemic	-0.14140	0.06974	-0.36175	0.34159
UNE	COVID-19 and post-COVID	0.01456	0.18207	-0.46572	1.48695
	Total	-0.06342	0.15839	-0.46572	1.48695

Notes: Variables are total debt (TD), long-term debt (LTD), short-term debt (STD), profitability (PRO), size (SIZ), tangibility (TANG), liquidity (LIQ), age (AGE), inflation (INF), interest rate (IR), and the growth in the municipality's unemployment (UNE). Pre-Pandemic and COVID-19 and post-COVID periods correspond, respectively, to 2016-2019 and 2020-2023.
Source: Own Elaboration.

Firms averaged 21 years of age. Profitability dropped from 6.62% to 5.79%, while liquidity slightly declined. Asset tangibility and size remained relatively stable. Macroeconomic indicators varied considerably: inflation nearly tripled in the COVID-19 and post-COVID period, and municipal unemployment growth more than doubled, reflecting broader economic disruption.

Table 4 presents the correlation matrix for the total sample. The correlation coefficients between the variables are generally low. The strongest associations appear between INF and COV_dum (r = 0.5072) and between UNE and COV_dum (r = 0.4923); both remain below the threshold of concern.

Table 4
Person correlation matrix

	PRO	SIZ	TANG	LIQ	AGE	INF	IR	UNE	COV_dum
PRO	1.0000								
SIZ	0.0381 (***)	1.0000							
TANG	-0.1503 (***)	0.1152 (***)	1.0000						
LIQ	0.0497 (***)	0.0039	-0.1418 (***)	1.0000					
AGE	0.0841 (***)	0.3392 (***)	0.0320 (***)	0.0543 (***)	1.0000				
INF	0.0246 (***)	0.0867 (***)	0.0116 (***)	0.0058	0.1208 (***)	1.0000			
IR	0.0301 (***)	0.0346 (***)	0.0028	0.0055	0.0540 (***)	0.3801 (***)	1.0000		
UNE	-0.0707 (***)	0.0454 (***)	0.0093 (**)	0.0166 (***)	0.0660 (***)	-0.2554 (***)	0.0617 (***)	1.0000	
COV_dum	-0.0443 (***)	0.1165 (***)	-0.0090 (**)	0.0227 (***)	0.1741 (***)	0.5072 (***)	0.1680 (***)	0.4923 (***)	1.0000

Notes: ***p < 0.01; **p < 0.05; *p < 0.1 Variables are total debt (TD), long-term debt (LTD), short-term debt (STD), profitability (PRO), size (SIZ), tangibility (TANG), liquidity (LIQ), age (AGE), inflation (INF), interest rate (IR), and the growth in the municipality's unemployment (UNE). Pre-Pandemic and Post-Covid periods correspond, respectively, to 2016-2019 and 2020-2023
Source: Own elaboration.

Although those values are not presented, comparing the correlation matrices between the independent variables for the pre-Pandemic, COVID-19, and post-COVID subperiods reveals relevant changes in the correlations. There is a strengthening in the COVID-19 and post-COVID period of the negative association between INF and UNE (r = -0.6992), as well as an increase in the correlation between IR and INF (r = 0.3551), which may reflect an intensification of the relationship between financial conditions and overall economic sentiment during this period.

To assess possible signs of multicollinearity, the VIF results indicate that, in all periods considered – pre-Pandemic, COVID-19 and post-COVID, and the total period – the values remain well within the limits normally accepted in the literature (i.e., below 5), showing no evidence of collinearity among the independent variables (Gujarati, 2003; Shrestha, 2020). The average VIF values also remain low across the three periods, ranging between 1.23 and 1.75.

Econometric results and discussion

Consistently, the Breusch-Pagan, F, and Hausman tests supported the choice of the fixed effects model (FEM) as the most appropriate for all specifications. Similar procedures were applied to the long-term and short-term debt variables, with the respective tests corroborating the same pattern of results, reinforcing the robustness of choosing the FEM for all dimensions of indebtedness analyzed. The model was estimated with clustered robust standard errors (HAC). This choice was due to detected heteroscedasticity and autocorrelation in the error components, as evidenced by the Modified Wald and Wooldridge tests.

