Heterogeneity in loan pricing: the role of bank capital

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July 2021

Abstract
In this article, we examine the role of bank characteristics in shaping loan pricing decisions. We evaluate the pricing differentials across banks lending to the same firm and find that lower levels of bank capital are associated with lower interest rates. Banks that are better capitalized compared to their historical average seem to be more conservative in loan pricing, offering higher loan spreads than the other banks lending to the same firm. However, bank capital does not seem to exert a screening incentive in the case of loans to riskier, smaller firms or firms with only two relationships. The results are stronger in the aftermath of the euro area sovereign debt crisis. (JEL: G21, G28, G32)

1. Introduction

Loan pricing should reflect the default risk of a loan. The characteristics of the borrower and loan attributes crucially influence the risk that a borrower might fail to repay the loan. However, interest rates applied by different banks on loans with similar characteristics to similar borrowers often exhibit a substantial dispersion. What else can explain differences in loan pricing across banks? The knowledge about the determinants of loan pricing is relevant in understanding the relation between bank behaviour and the economy and can help policy making in shaping bank regulation and supervision.

The goal of this article is to contribute to the understanding of the dispersion of loan spreads across banks. We use detailed loan level data that we can merge with firm-level indicators of risk and bank-level financial data to examine the role of bank characteristics in loan pricing decisions. This allows us to understand how different banks price risk. Directly comparing interest rates or loan spreads across banks is not enough, as banks may lend to borrowers with different characteristics. A bank may offer lower interest rates, on average, because it caters to a less risky pool of corporate borrowers. To make

Acknowledgements: We thank Nuno Alves, João Amador, António Antunes, Pedro Duarte Neves, Nicholas Kozeniauskas, Tiago Pinheiro, an anonymous referee, and participants in a seminar at Banco de Portugal for helpful comments and suggestions. The analyses, opinions and conclusions expressed herein are the sole responsibility of the authors and do not necessarily reflect the opinions of Banco de Portugal or the Eurosystem.

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sure we are truly capturing differences across banks, we focus on firms that borrow from more than one bank in the same quarter. By comparing loan spreads offered by different banks to the same firm, we are evaluating how each bank prices the same level of risk.

The main focus of our analysis is the effect of bank capital on spread differentials across banks. Financial intermediation theories suggest that bank capital strengthens the screening and monitoring incentives of banks. Holmstrom and Tirole (1997) and Dell' Ariccia and Marquez (2006) argue that more capitalised banks screen and monitor more intensively their borrowers. Other papers document that due to agency costs, risk-shifting incentives arise for undercapitalized banks (Acharya and Steffen, 2015, Drechsler et al., 2016, Crosignani, 2017, Bonaccorsi and Kashyap, 2017). The bank-fragility theory of Diamond and Rajan (2000) posits that, relative to high-capital banks, low-capital banks should charge higher rates to borrowers that have low cash flows. Santos and Winton (2019) examine the effect of bank characteristics on loan spreads and find a significant negative relationship between bank capital and loan spreads. This relationship can change through the cycle, as shown by Gambacorta and Mistrulli (2014), who find that the effects of the financial crisis on interest rate spreads were lower for borrowers of well-capitalized banks.

Even though the literature emphasizes the role of bank capital in loan pricing decisions, borrower characteristics might also be relevant and even shape the relationship between bank capital and interest rates. To examine this, we evaluate this relationship for borrowers of different size, risk and with different relationships with their lenders. Throughout the analysis, we control for loan characteristics, such as amount, maturity, and collateral, as all these ingredients are part of the loan approval process and determine the ultimate level of risk of the exposure. The effect of these variables on spreads is not consensual. Larger and longer loans may be riskier, but they are also more likely to be granted to more creditworthy firms. Collateral should protect banks against the risk of a loan. Bester (1985) and Besanko and Thakor (1987) argue that the willingness to provide collateral serves as a credible signal of borrower quality and predict that low credit risk borrowers post collateral and obtain lower spreads. Nevertheless, collateral may itself be a proxy for a negative assessment of borrowers' risk and go hand in hand with higher spreads (Boot et al., 1991).

Our article adds to the empirical literature on this topic by focusing on the differential between the spread that a bank charges to a given borrower and the average spread charged by all banks lending to the same borrower. We find that the lower banks' capital ratios are compared to their historical averages, the more they tend to underprice the risk of a borrower relative to the other banks that lend to the same borrower. Focusing on loans to firms that borrow from more than one bank in each period ensures that the differences in interest rates across banks derive from banks' characteristics and are not driven by selection. This could be an important concern if, for example, less capitalized banks specialize in riskier borrowers. We deal with endogeneity issues arising from potential reverse causality between spreads charged and bank capital by relying on multiple levels of fixed effects. In our preferred specification, which includes both bank and firm-quarter fixed effects, we regress spread differentials vis à vis the average spread charged by all banks lending to the same borrower on banks' capital ratios. We

then claim that our main result is consistent with the hypothesis that capital exerts a monitoring incentive upon banks.

