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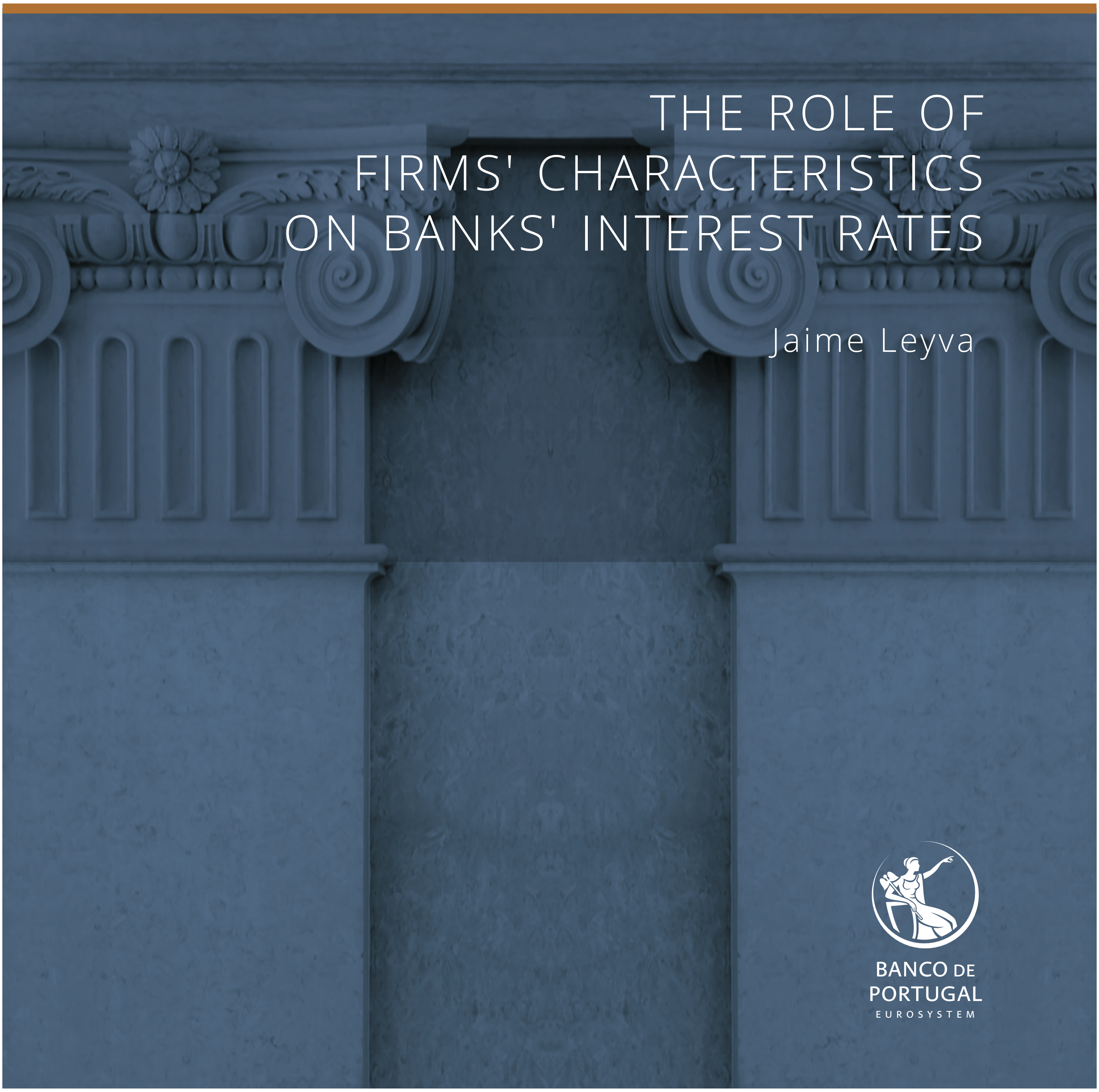

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The analyses, opinions and findings of these papers represent the views of the authors, they are not necessarily those of the Banco de Portugal or the Eurosystem.

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The role of firms' characteristics on banks' interest rates

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Abstract
This article investigates the importance of firms' characteristics in determining loan pricing by banks, both in the cross-section and over time in Portugal. A particular emphasis is placed on three financial aspects of firms: indebtedness, liquidity, and profitability. On average, the interest rate charged on new loans tends to increase with the level of firm indebtedness and decrease as liquidity and profitability rise. For micro and small firms, banks are more reactive to their leverage and less reactive to their measures of liquidity and profitability compared to medium-sized firms. For big firms, banks' loan pricing does not react to changes in their leverage or liquidity. however changes in their profitability have a stronger impact. Regarding firms' age, it is observed that throughout a firm's life cycle, banks' loan pricing places greater emphasis on the level of debt for younger firms, shifting focus to profitability as firms mature. Additionally, the study demonstrates that the sensitivity of banks' pricing to firms' financial conditions changes over time and depends on the macroeconomic and financial environment. During periods of high uncertainty or tight financial conditions, banks tend to be stricter in pricing firm leverage, resulting in higher interest rates compared to more stable periods. Banks become more attentive to firms' liquidity in times of tight financial conditions. Furthermore, during periods of lower economic growth, banks show increased sensitivity to firm profitability, whereas in environments of high interest rates, this sensitivity is reduced.

JEL: E43, E44, G21, G32

Keywords: Bank lending, loan pricing, firms' financial conditions, state-dependent pricing.

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1. Introduction

Loan pricing by banks takes into account various factors, including characteristics of the loan, the borrower, and the bank, as well as the macroeconomic and financial environment. When considering the borrower's profile, high-risk borrowers should be offered higher interest rates compared to those with lower risk. To evaluate firms' riskiness, banks need to look into different dimensions of firms, including structural characteristics, that which could ultimately depend on firm industry and/or size, and also to analyse firms' financial standing. Firms may face financial distress for a variety of reasons. For instance, a firm could be experiencing liquidity problems, without being insolvent or unprofitable. This study explores whether banks differentiate among various financial aspects of firms when pricing loans. Additionally, it investigates whether banks pricing of firms' financial characteristics is time-varying and influenced by the macroeconomic and financial environment.

The goal of this article is to assess the importance of firms' characteristics in determining loan pricing by banks, both in the cross-section and over time in Portugal. A special focus is given to three firms' financial aspects: indebtedness, liquidity and profitability. The main argument of the paper is to demonstrate that, although changes in these factors could classify a firm as high-risk or low-risk, banks do not uniformly price the diverse financial characteristics of firms. More importantly, the specific pricing of each financial aspect becomes more apparent when examining how the sensitivity of loan pricing to firms' financial conditions varies over time.

The interest rate charged on new loans is higher with the level of firm's indebtedness (leverage: financial debt over assets), and lower when liquidity (cash + deposits over assets) and profitability (EBITDA over assets) rises. Moreover, on average banks' pricing appears to respond more significantly to changes in liquidity than to changes in leverage or profitability. Our results are robust to including bank*time, industry*time fixed effects, increasing the control variables with firm age and the number of bank relationships, or using a spread as the dependent variable instead of interest rates in levels. Importantly, the coefficients for the firms' financial aspects remain stable across all specifications.

The pricing of firms' financial characteristics is also studied depending on firms' size, age and the number of bank relationships. In order to study, the heterogeneous effect depending on firm size, separate regression are run for micro, small, medium and large firms. For micro and small firms, banks are more reactive to their leverage and less reactive to their measures of liquidity and profitability compared to medium-sized firms. For medium-sized firms, there is a negative relationship between the charged interest rate and leverage. It seems that higher leverage for medium-sized firm is related to growing firm and better economic perspectives in the future, decreasing the charged interest rate. Interestingly, for the large firms in our sample, banks do not react to changes in leverage or liquidity. However, the influence of firm profitability on pricing is more significant compared to micro, small, and medium-sized firms. Those findings suggests that as firms grow, loan pricing becomes more closely tied to economic performance (profitability) rather than purely financial variables such as leverage and liquidity.

Regarding firms' age, it appears that throughout a firm's life cycle, banks' loan pricing place greater emphasis on the level of debt for younger firms, rather than on their profitability. As the firm ages, leverage becomes less relevant in loan pricing, while the importance of profitability grows. Finally, firms with few bank lending relationships are charged a higher interest rate regarding their leverage compared to firms with a high number of bank relationships.

Subsequently using the estimated model, the 6-month change in the average interest rate is analyzed, attributing it to various factors, including characteristics of firms, loans, and banks, common macroeconomic shocks, and a sample compositional factor. The common macroeconomic shock stands out as the primary driver of average interest rate changes, significantly contributing to the decrease in rates from 2013 to 2017 and leading the increase from June 2022 to mid-2023. The bank component was vital in explaining the reduction in the average interest rate until 2020, primarily due to a decrease in banks' implicit funding costs, thus enabling lower rates for firms. Starting from January 2023, the bank component has been instrumental in driving up rates, indicating the delayed effect of ECB policy rate hikes on banking variables, especially the implicit funding cost of Portuguese banks. During the COVID-19 period, loan characteristics played a significant role in lowering interest rates. The firm component contributed notably during various macroeconomic and financial events, driving rates higher following the sovereign debt crisis, during and after the COVID-19 crisis, as well as in the current tightening cycle of financial conditions.

Afterwards, the analysis explores whether banks' loan pricing of firm financial conditions is time-varying. During economic booms and relaxed financial conditions, banks may be less strict in loan pricing compared to situations with adverse macroeconomic and financial environments. The baseline regression is adjusted to incorporate a time-varying relation between the charged interest rate and firms' financial conditions. It is observed that the time-varying sensitivities fluctuate around their average effect, with many periods in which the time-varying effect coincides with the average effect. However, during some periods, the sensitivity of banks to indicators of a firm's financial soundness deviates from their average effect, underscoring that banks' pricing strategies vary over time.

As a next step, the drivers behind the time-varying sensitivities are studied by correlating them with variables tied to the economic and financial cycle. In times of high uncertainty or tight financial conditions, banks tend to be stricter in pricing firm leverage, resulting in higher interest rates compared to more stable periods. Banks become more attentive to firms' liquidity in times of tight general financial conditions. Furthermore, banks price firm profitability more sensitively during periods of low economic growth, whereas in environments of high interest rates, this sensitivity is reduced.

The findings regarding banks' pricing of various firms' financial characteristics align with prior research. Strahan (1999) examines a sample of US firms and demonstrates that riskier firms face higher interest rates. Specifically, smaller firms with higher leverage, lower cash reserves, and lower profitability tend to incur higher interest rates. Similarly, Bui *et al.* (2018) studies whether the managerial ability of a firm is priced by banks. They find similar results regarding the impact of firms' financial conditions on loan pricing. Unlike previous papers, this article examines whether banks' pricing of firms' financial conditions changes over time and disentangles the macroeconomic drivers of these time-varying relationships.

The literature also demonstrates, using granular data at the loan level, that the macroeconomic environment significantly influences loan pricing by banks. Anagnostopoulou and Drakos (2016). illustrate that banks' loan terms are influenced not only by firm-specific or institutional factors but also by macroeconomic conditions at the country level. They find that macroeconomic conditions explain loan terms, with periods of economic slowdown associated with tighter loan terms. Santos (2011) shows that following the subprime crisis, firms experienced higher loan spreads, especially from banks that incurred larger losses. Apart from previous findings, this paper sheds light on how different firms' financial conditions affect banks' loan pricing over time. It also demonstrates that the drivers behind the changing sensitivities are linked to the macroeconomic and financial environment.

There is a growing literature studying the importance of cash flow-based lending, instead of asset-based lending for corporate borrowing (Lian and Ma (2021), Caglio *et al.* (2021), Drechsel and Kim (2024)). Lian and Ma (2021). highlight that 80% of debt for U.S. non-financial firms is backed by cash flows, with this type of debt arrangement being more prevalent among large firms than small ones. Using EBITDA as the primary measure for operating earnings (cash flow), they demonstrate that an increase in EBITDA enables large firms to expand their debt issuance, indicating a relaxation of borrowing constraints. Conversely, for small firms, an increase in EBITDA does not lead to a corresponding rise in borrowed amounts. Apart from previous findings but in the same direction, this study observes that for large firms in our sample, banks' loan pricing exhibits a stronger response to profitability (proxied by EBITDA) compared to other firm sizes. These findings align with the notion that changes in profitability alleviate/deteriorate borrowing constraints more for large firms, as these constraints are closely tied to their earnings.

Previous research conducted by Bonfim *et al.* (2018) indicates that having a greater number of bank relationships generally leads to lower interest rates, particularly for smaller firms. Our study confirms that micro and small firms derive the greatest benefit from having a higher number of bank relationships. Additionally, we observe that in cases where the lending relationship relies on a few banks, the monitoring of leverage appears to have a more significant impact on loan pricing. Conversely, firms with a high number of bank relationships are able to obtain loans at lower interest rates primarily due to their profitability.

Our article contributes to the empirical literature on banks' loan pricing in the case of Portugal. In line with the findings of Santos (2013) and Bonfim *et al.* (2021), characteristics of the borrower, bank, and loan play a crucial role in determining interest rates. Santos (2013) using information from June 2012 until February 2013, find that banks price borrowers' characteristics such as firm risk (proxy by the probability of default) or size. Firms with more fragile financial conditions are charged a higher interest rate. Bonfim *et al.* (2021) shows the importance of banks characteristics in loan pricing, with a special focus on the role of banks capital. Their sample starts from 2012 until 2019. They find that better capitalized bank are more conservative in their loan pricing.

Previous studies often relied on a summary statistic such as the probability of default to represent a firm's financial condition. This obscure the distinct drivers of financial distress potentially arising from varying developments in firms' balance sheets. However, our research emphasizes that different firm financial indicators are treated differently in the determination of interest rates. Specifically, across time and in reaction to macroeconomic and financial events, banks' sensitivity to particular firm financial indicators changes. This detailed approach provides a better understanding of the nature of loan pricing and the relationship between firm financial characteristics and broader economic conditions.

The rest of the paper is structured as follows. Section 2 discusses the data sources and descriptive statistics. Section 3 studies the relations between banks' pricing and firms' financial conditions. Section 4 analyzes the time-varying sensitivity of loan pricing to firms' financial conditions, and study the drivers behind the changing sensitivities. Section 5 concludes the paper.

2. Data sources and descriptive statistics

The analysis draws upon loan-level data from the new operations dataset, collected on a monthly basis. This dataset provides details about all new banking loans issued to Portuguese non-financial corporations (NFCs) between July 2012 and December 2023. For each loan, the dataset provides information on the borrowed amount, interest rate, maturity, renegotiation status, and a binary indicator for collateral presence. While the majority of these transactions are based on truly new contracts, some stem from renegotiations. Renegotiated operations are specifically accounted for in the analysis. To enhance the dataset's reliability, credit lines, contracts shorter than one month, and those with unusually high interest rates have been excluded. The analysis is conducted on a monthly timeframe.

