The Joint Impact of Bank Capital and Funding Liquidity on the Monetary Policy's Risk-Taking Channel

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Abstract

Despite an extensive literature on the risk-taking channel of monetary policy, the joint influence of bank capital and funding liquidity on the latter remains poorly documented. Yet, that prospect is crucial when monetary policy is implemented under the concomitant capital and liquidity standards provided by the Basel III accords. Using data on the euro area from 1999 to 2018 and the triple interactions among monetary policy, equity capital, and deposits (as a proxy for funding liquidity), we show that banks concerned about the "crowding-out of deposits" effect before the 2008 global financial crisis (GFC) are more sensitive to the risk-taking channel of monetary policy. This supports the need to implement capital and funding liquidity ratios simultaneously to mitigate the monetary policy transmission to credit risk. Our findings also highlight the absence of such an effect among less efficient banks in the aftermath of the GFC. Accordingly, for inefficient banks operating in a low interest rate environment, a trade-off arises between financial stability and funding liquidity. These results have implications for euro area bank regulators advocating uniform funding liquidity requirements across a variety of banking systems when interest rates are "low-for-long."

Keywords: Credit risk, monetary policy transmission, capital buffer, funding liquidity
JEL classification: E5, G21, G28

1. Introduction

The 2008 global financial crisis (GFC) has been a milestone for banking regulation, suggesting a crucial need to understand how financial stability interacts with the real economy. Accordingly, risk-taking is considered to be a primary source of banks' vulnerability with the potential to be passed onto the whole banking industry or even undermine other sectors as systemic issues arise.

First, a broad literature seeks to understand the joint influence of capital and liquidity on banks' risk-taking (DeYoung et al., 2018). While banks have been required to maintain minimum capital ratios for three decades, the Basel III accords aim to strengthen capital thresholds at the same time as liquidity standards[1]. In addition to the existing capital-based regulation, the introduction of new liquidity requirements such as the net stable funding ratio (NSFR)[2] has led to debate in academic and policy arenas on the need for such regulatory tools, their interaction, and their potential contrasting effects on financial stability (Carletti et al., 2020). Still, banks' funding liquidity and their desired levels of equity are interrelated in ways that are not fully understood by regulators and researchers. Gorton and Winton (2017) examines such a path with the hypothesis of a "crowding-out of deposits" effect when higher capital ratios shift investors' funds from relatively liquid deposits (as a proxy for funding liquidity) to relatively illiquid equity capital. This mainly happens because deposits are insured and withdrawable at par value, whereas bank equity has a stronger stochastic value depending on the liquidity of the stock exchange as well as bank fundamentals (Distinguin et al., 2013).

Second, another growing strand of the literature (Adrian et al., 2019; Morais et al., 2019; Bonfim and Soares, 2018; Neuenkirch and Nöckel, 2018; Dell'Ariccia et al., 2017; Paligorova and Santos, 2017) has focused on the transmission of monetary policy to banks' risk, assuming that variations in monetary policy affect the risk appetite of financial intermediaries and shift the supply curve for credit to the real

[1] In this study, we focus exclusively on a specific type of liquidity, namely funding liquidity.

[2] The NSFR became a minimum standard applicable to all internationally active banks on a consolidated basis on January 1, 2018, although national supervisory committees may also apply it to any subset of entities of large internationally active banks or to all other banks (BIS, 2018).

economy. The key results suggest that monetary policy easing decreases overall credit risk in the short run (due to borrowers' higher capacity to repay outstanding loans), but triggers risk-taking behavior in the medium term with a deterioration in banks' asset quality. The existence of a "risk-taking channel of monetary policy transmission" (Borio and Zhu, 2012) is also well documented for the euro area. Under low interest rates, European banks are more likely to accept higher risk (Altunbas et al., 2014), lax lending standards (Maddaloni and Peydró, 2011), or low interest rate margins (Claessens et al., 2018).

Concerned by the close link between solvency and liquidity crises[3], the present study examines the joint influence of bank capital and funding liquidity on monetary policy's risk-taking channel since the introduction of the euro. As one of the largest bank-based financial systems worldwide(Bats and Houben, 2020), the euro area displays great diversity in banking industries, which makes it of special interest. Moreover, while the previous literature considers separately the causal relation from capital to funding liquidity and the transmission channel of monetary policy, this study is the first, to the best of our knowledge, to empirically investigate how credit risk is affected by the dual constraints of capital and funding liquidity in an environment of changing—and, lately, low—interest rates in the euro area.

Based on the triple interactions among monetary policy, equity capital, and funding liquidity[4], we use yearly data from 1999 to 2018 to show that euro area banks faced a "crowding-out of deposits" effect (Gorton and Winton, 2017) in the risk-taking channel of monetary policy before the GFC. These findings support the Basel III framework and need to strengthen the minimum funding liquidity standards concomitant to capital ratios to temper monetary policy transmission to credit risk. We also evidence a missing "crowding-out of deposits" effect on behalf of inefficient banks in the post-GFC period when interest rates decline to the zero lower bound. Accordingly, a trade-off arises between financial stability (achieved through higher capital ratios) and funding liquidity: when interest rates are low, imposing capital and funding liquidity standards on inefficient banks *at the same time* might further expose them to the risk-taking channel of monetary policy.

Our findings have major implications for bank regulators and policymakers in the euro area. We provide new insights into the joint influence of capital and funding liquidity regulation on monetary policy's risk-taking channel for inefficient banks in the post-GFC period. Hence, when interest rates are low, we suggest first addressing banks' inefficiency issues before requiring them to display simultaneously good levels of capital and funding liquidity. This outcome is all the more important given that the share of inefficient banks increased in most euro area countries (except for Belgium, Estonia, Finland, Greece, Malta, and Slovenia) between 2011 and 2018. The COVID-19 pandemic, which has led to the Great Lockdown (Gopinath, 2020), might also raise the interest of these results, as the low interest rate environment in the European banking industry is likely to extend further.

Accordingly, we present new empirical evidence extending the current literature in two directions. First, we add to the strand of the literature on the risk-taking channel of monetary policy in that the joint influence of capital and funding liquidity requirements on the latter has not yet been examined empirically for the euro area. Second, we assess the accuracy of the Basel III regulatory framework, particularly the extent to which funding liquidity regulation should consider the efficiency profiles of financial intermediaries before implementing uniform standards across the euro area.

The remainder of the paper is structured into five sections. Section 2 reviews the literature on the causal link between bank capital and funding liquidity as well as theories addressing the risk-taking channel of monetary policy. Section 3 presents the data and empirical strategy addressing our theoretical motivations, before section 4 defines the variables of interest and controls. Section 5 discusses the empirical results and robustness checks, while section 6 concludes.

2. Literature overview

We build our empirical approach by linking the causal relation between bank capital and funding liquidity with the framework of monetary policy's risk-taking channel. First, we briefly review the literature on how capital and funding liquidity affect banks' risk-taking behaviors (subsection 2.1). We then discuss the causal link between capital and funding liquidity (subsection 2.2) and theories on the risk-taking channel of monetary policy (subsection 2.3).

[3] Hong et al. (2014) evidence that liquidity risk leads to bank failures through systematic and idiosyncratic channels and was therefore an important contributor to banks' failures during 2009–2010.

[4] Following Acharya and Naqvi (2012), we use the ratio of total deposits to total assets to proxy for banks' funding liquidity in our empirical analysis.

2.1. Effects of capital and funding liquidity on banks' risk

Studies of the impact of capital on banks' risk lack consensus. Calem and Rob (1999) support the idea of a U-shaped relation: while under-capitalized banks lower risk as their level of capital rises, well-funded banks increase their risk-taking behavior in the long run. Jeitschko and Jeung (2005) note that banks' risk can be either negatively or positively related to capitalization depending on the relative forces of the incentives determining asset risk and risk/return of asset choices (i.e., the shareholder, manager, and deposit insurer). However, another stream of the literature suggests that banks with high levels of equity are less willing to take risks than banks with low equity.

Unlike established U.S. evidence, Altunbas et al. (2007) prove that inefficient European banks holding more capital appear to actually take on less risk. As shareholders of well-capitalized banks are risk-averse and fear huge losses in the case of default, Repullo (2004) argues that banks with high equity levels rather prefer to mitigate their risk-taking behavior. Similarly, Konishi and Yasuda (2004) find that capital requirements have reduced Japanese commercial banks' risk and Lindquist (2004) also suggest a negative relationship between capital buffers and risk-taking for Norwegian savings banks. Berger et al. (2008) establish that publicly traded U.S. bank holding companies actively manage their capital ratios, set target capital levels above well-capitalized regulatory minima, and make rapid adjustments toward their targets. Still in support of the risk reduction view, Hyun and Rhee (2011) and Lee and Hsieh (2013) evidence that banks restrict high-risk assets rather than issuing new equity when complying with capital requirements.

Regarding the relation between funding liquidity and banks' risk, Acharya and Naqvi (2012) theoretically show that excessive funding liquidity—proxied by the level of deposits on banks' balance sheets—induces greater risk-taking on the part of bank managers. This occurs when managerial performance is assessed on the basis of loan volume delivered to customers or when long-term risk is ignored in setting managers' premiums. As banks collect funds from depositors and lend them to borrowers, excess deposits might trigger managers' overconfidence in their lending practices and strengthen their belief that the bank will not experience any funding liquidity crisis in the near future. To induce bank managers to accept higher degrees of risk, Cheng et al. (2015) note that they need to be given higher compensation. However, to achieve such compensation levels, flexibility toward aggressive lending strategies is necessary, especially when funding liquidity is in abundance. Eventually, this creates the reverse causality of risk causing pay as opposed to pay causing risk.