Section 2 describes the data and presents the empirical strategy. Section 3 analyzes the results and section 4 concludes.

2. Data and empirical strategy

2.1. Data

To evaluate loan pricing differentials we use a loan-level dataset, internally labeled as *New operations dataset*. This dataset includes information on all the new loans granted to firms by Portuguese banks since mid-2012 (Santos, 2013). Until end-2014, only banks with an annual volume of new loans larger than EUR 50 million had to report this information. From 2015 onwards, all resident banks reported to this dataset. For each loan we are able to observe the date of origination, the loan amount, the interest rate, the maturity and whether or not the loan is collateralized. We use data up to the last quarter of 2019. We only include loans with fixed maturity to make sure that the results are anchored on comparable observations, and firms that borrow from more than one bank in the same quarter, to make sure that differences in interest rates across banks derive from bank characteristics. We exclude renegotiations in which the customer is involved, automatic renovations and restructurings. Given that we want to examine the role of bank capital on loan pricing decisions, we exclude branches from foreign banks operating in Portugal, as these institutions are not subject to regulatory capital requirements in the host country. This sample represents on average 12% of the total amount lent by banks each quarter.

To account for the effect of relationship lending on loan pricing, we use the Central Credit Registry to compute the number of bank relationships held by each firm in each quarter. Further, we also use this dataset to identify the formation of new bank relationships.

To understand how bank characteristics might be relevant in shaping loan pricing decisions, we merge the loan-level information with quarterly bank-level data. We use the Historical Series on the Portuguese Banking Sector (Esteves, 2020), which include detailed financial statements on all the banks reporting interest rate data.[1]

Finally, given the role played by risk on loan pricing, we merge our data with internal credit ratings and default probabilities estimated in an in-house credit risk model developed at Banco de Portugal (Antunes et al., 2016). These risk indicators are available at an yearly frequency.

We winsorize interest rates with unreasonably low or high values (below the 5th percentile and above the 95th percentile). Loan maturity is winsorized at the 95th percentile.

1. More details on this dataset may be found here.

The loan-level data is aggregated at the firm-bank-quarter level. Whenever one bank grants more than one loan to a given firm in a quarter, loan characteristics are aggregated using weighted averages (with the weight being the loan amount).

2.2. *Summary statistics*

Figure 1 shows the evolution of the average loan spread over time in Portugal. For each new loan that is granted, we compute the spread as the difference between the interest rate charged on the loan and the 3-month Euribor. The average corporate loan spread depicted in the figure is the simple mean of loan spreads in each quarter.

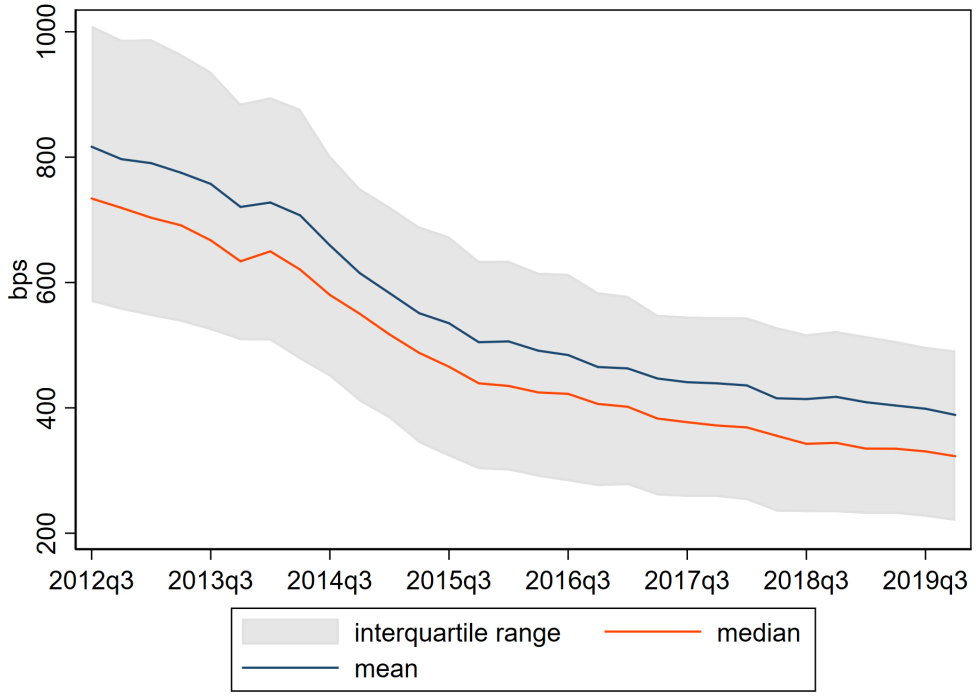

FIGURE 1: Dispersion in loan spreads

Source: Banco de Portugal and authors' estimates. Notes: The figure depicts the simple average of loan spreads, for all loans granted to firms in each quarter. The spread on a loan is the difference between the interest rate charged on the loan and the 3-month Euribor. The figure depicts the mean and median of the loan spread distribution, as well as the interquartile range. The sample begins in the 3rd quarter of 2012 and ends in the last quarter of 2019.

