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As Interest Rates Surge: From Funding to Lending

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WP Nº 24-011

2nd Quarter 2024

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As interest rates surge: from funding to lending*

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January 4, 2024

Very preliminary Draft: Please do Not Circulate

Abstract

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Keywords: Monetary policy, Banks, Bank deposits

JEL Codes: E51, E58, G21

*The findings of this paper cannot be attributed to the European Central Bank. The findings of this paper are those of the authors only, and do not necessarily represent the views of (or imply any responsibility for) the European Central Bank. The authors are thankful for the helpful comments and discussions provided by Steven Ongena, Alex Popov, Veronica Rappoport, Jean-David Sigaux and participants at the ECB internal seminar series. We are most grateful to James t Hooft on deposit data. The dataset used in this paper contains confidential statistical information. Its use for the purpose of the analysis described in the text has been approved by the relevant ECB decision making bodies. All the necessary measures have been taken during the preparation of the analysis to ensure the physical and logical protection of the information.

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Non-technical summary

Traditionally, in macroeconomic models banks are considered a passive conduit for monetary policy: as rates change, banks transmit homogeneously changes in their cost of funding to the asset side of their balance sheet by increasing lending rates, thus shifting the credit supply, just as markets adapt rapidly to the new rates. However there is a well-established literature that documents how banks are also an active part of the transmission mechanism, and how their characteristics determine additional bank specific supply effects in the provision of credit to the economy.

More recent research highlights also the importance of deposits as a transmission channel of monetary policy. When policy rates increase, banks earn more because they can keep rates on deposits low and earn more on their assets. As savers move out of sight deposits and into higher yielding products, banks, instead of increasing rates on deposits or finding alternative sources of funding at market rates, prefer to reduce lending correspondingly. This mechanism highlights the importance of banks' differences in funding structures in explaining how increases in rates affect the loan supply.

In this paper we shed light on the transmission of monetary policy during the largest increase in rates in the past decades by analyzing how banks change their supply of loans after large outflows of deposits. Our first finding is that they do this by rationing credit rather than by adjusting rates, which remain relatively stable. In practice, contrary to what is posited in standard models, banks don't transmit an increase in the cost of funding by a corresponding increase in the cost of lending, they adjust mostly via quantities: less funding with deposits translates into less lending, which allows banks to choose actively which borrowers to ration. To identify which borrowers are cut off by banks we leverage on a database with very detailed information on relationships between banks and their (individual) borrowers so that controlling for all other factors we can cleanly measure the effects of specific bank-level characteristics on lending. Our second finding is that new borrowers and borrowers who seek fixed rate loans suffer the most from the supply constraints imposed by banks, rather than borrowers that are less profitable for banks. This is consistent with banks trying to avoid adverse selection (i.e. taking on borrowers that are riskier than they appear) and wanting to minimize changes to their matching of maturities between assets and liabilities (the duration gap), which protects them form changes in interest rates. It appears that banks put more weight on protecting their duration gap, that allows them to lock in long-term profits, than on short-term profitability considerations that would have led to other choices, such as decreasing lending to less profitable borrowers.

1 Introduction

Traditionally, in macroeconomic models banks were considered as a passive conduit for monetary policy: as policy rates change, banks transmit homogeneously changes in their cost of funding to the asset side of their balance sheet by increasing lending rates, thus shifting the credit supply, just as markets adapt rapidly to the new rates.[1] However there is a by now well established strand of literature that documents how banks are an active part of the transmission mechanism (Bernanke and Gertler, 1995), and how their characteristics determine additional bank specific supply effects in the provision of credit to the economy via the bank lending channel. Empirically there is strong evidence that heterogeneity in banks' capital position (Peek and Rosengren, 2000 and Jiménez et al., 2012), income gap (see Gomez et al., 2021), and their ability to generate liquidity by securitizing their assets (Loutskina and Strahan, 2009) affects the supply of credit.

More recent research highlighted the importance of deposits as a transmission channel of monetary policy (Dreschsler et al., 2017).[2] With the deposit channel, When policy rates increase, banks earn more via the increase on the markdown on deposits. As the opportunity cost of holding deposits increases, savers move out of sight deposits and into higher yielding products, from term deposits to money market funds. However rather than repricing the yield on deposits, which would increase the cost of the whole stock, banks prefer to let marginal savers move out. Their market power allows banks to implement only a low pass-through of policy rates and keep a high markdown on the vast majority of deposits (to be noted that digitalization is eroding this market power, as shown by Koont et al., 2023). Furthermore, instead of compensating the outflow with funding at market rates, they prefer to reduce lending correspondingly. This mechanism highlights the importance of banks' differences in funding structures in explaining how increases in rates affect the loan supply. Empirically the funding side would matter more during certain periods, namely when policy rates increase unexpectedly, as this would heighten the opportunity cost of holding deposits,

[1] See Dou et al. (2020) for an overview of macro-finance models recently developed in the literature.

[2] Previously, the idea wasthat under most instances banks are able to easily complement deposits with alternative forms of funding, reflecting the changes in the new policy rate.

making previously assumed stable sources of funding potentially unstable and expensive. This type of mechanism and its macroeconomic implications are the focus of this paper.

We test how movements in deposits modulate the transmission of monetary policy during the largest increase in policy rates since the creation of the euro (Figure 1). The jump in rates was mostly unanticipated, at least in its magnitude (see Figure 2), and provides a natural experiment to understand better how banks' funding affect the transmission to the loan supply. The magnitude, surprise and speed of the shock was such that it led to an unexpected funding scenario and forced banks to make stark choices in terms of pricing of funding and lending conditions, this allowing us to understand better the drivers of banks' reaction.

From June 2022 to September 2023, the European Central Bank (ECB) increased aggressively its main policy rate, by more than 400 basis points. The magnitude of the increases was unexpected as they largely reflected a spike in inflation connected to exogenous shocks, meaning that banks would not have thought of adjusting their actions in advance (see Gagliardone and Gertler, 2023). This gives us a unique opportunity to clearly identify banks' funding dynamics with possible nonlinear effects related to the magnitude and the speed of the policy action. Banks' profits (and their stock market prices) experienced a turnaround and suddenly improved, which was mostly due to greater short-term net interest rate revenues, as the pass-through of higher rates to depositors was mostly slow and incomplete. In its wake, banks experienced the biggest reductions in sight deposits since these statistics started to be collected at the bank-level more than 15 years ago (3). Part of the outflow was associated with an increase in term deposit but the overall net flow implies a sizeable reduction in the total volume of deposits (see Figure 7). Most banks experienced a net outflow, which they did not replace with other sources. On average over the period considered (2020Q1 and 2023Q1) there is a positive inflow of deposits but the distribution of the net flow of deposits (inflows and outflows) across banks shifted to negative values after the beginning of the tightening of the monetary policy. After July 2022 a larger share of banks experienced a net outflow of deposits.

We thus aim to shed light on how this deposit shock generated by the rapid increase in the ECB policy rates impacted the supply of credit. We show in Figure 1, the cumulative interest rate increases reaching more than 4 percentage points in less than one year. Contemporaneously, we observed a net outflow of deposits driven by a sharp decrease of sight and overnight deposits (see Figure 7).

We use a detailed credit register to document how the funding shock is transmitted to lending, identifying the borrowers that are more affected and shedding light on banks' priorities in terms of profitability and asset and liability management. We leverage on the very detailed information on lending relationships between banks and their (individual) borrowers so that controlling for all other factors we can cleanly measure the effects of specific bank characteristics on lending. Specifically, we use Anacredit,[3] a recently constructed pan-European credit register which stores detailed data on the universe of bank loans to euro area firms. We build on the methodology developed by Khwaja and Mian (2008) to isolate supply shocks by looking at the differences in lending conditions to the same borrowers between banks affected by deposit outflows and banks not affected, before and after the increases in rates. That is, by using firms borrowing from several banks (i.e. multiple lending relations) including at least one bank suffering deposits outflows and at least one bank with stable deposits funding, we can identify the impact of deposits on lending conditions in terms of quantities and prices. This way we are able to control fully for any other shocks such as changes in borrowers' loan demand and riskiness. In additional tests, we study the lending to all firms (i.e. extensive margin) which would contain also firms borrowing from one bank only.

We first test a simple version of the deposit channel hypothesis and focus on whether, as the central bank raises rates, banks more affected by deposit outflows are forced to curtail lending more aggressively, and if they increase lending rates by more. Indeed, following a large increase in monetary policy rates, banks with the lowest pass-through of rates to deposits experience the largest deposit outflows and subsequently reduce their lending supply the most. Our key finding here is that they do this by rationing credit rather than by adjusting

[3]AnaCredit is the acronym for Analytical Credit Datasets. It consists of a harmonized (i.e. harmonizes data from national credit registers) statistical database on credits granted by financial institutions in Euro area countries to corporations if these loans are larger than €25,000.

rates, which remain stable. In practice, contrary to what is posited in standard models, banks don't transmit an increase in the cost of funding by a corresponding increase in the cost of lending, they adjust only via quantities: less funding with deposits translates into less lending, and banks choose actively which borrowers to ration rather than increasing rates and letting the demand for loans adjust consequently.

We then turn to analyzing which borrowers are rationed and why. Our second key finding is that new borrowers and fixed rate loans suffer the most from the supply constraints imposed by banks, rather than marginal borrowers or loans with an expected low risk-adjusted profitability. This is consistent with banks trying to avoid adverse selection (new borrowers that apply in the context of a sharp increase in rates would likely be very risky) and wanting to minimize changes to their duration gap, in line with findings by Drechsler et al. (2018) and Hoffmann et al. (2019). Indeed, by hedging themselves from interest rate risk banks can extract the maximum value from their deposits franchise, since deposits are considered a stable long-term form of funding at low rates. Deposit outflows, which reduce the duration of funding, are therefore compensated by reducing fixed rate loans, which other things being equal have a longer duration than floating rate loans. We test whether banks with deposit outflows reduce lending to borrowers for which risk-adjusted returns are the lowest and we don't find any significant evidence in this direction. It appears that banks put more weight on preserving the balance between assets and liabilities, that allows them to lock in long-term profits via a stable duration gap, than on short-term profitability considerations that would have led to other choices, such as decreasing lending to less profitable borrowers.

