THE TRANSMISSION OF MONETARY POLICY TO CREDIT SUPPLY IN THE EURO AREA

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Miguel García-Posada and Peter Paz

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Miguel García-Posada

BANCO DE ESPAÑA

Peter Paz

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This paper contains research conducted within the network "Challenges for Monetary Policy Transmission in a Changing World Network" (ChaMP). It consists of economists from the European Central Bank (ECB) and the national central banks (NCBs) of the European System of Central Banks (ESCB).

ChaMP is coordinated by a team chaired by Philipp Hartmann (ECB), and consisting of Diana Bonfim (Banco de Portugal), Margherita Bottero (Banca d'Italia), Emmanuel Dhyne (Nationale Bank van België/Banque Nationale de Belgique) and Maria T. Valderrama (Oesterreichische Nationalbank), who are supported by Melina Papoutsi and Gonzalo Paz-Pardo (both ECB), 7 central bank advisers and 8 academic consultants.

ChaMP seeks to revisit our knowledge of monetary transmission channels in the euro area in the context of unprecedented shocks, multiple ongoing structural changes and the extension of the monetary policy toolkit over the last decade and a half as well as the recent steep inflation wave and its reversal. More information is provided on its website.

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Abstract

We present empirical evidence on the transmission of monetary policy to banks' credit standards (i.e. loan approval criteria) in loans granted to non-financial corporations (NFCs) in the euro area. To this end, we use a confidential survey in which banks are asked about developments in their respective credit markets, coupled with banks' balance sheets and high-frequency monetary policy shocks. First, we find that poorly capitalized banks are more likely to tighten their credit standards in loans to NFCs. Second, these banks have tended to tighten their credit standards more in loans to SMEs than in loans to large firms during the current restrictive monetary phase. Third, the transmission of monetary policy to credit standards in loans to NFCs is stronger in poorly capitalized banks. Fourth, the relationship between monetary policy and credit standards is driven by large contractionary monetary policy shocks, which reveals important asymmetries in the bank lending channel. Finally, a tightening of the monetary policy stance also increases rejection rates in loans to NFCs, to a greater extent in poorly capitalized banks.

Keywords: monetary policy, bank capital, credit supply, bank lending channel.

JEL classification: E51, E52, G21.

Resumen

Este documento presenta evidencia empírica sobre la transmisión de la política monetaria a los criterios de aprobación de préstamos de los bancos en los créditos otorgados a sociedades no financieras (SNF) en el área del euro. Para ello se utiliza una encuesta confidencial en la que se pregunta a los bancos sobre la evolución de sus respectivos mercados de crédito, junto con sus balances y *shocks* de política monetaria de alta frecuencia. Se encuentra, primero, que los bancos poco capitalizados son más propensos a endurecer sus criterios de aprobación de préstamos en los créditos a las SNF. Segundo, que estos bancos tienden a endurecer más sus criterios de aprobación en los préstamos a las pymes que en los créditos a las grandes empresas durante la actual fase de política monetaria restrictiva. Tercero, que la transmisión de la política monetaria a los criterios de aprobación en los préstamos a las SNF es más fuerte en los bancos poco capitalizados. Y, cuarto, que la relación entre la política monetaria y los criterios de aprobación se debe principalmente a grandes *shocks* de política monetaria contractiva, lo que revela importantes asimetrías en la transmisión de esta a través del canal de crédito bancario. Finalmente, se observa un endurecimiento de la política monetaria también aumenta las tasas de rechazo en los préstamos a las SNF, en mayor medida en los bancos poco capitalizados.

Palabras clave: política monetaria, oferta de crédito, oferta crediticia, canal bancario de préstamos.

Códigos JEL: E51, E52, G21.

1 Introduction

The global energy crisis and disruptions in global supply chains have driven up prices in both developed and emerging economies, resulting in the highest inflation rates observed during the last decades. In response, major central banks, including the Eurosystem, have implemented substantial changes in their monetary policy stance not seen since the establishment of the euro area. As a consequence, banks have incrementally tightened their lending supply, limiting credit availability.

In such a complex scenario, the Bank Lending Survey (BLS) becomes a very useful tool to disentangle credit supply from credit demand, thus enhancing our understanding of the intricate dynamics within credit markets, where only equilibrium prices and quantities are directly observable.[1] Making use of the confidential micro-data from the Individual Bank Lending Survey (iBLS), we first carry out a detailed analysis to identify which banks are more likely to tighten their credit standards (i.e., their loan approval criteria). We then study the heterogeneous transmission of the Eurosystem's monetary policies to banks' credit supply through various channels such as capital, liquidity, deposits, and size, i.e., the bank lending channel.

In pursuing this research, we address several critical questions. (i) Which banks are more likely to tighten their credit supply, as measured by their credit standards, in loans to non-financial corporations (NFCs)?. (ii) Are there significant differences between the credit standards applied to loans to SMEs and those applied to loans to large firms? (iii) Do Spanish banks exhibit different behavioral patterns than their counterparts from other euro area countries? (iv) What is the effect of abrupt changes in the monetary policy stance on banks' credit standards? (v) Does this effect depend on bank characteristics? (vi) Do monetary policy shocks have asymmetric effects, depending on their sign (i.e., contractionary vs. expansionary) and magnitude?

To answer these questions, we conduct an empirical analysis that makes use of a large sample of banks from the euro area, combining the iBLS with banks' balance-sheet data and monetary shocks constructed using a high-frequency event-study approach. We first find a significant negative correlation between banks' capital ratios -as measured by their equity ratios- and banks' propensity to tighten their credit standards in loans to NFCs. In other words, banks with lower equity ratios are, on average, more likely to tighten their credit standards in loans to NFCs. A potential explanation is that poorly capitalized banks must take less risk[2], which forces them to implement more prudent lending policies. This pattern

[1] In addition, Köhler-Ulbrich and Hünnekes (2023) show that changes in BLS credit standards and loan demand have leading indicator properties for future growth in loans to firms and they improve loan growth forecasts for euro area firms.

[2] The relationship between bank capital and risk taking is a priori ambiguous. The risk-shifting hypothesis (Jensen and Meckling (1976)) implies stronger risk taking by poorly capitalized banks because, as their skin in the game is low, they may take more risk (Holmstrom and Tirole (1997); Freixas and Rochet (2008)). In contrast, the risk-bearing capacity hypothesis (Gambacorta and Mistrulli (2004); Adrian and Shin (2010); Kim and Sohn (2017)) suggests that higher bank capital allows more risk taking because of its loss-absorbing capacity.

is more pronounced in loans to small and medium-sized enterprises (SMEs) compared to loans to large firms during the current phase of restrictive monetary policy, arguably because the former are usually riskier, thereby consuming more capital.[3] Nevertheless, this tentative conclusion must be taken with caution, as our analyses rely on banks' equity ratios (ratio of total equity to total assets), rather than regulatory capital ratios or banks' capital buffers. We also analyze whether the role of capital in banks' lending policies is different in Spanish banks compared to those from other euro area countries, but our findings indicate that there are no significant differences. In addition, the transmission of monetary policy to credit standards in loans to NFCs is stronger in poorly capitalized banks. We also find that the relationship between monetary policy and credit standards is driven by large contractionary shocks, which reveals important asymmetries in the bank lending channel. In line with those results, we also document that a tightening in the monetary policy stance increases rejection rates -an alternative measure of credit supply- in loans to NFCs, to a greater extent in poorly capitalized banks.

Literature review and contribution. Prior research has extensively explored the transmission mechanisms of monetary policy to credit supply, the so-called bank lending channel. In particular, the relationship between changes in policy rates and the dynamics of bank lending and loan interest rates has been extensively studied. This paper contributes to the large literature on understanding the dynamics of bank credit supply within the bank lending channel, particularly in the euro area, drawing directly from bank-level data to analyze how monetary policy influences changes in lending across euro area countries. In particular, Maddaloni and Peydró (2011) and Ciccarelli et al. (2013) are closely related to our work, as they investigate the transmission of monetary policy through the bank lending channel, emphasizing its impact on economic performance and heterogeneity across euro area countries. Moreover, Altavilla et al. (2019b) estimate the impact of credit supply shocks on economic activity by building a loan supply indicator with the BLS for the euro area. Hempell and Kok (2010) make use of the BLS to show that the credit supply has a significant influence on the growth of loans to firms and households in the euro area. However, in contrast with those papers, we use individual bank-level data that allow us to analyze in detail banks' lending decisions and to identify the key characteristics that influence them.