The average loan spread has been declining steeply since 2012. It stabilized around 400 basis points (bps) after 2017. The overall decrease in loan spreads occurs in a period of historically low interest rates and of increasing pressure on net interest margins. After the surge in loan spreads during the financial and sovereign debt crises, spreads gradually decreased as a result of lower funding costs but also of increasing competition. Given the fragile economic recovery, both internally and externally, this heightened competition was especially targeted at low-risk firms. Since 2012 banks have been increasing the share of new loans granted to lower-risk firms, which has improved the risk profile of the loan book.

The decrease in loan premia was accompanied by a smaller variation across banks, as shown by the interquantile range also depicted in Figure 1. A better understanding of this dispersion is precisely the focus of this article. At the core of our analysis will be the $weighted\ deviation$ in interest rate spreads, that is, the difference between the spread charged by bank i to firm j in quarter t and the weighted average of the spreads charged by all banks lending to firm j in quarter t. The weights are the shares of each bank lending to the firm in that quarter:

$$Deviation_{ijt} = Spread_{ijt} - \sum_{i} w_{ijt} Spread_{ijt} \tag{1}$$

We want to understand how different banks price risk. Simply comparing interest rates or loan spreads across banks would not yield the desired results, as banks may lend to borrowers with different risk levels. To make sure we are truly capturing differences across banks, we focus on firms that borrow from more than one bank in the same quarter. By comparing loan spreads offered by different banks to the same firm ($deviation$), we are evaluating how each bank prices the same level of risk. That said, the loans may differ in terms of amounts, maturities or collateral, what would also affect pricing. We control for these dimensions in the regressions.

The simple mean of the weighted deviation is 17 bps (Table 1). This figure is positive as the average does not weigh each weighted deviation by its loan amount. The weighted mean of the weighted deviation is, by definition, 0 bps. The average pricing differential across banks is not very large. That said, there is a lot of dispersion in this variable. The average interest rate is 5.4% in our sample. This compares with an average interest rate of 5.86% in loans where the firm borrows from only one bank in the quarter. The firms included in the sample belong mainly to the services and industry sectors and have a higher share of firms in the industry sector and a smaller share of firms in services than firms which, in each quarter, only borrow term loans from one bank. The majority of firms analyzed are micro and small firms and are, on average, larger than the firms which borrow term loans from only one bank in each quarter.

In Table 1 we also report summary statistics for other variables used in our analysis. The median loan is 50 thousand euros, reflecting the fact that most of the firms in the economy are small and medium enterprises (SME). The median maturity for a loan is 104 days. Slightly more than half (54%) have collateral.

The average default probability for each firm is 4.6% and it has been declining throughout the last decade. The average share of each bank in the total amount of loans granted to a firm in each quarter is 40%. On average, each firm borrows from 7 different banks (the median is 6). More than half of the firms have established a new relationship in the previous 12 months.

Our main hypothesis is that banks' loan pricing decisions may be strongly affected by how well capitalized banks are. On average, banks' Tier 1 capital ratio was 13%. Banks became better capitalized over time, as they emerged from the pressures felt during the euro area sovereign debt crisis and responded to tighter capital requirements regulation. The average total capital ratio was slightly higher (14%). There are 31 different banks in

