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The impact of monetary policy and macroprudential policy on corporate lending rates in the Euro area

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Abstract

We examine the differential impact of monetary policy and macroprudential policy on bank lending rates in the euro area, using granular corporate loan-level data for the period 2019-2023. We find three results: First, consistent with the predictions of a stylized theoretical model of bank lending rates, monetary policy exerts an order of magnitude larger impact on lending rates than macroprudential policy. Second, the effectiveness of monetary policy transmission weakens when interest rates are close to or below zero. Third, the impact of macroprudential policy on lending rates increases when banks have limited capital headroom above capital buffer requirements, indicating cautious lending behavior when banks get close to regulatory constraints. Our findings have important policy implications for the joint conduct of monetary and macroprudential policy.

Keywords: interest rate pass-through, bank capitalization, credit supply, loan-level data
JEL codes: G21, G28, E43, E52

Non-technical summary

In this paper, we examine the relative importance of monetary policy and macroprudential policy on the supply of bank credit in the euro area during a period of unprecedented monetary tightening and simultaneous increases in countercyclical capital buffer rates by many national authorities.

We use a comprehensive, granular dataset, combining data on corporate loans from the euro area credit registry (AnaCredit) with supervisory bank data, covering approximately 16 million new loans across 15 countries over 2019-2023 period. We use the interest rate of new loans as a measure of loan supply and proxy macroprudential policy with the capital-to-asset ratio of the bank which issues the loan. This rich dataset allows us to control for a variety of characteristics at the loan, firm, bank, and country levels, as well as fixed effects, to isolate the impact on bank loan supply.

Our findings suggest that monetary policy has an order of magnitude larger effect on bank lending rates than macroprudential policy. These results are in line with predictions from a simple theoretical model where bank lending rates are determined by funding costs, a markup, and the equity premium. We also analyze the interaction between policy rates and the zero lower bound and find that the impact of monetary policy on bank lending rates is substantially weaker when policy rates are close to or below zero.

Our results also indicate that the impact of macroprudential policy on lending rates depends on the capital headroom above capital buffer requirements. In particular, we find that a impact of a change in macroprudential policy for a bank that close to regulatory constraints is associated with the response of lending rates that is 50% larger than for a bank with an average capital headroom.

Finally, in terms of policy implications, our results suggest that given comfortable capital headroom of euro area banks and solid profitability which allows banks to increase or headroom without issuing new equity, a potential further tightening of macroprudential buffer requirements is unlikely to have a big negative impact on bank loan supply and bank lending rates. Further, potential release of macroprudential buffer requirements at the current juncture where banks have ample capital headroom would not have a material impact on bank loan supply and lending rates.

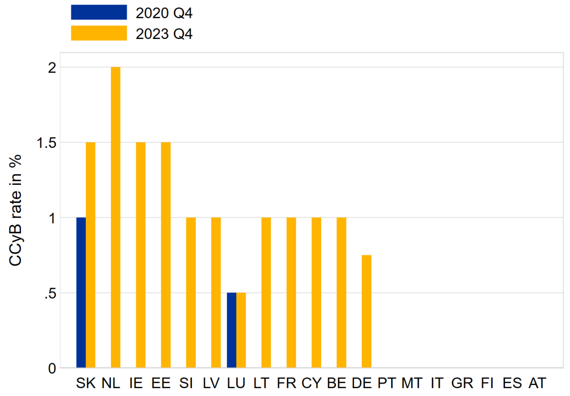
1 Introduction

Tighter monetary policy and higher macroprudential capital buffer requirements can exert downward pressure on the supply of bank credit. However, given that macroprudential policy is a fairly new policy domain, there is still considerable uncertainty regarding its relative impact on bank credit supply. A notable example of simultaneous monetary and macroprudential tightening is the recent experience in the euro area, where the ECB's raised the deposit facility from -0.5% to 4% between spring 2022 and autumn 2023, while many countries announced increases in their national countercyclical capital buffer (CCyB) rates (see Figures 1a and 1b). At the same time, bank loan growth decelerated sharply, bank lending rates rose significantly and banks reported a sustained tightening of bank credit standards. With this context in mind, the main goal of this paper is to assess the relative impact of monetary policy tightening and macroprudential policy tightening on bank credit supply with a special focus on the recent hiking cycle that started in 2022. We use lending rates as a measure for banks' credit supply.

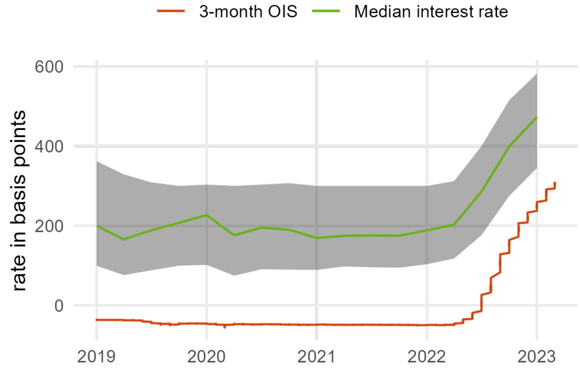
We show that monetary policy is the predominant driver of bank lending rates, exhibiting an order of magnitude larger impact compared to macroprudential capital buffer requirements. However, when banks have limited capital headroom above their capital buffer requirements, the impact of macroprudential policy on bank credit supply increases. To establish these results, we test and confirm the predictions of a simple theoretical model of bank lending rates using a novel, granular, confidential data set covering the universe of corporate loans in the euro area in combination with supervisory bank data. This unique data set allows us to study the impact of monetary policy and macroprudential policy on lending rates while holding loan characteristics and firm risk constant, which might both change endogenously in response to monetary and macroprudential policy. Moreover, our dataset enables a comprehensive analysis across a diverse set of countries.

More precisely, we estimate the impact of monetary policy and macroprudential policy on interest rates for new loans to euro area non-financial corporations (NFCs) over the period 2019 to 2023. We draw on the euro area NFC credit register (Anacredit) and merge it with bank-level supervisory data, as well as macroeconomic data, to estimate loan-pricing regressions on around 16 million new loans from 15 euro area countries. This allows us to control for various loan-level, firm-level, bank-level, and country-level observable characteristics as well as fixed effects to isolate the impact on bank loan supply that we are interested in. As our measure of

Figure 1: **Countercyclical Capital Buffer Rates and Interest Rates**



(a) **Announced National Countercyclical Capital Buffer Rates**



(b) **OIS and unconditional loan rates**

Notes: For all euro area countries, the left panel of this figure shows the announced national countercyclical capital buffer rates in 2020 Q4 (blue) and 2023 Q4 (yellow) in percent. The red line in the right panel shows the 3-month OIS rate for each business day. The green line shows the median interest rate of all new loans issued by euro area banks to non-financial firms and the grey area the corresponding interquartile range.

monetary policy we use the 3-month overnight indexed swap (OIS) rate, which is a short-term risk-free interest rate that follows key ECB monetary policy interest rates closely. In robustness tests, we show that our results are robust when we alternatively instrument the 3-month OIS rate with the monetary policy shocks identified by Altavilla, Brugnolini, Gürkaynak, Motto, and Ragusa (2019). As our measure of macroprudential policy, we use the bank capital-to-asset ratio as in Santos and Winton (2019) and we refer to this measure as bank capitalisation from now on.

We use the OIS rate rather than the ECB policy rate(s) for two reasons. First, the ECB sets different policy rates for it's main refinancing operations (MRO) and for the deposit facility (DF). Second, in an environment of excess central bank liquidity, risk free short-term interest rates will settle somewhere in between the MRO and the DF rate. Hence, by taking the OIS rate as our measure of monetary policy we are using the de facto short-term risk-free interest rate that materialises as a result of monetary policy actions. Furthermore, we prefer to use the OIS rate rather than the EURIBOR rate, as the latter is an interbank rate and can therefore also include some risk premia.

The main reason for using bank capitalisation in our regressions is that the impact of higher macroprudential capital buffer requirements on lending rates should ultimately depend on how much additional equity funding per unit of asset the bank decides to use. This in turn depends on how much the bank's capital ratio target increases in response to higher capital buffer requirements, which can be less than one-for-one and differ over time (Couaillier, 2021), and on the average risk-weight of the bank, which can differ considerably across banks as well as time. Using bank capitalisation in our regressions instead of the risk-weighted capital buffer requirement accounts for both of these channels and is therefore a good indirect proxy for the impact of higher macroprudential capital buffer requirements on lending rates.