We also contribute to the literature that connects individual BLS data with bank-level data on banks' financial conditions to model the impact of monetary policy on bank lending. Altavilla et al. (2021) find that an increase in the short-term interest rate reduces both credit supply and demand, particularly for less healthy banks. While their results are aligned with ours, rather than analyzing the effect of short-term interest rates we consider unexpected monetary policy shocks that are extracted from high-frequency data, using an event-study approach that follows Altavilla et al. (2019a) and Jarociński and Karadi (2020). In addition,

[3]This result is consistent with Faccia et al. (2024), who find that weaker, poorly capitalized banks adjust their credit standards more than healthier banks, especially for firms with a higher default risk.

we study the asymmetric effects of monetary policy shocks on banks' credit supply, both in terms of sign (i.e., contractionary vs. expansionary shocks) and their size.

This paper is also related to the literature that studies the impact of the ECB's unconventional monetary policy measures on banks' credit supply using individual BLS data and bank balance-sheet data, as in Blaes et al. (2019) and Andreeva and García-Posada (2021). In particular, we find that poorly capitalized banks are more likely to tighten their credit standards than well-capitalized banks following a contractionary unconventional monetary policy shock.

2 Data and empirical analysis

2.1 Data description

Our sample combines high-frequency monetary policy shocks with quarterly iBLS data and annual (consolidated) bank balance sheets from Fitch Connect. The iBLS database contains confidential, non-anonymized replies to the ECB's Bank Lending Survey (BLS) for a subsample of banks participating in the BLS. The BLS is a quarterly survey through which euro area banks are asked about developments in their respective credit markets since 2003. Currently the sample comprises more than 140 banks from 20 euro area countries, with coverage of around 60% of the amount outstanding of loans to the private non-financial sector in the euro area. While preference is given to including the largest banks of each country, smaller and specialized banks are also included in the sample if their lending behavior represents an important feature of the national banking system. However, there are 4 countries that do not share the confidential, non-anonymized replies to the BLS, so they are excluded from the iBLS.

2.1.1 Monetary policy shocks

We measure (unexpected) monetary shocks using a high-frequency event-study approach, a methodology that has been widely implemented in the recent literature.[4] The key idea of this identification strategy is to capture unexpected changes of monetary policy (e.g., fluctuations in the ECB policy rates) that are not correlated with current and expected economic conditions, i.e., the exogenous component of monetary policy. This would allow us to isolate the causal effect of monetary policy decisions on banks' credit supply, i.e., the bank lending channel of monetary policy. The main reason why we do not use other measures of monetary policy such as observed interest rates is that there are likely to be endogenous, as they may mainly reflect the reaction of the ECB to the current and expected state of the economy.

[4]See, inter alia, Cook and Hahn (1989), Gürkaynak et al. (2005), Gorodnichenko and Weber (2016), Nakamura and Steinsson (2018), Ottonello and Winberry (2020), Eichenbaum et al. (2022), Ma and Zimmermann (2023), Kwan et al. (2023), Ferrando and Grazzini (2023), Lo Duca et al. (2023), and Jeenas and Lagos (2024).

Following Altavilla et al. (2019a) and Jarociński and Karadi (2020) we construct the monetary surprise ε_τ as

$$\varepsilon_\tau = p_{\tau+\Delta_+} - p_{\tau-\Delta_-} \tag{1}$$

where τ represent the time of a central bank announcement and p is the median quote of a specific asset price at time τ. Δ_+ and Δ_- determine the duration of the time window surrounding the announcement.

We first follow Altavilla et al. (2019a) and use their Euro Area Monetary Policy event study Database (EA-MPD). In particular, we compute the change in the median quote of certain assets from the ten-minute window preceding the press release (13:25-13:35) to the median quote in the ten-minute window following the press conference (15:40-15:50),[5] which Altavilla et al. (2019a) call a "Monetary Event Window". We then extract the first principal component from the (normalized) changes in yields of risk-free rates (measured by the OIS[6]) at different maturities -1 month, 3 months, 6 months and 1-year- within the press release window. This factor is then standardized to ensure a unit impact on the 1-year OIS. Its interpretation is straightforward: it captures the unexpected change in the short-term policy rate, as well as changes in expectations about future short-term interest rates. Moreover, we calculate surprises in stock prices, in particular the EURO STOXX 50. Finally, we follow Jarociński and Karadi (2020), whose identification strategy to isolate pure monetary policy shocks involves categorizing the events of the short-term policy rate surprise in those months when the stock price surprise displays a sign opposite to that of the short-term policy rate surprise. The series starts in January 2004 and ends in June 2023. During this period there were 200 shocks with a mean of approximately zero and standard deviation of 4 basis points, as show in Table 1. We aggregate the high-frequency shocks at the quarterly frequency by summing all the shocks that occur within a quarter in order to merge them with the iBLS dataset. We will call this variable *MP shock*. Positive values of *MP shock* mean contractionary shocks, while negative values mean expansionary shocks.

Table 1: Summary statistics of monetary policy shocks

	High Frequency	Sum
Mean	0.0028	0.0071
Median	0	0
S.D.	0.035	0.054
Min	-0.13	-0.13
Max	0.20	0.25
Observations	200	78

Notes: Summary statistics of monetary policy shocks for the period from January 8, 2004, to June 15, 2023. "High-frequency" shocks are estimated using the event-study approach explained in Section 2.1.1. "Sum" means aggregating at quarterly frequency by summing all shocks within each quarter.

[5]Note that, as of 21 July 2022, following the change in the timing of the press release and the press conference to 14:15 and 14:45, respectively, the windows are 13:55-14:05 and 15:55-16:05, respectively.

[6]OIS stands for Overnight Indexed Swap.

2.1.2 Bank-level variables

The first set of bank-level variables comes from Fitch Connect, an annual panel of euro area banks that contains consolidated balance-sheet information. These variables, which measure banks' financial conditions, are *equity ratio* (ratio of total equity to total assets), *ROA* (ratio of net income to average total assets), *size* (log of total assets)[7], *liquidity ratio* (ratio of liquid assets to total assets)[8], *cost-to-income* ratio and the *loan-to-deposit ratio* (ratio of net loans to total deposits[9]). All these variables are windsorized at the 1th percentile and 99th percentile to ensure that our results are not driven by outliers.

The second set of bank-level variables comes from iBLS, a quarterly panel that provides information on bank lending conditions and credit demand in the euro area. Figure 1 shows the percentage of banks that tighten, leave unchanged, and ease their credit standards[10] applied to loans to NFCs during our sample period. We observe that most banks leave unchanged their credit standards most of the time, accounting for about 85% of the observations, while 11 % correspond to tightening and about 4% correspond to easing. The fact that the percentage of

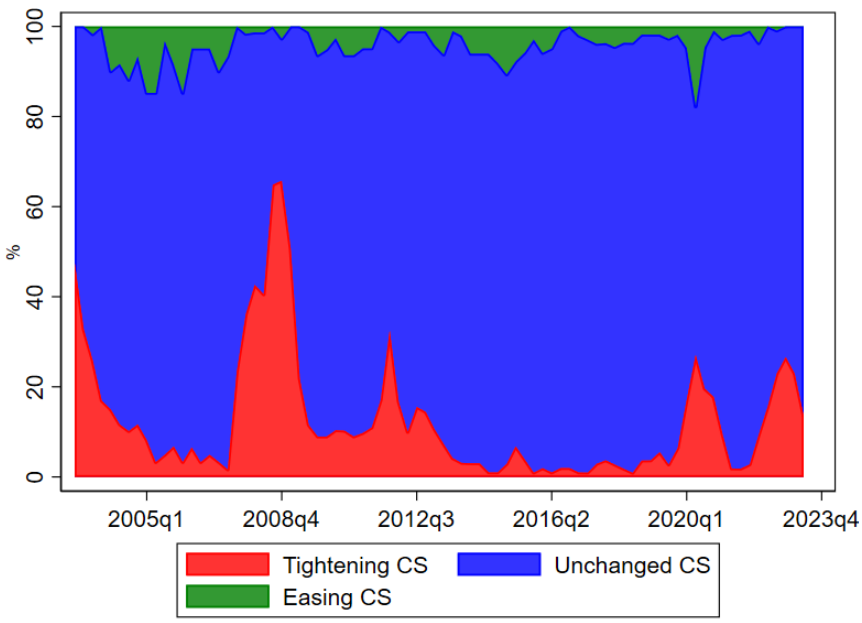


Figure 1: Percentage of banks that tighten, leave unchanged, and ease their credit standards during the sample period, 2004Q1-2023Q2

[7]Total assets are measured at book value.