	N	mean	std. dev	p5	p25	median	p75	p95
Interest rate and deviations:								
Interest rate (bps)	371,188	540	300	151	302	490	713	1167
Weighted deviation (bps)	371,188	17.40	204	-267	-65	-0.45	78	365
Simple mean deviation (bps)	371,188	0.00	180	-284	-88	-4.12	81	301
Loan characteristics:								
Loan amount (th euros)	371,188	262	5170.00	4	20	50	150	743
Maturity (in days)	371,188	352	545	32	76	104	183	1812
Collateral (0/1)	371,188	0.54	0.50	0.00	0.00	1.00	1.00	1.00
Firm variables:								
Rating	364,565	14.68	2.99	9	13	15	17	19
Default probability (%)	364,565	4.63	5.9	0.2	1.1	2.6	5.8	15.8
Share in firm financing (%)	371,188	40.43	27.4	3.2	16.7	36.5	61.3	90.5
Nr of relationships (quarter)	281,068	7.05	3.6	2.0	4.0	6.0	9.0	14.0
New rel. past 12 months (0/1)	281,068	0.54	0.5	0.0	0.0	1.0	1.0	1.0
Firm size	370,320	2.00	0.8	1.0	1.0	2.0	3.0	3.0
Bank variables:								
Tier 1 capital ratio (%)	371,188	12.83	3.02	9.34	10.93	12.32	13.98	18.47
Total capital ratio (%)	371,188	13.73	2.86	9.69	12.20	13.48	15.02	18.81
Loan loss charge (%)	371,188	1.02	0.85	-0.09	0.42	0.94	1.41	2.44
Funding cost (%)	371,188	1.66	0.99	0.47	0.84	1.44	2.27	3.46
RWA density (%)	371,188	58.05	10.76	40.82	53.25	57.65	64.85	77.70

TABLE 1. Summary statistics

Note: The weighted deviation is the difference between the spread charged by a bank on a loan to a given firm and the weighted average spread charged by all banks on loans to that firm in the same quarter. The simple mean deviation is the difference between the spread charged by a bank on a loan to a given firm and the simple average spread charged by all banks on loans to that firm in the same quarter. The rating and default probability are based on an internal credit scoring model used by Banco de Portugal (details may be found in Antunes et al., 2016). The share in firm financing is the ratio between the loan amount granted by a bank to a firm in a given quarter and the total loan amount granted by all banks to that firm in the same quarter. The number of banking relationships is defined quarterly. We consider that a firm has a new relationship if it obtains loans from at least one new bank in the previous 12 months. Firm size is defined using the Commission recommendation 2003/361/EC (micro firms take the value 1, small firms 2, medium firms 3 and large firms 4). The loan loss charge is the ratio between the annualized flow of loan impairments in the quarter and the (annual average) loan stock. The funding cost is the ratio between the annualized flow of interest paid in the quarter and the (annual average) stock of debt. The RWA density is the ratio between risk-weighted assets (RWA) and total assets. The data span from the 3rd quarter of 2012 until the last quarter of 2019.

the sample. On average, in each quarter, there are 20 different banks. However, in each regression, only banks lending to the same firm are compared. On average, firms obtain new loans from 3 different banks in a quarter.

Even though the literature on risk pricing suggests that bank capital plays a predominant role (Boot et al. 1993, Diamond and Rajan, 2000), there are other bank characteristics that might also be relevant in shaping banks' heterogeneous loan pricing decisions. During the euro area sovereign debt crisis, Portuguese banks accumulated loan losses, that had to be managed in the following years (Marques et al., 2020). To understand if loan losses change banks' pricing decisions, we consider the role of the loan loss charge, defined as the ratio between the annualized flow of loan impairments in each quarter and the (annual average) loan stock.

A critical aspect in shaping loan pricing decisions is of course the cost at which banks are financed. We consider the role of banks' funding costs, defined as the ratio between the annualized flow of interest paid in each quarter and the (annual average) stock of debt. Banks' funding costs stood at 1.66%, on average, reflecting the low rate environment prevailing throughout the sample period.

Finally, we consider the role of global riskiness embedded in banks' balance sheets by examining the role of the RWA density, which is defined as the ratio between risk-weighted assets (RWA) and total assets. Banks with higher RWA density have riskier assets. The risk profile of banks varies considerably in the sample.

2.3. Empirical strategy

Our empirical analysis is focused on understanding what explains the heterogeneity in loan pricing across banks. Our dependent variable is the (weighted) $deviation$ in interest rate spreads. To make sure that the differences derive from banks' characteristics but not from compositional effects arising from heterogeneity in the pool of borrowers that each bank caters to, we focus on firms that obtain loans from at least two banks in the same quarter. There is a trade-off in this choice: on one hand it allows us to understand how different banks price the exact same level of (observational) risk; on the other hand, this will bias the analysis towards larger firms, that are more likely to borrow simultaneously from several banks (Bonfim et al., 2018). That said, this latter point can actually be helpful to make sure we are capturing the role of bank characteristics on loan pricing, given that smaller firms are more informationally opaque. This implies that there is substantially more discretion in the pricing of smaller loans (Cerqueiro et al., 2011). By focusing on larger firms, we can be more certain that the heterogeneity in loan pricing can be attributed to bank capital (or other characteristics), rather than issues related with asymmetric information and rent extraction (Bonfim et al., 2021).