Additionally, the study limits the set to contracts associated with the seven largest banks in Portugal, which correspond to 79% of the total amount of new loans in 2023 (86% on average for the whole sample). Given the importance of these banks in Portugal, the analysis captures the main developments in loan pricing.

The sample covers the COVID-19 period, a time when the Portuguese government implemented special measures to aid firms. In light of this, a dummy variable was added to determine if a loan was supported by a government guarantee starting from April 2020. For the incorporation of the government guarantee variable, a contract identifier was essential. However, the new operations dataset did not include this identifier before March 2021. As a workaround, the Portuguese Credit Register was employed to replicate the new operations dataset from April 2020 to February 2021. Subsequently, the new operations computed from the CRC were merged with the government guarantee variable. Finally, original new operations data from April 2020 to February 2021 is dropped, and replaced with the CRC new operations.

The literature highlights the significance of bank characteristics in determining loan pricing (Bonfim *et al.* (2021)). To account for this, internal bank-level data is used, collected on a quarterly basis. While a wide range of variables is accessible, the main bank-level variables considered were capital ratios, funding costs, loan-to-deposit ratios and total assets.

Additionally, the loan-level dataset is augmented with firm-level data from the central balance sheet dataset. This information is available at a yearly frequency. The financial indicator variables are: i) leverage, the ratio of financial debt to total assets, represents firm indebtedness; Ii) liquidity, the ratio of cash plus deposits to total assets (mentioned as cash over assets, afterwards, for simplicity); and iii) profitability, the ratio of EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization) to total assets. These variables correspond to three core dimensions in a firm's financial assessment, related, broadly, to financial autonomy, ability to absorb shocks and returns. Moreover, we also control for the firm's size, which is usually a *proxy* for information's asymmetry.

The mean and median interest rates in our sample are 5% and 4.5%, respectively. As illustrated in Figure 1, interest rates peaked around the sovereign debt crisis, reaching an average of 8%. During the recent tightening cycle starting in June 2022, there was a significant and rapid increase in interest rates, climbing from an average of 3% in June 2022 to 6.6% by December 2023. Despite this increase, the current interest rates remain substantially lower than those observed from 2012 to 2014. The shaded areas in the Figure 1, representing the 20th and 80th percentiles, highlight a notable pattern of loan pricing dispersion around the mean and median over time.

The characteristics of firm-level variables in our sample reveal that 71% of the operations were conducted by micro and small firms. On average, micro firms accounted for 26% and small firms for 31% of the total amount of new credit (Figure A.2). This underscores the dominant role of micro and small firms in the Portuguese economy. In terms of industry distribution (Figure A.1), the sectors receiving the largest portions of credit on average over time include manufacturing (32%), trade (26%), construction (9%), and real estate (5%). The average firm in this sample has a leverage ratio of 34%, a cash to assets ratio of 8.8%, and an EBITDA to assets ratio of 6.8 %. Nevertheless, there is significant heterogeneity in the borrower characteristics, as indicated by the standard deviation and the distribution quantiles for these variables. Table 1 shows the descriptive statistics for all variables in the analysis. Firm-level variables are lagged by 12 months (1 year), while the bank-level ones are lagged by 3 months (1 quarter).

Variables	Mean	SD	Median	Perc5	Perc95	Obs
Loan						
Interest rate (%)	5.07	3.34	4.50	1.16	11.76	3330993
Amount Outs, (log, euros)	9.48	1.67	9.51	6.75	12.29	3330993
Maturity (log, days)	5.05	1.23	4.62	3.61	7.69	3330993
Collateral (dummy)	0.44	0.50	0.00	0.00	1.00	3330993
Renegotiation (dummy)	0.03	0.18	0.00	0.00	0.00	3330993
Gov. guarantee (dummy)	0.02	0.12	0.00	0.00	0.00	3330993
Firm						
Big firms (dummy)	0.07	0.25	0.00	0.00	1.00	3330993
Medium firms (dummy)	0.22	0.41	0.00	0.00	1.00	3330993
Small firms (dummy)	0.37	0.48	0.00	0.00	1.00	3330993
Total assets firms (log, euros)	14.45	2.00	14.43	11.31	17.74	3330993
Leverage	33.89	26.16	33.22	0.01	68.58	3330993
Cash over Assets	8.88	13.63	3.67	0.17	36.14	3330993
EBITDA over Assets	6.84	21.54	6.56	-6.84	25.58	3330993
# bank relationships	5.65	3.82	5.00	1.00	13.00	3282609
Firm age (years)	22.71	16.42	19.99	3.05	50.88	3330993
Probability of default (ICAS)	4.21	5.84	2.13	0.16	15.25	3328733
Bank						
Loan to deposits (%)	97.69	18.49	97.85	65.95	130.37	3330993
Total capital ratio (%)	14.47	3.26	13.97	9.85	20.10	3330993
Implicit funding cost banks (%)	1.22	1.00	0.97	0.08	3.16	3330993
Total assets banks (log, euros)	24.70	0.53	24.70	23.63	25.33	3330993

Table 1. Descriptive statistics

Notes: Firm-level variables are winzorized at the 1% level to prevent extreme outliers to affect the results.

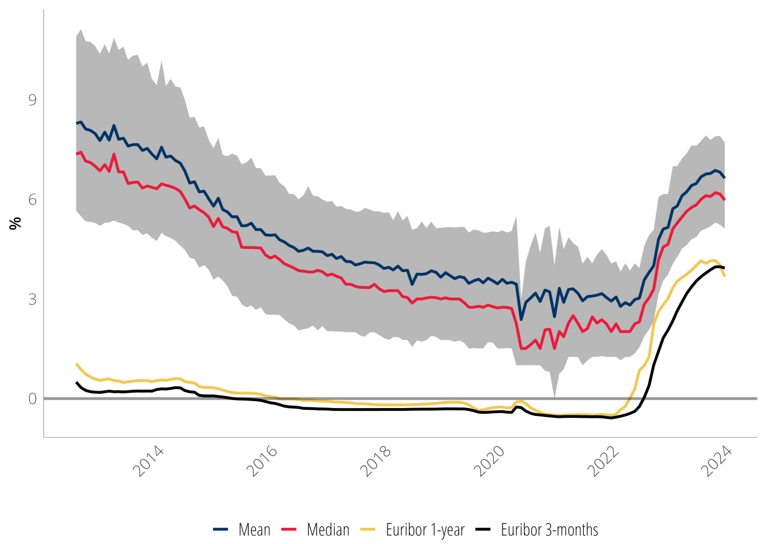


Figure 1: Interest rates on new loans to firms and 1-year/3-months Euribor

Notes: The blue line represents the simple average of interest rates on new loans to Portuguese firms, while the red line shows the median interest rate on these loans. The grey shaded area indicates the range between the 20th and 80th percentiles of the interest rates distribution.

3. Determinants of interest rates on new loans to firms

The main specification used in this paper decomposes the interest rates charged based on borrower, bank, and loan characteristics, along with several fixed effects and a residual. The goal is to quantify the impact of firms' characteristics on the variability of interest rates across firms. It also aims to identify which specific financial aspect of a firm—indebtedness, liquidity, or profitability—loan pricing is most sensitive to. To achieve this, we estimate the following model:

$$IR_{i,j,b,t,q,y} = \beta * borrower_{j,y-1} + \alpha * bank_{b,q-1} + \gamma * loan_{i,t} + \theta_b + \delta_k + T_{t,y} + \varepsilon_{i,j,b,t} \quad (1)$$

Where $IR_{i,j,b,t,q,y}$ corresponds to the interest rate charged on a new loan i, for a borrower j, given by a bank b in month t and quarter q of year y . $borrower_{j,y-1}$ stands for the borrower characteristics at year $y-1$: firm size proxied by the log of total assets, leverage, cash over assets and the EBITDA over assets. Industry fixed effects for every industry k are also included δ_k. $bank_{b,q-1}$ are the characteristics of the bank providing the loan at quarter $q-1$: total capital ratios, the ratio of loans to deposits, implicit funding cost of bank liabilities and banks' size. A bank fixed effect θ_b is also included for every bank b. θ_b captures permanent differences in the charged interest rate across banks. $loan_{i,t}$ controls by the characteristics of the loan at month t: amount borrowed, maturity, a dummy when the loan is collateralized, a dummy when the loan was renegotiated and a dummy to identify loans that have a government guarantee from April 2020 onwards. $T_{t,y}$ is a month-year time fixed effect to capture common macroeconomic shocks. In the baseline results, all continuous explanatory variables are standardized using their mean and standard deviation. This standardization aids in assessing the significance of changes across the cross-section for firm financial characteristics.

Firm characteristics significantly influence loan pricing as shown in Table 2. Firms with higher leverage encounter tighter financial conditions compared to those with lower leverage. Across the cross-section of firms, a 1 standard deviation increase in leverage (a rise of 26 percentage points from an average of 34%) results in an increase of 6.4 basis points in interest rates. Conversely, firm liquidity and profitability help to reduce borrowing costs, thereby improving financial conditions for these firms. A 1 standard deviation increase in the cash-to-assets ratio, 13.6 pp from 8.8%, leads to a 17 basis point decrease in interest rates. Similarly, a 1 standard deviation increase in EBITDA over assets (21.5 percentage points from an average of 6.8%) results in a decline of 3.7 basis points in interest rates. Additionally, firm size plays a critical role in financing, with larger firms obtaining loans at lower interest rates.

Changes in the cross-section of key firms' financial aspects significantly impact loan pricing. However, it raises the question of which factor—indebtedness, liquidity, or profitability—banks are most sensitive to. In Table B.1, the model is estimated similarly to equation 1 but without standardizing the continuous variables. To compare the impacts of firms' financial conditions, this analysis examines how a 1 percentage point increase in a specific financial variable relative to total assets affects interest rates. An interesting finding is that banks' pricing of loans is more sensitive to changes in firm liquidity compared to firms' indebtedness and profitability. A 1 percentage point increase in cash over assets decreases interest rates by 1.2 basis point, while an increase of 1 percentage point on leverage increase interest rate by 0.2 basis points. In parallel, a 1 percentage percent increase in profitability decreases interest rates by 0.2 basis points.

	Baseline (1)	PD (2)	bank*time FEs (3)	industry*time FEs (4)	Larger controls (5)
Firm controls					
Total assets (log)	−0.853***	−0.772***	−0.846***	−0.854***	−0.873***
	(0.025)	(0.022)	(0.025)	(0.025)	(0.034)
Leverage	0.064***		0.066***	0.064***	0.061***
	(0.012)		(0.012)	(0.012)	(0.012)
Cash over assets	−0.169***		−0.165***	−0.167***	−0.174***
	(0.013)		(0.013)	(0.013)	(0.013)
EBITDA over assets	−0.037***		−0.037***	−0.034***	−0.042***
	(0.007)		(0.007)	(0.007)	(0.007)
Prob. of default (ICAS)		0.385***			
		(0.016)			
# bank relationships					−0.015
					(0.024)
Age					0.009
					(0.020)
Num.Obs.	3 330 993	3 328 733	3 330 993	3 330 993	3 282 609
R2	0.508	0.517	0.523	0.510	0.509
Industry fixed effects	Yes	Yes	Yes		Yes
Bank fixed effects	Yes	Yes		Yes	Yes
Time fixed effects	Yes	Yes			Yes
Bank*Time fixed effects			Yes		
Industry*Time fixed effects				Yes	

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Standard errors clustered at the firm level
In all specifications are also included loan controls. For the specification in columns (1),(2),(4) and (5), banks' controls are added. All continuous variables are standardized.

Table 2. Interest rates on new loans

Traditionally, the literature has relied on summary statistics to represent a firm's financial condition, such as the probability of default, instead of using specific firm-level variables (Santos (2013) and Bonfim *et al.* (2021)). Table 2 column 2 examines how interest rates respond to an aggregate measure of firms' financial conditions. The ICAS (in-house Credit Assessment System) probability of default (PD) is used as the aggregate measure of firm's financial condition in the regression. This probability of default is estimated using an internal credit risk model developed at Banco de Portugal, Antunes *et al.* (2016). A 1 standard deviation increase in the PD leads to an increase of 38.5 basis points in interest rates, in line with *a priori* expectation on the relation between borrower's risk profile and interest rates. However, this specification does not allow for differentiation between various sources of a firm's financial vulnerabilities. More significantly, as demonstrated earlier, the pricing impact of each characteristic on banks' loan pricing is not uniform.

The findings from our baseline regression regarding loan and bank characteristics are consistent with previous studies by Santos (2013) and Bonfim *et al.* (2021). Table B.2 in the appendix B shows the coefficients for all the controls. Interest rates on new loans tend to decrease with larger borrowed amounts and longer maturities. This effect might be explained by the notion that larger sums borrowed and extended loan terms indicate a stronger credit relationship between the firm and the bank, leading to more favorable financial conditions from the lender. The analysis also reveals that loans secured with collateral are subject to higher interest rates, suggesting that such operations may carry greater risks than unsecured loans. Furthermore, loans resulting from renegotiations are associated with higher interest rates, indicating that renegotiations are generally related to higher risk levels compared to new loans not arising from renegotiation. In terms of bank-specific factors, the data shows that banks with higher capital ratios are inclined to charge higher interest rates, possibly because these banks adopt a more risk-averse stance in their lending practices. Additionally, banks facing a higher implicit cost of liabilities offer loans at higher interest rates. Moreover, banks with a higher loan-to-deposit ratio tend to impose higher interest rates, whereas larger banks generally offer lower interest rates.

Several alternative specifications are also estimated as robustness. In Table 2 column 3, bank*time fixed effects are included in the specification, instead of controlling for bank-level variables. This specification allows us to fully control for bank characteristics across time, preventing an omitted variable bias coming from banks' characteristics. There may also be a concern that our results are driven by particular sector trends, specially for the biggest sectors in our sample (manufacturing and trade). For this reason, in Table 2 column 4, sector*time fixed effects are added in the specification. In column 5, the analysis expands the number of firm controls by including the number of bank relationships and the age of the firm. Previous research, such as Bonfim *et al.* (2018), suggests that a greater number of bank relationships tends to result in lower interest rates charged. Additionally, firms' age has been identified as a determining factor in firm financing, with younger firms being more susceptible to financial frictions (Cloyne *et al.* (2023)). However, in our specification, neither the number of bank relationships nor the firm's age shows significant effects. More importantly, the coefficients for the firms' financial aspects do not change significantly across alternative specifications.