We also consider whether other bank characteristics shape the supply of credit, and if the bank capital channel interacts with the deposit channel, for example if banks' capital levels are associated with a sheltering effect on lending – better capitalized banks might be able to take on additional risk from an increased duration mismatch due to the outflow of deposits by lending to riskier borrowers in an environment of higher rates. We don't find significant evidence that core capital is an important driver of the supply of credit in this context. We do find, however, that banks with the largest improvements in net interest revenues are better able to sustain the flow of credit, consistent with findings by Gomez et al. (2021).

As net interest revenues are directly linked to the duration gap, this result indicates that a strong deposits franchise is conducive also to a more robust supply of credit when policy rates increase significantly.

Our results are supportive of the predictions of a stylized bank deposit channel channel and shed light on how it actually works. Following a consistent and large increase in monetary policy rates, banks experiencing the largest deposit outflows reduce their lending supply the most, and they do this by rationing credit rather than adjusting rates, which remain stable. Banks with the largest improvements in net interest revenues are better able to smooth the flow of credit. During interest rate increases, core capital does not seem to be a major driver sustaining the supply of credit. In addition, new borrowers, and existing borrowers with fixed rates suffer the most the supply constraints by banks. This is consistent with banks trying to minimize changes to their duration gap, in line with findings by Dreschsler et al. (2018).

Our work is most closely connected to the literature on the bank deposit channel (Drechsler et al., 2017 Drechsler et al., 2021) that builds on the fact that banks have market power in the market for deposits, therefore rates paid on deposits are sticky upwards (low pass-through, or deposits beta). This is attributed to imperfect oligopolistic competition in the deposit markets (see also earlier work by Hannan and Berger, 1991; Neumark and Sharpe, 1992). Drechsler et al. (2017) show that banks adjust their balance sheets to the outflow of deposits by reducing lending, and more so where they have more market power on deposits, but they don't investigate further whether banks reach their goal by increasing rates or by rationing firms, and which borrowers are targeted. Repullo (2020) shows that the relationship between increases in rates and deposit outflows is ambiguous, at least in theory, and advocates further analysis on how lending is affected. Tella and Kurlat (2021) develop a model in which banks actually expose themselves to the risk of an increase in interest rates the effects of which are masked by accounting rules. We provide evidence both on the channel of transmission from funding to lending and on the types of loans and borrowers that are hit. We don't dwell on the competitive structure of the market for deposits in Europe, as, there is already evidence that banks have significant market power (see e.g. Focarelli and Panetta, 2003) and that bank deposits are quite "sticky" (Ferrer et al., 2023). For our purposes it is enough to show that banks' deposit beta is low and heterogeneous, may it be because of market power, market imperfections or search and transactions costs. We also don't examine how well banks hedge interest rate risk, we only show that whatever hedging they are doing affects their decisions re the transmission to lending of a funding shock. What we add to this literature is our finding that banks adjust their lending to compensate for a funding gap exclusively by maneuvering quantities, rather than using a price mechanism, at least for the first part of a cycle of rate hikes. This allows them to be more in control of exactly who is targeted by their changes in lending strategy. Our results are consistent with the findings of Drechsler et al. (2018) and Hoffmann et al. (2019), who find that banks lock in the term premium and the premium on deposits (the difference between the market rate and the deposits rate) by insulating themselves from interest rate risk. We find that banks reduce the supply of fixed rate loans, which other things being equal have higher duration than floating rate ones. This way they compensate for the loss of deposits, which are considered to be behaviorally a source of long-term funding. They also reduce loans tpo new borrowers, consistent with the literature on adverse selection in lending markets (see Crawford et al., 2018). Our findings are also connected to the literature on the bank lending channel. While its theoretical foundations are somehow shaky, empirically bank specific characteristics have long been recognized to matter for lending and for the transmission of monetary policy to the real economy (Peek and Rosengren, 2000; Jiménez et al., 2012). Better-capitalized banks tend to lend more for a variety of reasons, including lower funding costs and the ability to better withstand shocks. There is also strong evidence from the United States that banks restrain lending following a monetary policy tightening not only if they face liquidity constraints (Kashyap and Stein, 1995) but also if they have low capital levels (Kishan and Opiela, 2000). We show that in the current context banks' capital position doesn't seem to matter so much in their lending decisions. What seems to matter more is their duration gap: for higher values of it banks experience higher increases in net interest income, which translates into smaller reductions in lending, consistently with the findings of Gomez et al. (2021) about the transmission of increases in policy rates. Our results can be read through the lens of the literature modelling banks as liquidity providers that engage in maturity transformation (Diamond and Dybvig, 1983; Gorton and Pennacchi, 1990; Diamond and Rajan, 2001; Kashyap et al., 2002). This dual role renders banks vulnerable to liquidity risk, as deposits are both a source of stable funding and subject to rapid outflows. This means that there is a hidden fragility in funding structures based on deposits, which in extreme cases can leads to runs when there are doubts about banks' solvency, as witnessed by the failure of Silicon Valley Bank in the Spring of 2023. We show that banks do not compensate for deposit outflows independently of their capital position: more solvent banks manage liquidity risk like the lesser capitalised ones, perhaps also because no bank in our sample is sufficiently close to insolvency. Finally, our focus on the effects of large increases in interest rates in 2022 and 2023 after a period of large injections of liquidity and prolonged low rates, is also linked to recent work on the sensitivity of interest rate changes on financial stability. Jiang et al. (2023) explore the financial stability consequences associated with the security losses that appear due to the unprecedented speed of interest rate rises by the Federal Reserve and show that these losses significantly increased the fragility of the US banking system to uninsured depositor runs. More broadly, Acharya et al. (2023) raised concerns about the financial stability implications when the Federal Reserve reversed its balance-sheet expansion after a long-period of ample liquidity and expansion of central banks' balance sheet. We show that banks try to contain the decrease in liquidity due to deposits outflows by avoiding to increase their most illiquid assets.

2 Data and empirical strategy

2.1 Data

We rely on several proprietary administrative sources to build our dataset.[4] We start with bank-level information for all banks operating in the euro area from the first quarter of 2021 to the first of 2023. Bank balance-sheet characteristics are gathered from two administrative databases; COREP (reporting on banks' capital) and FINREP (financial statements) databases, respectively. They are both supervisory confidential databases based on common

[4]For recent papers relying on similar data sources see, for instance, Barbiero et al. (2022) and Altavilla et al. (2020, 2021).

supervisory reporting standards and European Union banks are obliged to provide accurate information.[5] We match this supervisory data with granular data on deposits for different type of deposits obtained from the Individual Balance Sheet Items (IBSI) statistics.[6] The bank-level data from above is then combined with bank-firm level information taken from AnaCredit, the credit register of the European System of Central Banks that contains information on all individual bank loans to euro area firms above €25,000. Thus AnaCredit has matched bank-borrower instrument-level information including type of credit, credit volume, interest rate, firm location, firm size and firm sector. The data is collected by the ECB from the National Central Banks of the euro area in a harmonized manner to ensure consistency across countries. Importantly, we define the lending volume as the total agreed amount, i.e. including the undrawn credit line rather than only the outstanding amount. Therefore, the change in volume would not be contaminated by a firm drawing on pre-existing (pre-tightening) credit lines.

Table 1 presents the summary statistics of our main variables of interest including central tendencies, dispersion, and distribution. Thus, the table includes the number of observations, mean, standard deviation, minimum and maximum values, as well as 25th and 75th percentiles. As shown in Panel A, the unweighted change in loans is, on average, negative (approximately decreasing by 2 percentage points), suggesting an overall decline in loan growth with a moderate level of variability. Panel B shows that the share of banks that experimented a sizeable outflow of deposits between the first quarter of 2021 and the first quarter of 2023 ranges between 20 and 40 percent while fixed rate loans represent around the 70 percent of our observations. Banks in our sample show quite heterogeneous capital and liquidity levels (Panel C: Control variables). As indicated in Panel C, the average core equity (CET1) ratio is above 15 percent but varies across the sample from the regulatory

[5]COmmon REPorting (COREP) is the standardized reporting framework issued by the European Banking Authority (EBA) to comply with the Capital Requirements Directive reporting. It covers credit risk, market risk, operational risks, own funds and capital adequacy ratios. FINancial REPorting Standards (FINREP) include balance sheet, income statement, disclosure of financial assets and liabilities, off balance sheet activities and non-financial instrument disclosures.

[6]Individual Balance Sheet Items (IBSI) data are collected by ECB for monetary policy purposes to calculate credit and monetary aggregates for all banks operating in the euro area.

minimum to above 30 per cent, while the average cash over total assets ratio is around 12%, ranging from 0.5% to 32%. These banks in our sample rely on deposits as their main source of funding, as more than three quarters of banks have a share of deposits to total assets above 70 per cent (the simple average is almost 80%). Banks in the sample have different business models and show different levels of profitability and asset quality. For instance, the share of loans over total assets varies between 10 and 90 per cent, indicating that some banks are mainly intermediating deposits and loans, while others focus on other types of financial services. Banks also differ in terms of their credit risk quality, while the average share of non-performing loans (to total loans) is about 3%, for some banks it is well above 10%.

2.2 Empirical strategy

Our empirical setting relies on two factors that link bank deposit outflows to loan supply. The first focuses on the sensibility of deposits to changes on interest rates and leans on seminal work on the deposit channel (Drechsler et al., 2017). When the central bank raises the policy rate, for savers holding low-yielding cash and deposits becomes more expensive in relative terms as their alternative investment becomes more profitable. Households then have an incentive to reduce their holdings of deposits. This decline would on the gap between the policy rate and the remuneration of deposits but would also depend on banks' market power over their local deposit markets. From a funding perspective, banks can lift the interest rate they pay on deposits or, raise funds from non-deposit sources of funding (e.g. issuing bonds). In both cases, there would be a major increase in banks' marginal funding rates. The alternative if the withdrawal of deposits is large enough and the new funding to onerous would be to reduce their new lending.