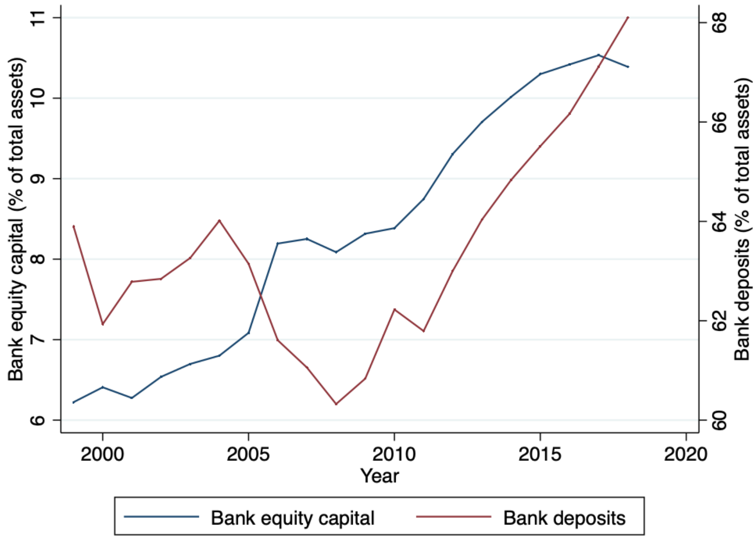
Similarly, Hong et al. (2014) show that systemic liquidity risk contributed to bank failures in 2009 and 2010, suggesting that an effective framework of funding liquidity risk management needs to target liquidity risk at both the individual and the system levels. Wagner (2007) argues that the higher funding liquidity of bank assets increases banking instability and the externalities associated with banking failures. Lucchetta (2007) also emphasizes that bank funding liquidity might rise because of monetary policy tightening. Higher risk-free interest rates boost risk-free bond investment, which, in turn, pushes up funding liquidity supply and stimulates interbank lending. This eventually results in massive investment in risky assets emanating from other banks. As pointed out by Keeley (1990), deposit insurance is also a breeding ground of moral hazard that leads to banks taking more risks: the higher the level of deposits, the higher the risk exposure of deposit insurers. Overall, there is a clear positive relationship between bank funding liquidity and risk-taking behavior.

2.2. Causal link between capital and funding liquidity

Among the theoretical literature on the relationship between bank capital and funding liquidity, Gorton and Winton (2017) suggest the presence of a "crowding-out of deposits" effect to explain why higher levels of bank capital reduce the volume of deposits. The reasoning goes as follows. Although equity capital reduces the probability of bank failure, to investors, bank equity is an information-sensitive asset that makes a poor hedge against liquidity needs. In the equilibrium in a banking system, investors hold deposits to the extent they need coverage against potential liquidity shocks. A system-wide increase in the required bank capital forces investors to reduce their deposit holdings in favor of equity, increasing the odds that the marginal bank shareholder will have to sell to meet his/her liquidity needs and increasing the resulting discount for expected trading losses. Once investors have acquired bank shares, they have an incentive to acquire costly information about the value of the bank. Although deposits are totally or partially insured and withdrawable at par value, bank equity capital has an important stochastic value depending on bank fundamentals and stock exchange liquidity (Distinguin et al., 2013). If capital ratios rise, then investors' funds shift from liquid deposits to illiquid bank equity.

Another consequence of rising capital adequacy ratios is the opportunity for banks to exit the industry because of the gap between the private and social costs of capital. While exit reduces the production

Figure 1: Trends in bank equity capital and deposits in the euro area (1999–2018)



of liquid demand deposits, Gorton and Winton (2017) emphasizes that this might lead to a "shadow banking" system and result in a socially suboptimal level of capital. Figure 1 illustrates the combined trends in bank equity and deposits in the euro area from 1999 to 2018. While capitalization steadily increased over the sample period, deposits as a share of banks' total assets declined from 2004 to 2007 before rising again after the GFC.

2.3. Risk-taking channel of monetary policy

Over the past decade, interest in the risk-taking channel of monetary policy has risen in the banking and financial literature. Since the GFC, unconventional monetary conditions have led banks to navigate a "low-for-long" interest rate environment, urging the need to understand monetary easing's impacts on risk-taking behaviors.

Dell'Ariccia and Marquez (2013) account for the existence of a "search-for-yield" effect through which the monetary policy channel operates. This occurs on the asset side of balance sheets when a drop in interest rates undermines bank profitability and leads either to monitoring laxity or riskier search-for-yield strategies. The final outcome is greater risk-taking in the banking industry overall.

Further, the "risk-shifting" effect occurs through the liabilities side of balance sheets when decreasing interest rates lower the cost of bank liabilities. As banks target a leverage ratio (Bruno and Shin, 2015), they choose to either increase market funding or expand credit (with the potential for covering riskier projects) to return to their target. Valencia (2014) and Dell'Ariccia and Marquez (2013) argue that such a strategy results in banks taking more risks. Moreover, if banks demand more assets, their price will rise and this will expand banks' balance sheets as well as leverage. Gambacorta (2009) suggests that a "low-for-long" interest rate environment might thus affect asset and collateral valuation and, therefore, reduce market volatility as well as risk perception.

While most empirical studies (Morais et al., 2019; Paligorova and Santos, 2017; Angeloni et al., 2015; Ioannidou et al., 2015; Altunbas et al., 2014) find a negative relationship between monetary policy and banks' risk, evidence is mixed in the U.S. case. For instance, Dell'Ariccia et al. (2017) show that this negative relationship is less pronounced for weakly capitalized banks or during financial distress. While Delis et al. (2017) evidence that monetary policy easing lessens banks' risk in the short run but raises it in the medium run, Buch et al. (2014) highlight important differences depending on the type of bank: small domestic banks increase their exposure to risk, while foreign banks behave the same but only when interest rates are "too low for too long."

Finally, the risk-taking channel is stronger for banks with lower levels of liquidity (Brissimis and Delis, 2010), smaller banks (Buch et al., 2014), and those involved in non-traditional banking activities than for other banks (Altunbas et al., 2014). Maddaloni and Peydró (2011) also draw on agency issues to justify that the impact of monetary easing on lending standards is amplified under weak capital supervision.

3. Data and empirical strategy

3.1. Data

The sample includes banks from the euro area (EA11-1999, EA12-2001, EA13-2007, EA15-2008, EA16-2009, EA17-2011, EA18-2014, EA19-2015) over 1999–2018. Annual unconsolidated financial statements are taken from the Fitch Connect database for the following bank categories: private, retail & consumer, trade finance, trading & investment, trust & processing, universal commercial, and wholesale commercial. We exclude bank-year observations with missing information on total assets over the full sample period. We also consider data from Eurostat to compute the macroeconomic controls. As outlier values may distort our results, all the variables except the macroeconomic controls are winsorized at the 5^{th} and 95^{th} percentiles, as it is common in the literature (Acharya and Mora, 2015)[5].

The final sample consists of 58,280 bank-year observations for 4,023 euro area banks. Table 1 presents the description, source, and summary statistics of the winsorized variables used in the empirical analysis. Table A1 in the appendix compares the country-level aggregates of total assets from the banks included in the final sample using data from Fitch Connect between 1999 and 2018. The last row of the table reports a weighted average ratio (computed using the number of banks available in Fitch Connect for each country) of 83.59%, indicating the representativeness of our sample.

On average, loan loss provisions and non-performing loans (our bank credit risk proxies) represent 0.60% and 6.18% of the total gross loans of banks included in the final sample, respectively. With a value of 0.78%, the standard deviation of loan loss provisions is notably lower than that of non-performing loans (5.95%). The monetary policy indicators display a mean value of -2.14e-09 percentage points for the Taylor residuals, 1.54% for the ECB rate, 1.44% for the EONIA, 1.67% for the 3-month EURIBOR, and 1.94% for the 12-month EURIBOR. The average share of equity capital to banks' total assets is 8.59% and this increased steadily from 1999 to 2018 in the euro area (see figure 1). Following Acharya and Naqvi (2012) and Khan et al. (2017), we proxy for bank funding liquidity using the ratio of deposits to total assets, which displays an average value of 63.48% throughout the sample period.

In addition, the bank-level controls report an average share of operating profits to banks' total assets of 0.70% and a standard deviation of 0.67%. Expenses represent 68.88% of banks' total revenues on average (with a standard deviation of 13.76%), and net loans display a mean value of 58.17% relative to banks' total assets (with a slightly higher standard deviation of 18.57%). We also include four country-level controls to examine the impact of the macroeconomic environment on the way bank capital and funding liquidity interact in the risk-taking channel of monetary policy. The mean percentage change on the previous period of real GDP is 1.32% over the sample period, with a standard deviation of 2.21%. On average, the share of the unemployed relative to the active population is 7.68% in the euro area. We also investigate the debt level of public sector and non-financial firms. In terms of the share of GDP, the average consolidated gross debt of general government is 77.13% between 1999 and 2018 in the euro area compared with 56.99% for non-financial firms. The standard deviations of both debt indicators are 23.10% and 25.30%, respectively.

Table B1 in the appendix reports the pairwise cross-correlation coefficients of the variables used in the empirical analysis. We do not find the bank-level explanatory variables to be highly correlated, indicating that multicollinearity is not a major issue in our estimations. The correlation coefficients of the monetary policy indicators (ECB rate and Taylor residuals) with the risk-taking proxies are 0.17, -0.05, 0.22, and 0.04, respectively. The correlation coefficients of deposits (funding liquidity proxy) with bank credit risk are -0.12 and -0.20, respectively.

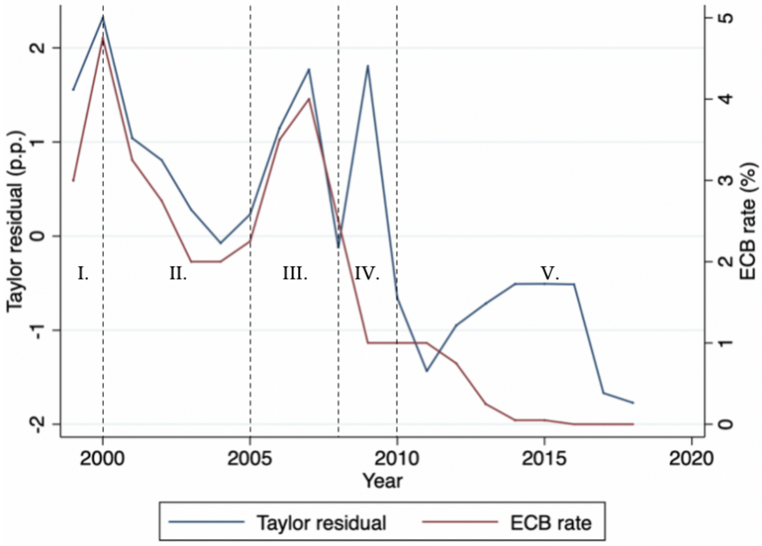
Figure 2 reports the evolution of the ECB rate and Taylor residuals from 1999 to 2018. For a more indepth analysis on the conduct of monetary policy since the euro area was implemented, we divide the sample period into five subperiods:

I. To contain inflationary pressures against the backdrop of strong economic growth, increasing import prices, and high monetary growth, key interest rates first rose from 1999 to mid-2000 (European Central Bank, 2011);

II. In response to receding inflationary pressures in an environment of subdued economic growth, marked adjustments in financial markets, and high geopolitical uncertainty, interest rates were cut between May 2001 and June 2003 and then left unchanged until December 2005 (European Central Bank, 2011);

[5] We found qualitatively similar results for variables winsorized at the 1^{st} and 99^{th} percentiles.

