Central Bank Liquidity Reallocation and Bank Lending: Evidence from the Tiering System

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March 2024

We document that the reallocation of central bank reserves towards banks with higher liquidity needs fosters credit supply. Exploiting the ECB's tiered reserve remuneration system for identification, we show that this system encouraged banks with low reserve holdings to obtain more reserves through the money market. Contextually, these banks reduced their securities holdings and extended more credit. We find no negative effects on the loan supply of banks with ex ante high reserves, which decreased their reserves holdings. Our results are not driven by banks' exposures to other policy measures and highlight that the distribution of liquidity across banks is at least as important as the level of central bank liquidity.

JEL Codes: G2; E5

Keywords: Money market; excess reserves; transmission mechanism; bank lending; negative interest rate policy

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1. Introduction

Central bank reserves represent the ultimate safe asset for banks due to their unwavering domestic value, even amidst crisis situations. No other asset in the economy can rival the safety of central bank reserves. Even highly-rated government bonds are susceptible to market risk, as evidenced by the collapse of Silicon Valley Bank and the ensuing tensions in the US banking system. Since issuing reserves is nearly cost-free for central banks, some would argue that reserves should be created in ample quantities (Logan, 2023; Friedman, 1969).

However, the effects of central bank reserves on bank lending are widely debated and are particularly important to study as central banks engage in quantitative tightening, which will ultimately drastically decrease the outstanding amount of reserves held by financial institutions. On the one hand, the exceptional liquidity insurance from holding reserves could encourage lenders to provide more credit to the economy. On the other hand, reserve holdings could crowd-out bank lending. Which of these effects dominates in practice is a yet-unresolved question.

This paper contributes to this emerging debate by showing that the extent to which reserves are positively associated with bank lending depends on their distribution within the banking system. Specifically, we find that excess reserves stimulate bank lending if they are held by banks with *ex ante* low reserve holdings, which – thanks to the increased liquidity – become better insured against liquidity shocks.[1]

We exploit a quasi-natural experiment related to a policy of the European Central Bank (ECB) that introduced a tiering system for remunerating excess reserve holdings. The policy increased the marginal return on reserves for banks with *ex ante* low reserve holdings. This specific feature of the policy led banks with previously low excess reserve holdings to acquire more

[1] Concerns about the consequences of uneven distribution of excess liquidity across banks in the euro area have been raised also in the policy discourse (see e.g., Lane 2023).

liquidity for reasons that were orthogonal to shocks to their clients' demand for credit. Controlling for the potential effects of concurrent policies and credit demand, we show that these banks expanded the credit supply more than other banks, whose loan supply did not change. Thus, the reallocation of reserves towards banks with higher liquidity needs, driven by the tiering system, ultimately enhanced the transmission mechanism of monetary policy.

Our analysis proceeds in two steps. First, we document that the tiering system created plausibly exogenous incentives for a subset of banks to increase their reserve holdings. Specifically, the tiering system exempted a share of excess liquidity (reserve) holdings from the application of the negative deposit facility rate (DFR) with the aim to support the bank-based monetary policy transmission, while preserving the positive contribution of the negative interest rate policies (NIRPs) to the accommodative policy stance. Crucially, the allocation of the exempt excess liquidity quotas to banks was unrelated to their individual *ex ante* reserve holdings. This allows us to study an exogenous increase in the marginal value of excess reserves for banks with "unused allowances", i.e., for those institutions holding *ex ante* less liquidity than they could exempt from negative rates. These banks had lower *ex ante* reserves holdings by construction but started to acquire more reserves because of the tiering system. The ECB intervention thus spurred the reallocation of excess liquidity away from banks with high reserve holdings, which had presumably reached their (reserve) satiation point, towards banks with high liquidity needs.

We show that the reserve reallocation largely occurred through the money market. In particular, we observe that after the implementation of the tiering system, banks with unused allowances increased their net borrowing in the money market without facing a higher interest rate or maturity rationing, and that high-excess-liquidity banks disproportionately increased their money market loans to banks with unused exemptions, but not to other banks.