In the latter case monetary policy is effectively transmitted to the loan supply via changes in the quantity of deposits for two reasons. First, the jump in funding rates would force banks to raise their lending rates and tus augmenting the likelihood of adverse selection. Second, the widening gap from "cheap" sight deposits to "expensive" alternative sources in the funding of loans could prove so large that the granting of new loans is no longer profitable. In terms of identification this appears particularly relevant on our setting; as the ECB started lifting the reference rates (see Figure 5) the cost of deposit funding by banks increased only modestly—by around 50 bps—, while that of bank bonds rose four times as much, by 400 basis points in 2023Q1.[7][8] Despite the moderate increase in deposit rates, a bank augmenting its deposits' remuneration by 50 bps (as reported in the Figure 5), would suffer from an increase of 80% of its overall funding costs. This is due to the large amounts of deposits outstanding which represent more than 75% of banks' funding in our sample. The evidence shows that banks with more deposit outflows (i.e. flighty deposits) passed the rise in the short-term interest rate to their depositors to a far lower extent compared than other banks. This is shown by the average beta for rates on deposits for these banks which is around 7.5% compared to 13% for other banks (see Figure 6).

The second channel connects changes in banks' duration gap to their loan supply. Banks manage their assets and liabilities so as to broadly insulate themselves from interest rate risks. Even though their contractual nature is short term, under low interest rates, sight deposits are, in practice, a stable source of funding for banks . The increase in rates would make sight deposits' expected duration suddenly shorter. Hence so to contain their duration risk banks would be forced to either issue expensive long-term debt or to reduce their loan supply. This reduction would be expected to be more pronounced for longer-term loans or those with fixed rates.

Our identification relies on within-firm comparisons across banks to dissect the effect connected to banks that experienced more deposits outflows keeping other factors constant. In the spirit Khwaja and Mian (2008) we exploit multiple bank-firm relationships and employ borrower and time fixed effects regressions as they allow us to effectively disentangle credit supply from demand shocks.

[7]The approximately 3.5% spread difference between these two alternative funding sources is mostly driven by sight deposits whose pricing appears quite sticky and their are the main source of deposit funding for banks.

[8]The weights for the cost of deposits are the deposit volumes for sight, term and redeemable at notice deposits, whilst the weights for the cost of bonds issuance are the amounts issued.

$$Y_{b,j,t} = \alpha DEP\_OUTFLOW_{b,t} + \beta DEP\_OUTFLOW_{b,t} \times MP\_Tightening + \Psi \Sigma X_{b,t-1} + \eta_{j,t} + \rho_b + \epsilon_{b,j,t} \quad (1)$$

Where b, j and t indicate bank, firm and time fixed effects respectively. Y represents credit growth (i.e. difference in the logarithm of the amounts outstanding by bank b to debtor j), or the interest rate charged by bank b to debtor j. $DEP\_OUTFLOW$ is a dummy variable that takes the value one for banks experiencing persistent deposit outflows since the start of the monetary policy tightening (2022Q3), and 0 otherwise. MP_Tightening is a dummy that takes the value one from 2022Q3, and 0 otherwise. β is our main coefficient of interest as it captures whether banks' deposit outflows during the monetary policy tightening cycle curtail more aggressively lending (or increase lending) rates to same borrowers, relative to the other banks.

Arguably, Equation 1 presents several additional empirical challenges. First, the demand for credit during interest rate increases might be heterogeneous across firms. For instance, firms relying on fixed-rate debt may be less affected by short-term increases in interest rates. The use of borrower-time fixed effects absorbs time-varying heterogeneity across firms so that η is effectively identified by comparing how loan supply responds post tightening for two banks with different deposit outflows *lending to the same firm*.

Second, bank characteristics may be correlated with the outflow of deposits affecting our coefficient of interest. For instance, weakly capitalised banks may face greater deposit outflows resulting in lower lending supply. We take into account these confounding factors with an X vector of lagged bank-level controls that includes bank size (i.e. logarithm of total assets, TA), and relevant balance sheet and prudential ratios to account for (i) Deposits (Deposits to total assets, DEP/TA); (ii) Credit risk (Nonperforming to total loans, NPLs); (iii) Profitability (Return on assets, ROA); (iv) Liquidity (Cash and cash at the central bank to total assets, CASH/TA); (v) Capital (Core capital to risk-weighted assets, CET1), and (vi) Total loans to assets ratio (LOAN/TA). We also include bank-fixed effects to account for bank unobservable characteristics potentially correlated to deposit inflows/outflows which can affect lending patterns. Third, in alternative specification, we also consider local market deposit development with a set of dummies and introduce banks headquarter country-time fixed effects to control for the heterogeneous effect of monetary policy tightening across euro area countries. Fourth, we also create a matched sample of banks with very similar characteristics prior to the tightening so that characteristics of treated are control groups are balanced.

3 Results

Our results are striking and underline bank deposits as key element modulating the transmission of monetary policy. Table (2) circumscribes the estimation to firms borrowing from *at least* one bank experiencing deposit outflows, and *at least* another institution. It shows that deposit outflows played a substantial role in the transmission of monetary policy across banks during the period of monetary tightening. Banks that experimented a persistent reduction in deposits decreased the supply of credit *to the same borrower* by around 2 percentage points more than other institutions.

An important related question is whether *new* borrowers are getting access to credit. This could take two forms, either a borrower obtains bank credit from for the first time, or receives credit from a new bank. We aim to answer this question on Table (3) where the dependent variable is whether borrowers form new relationships. It suggests that banks suffering from deposits outflows are far less likely to grant fresh credit to new borrowers even after accounting for factors such as the size, solvency, and liquidity of banks, along with unobservable attributes of banks that remain constant over time (i.e bank fixed effects), and allowing for changing borrowers and country characteristics.

To control for the possibility that endogeneity drives our results we augment the specification in Equation 1 with the Propensity Score Matching (PSM) (Rosenbaum and Rubin, 1983). By pairing each bank experiencing deposit outflows with a control unit, the PSM allows us to compare banks with similar characteristics during the pre-tightening period, thus mitigating the concern that changes in deposit outflows are driven by bank-specific attributes.[9]

The effect of this matching is observable in Table (4). It shows the differences in characteristics for both groups of banks, those experiencing deposit outflows (i.e. treated) and the control group. Panel A shows that the characteristics of both groups of banks are widely different in all dimensions but their NPL ratio (credit risk) prior to the matching. In contrast, Panel B vouches for the comparability of both groups in terms of banks' key characteristics. As a result of this matching process, in which only similar banks are included, the sample of banks and borrowers declines.[10] The results in Table (5) are consistent with those of the unmatched sample, and underline how banks suffering from deposit outflows curtail lending even more aggressively. Figure A.2 (on the Appendix) vouches for the existence of parallel trends of treated and control groups prior to the tightening episode.

The "pass-through" of policy to lending rates across banks is, besides quantities, the other major dimension of the transmission of monetary policy. Banks experiencing deposit outflows do not charge higher interest rates to the same borrower relative to the other banks, even when bank and economic conditions are taken into account (Table 6, see columns (2) to (3)). The increase in rates is both economically meaningless and statistically insignificant. The tightening in rates to the same borrower is statistically insignificant also in the matched sample (Columns (5) and (6)), suggesting that banks experiencing deposit outflows have toughen their credit standards via quantities rather than prices during the monetary policy tightening period.

One hypothesis consistent with the tightening via quantities observed above is due to increased banks' liquidity risk. The unexpected deposit shock would have stepped up liquidity risks as the stability of funding of those loans funded via deposits would be perceived as more volatile. In a situation of low interest rates deposits are as a highly "sticky" source of funds,

[9]The PSM applied a logit model and one-to-one nearest neighbour, imposing a tolerance level on the maximum propensity score distance (caliper) between the control and the treatment group equals to 0.01.

[10]Figure A.1 on the Appendix, shows, from left to right, how after the sample of banks is balanced due to the matching—effectively moving from Panel A to Panel B in Table (4)— there is an improvement on the comparability of banks included as treated and control groups.

yet the increase in interest rates makes banks also vulnerable to further withdrawals. Banks might be thus reluctant to grant additional loans which would increase their liquidity risk as loans are hard to redeem for liquidity particularly at short notice.

The withdrawal in deposits would also increase banks' interest rate repricing risk mismatch. This is because, as short-term interest rates augment, banks' liabilities would reprice faster than their assets for banks with wider mismatch. One way for banks to shorten this mismatch would be to reduce their share of fixed rate loans. Note that during the pre-tightening period banks had the opposite incentive as they tended to step up their interest rate risk by anchoring their margin between their deposit and lending rates in an environment of compressed margins. This is indeed what we see on Table 7, as during the tightening period banks with a higher proportion of fixed interest rate loans are less willing to grant additional loans probably in an effort to reduce their repricing mismatch. This effect becomes even more pronounced for banks experiencing deposit outflows as suggested by the triple difference results that shows that the combined withdrawal of deposits further exacerbates the reduction in the supply of credit by around 1 additional percentage point.

We dig deeper to assess how the increase in interest rates impacts on lending due to changes in banks' interest rate risk. For each bank we calculate their duration gap defined as the difference between the duration of banks' assets and liabilities (see on Banking Supervision, 2004, 2006).[11] Most importantly, the measure of duration gap is net of derivatives for interest rate risk hedging purposes. In Table 8 we set the duration gap at the second quarter of 2021 to avoid endogeneity concerns and test whether a greater duration gap drives the supply of credit. The findings of Table 8 are important for two reasons. First, banks experiencing deposit outflows contract lending even without facing a maturity mismatch. The double interaction (*DEP_OUTFLOW x Tightening*) is negative, sizeable and statistically significant, pointing to a lending reduction of about 4 pp. However, this effect is stronger the wider the duration gap. Specifically, a 1 pp higher duration gap results in an additional contraction of credit by around 4 bps. Considering a median duration gap of about 8%, it means

[11]Data about the duration gap is provided by banks to the ECB for supervisory purposes and contains granular confidential cash flow data divided by 14 maturity buckets for all on and off-balance sheet assets and liabilities.

a This suggests that banks' interest rate positions are highly relevant in the transmission of a tightening monetary policy decision.

Finally, according to the empirical literature, shocks to bank capital are consistently shown to be a major determinant of bank lending modulating the transmission mechanism of monetary policy (see for instance Peek and Rosengren (2000); Gambacorta and Mistrulli (2004); Jimenez et al. (2012); Drechsler et al. (2018); Bednarek et al. (2023)). How relevant is bank capital (compared to deposits shocks), during periods of surging interest rates? We build on our baseline identification to investigate the role of regulatory bank solvency. We leverage on the concept of distance to maximum distributable amount or "distance to MDA" which Couaillier et al. (2023) show to be the relevant solvency variable in normal times. The distance to MDA captures the amount of voluntary capital held by banks on top of the minimum capital buffer required by regulators. Since a breach of the MDA triggers restrictions on dividend distributions, bonuses and coupon payments,[12], we hypotheses that banks closer to the MDA trigger might curtail lending by more when experiencing deposit outflows. We posit that banks closer to the MDA, and therefore less capitalised from a regulatory perspective, as those in the first quartile of the distance to the MDA distribution. Table 9 shows that less capitalized banks—measured as closeness to the minimum regulatory requirements—do not restrict credit to the same borrower more than other banks thus vouching again for the role of bank deposits during the tightening phase.