As a final observation, the results can also be interpreted in terms of a spread between the interest rate on each loan to non-financial corporations and the implicit funding cost of the bank (Table B.3). If the dependent variable were the spread, the estimated coefficients would be very similar. Additionally, the previous baseline model does not consider temporal changes in pricing strategies. Section 4 addresses this by demonstrating that banks' loan pricing of firms' financial characteristics is time-varying, and that the changing sensitivities across time depend on economic and financial conditions.

3.1. Heterogeneous effect of firms' financial conditions

To enhance our understanding of how banks price firms' financial conditions, the analysis permits variations in the baseline results across different dimensions. Initially, the study examines banks' loan pricing of firms' financial aspects conditional on industry. Consequently, the model is adjusted to allow the coefficients for indebtedness, liquidity, and profitability to vary among industries (Appendix F). Regarding leverage (Figure F.1), the overall effect observed in the main analysis (6.4 basis points) is outpaced by the sector-specific impacts noted in trade (8.3 basis points) and construction (11 basis points), whereas for the manufacturing and real estate sector, leverage's influence on loan pricing is null. In examining liquidity's impact (Figure F.2), it's found that, apart from the transport industry, increased liquidity consistently leads to lower interest rates. Compared to the average effect of liquidity in the main results (-17 basis points), the real estate and manufacturing sectors have the strongest reactions to changes in liquidity, with -18.8 bps and -24 bps, respectively. Regarding the heterogeneous effect of profitability by sector (Figure F.3), there is significant variation in both the direction and magnitude. Typically, higher profitability results in lower interest rates. However, in the agriculture and real estate sectors, an increase in profits from the previous year is associated with higher interest rates.

In Table 3, the effect of firms' financial conditions depending on firm size is studied. The specification with age and number of bank relationships is kept in this section, to compare whether our results align with finding in the literature regarding those variables. Banks are more inclined to charge higher interest rates to micro and small firms due to their leverage. However, for medium-sized firms, an increase in leverage is associated with a decrease in interest rates. This might be because, for medium-sized firms, higher levels of debt are not only a reflect of financial vulnerability. Higher leverage could imply that these firms are more dynamic in its investment and could have better future economic perspectives. For big firms, leverage does not significantly influence loan pricing.

Regarding the pricing of liquidity conditional on firms size, for micro, small and medium firms, higher liquidity implies lower charged interest rates, however the effects is not significant for big firms. It is also observed that the benefits of liquidity increases with firms size, not including the big firms.

For firms profitability, not matter the firm size, higher profitability decreases the charged interest rate. Interestingly, it is observed that the magnitude of the effect increase with the firm size. For instance, a 1 standard deviation increase in firm profitability for micro firms decrease the interest rate by 4.6 basis points, while for big firms a 1 standard deviation increase in profitability decrease it by 62 basis points. To sum up, for micro and small firms, banks are more reactive to their leverage and less reactive to their measures of liquidity and profitability compared to medium-sized firms. For medium-sized firms, it seems that higher leverage is related to growing firm and better economic perspectives in the future, decreasing the charged interest rate. Interestingly, for the large firms in our sample, banks do not react to changes in leverage or liquidity. However, the influence of firm profitability on pricing is more significant compared to micro, small, and medium-sized firms. This suggests that as firms grow, loan pricing becomes more closely tied to economic performance rather than purely financial variables such as leverage and liquidity.

	All firms (1)	Micro (2)	Small (3)	Medium (4)	Big (5)
Firm controls					
Leverage	0.061***	0.091***	0.125***	−0.137*	−0.081
	(0.012)	(0.009)	(0.028)	(0.056)	(0.095)
Cash over assets	−0.174***	−0.042***	−0.115***	−0.241***	0.073
	(0.013)	(0.012)	(0.021)	(0.047)	(0.182)
EBITDA over assets	−0.042***	−0.046***	−0.179***	−0.397***	−0.619***
	(0.007)	(0.005)	(0.024)	(0.054)	(0.136)
# bank relationships	−0.015	−0.152***	−0.157***	−0.044	−0.001
	(0.024)	(0.034)	(0.031)	(0.037)	(0.062)
Age	0.009	−0.182***	−0.164***	−0.080*	−0.011
	(0.020)	(0.025)	(0.028)	(0.033)	(0.039)
Num.Obs.	3 282 609	1 128 855	1 215 534	713 106	225 114
R2	0.509	0.500	0.477	0.477	0.512

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Std. errors clustered at the firm level. In all specifications are also added loan and bank controls. Bank, industry and time fixed effects are also included. All continuous variables are standardized.

Table 3. Interest rates on new loans: Results by firm size

Interestingly, results in Table 3 are compatible with Bonfim *et al.* (2018) regarding the importance of the number of bank relationships and loan pricing. Micro and small firms benefit the most when they have a higher number of bank relationships. Regarding firms age, it is observed that older firms get lower interest rates. Conditioning on firm size, the effect of age is higher for micro and small firms.

In Table 4, the heterogeneous effect of firms' financial conditions depending on firms' age and number of banking relationships is studied. Compare with the regression for all firms (Column 1), younger firms are aligned with the results for indebtedness and liquidity. However, firms profitability do not play a role for young firms. For old firms, banks do not price their leverage, but they react more to their liquidity and profitability. It appears that throughout a firm's life cycle, banks' loan pricing place greater emphasis on the level of debt for younger firms, rather than on their profitability. As the firm matures, leverage becomes less relevant in loan pricing, while the importance of profitability grows.

Firms with few bank lending relationships are charged a higher interest rate regarding their leverage compared to firms with a high number of bank relationships (Table 4). When the lending relationship depends on few banks the monitoring of leverage seems to influence more the loan pricing. Increasing the number of bank relationships, seems to increase the reaction of banks to more liquid firms. Also, firms with a high number of banks relationships are able to secure loans at lower interest rates thanks to their profitability.

	All firms (1)	Young (2)	Old (3)	Few bank rel. (4)	Many bank rel. (5)
Firm controls					
Leverage	0.061^{***}	0.070^{***}	0.030	0.087^{***}	-0.015
	(0.012)	(0.011)	(0.029)	(0.009)	(0.047)
Cash over assets	-0.174^{***}	-0.159^{***}	-0.211^{***}	-0.156^{***}	-0.254^{***}
	(0.013)	(0.010)	(0.033)	(0.010)	(0.069)
EBITDA over assets	-0.042^{***}	-0.003	-0.292^{***}	-0.009	-0.423^{***}
	(0.007)	(0.006)	(0.032)	(0.006)	(0.057)
Num.Obs.	3 282 609	1 793 434	1 488 907	1 856 667	1 425 942
R2	0.509	0.511	0.508	0.518	0.487

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Std. errors clustered at the firm level. In all specifications are also added loan, bank controls and firm total assets. Bank, industry and time fixed effects are also included. All continuous variables are standardized. A firm is considered young (old) when its age is smaller (bigger) than the average age (22.7 years). A firm has few (many) bank relationships when the the number of lenders is smaller (bigger) than 5.6.

Table 4. Interest rates on new loans: Results by age and number of bank relationships

3.2. Decomposing the change in the average interest rate on new loans to firms

Leveraging the results from the baseline regression (Table 2, column (1)), this analysis investigates the factors driving the six-month change in the average interest rate over time. It decomposes these changes into components tied to characteristics of the loan, borrower, bank, common macroeconomic shocks and the sample's composition. Through this exercise, the relative importance of each factor in explaining the variations in interest rates over time is examined.

Ideally, one could decompose the change in the interest rate proposed by a bank b to a borrower j between month t and $t+h$ as follows:

$$IR_{i,j,b,t+h} - IR_{i,j,b,t} = \widehat{IR}_{i,j,b,t+h} - \widehat{IR}_{i,j,b,t} + \widehat{\varepsilon}_{i,j,b,t+h} - \widehat{\varepsilon}_{i,j,b,t} \tag{2}$$

Through this decomposition, it is possible to map the variation in interest rates back to the different factors previously examined. However, this approach assumes a panel data structure, whereas our dataset consists of a pooled cross-section, meaning repeated observations for the same borrower over time may not be consistently available. Consequently, instead of implementing the relationship at a granular level, the analysis applies it by comparing average interest rates over time. Let's denote N_t, the number of loans that are observed in month t. The change in the average interest rate between month t and $t+h$ is computed as follows:

$$\begin{aligned}\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} IR_{i,j,b,t+h} - \frac{1}{N_t}\sum_{i=1}^{N_t} IR_{i,j,b,t} &= \frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} \widehat{IR}_{i,j,b,t+h} - \frac{1}{N_t}\sum_{i=1}^{N_t} \widehat{IR}_{i,j,b,t} \\ &+ \frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} \widehat{\varepsilon}_{i,j,b,t+h} - \frac{1}{N_t}\sum_{i=1}^{N_t} \widehat{\varepsilon}_{i,j,b,t} \end{aligned} \tag{3}$$

At a very aggregate level like the one is studied here (change in the average interest rate), in our estimation the average predicted interest rate is equal to the average observed interest rate in every month t. This is due to the inclusion of time fixed effect in our regression. As a consequence, the average estimated residual across time will be equal to 0, and then $\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}}\widehat{\varepsilon}_{i,j,b,t+h} - \frac{1}{N_t}\sum_{i=1}^{N_t}\widehat{\varepsilon}_{i,j,b,t} = 0$. The decomposition can be written as follows:

$$
\begin{aligned}
&\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} IR_{i,j,b,t+h} - \frac{1}{N_t}\sum_{i=1}^{N_t} IR_{i,j,b,t} = \\
&\qquad \widehat{\beta}(\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} borrower_{i,j,t+h-12} - \frac{1}{N_t}\sum_{i=1}^{N_t} borrower_{i,j,t-12}) + \\
&\widehat{\alpha}(\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} bank_{i,b,t+h-3} - \frac{1}{N_t}\sum_{i=1}^{N_t} bank_{i,b,t-3}) + \widehat{\gamma}(\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} loan_{i,t+h} - \frac{1}{N_t}\sum_{i=1}^{N_t} loan_{i,t}) \\
&\quad + (\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} composition_{i,j,b,t+h} - \frac{1}{N_t}\sum_{i=1}^{N_t} composition_{i,j,b,t}) + (T_{t+h} - T_t) \qquad (4)
\end{aligned}
$$

The evolution in the average interest rate between month t and $t+h$ can be broken down into the average change of loan, borrower and bank characteristics, as well as common macroeconomic shocks and the sample's composition (Figure 2). The change in the composition of the cross-section influences the average change in interest rates. For instance, if there is a period during which a specific sector predominantly borrows. Changes in time-fixed effects capture the impact of common macroeconomic and financial shocks on the average interest rate variation. This common component may represent shifts in monetary policy, fluctuations in economic activity, or overall changes in credit risk associated with the macroeconomic environment. The appendix C details the derivation of this expression and provides further explanation of what each component represents.

Macroeconomic and financial environments, indicated by changes in time-fixed effects, are the primary drivers of changes in the average interest rate (Figure 2). These shocks notably reduced rates from 2013 to 2017, with a significant drop in 2014. For instance, in December 2014, the average interest rate dropped by 1 percentage point with respect to 6 months ago, with 0.85 percentage points of this decrease attributable to the common shock. In the current tightening period, common macroeconomic shocks were the main contributors to the increase in interest rates. Indeed, from June 2022 to January 2023, this factor has uniquely driven up interest rates. This reflects stricter monetary policies, lower GDP growth expectations, and lower general risk appetite. In December 2022, the analysis shows an average interest rate increase of 2.13 percentage points compared to six months earlier, with 2 percentage points coming from the common shock. More recently, this effect waned.

Overall, the evolution of banking variables has led to a notable decrease in interest rates until 2020, primarily due to reduced implicit funding costs for banks, allowing them to offer lower loan rates to firms. However, since the start of 2023, banking variables have begun influencing a rise in interest rates. In June 2023, the average interest rate increased by 1.30 percentage points over six months, with 0.40 percentage points of this increase attributed to banking variables, mainly from higher banking funding costs and reduced bank balance sheets.

The role of firm's component was relevant notably during various macroeconomic and financial events. At the outset of 2013, the influence of firm characteristics led to an increase in interest rates by about 0.16 percentage points. During the COVID-19 period in May 2020, firm characteristics further pushed up interest rates by 0.20 percentage points, underscoring the impact of the pandemic on financial conditions. However, by November 2020, a shift occurred with firm characteristics contributing to a decrease in interest rates, although this reduction was neutralized by an opposite effect from loan characteristics. Before the recent tightening cycle at the beginning of 2022, firm characteristics contributed to a fall in the interest rate. The most important driver of the firm component in this exercise is the change in average size of firms accessing credit, i.e. more credit granted to smaller firms which typically are charged higher interest rates. Despite the significant role of firm financial variables in loan pricing as identified in the cross-section of firms, their overall contribution to the fluctuation of the average interest rate appears small. This may be attributed to the fact that the averages of these variables over time do not show significant fluctuations in our sample.

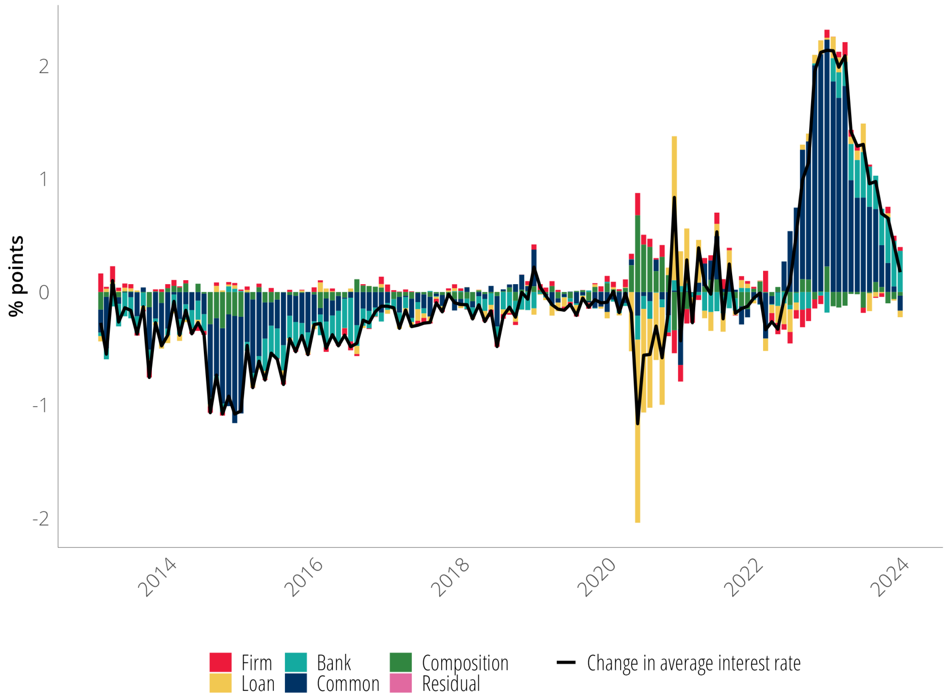


Figure 2: Decomposing the six-month change in the average interest rate

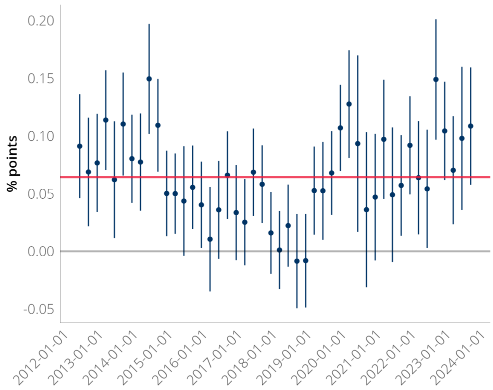
Notes: The plot displays the decomposition of the six-month change in the average interest rate (Black line) into different factors for each month.