Table 5 presents the estimated coefficients, along with their respective levels of statistical significance and robust standard deviations. Below we contextualize the findings across three dimensions: firm-specific determinants, macroeconomic factors, and the impact of the COVID-19 pandemic.

Firm-Specific Determinants

Consistent with the Pecking Order Theory and prior research on Portuguese SMEs (Matias & Serrasqueiro, 2017), profitability showed a consistent negative effect on all forms of debt. More profitable firms rely on internal resources, minimizing financial risk. Supporting the Pecking Order Theory, these results also support hypothesis H2.

Firm size was positively associated with leverage, particularly long-term debt, supporting the Trade-Off Theory. Larger firms benefit from greater access to credit markets and economies of scale in borrowing (Lisboa, 2017b; Pacheco, 2016; Pacheco & Carvalho, 2026), providing empirical support for H3. However, the coefficient is smaller in the COVID-19 and post-COVID period, possibly reflecting heightened credit selectivity and risk aversion.

Asset tangibility influenced capital structure as expected: positively related to long-term debt (due to collateral value) and negatively associated with short-term debt. These findings reinforce the view that tangible assets provide borrowing capacity in long-term arrangements but may be ill-suited for short-term collateralization. This result on tangibility aligns with existing literature, particularly studies by Lisboa (2019), Matias & Serrasqueiro (2017), and Neves et al. (2020), and supports hypothesis H4.

The relationship between liquidity and capital structure is ambiguous, so H5 is not fully supported. While no significant link was found between liquidity and total debt – echoing prior studies (Lisboa, 2019; Pacheco & Tavares, 2017) – maturity-level analysis reveals clearer patterns. Firms with greater liquidity tend to reduce short-term borrowing, consistent with conservative cash management, yet exhibit higher long-term debt. This suggests a strategic use of liquidity: avoiding short-term constraints while leveraging strong financial

positions to secure favorable long-term financing. These findings reflect both the Pecking Order theory (internal financing preference) and the Trade-Off theory (balancing debt benefits and costs).

Firm age was negatively associated with all debt lengths, supporting the idea that older firms favor more stable, conservative financial structures and confirming H6. Their longer credit histories and internal funds reduce dependency on short-term borrowing (Serrasqueiro & Nunes, 2012).

Table 5
Fixed Effects Model with robust standard errors

		TD	STD	LTD
Variables	**Period**	Coefficient (s.d.)	Coefficient (s.d.)	Coefficient (s.d.)
Constant	Pre-Pandemic	0.08182 * (0.04562)	-0.27947 *** (0.04626)	0.36129 *** (0.05388)
	COVID-19 and post-COVID	0.30893 *** (0.05780)	-0.03647 (0.05885)	0.34540 *** (0.06424)
	Total	0.62723 *** (0.02908)	0.01073 (0.02522)	0.61650 *** (0.03096)
PRO	Pre-Pandemic	-0.27332 *** (0.05416)	-0.13137 *** (0.02877)	-0.14196 *** (0.02842)
	COVID-19 and post-COVID	-0.29434 *** (0.01098)	-0.16703 *** (0.01030)	-0.12731 (0.01100)
	Total	-0.30598 *** (0.03487)	-0.16506 *** (0.01754)	-0.14092 *** (0.01976)
SIZ	Pre-Pandemic	0.09312 *** (0.00552)	0.05957 *** (0.00564)	0.03355 *** (0.00635)
	COVID-19 and post-COVID	0.08757 *** (0.00608)	0.06671 *** (0.00506)	0.02086 *** (0.00594)
	Total	0.03999 *** (0.00396)	0.04285 *** (0.00355)	-0.00286 (0.00417)
TANG	Pre-Pandemic	0.06527 *** (0.01307)	0.24889 *** (0.01540)	-0.18362 *** (0.01590)
	COVID-19 and post-COVID	0.02318 * (0.01325)	0.19740 *** (0.01522)	-0.17422 *** (0.01912)
	Total	0.07425 *** (0.01191)	0.22199 *** (0.01085)	-0.14774 *** (0.01357)
LIQ	Pre-Pandemic	-0.00096 (0.00079)	0.00197 * (0.00105)	-0.00294 (0.00183)
	COVID-19 and post-COVID	-0.00529 ** (0.00225)	0.00450 * (0.00240)	-0.00979 ** (0.00464)
	Total	-0.00262 (0.00160)	0.00238 ** (0.00119)	-0.00500 * (0.00278)
AGE	Pre-Pandemic	-0.11151 *** (0.00820)	-0.04245 *** (0.00958)	-0.06905 *** (0.01062)
	COVID-19 and post-COVID	-0.12806 *** (0.01581)	-0.10147 *** (0.01667)	-0.02659 (0.01812)
	Total	-0.12294 *** (0.00659)	-0.06639 *** (0.00639)	-0.05655 *** (0.00689)
INF	Pre-Pandemic	0.58539 *** (0.12340)	0.18654 (0.16437)	0.39886 ** (0.17396)
	COVID-19 and post-COVID	-0.12416 *** (0.01946)	-0.18469 *** (0.02334)	0.06053 ** (0.02525)
	Total	-0.11141 *** (0.01977)	-0.21173 *** (0.02293)	0.10031 *** (0.02490)