[8]Liquid assets are the sum of cash and due from banks, loans and advances to banks, trading securities, reverse repos and securities borrowing minus mandatory reserves.

[9]Total deposits are the sum of total customer deposits and deposits from banks.

[10]According to the BLS, credit standards are internal guidelines or loan approval criteria of a bank. They are established prior to the actual loan negotiation on the terms and conditions and the actual loan approval/rejection decision. They define the types of loan a bank considers desirable, the sectoral or geographic priorities, the collateral deemed acceptable and unacceptable, etc. They also specify the required borrower characteristics (e.g., balance sheet conditions, income situation, age, employment status) under which a loan can be obtained. Both changes in written loan policies and their application are considered. Credit standards may change owing to changes in: (i) the bank's cost of funds and balance sheet situation; (ii) competition; (iii) the bank's risk perception and risk tolerance; (iv) regulatory changes; etc.

observations corresponding to easing is much lower than the one corresponding to tightening may be due to banks being subject to close scrutiny since the Global Financial Crisis, making them reluctant to report an easing of credit standards that may indicate lax lending policies and excessive risk-taking. Detailed definitions of all bank-level variables can be found in the Appendix.

After merging the three datasets and removing the observations with missing values we end up with a sample of 6,249 observations that comprises 140 banks from 16 countries for the period 2004Q1-2023Q2. Table 2 presents summary statistics of the sample used in our analyses.

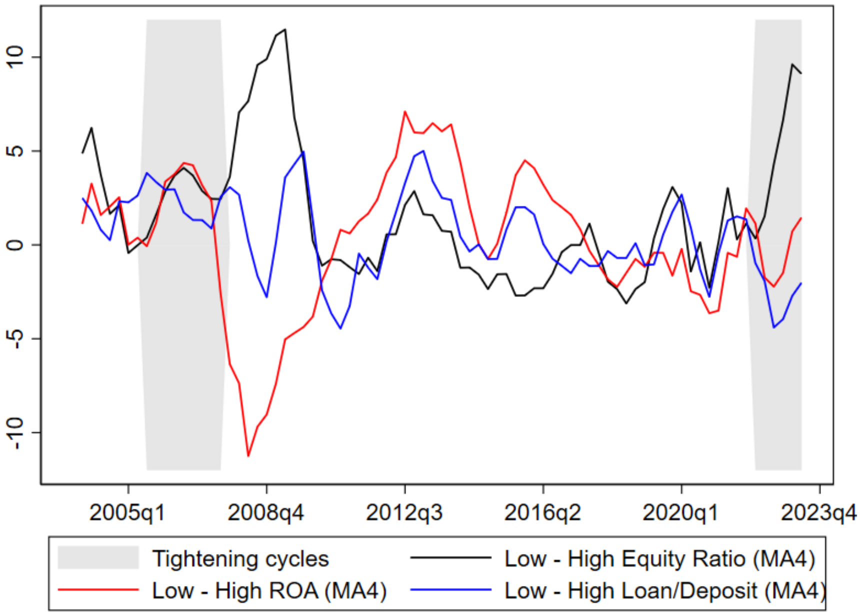
Table 2: Summary statistics of bank-level variables

	ROA	Equity Ratio	Total Assets	Liquidity Ratio	Cost to Income	Loans to Deposits
Mean	0.38	7.28	24.72	22.96	63.73	78.17
Median	0.34	6.48	24.74	18.23	63.10	78.31
S.D.	0.85	3.93	1.58	17.32	19.58	34.84
5th Percentile	-0.94	2.71	22.11	3.99	34.54	30.24
95th Percentile	1.54	14.15	27.22	57.34	95.38	124.89
Observations	6249	6249	6249	6249	6249	6249

	Credit Standards	Share of rejections
Mean	0.11	0.07
Median	0.00	0.00
S.D.	0.31	0.26
5th Percentile	0.00	0.00
95th Percentile	1.00	1.00
Observations	6249	3332

Notes: Summary statistics of bank-level variables for the period 2004Q1-2023Q2. *ROA* is the ratio of net income to average total assets; *Equity Ratio* is the ratio of total equity to total assets; *Total Assets* are measured at book value; *Liquidity Ratio* is the ratio of liquid assets to total assets, where liquid assets are the sum of cash and due from banks, loans and advances to banks, trading securities, reverse repos and securities borrowing minus mandatory reserves; *Cost-to-Income* is the ratio of a bank's costs to income, where costs are total non-interest expenses and income is the sum of total non-interest operating income, net interest income, and equity-accounted profit/loss; *Loan-to-Deposit Ratio* is the ratio of net loans to total deposits (total customer deposits+deposits from banks). *Credit Standards* is a dummy variable that equals one if a bank tightens its credit standards in loans to NFCs, and zero otherwise; *Share of Rejections* is a dummy variable that equals one if a bank increases its rejection rate in loans to NFCs, and zero otherwise. *Share of Rejections* is only available for the period 2015Q1-2023Q2.

Figure 2 displays the difference in the percentage of banks in each quarter that tighten their credit standards depending on whether their *ROA*, *equity ratio*, and *loan-to-deposit ratio* are "low" or "high" (below or above the median of each quarter, respectively) for the sample period. The three series are smoothed by computing moving averages. The figure shows that, during the global financial crisis and during the current period of monetary policy tightening, the percentage of banks that tighten their credit standards is higher in poorly capitalized banks than in well-capitalized banks (with an *equity ratio* below and above the median, respectively). In addition, during the global financial crisis the percentage of banks that tightened their credit standards was lower in banks that exhibited low profitability than in banks that exhibited high profitability (with a *ROA* below and above the median, respectively). This descriptive evidence suggests that some bank characteristics may influence their credit supply, as measured by their credit standards. We will study this subject with more analytical techniques in the following sections.



Note: the figure displays 4 quarter moving averages. In particular, they include both the current quarter and the three preceding quarters.

Figure 2: Difference in the percentage of banks that tighten their credit standards depending on some characteristics

2.2 Average and heterogeneous effects monetary policy

To study to relationship between certain bank characteristics and the evolution of credit standards we estimate the following regression model:

$$Y_{ict} = X'_{i,t-1}\beta + W'_{i,t-1}\delta + d_{ct} + \epsilon_{ict} \qquad (2)$$

where $Y_{ict} = 1$ if the bank i of country c tightens their credit standards in loans to NFCs in the year-quarter t and $Y_{ict} = 0$ otherwise; $X'_{i,t-1}$ is a vector a bank characteristics (*equity ratio*, *liquidity ratio*, *size*, *cost-to-income ratio*, *loan-to-deposit ratio*, *ROA*)[11], $W'_{i,t-1}$ is the evolution of the demand for loans by NFCs[12], d_{ct} are country-time fixed effects, and ϵ_{ict} is the regression disturbance. We include country-time fixed effects to control for the business cycles of the euro area countries, as they are likely to be correlated with banks' credit supply, as measured

[11]The explanatory variables have been standardized to facilitate the interpretation of their coefficients.

[12]It is a categorical variable that measures the evolution of credit demand. In particular, in the BLS banks report whether, over the past three months, the demand for loans or credit lines by firms has increased considerably, increased somewhat, remained unchanged, decreased somewhat, or decreased considerably.

by the evolution of their credit standards. In the spirit of Altavilla et al. (2019a), who develop a loan supply indicator that captures changes in credit standards that are orthogonal to bank-specific demand factors and macro-financial conditions, we also include the evolution of the demand for loans by NFCs. Both the vector of bank characteristics and the evolution of credit demand by NFCs are lagged one period to mitigate endogeneity concerns. Note that we do not include bank fixed effects because we want to exploit the cross-section variation of the data. In other words, by estimating equation (2) we aim to identify which banks are more prone to tighten their credit standards in loans to NFCs.