4 Conclusions

We study how banks transmit increases in interest rates to the loan supply. We analyse the largest increase in interest rates since the creation of the euro—which took place in the second half of 2022—and led to a large drop in sight deposits. We build on an comprehensive credit register which includes bank-firm lending relationships in all euro area countries above 25.000 euro, which we match with bank-level information on banks' deposit funding and financial conditions. We find that banks experiencing large deposits outflows restrict credit

[12]For an detailed explanation of the MDA refer to Svoronos and Vrbaski (2020).

to borrowers, rather than adjust rates. Our findings seem to be driven by augmented exposure to liquidity but also interest rate risk as the effect is larger for banks with larger duration gap, and credit is less available for new borrowers with fixed rates and longer maturities. Our results indicate that during periods of increasing rates, bank's funding could be more important than other bank characteristics—such as bank capital—for the transmission of monetary policy.

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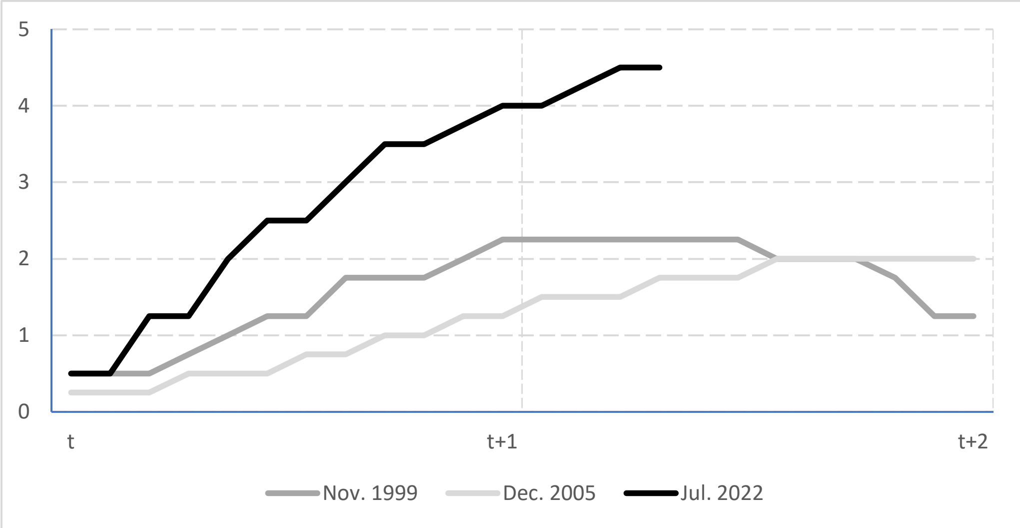
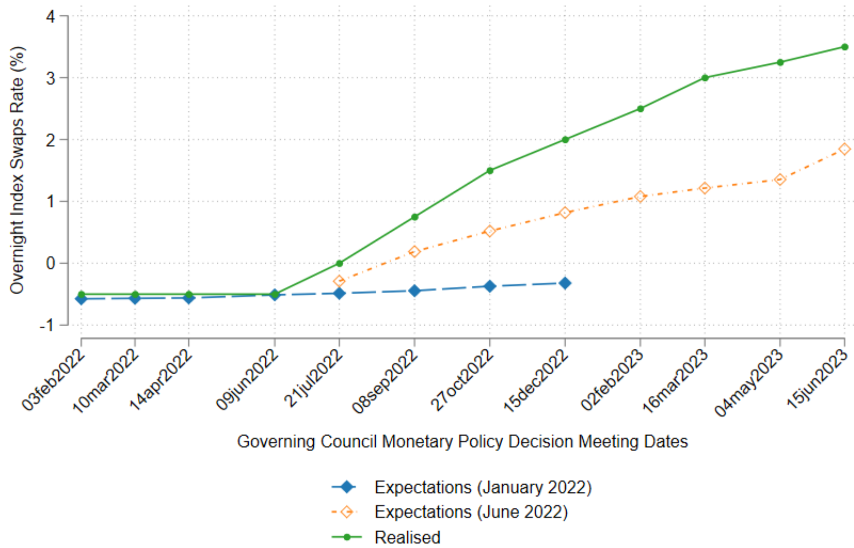
Figure 1: Euro area monetary policy rates during tightening cycles
(interest rate, annualized)



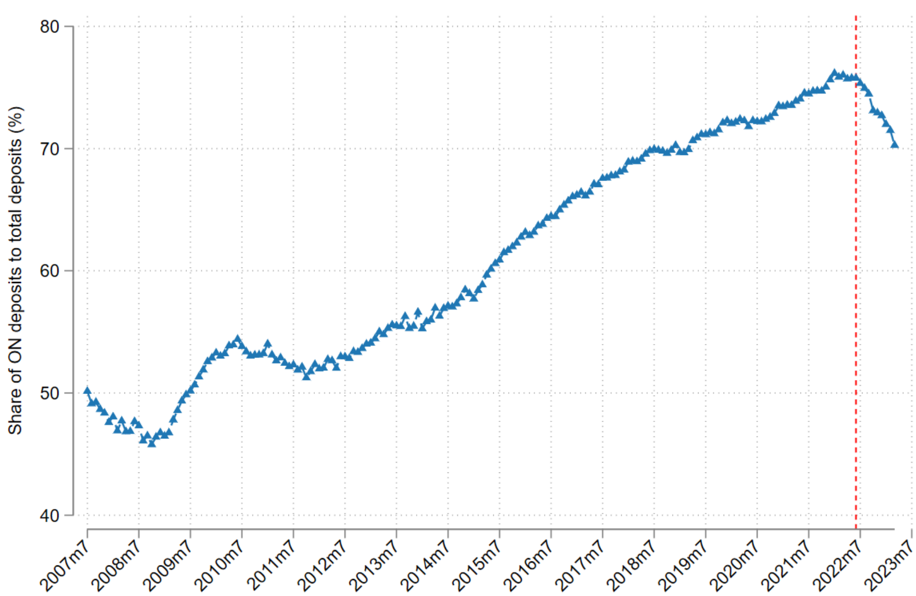
Source: ECB. **Note:** The ECB relevant policy rate is interest rate on the main refinancing operations (MRO) up to May 2014 and the deposit facility rate (DFR) thereafter. t marks the start of each hiking cycle.

Figure 2: Expected and realized monetary policy rates



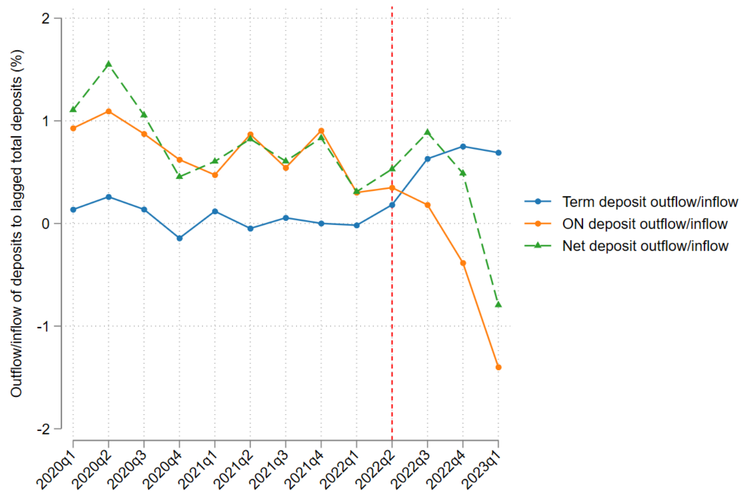
Source: ECB. **Note:** Euro area monetary policy interest rate expectations are obtained from overnight indexed swap-implied interest rate expectations observed in January. On the x-axis are the dates of the ECB's monetary policy meetings.

Figure 3: Share of sight over total deposits
(percentage points)



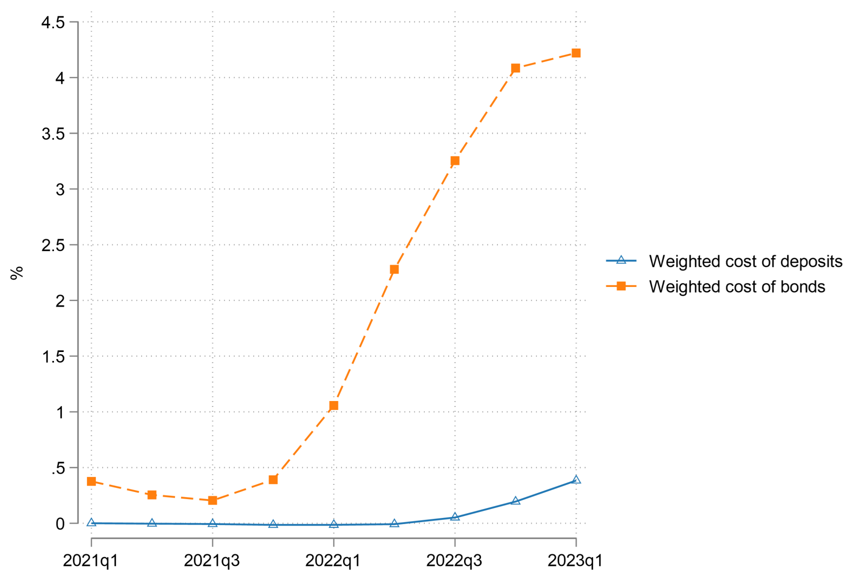
Source: ECB. **Note:** Monthly data on the amount outstanding of sight over total deposits from end of July 2007 to end of March 2023 in percentages.