IR	Pre-Pandemic	3.86055 *** (0.23121)	2.26368 *** (0.24821)	1.59687 *** (0.27814)
	COVID-19 and post-COVID	-0.75010 *** (0.05484)	-1.05833 *** (0.05777)	0.30823 *** (0.06178)
	Total	-0.43189 *** (0.03896)	-0.92583 *** (0.03903)	0.49394 *** (0.04325)
UNE	Pre-Pandemic	-0.02147 ** (0.01072)	-0.00792 (0.01203)	-0.01355 (0.01284)
	COVID-19 and post-COVID	-0.02495 *** (0.00381)	-0.00297 (0.00449)	-0.02198 *** (0.00485)
	Total	-0.03792 *** (0.00414)	-0.00725 * (0.00405)	-0.03067 *** (0.00460)
COV_dum	Pre-Pandemic	—	—	—
	COVID-19 and post-COVID	—	—	—
	Total	-0.00089 (0.00200)	0.02010 *** (0.00197)	-0.02099 *** (0.00216)
	Pre-pandemic	R^2 = 0.1949	R^2 = 0.0960	R^2 = 0.0675
		R^2 adj. = 0.1947	R^2 adj. = 0.0957	R^2 adj. = 0.0672
	COVID-19 and post-COVID	R^2 = 0.1891 R^2 adj. = 0.1889	R^2 = 0.1543 R^2 adj. = 0.1541	R^2 = 0.1012 R^2 adj. = 0.1009
	Total	R^2 = 0.1425 R^2 adj. = 0.1424	R^2 = 0.1047 R^2 adj. = 0.1046	R^2 = 0.0996 R^2 adj. = 0.0995

Notes: ***p < 0.01; **p < 0.05; *p < 0.1. Variables are total debt (TD), long-term debt (LTD), short-term debt (STD), profitability (PRO), size (SIZ), tangibility (TANG), liquidity (LIQ), age (AGE), inflation (INF), interest rate (IR), and the growth in the municipality's unemployment (UNE). Pre-Pandemic, COVID-19 and post-COVID periods correspond, respectively, to 2016-2019 and 2020-2023.
Source: Own elaboration.

Macroeconomic Determinants

Beyond internal characteristics, macroeconomic conditions significantly shape capital structure. A comparison between pre-Pandemic, COVID-19 and post-COVID estimates suggests that the relative importance of capital structure determinants differed across the two periods, consistent with the COVID-19 period being associated with changes in financing behavior. In the pre-pandemic period, leverage decisions were more strongly associated with traditional firm-specific characteristics, particularly size and tangibility, which reflected firms' access to collateral-based financing in a stable credit environment. In contrast, the COVID-19 and post-COVID results reveal a stronger influence of macroeconomic conditions, especially inflation, interest rates, and unemployment. This shift indicates that financing decisions became increasingly conditioned by external economic uncertainty and credit market conditions, reducing the explanatory power of conventional firm-level factors during the crisis period.