To estimate the average effect of monetary policy on the evolution of credit standards we run an augmented version of the previous regression:

$$Y_{ict} = \Delta_t^m \alpha_1 + X'_{i,t-1}\beta + W'_{i,t-1}\delta + d_c + \epsilon_{ict} \tag{3}$$

where Δ_t^m is the monetary policy shock. Note that we must replace the previous country-time fixed effects d_{ct} with country fixed effects d_c to identify the (average) impact of monetary policy shocks on credit standards, as Δ_t^m only varies across time.

Finally, to investigate whether the effect of monetary policy on the evolution of credit standards is heterogeneous we add to equation (2) the interaction between the monetary policy shock and the vector a bank characteristics:

$$Y_{ict} = \Delta_t^m X'_{i,t-1}\alpha_1 + X'_{i,t-1}\beta + W'_{i,t-1}\delta + d_{ct} + \epsilon_{ict} \tag{4}$$

By estimating equation (4) we can analyse whether the transmission of monetary policy to banks' credit supply is heterogeneous and depends on some banks' characteristics.

The three equations are estimated by OLS (i.e., a linear probability model[13]) using two-way clustered standard errors at the bank- and time- level to account for serial correlation within banks and cross-section correlation between banks. We estimate a linear probability model to avoid the separation problem we face with non-linear models such as logit or probit because of the inclusion of a large number of dummy variables (1,248 country-time fixed effects). The separation problem implies that the dummy variable that perfectly predicts failure of a binary outcome is dropped, as well as the corresponding observations to avoid that the rest of coefficients are biased. In our particular application, estimation of (2), (3) and (3) by a probit or a logit model decreases the estimation sample by more than 50%, thereby reducing the precision of the estimates substantially.

Table 3 presents the estimation results. Across the three columns, the dependent variable is a dummy that equals one if a bank tightens its credit standards in loans to NFCs and zero

[13]Despite its well-known shortcomings, Wooldridge (2003) states: "Even with these problems, the linear probability model is useful and often applied in economics. It usually works well for values of the independent variables that are near the average in the sample...Predicted probabilities outside the unit interval are a little troubling when we want to make predictions, but this is rarely central to an analysis. Usually, we want to know the ceteris paribus effect of certain variables on the probability." (page 243). For a defence of the linear probability model vs. non-linear models see also Angrist and Pischke (2009).

otherwise, and the estimation period is 2004Q1-2023Q2. Column (1) shows the estimation of equation (2) to study the relationship between the evolution of credit standards and bank characteristics. We only report the coefficient of *equity ratio* because the rest of them are not statistically different from zero. In particular, given that all bank characteristics are standardized, a one standard deviation decrease in *equity ratio* increases the probability that a bank tightens its credit standards by 3.4 pp., which is a sizeable effect given that the unconditional probability is 11.1%.[14] This result implies that poorly capitalized banks are, on average, more likely to tighten their credit standards in loans to NFCs than well-capitalized banks. A potential explanation is that poorly capitalized banks must take less risk, which makes them implement more prudent lending policies. Column (2) displays the estimation of equation (3) to gauge the average effect of monetary policy on the evolution of credit standards. The coefficient of the variable *MP shock* is positive and statistically significant, which means that a tightening of the monetary policy stance leads banks to tighten their credit standards in loans to NFCs. In particular, given that *MP shock* is also standardized, a one standard deviation increase of that variable raises, on average, the probability that a bank tightens its credit standards by 4.4 pp., which is again a sizeable effect. Finally, column (3) displays the estimation of equation (4) to analyse whether the transmission of monetary policy to banks' credit supply is heterogeneous and depends on some banks' characteristics.

Table 3: Average and heterogeneous effects of monetary policy and the role of bank capital

	(1)	(2)	(3)
equity ratio $t-1$	-0.034**	-0.086***	-0.033**
	(0.014)	(0.020)	(0.014)
MP shock t−1		0.044**	
		(0.021)	
equity ratio $t-1$ × MP shockt−1			-0.019***
			(0.006)
Observations	6152	6247	6150
R^2	0.379	0.059	0.379
Bank controls	yes	yes	yes
Demand NFC	yes	yes	yes
Country FE	no	yes	no
Country-Time FE	yes	no	yes
Two-way clustered SEs (bank, time)	yes	yes	yes

Notes: The dependent variable is a dummy that equals one if a bank tightens its credit standards in loans to NFCs, and zero otherwise. *MP shock* is computed using changes in the yields of OIS with maturities of 1 month, 3 months, 6 months and 1-year and following the methodology of Altavilla et al. (2019a) and Jarociński and Karadi (2020). Bank controls are *size*, *ROA*, *liquidity ratio*, *cost-to-income ratio*, and *loan-to-deposit ratio*. *Demand NFC* is a categorical variable that measures the evolution of credit demand by NFCs during the previous 3 months. All continuous regressors are standardized and all regressors are lagged one period. The estimation period is 2004Q1-2023Q2. Robust standard errors, in parentheses, are clustered at the bank- and time- level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

[14] The unconditional probability is the percentage of observations in which the dependent variable equals 1.

We only show the coefficient of the interaction between *MP shock* and *equity ratio* because the rest of the interaction terms are not statistically different from zero. In particular, that coefficient is negative and highly significant. This means that, following a tightening of the monetary policy stance (reflected in a positive MP shock), poorly capitalized banks are, on average, more likely to tighten their credit standards than well-capitalized banks. To put it differently, having low capital amplifies the effect of contractionary monetary policy on banks' credit supply, as measured by credit standards. The underlying intuition is that poorly capitalized banks exhibit a lower loss-absorption capacity, which may induce them to restrict their credit supply (especially to risky borrowers) when monetary policy becomes tighter.

2.3 Asymmetric effects of monetary policy

In this section we study whether monetary policy shocks exhibit asymmetric effects depending on their sign (i.e., expansionary vs. contractionary[15]) and magnitude. Given that our previous analysis (presented in Table 3) reveals that monetary policy shocks have significant effects on the probability that banks tighten their credit standards, we now aim to study whether those effects are driven by particular types of shocks. Table 4 displays the average effect of monetary policy, taking into account the two potential sources of asymmetry, the sign and the magnitude of the shocks. For reference purposes, column (1) of Table 4 presents the estimation results when no asymmetric effects are explored, and they are identical to those reported in column (2) of Table 3. In column (2) we replace the variable *MP shock* by two variables, *Positive MP shock* and *Negative MP shock*, which are constructed by aggregating all the positive and negative shocks (contractionary and expansionary, respectively) that take place every quarter. The fact that the coefficient of *Positive MP shock* is statistically significant, while the coefficient of *Negative MP shock* is not, indicates that the average effect of monetary policy is driven by contractionary shocks. In particular, as *Positive MP shock* is standardized, a one standard deviation increase of that variable raises, on average, the probability that a bank tightens its credit standards by 6.4 pp., which is a sizeable effect given that the unconditional probability is 11.1%. Finally, in column (3) we replace the variable *Positive MP shock* by two variables, *Positive small MP shock* and *Positive large MP shock*, which are constructed by aggregating all the small and all the large positive shocks that take place every quarter. Small (large) positive shocks are those below (above) the median of the distribution of positive shocks. The fact that the coefficient of *Positive large MP shock* is statistically significant, while the coefficient of *Positive small MP shock* is not, reveals that the average effect of monetary policy is driven by contractionary large shocks. In particular, as *Positive large MP shock* is also standardized, a one standard deviation increase of that variable raises, on average, the probability that a bank tightens its credit standards by 6.5 pp., which is again a sizeable effect. Therefore, we may conclude that there are important

[15]Recall that positive values of the variable *MP shock* mean contractionary shocks, while negative values mean expansionary shocks.