In the second step of our analysis, we show that banks that increased their reserves holdings to fill their unused exemptions increased the supply of credit to the real sector. They also granted loans at lower rates and with longer maturity. These results are obtained controlling for credit demand shocks by either using interactions of firm and time fixed effects, following Khwaja and Mian (2008), or interacting industry, location, borrower size, and time fixed effects. In addition, significant differences in the behavior of banks with unused exemptions emerge only after the tiering implementation. The lack of pre-existing trends, together with the granularity of our data, allows us to thoroughly control for credit demand shocks and other concomitant policies implemented by the ECB. For instance, we evaluate alternative mechanisms associated with the tiering adoption and the response of banks with high excess liquidity and high tiering savings, and we control for the effects of other policy measures, such as the negative interest rate policy (NIRP), the exposure to the ECB's asset purchase program (APP), and the targeted longer-term refinancing operations (TLTROs). We find no evidence that these alternative channels affected banks' lending policies. Furthermore, we find no evidence that banks without unused exemptions, including those with *ex ante* high excess liquidity and higher tiering savings, changed their lending policies.

Taken together, our results suggest that a reallocation of liquidity towards banks with higher liquidity needs increases the willingness of banks with previously scarce reserve holdings to extend loans. We provide several additional pieces of evidence consistent with this hypothesis. First, with the help of a simple framework we show that if the uneven distribution of reserves had indeed reduced the credit supply, the banks with unused exemptions that responded more to the tiering implementation should have had *ex ante* higher cost of funding. We show that our results are indeed driven by banks with unused allowances and high funding costs, which, before the implementation of the tiering system, were more likely to be less insured against liquidity shocks

through their reserve holdings. These include banks with higher borrowing rates prior to the implementation of the system, banks with low capitalizations, and banks with high CDS spreads.

Second, we show that financially constrained banks with unused exemptions committed more credit lines in response to the increased liquidity. Since credit lines imply hard-to-predict liquidity needs for the lender (Cooperman et al, 2023), this result suggests that banks' precautionary behavior is reduced thanks to more reserve holdings. Furthermore, we show that banks with unused allowances also reduced their government bond holdings.[2] Since sovereign bonds can be mobilized as collateral in secured money market transactions and are more liquid than bank loans, but are not as liquid as reserves, net bond sales indicate that banks hoard less collateral and are therefore also consistent with better insurance of banks' liquidity needs associated with high reserve holdings.

Finally, we explore whether the increased propensity to take risk of banks that obtained more reserves led them not only to expand the supply of credit but also to misallocate credit by lending to riskier borrowers. We find no evidence that this is the case.

We contribute to a growing literature exploring the transmission mechanism of central banks' large-scale asset purchases. Existing literature has mainly focused on the reaction of asset prices (Krishnamurthy and Vissing-Jorgensen 2011), the transmission mechanism through long-term interest rates and mortgage origination (e.g., Chakraborty, Goldstein, and MacKinlay, 2020; Di Maggio, Kermani, and Palmer, 2020), or the effects of the capital gains generated by banks' security holdings (e.g., Acharya et al., 2019). An emerging strand of this literature explores whether the reserves created by central banks' large-scale asset purchases crowd in or crowd out

[2] In work that was distributed subsequently to our paper and using less granular data that do not allow to identify the demand and supply for reserves, Baldo et al. (2022) study how banks adjusted their balance sheets to achieve higher liquidity holdings and provide evidence consistent with our findings.

bank lending, and its findings are mixed. Diamond, Jiang and Ma (forthcoming) show that an increase in excess reserve holdings crowds out bank lending considering also periods in which reserves were scarce and policy rates high. During periods of quantitative easing, Acharya et al. (2023) find that banks with higher excess reserve holdings grant more credit lines and take excess risk (Acharya and Rajan, 2022). Relatedly, Rodnyansky and Darmouni (2017) and Kandrac and Schlusche (2021) show that banks that increased their reserve holdings, following the third round of quantitative easing by the Federal Reserve Board, increased lending. Existing literature largely focuses on changes in the outstanding amount of reserves, which may affect lending through their effects on the valuations of banks' security holdings. Thanks to the tiering system, we can consider an exogenous change in the distribution of reserves, which allows us to evaluate whether reserves matter independently from the effects on banks' security holdings and their yields. More importantly, we show that the distribution of reserves is as important as the aggregate amount of outstanding reserves for bank lending, even when reserves are abundant and policy rates are low.

2. Data Sources

We rely on a wide array of data sources. Our main source to explore bank lending in the euro area is Anacredit, a new credit register maintained by the European System of Central Banks, which includes harmonized transaction-level data for euro area banks. All banks report any loan provided to firms if the exposure to the borrower exceeds EUR 25,000.