4. Time-varying sensitivity of interest rates to firms' financial conditions

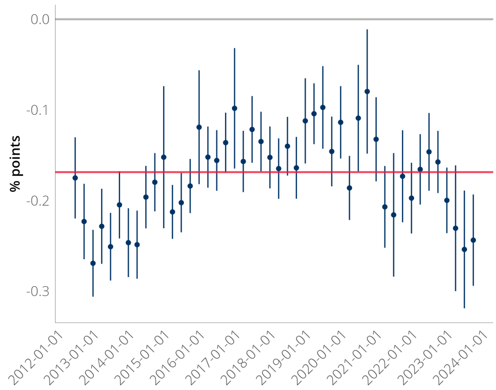
Firms' financial conditions significantly affect loan pricing. This section explores how banks' sensitivity to these conditions might vary over time. Indeed, in times of economic boom and relaxed financial conditions, banks may be less strict in loan pricing compared with situations where there is an adverse macroeconomic environment. To examine this, the baseline specification in equation 1 is modified to incorporate time-varying parameters for financial performance variables. The modified equation is as follows:

$$IR_{i,j,b,t,q,y} = \beta_q * Leverage_{j,y-1} + \alpha_q * Cash_{j,y-1}/Assets_{j,y-1} \\ + \gamma_q * EBITDA_{j,y-1}/Assets_{j,y-1} + \mu * X_{i,j,b,(t \text{ or } q-1)} + \varepsilon_{i,j,b,t} \quad (5)$$

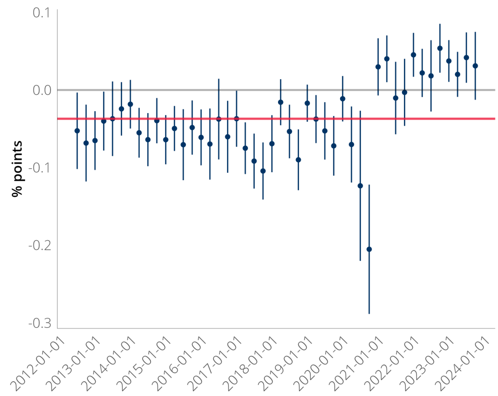
where the estimated coefficients for leverage, cash over assets and EBITDA over assets are allowed to change at a quarterly frequency q. The remaining regressors $X_{i,j,b,(t \text{ or } q-1)}$ are the same as the baseline specification (equation 1).



(A) Interest rate sensitivity to Leverage, β_q



(B) Interest rate sensitivity to Cash/Assets, α_q



(C) Interest rate sensitivity to EBITDA/Assets γ_q

Figure 3: Changing sensitivities of banks' interest rates

Notes: Every panel shows the corresponding changing sensitivity of interest rates to leverage (Panel (A)), cash over assets (Panel (B)) and EBITDA over assets (Panel (C)) across time. The changing sensitivities (Blue dots) are estimated using equation 5. The 90% confidence intervals are shown. The red line shows, for every financial indicator, the sensitivity estimated in the static version (equation 1)

In Figure 3, the sensitivity of banks' pricing to firms' financial conditions is illustrated (blue dots), alongside the estimated time-invariant parameters of the baseline specification (red line). The time-varying sensitivities fluctuate around their average effect, with many periods in which the time-varying effect coincides with the average effect. However, during some periods the sensitivity of banks to indicators of firm's financial soundness deviates from their average effect, underscoring that banks' pricing strategies vary over time. Section 4.1 focus on understanding the macroeconomic and financial drivers of those deviations.

Panel (A) of Figure 3 shows the sensitivity of interest rates to firm leverage, which is positive for most of the time. The effect peaks during certain periods but then returns to its average value. For instance in Q3 2014, a 1 standard deviation increase in leverage led to a 15 basis point increase in interest rates. This effect is twice as much compared to the average impact of leverage discussed in the previous section (6.4 basis points). Other periods where interest rate sensitivity to leverage peaked include Q2 2020 (13 basis points) and Q4 2022 (15 basis points). The lowest sensitivity to leverage occurred during 2018 and the 1st quarter of 2019.

The sensitivity of interest rates to firm's liquidity is displayed in Panel (B) of Figure 3, showing an inverse relationship between interest rates and firm liquidity. In Q1 2013, a one standard deviation increase in cash over assets resulted in a 27 basis point decrease in interest rates charged on new loans, which is 10 basis points above the average effect (17 basis points) identified specification without time-varying effects. Interestingly, the sensitivity to liquidity remains elevated from the start of the dataset until 2016, during which it stabilizes at around 10 basis points. This sensitivity then increases from 2021 through the fourth quarter of 2023, reaching a 24 basis point effect.

Panel (C) of Figure 3 shows the sensitivity of interest rates to firm profitability. From 2012 until 2020, there is an inverse relationship between the two variables, meaning that higher profitability implies lower borrowing costs. The peak in sensitivity occurred in Q3 2020 and Q4 2020. It was observed that a one standard deviation increase in profitability resulted in a 12 basis point decrease in interest rates in Q3 2020 and a 20 basis point decrease in Q4 2020. Since 2021, interest rates have become less responsive to firms' profitability, with the sensitivity becoming more frequently insignificant as demonstrated by the error bands crossing the zero line.

In Appendix D, the time-varying sensitivities at a monthly frequency are displayed. They exhibit the same patterns as those seen quarterly; however, to reduce noise that may occur on a monthly basis, the quarterly sensitivities are preferred. Additionally, the time-varying effects of firms' financial conditions by sector are further analyzed in Appendix G. Despite observing some heterogeneity across time and sectors, the average time-varying effects are consistent for the three largest industries demanding credit: manufacturing, trade, and construction.

The changing sensitivities across different firm sizes are analyzed in Appendix H. Interest rate sensitivities to liquidity and profitability are relatively consistent with the results observed for all firms, although there is some variation in the magnitude of these effects. Across different firm sizes, the sensitivities to profitability and liquidity are predominantly negative when they are statistically significant. When these sensitivities are positive, they typically do not differ statistically from zero. Regarding the effect of leverage on loan pricing over time, there is significant heterogeneity between micro/small firms and medium/large firms. Banks' interest rates respond positively over time to changes in leverage for micro and small firms, similar to the effect observed for all firms. For medium-sized and large firms, from 2016 to 2019, it has been noted that higher levels of leverage correlate with lower interest rates. This could suggest that during this period, a higher level of debt was seen as indicative of better future economic prospects for these firms. Since 2021, higher levels of leverage have been associated with higher interest rates for medium-sized and large firms.

As an additional robustness check, a specification was run to assess the changing sensitivity of interest rates to the probability of default (PD) from ICAS. Figure E.1 displays the time-varying sensitivity of interest rates to the probability of default. Although there were some fluctuations in sensitivity from the start of the dataset until the end of 2019, no clear pattern emerged. The response to a one standard deviation increase in PD during those seven years oscillated between 34 and 45 basis points. In Q2 2020, there was a notable increase in the sensitivity of the charged interest rate to the PD, jumping to 50 basis points and further rising to 58 basis points by Q4 2022.

The sensitivity of banks across time to indicators of firm's financial soundness, such as indebtedness, liquidity, and profitability, exhibits different patterns, underscoring that banks' pricing strategies for these factors are not uniform and vary over time. The heterogeneous pricing of firms' financial conditions is especially noteworthy when compared to the changing sensitivity of interest rates to the probability of default (PD). In examining the response to the PD alone, it is challenging to discern distinct patterns of time-varying sensitivity from 2012 to 2019. This suggests that incorporating a wider range of financial indicators offers a more detailed insight into how banks adjust their loan pricing strategies based on firms' financial conditions.

4.1. Drivers of time-varying sensitivities to firms' financial conditions

The analysis now turns to the drivers behind the changing sensitivities. The time-varying quarterly sensitivities β_q , α_q and γ_q are regressed against measures of economic activity, proxied by GDP growth (year-on-year) and financial conditions, measured by 10-year PT government bond yield and the 1-year Euribor rate. These rates capture the main developments and sentiment in the financial markets, and changes in the monetary policy. In addition, to identify periods of economic and political uncertainty, the index developed by Ahir *et al.* (2022) is employed. This uncertainty measure aims to highlight specific periods and events, such as the COVID-19 shock, that have adversely impacted the economy.

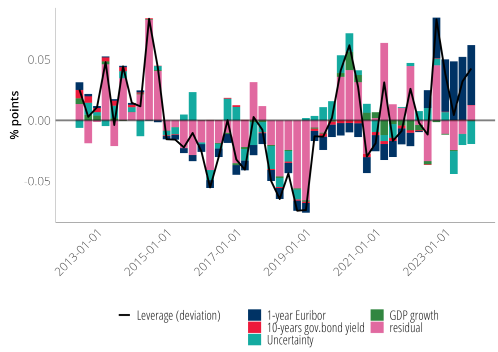
Table 5 displays the results for the drivers of the changing sensitivities. Moreover using the estimated relationships, Figure 4 decomposes the changing sensitivities (as deviations from their average effect) into different drivers across time.

	Leverage β_q	Cash/Assets α_q	EBITDA/Assets γ_q
(Intercept)	0.066***	−0.173***	−0.037***
	(0.005)	(0.006)	(0.005)
GDP growth (YoY)	−0.004	−0.005	0.024*
	(0.007)	(0.008)	(0.010)
10-years gov. bond yield	0.002	−0.020*	−0.004
	(0.004)	(0.008)	(0.007)
1-year Euribor	0.017***	−0.016**	0.028***
	(0.004)	(0.005)	(0.003)
Uncertainty	0.010*	0.006	0.007
	(0.004)	(0.006)	(0.006)
Num.Obs.	46	46	46
R2 Adj.	0.204	0.331	0.456
F	5.238	9.064	45.931

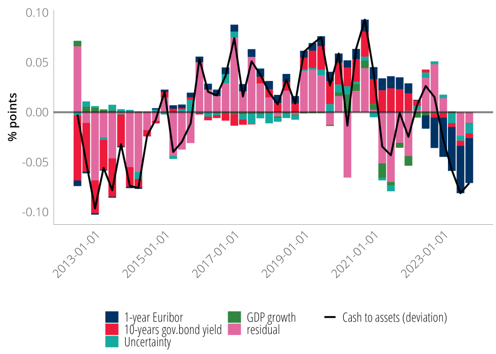
Robust standard errors are used, + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001
The explanatory variables are standardized

Table 5. Drivers of time-varying sensitivities

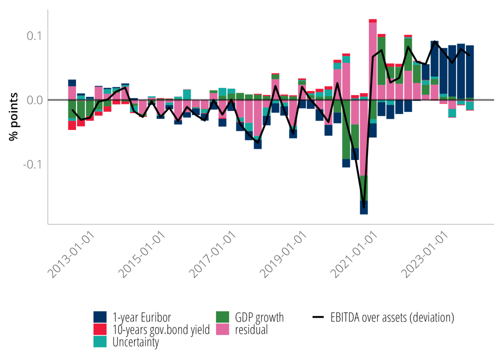
During periods of high economic uncertainty, an increase in firms' leverage results in a more pronounced rise in the charged interest rate compared to more stable periods (Table 5). This response is attributed to the negative impact of economic uncertainty on firms' performance, ultimately increasing firms' default risk. In times of tighter financial conditions (indicated by a higher 1-year Euribor), banks show increased sensitivity to changes in firm leverage, understanding that a firm's indebtedness becomes significantly more relevant in loan pricing due to the increased risk of non-repayment in an environment of high interest rates. Looking at Panel (A) of Figure 4, the rise in the sensitivity to leverage during the COVID-19 outbreak is related to an increase in economic uncertainty and lower economic growth. Moreover, the fact that financial conditions where loosed by the ECB during the COVID-19, contributed to contain the increase in banks' loan pricing of firm leverage during and after the pandemic crises. The increase in the sensitivity to leverage at the end of 2022 is due to monetary policy tightening, as indicated by the positive contribution of the 1-year Euribor.



(A) Interest rate sensitivity to Leverage, β_q-β



(B) Interest rate sensitivity to Cash/Assets, α_q-α



(C) Interest rate sensitivity to EBITDA/Assets γ_q-γ

Figure 4: Changing sensitivities (deviation from average effect): Decomposition on drivers

Notes: Each panel displays the decomposition of the drivers contributing to the changing sensitivity over time. Sensitivities are depicted as deviations from their average effect.

In parallel, during periods of tight general financial conditions (indicated by high government bond yields or 1-year Euribor rates), banks pay closer attention to firms' liquidity levels, i.e. a more intense monitoring of firms' capacity to accommodate an increase in debt service. An increase in firms' liquidity leads to a more significant reduction in borrowing costs during these periods compared to periods with more relaxed financial conditions (Table 5). This effect could be attributed to the fact that higher liquidity ratios enable firms to meet their liquidity needs without incurring additional debt, serving as an indicator of short-term financial resilience especially in periods of tighter financial conditions. In Panel (B) of Figure 4, during 2012-2014 in the aftermath of the sovereign debt crisis, the increased sensitivity to liquidity is driven by tight financial conditions in Portugal, indicated by high 10-years PT government bond yield. Until the end of 2021, loose financial conditions, reflected in periods of low/negative interest rates, contributed to a lower sensitivity of bank pricing to firms' liquidity. In the recent period 2022-2023, the sensitivity to liquidity has increased, driven by tighter financial conditions following the tightening of monetary policy, indicated by a higher contribution of the 1-year Euribor.

In times of lower economic growth, the responsiveness of interest rates to firms' profitability becomes more pronounced (Table 5). An improvement in firms' profitability results in a more substantial decrease in borrowing costs during periods of lower economic activity. This shows the importance of firms' performance in reducing borrowing costs in periods of negative economic shocks. Additionally, during periods of tighter financial conditions, assessed by a higher 12-month Euribor, banks reduce their sensitivity to changes in firm profitability.