Figure 2: ECB main refinancing rate and estimated Taylor residuals for the euro area (1999-2018)



III. Owing to increasing inflation against the background of sound economic growth and a rapid expansion in the supply of money and credit, the degree of monetary policy accommodation was then gradually reduced. With upside risks to price stability prevailing until mid-2008, interest rates rose again, bringing the main refinancing rate to 4.25% in July 2008 (European Central Bank, 2011);

IV. Taking account of the subdued inflationary pressures in a setting in which financial strains had weakened the economic outlook and significantly diminished upside risks to price stability, the ECB rate was reduced between October 2008 and May 2009 and then remained at the 1% level until April 2011 (European Central Bank, 2011);

V. The last subperiod corresponds to the low interest rate environment in the euro area starting from 2011 and remaining at historical lows.

3.2. Empirical strategy

To investigate the causal link between bank capital and funding liquidity in the risk-taking channel of monetary policy, we use a panel regression with heteroskedasticity-robust standard errors. The empirical model includes both bank-level and country-level controls (described in table 1 and discussed in subsection 4.4), which may modify the monetary policy impact on banks' risk-taking. Bank-, country-, and time-specific effects are captured using bank, country, and year dummies, respectively.

The baseline specification developed to initially examine the way the risk-taking channel of monetary policy has operated since the launch of the single currency is as follows:

$$\begin{aligned} Risk_{b,c,t} \; &= \; \alpha \; + \; \beta \; Monetary_{c,t} \; + \; \gamma \; Capital_{b,c,t} \\ &+ \; \delta \; Liquidity_{b,c,t} \; + \; \zeta \; Controls_{b,c,t} \\ &+ \; \eta_b \; + \; \theta_t \; + \; \epsilon_{b,c,t} \end{aligned} \tag{1}$$

where the b, c, and t subscripts stand for bank b headquartered in country c in year t, respectively. The coefficients β, γ, δ, ζ, η, and θ reflect the extent to which the relative factors contribute to the change in the dependent variable. While α serves as a constant variable, $\epsilon_{b,c,t}$ represents the heteroskedasticity-robust standard errors for bank b headquartered in country c in year t. Standard errors are clustered by banks in the preliminary analysis (see table 2) and then clustered at the bank and country levels in the remaining empirical analysis. The coefficients η_b and θ_t account for omitted bank-specific and time fixed effects, respectively. The dependent variable $Risk_{b,c,t}$ is measured alternatively by loan loss provisions and non-performing loans. The three independent variables of interest used in the empirical analysis are $Monetary_{c,t}$, $Capital_{b,c,t}$, and $Liquidity_{b,c,t}$, which assess the monetary policy stance, level of bank capitalization, and level of funding liquidity (proxied by deposits), respectively.

The $Controls_{b,c,t}$ include a set of bank- and country-specific variables. The list of bank-level controls are those commonly adopted in the literature. Consistent with Bonfim and Soares (2018); Dell'Ariccia et al. (2017); Delis et al. (2017), and Khan et al. (2017), we consider bank size, profitability, inefficiency, and net loans (see subsection 4.4 for definitions and a discussion) as potential determinants of banks' risk-taking. We also include macroeconomic variables in our panel regressions to investigate the joint influence of bank capital and funding liquidity on the risk-taking channel of monetary policy. Further, we use the four nationwide controls discussed in subsection 4.4: economic growth, unemployment, government debt, and non-financial firms' debt.

To examine the compositional changes of bank capital and funding liquidity on the risk-taking channel of monetary policy, we extend equation 1 by drawing on the methodology of Jiménez et al. (2014) and Delis et al. (2017) based on the triple interaction coefficients. For our empirical analysis, we assess the following specification:

$$\begin{aligned} Risk_{b,c,t} \;=\; \alpha \;+\; \beta\, Monetary_{c,t} \;+\; \gamma\, Monetary_{c,t} * High\ capital_{b,c,t} \\ +\; \delta\, Monetary_{c,t} * Liquidity_{b,c,t} \;+\; \zeta\, High\ capital_{b,c,t} * Liquidity_{b,c,t} \\ +\; \eta\, Monetary_{c,t} * High\ capital_{b,c,t} * Liquidity_{b,c,t} \;+\; \theta\, Controls_{b,c,t} \\ +\; \iota_b \;+\; \kappa_c \;+\; \lambda_t \;+\; \epsilon_{b,c,t} \end{aligned} \tag{2}$$

where $High\ capital_{b,c,t}$ is a dummy equaling 1 if bank equity capital is above the full sample median value computed for each country-year combination and 0 otherwise. Here, we are particularly interested in the coefficient η on the triple interactions among monetary policy, bank capital, and funding liquidity. Considering a cycle of monetary easing, a positive (negative) coefficient on this "triple" implies that banks with high levels of capital and low (high) levels of funding liquidity are inclined to more risk-taking, which might therefore exacerbate the strength of the risk-taking channel of monetary policy. The variables $Monetary_{c,t}$, $High\ capital_{b,c,t}$, and $Liquidity_{b,c,t}$ in their simple forms and in the double interactions are included in table 3 to table 8 but left unreported for the ease of readability of the results. We briefly define the variables included in equation 1 and equation 2 in the following section.

4. Variables' definition

4.1. Banks' risk-taking

The dependent variable $Risk_{b,c,t}$ is the vector of the alternative bank credit risk variables for bank b in country c in year t. Banks' risk-taking is assessed using the two ratios of loan loss provisions to banks' total gross loans (*LLP*) and non-performing loans to banks' total gross loans (*NPL*). *LLP* captures the asset quality of banks (Delis et al., 2014) and shows the share of gross loans used as an allowance for uncollected loans and loan payments to cover possibilities of impairments. An increase in *LLP* is associated with a riskier position. In turn, *NPL* identifies problems with asset quality in bank loan portfolios and highlights the potential adverse exposure to earnings and asset market values due to worsening loan quality. A high value of this ratio also means greater risk-taking by banks. table 1 presents the summary statistics for both indicators.

4.2. Monetary policy

To capture the monetary policy stance, we first use the ECB's main refinancing rate (*ECB rate*) at the end of each year[6]. In addition, we consider a Taylor rule residual as an alternative measure to examine the exogenous component of monetary policy (Dell'Ariccia et al., 2017). *Taylor residuals* are the residuals of rolling regressions of *ECB rate* on CPI inflation and the difference between current and previous real GDP. We proceed by following the essence of the methodology proposed by Maddaloni and Peydró (2011). Figure 2 shows the trend of these two monetary policy proxies.

To check the robustness of our results, we also run equation 2 using *EONIA*, *EURIBOR 3-month*, and *EURIBOR 12-month*. table 8 reports the results. While *EONIA* represents the weighted average at the end of the year of all overnight unsecured lending transactions in the interbank market, *EURIBOR 3-month* and *EURIBOR 12-month* stand for the short-term interest rate with a 3-month maturity at the end of the year and the medium-term interest rate with a 12-month maturity, respectively. table 1 (panel A) provides the summary statistics.

Since the major contribution of Borio and Zhu (2012) on the risk-taking channel of monetary policy, numerous theoretical (Acharya and Naqvi, 2012; Dell'Ariccia and Marquez, 2006) and empirical (Ioannidou et al., 2015; Bekaert et al., 2013) studies have documented that lax monetary policy is associated

[6]We obtain qualitatively similar results when computing the annual average of the ECB policy rate.

with higher risk-taking in the banking industry. As a result, we expect to observe a negative relationship between, on the one hand, *LLP* and *NPL* and, on the other hand, *ECB rate* and *Taylor residuals*.

4.3. Bank capital and funding liquidity

This empirical study analyzes how the causal link between bank capital and funding liquidity influences the way monetary policy acts on the risk-taking behavior of banks. To this end, we consider the *Capital* variable as the ratio of equity capital to banks' total assets to proxy for the level of capitalization of each financial intermediary in the final sample.

Similarly to Khan et al. (2017), we use the ratio of total deposits to total assets as a proxy for funding liquidity. Following Acharya and Naqvi (2012), we assume that banks with high levels of deposits benefit from lower bankruptcy risk and might encourage managers to take more risk as they are less likely to face a funding crisis in the near future. Another reason relates to deposit insurance acting as a put option on the assets of banks. Hence, banks display greater risk-taking when their levels of deposits rise because of deposit insurance contracts. Accordingly, we anticipate a positive relationship between the *Deposits* variable and credit risk proxies *LLP* and *NPL*. Panel A in table 1 provides a description and the summary statistics for the capital and funding liquidity proxies.

4.4. Control variables

The bank-level controls used in our estimations are commonly adopted in the literature. Consistent with Dinger and te Kaat (2020); Danisman and Demirel (2019) and Lee and Hsieh (2013), we use the natural logarithm of total assets to measure bank *Size*. We also consider three additional ratios that might be important factors in shaping banks' risk: the ratio of operating profits to total assets as a measure of *Profitability*, the ratio of expenses to total revenues as an *Inefficiency* indicator, and the ratio of net loans to total assets (*Net Loans*) as a proxy for banks' involvement in financial intermediation. If we assume that larger banks better manage risk than smaller banks, then a negative relationship prevails between *Size* and the risk-taking indexes. We also expect a negative relation between, on the one hand, *Profitability*, *Inefficiency*, and *Net loans* and, on the other hand, the credit risk proxies. As too high risks might lead to greater volumes of problem loans and eventually affect profitability, we anticipate a negative relationship between *Profitability* and banks' risk-taking.