Table 4: Asymmetries in the average effect of monetary policy: expansionary vs. contractionary shocks and shock size

	(1)	(2)	(3)
equity ratio $t-1$	-0.086***	-0.070***	-0.070***
	(0.020)	(0.018)	(0.018)
MP shock t−1	0.044**		
	(0.021)		
Positive MP shock t−1		0.064***	
		(0.013)	
Negative MP shock t−1		-0.028	-0.028
		(0.021)	(0.022)
Positive small MP shock t−1			0.006
			(0.008)
Positive large MP shock t−1			0.065***
			(0.013)
Observations	6247	6247	6247
R^2	0.059	0.081	0.081
Bank controls	yes	yes	yes
Demand NFC	yes	yes	yes
Country FE	yes	yes	yes
Country-Time FE	no	no	no
Two-way clustered SEs (bank, time)	yes	yes	yes

Notes: The dependent variable is a dummy that equals one if a bank tightens its credit standards in loans to NFCs, and zero otherwise. Positive (negative) MP shocks are contractionary (expansionary) MP shocks. Positive small (large) MP shocks are those below (above) the median of the distribution of positive MP shocks. Bank controls are *size*, *ROA*, *liquidity ratio*, *cost-to-income*, and *loan-to-deposit ratio*. *Demand NFC* is a categorical variable that measures the evolution of credit demand by NFCs during the previous 3 months. All continuous regressors are standardized and all regressors are lagged one period. The estimation period is 2004Q1-2023Q2. Robust standard errors, in parentheses, are clustered at the bank- and time- level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

asymmetries in the transmission of monetary policy to banks' credit supply, as measured by credit standards, both in terms of the sign and the magnitude of the shocks.[16]

In analogous fashion, we now investigate the existence of asymmetries in the heterogeneous effect of monetary policy. Therefore, we are interested in the interaction between bank capital and different types of monetary policy shocks. Table 5 presents the estimation results. For reference purposes, column (1) of this table displays the results when no asymmetric effects are explored, and it is identical to column (3) of Table 3. Column (2) of Table 5 explores the interaction between *equity ratio* and both positive and negative monetary policy shocks (contractionary and expansionary shocks, respectively). The fact that the interaction between *equity ratio* and *Positive MP shock* is highly significant, while the interaction between *equity ratio* and *Negative MP shock* is not, indicates that contractionary shocks are the drivers

[16]In addition, we conducted a robustness analysis in which all monetary policy shocks (both negative and positive) were classified according to their size (lower than the 25th percentile, between the 25th and the 75th percentiles, greater than the 75th percentile) and interacted with *equity ratio*. The results of this analysis -available upon request- confirm that the observed relationship between the probability of tightening credit standards and monetary policy shocks is driven by large positive shocks.

of the heterogeneous effects of monetary policy on credit standards. Finally, column (3) of Table 5 examines the interaction between *equity ratio* and positive small and positive large shocks. As in the previous analysis, small (large) positive shocks are those below (above) the median of the distribution of positive shocks. The results show that only the coefficient of the interaction between *equity ratio* and the variable *Positive large MP shock* is statistically significant. In fact, the coefficient of such interaction has the same value (-0.017) as the coefficient of the interaction between *equity ratio* and *Positive MP shock* in column (2). Therefore, the heterogeneous effect of monetary policy is driven by contractionary large shocks. The conclusion of this analysis is that the transmission of monetary policy to banks' credit supply, as measured by credit standards, is stronger in poorly capitalized banks, following contractionary large shocks.

Table 5: Asymmetries in the heterogeneous effect of monetary policy: expansionary vs. contractionary shocks and shock size

	(1)	(2)	(3)
equity ratio $t-1$	-0.033**	-0.035**	-0.034**
	(0.014)	(0.014)	(0.014)
equity ratio $t-1$ × MP shock $t-1$	-0.019***		
	(0.006)		
equity ratio $t-1$ × Positive MP shock t−1		-0.017***	
		(0.006)	
equity ratio $t-1$ × Negative MP shock t−1		-0.002	-0.004
		(0.007)	(0.007)
equity ratio $t-1$ × positive small MP shock t−1			0.007
			(0.012)
equity ratio $t-1$ × positive large MP shock t−1			-0.017**
			(0.007)
Observations	6150	6150	6150
R^2	0.379	0.380	0.381
Bank controls	yes	yes	yes
Demand NFC	yes	yes	yes
Country FE	no	no	no
Country-Time FE	yes	yes	yes
Two-way clustered SEs (bank, time)	yes	yes	yes

Notes: The dependent variable is a dummy that equals one if a bank tightens its credit standards in loans to NFCs, and zero otherwise. Positive (negative) MP shocks are contractionary (expansionary) MP shocks. Positive small (large) MP shocks are those below (above) the median of the distribution of positive MP shocks. Bank controls are *size*, *ROA*, *liquidity ratio*, *cost-to-income*, and *loan-to-deposit ratio*. *Demand NFC* is a categorical variable that measures the evolution of credit demand by NFCs during the previous 3 months. All continuous regressors are standardized and all regressors are lagged one period. The estimation period is 2004Q1-2023Q2. Robust standard errors, in parentheses, are clustered at the bank- and time- level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

2.4 The heterogeneous effect of unconventional monetary policy

We now turn our attention to the transmission of unconventional monetary policy to banks' credit supply, as measured by credit standards in loans to NFCs, studying the potential role of bank capital.

We employ a similar methodology to the one used to identify conventional monetary policy shocks, but with a key difference: the use of changes in yields of risk-free rates (Overnight Indexed Swaps, OIS) at longer maturities. In the spirit of Altavilla et al. (2019a) and Jarociński and Karadi (2020), we distinguish between forward guidance (FG) and quantitative easing (QE) monetary policy shocks. To identify FG shocks, we use changes in OIS yields with maturities from 2 to 5 years. For QE shocks, we compute changes in OIS yields with maturities from 6 to 10 years. The rationale behind this distinction is that conventional monetary policy primarily targets short-term interest rates, while unconventional monetary policies such as FG and QE aim to control the longer end of the yield curve.[17] We assume that medium-term OIS rates (from 2 to 5 years) are more indicative of market reactions to forward guidance announcements, as they reflect expectations about medium-term monetary policy. Similarly, long-term OIS rates (from 6 to 10 years) are more sensitive to quantitative easing policies, which directly impact long-term liquidity conditions and risk premia. This categorization allows us to isolate the various mechanisms through which FG and QE exert their influence on financial markets.

For that purpose, we estimate a variation of equation (4) to analyse the heterogeneous effects of unconventional monetary policy shocks. Table 6 reports the estimation results. For reference purposes, column (1) of that table shows the heterogeneous effect of conventional monetary policy shocks (i.e., the coefficient of the interaction between *equity ratio* and *MP shock*) and it is identical to column (3) of Table 3. Column (2) displays the coefficient of the interaction between *equity ratio* and *FG shock,* while column (3) shows the coefficient of the interaction between *equity ratio* and *QE shock.* It is important to note that the number of observations in columns (2) and (3) is much lower than in column (1) because data on yield changes of OIS with a maturity of 2 years or longer are only available since 2011. This implies that the corresponding standard errors are expected to be much larger, which may reduce the statistical significance of the relevant coefficients. In particular, in column (2) the coefficient of the interaction between *equity ratio* and *FG shock* is only marginally significant, but it is slightly larger -in absolute value- than the coefficient of the interaction between *equity ratio* and *MP shock* (-0.024 and -0.019, respectively). Similarly, in column (3) the coefficient of the interaction between *equity ratio* and *QE shock* is only marginally significant, but its size is

[17] Some of the assumptions of our methodology differ from those of Altavilla et al. (2019a), who do not categorize monetary policy surprises based on OIS rates at specific maturities. Instead, they employ principal component analysis to aggregate OIS yields of all horizons and rotate the resulting factors to align them with certain theoretical assumptions. This method captures a broader spectrum of information from the entire yield curve. Specifically, Altavilla et al. (2019a) differentiate QE and FG by normalizing the factors to have unit effects on yields of different maturities: the Forward Guidance factor is normalized to have a unit effect on the 2-year OIS, while the QE factor is normalized to have a unit effect on the 10-year yield.