In the aftermath of the sovereign debt crisis, and during the COVID-19 outbreak, lower economic activity explained the increase in sensitivity of interest rates to profitability (Panel (C) of Figure 4) . Since 2021, interest rates have become less responsive to firms' profitability, driven by the tightening of monetary policy (higher contribution of the 1-year Euribor). This pattern likely stems from the banks' perspective that, during times of tightening financial conditions, the financial vulnerabilities of firms are more closely associated with their leverage and liquidity rather than their profitability. In these periods, banks may also be less sensitive to past profitability, given that an increase in funding costs can negatively impact economic activity and deteriorate future prospects of firms' profitability.

5. Conclusion

Banks price firms' financial conditions when providing loans. Factors related to firms' indebtedness, liquidity and profitability are shown to have a significant and economic effect on interest rates setting by banks. The interest rate charged on new loans tends to be higher with the level of firm's indebtedness, and lower when liquidity and profitability rises. Importantly, banks' pricing of loans is more sensitive to changes in firm liquidity.

The pricing of firms' financial characteristics is also studied depending on firms' size, age and the number of bank relationships. For micro and small firms, banks are more reactive to their leverage and less reactive to their measures of liquidity and profitability compared to medium-sized firms. For medium-sized firms, there is a negative relationship between the charged interest rate and leverage. It seems that higher leverage for medium-sized firm is related to growing firm and better economic perspectives in the future, decreasing the charged interest rate. Interestingly, for the big firms in our sample, banks do not react to changes in leverage or liquidity. However, the influence of firm profitability on pricing is more significant compared to micro, small, and medium-sized firms. Those findings suggests that as firms grow, loan pricing becomes more closely tied to economic performance (profitability) rather than purely financial variables such as leverage and liquidity. Regarding firms' age, it appears that throughout a firm's life cycle, banks' loan pricing place greater emphasis on the level of debt for younger firms, rather than on their profitability. As the firm ages, leverage becomes less relevant in loan pricing, while the importance of profitability grows. Finally, firms with few bank lending relationships are charged a higher interest rate regarding their leverage compared to firms with a high number of bank relationships.

The 6-month change in the average interest rates is analyzed, attributing it to various factors, including characteristics of firms, loans, and banks, common macroeconomic shocks, and a sample compositional factor. The common macroeconomic shock stands out as the primary driver of average interest rate changes, significantly contributing to the decrease in rates from 2013 to 2017 and leading the increase from June 2022 to mid-2023. The bank component was vital in explaining the reduction in the average interest rate from 2013 to 2017, primarily due to a decrease in banks' implicit funding costs, thus enabling lower rates for firms. Starting from January 2023, the bank component has been instrumental in driving up rates, indicating the delayed effect of ECB policy rate hikes on banking variables, especially the implicit funding cost of Portuguese banks. During the COVID-19 period, loan characteristics played a significant role in lowering interest rates. The firm component responded notably during various macroeconomic and financial events, driving rates higher following the sovereign debt crisis, during, and after the COVID-19 crisis, as well as in the current tightening cycle of financial conditions.

Furthermore, significant evidence points to time-varying sensitivities in loan pricing concerning the three financial characteristics of firms. The time-varying sensitivities fluctuate around their average effect, with many periods in which the time-varying effect coincides with the average effect. However, during some periods the sensitivity of banks to indicators of firm's financial soundness deviates from their average effect, underscoring that banks' pricing strategies vary over time. Those deviations are linked to macroeconomic and financial variables.

In times of high uncertainty or tight financial conditions, banks tend to be stricter in pricing firm leverage, resulting in higher interest rates compared to more stable periods. The rise in the sensitivity to leverage during the COVID-19 outbreak is related to an increase in economic uncertainty and lower economic growth, while at the end of 2022 is due to the monetary policy tightening.

Banks become more attentive to firms' liquidity in periods of tight financial conditions. During 2012-2014 and 2022-2023 when overall financial conditions were tight, banks were more sensitive about firms' liquidity, and less responsive during the period of low/negative interest rates from 2015 to 2021.

During periods of low economic growth, the responsiveness of interest rates to firms' profitability becomes more pronounced. Additionally, during periods of tighter financial conditions, assessed by a higher 12-month Euribor, banks reduce their sensitivity to changes in firm profitability. In the aftermath of the sovereign debt crisis, and during the COVID-19 outbreak, lower economic activity explained the increase in sensitivity of interest rates to profitability. Since 2021, interest rates have become less responsive to firms' profitability, driven by the tightening of monetary policy (higher contribution of the 1-year Euribor). In the recent period of monetary policy tightening, banks may be less sensitive to past profitability, given that an increase in funding costs can negatively impact economic activity and deteriorate future prospects of firms' profitability.

Our results indicate that in the current environment of high-interest rates, firms' liquidity is expected to significantly mitigate credit costs. Firms with greater liquidity are better positioned to cope with the ongoing tightening cycle and increases in debt service. Notably, there has been a significant increase in the sensitivity of interest rates to firms' liquidity over the past year. Moreover, the findings also highlight the necessity of monitoring firm leverage closely. The responsiveness of interest rates to firms' leverage has increased in the recent period. Should an economic shock occur, leading to economic uncertainty or more restrictive financial conditions, NFCs with substantial leverage will encounter higher financing costs, which could increase their likelihood of default. Finally, the sensitivity to firm profitability has recently decreased, likely due to reduced prospects for future profitability following the recent tightening of monetary policy.

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Appendix

Appendix A: Data sources and additional information on the data set

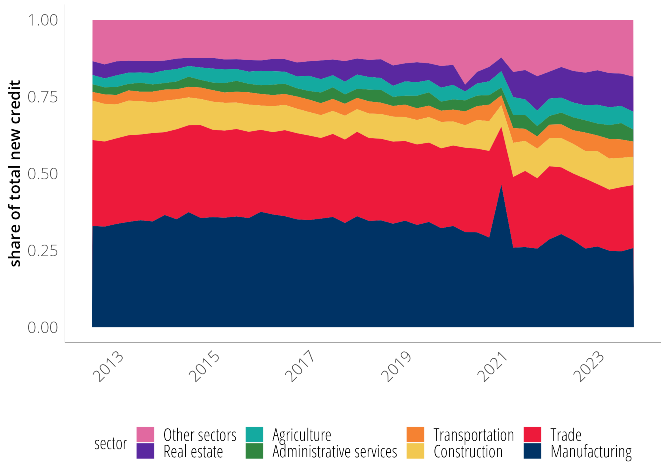


Figure A.1: New credit by sector 2012-2023

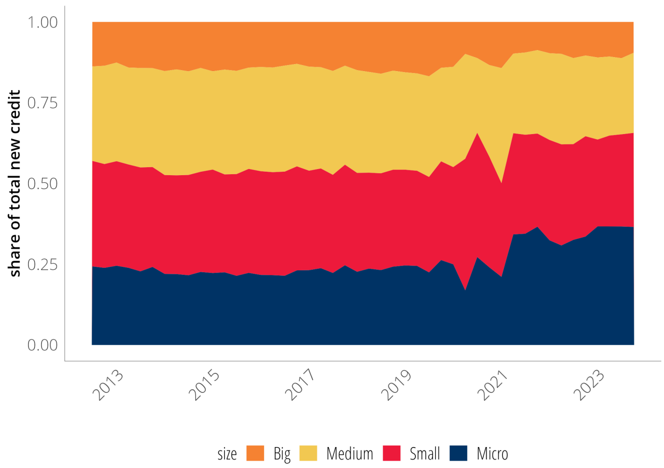


Figure A.2: New credit by firm size 2012-2023

Loan-level information on new loans for Portugal, monthly frequency
Source: New operations (2012 Jul-2020 Mar, 2021 Mar - 2023 Aug). Portuguese credit register (2020 Apr - 2021 Feb)
Variables: Amount outstanding, maturity, collateral (dummy), renegotiated loan (dummy), government guarantee (dummy)
The government guarantee is computed as follows: Loans whose "guarantor" is an institution providing loans backed by the gov. or the general government
Firm-level variables, yearly frequency for balance sheet data and monthly frequency for CRC computed variables
Source: IES (2011-2022) for the firm-level variables. ICAS (2011-2022) for the probability of default. CRC (2012-2023) for the number of bank-firm relationships
Variables: Total assets, leverage (Financial debt over / total assets), liquidity (cash + deposits over total assets), profitability (EBITDA over total assets), firm age, number of bank-firm relationships, probability of default (ICAS).
Bank-level variables, quarterly frequency
Source: Caderno do sistema bancario and Relatorio do sistema bancario, Q3 2012-Q3 2023
Variables: Loans to deposits, total capital ratio (Ratio of own funds to risk-weighted assets), total assets, implicit funding cost.
Implicit funding cost: The cost of funding for a bank includes expenses related to interbank liabilities, central bank financing, deposits, securities-related liabilities, and subordinated liabilities. This cost is calculated as a weighted average of interest rates paid for each type of liability funding.
Macroeconomic variables, quarterly frequency
Source: BPstat, Banco de portugal statistics
Variables: Nominal GDP growth (year over year), Euribor 1 year, 10-years government bond yield for Portugal, World uncertainty index for Portugal Ahir *et al.* (2022))

Table A.1. Data sources and description of variables

Appendix B: Static specification with all controls

In the following specification, the continuous explanatory variables are not standardized. Therefore, the estimated coefficients need to be interpreted in the scale of each independent variable.

	(1)
Loan	
Amount Outstanding (log)	−0.237***
	(0.012)
Maturity (log)	−0.612***
	(0.011)
Collateral	0.403***
	(0.035)
Renegotiation	0.306***
	(0.044)
Government guarantee	−0.898***
	(0.040)
Firm	
Total assets (log)	−0.426***
	(0.013)
Leverage	0.002***
	(0.000)
Cash over assets	−0.012***
	(0.001)
EBITDA over assets	−0.002***
	(0.000)
Bank	
Loan to deposits	0.014***
	(0.001)
Capital ratio	0.069***
	(0.005)
Funding cost	0.664***
	(0.045)
Total assets (log)	−1.507***
	(0.075)
Num.Obs.	3 330 993
R2	0.508
Industry fixed effects	Yes
Bank fixed effects	Yes
Time fixed effects	Yes
Std. Errors clustered	by: Firm

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B.1. Interest rates on new loans

	Baseline (1)	PD (2)	bank*time FEs (3)	industry*time FEs (4)	Larger controls (5)
Loan					
Amount Outstanding (log)	−0.395***	−0.375***	−0.389***	−0.397***	−0.393***
	(0.020)	(0.019)	(0.021)	(0.020)	(0.020)
Maturity (log)	−0.759***	−0.759***	−0.760***	−0.759***	−0.769***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Collateral	0.403***	0.402***	0.439***	0.402***	0.394***
	(0.035)	(0.033)	(0.035)	(0.034)	(0.035)
Renegotiation	0.306***	0.285***	0.239***	0.306***	0.313***
	(0.044)	(0.038)	(0.043)	(0.044)	(0.044)
Government guarantee	−0.898***	−0.906***	−0.863***	−0.850***	−0.900***
	(0.040)	(0.039)	(0.039)	(0.038)	(0.041)
Firm					
Total assets (log)	−0.853***	−0.772***	−0.846***	−0.854***	−0.873***
	(0.025)	(0.022)	(0.025)	(0.025)	(0.034)
Leverage	0.064***		0.066***	0.064***	0.061***
	(0.012)		(0.012)	(0.012)	(0.012)
Cash over assets	−0.169***		−0.165***	−0.167***	−0.174***
	(0.013)		(0.013)	(0.013)	(0.013)
EBITDA over assets	−0.037***		−0.037***	−0.034***	−0.042***
	(0.007)		(0.007)	(0.007)	(0.007)
Prob. of default (ICAS)		0.385***			
		(0.016)			
# bank relationships					−0.015
					(0.024)
Age					0.009
					(0.020)
Bank					
Loan to deposits	0.253***	0.238***		0.250***	0.251***
	(0.017)	(0.016)		(0.016)	(0.017)
Capital ratio	0.224***	0.225***		0.224***	0.219***
	(0.016)	(0.015)		(0.013)	(0.016)
Funding cost	0.662***	0.614***		0.643***	0.672***
	(0.045)	(0.045)		(0.045)	(0.045)
Total assets (log)	−0.796***	−0.795***		−0.796***	−0.823***
	(0.039)	(0.038)		(0.040)	(0.040)
Num.Obs.	3 330 993	3 328 733	3 330 993	3 330 993	3 282 609
R2	0.508	0.517	0.523	0.510	0.509
Industry fixed effects	Yes	Yes	Yes		Yes
Bank fixed effects	Yes	Yes		Yes	Yes
Time fixed effects	Yes	Yes			Yes
Bank*Time fixed effects			Yes		
Industry*Time fixed effects				Yes	
Std. Errors clustered	by: Firm	by: Firm	by: Firm	by: Firm	by: Firm

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001. All continuous variables are standardized.