Figure 4: Net flow of overnight and term deposits
(percentage points)



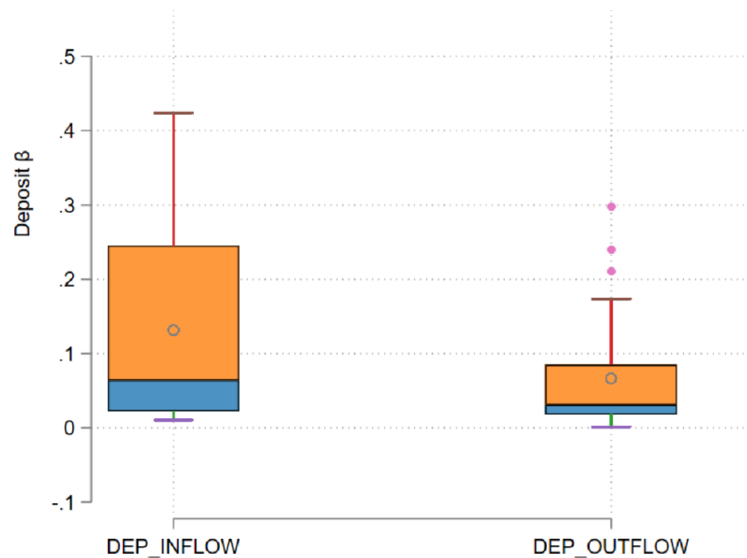
Source: ECB. **Source:** ECB **Note:** Overnight (and term) flows of deposits is calculated as the difference between overnight (and term) deposits outstanding at time t and t-1 to lagged total deposits outstanding from the first quarter of 2020 to the first quarter 2023. Net flows of deposits is calculated as the difference between total deposits outstanding at time t and t-1 to lagged total deposits outstanding from the first quarter of 2020 to the first quarter 2023.

Figure 5: Cost of deposit and bond issuances by banks
(percentage points)



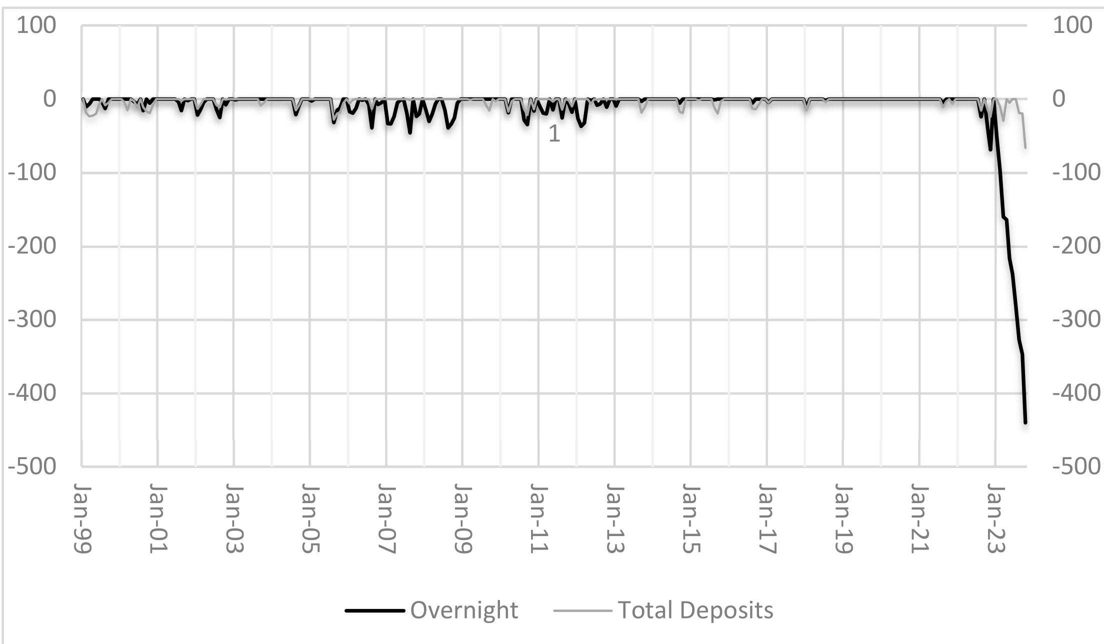
Source: ECB. **Note:** Weighted cost of deposit and bonds outstanding from first quarter of 2021 to first quarter of 2023. The weights for the cost of deposits are the deposit volumes for sight, term and redeemable at notice deposits, whilst the weights for the cost of bonds issuance are the amount issued.

Figure 6: Deposit betas by s of deposits during tightening
(percentage points)



Note: Beta of banks calculated as the pass-through of interest rates from the monetary policy to the sight deposit rates during the tightening period (see paper identification). The sample of banks is divided into two groups, distinguishing between banks with net inflows and banks with continuous net outflows of sight deposits after July 2022. Each panel of the chart show the max, the 75th percentile the median, the 25th percentile and the minimum of the distribution. The circle represents the average of the distribution.

Figure 7: Net flow of overnight deposits and total deposits from its peak (billions Euro)



Source: ECB.
Note:

Table 1: Summary statistics

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Panel A							
Δ Log (loans)	11,529,195	-0.020	0.275	-1.001	-0.068	0	1.207
New loans	28,521,157	0.045	0.208	0.000	0.000	0.000	1.000
Weighted average Interest Rate on Loans	11,529,195	0.029	0.021	0.002	0.015	0.038	0.119
Panel B							
Deposits outflow	11,529,195	0.212	0.408	0.000	0.000	0.000	1.000
Fixed rate loans	11,529,195	0.720	0.448	0.000	0.000	1.000	1.000
Banks with low distance to MDA	11,527,316	0.307	0.461	0.000	0.000	1.000	1.000
Panel C							
L.CET1 ratio	11,529,195	0.152	0.040	0.099	0.125	0.164	0.318
L.DEP/TA	11,529,195	0.789	0.116	0.289	0.735	0.872	0.924
L.TA (log)	11,529,195	11.184	2.155	6.561	9.583	13.299	14.697
L.LOAN/TA	11,529,195	0.629	0.112	0.397	0.562	0.672	0.927
L.ROA	11,529,195	0.435	0.448	-0.906	0.187	0.617	1.941
L.NPLs ratio	11,529,195	3.625	2.223	0.472	2.150	4.447	13.688
L.CASH/TA	11,529,195	0.127	0.062	0.005	0.081	0.168	0.320

Note: The sample includes 1,620 banks and 746,315 firms. Over the period starting from the first quarter of 2021 till the first quarter 2023 we consider all loans of borrowers having either at least outstanding loan

Table 2: Baseline results - Intensive margin

This table shows the results of the bank-firm panel regressions as in equation (1). The quarterly data cover the period from the first quarter 2021 and the first quarter 2023. Δ Log (loans) is the change in bank-firm logarithm of outstanding lending. DEP/OUTFLOW is a dummy variable that takes the value 1 for banks experiencing deposit outflows in all quarters following the start of monetary tightening, and 0 otherwise. L.CET1 ratio is the lag of the Common Equity Tier1 ratio. L.DEP / TA is the lag of the deposits-to-total asset ratio. L.TA.(log) is the lag of the logarithm of bank total assets. L.LOAN/TA is the lag of the credit exposures-to-total assets ratio. L.ROA is the lag of the return on assets. L.NPLs in the lag of the non-performing loans-to-total loans ratio. L.CASH/TA is the lag of the ratio of cash and cash held at the central bank-to-total assets ratio. Standard errors are clustered at bank and firm level. *, **, *** indicate statistical significance of 1%, 5% and 10% respectively.

	Dependent variable: $\Delta Log(loans)$		
	(1)	(2)	(3)
DEP_OUTFLOW	0.0050		
	(0.004)		
DEP_OUTFLOW × Tightening	-0.0188**	-0.0167**	-0.0167**
	(0.008)	(0.008)	(0.008)
L.CET1 ratio	-0.0719***	0.0013	-0.0003
	(0.019)	(0.049)	(0.049)
L.DEP/TA	0.0343***	0.1119*	0.1132*
	(0.011)	(0.067)	(0.068)
L.TA (log)	0.0020***	0.0004	0.0010
	(0.001)	(0.012)	(0.012)
L.LOAN/TA	-0.0179**	-0.0254	-0.0254
	(0.008)	(0.040)	(0.040)
L.ROA	0.0049*	0.0132***	0.0132***
	(0.002)	(0.003)	(0.003)
L.NPLs ratio	0.0007	0.0018	0.0018
	(0.001)	(0.001)	(0.001)
L.CASH/TA	-0.0035	-0.0085	-0.0089
	(0.015)	(0.037)	(0.037)
Constant	-0.0519***	-0.1074	-0.1152
	(0.018)	(0.152)	(0.153)
Observations	11,529,195	11,529,182	11,529,182
Bank FE	No	Yes	Yes
Borrower*time FE	Yes	Yes	Yes
Country*time FE	No	No	Yes

Table 3: Baseline results - Extensive margin

This table shows the results of the bank-firm panel regressions as in equation (1). The quarterly data is from 2021Q1-2023Q1. New bank-firm relationships is a dummy variable taking the value 1 if in a given quarter: a) a firm enters in the sample establishing a relationship and b) a firm with an already existing bank relationship at t-1 establishes a new relationship with a different bank. DEP_OUTFLOW is a dummy variable that takes the value 1 for banks experiencing constant deposit outflows post tightening, and 0 otherwise. L.CET1 ratio is the lag of the common equity tier1 ratio. L.DEP/TA is the lag of the deposits-to-total asset ratio. L.TA.(log) is the lag of the logarithm of bank total assets. L.LOAN/TA is the lag of the credit exposures-to-total assets ratio. L.ROA is the lag of the return on assets. L.NPLs in the lag of the non-performing loans-to-total loans ratio. L.CASH/TA is the lag of the ratio of cash and cash held at the central bank-to-total assets ratio. Standard errors are clustered at bank and firm level. *, **, *** indicate statistical significance of 1%, 5% and 10% respectively.