Table 6: The heterogeneous effects of conventional and unconventional monetary policy shocks

	(1)	(2)	(3)
equity ratio $t-1$	-0.033**	-0.037**	-0.037**
	(0.014)	(0.016)	(0.017)
equity ratio $t-1$ × MP shock t−1	-0.019***		
	(0.006)		
equity ratio $t-1$ × FG shock t−1		-0.024*	
		(0.012)	
equity ratio $t-1$ × QE shock t−1			-0.018*
			(0.010)
Observations	6150	4370	4370
R^2	0.379	0.294	0.294
Bank controls	yes	yes	yes
Demand NFC	yes	yes	yes
Country FE	no	no	no
Country-Time FE	yes	yes	yes
Two-way clustered SEs (bank, time)	yes	yes	yes

Notes: The dependent variable is a dummy that equals one if a bank tightens its credit standards in loans to NFCs, and zero otherwise. *MP shock* is computed using changes in the yields of OIS with maturities of 1 month, 3 months, 6 months and 1-year and following the methodologies of Altavilla et al. (2019a) and Jarociński and Karadi (2020). Based on the same methodologies, *FG shock* is computed using changes in the yields of OIS with maturities of 2, 3, 4, and 5 years, while *QE shock* is computed using changes in the yields of OIS with maturities of 6, 7, 8, 9, and 10 years. Bank controls are *size*, *ROA*, *liquidity ratio*, *cost-to-income*, and *loan-to-deposit ratio*. *Demand NFC* is a categorical variable that measures the evolution of credit demand by NFCs during the previous 3 months. All continuous regressors are standardized and all regressors are lagged one period. The estimation period is 2004Q1-2023Q2. Robust standard errors, in parentheses, are clustered at the bank- and time- level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

roughly the same as the coefficient of the interaction between *equity ratio* and *MP shock* (-0.018 and -0.019, respectively). In fact, given that the unconditional probability[18] in the sample of columns (2) and (3) is substantially lower than the unconditional probability in the sample of column (1) (8.30% and 11.1%, respectively), the heterogeneous effects of unconventional monetary policy are somewhat larger than the heterogeneous effect of conventional monetary policy, although the former are estimated with less precision. In any case, this simple analysis highlights the importance of considering different maturities of risk-free assets when assessing the effect of monetary policy on banks' credit supply, in order to encompass both conventional and unconventional monetary policy.

2.5 Banks' credit standards and bank capital: analysis by sub-periods and firm size

In this section we study in more detail the relationship between bank capital and the propensity to tighten credit standards in loans to NFCs. In particular, we first estimate equation (2) for

[18] Recall that the unconditional probability is the percentage of observations in which the dependent variable equals 1.

different sub-periods[19] to assess whether our previous finding for the whole sample period (i.e., a negative correlation between bank capital, as measured by *equity ratio*, and the probability of tightening credit standards) is driven by macroeconomic and monetary policy developments that occurred in some specific sub-period or it always holds.

The estimation results are presented in Table 7. For reference purposes, column (1) displays the results using the entire sample, and it is identical to column (1) of Table 3. Column (2) shows the results for 2004Q1-2007Q4, a period of strong economic expansion. Column (3) displays the results for 2008Q1-2014Q4, a strong and long recession due to the global financial crisis and the European sovereign debt crisis. Column (4) refers to 2015Q1-2019Q4, a period of economic recovery before the COVID-19 crisis. Finally, column (5) refers to 2021Q3-2023Q2, the recent phase of strong tightening of the monetary policy stance. Consistent with the previous analysis, we find a negative correlation between *equity ratio* and the likelihood of tightening credit standards in all sub-periods except for 2004Q1-2007Q4 (column (2)). A potential explanation is that, during the period just before the global financial crisis, while banks' capital ratios were usually low, so were capital requirements, implying that banks' capital constraints were not generally binding and capital did not play a significant role in banks' lending policies. Nevertheless, this tentative conclusion must be taken with caution, as the variable *equity ratio* does not measure neither regulatory capital nor banks' capital buffers. Regarding columns (3), (4) and (5), the fact that the coefficients of *equity ratio* are only significant at the 10% level is mainly explained by the reduced sample size, which leads to less precise estimates compared to column (1), as those coefficients are sizeable. The upshot of this discussion is that our previous finding, a negative correlation between *equity ratio* and the probability of tightening credit standards, does not seem to be driven by certain macroeconomic and monetary policy developments, as it is observed both in economic expansions and recessions and both in periods of tight and loose monetary policy stance.

In light of the observed negative correlation between *equity ratio* and the probability of tightening credit standards in loans to NFCs, we now analyze whether such correlation differs between loans to small and medium-sized enterprises (SMEs) and loans to large firms during periods of monetary policy tightening. To do so, we estimate a variation of equation (2) for the sub-periods 2004Q1-2007Q4 and 2021Q3-2023Q2. In particular, we use two different dependent variables. *Tighter CS SME* is a dummy variable that equals one if a bank tightens its credit standards in loans to SMEs, and zero otherwise. Similarly, *Tighter CS large* is a dummy variable that equals one if a bank tightens its credit standards in loans to large firms, and zero otherwise. Table 8 reports the estimation results. For reference purposes, columns (1) and (2) display the previous results on credit standards in loans to all NFCs, and are identical to columns (2) and (5) of Table 7. In columns (3) and (4) the dependent variable is *Tighter*

[19] Note that, for the estimation of equation (2) using different sub-periods, standard errors are clustered at the bank-level, rather than at the bank- and time- level because two-way clustering requires that both dimensions are fairly large for standard errors to be consistent. Formally, min [G,T] must tend to infinity, where G is the number of groups (banks in our case) and T is the number of time periods. For a detailed analysis see Cameron et al. (2011).

Table 7: Banks' credit standards in loans to NFCs and bank capital: analysis by subperiods

	Entire sample	2004Q1-2007Q4	2008Q1-2014Q4	2015Q1-2019Q4	2021Q3-2023Q2
equity ratio $t-1$	-0.034**	0.072	-0.053*	-0.025*	-0.123*
	(0.014)	(0.074)	(0.027)	(0.014)	(0.068)
Observations	6152	754	2082	1954	771
R^2	0.379	0.310	0.479	0.257	0.207
Bank controls	yes	yes	yes	yes	yes
Demand NFC	yes	yes	yes	yes	yes
Country-Time FE	yes	yes	yes	yes	yes
Clustered SEs (bank)	no	yes	yes	yes	yes
Two-way clustered SEs (bank, time)	yes	no	no	no	no

Notes: This table reports the estimates of equation (2) by OLS for the whole sample period and different subperiods. The dependent variable is a dummy that equals one if a bank tightens its credit standards in loans to NFCs, and zero otherwise. Bank controls are *size*, *ROA*, *liquidity ratio*, *cost-to-income ratio*, and *loan-to-deposit ratio*. *Demand NFC* is a categorical variable that measures the evolution of credit demand by NFCs during the previous 3 months. All continuous regressors are standardized and all regressors are lagged one period. Robust standard errors, in parentheses, are clustered at the bank- and time- level in column (1) and the bank-level in the remaining columns. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 8: Banks' credit standards in loans to NFCs (SMEs and large) and bank capital: analysis by subperiods

	2004Q1-2007Q4	2021Q3-2023Q2	2004Q1-2007Q4	2021Q3-2023Q2	2004Q1-2007Q4	2021Q3-2023Q2
	Tighter CS All		Tighter CS SME		Tighter CS large	
equity ratio $t-1$	0.072	-0.123*	0.099	-0.145**	-0.009	-0.118
	(0.074)	(0.068)	(0.071)	(0.068)	(0.073)	(0.084)
Observations	754	771	754	735	741	741
R^2	0.310	0.207	0.320	0.229	0.293	0.187
Bank controls	yes	yes	yes	yes	yes	yes
Demand NFC	yes	yes	yes	yes	yes	yes
Country-Time FE	yes	yes	yes	yes	yes	yes
Clustered SEs (bank)	yes	yes	yes	yes	yes	yes

Notes: This table reports the estimates of a variation of equation (2) for two different subperiods of restrictive monetary policy. The dependent variable is a dummy that equals one if a bank tightens its credit standards in loans to NFCs -columns (1) and (2)-, in loans to SMEs -columns (3) and (4)- and in loans to large firms -columns (5) and (6), and zero otherwise. Bank controls are *size*, *ROA*, *liquidity ratio*, *cost-to-income ratio*, and *loan-to-deposit ratio*. *Demand NFC* is a categorical variable that measures the evolution of credit demand by NFCs during the previous 3 months. All continuous regressors are standardized and all regressors are lagged one period. The estimation period is 2004Q1-2007Q4 in columns (1), (3) and (5), while 2021Q3-2023Q2 in columns (2), (4) and (6). Robust standard errors, in parentheses, are clustered at the bank-level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

CS SME, while in columns (5) and (6) the dependent variable is *Tighter CS large*. According to columns (1), (3) and (5), during the period 2004Q1-2007Q4 there was not a significant correlation between *equity ratio* and the probability of tightening credit standards, regardless of firm size. By contrast, during the sub-period 2021Q3-2023Q2 there is a significant negative correlation between *equity ratio* and the probability of tightening credit standards in the case of loans to all NFCs (column (2)) and in the segment of loans to SMEs (column (4)), while such correlation is not statistically different from zero in the segment of loans to large firms (column (6)). This finding means that poorly capitalized banks are more prone to tighten their credit standards in loans to SMEs than in loans to large firms, arguably because the former consume more capital than the latter as they are usually riskier.