The findings reveal a consistent reduction in total debt during periods of high inflation, rising interest rates, and worsening unemployment. Specifically, the negative relationship between inflation and indebtedness leads to the rejection of hypothesis H7, contradicting predictions from the Trade-Off and Pecking Order theories, though consistent with prior studies (Bai &

Ho, 2022; Beck et al., 2008; Jõeveer, 2013; Neves et al., 2020). Inflation showed a mixed effect: reducing short-term borrowing while remaining positively associated with long-term debt, although the positive effect became substantially weaker in the COVID-19 and post-COVID period. Comparing between periods, it is interesting to observe a change in the coefficients' signs for the inflation and interest rate variables. The most notable sign reversal occurs for short-term debt, where the inflation coefficient changes from positive (and statistically insignificant) before the pandemic to significantly negative afterward. By contrast, the coefficient for long-term debt remains positive but declines substantially in magnitude.

Interest rates exhibit a strong negative effect on leverage, supporting hypothesis H8 and aligning with the Trade-Off theory: as borrowing costs increase, firms reduce debt use (Hatzinikolaou et al., 2002; Ramli et al., 2019). That negative relation is particularly relevant in the post-COVID-19 period. Higher unemployment is associated with lower debt levels, confirming hypothesis H9 and reflecting a cautious financial posture in response to labor market uncertainty (Vega-Gutierrez et al., 2021).

Short-term debt declines during inflationary periods, suggesting firms become more cautious about relying on short-term financing as inflation rises and economic uncertainty intensifies. Long-term debt, in contrast, remains positively associated with inflation, although the coefficient becomes substantially smaller in the COVID-19 and post-COVID period, indicating that inflation no longer provides the same incentive for longer-term borrowing observed before the pandemic. This attenuation likely reflects greater uncertainty about investment returns and future financing conditions, even though some studies (e.g., Muthama et al., 2013) suggest that firms may still pursue long-term financing under inflationary conditions. By comparison, rising interest rates and unemployment reduce short-term borrowing, supporting the view that firms avoid high-cost, short-term obligations in volatile environments.

Impact of the COVID-19 Pandemic

The inclusion of the COVID-19 dummy revealed no significant direct effect on overall debt levels. However, the comparison between pre-Pandemic, COVID-19, and post-COVID periods reveals changes in firms' capital structure decisions, providing evidence consistent with H1.

Using separate estimates for the pre-Pandemic (2016–2019) and COVID-19 and post-COVID (2020–2023) periods is intended to capture potential structural shifts in SME financing behavior associated with the COVID-19 shock. Rather than identifying only a direct level effect of the pandemic through the COVID dummy variable, the period-split approach allows the analysis to compare how the magnitude, direction, and statistical significance of the determinants evolved across different economic environments. This approach is particularly relevant in systemic crises, where changes in risk perception, credit

conditions, and financial constraints may alter the relative importance of firm-specific and macroeconomic drivers of capital structure decisions.

The coefficients in models with LTD and STD as dependent variables provide valuable insight into how firms responded to COVID-19. The significantly negative coefficient in the model with STD and the significantly positive coefficient in the model with LTD can be interpreted as an increase in debt maturity, a result in line with Palminha et al., 2027.

Notably, the negative relationship between profitability and indebtedness – particularly long-term debt – became more pronounced during COVID-19 and post-COVID, contrary to previous findings (Jain et al., 2024; Vo et al., 2022). This suggests a stronger preference for internal financing amid heightened uncertainty, aligning with the Pecking Order theory (Alhajjeah & Besim, 2024).

The estimated coefficients for asset tangibility and firm size are smaller in the COVID-19 and post-COVID period, reflecting reduced creditor reliance on physical collateral and possibly tighter lending criteria, especially in the Portuguese SME context (Ahmed et al., 2024; Gao & Tsusaka, 2023). Older firms further distanced themselves from debt, except in short-term financing, highlighting conservative financial behavior tempered by liquidity needs during crises.

A COVID-19 and post-COVID shift also emerged in how firms respond to macroeconomic conditions. Whereas pre-pandemic borrowing sometimes increased despite rising interest rates and inflation (Daskalakis et al., 2017; Mokhova & Zinecker, 2014), the crisis ushered in greater caution, consistent with the Trade-Off theory (Panda & Nanda, 2020). Inflation, once seen as a tool to erode real debt, is now perceived as a source of financial risk (Neves et al., 2020). Similarly, rising unemployment has become a stronger deterrent to short-term debt, indicating greater sensitivity to labor market signals and an effort to avoid workforce reductions (Agrawal & Matsa, 2013; Vega-Gutierrez et al., 2021).