Our first key finding is that monetary policy has a much bigger impact on bank lending rates than bank capitalisation. For example, in model specifications with firm-time fixed effects that proxy for loan demand, a one standard deviation (0.9 pp) higher monetary policy interest rate is associated with 58 basis points (bps) higher bank lending rates on new loans, whereas a one standard deviation (2.4%) higher bank capitalisation is associated with just 5.8 bps higher bank lending rates. Both estimated impacts are statistically significant at the 1% level. Hence, the impact of changes in monetary policy on bank lending rates is more than an order of magnitude larger than the impact of changes in bank capitalisation induced through macroprudential policy. In less saturated model specifications the impact of bank capitalisation is often even slightly negative and in most cases insignificant, while the estimated impact of monetary policy is even larger, ranging up to 68 bps (after a one standard deviation increase).

Our second key finding is that the impact of changes in monetary policy on bank lending rates is much weaker when policy interest rates are below zero. For example, in state-dependent model specifications with firm-time fixed effects that proxy for loan demand, a one standard deviation higher monetary policy interest rate is associated with just 23 bps higher bank lending rates when policy interest rates are below zero, while the same monetary policy impulse is associated with 60 bps higher lending rates when policy interest rates are positive. We also find that the transmission of monetary policy shocks to loan rates is much weaker at the zero lower bound. Thus, our findings suggest that the zero lower bound on interest rates exerts important constraints on monetary policy and that monetary policy transmission via bank lending is much weaker below the zero bound.

Our third key finding is that the impact of bank capitalisation on lending rates is larger when banks are close to macroprudential capital buffer requirements. In state-dependent model specifications with firm-time fixed effects that proxy for loan demand, a one standard deviation higher capital-to-asset ratio (2.4pp) is associated with 9 bps higher bank lending rates for a bank with a median capital headroom of 3pp, while the same increase in bank capitalisation is associated with 13 bps higher lending rates if banks do not have any capital headroom above macroprudential capital buffer requirements, and is hence 1.4 times as large. These findings indicate that banks are reluctant to breach macroprudential buffer requirements and reduce loan supply when their capital ratios get close to them, which is in line with the findings in Mathur, Naylor, and Rajan (2023) and Couaillier, Lo Duca, Reghezza, and Rodriguez d'Acri (2022). Moreover, these findings suggest that changes in bank capitalisation have a limited impact on loan supply and loan pricing when banks have comfortable capital headroom.

The estimated magnitudes for the impact of monetary policy and macroprudential policy (bank capitalisation) on bank lending rates that we find in our empirical study are consistent with the implications of a simple theoretical model of bank lending rates. In the model, lending rates are determined by bank funding costs and a mark-up. Bank funding costs are in turn determined by monetary policy interest rates, the bank capital-to-asset ratio, and the equity premium, i.e. the difference between the cost of bank equity and bank debt. Within this theoretical framework a 1 pp increase in the monetary policy interest rate should increase bank lending rates by 75 bps[1]. Moreover, for a bank equity premium of 8%, a 1 pp increase in the capital-to-asset ratio should increase bank lending rates by 8 bps. Both magnitudes are similar to our empirical estimates, although we estimate slightly lower coefficients than implied by this arguably stylised model.

Our findings have important policy implications. First, monetary policy tightening seems to have been the major driver behind the recent increases in bank lending rates and tightening of bank credit supply observed in the euro area, while increases in macroprudential capital buffer requirements seem to have played a limited role. Second, given comfortable capital headroom of euro area banks and solid profitability, which allows banks to increase capital without issuing new equity, a potential further tightening of macroprudential buffer requirements is unlikely to have a big negative impact on bank loan supply and bank lending rates. Third, a potential release of macroprudential buffer requirements at the current juncture where banks have ample capital headroom would not have a material impact on bank loan supply and lending rates and therefore does not seem to be advisable.

Our paper contributes to the abundant literature on the pass-through of monetary policy to bank lending rates. Most studies on this topic use country-level or bank-level data (Gregor, Melecký, and Melecký, 2021; Beyer, Chen, Misch, Li, Ozturk, and Ratnovski, 2024). The estimated pass-through is typically found to be incomplete because of imperfect information and

[1] Under the assumption that monetary policy pass-through to bank debt funding costs is 75%.

competition and varies depending on many factors such as borrower characteristics, maturity, credit risk as well as bank characteristics such as size, capital, asset quality and macro-financial characteristics (Gambacorta, Illes, and Lombardi, 2015; Andries and Billon, 2016; Holton and Rodriguez d'Acri, 2018; Gregor, Melecký, and Melecký, 2021; Beyer, Chen, Misch, Li, Ozturk, and Ratnovski, 2024). We contribute to the literature by estimating the impact of monetary policy at the individual loan level, which allows us to control for loan demand and granular loan terms. In addition, we test whether the pass-through is different in times of negative interest rates as opposed to periods when interest rates are positive. While the calibrated model of Abadi, Brunnermeier, and Koby (2023) implies that pass-through of monetary policy could be lower in proximity of the zero-lower bound, the empirical evidence on this is scarce to our knowledge. Finally, relative to the existing literature, we contribute by evaluating and comparing the effects of monetary policy and macroprudential policy in a joint specification.

Our paper is also related to the vast literature studying the impact of bank capital on lending rates. The estimates reported in the literature are generally small and inconclusive: the estimated impact of 1pp increase in the capital-to-asset ratio of banks on lending rates ranges between -0.1pp to 0.3pp based on the 41 standardised estimates[2] from 16 studies published until 2019 that are available in the BIS FRAME repository (Boissay, Cantu, Claessens, and Villegas, 2019).[3] Most of the literature studying the impact of bank capital on lending rates uses country-level or bank-level data (Boissay, Cantu, Claessens, and Villegas, 2019), but there is relatively little evidence using loan-level data.[4] The contribution of our paper is to provide evidence by employing micro data from the recently developed harmonized corporate credit register covering all euro area countries (while existing scarce evidence is limited to individual countries or segment of the lending market e.g. syndicated loans). More granular, loan-level data allows us to estimate the impacts more precisely due to a larger number of observations and availability of detailed information on individual bank loans, while allowing better compa-

[2] This includes both estimates using NFC and HH lending rates.

[3] Similarly, the most recent empirical studies also do not provide conclusive evidence: several studies do not find a significant effect of bank capital or bank capital requirements on lending rates (Imbierowicz, Löffler, and Vogel, 2021; Ehrenbergerová, Hodula, and Gric, 2022), while others find positive but small effect (Bichsel, Lambertini, Mukherjee, and Wunderli, 2022; Glancy and Kurtzman, 2021).

[4] Santos and Winton (2019) use granular data on pre-2007 US publicly traded firms from mostly syndicated loans and find that higher bank capital has a negative impact on loan rates. Glancy and Kurtzman (2021) use loan-level data covering US commercial real estate firms collected in the context of Comprehensive Capital Analysis and Review and find that a 1pp increase in capital requirements increases loan rates by 8.5 basis points. Jaunius Karmelavičius and Buteikis (2023) use granular data on lending by Lithuanian banks and find that capital requirements may have elevated lending rates by only 0.1 pp on average, but the primary driver behind the interest rate changes during 2015-2019 was market concentration.

rability across banks and countries.[5] An additional distinguishing aspect of our contribution is that our analysis covers the period of the recent monetary tightening allowing us to exploit variation in lending rates following a longer period of very low interest rates. Finally, we also contribute by taking into account a possible state dependence of the effect of bank capitalisation depending on the distance to regulatory requirements.

The remainder of this paper is structured as follows. In section 2 we describe a simple theoretical model of bank lending rates that helps to put structure on the empirical analysis and allows for a better interpretation of estimated results. In section 3 we describe the dataset for our empirical analysis. In section 4 we lay out in detail our empirical strategy. Section 5 then presents the main empirical results regarding the impact of monetary policy and macroprudential policy on bank credit supply. Finally, section 6 provides a brief conclusion.

2 A model of bank lending rates

To guide or empirical analysis, we first develop a simple model of how monetary policy and bank capitalisation affect the pricing of bank loans. Such a model framework helps to put structure on the empirical analysis and allows for a better interpretation of the estimated results.

Consider a bank that provides loans (L) and finances these with debt (D) and equity (E), so that the balance sheet identity is $L = D + E$. Bank capitalisation is measured by the leverage ratio, which is defined as the ratio of equity over total loans $LR = E/L$. Hence, the balance sheet identity can be rewritten as $D/L = 1 - LR$.