2.6 Do Spanish banks behave differently?

We now study whether the relationship between bank capital -as measured by *equity ratio*- and the propensity to tighten credit standards in loans to SMEs by Spanish banks is the same as the one observed by the rest of banks from the euro area. For that purpose, we augment equation (2) by including interactions between the previous bank characteristics (*equity ratio*, *size*, *ROA*, *liquidity ratio*, *cost-to-income ratio*, and *loan-to-deposit ratio*) and *ES*, a dummy variable that equals one if the bank is Spanish and zero otherwise. We then estimate such

Table 9: Banks' credit standards in loans to NFCs and bank capital

	Entire sample	2021Q3-2023Q2
equity ratio $t-1$	-0.044**	-0.134
	(0.021)	(0.091)
equity ratio $t-1$ × ESP	0.039	0.341
	(0.031)	(0.230)
Observations	6152	771
R^2	0.380	0.222
Bank controls	yes	yes
Demand NFC	yes	yes
Country-Time FE	yes	yes
Clustered SEs (bank)	no	yes
Two-way clustered SEs (bank, time)	yes	no

Notes: This table reports the estimates of a variation of equation (2). In particular, several bank characteristics (*equity ratio*, *size*, *ROA*, *liquidity ratio*, *cost-to-income ratio*, and *loan-to-deposit ratio*) are interacted with *ES*, which is a dummy variable that equals one if a bank is Spanish, and zero otherwise. The dependent variable is a dummy that equals one if a bank tightens its credit standards in loans to NFCs, and zero otherwise. Bank controls are *size*, *ROA*, *liquidity ratio*, *cost-to-income ratio*, and *loan-to-deposit ratio*. *Demand NFC* is a categorical variable that measures the evolution of credit demand by NFCs during the previous 3 months. All continuous regressors are standardized and all regressors are lagged one period. The estimation period is 2004Q1-2023Q2 in column (1) and 2021Q3-2023Q2 in column (2). The estimation method is OLS. Robust standard errors, in parentheses, are clustered at the bank- and time- level in column (1) and the bank-level in column (2). ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

equation for the whole sample period and for the recent period of restrictive monetary policy, 2021Q3-2023Q2. The results, reported in Table 9, show that the coefficient of the interaction between *equity ratio* and *ES* is not statistically different from zero neither in the whole sample period nor in 2021Q3-2023Q2. Therefore, we may conclude that that there are no meaningful differences between Spanish banks and the rest of banks of the euro area concerning the link between bank capital -as measured by *equity ratio*- and the probability of tightening credit standards in loans to NFCs.

2.7 Robustness analyses

This section presents two robustness analyses to verify our previous findings regarding the relationship between bank capital and the propensity to tighten credit standards in loans to NFCs and the transmission of monetary policy through the bank lending channel. In the first analysis we augment equations (2), (3) and (4) by including, as an additional control, the variable *business model*. This is a categorical variable that classifies a bank's business model. In particular, we consider 5 categories: corporate wholesale, G-SIB (Global Systemically Important Banks), retail lender, specialized lender, and universal bank. The estimation results, reported in Table 10, are quite similar to the ones previously displayed in Table one standard deviation increase of *MP shock* raises, on average, the probability that a bank tightens its credit standards by 4.4 pp. This is a sizeable effect, significant at the 5% level and identical to the one reported in column (2) of Table 3. Finally, in column (3), which displays the estimation of equation (4), the coefficient of the interaction between *MP shock* and *equity ratio* is negative, significant at the 1% level and identical to the one reported in column (3) of Table 3 (-0.019). Therefore, our previous results are robust to controlling for banks' business models, although the correlation between *equity ratio* and the probability of tightening credit standards in loans to NFCs becomes somewhat smaller. While this last result may be attributed to an omitted variable bias in our baseline estimates, it may also be due to measurement error in the variable *business model*, as it classifies a bank's business model into five mutually exclusive categories. Therefore, we prefer to carry out all the paper's baseline analyses without this variable and relegate it to this robustness test.

The second robustness analysis concerns the asymmetric effects of monetary policy on banks' credit supply, which were studied in Section 2.3. In particular, we examined whether monetary policy shocks exhibited asymmetric effects depending on their sign (i.e., expansionary vs. contractionary[20]) and magnitude. We now modify the previous analysis by using a different dependent variable. Specifically, rather than a dummy variable that equals one if credit standards are tightened, and zero otherwise, the new dependent variable is a categorical variable that may take 5 different values according to the evolution of credit standards (cs): 1 if cs are eased, 2 if cs are eased somewhat, 3 if cs remain unchanged, 4 if cs are tightened

[20]Recall that positive values of the variable *MP shock* mean contractionary shocks, while negative values mean expansionary shocks.

Table 10: Average and heterogeneous effects of monetary policy and the role of bank capital (controlling for banks' business models)

	(1)	(2)	(3)
equity ratio $t-1$	-0.024*	-0.080***	-0.024*
	(0.014)	(0.021)	(0.014)
MP shock t−1		0.044**	
		(0.021)	
equity ratio $t-1$ × MP shockt−1			-0.019***
			(0.006)
Observations	6152	6247	6150
R^2	0.383	0.061	0.384
Bank controls	yes	yes	yes
Business model control	yes	yes	yes
Demand NFC	yes	yes	yes
Country FE	no	yes	no
Country-Time FE	yes	no	yes
Two-way clustered SEs (bank, time)	yes	yes	yes

Notes: The dependent variable is a dummy that equals one if a bank tightens its credit standards in loans to NFCs, and zero otherwise. *MP shock* is computed using changes in the yields of OIS with maturities of 1 month, 3 months, 6 months and 1-year and following the methodology of Altavilla et al. (2019a) and Jarociński and Karadi (2020). Bank controls are *size*, *ROA*, *liquidity ratio*, *cost-to-income ratio*, and *loan-to-deposit ratio*. *Business model* is a categorical variable that classifies a bank's business model into one of the following 5 categories: corporate wholesale, G-SIB (Global Systemically Important Banks), retail lender, specialized lender, and universal bank. *Demand NFC* is a categorical variable that measures the evolution of credit demand by NFCs during the previous 3 months. All continuous regressors are standardized and all regressors are lagged one period. The estimation period is 2004Q1-2023Q2. Robust standard errors, in parentheses, are clustered at the bank- and time- level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

somewhat, 5 if cs are tightened. The estimation results, reported in Table 11, are qualitatively similar to the ones from the baseline analysis (Table 5). In column (1) the coefficient of the interaction between *equity ratio* and *MP shock* is negative and significant at the 10% level, implying that, following a contractionary (i.e., positive) monetary policy shock, poorly capitalized banks are more likely to tighten their credit standards in loans to NFCs. In column (2) monetary policy shocks are classified as positive (i.e., contractionary) and negative (i.e., expansionary) to construct two variables, *Positive MP shock* and *Negative MP shock.* The fact that the coefficient of the interaction between *equity ratio* and *Positive MP shock* is negative and highly significant, while the coefficient of the interaction between *equity ratio* and *Negative MP shock* is not statistically different from zero, indicates that the heterogeneous effects of monetary policy are driven by contractionary shocks. Finally, in column (3) positive monetary policy shocks are classified as small and large (below and above the median of the distribution of positive shocks, respectively) to construct two variables, *Positive Small MP shock* and *Positive Large MP shock.* The fact that only the coefficient of the interaction between *equity ratio* and *Positive Large MP shock* is negative and significant implies that the heterogeneous effects of monetary policy are driven by large contractionary shocks. A final

Table 11: Asymmetries in the heterogeneous effect of monetary policy: expansionary vs. contractionary shocks and shock size (alternative dependent variable)