Table B.2. Interest rates on new loans

	(1)
Loan	
Amount Outstanding (log)	−0.395***
	(0.020)
Maturity (log)	−0.758***
	(0.013)
Collateral	0.401***
	(0.035)
Renegotiation	0.312***
	(0.044)
Government guarantee	−0.904***
	(0.040)
Firm	
Total assets (log)	−0.852***
	(0.025)
Leverage	0.064***
	(0.012)
Cash over assets	−0.168***
	(0.013)
EBITDA over assets	−0.037***
	(0.007)
Bank	
Loan to deposits	0.211***
	(0.018)
Capital ratio	0.218***
	(0.016)
Total assets (log)	−0.956***
	(0.036)
Num.Obs.	3 330 993
R2	0.388
Industry fixed effects	Yes
Bank fixed effects	Yes
Time fixed effects	Yes
Std. Errors clustered	by: Firm

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B.3. Dependent variable: Spread (Interest rate - Bank funding cost)

Appendix C: Decomposing the change in average interest rate in new loans to firms

We would like to decompose the interest rate between different drivers using the coefficients in the baseline regression. For every loan in our sample, the following equation holds:

$$IR_{i,j,b,t} = \widehat{IR}_{i,j,b,t} + \widehat{\varepsilon}_{i,j,b,t} \tag{C.1}$$

We decide to decompose the change in the interest rate since decomposing the levels will be influenced by the choose of the reference group to estimate the fixed effects model. Ideally, one could decompose the change in the interest rate proposed by a bank b to a borrower j between month t and $t+h$ as follows:

$$IR_{i,j,b,t+h} - IR_{i,j,b,t} = \widehat{IR}_{i,j,b,t+h} - \widehat{IR}_{i,j,b,t} + \widehat{\varepsilon}_{i,j,b,t+h} - \widehat{\varepsilon}_{i,j,b,t} \tag{C.2}$$

However, this approach assumes a panel data structure, whereas our dataset consists of a pooled cross-section, meaning repeated observations for the same borrower over time may not be consistently available. Consequently, instead of implementing the relationship at a granular level, the analysis applies it by comparing average interest rates over time. Let's denote N_t, the number of loans that are observed in month t. The average change in interest rate is computed as follows:

$$\begin{aligned}\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} IR_{i,j,b,t+h} - \frac{1}{N_t}\sum_{i=1}^{N_t} IR_{i,j,b,t} = \frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} \widehat{IR}_{i,j,b,t+h} - \frac{1}{N_t}\sum_{i=1}^{N_t} \widehat{IR}_{i,j,b,t} \\ + \frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} \widehat{\varepsilon}_{i,j,b,t+h} - \frac{1}{N_t}\sum_{i=1}^{N_t} \widehat{\varepsilon}_{i,j,b,t}\end{aligned} \tag{C.3}$$

The average value of the predicted interest rate can be decomposed as follows

$$\begin{aligned}\frac{1}{N_t}\sum_{i=1}^{N_t} \widehat{IR_{i,j,t}} = \widehat{\beta}\frac{1}{N_t}\sum_{i=1}^{N_t} borrower_{i,j,t-12} + \widehat{\alpha}\frac{1}{N_t}\sum_{i=1}^{N_t} bank_{i,b,t-3} + \widehat{\gamma}\frac{1}{N_t}\sum_{i=1}^{N_t} loan_{i,t} \\ + \frac{1}{N_t}\sum_{i=1}^{N_t} compo_{i,j,b,t} + T_t\end{aligned} \tag{C.4}$$

$industry_{i,j}$ represents for a loan i and a borrower j, the industry k at which the borrower belongs to. $bank_{i,b}$ represents for a loan i, the bank b that provided the credit. In our sample we have different industries represented by $k \in K = \{1, ..., K^*\}$. There are also different banks providing credits $b \in B = \{1, ..., B^*\}$. With the previous information, the composition factor is detailed:

$$\frac{1}{N_t}\sum_{i=1}^{N_t} compo_{i,j,b,t} = \frac{1}{N_t}\sum_{k=1}^{K^*}\sum_{i=1}^{N_t} \widehat{\delta}_k * 1\{industry_{i,j} = k\} + \frac{1}{N_t}\sum_{b=1}^{B^*}\sum_{i=1}^{N_t} \widehat{\theta}_b * 1\{bank_{i,b} = b\}$$

$$\frac{1}{N_t}\sum_{i=1}^{N_t} compo_{i,j,b,t} = \frac{1}{N_t}\sum_{k=1}^{K^*} \widehat{\delta}_k \sum_{i=1}^{N_t} 1\{industry_{i,j} = k\} + \frac{1}{N_t}\sum_{b=1}^{B^*} \widehat{\theta}_b \sum_{i=1}^{N_t} *1\{bank_{i,b} = b\}$$

$$\frac{1}{N_t}\sum_{i=1}^{N_t} compo_{i,j,b,t} = \frac{1}{N_t}\sum_{k=1}^{K^*}\widehat{\delta_k} * N_t^k + \frac{1}{N_t}\sum_{b=1}^{B^*}\widehat{\theta_b} * N_t^b \tag{C.5}$$

Equation C.5 shows that the average compositional effect is equal to a weighted average of industry and banks' fixed effects.

All the explanatory variables in the borrower and bank component are continuous, therefore their interpretation is straigthforward. However, for the loan component there are continuois and dummy variables. The continuous variables are the amount outstanding and maturity of the loan. For the dummy variables we have the collateral, loan renegotiation and government guarantee. The loan component can be decomposed as follows:

$$\begin{aligned}\widehat{\gamma}\frac{1}{N_t}\sum_{i=1}^{N_t} loan_{i,t} = \widehat{\gamma_1}\frac{1}{N_t}\sum_{i=1}^{N_t} loan_{i,t}^C + \frac{1}{N_t}\sum_{i=1}^{N_t}(\widehat{\gamma_2} * 1\{Collat_{i,t}=1\} \\ + \widehat{\gamma_3} * 1\{Reneg_{i,t}=1\} + \widehat{\gamma_4} * 1\{\mathsf{Govguar}_{i,t}=1\})\end{aligned} \tag{C.6}$$

$$\widehat{\gamma}\frac{1}{N_t}\sum_{i=1}^{N_t} loan_{i,t} = \widehat{\gamma_1}\frac{1}{N_t}\sum_{i=1}^{N_t} loan_{i,t}^C + \frac{\widehat{\gamma_2} * N_t^{Collat}}{N_t} + \frac{\widehat{\gamma_3} * N_t^{Reneg}}{N_t} + \frac{\widehat{\gamma_4} * N_t^{Govguar}}{N_t} \tag{C.7}$$

With $\frac{1}{N_t}\sum_{i=1}^{N_t} loan_{i,t}^C$ being the average value for the continuous variables. We now develop equation C.3 knowing the information for equations C.4, C.5 and C.7.

$$\begin{aligned}&\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} IR_{i,j,b,t+h} - \frac{1}{N_t}\sum_{i=1}^{N_t} IR_{i,j,b,t} = \\ &\quad\widehat{\beta}(\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} borrower_{i,j,t+h-12} - \frac{1}{N_t}\sum_{i=1}^{N_t} borrower_{i,j,t-12}) \\ &+\widehat{\alpha}(\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} bank_{i,b,t+h-3} - \frac{1}{N_t}\sum_{i=1}^{N_t} bank_{i,b,t-3}) + \widehat{\gamma}(\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} loan_{i,t+h} - \frac{1}{N_t}\sum_{i=1}^{N_t} loan_{i,t}) \\ &\quad+(\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} compo_{i,j,b,t+h} - \frac{1}{N_t}\sum_{i=1}^{N_t} compo_{i,j,b,t}) + (T_{t+h} - T_t) \\ &\quad\quad+\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}}\widehat{\varepsilon}_{i,j,b,t+h} - \frac{1}{N_t}\sum_{i=1}^{N_t}\widehat{\varepsilon}_{i,j,b,t}\end{aligned} \tag{C.8}$$

The average change in interest rate between t and $t+h$ can be broken down into the average change in borrower, bank and loan characteristics, the change in the time fixed effects, the sample composition and average residuals.

At a very aggregate level like the one is studied in section 2 (average change in interest rate), the average predicted interest rate is equal to the average observed interest rate for every month t. Therefore, the average estimated residual across time is equal to 0. The conditional average of the residuals is zero because the conditioning variable (a given month t) is included in the model as fixed effects and the equation is estimated with OLS. For this reason $\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}}\widehat{\varepsilon}_{i,j,b,t+h} - \frac{1}{N_t}\sum_{i=1}^{N_t}\widehat{\varepsilon}_{i,j,b,t} = 0$.

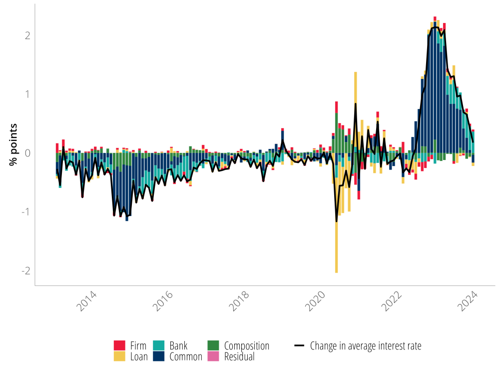
Now let's detail the change in the composition and loan factor, denoting N_t the number of loans that are observed in month t, N_t^k the number of loans that are given to firms in industry k and N_t^b the number of loans that are given by firm b.

$$\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} compo_{i,j,b,t+h} - \frac{1}{N_t}\sum_{i=1}^{N_t} compo_{i,j,b,t} = \sum_{k=1}^{K^*}\widehat{\delta}_k\left(\frac{N_{t+h}^k}{N_{t+h}} - \frac{N_t^k}{N_t}\right) + \sum_{b=1}^{B^*}\widehat{\theta}_b\left(\frac{N_{t+h}^b}{N_{t+h}} - \frac{N_t^b}{N_t}\right) \tag{C.9}$$

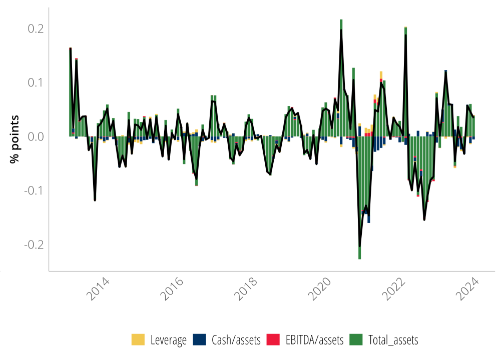
The change in the compositional factor will be equal to the change in the proportion of loans given to different sector or by different banks multiplied by the respective fixed effect.

$$\widehat{\gamma}\left(\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} loan_{i,t+h} - \frac{1}{N_t}\sum_{i=1}^{N_t} loan_{i,t}\right) = \widehat{\gamma_1}\left(\frac{1}{N_{t+h}}\sum_{i=1}^{N_{t+h}} loan_{i,t+h}^C - \frac{1}{N_t}\sum_{i=1}^{N_t} loan_{i,t}^C\right)$$
$$+\widehat{\gamma_2} * \left(\frac{N_{t+h}^{Collat}}{N_{t+h}} - \frac{N_t^{Collat}}{N_t}\right) + \widehat{\gamma_3} * \left(\frac{N_{t+h}^{Reneg}}{N_{t+h}} - \frac{N_t^{Reneg}}{N_t}\right) + \widehat{\gamma_3} * \left(\frac{N_{t+h}^{Govguar}}{N_{t+h}} - \frac{N_t^{Govguar}}{N_t}\right) \tag{C.10}$$

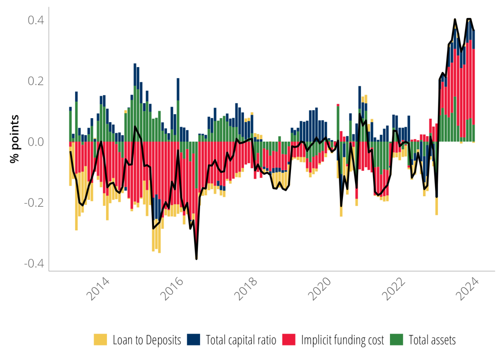
The change in the loan factor will be equal to the change in the average value of the continuous loan variables, plus the change in the proportion of different loan characteristics.



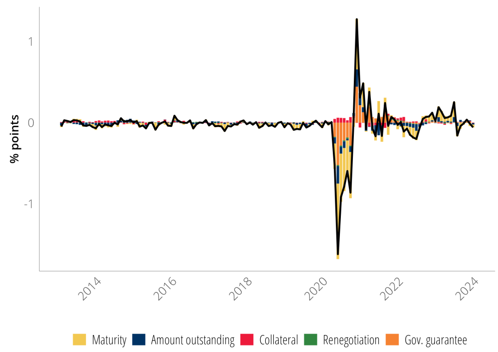
All



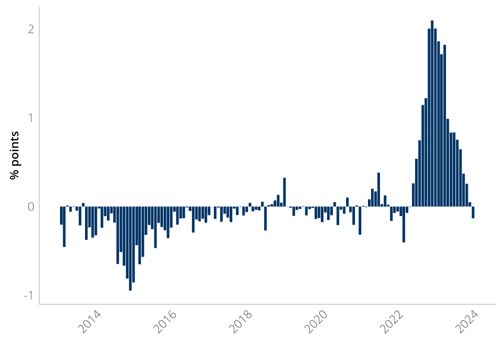
Borrower contribution



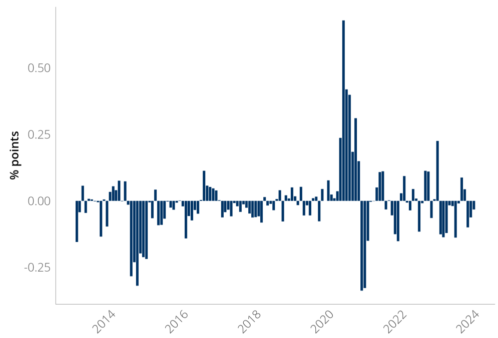
Bank contribution



Loan contribution



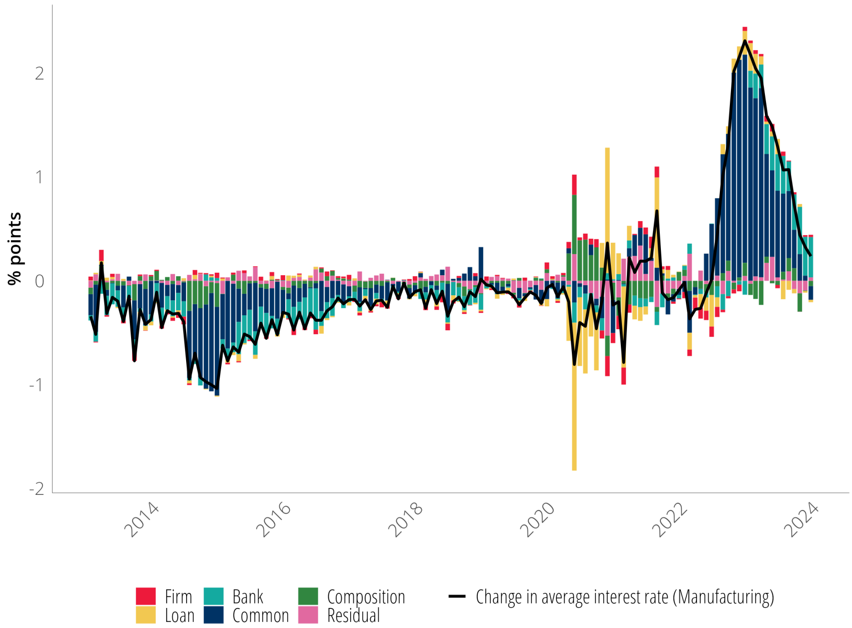
Common macroeconomic shocks



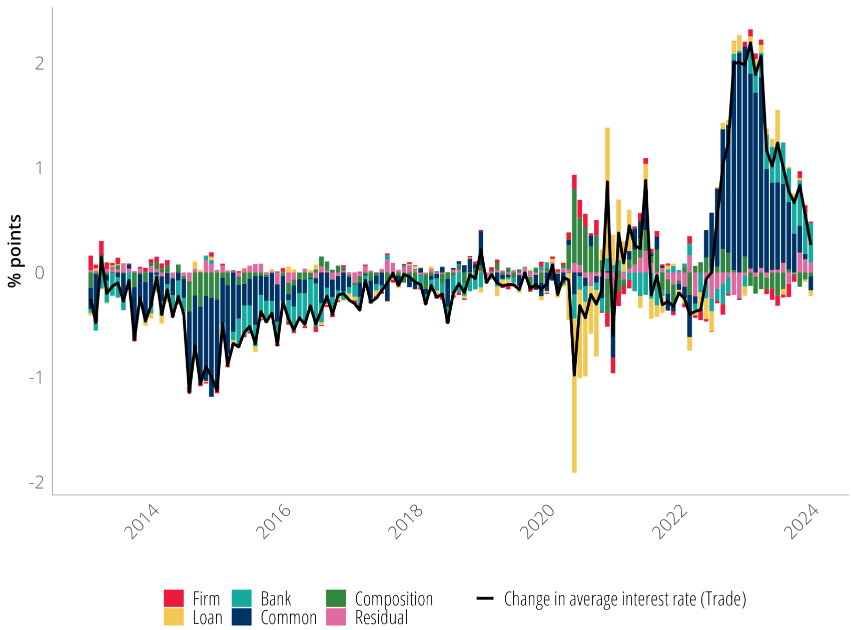
Compositional effect

Figure C.1: Six-month change in average interest rate: Decomposition by type of driver category

Notes: Decomposition of six-month change in the average interest rate for each month. The decomposition of every subcomponent is also shown.