To examine the role of bank characteristics on loan pricing decisions we estimate the following specification:

$$Deviation_{ijt} = \beta BankVariables_{it} + \gamma LoanControls_{ijt} + \eta_i + \theta_{jt} + \varepsilon_{ijt} \quad (2)$$

The coefficient β will capture the importance of bank variables on loan pricing heterogeneity, captured by the deviation on loan spreads obtained by firm j from banks i in quarter t. In our preferred specification we estimate the effect of bank capital. We control for loan characteristics that may be important to explain pricing deviations. These include the loan amount, the maturity, the share of financing that the firm obtains from each bank in each quarter and the existence of collateral. In some specifications we estimate the effect of other time-varying bank characteristics besides bank capital, such as the loan loss charge, funding costs or RWA density. We control for unobserved time-invariant bank heterogeneity (η_i). This allows to capture time-invariant bank-specific characteristics, such as business models or risk aversion preferences. In the most demanding specifications in terms of identification we also control for $firm \times quarter$ fixed effects (θ_{jt}). This means that the results identified in these specifications will

rely on the comparison of banks lending to the same firm during a given quarter. By relying on multiple levels of fixed effects we are able to limit endogeneity issues due to potential reverse causality between spreads charged and bank capital. In our preferred specification, which includes both bank and firm-quarter fixed effects, we regress spread differentials vis à vis the average spread charged by all banks lending to the same borrower on banks' capital ratios.

3. Results

In Table 2 we present our main estimation results. In column (1) we consider the role of the Tier 1 capital ratio in explaining loan pricing heterogeneity. In this first estimation we control for firm, quarter, and bank fixed effects. The dependent variable is the weighted interest rate spread deviation. We find that banks' deviation in terms of loan pricing is larger the higher their capital ratios are compared to their historical average.[2] Conversely, this means that when banks' capital constraints become more binding, they might underprice the risks they are assuming, when compared to other banks simultaneously lending to the same firm.

This main result holds in all other specifications reported in this table. In column (2) we control for $bank$ and $firm \times quarter$ fixed effects. Banks whose capital ratios are high compared to their historical average seem to offer to the same firm higher rates than their peers, thus becoming more prudent in their pricing decisions. In columns (3) and (4) we repeat these first two estimations, but adding variables that capture loan characteristics that might be important to capture heterogeneity in loan pricing. After we control for loan amount, maturity, the share of financing granted by the bank and the existence of collateral, the coefficient on bank capital remains positive and statistically significant.

We observe that larger loans have smaller spread deviations. The same is true for loans with longer maturities. When banks are responsible for a larger share of financing to a given firm in a given quarter, they also charge lower spreads (Petersen and Rajan, 1994). Taken together, this suggests that banks that are more involved with a given firm offer generally better financing conditions. Given the high number of bank relationships and the frequency with which firms establish new ones, these results are consistent with a broadly competitive environment where hold-up costs are not large.

Finally, loans with collateral are associated with higher spreads. Even though collateral mitigates the risk incurred by the lender, there is evidence that the presence of collateral may in itself be a proxy for a negative assessment of borrowers' risk, also reflected in higher spreads (Boot et al., 1991, Berger and Udell, 1990, Cerqueiro et al., 2016). In an environment with information asymmetries, by requiring collateral the bank increases the level of effort adopted by the debtor to successfully carry out his projects, thereby better aligning the incentives between the two parties (Boot et al., 1991). The

2. Given that bank fixed effects are being used to control for time-invariant bank heterogeneity, identification comes from within bank variation.

Dep. variable: deviation				
	(1)	(2)	(3)	(4)
Tier 1 capital ratio	3.729***	4.760***	2.434***	2.760***
	(0.324)	(0.406)	(0.314)	(0.383)
Log amount			-0.366	-11.62***
			(0.684)	(1.489)
Log maturity			-39.63***	-61.68***
			(0.521)	(0.733)
Share financing			-1.040***	-0.540***
			(0.026)	(0.052)
Collateral (1/0)			4.599***	5.286***
			(1.573)	(2.022)
Constant	-30.45***	-43.68***	223.2***	275.8***
	(4.164)	(5.207)	(5.613)	(8.631)
Observations	371,186	371,186	371,186	371,186
R2	0.200	0.346	0.259	0.426
Firm fixed effects	Y	N	Y	N
Quarter fixed effects	Y	N	Y	N
Bank fixed effects	Y	Y	Y	Y
Firm*quarter fixed effects	N	Y	N	Y

TABLE 2. Loan pricing deviations and bank capital

Notes: The dependent variable in all regressions is the weighted deviation, defined as the difference between the spread charged by a bank on a loan to a given firm and the weighted average spread charged by all banks on loans to that firm in the same quarter. Other variables defined in Table 1. Data used in these regressions span from the 3rd quarter of 2012 until the 4th quarter of 2019. Robust standard errors in parentheses (clustered at the firm level). *** significant at 1%, ** significant at 5%, * significant at 10%

results remain entirely consistent if we use an unweighted version of the dependent variable or if we exclude collateral.[3]