Moreover, if greater risks explain the high technical efficiency levels (as they are responsible for the level of banks' income, the latter therefore acting as an incentive for greater risk-taking), a negative link is most likely between *Inefficiency* and both *LLP* and *NPL*. In addition, the relation between *Net loans* and banks' risk-taking behavior strongly depends on the quality of the screening of borrowers. A positive sign implies low screening standards, whereas a negative sign means sound screening practices. Panel B in table 1 reports the summary statistics of the variables controlling for bank characteristics and activities.

We also include country-level controls in the panel regressions to consider the impact of the macroeconomic environment on banks' risk-taking. We enrich our model with the percentage change in the previous period of GDP at market prices (*Real GDP*), the percentage of the active population being unemployed (*Unemployment*), the level of general government debt expressed as a percentage of GDP (*Government debt*), and the level of non-financial firms' debt as a share of GDP (*NF firms debt*). Panel C in table 1 shows the summary statistics of the variables controlling for the macroeconomic conditions in which euro area banks operate.

5. Discussion of findings

In this section, we present early results on the joint influence of bank capital and funding liquidity on the risk-taking channel of monetary policy in subsection 5.1 and account for endogeneity issues regarding monetary policy in subsection 5.2. From that point, we provide comprehensive results on the presence of a "crowding-out of deposits" effect before the GFC in the euro area banking industry (subsection 5.3) and, interestingly, the absence of such an effect among inefficient banks in the aftermath of the GFC (subsection 5.4). subsection 5.5 provides several robustness checks.

5.1. Preliminary analysis

Table 2 provides the results of a preliminary analysis on the risk-taking channel of monetary policy specified in equation 1 over 1999 to 2018. OLS panel regressions are estimated with standard errors clustered at the bank level; both bank-level and country-level controls are included. When they are significant, the monetary policy proxies *ECB rate* and *Taylor residuals* display negative relationships with risk-taking. The impact of *ECB rate* on bank credit risk is economically significant, as a one standard deviation decrease implies that *LLP* rises by 0.0765 in regression (1) and *NPL* increases by 1.0945 in regression (3). Conversely, the economic impact of *Taylor residuals* is also significant, as a one standard deviation decrease causes *NPL* to increase by 0.4869 in regression (4).

Capital appears to be negatively related to credit risk, suggesting that well-capitalized banks are less risky. A one standard deviation increase in bank capitalization decreases *LLP* by 0.0397 in regression (1) and lowers *NPL* by 0.7702 in regression (3). Consistent with the theoretical predictions of Acharya and Naqvi (2012) and empirical results of Khan et al. (2017), we find that funding liquidity (proxied by *Deposits*) significantly increases the risk-taking behavior of banks (a one standard deviation increase in funding liquidity raises *LLP* by 0.0331 in regression (2)).

We include bank characteristics in all the panel regressions as well as bank and year fixed effects to capture other unobservable factors that may affect risk-taking. As reported in table 2, most of these controls are significant and in the expected direction. *Size* appears to be negatively linked to bank credit risk, which implies that larger banks display better risk management. *Profitability* is also an important component in taming bank credit risk, as evidenced by the negative coefficients related to this indicator. The negative *Inefficiency* coefficients confirm that higher technical efficiency is responsible for riskier positions. The negative sign of the *Net loans* proxy indicates that banks granting higher volumes of loans have better risk management. This result suggests the greater ability to reduce information asymmetries on behalf of banks highly involved in traditional financial intermediation.

As regards the country-level controls, the *Real GDP* coefficient is negative and insignificant when *LLP* is used as the dependent variable and significantly positive when we use *NPL* as the dependent variable[7]. Interestingly, *Unemployment* is positively related to banks' risk-taking behavior: a one standard deviation increase in unemployment leads *LLP* to increase by 0.1574 in regression (1) and *NPL* to rise by 1.6164 in regression (3). While there is no significant relationship between *Government debt* and *LLP*, public debt is positively linked to *NPL* (see regressions (3) and (4)). However, the *NF firms debt* index is only significantly positive in regression (1), as a one standard deviation increase in non-financial sector debt results in a 0.0202 upward shift in *LLP*.

Next, we examine the compositional change of bank capital and funding liquidity on the risk-taking channel of monetary policy over the full sample period (table 3). We estimate equation 2, which includes the triple interactions among monetary policy, capital, and funding liquidity (the simple forms and double interactions of these variables are included but left unreported for ease of readability). The bank-level and country-level controls are included, but the latter are left unreported for brevity. Also included are the bank*country fixed effects and year fixed effects in regressions (2), (4), (6), and (8). Standard errors are clustered at the bank-country level in regressions (3), (4), (7), and (8).

Interestingly, the η coefficients on the triple interactions are mostly negative and statistically significant regardless of the *ECB rate* or *Taylor residuals* we use to examine monetary policy. However, it is still impossible to interpret these early findings because interest rates presented different trends from 1999 to 2018 (see figure 2). Accordingly, we would not reach the same conclusions on capital and funding liquidity interactions whenever monetary policy is eased or tightened.

The results of the bank-level control variables are in line with those in table 2. Before further exploring the above early findings, we address endogeneity issues regarding the response of monetary policy to bank credit risk in subsection 5.2.

5.2. Endogeneity of monetary policy

Our empirical approach relies on the key assumption that monetary policy changes are exogenous to banks' risk. Since the GFC, regulators and policymakers have discussed at length the need for monetary policy to include financial stability as an explicit target. Therefore, we perform several checks and sample splits to address endogeneity issues and eliminate risks of bias in our estimations (table 4).

First, we are concerned that our results are driven by the business cycle. This would happen if capital or funding liquidity fluctuates with the economic conditions or because the risk-taking scale adjusts endogenously with the state of the economy (Dell'Ariccia et al., 2017). We control directly for changes in the economic cycle in regressions (1) and (2). We include the interaction terms between the monetary policy proxy *Taylor residuals* and state of the economy based on *Real GDP*; the time-specific *Recession*

[7] Delis and Kouretas (2011) argue that during more favorable macroeconomic conditions, banks increase their lending in search of higher yields; hence, a positive relationship between GDP growth and banks' risk is expected.

dummy takes one if *Real GDP* is negative and zero otherwise. We find that the coefficients on the triple interactions among interest rates, capital, and funding liquidity remain negative and statistically significant[8]. These results are a first step in allaying concerns that our results are influenced by a cyclical bias in risk ratings or close links among capital, funding liquidity, and economic cycles.

Second, monetary policy is likely to be more responsive to risk-taking behavior during periods of financial instability. Therefore, endogeneity issues should be more of a concern in times of crisis. In regressions (3) and (4), we rerun our main regressions from equation 2 excluding the GFC period (2008 to 2010) when monetary policy responded strongly to financial stability. Again, the triple interactions among monetary policy, bank capital, and funding liquidity are significantly negative. This result confirms the absence of endogeneity due to the GFC turmoil and provides additional robustness to our empirical results.

Third, endogeneity might be more of a concern for large national banks than smaller financial institutions affected primarily by regional shocks. Columns (5) and (6) in table 4 report the regression results when removing large banks from the sample, with large banks defined as those with total assets in the top quartile of the full sample (with a value of 21.372). Similarly to the estimates including large banks, we continue to find significant and negative triple interactions, which confirms that our results are not contaminated by the inclusion of large financial institutions.

Endogeneity bias might also arise from the reverse causality between the bank-level variables (Delis et al., 2017). To rule out that possibility, we rerun equation 2 using the bank-specific characteristics in their lagged form (lagged by one year), as this methodology provides robust estimates of the effects of bank-level coefficients. Once again, we observe that the triple interactions among interest rates, capital, and funding liquidity remain negative and statistically significant. Taken together, the above tests and sample splits confirm that our empirical results are unaffected by the endogenous response of monetary policy to banks' risk-taking.

5.3. The "crowding-out of deposits" effect before to the GFC

Figure 2 shows the interest rate variations in the early days of the euro area. At the beginning of the euro system, interest rates initially rose in 1999 and the first half of 2000. However, because of insufficient observations, we exclude this short subperiod (identified under area *I.* in figure 2) from our analysis.

We examine two distinct subperiods of monetary policy before the outbreak of the GFC. First, from 2000 to 2005, interest rates were cut in response to inflationary pressures in an environment of subdued economic growth, marked adjustments in financial markets, and high geopolitical uncertainty. This moment, shown under area *II.* in figure 2, typically reflects the first prolonged period of decreasing interest rates in the euro area. Second, interest rates again rose from December 2005 until mid-2008 as the subprime crisis hit the European banking industry. After a prolonged period of monetary policy easing, the ECB communication changed in October 2005, signaling a possible increase in interest rates. In the words of Bonfim and Soares (2018), *"this leads to a substantial revision of interest rate expectations"* as *"this revision was fast and sizeable."* This moment is identified under area *III.* in figure 2. Accordingly, the end of 2005 was a key turning point in pre-GFC monetary policy.

We analyze this turning point in table 5. In regressions (1) and (3), we define the *low interest rate expectations* subsample as the first prolonged period of decreasing interest rates from 2000 to 2005. In addition, we build in regressions (2) and (4) the *high interest rate expectations* subsample as the pre-crisis monetary tightening between 2006 and 2008. Interestingly, we find significantly different signs from one sample to the other regarding the triple interactions among interest rates, bank capital, and funding liquidity.

In the *low interest rate expectations* subsample, we observe the significantly positive sign of *triples*. This result implies that when interest rates edge higher, well-capitalized banks with relatively low levels of deposits display greater risk-taking. Similarly, we identify negative triple interactions in the *high interest rate expectations* subsample, meaning that when interest rates are expected to rise, well-capitalized banks with relatively less funding liquidity also increase their risk exposure. This confirms that financial institutions concerned with the "crowding-out of deposits" effect (Gorton and Winton, 2017) (i.e., displaying low levels of deposits when equity capital is high) are more sensitive to the risk-taking channel of monetary policy regardless of whether interest rates are eased (2000–2005) or tightened (2006–2008).

[8] We found qualitatively similar results using *ECB rate* as the proxy for monetary policy.

Accordingly, in the presence of such a "crowding-out of deposits" effect, imposing capital and funding liquidity standards on the banking industry simultaneously would help offset the monetary policy transmission to credit risk. This result supports the Basel II specifications in the pre-crisis period, namely, adopting systems to measure and monitor funding liquidity risk as well as evaluating the adequacy of capital ratios. We now explore whether these results hold after the GFC.