	(1)	(2)	(3)
equity ratio $t-1$	-0.015	-0.018	-0.018
	(0.017)	(0.017)	(0.017)
equity ratio $t-1$ × MP shock $t-1$	-0.016*		
	(0.009)		
equity ratio $t-1$ × Positive MP shock t−1		-0.022***	
		(0.007)	
equity ratio $t-1$ × Negative MP shock t−1		0.011	0.007
		(0.010)	(0.010)
equity ratio $t-1$ × positive small MP shock t−1			0.016
			(0.019)
equity ratio $t-1$ × positive large MP shock t−1			-0.020**
			(0.008)
Observations	6150	6150	6150
R^2	0.365	0.366	0.366
Bank controls	yes	yes	yes
Demand NFC	yes	yes	yes
Country FE	no	no	no
Country-Time FE	yes	yes	yes
Two-way clustered SEs (bank, time)	yes	yes	yes

Notes: The dependent variable is a categorical variable that may take 5 different values according to the evolution of credit standards (cs). It equals 1 if cs are eased, 2 if cs are eased somewhat, 3 if cs remain unchanged, 4 if cs are tightened somewhat, and 5 if cs are tightened. Positive (negative) MP shocks are contractionary (expansionary) MP shocks. Positive small (large) MP shocks are those below (above) the median of the distribution of positive MP shocks. Bank controls are *size*, *ROA*, *liquidity ratio*, *cost-to-income*, and *loan-to-deposit ratio*. *Demand NFC* is a categorical variable that measures the evolution of credit demand by NFCs during the previous 3 months. All continuous regressors are standardized and all regressors are lagged one period. The estimation period is 2004Q1-2023Q2. Robust standard errors, in parentheses, are clustered at the bank- and time- level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

remark we must make is that, while the categorical variable used in this section may seem to be more accurate in capturing the evolution of credit standards than the dummy variable we use in our baseline analyses, we prefer the latter because of two reasons. First, very few observations -less than 1%- correspond to the values 1 (credit standards are eased) and 5 (credit standards are tightened), which reduces the variation of the categorical variable.[21] Second, we must keep in mind that the BLS is a qualitative survey that is answered by senior loan officers of banks from 20 different countries of the euro area, implying that cultural differences across those countries may reduce the comparability of the answers. In particular, the distinction between the survey options "credit standards were eased (tightened)" and "credit standards were eased (tightened) *somewhat*" depends on the interpretation of the

[21]The percentage of observations that correspond to each category is the following: (1) credit standards are eased (0.06%); (2) credit standards are eased somewhat (3.90%); (3) credit standards remain unchanged (84.96%); (4) credit standards are tightened somewhat (10.34%); (5) credit standards are tightened (0.74%).

concept *somewhat* by each survey respondent, which is likely to be influenced by cultural factors. This implies that the categorical variable may be subject to measurement error. By contrast, it seems safer to assume that the distinction among the ideas "credit standards were eased", "credit standards remained unchanged" and "credit standards were tightened" made by senior loans officers from different countries is less affected by cultural factors, implying that these three categories are more homogeneous. Therefore, we prefer to use the dummy variable denoting tightening in credit standards in the paper's baseline analyses, relegating the categorical variable to this robustness test.

2.8 Further analysis: banks' rejection rates

Finally, we conduct an additional analysis regarding the transmission of monetary policy to banks' rejection rates in loans to NFCs. We estimate equations (3) and (4), but now the dependent variable is a dummy that equals one if a bank's rejection rate in loans to NFCs loans increases, and zero otherwise. Because the question used to construct this variable was introduced in the BLS in 2015, the estimation period is 2015Q1-2023Q2. Table 12 reports the estimation results. Column (1) shows the average effect of monetary policy. The coefficient of *MP shock* is positive and significant. In particular, a one standard deviation increase in *MP shock* raises the probability that a bank's rejection rate increases by 3.8 pp., which is large effect because the unconditional probability is 7%. Column (2) displays the heterogeneous effect of monetary policy. The coefficient of the interaction between *equity ratio* and *MP shock* is negative and highly significant. This result implies that, following a

Table 12: Average and heterogeneous effects of monetary policy on banks' rejection rates

	(1)	(2)
MP shock t−1	0.038**	
	(0.017)	
equity ratio $t-1$ × MP shock $t-1$		-0.047***
		(0.016)
Observations	3332	3308
R^2	0.031	0.209
Bank controls	yes	yes
Demand NFC	yes	yes
Country FE	yes	no
Country-Time FE	no	yes
Two-way clustered SEs (bank, time)	yes	yes

Notes: The dependent variable is a dummy that equals one if a bank's rejection rate in loans to NFCs increases, and zero otherwise. *MP shock* is computed using changes in the yields of OIS with maturities of 1 month, 3 months, 6 months and 1-year and following the methodology of Altavilla et al. (2019a) and Jarociński and Karadi (2020). Bank controls are *equity ratio*, *size*, *ROA*, *liquidity ratio*, *cost-to-income ratio*, and *loan-to-deposit ratio*. *Demand NFC* is a categorical variable that measures the evolution of credit demand by NFCs during the previous 3 months. All continuous regressors are standardized and all regressors lagged one period. The estimation period is 2015Q1-2023Q2. Robust standard errors, in parentheses, are clustered at the bank- and time-level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

positive (i.e., contractionary) monetary policy shock, poorly capitalized banks are more likely to increase their rejection rates. The main conclusion of this analysis is that a tightening of the monetary policy stance increases rejection rates in loans to NFCs, to a greater extent in poorly capitalized banks. Given that banks' approval/rejection rates can be considered an alternative measure of credit supply,[22] the findings of this section are consistent with the other results of the paper, which make use of banks' credit standards.

3 Conclusions

In this paper, by exploiting bank-level data from a confidential survey on credit market conditions in the euro area, combined with banks' balance sheets and information on high-frequency monetary policy shocks, we obtain several results. First, poorly capitalized banks are more likely to tighten their credit standards (i.e., loan approval criteria, a qualitative measure of credit supply) in loans to non-financial corporations (NFCs). Second, those banks tend to tighten their credit standards in loans to small and medium-sized enterprises (SMEs) more than in loans to large firms during the current restrictive monetary phase, arguably because loans to SMEs are usually riskier, implying that they consume more capital. Third, the transmission of monetary policy to credit standards in loans to NFCs is stronger in poorly capitalized banks. Fourth, the relationship between monetary policy and banks' credit standards is driven by large contractionary monetary policy shocks, which reveals important asymmetries in the bank lending channel. Consistent with those results, a tightening of the monetary policy stance also increases rejection rates in loans to NFCs, to a greater extent in poorly capitalized banks. These findings highlight the necessity for policymakers to take into account banks' capitalization levels when designing and implementing monetary policy, as they significantly influence its effect on banks' credit supply. They also underscore the important interactions between monetary policy and micro- and macro-prudential policies.

[22] For instance, Jiménez et al. (2012) use data on loan applications and the Khwaja and Mian (2008) methodology to analyze the effect of GDP's growth and short-term interest rate changes on banks' credit supply.

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Appendix

A Definitions of bank-level variables

- *Equity ratio*: ratio of total equity to total assets
- *ROA*: ratio of net income to average total assets
- *Liquidity ratio*: ratio of liquid assets to total assets, where liquid assets are the sum of cash and due from banks, loans and advances to banks, trading securities, reverse repos and securities borrowing minus mandatory reserves
- *Cost-to-income ratio*: ratio of a bank's costs to income, where costs are total non-interest expenses and income is the sum of total non-interest operating income, net interest income, and equity-accounted profit/loss
- *Loan-to-deposit ratio*: ratio of net loans to total deposits (total customer deposits+deposits from banks)
- *Size*: natural logarithm of total assets, where total assets are measured at book value
- *Demand NFC*: categorical variable that measures the evolution of credit demand. In particular, in the BLS banks report whether, over the past three months, the demand for loans or credit lines by firms has increased considerably, increased somewhat, remained unchanged, decreased somewhat, or decreased considerably
- *Credit standards*: dummy variable that equals one if a bank tightens its credit standards in loans to NFCs, and zero otherwise.
- *Tighter CS SME* is a dummy variable that equals one if a bank tightens its credit standards in loans to SMEs, and zero otherwise.
- *Tighter CS large* is a dummy variable that equals one if a bank tightens its credit standards in loans to large firms, and zero otherwise.
- *Share of rejection*s: dummy variable that equals one if a bank increases its rejection rate in loans to NFCs, and zero otherwise.

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