Figure 1 shows that loan spreads decreased considerably during our sample period and that dispersion across banks also decreased. Further, Ordoñez (2013) shows that monitoring efforts change as the economy moves into and out of financial crises. To examine if the positive relationship between bank capital and deviations in loan pricing also changed during this period, we estimate a dynamic version of equation 2, such that:

$$Deviation_{ijt} = \beta_y BankCapital_{it} + \gamma LoanControls_{ijt} + \eta_i + \theta_{jt} + \varepsilon_{ijt} \tag{3}$$

The difference is that now β_y will take a different value for each year in the sample. The results for this coefficient are reported in Figure 2. Interestingly, we find that even

3. When splitting the sample by firm risk, firm size and loan maturity, alternatively, we verify that collateral is statistically significant and has a positive coefficient only in the case of firms in the top risk quartile (with risk measured by firms' credit ratings), micro firms and loans with longer maturities (over 2 years), respectively. Given that smaller firms are usually riskier, more opaque and expected to have a higher marginal return on the entrepreneur's effort, these results are consistent with the role of collateral in correcting borrowers' incentives. We also estimated several versions of column (4) with lags on the capital variable. While the results do not hold for all lag combinations, the main conclusion still holds.

though the deviations in loan pricing decreased throughout the sample, the role of bank capital in shaping those deviations actually increased. In the first two years of the sample, 2013 and 2014, the effect of bank capital on interest rate spread deviations was actually negative. Banks with more capital granted lower interest rates, for the same level of risk, when the country was emerging from the financial assistance program. In 2015 the coefficient was not statistically significant. After that, the coefficient became positive and increased until 2018. The results that we obtain for the entire sample, reported in Table 2, mainly reflect the period 2016-2019. This dynamic analysis shows that the effect of capital ratios on loan pricing differentials can change through time.

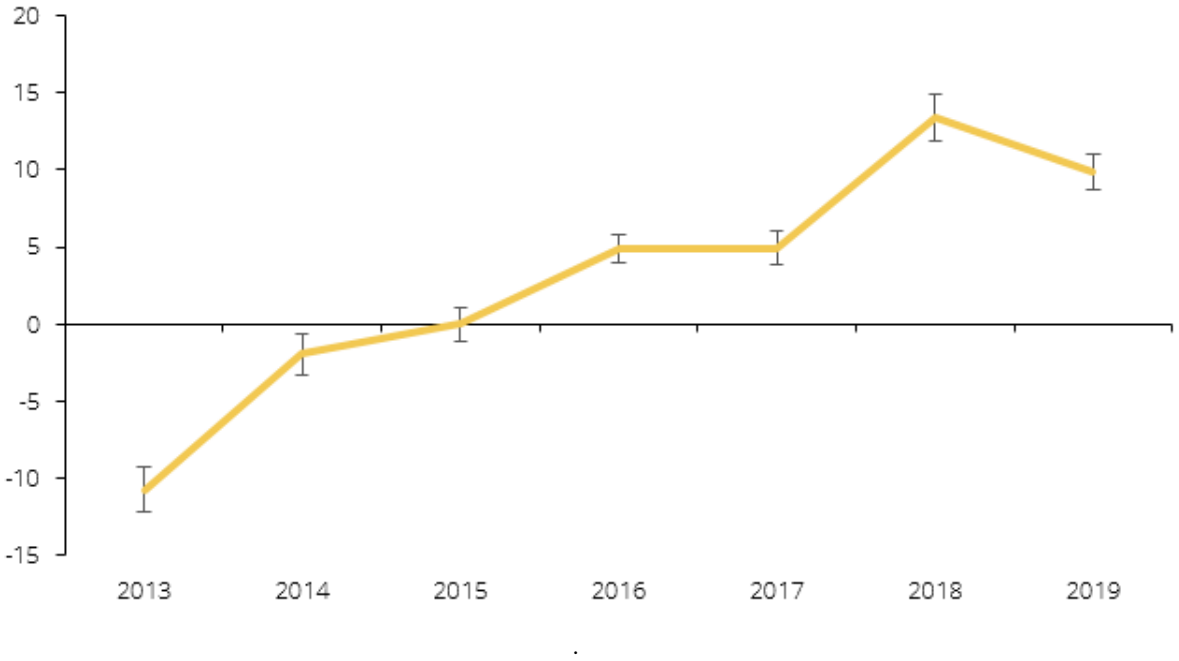

FIGURE 2: Effect of bank capital on pricing deviations

Source: Banco de Portugal and authors' estimates. Notes: This figure depicts the coefficients of a dynamic specification of equation 2. Each point in the graph is the estimated coefficient on the Tier 1 capital ratio interacted with year dummies, as defined in equation 3. Thin bars indicate 95% confidence intervals. Loan controls (loan log-amount, loan log-maturity, share in firm financing and a collateral dummy) are included in the regression. Data used in the regression span from the 3rd quarter of 2012 until the 4th quarter of 2019.