5.4. The missing "crowding-out of deposits" effect for inefficient banks after the GFC

Area *IV.* in figure 2 reflects the GFC period during which the ECB rate was drastically reduced between October 2008 and May 2009 because of subdued inflationary pressures, weakened economic conditions, and diminished upside risks to price stability (European Central Bank, 2011). Subperiod *IV.* is a time of high uncertainty, calling for special attention that goes beyond the scope of this study. Although we provide show in subsection 5.2 that our results are not contaminated by the endogenous response of monetary policy to banks' risk-taking during the GFC (see columns (3) and (4) in table 4), we do not analyze this short and exceptional subperiod and rather focus on the post-crisis years.

We observe in area *V.* in figure 2 that the post-GFC period signals the start of decreasing interest rates fueled by monetary authorities' actions to stimulate economic growth and prevent deflation. As a result, the ECB rate for main refinancing operations has stagnated at the 0% level since March 16, 2016. Table 6 focuses on the 2011–2018 subperiod to study the triple interactions among monetary policy, equity capital, and funding liquidity in the post-GFC period.

The *Inefficient banks* subsample in regressions (1) and (3) includes banks whose ratio of expenses to total revenues is above the full sample quintile. Conversely, the *Efficient banks* subsample in regressions (2) and (4) groups banks with a ratio of expenses to total revenues below the 15^{th} percentile of the full sample. Interestingly, we find significantly different results depending on bank efficiency. Inefficient banks exhibit significantly negative triple interactions among interest rates, bank capital, and deposits. As we consider a period of decreasing interest rates, this suggests that inefficient banks take more risk if they display high levels of equity capital and funding liquidity *at the same time*. Given the positive relation between capital and deposits, this result speaks of the absence of a "crowding-out of deposits" effect among inefficient banks in the wake of the GFC.

After 2010, the least efficient credit institutions are more sensitive to the risk-taking channel of monetary policy when they have high levels of capital and funding liquidity simultaneously. This means that the concomitant capital ratios and NSFR would become counterproductive in taming risk-taking behaviors. Accordingly, the Basel III requirements on capital and funding liquidity might exacerbate the risk-taking behavior of inefficient banks in such a low interest rate environment. Conversely, the results suggest a positive sign of *triples* regarding efficient banks in regressions (2) and (4) in table 6. As interest rates decline between 2011 and 2018, this shows that efficient banks increase credit risk if they deal with high levels of equity capital but low levels of deposits. Similarly to before the GFC (see subsection 5.3), banks recovering in terms of efficiency after the GFC continue to display a "crowding-out of deposits" effect, which makes the case for the Basel III regulation on capitalization and funding liquidity. As reported in table 6, the results are significantly different from one subsample to another, confirming this empirical evidence.

Table 7 reports the distribution of inefficient banks between 2011 and 2018 in the euro area. Surprisingly, most national banking industries increased their share of inefficient banks between 2011 and 2018, apart from Belgium, Estonia, Finland, Greece, Malta, and Slovenia. In 2011, Germany and Italy had the highest shares of inefficient banks in the euro area (39.58% and 23.58%, respectively)[9]. In 2018, Germany and Italy still accounted for an important share of inefficient banks in the euro area (35.03% and 16.56%, respectively), with Austria accounting for 22.29% (compared with 8% in 2011).

We also note two trends in the euro area depending on industry concentration (see the Herfindahl–Hirschman indexes reported in table 7). On the one side, Austria, Cyprus, France, Germany, and Portugal have a growing share of inefficient banks as well as a deconcentration of their national industry. On the other side, Ireland, Italy, Luxembourg, the Netherlands, Slovakia, and Spain are banking industries that have a rising share of inefficient banks but higher levels of concentration. This means that banking industry concentration does not systematically help solving banks' efficiency issues. Nevertheless, we leave this open path for future research.

Banks' inefficiency in the euro area remains an unaddressed issue. However, our results suggest that inefficiency is a key factor in the risk-taking channel of monetary policy when the dual constraints

[9] This result is partly due to the relatively large number of banks in these countries.

on capital and funding liquidity are implemented under Basel III. Accordingly, inefficient banks in the euro area are a major concern if regulators want to strengthen capital and funding liquidity standards simultaneously in such a "low-for-long" interest rate environment.

5.5. Robustness checks

First, we explore the robustness of our results with respect to four alternative measures of interest rates. Regressions (1), (2), (3), and (4) in table 8 rely on *EONIA*, *EURIBOR 1-month*, *EURIBOR 6-month*, and *EURIBOR 12-month*, respectively to explain the triple influence of monetary policy, capitalization, and funding liquidity on bank credit risk (the dependent variable is *LLP*). The findings from the triple interactions remain significant and quantitatively similar to the baseline results in table 3 when applying these alternative identification schemes. The maturity of interest rates used to conduct monetary policy does not appear to affect the coefficients on the *triples*, which remain negative and statistically significant at the 5% level.

Second, we contrast our findings to examine another aspect of liquidity in banks' balance sheets in the remaining regressions in table 8, namely *Liquid assets* (measured by the natural logarithm of the total liquid assets of banks included in our final sample). As our key results remain qualitatively robust, we observe that they are quantitatively more important than our early findings using the full sample period and *NPL* as the dependent variable (see table 3). Finally, we combine the alternative Taylor residuals computed from *EONIA* with our asset liquidity indicator in regression (8) and find similar results to those provided in our baseline analysis. In summary, the previous results on funding liquidity have direct implications for the NSFR in the Basel III framework. Conversely, the robustness checks on assets liquidity are more relevant for the liquidity coverage ratio, which goes beyond the scope of this research.

6. Concluding remarks

This study examines the joint influence of capital and funding liquidity on the risk-taking channel of monetary policy. Based on previous studies suggesting that bank equity and funding liquidity are closely intertwined, we draw on the methodology of Jiménez et al. (2014) and Delis et al. (2017) to investigate the triple interactions among monetary policy, capital, and deposits (as a proxy for funding liquidity) to assess their simultaneous impact on credit risk.

Using an extensive dataset on the euro area from 1999 to 2018, we provide empirical evidence that before the GFC, banks concerned with the "crowding-out of deposits" effect (Gorton and Winton, 2017) (i.e., displaying low levels of deposits when equity capital is high) are more sensitive to the risk-taking channel of monetary policy. However, in the aftermath of the GFC, only efficient banks continue to display such an effect. Under low interest rates, inefficient banks become more sensitive to the risk-taking channel of monetary policy if they have to comply with capital and funding liquidity requirements *at the same time*. Under this scenario, concomitant capital ratios and the NSFR might be counterproductive in taming risk-taking behaviors. These results have important implications for bank regulators and policymakers.

First, our findings on the "crowding-out of deposits" effect before the GFC make the case for the Basel III accords, as imposing capital and funding liquidity standards simultaneously helps offset the monetary policy transmission to credit risk. Second, this study argues for special treatment for banks unable to recover in terms of efficiency after the GFC. As inefficient banks lack the "crowding-out of deposits" effect, it might be harmful for them to require funding liquidity standards along with the existing capital ratios. The growing share of inefficient banks in most euro area countries between 2011 and 2018 also suggests that inefficiency is a major concern when regulators strengthen capital and funding liquidity standards *simultaneously* under "low-for-long" interest rates.

Risk persistence due to strong regulation (Delis and Kouretas, 2011) might explain this scenario. In particular, capital requirements and liquidity guarantees might broaden moral hazard, leading to inefficient and risky investments or portfolio rebalancing toward trading activities over a considerable period. Whereas prolonged low interest rates erode banks' income and franchise value, only financial institutions able to fix moral hazard (due to strengthened capital and funding liquidity regulation) eventually mitigate the risk-taking channel of monetary policy. In line with Distinguin et al. (2013), our results also question the implementation of uniform funding liquidity requirements when less efficient banks seem to manage their credit risk differently in the face of a low interest rate environment (which the COVID-19 pandemic is likely to extend further).

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Tables of results

Table 1: Variables' description and summary statistics

	Description	Unit	Source	Obs.	Mean	Median	Std. dev.	Min.	Max.
Panel A: Variables of interest									
LLP	Loan loss provisions over the total gross loans of the bank	%	Fitch Connect	58,280	0.6025	0.4400	0.7803	-0.6200	2.7100
NPL	Non-performing loans over the total gross loans of the bank	%	Fitch Connect	22,029	6.1806	3.9900	5.9493	0.3500	22.1800
ECB rate	ECB main refinancing rate at the end of the year	%	Eurostat	58,280	1.5357	1.0000	1.4683	0	4.7500
Taylor residuals	Residuals of the regression of the ECB rate on country contemporaneous GDP growth and inflation, applied to the country where the bank is headquartered	p.p.	Eurostat	58,280	-2.14e-09	-0.5931	1.3726	-3.1598	3.1450
EONIA	Weighted average at the end of the year of all overnight unsecured lending transactions in the interbank market	%	Eurostat	58,280	1.4410	0.7100	1.6501	-0.3600	4.3900
Taylor residuals EONIA	Residuals of the regression of the EONIA rate on country contemporaneous GDP growth and inflation, applied to the country where the bank is headquartered	p.p.	Eurostat	58,280	-1.05e-08	-0.5295	1.5261	-3.4372	2.7725
EURIBOR 1-month	Representative short-term interest rate series with 1-month maturity at the end of the year (benchmark at which euro interbank term deposits are offered by prime banks to one another)	%	Eurostat	58,280	1.5376	0.8900	1.6961	-0.3700	4.3300
EURIBOR 6-month	Representative short-term interest rate series with 6-month maturity at the end of the year (benchmark at which euro interbank term deposits are offered by prime banks to one another)	%	Eurostat	58,280	1.7783	1.4300	1.6941	-0.2700	4.7300
EURIBOR 12-month	Representative medium-term interest rate series with 12-month maturity at the end of the year (benchmark at which euro interbank term deposits are offered by prime banks to one another)	%	Eurostat	58,280	1.9388	1.6100	1.6775	-0.1700	4.8300
Capital	Equity capital over the total assets of the bank	%	Fitch Connect	58,280	8.5902	7.4500	5.0872	3.1100	32.3600
High capital	Dummy = 1 if the bank' equity capital over total assets is above the full sample median value (computed for each country-year combination) ; = 0 otherwise	{0,1}	Fitch Connect	58,280	0.4999	0	0.5000	0	1
Deposits	Total deposits over the total assets of the bank	%	Fitch Connect	58,280	63.4840	70.8000	22.0906	3.4900	87.4000
Liquid assets	Natural logarithm of the total liquid assets of the bank	ln(€)	Fitch Connect	58,252	18.2474	18.0217	1.7517	15.1268	22.0424
Panel B: Bank-level controls									
Size	Natural logarithm of the total assets of the bank	ln(€)	Fitch Connect	58,280	20.3412	20.1909	1.6074	17.4860	23.6317
Profitability	Operating profits over the total assets of the bank	%	Fitch Connect	58,280	0.7025	0.6200	0.6729	-0.5800	2.7700
Inefficiency	Expenses over the total revenues of the bank	%	Fitch Connect	58,280	68.8822	69.1400	13.7607	35.0600	98.9600
Net loans	Net loans over the total assets of the bank	%	Fitch Connect	58,280	58.1675	61.0800	18.5655	7.3700	87.0100
Panel C: Country-level controls									
Real GDP	Percentage change on previous period of the GDP at market prices (chain linked volumes)	%	Eurostat	58,280	1.3192	1.7000	2.2110	-9.1000	25.2000
Recession	Dummy = 1 if the real GDP is negative ; = 0 otherwise	{0,1}	Eurostat	58,280	0.1510	0	0.3580	0	1
Unemployment	Percentage of the active population being unemployed	%	Eurostat	58,280	7.6845	7.6000	3.1663	1.9000	27.5000
Government debt	General government consolidated gross debt (percentage of GDP)	%	Eurostat	58,280	77.1308	72.1000	23.0970	6.1000	181.2000
NF corporations debt	Non-financial corporations consolidated debt (percentage of GDP)	%	Eurostat	58,280	56.9857	49.3000	25.3042	31.3000	256.6000