The bank pays an interest rate i^D on its debt and bank equity is assumed to always be more costly than debt by a constant equity premium (ρ), so that $i^E = i^D + \rho$. Furthermore, assume that the cost of bank debt moves in line with the monetary policy interest rate set by the central bank (i^{CB}) according to a constant pass-through parameter $\beta \in [0; 1]$, so that we can write $i^D = \beta \cdot i^{CB}$.

Finally, assume that bank funding costs are passed on one-for-one to bank lending rates and

[5] A number of papers used AnaCredit data to study credit supply and demand (Barbieri, Couaillier, Perales, and Rodriguez d'Acri, 2022; Altavilla, Boucinha, and Bouscasse, 2022), firm-bank relationship (Kosekova, Maddaloni, Papoutsi, and Schivardi, 2023), impact of capital requirements on lending during the Covid-19 pandemic (Couaillier, Reghezza, Rodriguez d'Acri, and Scopelliti, 2022), and collateral revaluation and lending decision (Horan, Jarmulska, and Ryan, 2023).

that banks charge a constant mark-up (μ) over their funding costs to cover operating and other expenses and as compensation for credit risk. Hence, lending rates can be expressed as $i^L = \mu + i^D \cdot D/L + i^E \cdot E/L$. If we make use of the balance sheet identity, the definition of the leverage ratio, and the definitions of debt and equity funding costs, this can also be written as:

$$i^L = \mu + \beta i^{CB} \cdot (1 - LR) + (\beta i^{CB} + \rho) \cdot LR \tag{1}$$

As the markup (μ), the monetary policy pass-through (β) and the equity premium (ρ) are all assumed to be constant over time, changes in bank lending rates will be driven by changes in monetary policy interest rates (i^{CB}) and changes in bank capitalisation as measured by the leverage ratio (LR). If we rearrange equation (1), we get the following expression for bank lending rates:

$$i^L = \mu + \beta \cdot i^{CB} + \rho \cdot LR \tag{2}$$

Hence, for a pass-through coefficient of $\beta = 1$, a 100 bps increase in the monetary policy rate should increase bank lending rates by 100 bps. If the pass-through coefficient was 0.75, the same monetary policy tightening impulse would lead to an increase in lending rates of 75 bps. Moreover, for a bank equity premium (ρ) of 8%, a 100 bps increase in the leverage ratio should increase bank lending rates by 8 bps.[6] These indicative magnitudes will be useful to benchmark our empirical results in the remainder of this paper. For simplicity we have assumed that monetary policy pass-through is constant. However, there are good reasons to assume that pass-through is different when monetary policy rates are negative (Abadi, Brunnermeier, and Koby, 2023). This will be important to keep in mind for the empirical analysis.

3 Data

Our empirical analysis relies primarily on loan-level data from the euro area credit registry (AnaCredit), which covers the universe of all corporate loans and provides detailed information on loan and borrower characteristics. We combine this dataset with confidential supervisory bank information and macroeconomic data. Next, we describe the different data sources in turn.

[6] Altavilla, Bochmann, De Ryck, Dumitru, Grodzicki, Kick, Fernandes, Mosthaf, O'Donnell, and Palligkinis (2021) provide comprehensive empirical evidence that the equity premium for euro area banks is between 8% and 12%.

3.1 Loan-level Microdata

AnaCredit contains the universe of all loans issued by euro area banks to legal entities at the loan level. National central banks collect the data and the ECB harmonizes it. We obtain the microdata for 2019Q1 to 2023Q1. Our analysis is based only on new loans to non-financial corporations located in a euro area country. We exclude borrowers in NACE sectors 64-66. In total, our sample contains 16.6 million observations. The microdata on these loans provides detailed information on the borrower, such as probability of default (PD), industry, location, and size. Furthermore, it contains detailed loan characteristics such as loan amount, maturity, instrument type, amortization scheme, recourse, interest rate type, and collateral.

Only banks that use internal models to calculate risk weights for the calibration of capital requirements are required to report the PD of borrowers. If the PD is not reported for a loan, we impute the PD using the median PD reported for all loans to the same borrower in the same month. If this information is not available because the borrower only received new loans from banks that do not report PDs, we drop the loan. Since this leaves us with almost no loans for Cyprus, Estonia, Malta, and Slovenia, we drop these countries from our sample. For the few cases where industry or firm size are missing, we impute the information in a similar way as for the PD.

We apply some additional filters to our raw sample. First, we exclude loans under government Covid-19 support programs and loans with a guarantee where the guarantor belongs to any level of government because for these loans we expect the government involvement to significantly affect the relationship between monetary policy, bank capital, and interest rates. Second, we exclude loans with no outstanding loan amount and loans for which any of our key variables is missing. This includes loans issued by banks that are not supervised by the Single Supervisory Mechanism (SSM) as either Significant or Less Significant Institution for which we do not have bank information. Finally, we exclude loans with an interest rate below 0 or above 20% as these are likely to be reporting errors. Furthermore, we exclude some instrument types: Deposits, repos, overdrafts, credit cards, and missing. We restrict our sample to euro-denominated loans and loans with only one debtor and one creditor.[7] We exclude loans for which the interest rate is missing and either the borrower or the instrument is classified as in default at the time of origination. We restrict the sample to loans issued by banks, thus excluding other financial institutions.

[7]Note that this does not exclude syndicated loans which are classified as multiple loans.

Table 1: **Summary statistics: Loan and borrower characteristics**

	Mean	SD	Min	P25	Median	P75	Max	N
Interest rate (in bps.)	253.3	202.8	0.0	100.4	214.1	351	2,000.0	16,642,784
PD (in %)	2.7	5.0	0.0	0.5	1.3	2.4	51.3	16,642,784
Loan amount (in thsd.)	78.5	456.0	0.0	5.7	19.8	44.3	521,681.0	16,642,784
Recourse	0.5	0.5	0.0	0.0	1.0	1.0	1.0	16,642,784
Collateralized	0.4	0.5	0.0	0.0	0.0	1.0	1.0	16,642,784

(a) **Continuous and binary variables**

		Percent
Firm size	Large	20.6
	Medium	28.9
	Micro	23.3
	Small	27.2
Maturity bucket	below 3 months	34.0
	3-12 months	33.4
	1-2 years	6.8
	2-5 years	12.1
	5-7 years	3.1
	7-15 years	2.1
	above 15 years	0.7
	none	7.8
Instrument type	Financial leases	6.8
	Loan	42.9
	Non revolving credit line	13.2
	Revolving credit	3.5
	Trade receivables	33.5
Amortization scheme	Bullet	34.5
	French, German, fixed	26.7
	Other	38.8
Interest rate type	Fixed	54.6
	Floating	42.1
	Mixed	3.3

(b) **Categorical variables**

Notes: The table reports summary statistics for all new loans issued by euro area banks to non-financial firms between 2019 and 2023Q1. The upper panel displays continuous and binary variables, including the interest rate at issuance, the bank's estimated probability of default (PD) for the borrower, loan amount at issuance, and binary indicators for recourse and collateralization that are 1 if the bank has recourse over the borrower and if the loan is collateralized. The lower panel presents categorical variables such as firm size, maturity bucket, instrument type, amortization scheme, and interest rate type. Firm size is categorized as Large, Medium, Micro, or Small. Maturity buckets range from below 3 months to above 15 years. Instrument types include financial leases, loans, non-revolving credit lines, revolving credit, and trade receivables. Amortization schemes are classified as Bullet, French/German/fixed, or Other. Interest rate types are Fixed, Floating, or Mixed. These variables are crucial for understanding the dynamics of loan pricing and risk assessment in the euro area banking sector.

AnaCredit allows for several ways to define *new* loans. Ultimately, we are interested in how monetary policy and bank capital on the day the contract is signed affect the interest rate. However, banks are only required to report a loan when money is first drawn. Some time may elapse between the signing of the contract and the drawing of money, in particular for credit lines. We use the date the contract is signed ("inception date") as the relevant date to which we merge other variables. In order to rule out that the loan terms have changed between the date the contract is signed and the date we first observe the contract, we remove all loans that are reported for the first time more than two months after issuance.

For the outstanding amount and the PD, we have to deal with outliers. We winsorize the upper end of the outstanding amount at the 1% level. We exclude 1% of the highest PDs because it is unreasonable that banks issue new loans to defaulted borrowers.

In AnaCredit, each financial instrument is reported separately and a contract may contain several financial instruments. However, the same borrower and debtor often agree on multiple instruments with identical conditions within one contract. Whenever this happens, we collapse all instruments with identical characteristics within one loan contract into one observation and aggregate the loan amount. This reduces the sample from 22 million to 17 million observations.