	Dependent variable: New bank-firm relationships		
	(1)	(2)	(3)
DEP_OUTFLOW	0.0181***		
	(0.005)		
DEP_OUTFLOW × Tightening	-0.0223***	-0.0162***	-0.0161***
	(0.006)	(0.006)	(0.006)
L.CET1 ratio	-0.1431***	0.1778	0.1764
	(0.037)	(0.118)	(0.118)
L.DEP/TA	-0.0620***	-0.0483	-0.0444
	(0.020)	(0.087)	(0.085)
L.TA (log)	-0.0055***	0.0733***	0.0757***
	(0.001)	(0.025)	(0.024)
L.LOAN/TA	0.0082	0.1041	0.0995
	(0.019)	(0.076)	(0.076)
L.ROA	0.0152***	0.0019	0.0015
	(0.004)	(0.006)	(0.006)
L.NPLs ratio	-0.0004	0.0008	0.0010
	(0.001)	(0.002)	(0.002)
L.CASH/TA	0.0453*	0.0257	0.0224
	(0.026)	(0.058)	(0.059)
Constant	0.1593***	-0.8351***	-0.8619***
	(0.027)	(0.305)	(0.296)
Observations	28,521,124	28,521,122	28,521,122
Bank FE	No	Yes	Yes
Borrower*time FE	Yes	Yes	Yes
Country*time FE	No	No	Yes

Table 4: Differences in bank characteristics

This table shows bank-specific characteristics for banks with constant deposit outflows and banks with mixed inflows and outflows post-tightening. The table is divided in two panels. Panel A reports descriptive statistics for the unmatched sample of bank covariates employed the loan-level analysis, whilst Panel B reports descriptive statistics for the matched sample. The PSM applies a logit model and one-to-one nearest neighbour imposing a tolerance level on the maximum propensity score distance (caliper) between the control and the treatment group equals to 0.01. DEP_OUTFLOW is a dummy variable that takes the value 1 for banks experiencing constant deposit outflows post tightening, and 0 otherwise. L.CET1 ratio is the lag of the common equity tier1 ratio. L.DEP/TA is the lag of the deposits-to-total asset ratio. L.TA.(log) is the lag of the logarithm of bank total assets. L.LOAN/TA is the lag of the credit exposures-to-total assets ratio. L.ROA is the lag of the return on assets. L.NPLs in the lag of the non-performing loans-to-total loans ratio. L.CASH/TA is the lag of the ratio of cash and cash held at the central bank-to-total assets ratio. *, **, *** indicate statistical significance of 1%, 5% and 10% respectively.

	DEP_OUTFLOWS=1 N. banks=151	**DEP_OUTFLOW=0 N. banks= 1,426**	**Welch test**
Panel A: Pre-PSM			
CET1 ratio	0.184	0.174	0.010**
DEP/TA	0.837	0.858	-0.020***
TA (log)	8.895	7.794	1.101***
LOAN/TA	0.645	0.684	-0.038***
ROA	0.400	0.275	0.125***
NPLs ratio	0.026	0.025	0.001
CASH/TA	0.136	0.091	0.045***
Panel B: Post-PSM			
	DEP_OUTFLOWS=1 N. banks=151	**DEP_OUTFLOW=0 N. banks= 131**	**Welch test**
CET1 ratio	0.184	0.187	-0.002
DEP/TA	0.837	0.841	-0.003
TA (log)	8.89	8.64	0.254
LOAN/TA	0.645	0.642	0.03
ROA	0.400	0.434	-0.03
NPLs ratio	0.025	0.027	-0.002
CASH/TA	0.136	0.139	-0.03

Table 5: Baseline results - PSM

This table shows the results of the bank-firm panel regressions as in equation (1). The quarterly data is from 2021Q1-2023Q1. Δ Log (loans) is the change in bank-firm lending in logarithm. DEP_OUTFLOW is a dummy variable that takes the value 1 for banks experiencing constant deposit outflows post tightening, and 0 otherwise. L.CET1 ratio is the lag of the common equity tier1 ratio. L.DEP/TA is the lag of the deposits-to-total asset ratio. L.TA.(log) is the lag of the logarithm of bank total assets. L.LOAN/TA is the lag of the credit exposures-to-total assets ratio. L.ROA is the lag of the return on assets. L.NPLs in the lag of the non-performing loans-to-total loans ratio. L.CASH/TA is the lag of the ratio of cash and cash held at the central bank-to-total assets ratio. Standard errors are clustered at bank and firm level. *, **, *** indicate statistical significance of 1%, 5% and 10% respectively.

	Dependent variable: Δ Log (loans)		
	(1)	(2)	(3)
DEP_OUTFLOW	0.0057		
	(0.004)		
DEP_OUTFLOW*Tightening	-0.0282***	-0.0253***	-0.0257***
	(0.009)	(0.008)	(0.008)
L.CET1 ratio	-0.0634	0.1248	0.1197
	(0.040)	(0.116)	(0.118)
L.DEP/TA	0.0097	0.1089	0.1229
	(0.011)	(0.167)	(0.173)
L.TA (log)	0.0027**	0.0561*	0.0610**
	(0.001)	(0.029)	(0.030)
L.LOAN/TA	-0.0122	0.0283	0.0169
	(0.010)	(0.087)	(0.085)
L.ROA	0.0002	0.0158**	0.0166**
	(0.003)	(0.007)	(0.007)
L.NPLs ratio	0.0006	0.0034	0.0032
	(0.001)	(0.003)	(0.003)
L.CASH/TA	-0.0180	-0.0512	-0.0585
	(0.029)	(0.092)	(0.092)
Constant	-0.0390	-0.7989*	-0.8579**
	(0.024)	(0.412)	(0.432)
Observations	2,199,608	2,199,606	2,199,597
Bank FE	No	Yes	Yes
Borrower*time FE	Yes	Yes	Yes
Country*time FE	No	No	Yes

Table 6: Interest rate pass-through

This table shows the results of the bank-firm panel regressions as in equation (1). The quarterly data is from 2021Q1-2023Q1. Weighted average interest rate is the bank-firm weighted average interest rate (weighted by the volume of different instruments). DEP_OUTFLOW is a dummy variable that takes the value 1 for banks experiencing constant deposit outflows post tightening, and 0 otherwise. L.CET1 ratio is the lag of the common equity tier1 ratio. L.DEP/TA is the lag of the deposits-to-total asset ratio. L.TA.(log) is the lag of the logarithm of bank total assets. L.LOAN/TA is the lag of the credit exposures-to-total assets ratio. L.ROA is the lag of the return on assets. L.NPLs in the lag of the non-performing loans-to-total loans ratio. L.CASH/TA is the lag of the ratio of cash and cash held at the central bank-to-total assets ratio. Standard errors are clustered at bank and firm level. *, **, *** indicate statistical significance of 1%, 5% and 10% respectively.

	Dependent variable: Δ interest rate					
	Unmatched			*Matched*		
	(1)	(2)	(3)	(4)	(5)	(6)
DEP_OUTFLOW	-0.0000			0.0001		
	(0.000)			(0.000)		
DEP_OUTFLOW × Tightening	0.0001	0.0002	0.0002	0.0002	0.0003	0.0003
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L.CET1 ratio	-0.0013	0.0039	0.0040	-0.0038**	-0.0016	-0.0016
	(0.001)	(0.003)	(0.003)	(0.002)	(0.006)	(0.006)
L.DEP/TA	0.0005	0.0017	0.0015	0.0008	-0.0081	-0.0090
	(0.000)	(0.003)	(0.003)	(0.001)	(0.007)	(0.007)
L.TA (log)	-0.0000	0.0003	0.0003	0.0000	-0.0007	-0.0009
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
L.LOAN/TA	-0.0010**	0.0011	0.0012	0.0006	-0.0054	-0.0052
	(0.000)	(0.002)	(0.002)	(0.001)	(0.005)	(0.005)
L.ROA	-0.0001	-0.0000	-0.0000	-0.0009***	-0.0007**	-0.0007**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L.NPLs ratio	-0.0001***	-0.0002***	-0.0002***	-0.0001	-0.0006***	-0.0006***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L.CASH/TA	-0.0005	0.0001	0.0001	0.0018	0.0012	0.0016
	(0.001)	(0.002)	(0.002)	(0.001)	(0.003)	(0.003)
Constant	0.0025***	-0.0037	-0.0033	0.0011	0.0220	0.0242
	(0.001)	(0.008)	(0.008)	(0.002)	(0.018)	(0.018)
Observations	11,529,195	11,529,182	11,529,182	2,199,608	2,199,606	2,199,597
Bank FE	No	Yes	Yes	No	Yes	Yes
Borrower*time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country*time FE	No	No	Yes	No	No	Yes

Table 7: Triple interactions fixed rate loans

This table shows the results of the bank-firm panel regressions as in equation (1). The quarterly data is from 2021Q1-2023Q1. Δ Log (loans) is the change in bank-firm lending in logarithm. DEP_OUTFLOW is a dummy variable that takes the value 1 for banks experiencing constant deposit outflows post tightening, and 0 otherwise. Fixed is a dummy variable taking the value 1 for fixed rate loans, and 0 otherwise. L.CET1 ratio is the lag of the common equity tier1 ratio. L.DEP/TA is the lag of the deposits-to-total asset ratio. L.TA.(log) is the lag of the logarithm of bank total assets. L.LOAN/TA is the lag of the credit exposures-to-total assets ratio. L.ROA is the lag of the return on assets. L.NPLs in the lag of the non-performing loans-to-total loans ratio. L.CASH/TA is the lag of the ratio of cash and cash held at the central bank-to-total assets ratio. Standard errors are clustered at bank and firm level. *, **, *** indicate statistical significance of 1%, 5% and 10% respectively.