Notes. The table reports the description, along with the unit, source, number of observations, mean, median, standard deviation, minimum, and maximum for the variables used in the empirical analysis. The sample consists of yearly bank panel data from euro area countries (EA11–1999, EA12–2001, EA13–2007, EA15–2008, EA16–2009, EA17–2011, EA18–2014, EA19–2015) over the period 1999–2018. The top and bottom 5% observations of all variables have been winsorized to limit the impact of extreme values, except for country–level controls, ECB rate, Taylor residuals, EONIA, Taylor residuals EONIA, EURIBOR 1–month, EURIBOR 6–month, and EURIBOR 12–month.

Table 2: Preliminary analysis on the risk-taking channel of monetary policy transmission (1999–2018)

	LLP		NPL	
	(1)	(2)	(3)	(4)
ECB rate	-0.0521***		-0.7454**	
	(0.0041)		(0.2912)	
Taylor residuals		-0.0093		-0.3547***
		(0.0185)		(0.0570)
Capital	-0.0078***	-0.0049*	-0.1514***	-0.1057***
	(0.0026)	(0.0029)	(0.0348)	(0.0323)
Deposits	0.0010*	0.0015**	0.0107	0.0208**
	(0.0006)	(0.0006)	(0.0087)	(0.0082)
Size	-0.1752***	-0.1428***	-1.9282***	-1.3575***
	(0.0191)	(0.0229)	(0.3491)	(0.2813)
Profitability	-0.8497***	-0.8411***	-1.5779***	-1.6816***
	(0.0142)	(0.0146)	(0.0875)	(0.0889)
Inefficiency	-0.0346***	-0.0342***	-0.0418***	-0.0443***
	(0.0008)	(0.0008)	(0.0048)	(0.0049)
Net loans	-0.0034***	-0.0033***	-0.0933***	-0.0980***
	(0.0006)	(0.0006)	(0.0083)	(0.0083)
Real GDP	-0.0072***	0.0043	0.3581***	0.1582***
	(0.0013)	(0.0036)	(0.0448)	(0.0226)
Unemployment	0.0497***	0.0513***	0.5105***	0.5220***
	(0.0020)	(0.0029)	(0.0415)	(0.0390)
Government debt	0.0003	0.0005	0.0335***	0.0637***
	(0.0005)	(0.0009)	(0.0101)	(0.0072)
NF corporations debt	0.0008*	0.0006	0.0027	-0.0002
	(0.0005)	(0.0005)	(0.0136)	(0.0131)
Constant	6.8287***	6.1399***	49.4208***	34.0709***
	(0.4234)	(0.4947)	(8.2046)	(6.4740)
Bank-level controls	Yes	Yes	Yes	Yes
Country-level controls	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	No	Yes	Yes	No
Clustered s.e.	Bank	Bank	Bank	Bank
Adjusted R-squared	0.6609	0.6643	0.8167	0.8109
Sample period	1999-2018	1999-2018	1999-2018	1999-2018
Observations	57,792	57,792	21,813	21,813

Notes. The table reports results of estimating panel regressions regarding banks' credit risk in the euro area (EA11–1999, EA12–2001, EA13–2007, EA15–2008, EA16–2009, EA17–2011, EA18–2014, EA19–2015) over the period 1999–2018. Description and summary statistics of all variables used are reported in Table 1. The dependent variables are the ratios of loan loss provision to gross loans (*LLP*) in regressions (1) and (2), and non-performing loans to gross loans (*NPL*) in regressions (3) and (4). The variables of interest are the two measures of interest rates (*ECB rate* and *Taylor residuals*), the measure of bank equity capital (*Capital*), and the measure of bank funding liquidity (*Deposits*). Both bank–level and country–level controls are included and reported. All regressions include bank fixed effects. Year fixed effects are also included in regressions (2) and (3). *P*–values are computed using heteroskedasticity–robust standard errors clustered by banks (in parentheses).

* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

Table 3: The joint influence of bank capital and funding liquidity on the monetary policy's risk-taking channel: early findings (1999–2018)

	LLP				NPL			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ECB rate * High capital * Deposits	-0.0008***	-0.0008***			-0.0036*	-0.0033†		
	(0.0001)	(0.0001)			(0.0020)	(0.0020)		
Taylor residuals * High capital * Deposits			-0.0010***	-0.0009***			-0.0084**	-0.0070*
			(0.0003)	(0.0003)			(0.0035)	(0.0034)
Size	-0.1468***	-0.1161***	-0.1566***	-0.1188***	-1.1538***	-1.2680***	-1.0303	-1.3093**
	(0.0078)	(0.0083)	(0.0252)	(0.0207)	(0.0979)	(0.1035)	(0.6744)	(0.4885)
Profitability	-0.8497***	-0.8393***	-0.8505***	-0.8405***	-1.7123***	-1.7153***	-1.7509*	-1.6974**
	(0.0047)	(0.0048)	(0.0571)	(0.0558)	(0.0473)	(0.0471)	(0.8387)	(0.7874)
Inefficiency	-0.0345***	-0.0341***	-0.0346***	-0.0342***	-0.0430***	-0.0410***	-0.0437*	-0.0412**
	(0.0003)	(0.0003)	(0.0035)	(0.0035)	(0.0024)	(0.0025)	(0.0214)	(0.0188)
Net loans	-0.0033***	-0.0032***	-0.0034***	-0.0032**	-0.0997***	-0.0948***	-0.0998***	-0.0956***
	(0.0003)	(0.0003)	(0.0010)	(0.0012)	(0.0032)	(0.0032)	(0.0109)	(0.0091)
Constant	6.3772***	5.5875***	6.5933***	5.6062***	31.2929***	34.8970***	26.4888*	32.7562***
	(0.1696)	(0.1864)	(0.4900)	(0.4707)	(2.1941)	(2.3378)	(14.9636)	(11.2471)
Bank-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Bank*Country) fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Clustered s.e.	—	—	Bank & Country	Bank & Country	—	—	Bank & Country	Bank & Country
Adjusted R-squared	0.6622	0.6657	0.6609	0.6653	0.8118	0.8164	0.8109	0.8162
Sample period	1999-2018	1999-2018	1999-2018	1999-2018	1999-2018	1999-2018	1999-2018	1999-2018
Observations	57,792	57,792	57,792	57,792	21,813	21,813	21,813	21,813

Notes. The table reports results of estimating panel regressions regarding banks' credit risk in the euro area (EA11–1999, EA12–2001, EA13–2007, EA15–2008, EA16–2009, EA17–2011, EA18–2014, EA19–2015) over the period 1999–2018. Description and summary statistics of all variables used are reported in table 1. The dependent variables are the ratios of loan loss provision to gross loans (*LLP*) in regressions (1) to (4), and non–performing loans to gross loans (*NPL*) in regressions (4) to (8). The variables of interest in triple interactions are included and reported. For ease of readability, all the variables of interest and the variables of interest in double interactions are included but left unreported. Bank–level controls are included and reported. For brevity, country–level controls are included but left unreported. All regressions include bank∗country and year fixed effects. *P*–values are computed using heteroskedasticity–robust standard errors multiclustered at the bank and country level (in parentheses). †The coefficient has a *p*–value that equals 10.5 percent.

* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

Table 4: The joint influence of bank capital and funding liquidity on the monetary policy's risk-taking channel: endogeneity issues†

	Business cycle and recession		Crisis years excluded		Large banks excluded		Lagged bank–level controls	
	LLP (1)	NPL (2)	LLP (3)	NPL (4)	LLP (5)	NPL (6)	LLP (7)	NPL (8)
Taylor residuals * High capital * Deposits	-0.0009***	-0.0072*	-0.0008***	-0.0100**	-0.0012***	-0.0217***		
	(0.0003)	(0.0035)	(0.0002)	(0.0037)	(0.0003)	(0.0049)		
Taylor residuals * High capital$_{(t-1)}$ * Deposits$_{(t-1)}$							-0.0011**	-0.0091**
							(0.0004)	(0.0035)
Size	-0.1195***	-1.3667**	-0.1205***	-1.1296**	-0.1351***	-1.5088**		
	(0.0207)	(0.4789)	(0.0224)	(0.5290)	(0.0367)	(0.6229)		
Profitability	-0.8390***	-1.6640**	-0.8279***	-1.5484*	-0.8893***	-1.6085*		
	(0.0571)	(0.7789)	(0.0480)	(0.8209)	(0.0417)	(0.8937)		
Inefficiency	-0.0340***	-0.0416**	-0.0338***	-0.0359*	-0.0408***	-0.0492*		
	(0.0035)	(0.0189)	(0.0028)	(0.0178)	(0.0026)	(0.0246)		
Net loans	-0.0032**	-0.0933***	-0.0021*	-0.0837***	-0.0037***	-0.1100***		
	(0.0012)	(0.0088)	(0.0010)	(0.0105)	(0.0009)	(0.0121)		
Size$_{(t-1)}$							0.0506**	-0.4945
							(0.0189)	(0.4250)
Profitability$_{(t-1)}$							-0.2217***	-1.5342*
							(0.0551)	(0.8101)
Inefficiency$_{(t-1)}$							-0.0099***	-0.0478*
							(0.0023)	(0.0241)
Net loans$_{(t-1)}$							-0.0014	-0.0576***
							(0.0021)	(0.0107)
Taylor residuals * Real GDP	0.0062	0.0218						
	(0.0039)	(0.0655)						
Recession dummy	0.0717***	-1.3776***						
	(0.0216)	(0.2431)						
Taylor residuals * Recession dummy	-0.0040	-0.8106						
	(0.0321)	(0.5766)						
Constant	5.5323***	33.8520***	5.6155***	26.6196**	6.3223***	37.2944**	0.2506	14.4510
	(0.4439)	(10.6635)	(0.4898)	(12.0047)	(0.7455)	(13.3954)	(0.6340)	(10.3097)
Bank-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Bank*Country) fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered s.e.	Bank & Country	Bank & Country	Bank & Country	Bank & Country	Bank & Country	Bank & Country	Bank & Country	Bank & Country
Adjusted R-squared	0.6656	0.8175	0.6814	0.8409	0.6892	0.8226	0.4805	0.8272
Sample period	1999-2018	1999-2018	1999-2007/2011-2018	1999-2007/2011-2018	1999-2018	1999-2018	1999-2018	1999-2018
Observations	57,792	21,813	48,270	18,792	43,237	14,256	51,226	20,263

Notes. The table reports results of estimating panel regressions regarding banks' credit risk in the euro area (EA11–1999, EA12–2001, EA13–2007, EA15–2008, EA16–2009, EA17–2011, EA18–2014, EA19–2015) over the period 1999–2018 (except in regressions (3) and (4)). Description and summary statistics of all variables used are reported in table 1. The dependent variables are the ratios of loan loss provision to gross loans (*LLP*) in regressions (1), (3), (5) and (7), and non–performing loans to gross loans (*NPL*) in regressions (2), (4), (6) and (8). The variables of interest in triple interactions are included and reported. For ease of readability, all the variables of interest and the variables of interest in double interactions are included but left unreported. Current and lagged bank–level controls are included and reported. For brevity, country–level controls are included but left unreported. All regressions include bank∗country and year fixed effects. *P*–values are computed using heteroskedasticity–robust standard errors multiclustered at the bank and country level (in parentheses).
† Qualitatively similar results are obtained when using the *ECB rate* variable to proxy the monetary policy stance.
* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

Table 5: The "crowding-out of deposits" effect before the GFC (2000–2008)

	LLP			
	Low interest rate expectations	High interest rate expectations	Low interest rate expectations	High interest rate expectations
	(1)	(2)	(3)	(4)
ECB rate * High capital * Deposits	0.0012***	-0.0029***		
	(0.0004)	(0.0004)		
Taylor residuals * High capital * Deposits			0.0012***	-0.0025***
			(0.0003)	(0.0005)
Size	-0.0984	-0.0102	-0.1012	-0.0102
	(0.0808)	(0.0913)	(0.0816)	(0.0916)
Profitability	-1.1212***	-0.9219***	-1.1206***	-0.9257***
	(0.1325)	(0.1876)	(0.1325)	(0.1891)
Inefficiency	-0.0485***	-0.0394***	-0.0485***	-0.0390***
	(0.0056)	(0.0097)	(0.0056)	(0.0096)
Net loans	-0.0036	-0.0019	-0.0037	-0.0021
	(0.0030)	(0.0022)	(0.0030)	(0.0024)
Constant	6.5261***	2.8793	8.1035***	2.2800
	(1.3834)	(2.3797)	(1.3178)	(2.3350)
Bank-level controls	Yes	Yes	Yes	Yes
Country-level controls	Yes	Yes	Yes	Yes
(Bank*Country) fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Clustered s.e.	Bank & Country	Bank & Country	Bank & Country	Bank & Country
Adjusted R-squared	0.7207	0.6873	0.7213	0.6891
Sample period	2000-2005	2006-2008	2000-2005	2006-2008
Observations	12,109	9,209	12,109	9,209
Ho: (Rate * High capital * Deposits) [Low expectations] =	0.0000[a]		0.0000[b]	
(Rate * High capital * Deposits) [High expectations]	F(1,10) = 124.22		F(1,10) = 129.16	

Notes. The table reports results of estimating panel regressions regarding banks' credit risk in the euro area (EA11–1999, EA12–2001, EA13–2007, EA15–2008, EA16–2009, EA17–2011, EA18–2014, EA19–2015) over the subperiods 2000–2005 and 2006–2008. Description and summary statistics of all variables used are reported in table 1. The dependent variable is the ratio of loan loss provision to gross loans (*LLP*) in all regressions. Low interest rate expectations subsample in regressions (1) and (3), and high interest rate expectations subsample in regressions (2) and (4) refer to observations from, respectively, the subperiod 2000–2005 and and the (pre–crisis) subperiod 2006–2008. The variables of interest in triple interactions are included and reported. For ease of readability, all the variables of interest and the variables of interest in double interactions are included but left unreported. Bank–level controls are included and reported. For brevity, country–level controls are included but left unreported. All regressions include bank∗country and year fixed effects. *P*–values are computed using heteroskedasticity–robust standard errors multiclustered at the bank and country level (in parentheses).

* Statistical significance at the 10% level.

** Statistical significance at the 5% level.

*** Statistical significance at the 1% level.

[a] *p*-value of F-statistics testing the null hypothesis that the coefficient (ECB rate * High capital * Deposits) from *Low interest rate expectations* subsample equals the coefficient (ECB rate * High capital * Deposits) from *High interest rate expectations* subsample.

[b] *p*-value of F-statistics testing the null hypothesis that the coefficient (Taylor residuals * High capital * Deposits) from *Low interest rate expectations* subsample equals the coefficient (Taylor residuals * High capital * Deposits) from *High interest rate expectations* subsample.

Table 6: The missing "crowding-out of deposits" effect for inefficient banks after the GFC (2011–2018)

	LLP		NPL	
	Inefficient banks	Efficient banks	Inefficient banks	Efficient banks
	(1)	(2)	(3)	(4)
Taylor residuals * High capital * Deposits	-0.0048**	0.0030*	-0.0436*	0.0224*
	(0.0022)	(0.0018)	(0.0248)	(0.0132)
Size	-0.0561	-0.0899	-1.7970*	-2.1790***
	(0.0670)	(0.0622)	(1.0253)	(0.5234)
Profitability	-0.4794***	-0.6264***	-0.5730*	-1.1579***
	(0.1306)	(0.0464)	(0.2876)	(0.2009)
Inefficiency	-0.0290***	-0.0413***	-0.0135	-0.0772***
	(0.0026)	(0.0033)	(0.0198)	(0.0194)
Net loans	-0.0030	-0.0004	-0.0886***	-0.0530**
	(0.0029)	(0.0020)	(0.0225)	(0.0210)
Constant	4.5062**	4.7262***	43.0005*	54.8903***
	(1.5755)	(1.4004)	(22.0729)	(13.3650)
Bank-level controls	Yes	Yes	Yes	Yes
Country-level controls	Yes	Yes	Yes	Yes
(Bank*Country) fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	No	No	No	No
Clustered s.e.	Bank & Country	Bank	Bank & Country	Bank
Adjusted R-squared	0.5553	0.7924	0.8700	0.8901
Sample period	2011-2018	2011-2018	2011-2018	2011-2018
Observations	5,120	3,783	2,103	2,512
Ho: (Taylor residuals * High capital * Deposits) [Inefficient banks] = (Taylor residuals * High capital * Deposits) [Efficient banks]	0.0027 F(1,18) = 12.12		0.0159 F(1,18) = 7.08	

Notes. The table reports results of estimating panel regressions regarding banks' credit risk in the euro area (EA11–1999, EA12–2001, EA13–2007, EA15–2008, EA16–2009, EA17–2011, EA18–2014, EA19–2015) over the period 2011–2018. Description and summary statistics of all variables used are reported in table 1. The dependent variables are the ratios of loan loss provision to gross loans (*LLP*) in regressions (1) to (2), and non–performing loans to gross loans (*NPL*) in regressions (3) to (4). *Inefficient banks* subsample in regressions (1) and (3) and *Efficient banks* subsample in regressions (2) and (4) refer to observations for which the ratio of expenses over the total revenues is, respectively, above the full sample 80^{th} percentile and below the full sample 15^{th} percentile. The variables of interest in triple interactions are included and reported. For ease of readability, all the variables of interest and the variables of interest in double interactions are included but left unreported. Bank-level controls are included and reported. For brevity, country–level controls are included but left unreported. All regressions include bank∗country and year fixed effects. *P*–values are computed using heteroskedasticity–robust standard errors multiclustered at the bank and country level in the *Inefficient banks* subsample, and clustered at the bank level in the *Efficient banks* subsample (in parentheses).

* Statistical significance at the 10% level.