Table 1 reports descriptive statistics at the loan level, in particular for our key variable of interest: The average (median) loan is issued at an interest rate of 2.5% (2.1%) but there is wide variation in our dependent variable: The 25th percentile is issued at 1.0% while the 75th percentile is issued at 3.5%.

3.2 Bank-level Data

We combine the loan-level microdata with supervisory bank information for the quarter preceding the quarter in which the loan was issued. For banking groups, we always refer to the highest consolidation level within the euro area. In particular, our variables of interest are the capital-to-asset ratio and the capital headroom of banks. The capital headroom is defined as the ratio of the core equity tier 1 capital (CET1) that the bank has above all regulatory requirements to its risk-weighted assets (RWA) including pillar 2 guidance (P2G).[8] It measures how much capital the bank can deplete before regulators impose consequences such as limits on

[8] Banks have to meet several regulatory requirements simultaneously: The CET1 requirement can only be met with CET1 capital. However, the Tier 1, Tier 2 and Leverage Ratio requirements can, but do not have to be met with CET1 capital.

Table 2: **Summary statistics: Bank characteristics**

	Mean	SD	Min	P25	Median	P75	Max	N
Capital-to-assets (in %)	7.6	2.4	−2.3	6	7.0	8.7	94.4	16,641,626
Capital headroom (in pp.)	3.2	1.9	0.0	1.7	3	4.6	8.6	16,642,275
Total assets (in bln.)	732.1	747.9	0.0	56.9	572.2	1,497.2	2,766.4	16,642,784
Return on income (in %)	0.6	0.6	−41.8	0.4	0.5	0.8	5.9	16,642,784
NPL ratio (in %)	3.5	2.8	0.0	1.9	2.7	3.8	75.5	16,642,784
Provisioning ratio (in %)	0.7	0.7	−11.3	0.3	0.5	0.9	26.3	16,582,061

Notes: The table reports summary statistics for the bank characteristics of all new loans issued by euro area banks to non-financial firms between 2019 and 2023Q1. Bank characteristics are lagged by one quarter.

its dividend payments. Furthermore, we use a bank's size, its NPL ratio, profitability[9], and the provisioning ratio as control variables. We winsorize the capital headroom at the 1% and 99% levels.

As mentioned in the introduction, we use the bank capital-to-asset ratio as in Santos and Winton (2019) as our measure of macroprudential policy, and we refer to this measure as bank capitalisation. The main reason for using bank capitalization in our regressions is that the effect of higher macroprudential capital buffer requirements on lending rates should ultimately depend on how much additional equity funding per unit of asset the bank decides to use. This in turn depends on how much the bank's capital ratio target increases in response to higher capital buffer requirements, which can be less than one-for-one and differ over time (see Couallier 2021), and on the average risk-weight of the bank, which can differ considerably across banks as well as time. Using bank capitalization in our regressions instead of the risk-weighted capital buffer requirement accounts for both of these channels and is therefore a good indirect proxy for the impact of higher macroprudential capital buffer requirements on lending rates.

One caveat regarding the use of bank capitalisation as an explanatory variable is that it is not fully exogenous. For example, the loan pricing behaviour of a bank could affect its Pillar 2 capital requirement set by the supervisor and therefore also impact bank capitalisation. However, the same type of criticism would also apply when using the capital buffer requirement as an explanatory variable as this could also be affected by the loan pricing behaviour of banks. It is also important to note that there are a number of other factors than macroprudential capital buffer requirements that will drive bank capitalisation across time and across banks. These include microprudential capital requirements, the average risk-weight of a bank, and capital

[9] We measure profitability as return on assets. If values for the return on assets are missing, we interpolate linearly if values are not missing for more than three consecutive quarters.

Table 3: **Summary statistics: Macroeconomic Data**

	Mean	SD	Min	P25	Median	P75	Max	N
3-month OIS (in pp)	−0.1	0.9	−0.6	−0.5	−0.5	−0.4	3.1	16,642,784
10-year Goverment Bond Yield	1.0	1.2	−0.8	0.0	0.8	1.8	5.4	16,642,784
Projected GDP growth	2.6	1.9	−0.5	1.0	1.7	4.1	9.1	16,480,878
Projected Inflation	1.8	1.5	−0.7	1.0	1.3	2.5	7.3	16,480,878
Country-Level Index of Financial Stress	0.1	0.1	0.0	0.1	0.1	0.2	0.6	16,642,784

Notes: The table reports summary statistics for the macroeconomic data of all new loans issued by euro area banks to non-financial firms between 2019 and 2023Q1.

headroom chosen by banks, which tends to be pro-cyclical and lower for bigger banks and banks with better capital market access.

Table 2 reports descriptive statistics of the bank characteristics at the loan level. The average (median) loan is issued by a bank with a capital-to-asset ratio of 7.6% (7.0%). In other words, more than 90 % of banks' funding is debt. Observations in the interquartile range are relatively concentrated between 6.0 and 8.7% but overall there is a lot of variation. Over time, the ratio is quite persistent over the four years of our sample: For the average (median) bank, the difference between the highest and the lowest value for the capital-to-assets ratio is only 2.0 (1.4) percentage points. On average, banks have 3.2 percentage points capital (relative to RWAs) above their regulatory requirements. However, there is also wide variation and some banks are close to their regulatory requirements.

3.3 Macroeconomic Data

Futhermore, we combine the data with macroeconomic variables. Primarily, we use the 3-month Overnight Index Swap (OIS) rate on the date of loan issuance as a measure of the monetary policy stance. If no observation is available because the date is not a business day, we use the last available observation prior to the date of inception. In addition, we include variables that proxy for the current and expected macroeconomic conditions of the borrower's country: The yield on the 10-year government bond, as well as the one-year ahead projections for GDP growth and inflation from the ECB projection exercise that were known in the quarter of loan issuance, and the monthly Country-Level Index of Financial Stress[10].

Table 3 reports descriptive statistics for the macroeconomic variables at the loan level. Throughout most of our sample, monetary policy was at the zero lower bound, resulting in a slightly

[10] See Duprey, Klaus, and Peltonen (2015) for details on this index.

negative OIS rate. However, due to the recent monetary policy tightening, we cover a wide range of monetary policy from -0.6 to 3.1 percentage points.

4 Empirical strategy

We want to isolate the impact of monetary policy and bank capitalization on banks' pricing of new loans. To do so, we eliminate other factors that have been shown to affect the interest rate of new loans and that may be correlated with monetary policy or bank capitalisation (e.g. Berg, Saunders, Steffen, and Streitz, 2017; Dell'ariccia, Laeven, and Suarez, 2017; Ioannidou, Ongena, and Peydró, 2015; Jiménez, Ongena, Peydró, and Saurina, 2014; Luck and Santos, 2023; Schwert, 2020). In particular, we control for credit demand with fixed effects. In the most stringent specification, we use firm-quarter fixed effects. Furthermore, the granularity of our data allows us to control for loan characteristics that may lead to different interest rates even for the same firm in the same quarter. For example, if a firm takes out two loans in the same quarter, but one is collateralized and the other is not, the latter should be more expensive (Luck and Santos, 2023). With our rich set of control variables and fixed effects, we eliminate such factors, allowing us to study the pure supply effect of loan pricing.

We then estimate the following loan-level regression specification:

$$\begin{aligned}\text{interest rate}_i =& \beta \text{Monetary policy}_t \\ &+ \rho^* \text{Capital-to-assets}_{b,q-1} \\ &+ \gamma_1 X_{f,m} + \gamma_2 X_{c,m} + \delta Y_{b,q-1} + \zeta Z_i \\ &+ \theta_{f,q} + \varepsilon_i\end{aligned} \tag{3}$$

where i identifies a new loan, q, m, and t index the quarter, month and day of issuance, b the issuing bank, f the borrowing firm, and c the country of the firm. We measure monetary policy as the 3-month OIS rate. β corresponds to the theoretical parameter in model equation (2). To account for the fact that the pass-through of higher funding costs to lending rates may not be 1-for-1 in reality, we refer to ρ^* instead of ρ in our empirical model specification. ρ^* should be thought of as the equity premium in model equation (2) multiplied by the pass-through of higher funding costs to lending rates.

Firm-quarter fixed effects $\theta_{f,q}$ capture unobserved heterogeneity at the firm-quarter level, in particular credit demand (Khwaja and Mian, 2008). In an alternative specification, we replace the firm-quarter fixed effects with location-firm size-industry-quarter fixed effects to get identification from a wider set of firms (Degryse, De Jonghe, Jakovljević, Mulier, and Schepens, 2019) where we define location as the combination of the country and the two first digits of the postal code of the firm.