Interestingly, the COVID-19 dummy lacked statistical significance, suggesting the pandemic's impact was not direct but mediated through shifts in firm behavior and risk perception. The different signs of the coefficient in the models with STD and LTD suggest a strategic move to stabilize financing and increase the debt maturity, likely facilitated by public support measures implemented in a scenario of high operational uncertainty (Alhajjeah & Besim, 2024; Palminha et al., 2027; Vo et al., 2022).

CONCLUSIONS

In a context of heightened economic uncertainty, this study examined how the COVID-19 pandemic influenced the determinants of capital structure among Portuguese industrial SMEs (2016–2023). Using panel data for 7,006 firms and a fixed effects model, the analysis incorporated firm-specific (profitability, size, tangibility, liquidity, age) and macroeconomic variables (inflation, interest rates, unemployment).

The results show that profitable, mature, and liquid firms tend to avoid debt, while larger and more asset-heavy firms are more likely to borrow, particularly long-term. However, macroeconomic instability led to overall deleveraging. Comparing the pre-Pandemic, COVID-19, and post-COVID estimates, macroeconomic variables appear more influential in the later period, suggesting a shift toward more risk-averse financing behavior. While the COVID-19 dummy was not statistically significant, segmented analysis revealed changes in capital structure dynamics, namely, a slight rise in long-term and a decline in short-term debt, likely linked to public support measures and precautionary strategies. These findings reaffirm the relevance of Pecking Order and Trade-Off theories, especially when adapted to crisis contexts.

The results highlight the importance of financial flexibility for SMEs operating in bank-based economies, where access to external finance depends heavily on credit conditions. The stronger negative relationship between profitability and leverage in the COVID-19 and post-COVID period suggests that firms with greater internal funding capacity were better able to cope with uncertainty. From a managerial perspective, this underscores the need to prioritize retained earnings, liquidity buffers, and prudent cash-flow management as key elements of financial resilience.

The shift from short-term to long-term debt, despite relatively stable overall leverage, highlights the strategic importance of debt maturity management. In a bank-centered financial system, extending debt maturities can reduce refinancing risk and vulnerability to sudden tightening in credit supply. SME managers should therefore focus not only on the level of indebtedness but also on its maturity structure, aligning financing decisions with investment horizons and expected cash flows.

The weakened role of asset tangibility and firm size during the COVID-19 and post-COVID period suggests that traditional collateral-based lending became less decisive during systemic shocks. This implies that SMEs should not rely exclusively on physical assets to secure bank financing in crisis contexts, but instead strengthen financial transparency, operating performance, and long-term banking relationships as alternative signals of creditworthiness.

From a policy perspective, the heightened influence of macroeconomic variables indicates that inflation, interest rates, and labor market conditions significantly affect SME leverage decisions in bank-based economies. Policy measures implemented during the pandemic appear to have supported financing stability by facilitating longer debt maturities rather than increasing overall indebtedness. Future interventions should continue to focus on maturity extension and risk mitigation mechanisms, such as credit guarantees, to enhance SME resilience during periods of economic stress.

Limitations include the exclusive use of quantitative accounting data and a broad COVID-19 and post-COVID period definition that may overlook temporal nuances. Future research could expand into other sectors and explore the role of public policy in financial resilience. In addition, the balanced-panel structure of the sample implies that only firms continuously observed throughout the 2016–2023 period were retained. This may introduce potential survivorship or selection effects, as SMEs that exited the market during the crisis are not represented in the analysis. Consequently, the findings may better reflect the financing behavior of relatively more resilient firms, limiting the generalizability of the results under severe crisis conditions. In sum, the study provides evidence of SMEs' ability to strategically adjust their capital structures in response to shocks, reflecting not only financial constraints but also deliberate resilience strategies.

Conflict of Interest Statement

The authors declare no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethics Statement

This study did not involve human participants or animals, and therefore ethical approval was not required.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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