	Dependent variable: Δ Log (loans)		
	(1)	(2)	(3)
DEP_OUTFLOW	-0.0108***		
	(0.004)		
DEP_OUTFLOW×Tightening	-0.0068	-0.0072	-0.0070
	(0.010)	(0.010)	(0.010)
Fixed Loans	0.0251***	0.0294***	0.0294***
	(0.003)	(0.003)	(0.003)
DEP_OUTFLOW×Fixed Loans	0.0207***	0.0230***	0.0231***
	(0.008)	(0.008)	(0.008)
Tightening×Fixed loans	-0.0092***	-0.0105***	-0.0105***
	(0.002)	(0.002)	(0.002)
DEP_OUTFLOW×Tighening×Fixed loans	-0.0152**	-0.0117*	-0.0119*
	(0.007)	(0.007)	(0.007)
L.CET1 ratio	-0.0892***	-0.0119	-0.0134
	(0.019)	(0.049)	(0.049)
L.DEP/TA	0.0336***	0.1133*	0.1148*
	(0.011)	(0.067)	(0.068)
L.TA (log)	0.0013*	-0.0052	-0.0046
	(0.001)	(0.011)	(0.012)
L.LOAN/TA	-0.0188**	-0.0239	-0.0241
	(0.008)	(0.040)	(0.040)
L.ROA	0.0056**	0.0132***	0.0132***
	(0.002)	(0.003)	(0.003)
L.NPLs ratio	0.0013**	0.0017	0.0017
	(0.001)	(0.001)	(0.001)
L.CASH/TA	-0.0026	-0.0041	-0.0046
	(0.016)	(0.037)	(0.037)
Constant	-0.0591***	-0.0669	-0.0754
	(0.018)	(0.149)	(0.150)
Observations	11,529,195	11,529,182	11,529,182
Bank FE	No	Yes	Yes
Borrower*time FE	Yes	Yes	Yes
Country*time FE	No	No	Yes

Table 8: Triple interactions duration gap

This table shows the results of the bank-firm panel regressions as in equation (1). The quarterly data is from 2021Q1-2023Q1. Δ Log (loans) is the change in bank-firm lending in logarithm. DEP_OUTFLOW is a dummy variable that takes the value 1 for banks experiencing constant deposit outflows post tightening, and 0 otherwise. Fixed is a dummy variable taking the value 1 for fixed rate loans, and 0 otherwise. L.CET1 ratio is the lag of the common equity tier1 ratio. L.DEP/TA is the lag of the deposits-to-total asset ratio. L.TA.(log) is the lag of the logarithm of bank total assets. L.LOAN/TA is the lag of the credit exposures-to-total assets ratio. L.ROA is the lag of the return on assets. L.NPLs in the lag of the non-performing loans-to-total loans ratio. L.CASH/TA is the lag of the ratio of cash and cash held at the central bank-to-total assets ratio. Standard errors are clustered at bank and firm level. *, **, *** indicate statistical significance of 1%, 5% and 10% respectively.

	Dependent variable: Δ *Log (loans)*		
	(1)	(2)	(3)
DEP_OUTFLOW	0.0193***		
	(0.003)		
DEP_OUTFLOW×Tightening	-0.0420***	-0.0437***	-0.0438***
	(0.001)	(0.003)	(0.003)
Duration Gap	-0.0041		
	(0.006)		
DEP_OUTFLOW×Duration Gap	0.0403***		
	(0.012)		
Tightening×Duration Gap	0.0106***	0.0110***	0.0111***
	(0.003)	(0.004)	(0.004)
DEP_OUTFLOW×Tighening×Duration Gap	-0.0454***	-0.0359***	-0.0357***
	(0.004)	(0.005)	(0.005)
L.CET1 ratio	-0.1364**	-0.3781	-0.3793
	(0.058)	(0.283)	(0.285)
L.DEP/TA	0.0500**	-0.0511	-0.0521
	(0.022)	(0.209)	(0.210)
L.TA (log)	0.0032	-0.0073	-0.0076
	(0.002)	(0.032)	(0.032)
L.LOAN/TA	-0.0786*	0.0518	0.0522
	(0.040)	(0.117)	(0.118)
L.ROA	0.0147***	0.0144**	0.0145**
	(0.004)	(0.006)	(0.006)
L.NPLs ratio	0.0055***	0.0123***	0.0124***
	(0.002)	(0.004)	(0.004)
L.CASH/TA	0.0988*	0.1463	0.1472
	(0.055)	(0.172)	(0.173)
Constant	-0.0747	0.0652	0.0686
	(0.059)	(0.513)	(0.515)
Observations	3,812,148	3,812,148	3,812,110
Bank FE	No	Yes	Yes
Borrower*time FE	Yes	Yes	Yes
Country*time FE	No	No	Yes

Table 9: Triple interactions distance to MDA

This table shows the results of the bank-firm panel regressions as in equation (1). The quarterly data is from 2021Q1-2023Q1. Δ Log (loans) is the change in bank-firm lending in logarithm. DEP_OUTFLOW is a dummy variable that takes the value 1 for banks experiencing constant deposit outflows post tightening, and 0 otherwise. Low_D2MDA is a dummy variable taking the value 1 for those banks with a distance to the MDA below the first quartile of the distance to MDA distribution. L.CET1 ratio is the lag of the common equity tier1 ratio. L.DEP/TA is the lag of the deposits-to-total asset ratio. L.TA.(log) is the lag of the logarithm of bank total assets. L.LOAN/TA is the lag of the credit exposures-to-total assets ratio. L.ROA is the lag of the return on assets. L.NPLs in the lag of the non-performing loans-to-total loans ratio. L.CASH/TA is the lag of the ratio of cash and cash held at the central bank-to-total assets ratio. Standard errors are clustered at bank and firm level. *, **, *** indicate statistical significance of 1%, 5% and 10% respectively.

	Dependent variable: Δ *Log (loans)*		
	(1)	(2)	(3)
DEP_OUTFLOW	0.0045		
	(0.005)		
DEP_OUTFLOW×Tightening	-0.0222***	-0.0220***	-0.0221***
	(0.008)	(0.008)	(0.008)
Low_D2MDA	-0.0026	0.0011	0.0010
	(0.003)	(0.003)	(0.003)
DEP_OUTFLOW×Low_D2MDA	0.0020	-0.0073	-0.0074
	(0.010)	(0.011)	(0.011)
Low_D2MDA×Tightening	-0.0033	-0.0061	-0.0062
	(0.004)	(0.005)	(0.005)
DEP_OUTFLOW×Tightening×Low_D2MDA	0.0150	0.0246	0.0250
	(0.017)	(0.017)	(0.017)
L.CET1 ratio	-0.0868***	-0.0103	-0.0124
	(0.023)	(0.051)	(0.051)
L.DEP/TA	0.0319***	0.1271**	0.1290**
	(0.010)	(0.063)	(0.063)
L.TA (log)	0.0019***	0.0039	0.0047
	(0.001)	(0.011)	(0.011)
L.LOAN/TA	-0.0145*	-0.0206	-0.0206
	(0.007)	(0.039)	(0.039)
L.ROA	0.0048**	0.0138***	0.0138***
	(0.002)	(0.003)	(0.003)
L.NPLs ratio	0.0008	0.0020*	0.0020*
	(0.001)	(0.001)	(0.001)
L.CASH/TA	-0.0000	-0.0073	-0.0077
	(0.016)	(0.038)	(0.038)
Constant	-0.0478***	-0.1605	-0.1701
	(0.017)	(0.151)	(0.152)
Observations	11,526,410	11,526,397	11,526,397
Bank FE	No	Yes	Yes
Borrower*time FE	Yes	Yes	Yes
Country*time FE	No	No	Yes

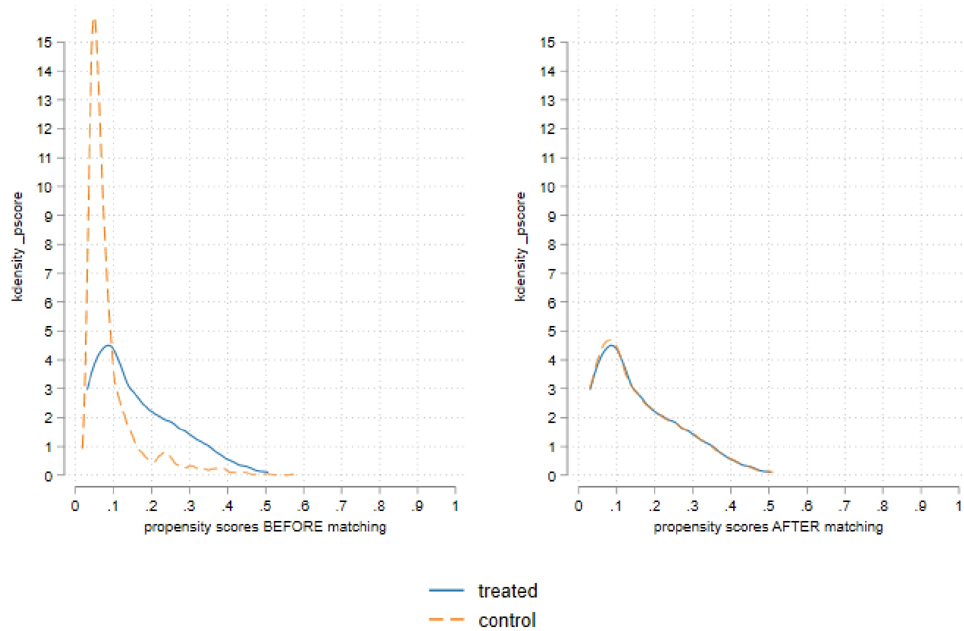
Table 10: Triple interactions risk-adjusted returns

This table shows the results of the bank-firm panel regressions as in Equation 1. The quarterly data is from 2021Q1-2023Q1. Δ Log (loans) is the change in bank-firm lending in logarithm. DEP_OUTFLOW is a dummy variable that takes the value 1 for banks experiencing constant deposit outflows post tightening, and 0 otherwise. Fixed is a dummy variable taking the value 1 for fixed rate loans, and 0 otherwise. L.CET1 ratio is the lag of the common equity tier1 ratio. L.DEP/TA is the lag of the deposits-to-total asset ratio. L.TA.(log) is the lag of the logarithm of bank total assets. L.LOAN/TA is the lag of the credit exposures-to-total assets ratio. L.ROA is the lag of the return on assets. L.NPLs in the lag of the non-performing loans-to-total loans ratio. L.CASH/TA is the lag of the ratio of cash and cash held at the central bank-to-total assets ratio. Standard errors are clustered at bank and firm level. *, **, *** indicate statistical significance of 1%, 5% and 10% respectively.