$X_{f,m}$ contains firm-month level control variables that could affect the interest rate. In particular, we control for a firm's PD, as riskier firms should pay higher interest rates. Unless we saturate the specification with firm-time or location-size-industry-time fixed effects, we also control for the firm's industry, size, and country. Smaller firms are less transparent and therefore riskier and the general macro risk may differ across industries and countries. Similarly, $X_{c,m}$ contains the index of financial stress and the 10-year government bond yield which controls for country-specific macroeconomic risk. In specifications saturated with fewer fixed effects, we also include $X_{c,q}$ which includes ECB projections for GDP growth and inflation one year ahead, but these are absorbed when we add quarter-firm or quarter-location fixed effects.

$Y_{b,q-1}$ contains bank-level control variables, measured in the previous quarter. Specifically, we control for log total assets, the NPL ratio, the return on assets, and the provisioning ratio.

Z_i contains loan-level control variables, namely the log loan amount and dummy variables for whether the loan is recourse or non-recourse and whether the loan is collateralized, since, all else equal, non-collateralized and non-recourse loans are riskier. Furthermore, the set of control variables includes the interest rate type (fixed, floating, mixed), the amortization scheme and a maturity bucket-year fixed effect to control for the term premium. As quantitative easing is likely to have had different effects along the yield curve over the years, it is important to interact the maturity bucket with the year of issuance.

Our coefficients of interest are β and ρ^*. Equation (3) is the most stringent specification we estimate. To understand the effects, we enrich the regressions in a stepwise procedure when presenting the results below. We cluster standard errors at the firm-bank and issuance date level.

Table 4: **Monetary policy, bank capitalisation and bank lending rates**

Dependent variable:	Interest rate (in bps)					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	257.9***	269.2***	267.2***			
	(2.3)	(8.8)	(7.7)			
3-month OIS (in pp)$_t$	70.1***		70.0***	69.0***	56.7***	64.0***
	(2.1)		(2.1)	(2.6)	(5.0)	(4.8)
Capital-to-assets (in %)$_{b,q-1}$		-2.2**	-1.2	3.0***	1.4***	2.4***
		(1.0)	(0.9)	(0.9)	(0.4)	(0.6)
Firm PD (in %)$_{f,b,m}$				2.8***	3.2***	0.2
				(0.2)	(0.1)	(0.2)
Country characteristics				X	(X)	(X)
Firm characteristics				X		
Bank characteristics				X	X	X
Loan characteristics				X	X	X
Maturity bucket-Year FE				X	X	X
Industry-Size-Quarter-Country Postal code FE					X	
Firm-Quarter FE						X
Observations	16,876,522	16,875,364	16,875,364	16,653,255	16,814,632	16,814,632
R^2	0.11	0.00	0.11	0.27	0.56	0.86

Notes: The table reports results for regression (3) with different control variables. The sample is a panel of new loans issued by euro area banks to non-financial firms from 2019 Q1 to 2023 Q1. *Country characteristics* include the 10-year government bond yield, the GDP and inflation projection fo the next year and the CLIFS. *Firm characteristics* include sector, size, and country. *Loan characteristics* include log outstanding amount, a dummy for resource vs. non-recourse loans, the interest rate type, the amortization scheme, the type of instrument, and a dummy whether the loan has some form of collateral. *Bank characteristics* include lagged log total asset, NPL ratio, return on assets, and provisioning ratio. (X) means that some of the variables are included and others are absorbed by the fixed effects. Standard errors clustered at the bank-firm and day level are in parenthesis.

5 Empirical Results

5.1 Monetary Policy, Bank Capitalization, and Loan Rates

We start our analysis by examining the linear impact of monetary policy and bank capitalisation on bank lending rates for NFCs and estimate equation (3). Table 4 shows the regression results with various sets of control variables. Columns (1) and (2) show basic individual correlations between bank lending rates and monetary policy and bank capitalisation respectively. Column (3) looks at both impacts jointly. In column (4) we add various country, bank, and debtor control variables as well as some fixed effects. On top of that, the results in columns (5) and (6) explicitly control for time-varying firm loan demand following Degryse, De Jonghe, Jakovljević, Mulier, and Schepens (2019) and Khwaja and Mian (2008).

As shown in column (1) of Table 4, monetary policy alone explains around 10% of the variation in bank lending rates. Throughout specifications, we find a strong positive relationship between monetary policy rates and loan rates. The estimate of the monetary policy pass-through is rather stable across specifications and varies between 57 bps and 70 bps for a 100 bps change in monetary policy rates. This implies that tighter monetary policy is transmitted to lending rates of new corporate loans by around two thirds. The results hold even when we estimate the most saturated specifications in columns (5) and (6) that control for time-varying firm loan demand. Overall, the monetary policy impact is tightly estimated across all specifications resulting in statistically significant estimates at the 1% level.

Our results for the impact of monetary policy on bank lending rates in the euro area during the most recent tightening cycle are in line with typical estimates found in the literature. In particular, in their meta-analysis Gregor, Melecký, and Melecký (2021) find that average interest rate pass-through based on over thousand estimates reported in the literature is around 80 (the conditional average is 60 when controlling for research methodologies, publication characteristics, and country macro-financial and institutional factors). Nonetheless, to our knowledge existing studies haven't considered potential state-dependence with respect to the level of interest rates, and in particular with respect to the zero lower bound. This will be explored in section 5.2 further below.

We now turn to the results regarding the impact of bank capitalisation on bank loan pricing, where bank capitalisation is measured with the capital-to-assets ratio. As outlined above, the estimated coefficient for the capital-to-assets ratio should represent two factors: (i) the difference in the cost of bank equity and the cost of bank debt (equity premium) and (ii) to what extent this funding cost difference is passed on to lending rates of bank customers.

First, we find that in the model specifications that do not control for borrower characteristics, the estimated impact of bank capitalisation on lending rates is negative at -1.2 to -2.2 bps (columns 2 and 3 in Table 4). These estimates imply that more equity funding of a bank slightly reduces lending rates. However, these coefficient estimates should not be over-interpreted as none of these specifications controls for debtor or bank characteristics. As shown in column 2, bank capitalisation alone explains very little of the variation in bank lending rates over time and across borrowers, with an R^2 of just 0.0007%. As a comparison, country, debtor, bank, and loan characteristics, as well as fixed effects together explain around 16% of the variation in lending rates as shown by the difference in R^2 between columns (3) and (4).

Once we control for bank characteristics and loan demand through the inclusion of borrower characteristics and fixed effects (columns 4-6), we find a positive relationship between bank capitalisation and lending rates with coefficients between 1.4 - 3.0 bps, that are statistically significant at the 1% level. As bank capitalisation varies across banks it is not surprising that the estimated coefficient changes a lot once we include these control variables. The most saturated specification with firm-quarter fixed effects in column 6 results in a somewhat higher coefficient estimate of 2.4 compared to the specification with location-sector-firm size fixed effects in column 5, with a coefficient estimate of 1.4. A coefficient of 2.4 implies that banks with a 1 pp higher capital-to-assets ratio charge on average a 2.4 bps higher interest rate on their loans. Alternatively, banks with a 1 standard deviation higher capital-to-assets ratio (2.4) charge on average a 5.8 ($= 2.4 \times 2.4$) bps higher interest rate on their loans. Under the assumption of perfect pass-through of funding costs to lending rates, the estimate implies an equity premium of 2.4pp. If pass-though of funding costs to lending rates was only 50%, the coefficient estimate would be consistent with an equity premium of 4.8pp.

We can now compare the relative importance of the two policies for bank lending rates. For this purpose we focus on the results in column (6) in Table 4, which is the most stringent regression specification. Overall, the monetary policy impact on lending rates is an order of magnitude larger than the impact of bank capitalisation: a standard monetary policy rate hike increment of 25bps is passed on to bank lending rates as 0.25 * 64, resulting in 16 bps higher lending rates; in contrast a 1 pp higher capital-to-asset ratio is associated with 2.4 bps higher loan rates. Therefore, a monetary policy tightening of 25bps has an equivalent impact on bank lending rates as a $16/2.4 = 6.7$ pp higher capital-to-assets ratio, which is a very big increase in bank capitalisation (around 2.8 standard deviations). Under the assumption of a 75% bank risk weight and one-for-one movements between bank capitalisation and bank capital requirements, this would imply an increase in risk-weighted capital requirements of 9pp.[11] Note also that while the point estimates differ across the specifications in columns (4) - (6), the qualitative implications are similar. Moreover, the estimated magnitudes are consistent with the simple theoretical framework outlined in section 2.