** Statistical significance at the 5% level.

*** Statistical significance at the 1% level.

Table 7: Distribution of inefficient banks and industry concentration in the euro area after the GFC (2011–2018)

	National banking industry				Euro area banking industry	
	Share of inefficient banks in 2011 (%)	HHI in 2011 (%)	Share of inefficient banks in 2018 (%)	HHI in 2018 (%)	Share of inefficient banks in 2011 (%)	Share of inefficient banks in 2018 (%)
	(1)	(2)	(3)	(4)	(5)	(6)
Austria	15.8333	2.1377	34.7222	1.5911	8.0000	22.2930
Belgium	34.2857	6.2380	20.8333	6.7527	2.5253	0.6369
Cyprus	11.1111	20.8619	50.0000	16.0124	0.2105	0.8918
Estonia	50.0000	48.0814	0.0000	28.4678	0.6348	0.0000
Finland	37.5000	13.6083	36.8421	9.5563	1.2632	1.7834
France	18.1818	0.7472	25.8964	0.7367	10.1043	8.2803
Germany	10.9430	0.2990	18.2724	0.2660	39.5779	35.0318
Greece	35.2941	13.9481	23.0769	21.0623	1.2632	0.3822
Ireland	6.2500	8.2020	36.3636	11.5075	0.2105	0.5096
Italy	18.6978	0.8837	35.2303	1.0939	23.5788	16.5605
Latvia	–	–	35.7143	15.8885	–	0.6369
Lithuania	–	–	0.0000	28.3741	–	0.0000
Luxembourg	16.0000	4.0777	39.2857	4.4837	1.6842	2.8025
Malta	22.2222	25.2688	15.3846	24.7308	0.4211	0.2548
Netherlands	25.9259	5.3175	26.0870	6.3388	1.4736	0.7643
Portugal	37.5000	8.3619	37.9630	7.6314	1.8947	5.2229
Slovakia	6.6667	12.9610	8.3333	17.8392	0.2105	0.1274
Slovenia	23.5294	16.3592	7.6923	15.7431	0.8421	0.1274
Spain	22.6563	2.1384	28.1553	3.0692	6.1053	3.6943

Notes. The table reports changes in banks' inefficiency and industry concentration in the euro area (EA11–1999, EA12–2001, EA13–2007, EA15–2008, EA16–2009, EA17–2011, EA18–2014, EA19–2015) between 2011 and 2018. We compute in columns (1) and (3) the share of inefficient banks (i.e., observations for which the ratio of expenses over the total revenues is above the full sample 80^{th} percentile) in each national banking industry in 2011 and 2018, respectively. Columns (2) and (4) report the Herfindahl–Hirschman Index (HHI) (i.e., the sum of the squares of the market shares of banks within the national industry as a measure of the amount of competition among them) in each national banking industry in 2011 and 2018, respectively. For each country, we also compute in columns (5) and (6) the share of national inefficient banks regarding the whole euro area banking industry in 2011 and 2018, respectively.

Table 8: The joint influence of bank capital and funding liquidity on the monetary policy's risk-taking channel: robustness checks (1999–2018)

	LLP				NPL			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Funding liquidity								
EONIA * High capital * Deposits	-0.0005**							
	(0.0002)							
EURIBOR 1-month * High capital * Deposits		-0.0005**						
		(0.0002)						
EURIBOR 6-month * High capital * Deposits			-0.0005**					
			(0.0002)					
EURIBOR 12-month * High capital * Deposits				-0.0005**				
				(0.0003)				
Assets liquidity								
ECB rate * High capital * Liquid assets					-0.1474*			
					(0.0718)			
Taylor residuals * High capital * Liquid assets						-0.1430*		
						(0.0811)		
EONIA * High capital * Liquid assets							-0.1233**	
							(0.0553)	
Taylor residuals EONIA * High capital * Liquid assets								-0.1083*
								(0.0620)
Size	-0.1174***	-0.1172***	-0.1168***	-0.1165***	-1.1413**	-1.1062**	-1.1216**	-1.0732**
	(0.0204)	(0.0204)	(0.0204)	(0.0203)	(0.4427)	(0.4185)	(0.4404)	(0.4142)
Profitability	-0.8397***	-0.8399***	-0.8401***	-0.8402***	-1.6577**	-1.6530**	-1.6580**	-1.6581**
	(0.0558)	(0.0558)	(0.0558)	(0.0558)	(0.7614)	(0.7670)	(0.7661)	(0.7697)
Inefficiency	-0.0341***	-0.0341***	-0.0341***	-0.0341***	-0.0399**	-0.0398**	-0.0401**	-0.0401**
	(0.0035)	(0.0035)	(0.0035)	(0.0035)	(0.0172)	(0.0178)	(0.0172)	(0.0177)
Net loans	-0.0032**	-0.0032**	-0.0032**	-0.0032**	-0.1019***	-0.1031***	-0.1021***	-0.1038***
	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0099)	(0.0105)	(0.0099)	(0.0106)
Constant	5.5744***	5.5746***	5.5822***	5.5918***	43.1969***	36.8051***	42.0255***	37.1554***
	(0.5035)	(0.5036)	(0.5054)	(0.5075)	(11.9889)	(10.6366)	(11.7963)	(10.5612)
Bank-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Bank*Country) fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered s.e.	Bank & Country	Bank & Country	Bank & Country	Bank & Country	Bank & Country	Bank & Country	Bank & Country	Bank & Country
Adjusted R-squared	0.6654	0.6654	0.6654	0.6654	0.8179	0.8177	0.8178	0.8173
Sample period	1999-2018	1999-2018	1999-2018	1999-2018	1999-2018	1999-2018	1999-2018	1999-2018
Observations	57,792	57,792	57,792	57,792	21,807	21,807	21,807	21,807

Notes. The table reports robustness checks of estimating panel regressions regarding banks' credit risk in the euro area (EA11–1999, EA12–2001, EA13–2007, EA15–2008, EA16–2009, EA17–2011, EA18–2014, EA19–2015) over the period 1999–2018. Description and summary statistics of all variables used are reported in table 1. The dependent variables are the ratios of loan loss provision to gross loans (*LLP*) in regressions (1) to (4), and non–performing loans to gross loans (*NPL*) in regressions (5) to (8). The variables of interest in triple interactions are included and reported. For ease of readability, all the variables of interest and the variables of interest in double interactions are included but left unreported. Bank–level controls are included and reported. For brevity, country–level controls are included but left unreported. All regressions include bank∗country and year fixed effects. *P*–values are computed using heteroskedasticity–robust standard errors multiclustered at the bank and country level (in parentheses).

* Statistical significance at the 10% level.

** Statistical significance at the 5% level.

*** Statistical significance at the 1% level.

Appendix A.

Table A.1: Distribution of euro area banks

	Banks available in Fitch Connect database	Banks included in the final sample	Percentage of total assets of banks in the final sample against total assets of banks available in Fitch Connect database (%)
	(1)	(2)	(3)
Austria	787	617	93.0342
Belgium	161	48	88,9235
Cyprus	40	16	68,3288
Estonia	20	10	30,0331
Finland	90	51	89,3512
France	779	304	92,8296
Germany	3,057	1,850	76,5214
Greece	42	20	95,2358
Ireland	100	22	76,1783
Italy	1,074	638	93,2960
Latvia	36	15	32,3420
Lithuania	17	6	20,7673
Luxembourg	214	74	77,0354
Malta	35	15	38,3876
Netherlands	122	29	65,6468
Portugal	165	111	92,7406
Slovakia	37	15	57,2920
Slovenia	40	18	32,9301
Spain	319	164	92,9204
Euro area	**7,135**	**4,023**	**83,5905**[a]

Notes. To deal with sample representativeness, we compute in column (3) the ratio of total assets of banks in our final sample to total assets of nationwide banking system available in Fitch Connect database from 1999 to 2018. Bank categories included in the sample are: private banks, retail & consumer banks, trade finance banks, trading & investment banks, trust & processing banks, universal commercial banks and wholesale commercial banks.
[a] Weighted average of the percentage of total assets of banks in the final sample against total assets of banks available in Fitch Connect database (based on the number of banks available for each country).

Appendix B.

Table B.1: Pairwise Pearson cross–correlation coefficients

Variables	LLP	NPL	Taylor residuals	ECB rate	Capital	Deposits	Size	Profi-tability	Inefficiency	Net loans	Real GDP	Unem-ployment	Govt. debt	NF corp. debt
LLP	1.0000													
NPL	0.6363	1.0000												
	(0.0000)													
Taylor residuals	0.2152	0.0448	1.0000											
	(0.0000)	(0.0000)												
ECB rate	0.1749	-0.0503	0.9348	1.0000										
	(0.0000)	(0.0000)	(0.0000)											
Capital	-0.0413	0.0947	-0.2461	-0.2357	1.0000									
	(0.0000)	(0.0000)	(0.0000)	(0.0000)										
Deposits	-0.1210	-0.1970	-0.0651	-0.0627	-0.2515	1.0000								
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)									
Size	-0.0345	-0.1106	-0.0397	-0.0389	-0.2729	-0.2690	1.0000							
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)								
Profitability	-0.3325	-0.3418	-0.0858	-0.0553	0.3295	-0.0623	-0.0522	1.0000						
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)							
Inefficiency	-0.1294	-0.0405	-0.0032	-0.0080	-0.0636	0.2203	-0.2369	-0.4535	1.0000					
	(0.0000)	(0.0000)	(0.4336)	(0.0528)	(0.0000)	(0.0000)	(0.0000)	(0.0000)						
Net loans	-0.0492	-0.0346	0.0318	0.0236	-0.1071	-0.0323	0.0495	-0.0085	-0.1075	1.0000				
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0411)	(0.0000)					
Real GDP	-0.1406	-0.2183	-0.0000	0.2073	-0.0081	0.0687	-0.0012	0.1222	-0.0042	-0.0625	1.0000			
	(0.0000)	(0.0000)	(1.0000)	(0.0000)	(0.0492)	(0.0000)	(0.7702)	(0.0000)	(0.3094)	(0.0000)				
Unemployment	0.3017	0.4483	0.2130	0.1286	-0.0388	-0.1524	0.1034	-0.1735	-0.0760	0.0263	-0.1887	1.0000		
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)			
Govt. debt	0.1396	0.5632	-0.2984	-0.3592	0.2052	-0.1715	-0.0207	-0.0615	-0.0242	0.0721	-0.2605	0.3190	1.0000	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		
NF corp. debt	0.0498	0.2385	-0.0751	-0.0431	0.0666	-0.1630	0.1629	-0.0493	-0.1403	-0.1024	-0.0204	0.1816	-0.0410	1.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	

Notes. The table reports the correlation coefficients of variables used in the empirical analysis for 4,023 euro area banks over the period 1999 to 2018, with a final sample of 58,280 observations at annual frequency. The top and bottom 5% observations of all variables except macroeconomic variables have been winsorized to limit bias impact in our results. *P*–values are reported in parentheses.