	Dependent variable: Δ Log (loans)		
	(1)	(2)	(3)
DEP_OUTFLOW	0.0109**		
	(0.005)		
DEP_OUTFLOW*Tightening	-0.0213**	-0.0185*	-0.0185*
	(0.010)	(0.010)	(0.010)
L.risk-adjusted returns	0.0004***	0.0005***	0.0005***
	(0.000)	(0.000)	(0.000)
DEP_OUTFLOW*L.risk-adjusted returns	-0.0004**	-0.0005***	-0.0005***
	(0.000)	(0.000)	(0.000)
Tightening*L.risk-adjusted returns	0.0004**	0.0003	0.0003
	(0.000)	(0.000)	(0.000)
DEP_OUTFLOW*Tightening*L.risk-adjusted returns	-0.0003	-0.0002	-0.0002
	(0.000)	(0.000)	(0.000)
L.CET1 ratio	-0.0641**	-0.0683	-0.0684
	(0.025)	(0.116)	(0.117)
L.DEP/TA	0.0725***	-0.1030	-0.1034
	(0.025)	(0.123)	(0.123)
L.TA (log)	0.0042***	0.0708***	0.0724***
	(0.002)	(0.026)	(0.026)
L.LOAN/TA	-0.0381*	0.1486**	0.1501**
	(0.020)	(0.073)	(0.073)
L.ROA	0.0108***	0.0109***	0.0108***
	(0.003)	(0.003)	(0.003)
L.NPLs ratio	0.0028***	0.0074*	0.0074*
	(0.001)	(0.004)	(0.004)
L.CASH/TA	0.0179	0.1358**	0.1352**
	(0.023)	(0.066)	(0.066)
Constant	-0.1131***	-0.9538**	-0.9738**
	(0.038)	(0.378)	(0.380)
Observations	5,381,057	5,381,054	5,381,054
Bank FE	No	Yes	Yes
Borrower*time FE	Yes	Yes	Yes
Country*time FE	No	No	Yes

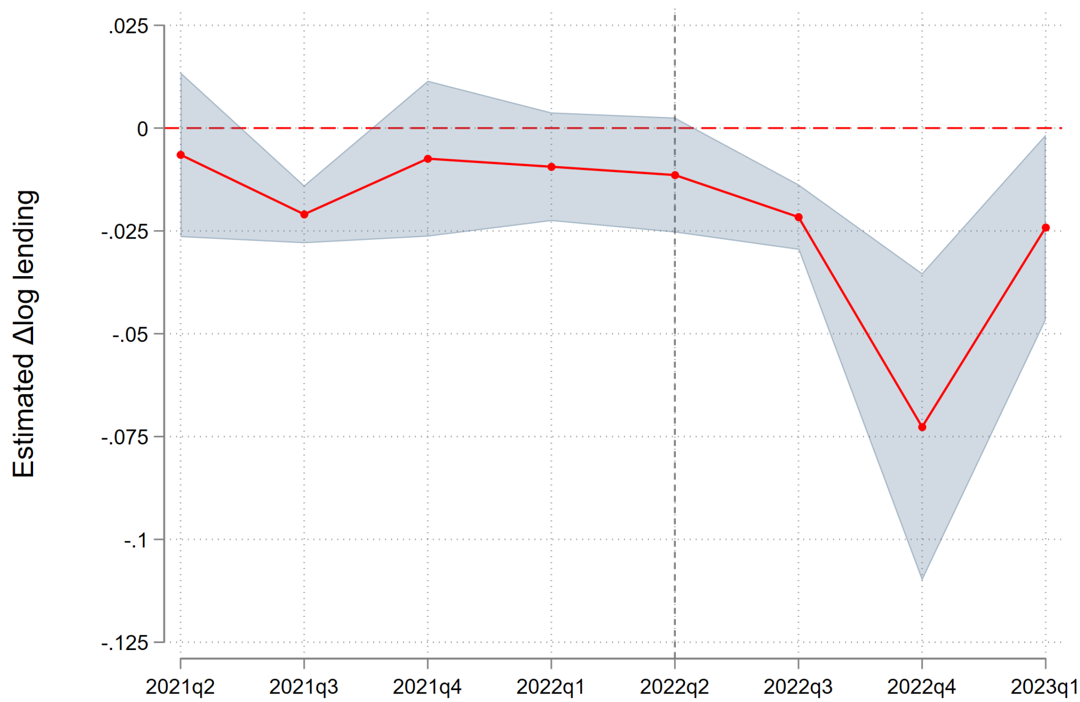
A Additional charts

Figure A.1: P-score before and after matching



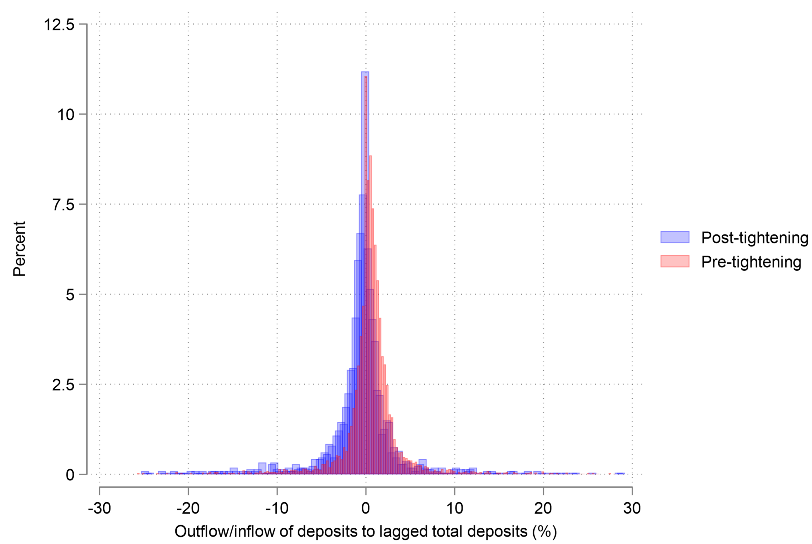
Note: The chart plots the Kernel density function of the propensity scores for the treated (blue solid line) and the control (yellow dashed line) before (left) and after (right) the application of the propensity score matching approach. The propensity score matching is applied via a logit model and one-to-one nearest neighbour with replacement, imposing a tolerance level on the maximum propensity score distance (caliper) between the control and the treatment group equals to 0.03.

Figure A.2: Conditional parallel trend assumption based on PSM



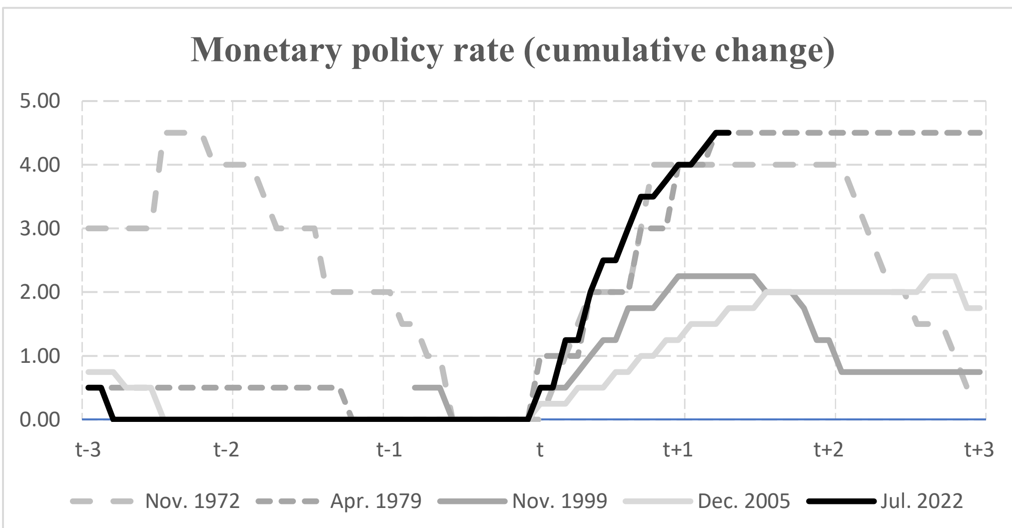
Note: The chart plots .

Figure A.3: Outflows/inflows of deposits distribution pre-post tightening



Note: Distribution of net flows of overnight and term deposits before (from the first quarter of 2020 to the second quarter of 2021) and after (from the third quarter of 2021 to the first quarter of 2023) the tightening in the monetary policy.

Figure A.4: Cumulative increase of monetary policy rates (ECB and Bundesbank; percentage points)



Sources: Sources: ECB and Bundesbank. // **Notes:**: The ECB relevant policy rate is the Lombard rate up to December 1998, the MRO up to May 2014 and the DFR thereafter. t marks the start of each hiking cycle.

Table A1: Baseline results - Intensive margin on a restricted sample

This table shows the results of the bank-firm panel regressions as in equation (1). The quarterly data is from 2021Q1-2023Q1. Δ Log (loans) is the change in bank-firm lending in logarithm. DEP_OUTFLOW is a dummy variable that takes the value 1 for banks experiencing constant deposit outflows post tightening, and 0 otherwise. L.CET1 ratio is the lag of the common equity tier1 ratio. L.DEP/TA is the lag of the deposits-to-total asset ratio. L.TA.(log) is the lag of the logarithm of bank total assets. L.LOAN/TA is the lag of the credit exposures-to-total assets ratio. L.ROA is the lag of the return on assets. L.NPLs in the lag of the non-performing loans-to-total loans ratio. L.CASH/TA is the lag of the ratio of cash and cash held at the central bank-to-total assets ratio. Standard errors are clustered at bank and firm level. *, **, *** indicate statistical significance of 1%, 5% and 10% respectively.

	Dependent variable: Δ Log (loans)		
	(1)	(2)	(3)
DEP_OUTFLOW	0.0030		
	(0.006)		
DEP_OUTFLOW*Tightening	-0.0276***	-0.0205**	-0.0214**
	(0.010)	(0.010)	(0.010)
L.CET1 ratio	-0.0539*	0.2881***	0.2856***
	(0.033)	(0.104)	(0.106)
L.DEP/TA	0.0525***	0.2127	0.2416
	(0.018)	(0.175)	(0.178)
L.TA (log)	0.0046***	0.1291***	0.1425***
	(0.002)	(0.040)	(0.043)
L.LOAN/TA	-0.0347**	0.0160	-0.0158
	(0.015)	(0.107)	(0.107)
L.ROA	-0.0017	0.0132*	0.0134*
	(0.003)	(0.007)	(0.007)
L.NPLs ratio	-0.0003	0.0057	0.0055
	(0.001)	(0.007)	(0.007)
L.CASH/TA	-0.0797**	-0.1510*	-0.1640*
	(0.036)	(0.085)	(0.089)
Constant	-0.0673**	-1.7319***	-1.8851***
	(0.029)	(0.524)	(0.555)
Observations	1,137,038	1,137,035	1,137,031
Bank FE	No	Yes	Yes
Borrower*time FE	Yes	Yes	Yes
Country*time FE	No	No	Yes

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