5.2 Heterogeneous impact depending on the interest rate level and banks' capital headroom

In the previous section, we assumed the impact of monetary policy not to vary with the macro-financial environment, and in particular with whether monetary policy might face a zero-lower bound. Similarly, the effect of bank capital was assumed to be the same regardless of the capital

[11] For reference, the average risk weights for exposures to corporates in the euro area are around 85% and 45% under the standardised approach and the internal ratings-based approach respectively.

headroom, i.e. level of capital on the top of overall capital requirements. In this section, we extend our baseline specifications to capture potential non-linearities with respect to the level of interest rates and capital headroom. In order to do so, we estimate the following regression:

$$\begin{aligned}\text{interest rate}_i =& \beta \text{Monetary policy}_t \\ &+ \rho^* \text{Capital-to-assets}_{b,q-1} \\ &+ \beta_1 \mathbb{1}_{\text{Monetary policy}_t < 0} \\ &+ \rho_1^* \text{Capital headroom}_{b,q-1} \\ &+ \beta_2 \text{Monetary policy}_t \times \mathbb{1}_{\text{Monetary policy}_t < 0} \\ &+ \rho_2^* \text{Capital-to-assets}_{b,q-1} \times \text{Capital headroom}_{b,q-1} \\ &+ \gamma_1 X_{f,m} + \gamma_2 X_{c,m} + \delta Y_{b,q-1} + \zeta Z_i \\ &+ \theta_{f,q} + \varepsilon_i\end{aligned} \tag{4}$$

First, we add to the baseline specification an interaction term to assess the presence of non-linearities depending on the level of interest rates. In particular, we include a dummy variable 3-month OIS < 0 that is 1 in cases when the 3M OIS rate is negative and also its interaction with the 3-month OIS rate. The results summarized in Table 5 indicate that the effect of monetary policy on lending rates is much lower in periods of negative interest rates. While the interaction term is insignificant in specifications that capture just basic individual correlations (columns 1 and 3), when we control for country, bank, and debtor characteristics (columns 4-6), the interaction term is statistically and economically significant. In particular, an increase of the 3-month OIS rate by one standard deviation (0.9pp) is associated with just 19 - 27 bps higher bank lending rates with negative policy interest rates are below zero, while the same monetary policy difference is associated with 54-60 bps higher bank lending rates with positive interest rates.

The OIS rate does not vary much in the low interest rate environment. Therefore, we additionally use monetary policy shocks to examine how the pass-through varies at the zero lower bound, as there is more variation in monetary policy shocks. We use shocks to the 3-month rate provided by Altavilla, Brugnolini, Gürkaynak, Motto, and Ragusa (2019), which are identified from high-frequency market reactions around the short window of ECB monetary policy decisions.

Table 5: **Non-linearity depending on zero lower bound and bank capital headroom**

Dependent variable:	Interest rate (in bps)					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	253.3***	275.4***	243.4***			
	(8.5)	(16.1)	(17.6)			
3-month OIS (in pp)$_t$	72.0***		72.4***	70.4***	59.8***	66.9***
	(2.4)		(2.3)	(2.8)	(5.2)	(5.1)
$\mathbb{1}_{\text{3-month OIS}_t<0}$	16.4		1.3	-19.3**	3.8	4.6
	(12.2)		(11.7)	(8.8)	(4.5)	(4.8)
3-month OIS (in pp)$_t$ $\times \mathbb{1}_{\text{3-month OIS}_t<0}$	24.2		-5.3	-63.2***	-42.8*	-41.3*
	(25.3)		(24.3)	(21.2)	(21.9)	(24.1)
Capital-to-assets (in %)$_{b,q-1}$		-1.7	4.0**	15.9***	9.7***	5.6***
		(2.1)	(1.9)	(1.7)	(0.9)	(1.4)
Capital headroom (in %)$_{b,q-1}$ $\times$ Capital-to-assets (in %)$_{b,q-1}$		0.1	-0.8***	-1.3***	-1.3***	-0.6***
		(0.3)	(0.3)	(0.2)	(0.1)	(0.2)
Capital headroom (in %)$_{b,q-1}$		-4.1*	0.7	-0.9	6.5***	5.1***
		(2.5)	(2.4)	(1.7)	(1.0)	(1.4)
Firm PD (in %)$_{f,b,m}$				2.8***	3.2***	0.2
				(0.3)	(0.1)	(0.2)
Country characteristics				X	(X)	(X)
Firm characteristics				X		
Bank characteristics				X	X	X
Loan characteristics				X	X	X
Maturity bucket-Year FE				X	X	X
Industry-Size-Quarter-Country Postal code FE					X	
Firm-Quarter FE						X
Observations	16,876,522	16,874,855	16,874,855	16,652,953	16,814,123	16,814,123
R^2	0.11	0.00	0.11	0.28	0.56	0.86

Notes: The table reports results for regression (4) with different control variables. The sample is a panel of new loans issued by euro area banks to non-financial firms from 2019 Q1 to 2023 Q1. *Country characteristics* include the 10-year government bond yield, the GDP and inflation projection fo the next year and the CLIFS. *Firm characteristics* include sector, size, and country. *Loan characteristics* include log outstanding amount, a dummy for resource vs. non-recourse loans, the interest rate type, the amortization scheme, the type of instrument, and a dummy whether the loan has some form of collateral. *Bank characteristics* include lagged log total asset, NPL ratio, return on assets, and provisioning ratio. (X) means that some of the variables are included and others are absorbed by the fixed effects. Standard errors clustered at the bank-firm and day level are in parenthesis.

Since our variable of interest is the monetary policy rate in *levels*, we use the cumulative sum of monetary policy shocks from the beginning of our sample to day t to construct a time series:

$$\text{Monetary policy shock}_t \text{ (cumulative)} = \sum_{\tau=01.01.2019}^{t} \text{Monetary policy shock}_\tau \tag{5}$$

where t, τ describe business days. We then replace the 3-month OIS rate with Monetary policy shock$_t$ (cumulative) and estimate the following regression equation:

$$\begin{aligned} \text{interest rate}_i = & \phi_1 \text{Monetary policy shock}_t \text{ (cumulative)} \\ & + \rho^* \text{Capital-to-assets}_{b,q-1} \\ & + \phi_2 \text{Monetary policy shock}_t \text{ (cumulative)} \times \mathbb{1}_{\text{Monetary policy}_t < 0} \\ & + \gamma_1 X_{f,m} + \gamma_2 X_{c,m} + \delta Y_{b,q-1} + \zeta Z_i \\ & + \theta_{f,q} + \varepsilon_i \end{aligned} \tag{6}$$

We show the results in Table 6. Columns (1) and (3), without interaction terms, show that the cumulative shocks are transmitted almost one-for-one to loan rates. However, consistent with our results above, columns (2) and (4) show that the pass-through is close to zero when the 3-month OIS rate is negative.

Second, as it is difficult for banks to quickly raise new equity in the short-run, banks can end up in situations where they are equity constrained, i.e. where they cannot attain jointly their desired bank capitalisation and desired loan volume. In such situations, banks could be incentivised to reduce lending in order to increase their capitalisation for a given level of available equity. This reduction in loan supply for equity constrained banks should then show up in higher interest rates charged as long as loan demand does not drop to the same extent. To capture such potential state-dependence, we include an interaction term between bank capitalisation and the banks' capital headroom. The capital headroom captures the distance between the banks' capital ratio and the banks' regulatory capital requirement, and the closer it is to zero the more likely it is that the bank could be equity constrained.