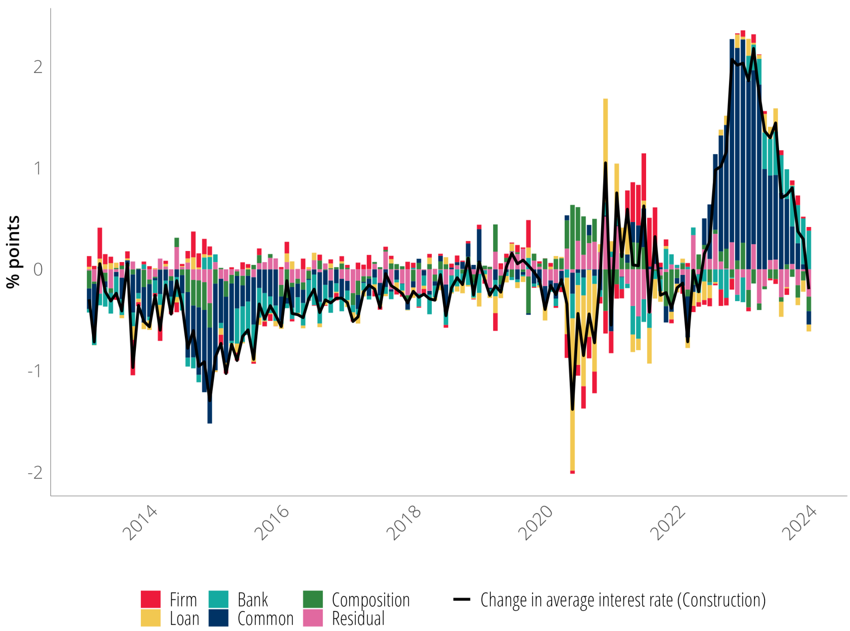
Manufacturing



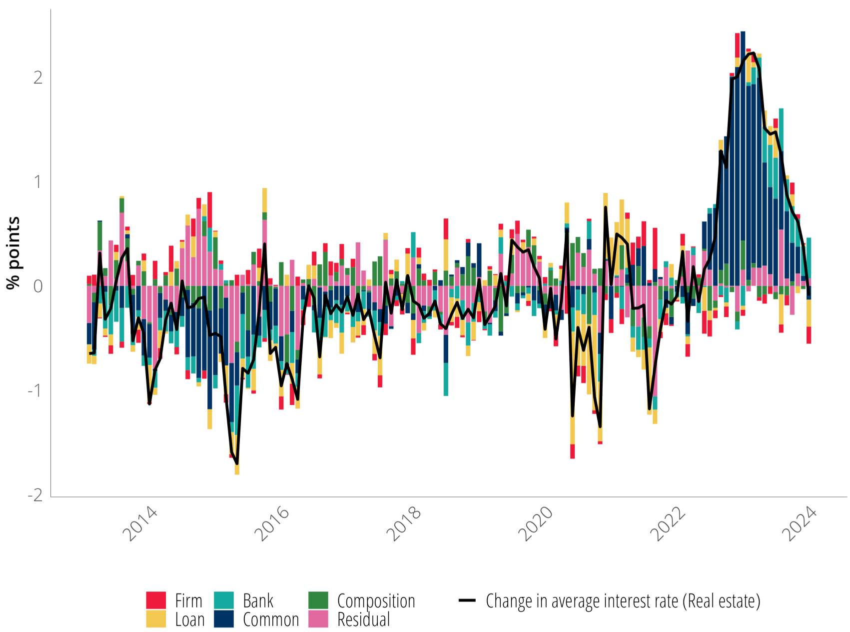
Trade

Figure C.2: Six-month change in average interest rate decomposition across time, for the sectors contracting more credit

Notes: Decomposition of six-month change in the average interest rate by sector



Construction



Real estate

Figure C.3: Six-month change in average interest rate decomposition across time, for the sectors contracting more credit

Notes: Decomposition of six-month change in the average interest rate by sector

Appendix D: Time-varying effect of firms' financial conditions at monthly frequency

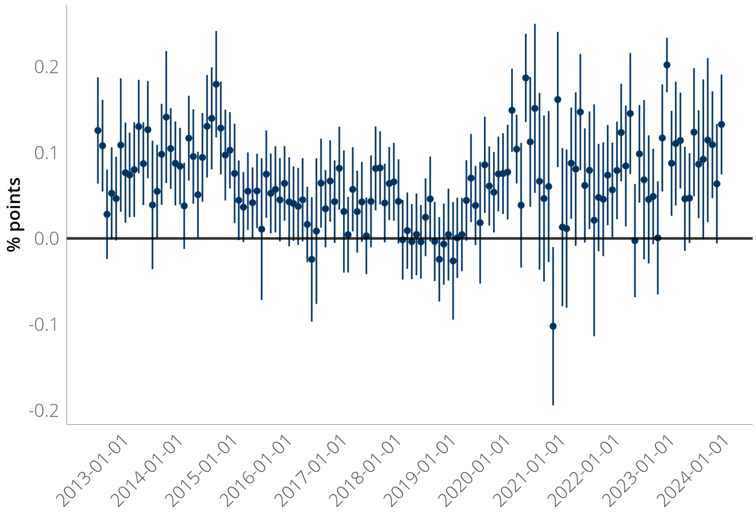


Figure D.1: Interest rate sensitivity to leverage

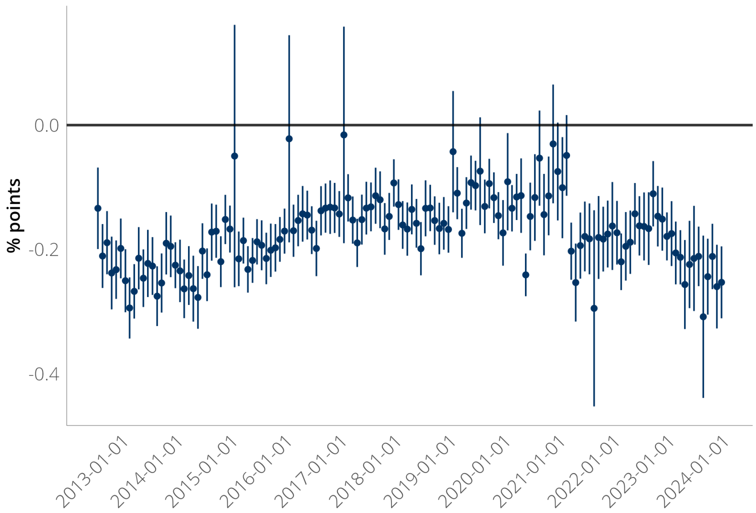


Figure D.2: Interest rate sensitivity to liquidity

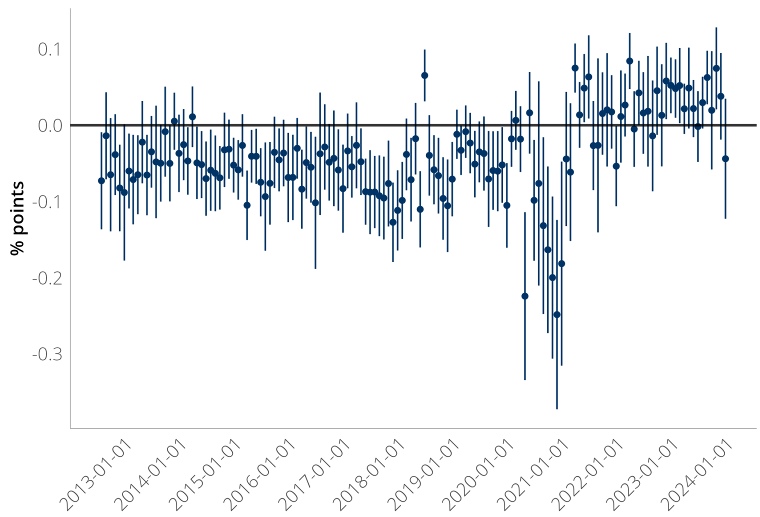


Figure D.3: Interest rate sensitivity to profitability

Appendix E: Time-varying effect of probability of default on banks' interest rates