From Anacredit, we obtain information on banks and their borrowers. The sample consists of a panel of 122 banks and 2,624,856 firms, for a total of 3,439,580 bank-firm relations, from September 2018 to February 2020 (18 months). Firms are distributed across 19 countries (Austria, Belgium, Cyprus, Germany, Estonia, Spain, Finland, France, Greece, Ireland, Italy, Lithuania,

Latvia, Luxembourg, Malta, the Netherlands, Portugal, Slovenia and Slovakia), 89 2-digit NACE industries, and 1,055 NUTS2 locations. We further partition borrowers into size deciles based on their outstanding bank liabilities during the previous month. This provides us with 3,087,276 industry-location-size-month clusters. The large number of clusters available, together with the fact that many borrowers have multiple bank relationships, helps us in the identification of the credit supply.

We complement Anacredit with bank level information from the Individual Balance Sheet Indicators (IBSI), another proprietary database maintained by the ECB, which reports the main asset and liability items of over 300 banks resident in the euro area at monthly frequency. This dataset provides information on the amount of outstanding loans, household and corporate deposits, and other relevant bank balance sheet information. Information on each bank's borrowing in targeted longer-term refinancing operations (TLTROs) is collected from the ECB's proprietary liquidity data. We also obtain banks' stock prices and CDS spreads from Thomson Reuters.

In addition, we explore bank behavior in the money market using the Money Market Statistical Reporting (MMSR) data. These data are collected to provide information on the transmission of monetary policy to the money market. Around 50 large banks from across the euro area are required to submit a detailed list of all money market transactions daily. The dataset has been collected since July 2016 and covers all secured and unsecured transactions by the reporting banks with banks and non-banks with maturity of up to twelve months. It comprises around 30 million transactions in the secured (repo) market and around 12 million transactions in the unsecured market during our sample period. In our empirical analysis, we aggregate the individual outstanding transactions at the borrowing-bank level or at the borrowing-bank and counterparty (relationship) level to create a daily panel of the stock of outstanding money market transactions.

Table 1 provides variable definitions and summary statistics.

3. Implementation of the Tiering

Tiering systems make the remuneration of bank reserves negatively related to the level of a bank's reserve holdings and are most often introduced when policy rates are negative.[3] A tiering system for reserve remuneration exempts some proportion of banks' excess liquidity from negative rates and can introduce substantial savings for the banking system.

The possible adoption of a tiering system in the euro area was first hinted at on March 27, 2019, in a speech by then-ECB president Mario Draghi at the "The ECB and its watchers" conference. After almost five years of negative interest rates, analysts had increasingly voiced concerns about the possible adverse side effects on bank profitability. The speech by Draghi represented the first mention of specific measures to contain the potential side effects of the NIRP by an ECB policymaker: "*if necessary, we need to reflect on possible measures that can preserve the favourable implications of negative rates for the economy, while mitigating the side effects, if any.*"

A news report published a few hours after the speech further buoyed market expectations by claiming that the ECB was preparing the introduction of a tiering system.[4] This information triggered a sharp market reaction: As shown in Figure 1 using high-frequency data, euro area bank

[3]Switzerland has maintained a tiring system also after abandoning the NIRP. Concurrent work by Fuster, Schelling and Towbin (2021) shows that in Switzerland after the introduction of the tiering, banks that benefitted most from the increase in the exemption threshold charged higher loan spreads, took less risk, and obtained liquidity by increasing the interest rate on deposits, effectively lowering the pass-through of policy easing. Our paper focuses on the larger and heterogenous money market of the euro area and shows that when the distribution of reserves is *ex ante* skewed towards banks that are likely to have reached their satiation point, tiering systems, by increasing the benefits of trading, can stimulate bank lending.

[4] Reuters, "ECB studying tiered deposit rate to alleviate banks' plight", March 27, 2019, released at 13h25.

stocks jumped by almost 3% upon the news release, considerably outperforming a broader market index.

The ECB's Governing Council formally decided about the introduction of a tiering system and the actual size of the exemptions on September 12, 2019, together with an interest rate cut from -0.40% to -0.50%. The tiering system exempted excess liquidity holdings of up to six times banks' minimum reserve requirements (MRR) from the application of the negative DFR. This recognized that banks' needs for liquidity are proportional to their deposits (which in turn determine minimum reserve requirements). Thus, banks with unused exemptions were banks with low excess reserves *ex ante*.