As shown in column 2 of Table 5, bank capitalisation and bank capital headrooms together also explain very little of the variation in lending rates, just 0.1% and their effect is largely insignificant. If the 3M OIS rate as well as terms capturing nonlinear effect of interest rate level are added (column 3), the coefficient capturing impact of bank capital on lending rates is

Table 6: **Effects of monetary policy shocks and zero lower bound**

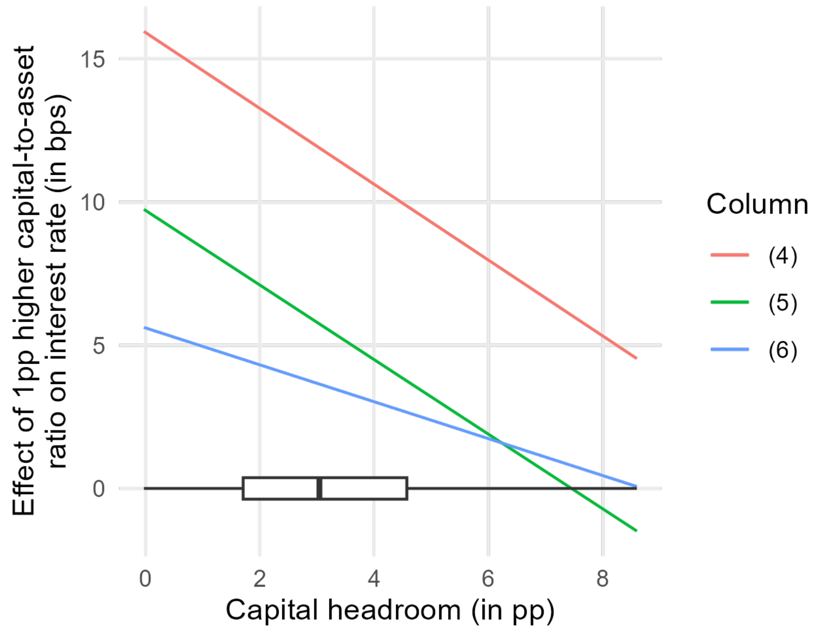
Dependent variable:	Interest rate (in bps)			
	(1)	(2)	(3)	(4)
Monetary policy shock$_t$ (cumulative, in bps)	0.9***	0.9***	1.0***	1.0***
	(0.2)	(0.2)	(0.2)	(0.2)
Monetary policy shock$_t$ (cumulative, in bps) × $\mathbb{1}_{\text{3-month OIS}_t<0}$		-0.7***		-0.7***
		(0.2)		(0.2)
Capital-to-assets (in %)$_{b,q-1}$	1.3***	1.3***	2.5***	2.5***
	(0.4)	(0.4)	(0.6)	(0.6)
Country characteristics	X	X	X	X
Bank characteristics	X	X	X	X
Loan characteristics	X	X	X	X
Maturity bucket-Year FE	X	X	X	X
Firm PD	X	X	X	X
Industry-Size-Quarter-Country Postal code FE	X		X	
Firm-Quarter FE		X		X
Observations	16,814,632	16,814,632	16,814,632	16,814,632
Adjusted R^2	0.54	0.54	0.82	0.82

Notes: The table reports results for regression (6) with different control variables. The sample is a panel of new loans issued by euro area banks to non-financial firms from 2019 Q1 to 2023 Q1. The cumulative monetary policy shock series is defined in (5). *Country characteristics* include the 10-year government bond yield, the GDP and inflation projection fo the next year and the CLIFS. *Firm characteristics* include sector, size, and country. *Loan characteristics* include log outstanding amount, a dummy for resource vs. non-recourse loans, the interest rate type, the amortization scheme, the type of instrument, and a dummy whether the loan has some form of collateral. *Bank characteristics* include lagged log total asset, NPL ratio, return on assets, and provisioning ratio. (X) means that some of the variables are included and others are absorbed by the fixed effects. Standard errors clustered at the bank-firm and day level are in parenthesis.

positive, statistically significant and similar in magnitude to the estimates from the previous subsection. Further, the interaction term of bank capital and capital headroom also becomes significant and negative, indicating a higher impact for banks that are more constrained. These results are further corroborated in the specifications in which we control for country, bank characteristics as well as loan demand through fixed effects (columns 4-6). The coefficient of the impact of bank capital ranges from 5.5-16, while the coefficient on interaction term between capital headroom and bank capital is between -0.6 and -1.3. According to the results in our preferred specification with borrower-quarter fixed effects (column 6), a one standard deviation higher capital-to-assets ratio (2.4pp) is associated with 13bps higher lending rates when the capital headroom is zero, while the same difference in the capital-to-assets ratio is associated with 9 bps higher lending rates when the capital headroom is 3pp (obtained by using the estimated coefficients: $2.4 * 5.5 - 2.4 * 0.6 * 3$).

Figure 2 further illustrates the state-dependent impact of changes in the capital-to-assets ratio on loan rates depending on the available capital headroom for the different model specifications that we estimate with fixed-effects. The boxplot shows the distribution of the capital headroom

Figure 2: **State-dependent impact of bank capitalisation on lending rates**



Notes: This figure visualizes the results of Table 5 of the non-linear impact of bank's capital-to-asset ratio on loan rates. For each value of capital headroom on the x-axis, the y-axis depicts the effect of a 1pp increase in the capital-to-asset ratio on loan rates. The different lines represent the results from different columns of Table 5 with different sets of control variables. The line is calculated as $\rho^* + \rho_2^* \times$ Capital headroom based on equation (4). The boxplot visualizes the distribution of capital headroom in our sample.

in our sample. Across all specifications, the estimated coefficients imply that higher bank capitalisation has a stronger effect on bank loan supply and lending rates when banks are close to regulatory requirements and are most likely equity constrained. At capital headrooms of 7.5% changing bank capitalisation has close to a zero (or even negative) impact on lending rates.

5.3 Instrumental Variable Results

Monetary policy rates might be endogenous to loan rates. This can be the case when, for example, both react to expected future economic developments. In this section, we employ the monetary policy shock series introduced above for identification of the effect of monetary policy on loan rates. In doing so, we use only the part of monetary policy changes that were not expected by financial markets.

The monetary policy shocks in Altavilla, Brugnolini, Gürkaynak, Motto, and Ragusa (2019) are identified from high-frequency market reactions around the short window of ECB monetary policy decisions. Therefore, they arguably affect loan rates only via monetary policy.

Since our endogenous variable is the monetary policy rate in levels, we again use the cumulative sum of monetary policy shocks as an instrument. We then estimate the following IV regression:

$$
\begin{aligned}
\text{1st stage: Monetary policy}_t = & \eta_1 \sum_{\tau=01.01.2019}^{t} \text{Monetary policy shock}_\tau \\
& + \eta_2 \text{Capital-to-assets}_{b,q-1} \\
& + \eta_3 X_{f,m} + \eta_4 X'_{c,m} + \eta_5 Y_{b,q-1} + \eta_6 Z'_i \\
& + \lambda_f + u_i
\end{aligned} \tag{7}
$$

$$
\begin{aligned}
\text{2nd stage: interest rate}_i = & \beta \widehat{\text{Monetary policy}}_t \\
& + \rho^* \text{Capital-to-assets}_{b,q-1} \\
& + \gamma_1 X_{f,m} + \gamma_2 X'_{c,m} + \delta Y_{b,q-1} + \zeta Z'_i \\
& + \lambda_f + \varepsilon_i
\end{aligned} \tag{8}
$$

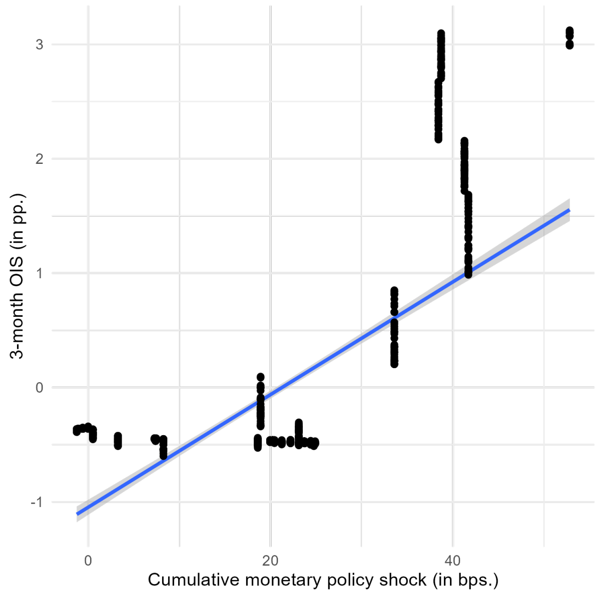
where t, τ describe business days.

We adjust the estimation relative to the OLS specification in equation (3) and remove control variables that would predict the level of monetary policy in the first stage regression almost perfectly: We switch from firm-time to firm fixed effects, from maturity bucket-time to maturity bucket fixed effects and remove the 10 year government bond yield from the set of control variables. This adjustment restricts the comparability of our IV results with the results in Table 4.

Monetary policy shocks are a relevant instrument for the 3-month OIS rate. Figure 3 plots the cumulative sum of monetary policy shocks against the actual observed 3-month OIS rate for each day in our sample. The blue line represents the best linear fit. Clearly, there is a positive relationship, suggesting that financial markets were partially surprised by monetary policy decisions over our sample period.