Bank capital clearly plays a role in shaping banks' loan pricing decisions. However, other bank characteristics might also be relevant. In Table 3 we estimate equation 2 using other potentially relevant bank variables. In the first column we repeat the results reported in column (4) of Table 2. This can be considered our baseline specification and it includes loan controls, $bank$ fixed effects and $firm \times quarter$ fixed effects. The dependent variable is the weighted deviation of interest rate spreads.

In the following columns we repeat this estimation using alternative bank variables. We do not consider simultaneously the role of several variables, as that would be excessively demanding in terms of the data structure. Recall that we are exploring differences in interest rate spreads across the set of banks that lend to the same firm in

Dep. variable: deviation					
	(1)	(2)	(3)	(4)	(5)
Tier 1 capital ratio	2.760***				
	(0.383)				
Total capital ratio		4.172***			
		(0.387)			
Loan loss charge			-8.548***		
			(0.924)		
Funding costs				-9.604***	
				(1.781)	
RWA density					-0.297
					(0.208)
Constant	275.8***	253.6***	319.5***	327.8***	329.1***
	(8.631)	(8.809)	(7.351)	(7.884)	(14.160)
Observations	371,186	371,186	371,186	371,186	371,186
R2	0.426	0.426	0.426	0.426	0.426
Firm fixed effects	N	N	N	N	N
Quarter fixed effects	N	N	N	N	N
Bank fixed effects	Y	Y	Y	Y	Y
Firm*quarter fixed effects	Y	Y	Y	Y	Y
Loan controls	Y	Y	Y	Y	Y

TABLE 3. Loan pricing deviations and other bank characteristics

Notes: The dependent variable in all regressions is the weighted deviation. Variables defined in Table 1. Loan controls (loan log-amount, loan log-maturity, share in firm financing and a collateral dummy) are included in all regressions. Data used in these regressions span from the 3rd quarter of 2012 until the 4th quarter of 2019. Robust standard errors in parentheses (clustered at the firm level). *** significant at 1%, ** significant at 5%, * significant at 10%

a given quarter. By including more bank characteristics at the same time, we would be exploring differences in variables that are highly correlated within small sets of banks.

In column (2) we consider the role of the total capital ratio, instead of the Tier 1 capital ratio. The two ratios are highly correlated and, as expected, the results are broadly consistent.

When banks record higher loan loss charges, they seem to underprice their loans, for the same level of risk. When banks are facing increasing losses, their franchise value is being eroded and they may have weaker incentives to adequately screen borrowers. They might even attract riskier borrowers as an attempt to boost their weakened profitability. This underscores the importance of a prompt recognition of loan losses (Ari et al., 2020, Bonfim et al., 2020).

When banks' financing costs increase, they actually charge lower interest rates for the same level of risk.[4] Higher funding costs possibly reflect higher risk for a given bank, what is often related with low capital ratios (Gambacorta and Shin, 2018). This negative

4. If we include both the Tier 1 capital ratio and the funding cost in the same regression, the Tier 1 capital ratio remains statistically significant and positive and the funding cost remains statistically significant and negative.

coefficient can thus be seen as the reverse of the positive coefficient on bank capital. Finally, RWA density is not significantly related with loan pricing deviations.

3.1. Loan pricing and firm characteristics

The pricing of loans is not necessarily a linear function of risk. That should be especially true for smaller and more opaque firms, where the information conveyed within a firm-bank relationship can mitigate information asymmetries and improve financing conditions (Bonfim et al., 2018). At the same time, firms may also become locked in a relationship, allowing banks to extract rents (Sharpe, 1990, Schenone, 2010).

To better understand the role played by firm heterogeneity and firm-bank relationships, we interact bank capital with several variables (Table 4). The first step we take is to try to understand if there are non-linearities between the level of risk and the heterogeneity in loan pricing. It is possible that the relationship between banks' capital and deviations in loan pricing is not the same for firms with different degrees of risk. To test this hypothesis, we classify firms as high or low risk, depending on whether firms have credit ratings above or below the median. We find that the relationship between bank capital and interest rate deviations is positive only for the low-risk firms. For high-risk firms, banks' capital ratios become less relevant in explaining pricing differentials.

Another important dimension shaping loan pricing is the number of bank relationships. Firms are able to obtain better financing conditions when they borrow from more banks, as this mitigates information asymmetries (Farinha and Santos, 2002, Bonfim et al., 2018). When we interact bank capital with a variable that captures whether firms have more than two bank relationships, we find that the relationship between bank capital and more prudent risk pricing is negative for firms with one or two banking relationships and becomes positive for these multiple loans firms.This result is consistent with the idea that information is more asymmetric for firms with fewer bank relationships and thus banks may rely on collateral requirements to correct borrower moral hazard, with capital exerting fewer monitoring incentives. It should be said that loans to firms with up to two bank relationships represent only 5% of our sample.