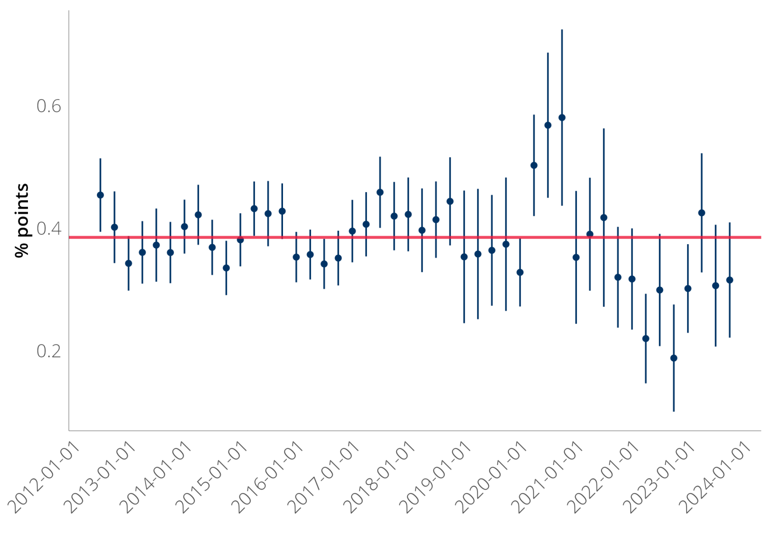


Figure E.1: Interest rate sensitivity to PD

Appendix F: Heterogenity across sectors

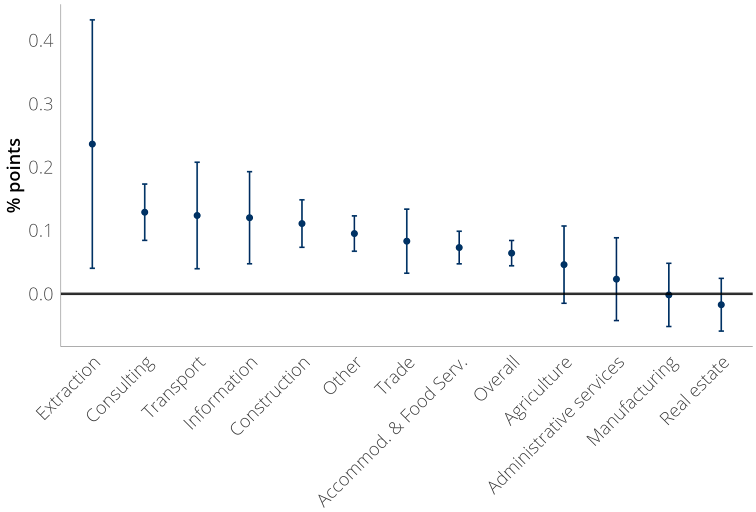


Figure F.1: Effect of firms' leverage, by sector

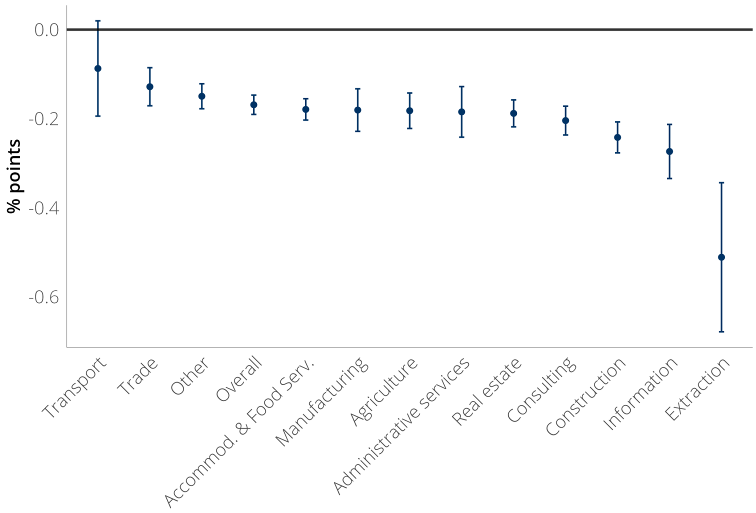


Figure F.2: Effect of firms' cash over assets, by sector

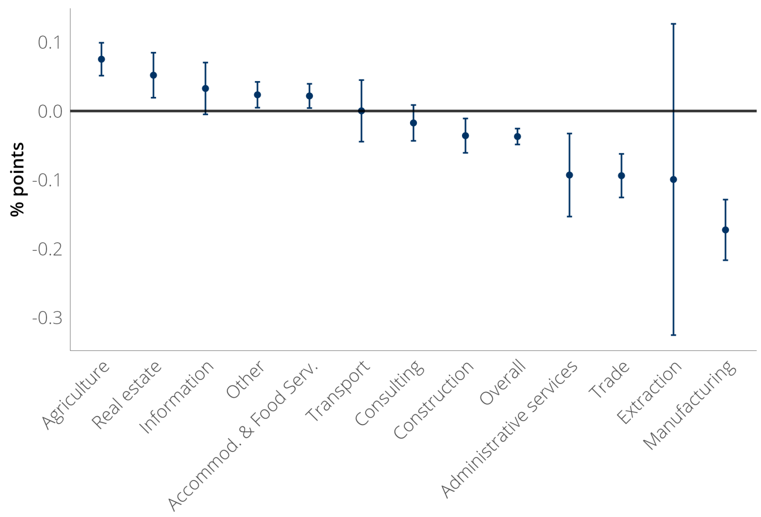


Figure F.3: Effect of firms' profitability, by sector

Appendix G: Heterogenity across sectors, time-varying specification

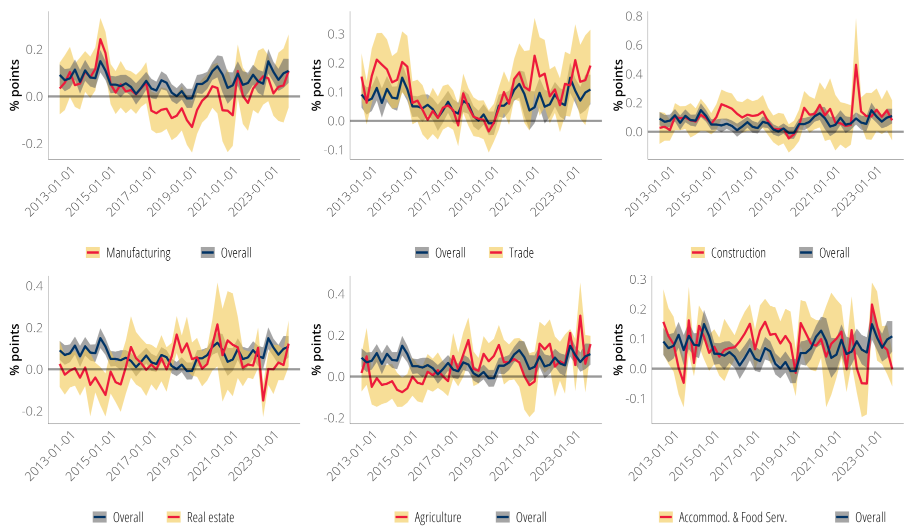


Figure G.1: Changing sensitivity to leverage, by sector

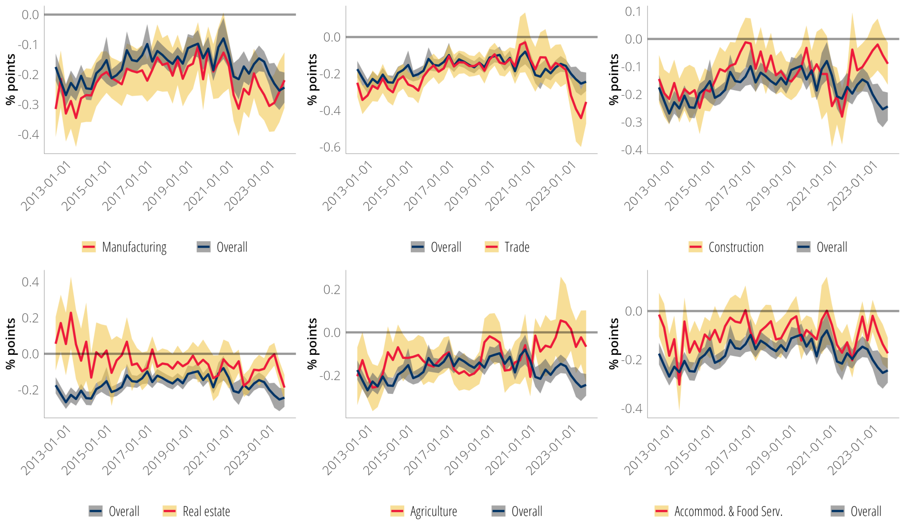


Figure G.2: Changing sensitivity to cash over assets, by sector

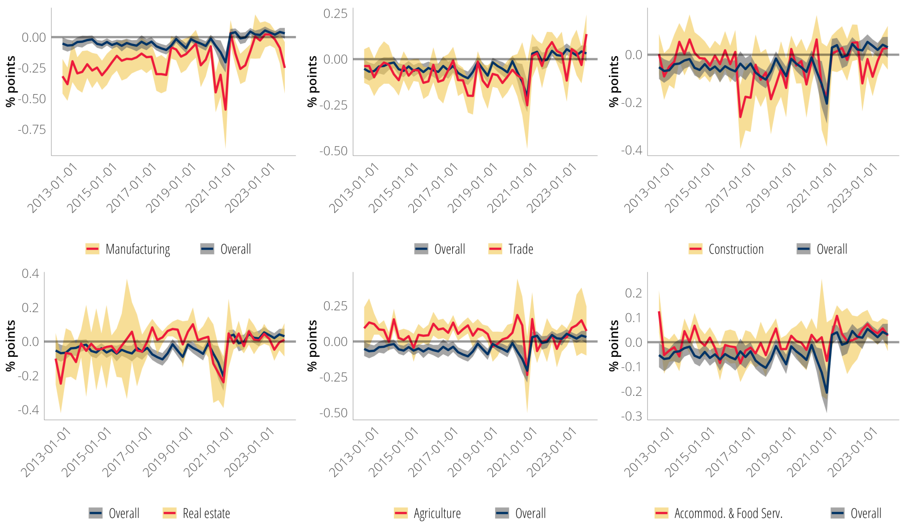
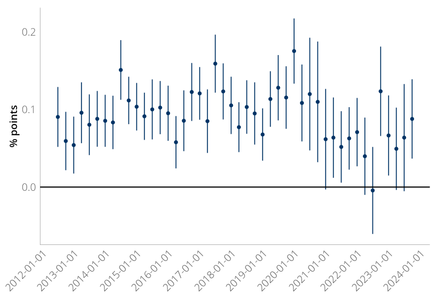


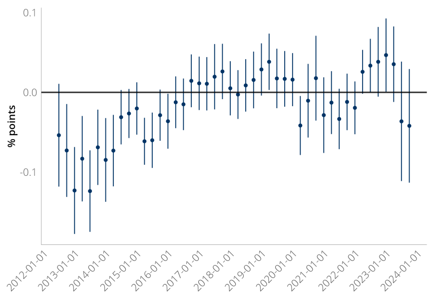
Figure G.3: Changing sensitivity to EBITDA over assets, by sector

Appendix H: Heterogenity across firm size, time-varying spec.

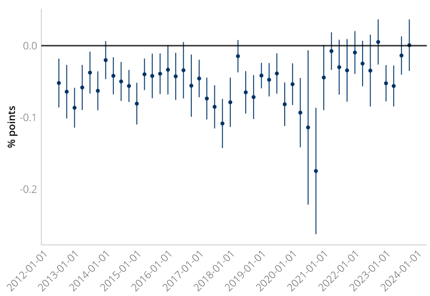
H.1. Micro firms



(A) IR sensitivity to Leverage, β_Q



(B) IR sensitivity to Cash/Assets, α_Q



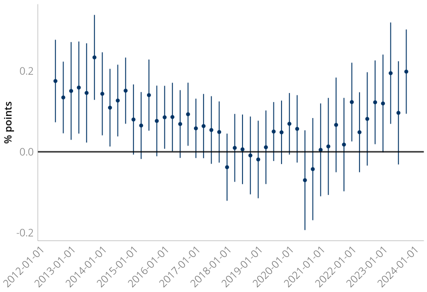
(C) IR sensitivity to EBITDA/Assets γ_Q

Notes: The changing sensitivities (Blue dots) are estimated using equation 5 for micro firms. The 90% confidence intervals are shown.

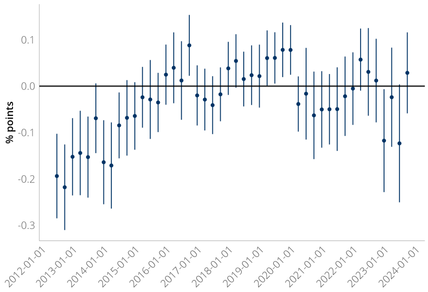
	Leverage β_q	Cash/Assets α_q	EBITDA/Assets γ_q
(Intercept)	0.091***	−0.017**	−0.052***
	(0.005)	(0.005)	(0.004)
GDP growth (Y-o-Y)	−0.008+	0.008+	0.019**
	(0.004)	(0.005)	(0.005)
10-years gov. bond yield	−0.004	−0.026***	0.003
	(0.004)	(0.006)	(0.004)
1-year Euribor	−0.007	0.010	0.010*
	(0.005)	(0.006)	(0.004)
Uncertainty	0.002	0.004	0.004
	(0.006)	(0.005)	(0.004)
Num.Obs.	46	46	46
R2 Adj.	0.058	0.364	0.352
F	2.128	4.547	5.851

Drivers of changing sensitivities for micro firms. The explanatory variables are standardized
Robust standard errors are used, + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

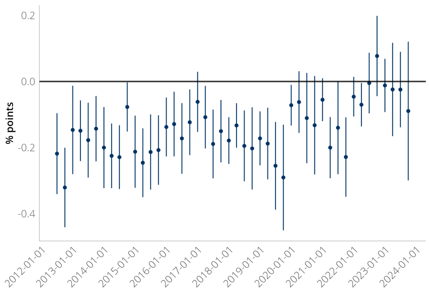
H.2. Small firms



(A) IR sensitivity to Leverage, β_Q



(B) IR sensitivity to Cash/Assets, α_Q



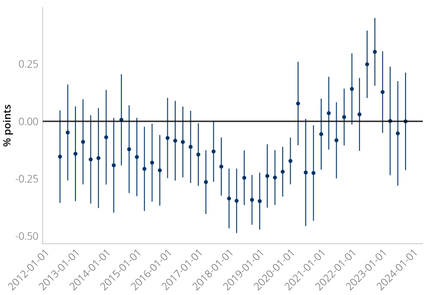
(C) IR sensitivity to EBITDA/Assets γ_Q

Notes: The changing sensitivities (Blue dots) are estimated using equation 5 for small firms. The 90% confidence intervals are shown.

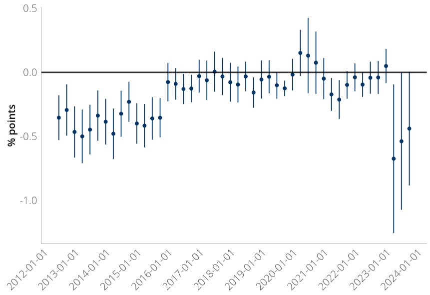
	Leverage β_q	Cash/Assets α_q	EBITDA/Assets γ_q
(Intercept)	0.078***	-0.033***	-0.145***
	(0.006)	(0.009)	(0.010)
GDP growth (Y-o-Y)	0.008	0.015	-0.005
	(0.008)	(0.010)	(0.010)
10-years gov. bond yield	0.041***	-0.049***	-0.028*
	(0.007)	(0.008)	(0.011)
1-year Euribor	0.025**	0.000	0.051***
	(0.008)	(0.011)	(0.010)
Uncertainty	0.008	0.010	0.009
	(0.006)	(0.010)	(0.012)
Num.Obs.	46	46	46
R2 Adj.	0.587	0.440	0.292
F	15.518	13.681	7.669

Drivers of changing sensitivities for small firms. The explanatory variables are standardized
Robust standard errors are used, + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

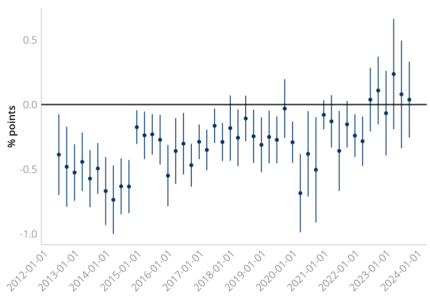
H.3. Medium firms



(A) IR sensitivity to Leverage, β_Q



(B) IR sensitivity to Cash/Assets, α_Q



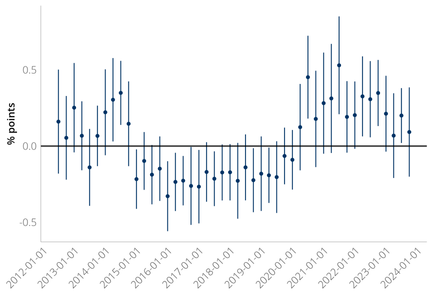
(C) IR sensitivity to EBITDA/Assets γ_Q

Notes: The changing sensitivities (Blue dots) are estimated using equation 5 for medium-size firms. The 90% confidence intervals are shown.

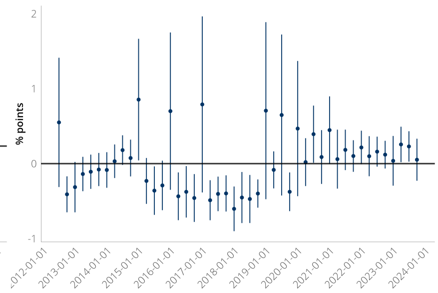
	Leverage β_q	Cash/Assets α_q	EBITDA/Assets γ_q
(Intercept)	-0.112***	-0.186***	-0.295***
	(0.018)	(0.023)	(0.022)
GDP growth (Y-o-Y)	0.026	-0.023	0.068**
	(0.031)	(0.014)	(0.020)
10-years gov. bond yield	-0.011	-0.096***	-0.097***
	(0.017)	(0.021)	(0.027)
1-year Euribor	0.081***	-0.050	0.133***
	(0.020)	(0.038)	(0.018)
Uncertainty	0.043*	0.033	-0.019
	(0.020)	(0.029)	(0.025)
Num.Obs.	46	46	46
R2 Adj.	0.261	0.382	0.529
F	4.308	11.392	22.701

Drivers of changing sensitivities for medium-size firms. The explanatory variables are standardized
Robust standard errors are used, + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

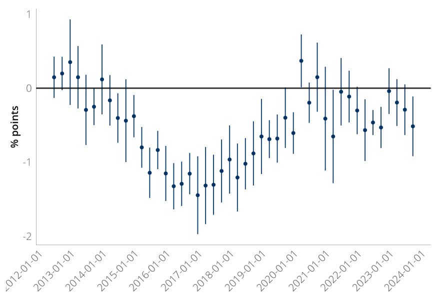
H.4. Big firms



(A) IR sensitivity to Leverage, β_Q



(B) IR sensitivity to Cash/Assets, α_Q



(C) IR sensitivity to EBITDA/Assets γ_Q

Notes: The changing sensitivities (Blue dots) are estimated using equation 5 for big firms. The 90% confidence intervals are shown.

	Leverage β_q	Cash/Assets α_q	EBITDA/Assets γ_q
(Intercept)	0.028	0.011	-0.538***
	(0.034)	(0.058)	(0.066)
GDP growth (Y-o-Y)	-0.014	-0.024	-0.185*
	(0.039)	(0.042)	(0.073)
10-years gov. bond yield	-0.031	-0.077	0.039
	(0.032)	(0.074)	(0.063)
1-year Euribor	0.073**	0.080*	0.131**
	(0.025)	(0.035)	(0.045)
Uncertainty	0.007	0.061	0.074
	(0.034)	(0.063)	(0.068)
Num.Obs.	46	46	46
R2 Adj.	-0.002	-0.020	0.190
F	2.587	1.452	3.207

Drivers of changing sensitivities for big firms. The explanatory variables are standardized
Robust standard errors are used, + p $<$ 0.1, * p $<$ 0.05, ** p $<$ 0.01, *** p $<$ 0.001

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