Our overall results are robust to IV estimation: Table 7 reports the results of estimating equation 7. The results mirror columns (5) and (6) in Table 4. The F-statistic confirms that our instrument is relevant. The estimates change relative to the OLS specification: The estimates for the 3-month OIS rate are about 12bps larger, while the estimates for the capital-to-asset ratio are about twice as large. However, this can be due to the different set of control variables.

Figure 3: **Cumulative monetary policy shocks and OIS rate**



Notes: For each loan issuance day in our sample, this figure plots the cumulative monetary policy shock series defined in (5) against the 3-month OIS rate. The figure reflects the first stage of the IV regression defined in (7). The blue line depicts the best linear fit.

Table 7: **IV estimates**

Dependent variable: IV stages	Interest rate (in bps) Second (1)	3-month OIS (in pp)$_t$ First (2)	Interest rate (in bps) Second (3)	3-month OIS (in pp)$_t$ First (4)
3-month OIS (in pp)$_t$	68.3***		75.6***	
	(3.4)		(3.7)	
Capital-to-assets (in %)$_{b,q-1}$	3.2***	0.0	5.0***	0.0**
	(0.6)	(0.0)	(0.9)	(0.0)
Firm PD (in %)$_{f,b,m}$	3.0***	0.0	0.5***	0.0
	(0.1)	(0.0)	(0.1)	(0.0)
Monetary policy shock$_t$ (cumulative, in pp.)		4.2***		4.2***
		(0.2)		(0.2)
Country characteristics	(X)	(X)	(X)	(X)
Bank characteristics	X	X	X	X
Loan characteristics	X	X	X	X
Maturity bucket FE	X	X	X	X
Industry-Size-Country Postal code FE	X	X		
Firm FE			X	X
Observations	16,653,255	16,653,255	16,653,255	16,653,255
Adjusted R^2	0.43	0.82	0.68	0.83
F-test (1st stage)		10,767,714.99		9,768,838.08

Notes: The table reports first and second stage results for IV regression (7) with two different sets of fixed effects. Columns (2) and (4) report results of first stage regressions and columns (1) and (3) second stage results. The sample is a panel of new loans issued by euro area banks to non-financial firms from 2019 Q1 to 2023 Q1. *Country characteristics* include the GDP and inflation projection fo the next year and the CLIFS. *Firm characteristics* include sector, size, and country. *Loan characteristics* include log outstanding amount, a dummy for resource vs. non-recourse loans, the interest rate type, the amortization scheme, the type of instrument, and a dummy whether the loan has some form of collateral. *Bank characteristics* include lagged log total asset, NPL ratio, return on assets, and provisioning ratio. (X) means that some of the variables are included and others are absorbed by the fixed effects. Standard errors clustered at the bank-firm and day level are in parenthesis.

Table 8: **Weighted results**

Dependent variable:	Interest rate (in bps)			
	(1)	(2)	(3)	(4)
3-month OIS (in pp)$_t$	64.5***	64.7***	64.2***	64.7***
	(3.1)	(3.9)	(3.1)	(3.9)
Capital headroom (in %)$_{b,q-1}$ × Capital-to-assets (in %)$_{b,q-1}$			-0.9***	-0.6***
			(0.1)	(0.1)
Capital-to-assets (in %)$_{b,q-1}$	2.3***	2.4***	7.9***	5.2***
	(0.2)	(0.2)	(0.6)	(0.5)
Capital headroom (in %)$_{b,q-1}$			5.3***	5.8***
			(0.5)	(0.5)
Firm PD (in %)$_{f,b,m}$	3.0***	0.6***	3.0***	0.6***
	(0.2)	(0.2)	(0.2)	(0.2)
Country characteristics	(X)	(X)	(X)	(X)
Bank characteristics	X	X	X	X
Loan characteristics	X	X	X	X
Maturity bucket-Year FE	X	X	X	X
Industry-Size-Quarter-Country Postal code FE	X		X	
Firm-Quarter FE		X		X
Observations	16,814,632	16,814,632	16,814,123	16,814,123
R^2	0.63	0.88	0.63	0.88

Notes: The table reports results for regression (4) with different control variables. Each loan is weighted with the loan amount at issuance. The sample is a panel of new loans issued by euro area banks to non-financial firms from 2019 Q1 to 2023 Q1. *Country characteristics* include the 10-year government bond yield, the GDP and inflation projection fo the next year and the CLIFS. *Firm characteristics* include sector, size, and country. *Loan characteristics* include log outstanding amount, a dummy for resource vs. non-recourse loans, the interest rate type, the amortization scheme, the type of instrument, and a dummy whether the loan has some form of collateral. *Bank characteristics* include lagged log total asset, NPL ratio, return on assets, and provisioning ratio. (X) means that some of the variables are included and others are absorbed by the fixed effects. Standard errors clustered at the bank-firm and day level are in parenthesis.

In particular, monetary policy has the dominant effect on loan rates in the IV regressions similar to our estimates above.

5.4 Results Weighted by Loan Amount

We find that the results for the average euro are similar to the results for the average loan. So far, our level of observation has been the individual loan level. For policy decisions, it is equally important to understand what happens at the aggregate level. If there were systematic differences in the effects of monetary policy and bank capital on small and large loans, the aggregate would differ from the average effect estimated in the sections above. Therefore, we rerun the regressions from above as weighted regressions, using the loan amount at origination as the weight. We report the results in Table 8.

Overall, the results confirm our earlier findings: Monetary policy has the predominant effect on loan rates. The estimates of monetary policy pass-through are very close to the unweighted

Table 9: **Sample without zero interest rate environment**

Dependent variable:	Interest rate (in bps)	
	(1)	(2)
3-month OIS (in pp)$_t$	52.0***	56.1***
	(3.8)	(4.1)
Capital-to-assets (in %)$_{b,q-1}$	17.9***	4.6**
	(1.1)	(1.9)
Capital headroom (in %)$_{b,q-1}\times$ Capital-to-assets (in %)$_{b,q-1}$	-2.2***	-0.5**
	(0.1)	(0.2)
Capital headroom (in %)$_{b,q-1}$	0.8	-6.8***
	(1.2)	(1.7)
Firm PD (in %)$_{f,b,m}$	4.2***	-0.2
	(0.4)	(0.2)
Country characteristics	(X)	(X)
Bank characteristics	X	X
Loan characteristics	X	X
Maturity bucket-Year FE	X	X
Industry-Size-Quarter-Country Postal code FE	X	
Firm-Quarter FE		X
Observations	4,421,481	4,421,481
R^2	0.64	0.88

Notes: The table reports results for regression (4) with different control variables. The sample is a panel of new loans issued by euro area banks to non-financial firms now only from 2022 Q1 to 2023 Q1. *Country characteristics* include the 10-year government bond yield, the GDP and inflation projection fo the next year and the CLIFS. *Firm characteristics* include sector, size, and country. *Loan characteristics* include log outstanding amount, a dummy for resource vs. non-recourse loans, the interest rate type, the amortization scheme, the type of instrument, and a dummy whether the loan has some form of collateral. *Bank characteristics* include lagged log total asset, NPL ratio, return on assets, and provisioning ratio. (X) means that some of the variables are included and others are absorbed by the fixed effects. Standard errors clustered at the bank-firm and day level are in parenthesis.

results. The estimated effect of bank capital on loan rates is also similar, in particular when we include firm-quarter fixed effects. We also confirm that the effect of the capital-to-asset ratio declines with distance from the capital requirement.

5.5 Sample without zero interest rate environment

Our results also hold during the period of monetary tightening. We show in Figure 1b that there is little variation in the OIS rate before 2022. Therefore, we rerun our regressions for the subsample starting in 2022. We present the results in Table 9. They confirm our earlier results that monetary policy has the predominant effect on loan rates and that the effect of capital decreases with distance from the regulatory requirement.

6 Conclusion

In this paper, we analyze the effect of monetary policy and bank capitalization on the interest rate on new loans to non-financial firms in the euro area in 2019-2023. New granular loan-level data allow us to control not only for loan demand and firm characteristics, but also for potentially endogenous loan-level characteristics that may also affect interest rates. We find that, consistent with our stylized model of bank funding costs, monetary policy has the predominant effect on loan rates relative to bank capitalisation. However, at the zero lower bound, or when banks are close to their regulatory capital requirements, the effect of bank capitalisation relative to monetary policy becomes stronger. Nevertheless, monetary policy remains the dominant driver. This also holds for the aggregate, i.e. volume-weighted effect. Furthermore, we employ IV estimation using high-frequency identified monetary policy shocks around policy decisions to provide robustness for the estimated pass-through coefficient of monetary policy.

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