Next, we examine if there are significant differences between firms that establish new relationships and others. We consider that a new relationship is established when a firm obtains loans from at least one new bank in the previous 12 months. The relationship between bank capital and interest rate deviations is positive as in the baseline specification and the effect is stronger for firms that recently established new relationships. This should reflect more heterogeneity in loan pricing for firms with new relationships, which are differentially assessed by banks with different levels of capitalization.

Another hypothesis that can be examined is whether the heterogeneity in risk pricing for banks with different capital ratios holds regardless of firm size or if there are differences, which may be attributable to information asymmetries. In column (4) we consider the interaction between bank capital and firm size. In this case, the coefficient of bank capital becomes negative, capturing the effect of the omitted size category (micro

Dep. variable: deviation				
	(1)	(2)	(3)	(4)
Tier 1 capital ratio	5.991***	-4.845***	1.144**	-3.894***
	(0.466)	(1.097)	(0.499)	(0.603)
Tier 1 * High risk firms	-7.538***			
	(0.575)			
Tier 1 * More than 2		7.563***		
		(1.058)		
Tier 1 * New relationships			2.054***	
			(0.476)	
Tier 1 capital * small				6.403***
				(0.666)
Tier 1 capital * medium				13.43***
				(0.781)
Tier 1 capital * large				15.11***
				(1.340)
Constant	276.7***	287.9***	286.0***	345.2***
	(8.668)	(9.477)	(9.471)	(12.410)
Observations	364,561	281,067	281,067	369,751
R2	0.428	0.441	0.44	0.429
Firm fixed effects	N	N	N	N
Quarter fixed effects	N	N	N	N
Bank fixed effects	Y	Y	Y	Y
Firm*quarter fixed effects	Y	Y	Y	Y
Loan controls	Y	Y	Y	Y

TABLE 4. Loan pricing deviations, bank capital and firm characteristics

Notes: The dependent variable in all regressions is the weighted deviation. A high (low) risk firm is a firm with a credit rating above (below) the median credit rating of all firms that received loans in the same quarter. The number of banking relationships is defined quarterly. We consider that a firm has a new relationship if it obtains loans from at least one new bank in the previous 12 months. Firm size is defined using the Commission recommendation 2003/361/EC. Other variables defined in Table 1. Loan controls (loan log-amount, loan log-maturity, share in firm financing and a collateral dummy) are included in all regressions. Data used in these regressions span from the 3rd quarter of 2012 until the 4th quarter of 2019. Robust standard errors in parentheses (clustered at the firm level). *** significant at 1%, ** significant at 5%, * significant at 10%

firm). The interactions are positive and increasing with firm size, suggesting that there is more dispersion on loan pricing for larger firms, for the same level of bank capital.

4. Concluding remarks

In this article we examine the role of bank capital in shaping loan pricing decisions. The results were obtained taking into account the entire set of new term loans granted to non-financial corporations by Portuguese banks.

Focusing on firms that simultaneously borrow from several banks, our results show that bank capital plays an important positive role on shaping the pricing of loans. We deal with endogeneity issues due to potential reverse causality between spreads charged and bank capital by relying on multiple levels of fixed effects in our main empirical specification.

The positive relation between bank capital and spreads only holds for firms with a rating better than the median, for firms in all size classes except the very small ones, and those with more than two relationships. Bank capital does not seem to be associated with higher interest rates for the same level of risk in the case of loans to riskier, smaller or firms with only two relationships.

Between 2012 and 2019, loan spreads gradually decreased. The relationship between bank capital and loan pricing also changed. Until 2014, this relationship was actually negative. When banks were still recovering from the severe consequences of the euro area sovereign debt crisis, banks with more capital granted lower interest rates, for the same level of risk. From 2016 onwards, the coefficient becomes positive. Our main result thus holds mainly in the post-crisis period.

Our results show that bank capital plays an important role on shaping the pricing of loans. Banks that are better capitalized compared to their historical average seem to be more conservative in loan pricing, offering higher loan spreads than the other banks lending to the same firm.

That said, there are further limitations in the analysis that should be acknowledged. These relate to the relatively small dimension of the sample, as the identification strategy requires exploring differences across firms that borrow from several banks simultaneously. The evaluation of banks' capitalization is also partial, due to the lack of data on effective capital requirements (i.e., pillar 2 requirements). Furthermore, 2015-2019 is a period characterized by the recovery from one of the largest crises in the history of the Portuguese financial system, which might challenge the external validity of the results.

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