Importantly, to avoid an unintended tightening in bank funding conditions, the tiering system was calibrated such that the "non-exempted tier" – the amount of excess liquidity that remained subject to negative interest rates – was sufficiently large to avoid upward pressure on money market rates, thus ensuring that the monetary policy stance was not tightened.

The ECB's tiering system started to be operational on October 30, 2019, in accordance with the September announcement, and remained in place until the ECB lifted interest rates into positive territory in September 2022.

In what follows, we dissect how upon the introduction of the tiering a change in the marginal rate on excess reserves holdings affects banks' asset composition. We discuss in Section 6 how we control for the fact that the tiering announcements were accompanied by other policy measures, notably a further interest rate cut, and were perceived by market participants to signal an intention to maintain current (or lower) interest rate levels for a longer period.

4. Hypotheses on the Effects of the Tiering on Bank Asset Composition

We describe a simple framework explaining how an asymmetric distribution of reserves can constrain the loan supply of banks with the lowest excess reserve holdings, without favoring credit extension by banks with high reserve holdings. To conceptualize this, we model the profit maximization of a bank that can hold reserves, securities, and loans and has a cost of capital that is determined outside the model.

Whether the distribution of reserves becomes more even because of changes in the demand or supply is immaterial for the effect on bank lending we aim to capture in our empirical analysis. However, since we focus on a period with vast amounts of excess liquidity, in which the ECB was ready to meet any demand for liquidity through its refinancing operations, the supply of liquidity can be thought as perfectly elastic. Therefore, we cast our conceptual framework focusing on the demand for reserves.

We think of reserves as providing unique liquidity services to the bank, similarly to Lopez-Salido and Vissing-Jorgensen (2023). Since our objective is studying the effect of reserve holdings on banks' asset composition, we assume that there is a complementarity between loans and reserves. The complementarity arises from the fact that loans are relatively illiquid, and additional illiquidity arising from more lending is mitigated by extra liquidity on the rest of the asset side when a bank holds more excess reserves (Rodnyansky and Darmouni 2017). This captures the idea that reserves may render bank runs less likely or at least reduce their costs. Consistent with Afonso et al. (2023), we also assume that there is a satiation point beyond which the marginal benefit of holding reserves is zero (or constant at a very low level).

Thus, excess reserves, besides yielding an interest rate *r(reserves)*, increase a bank's expected profits according to the following function, which can be thought as capturing the benefits of insuring expected liquidity shocks: $v(reserves, loans) > 0$, where $v_R > 0, v_{RR} \leq$

$0, v_L < 0, v_{LL} < 0,$ and $v_{RL} > 0$. Specifically, while more loans decrease a bank's expected profits because they expose it to higher expected costs from funding shocks, $v_{RL} > 0$ captures that reserves allow the bank to extend credit with lower expected costs arising from funding shocks. Because of the satiation point, $v_{RR} = v_{RL} = 0$ if $R > \bar{R}$.

For similar reasons to those discussed above, securities, which are far more liquid than loans, are second-best substitutes for reserves. Differently from reserves that can be used directly to fulfill cash demand needs, even safe securities – such as Treasuries or other highly-rated government bonds – need to be sold or pledged to be converted into cash. The tensions in the US banking system in 2023 are a stark reminder that even the highest-quality assets cannot rival central bank reserves in liquidity value. To capture this, we assume that: $u(reserves, securities) > 0$, where $0 < u_R < v_R, u_{RR} \leq 0,\ u_S > 0, u_{SS} \leq 0,$ and $u_{RS} < 0$ as long as if $R < \bar{R}$; $u_{RR} = u_{RS} = 0$ if $R > \bar{R}$. While more illiquid than reserves, securities have higher yields and for this reason they may be preferred by some banks with high cost of capital.

A bank's profits can be written as:

$$\pi = r(reserves)\ Reserves + r(securities)\ Securities + r(loans)\ Loans + v(reserves, loans) + u(reserves, securities) - cost\ of\ capital * Liabilities$$

where *Liabilities = Reserves + Securities + Loans.*

The first order conditions are:

$$r(reserves) + v_R + u_R - cost\ of\ capital = 0,$$

$$r(loans) + v_L - cost\ of\ capital = 0,$$

$$r(securities) + u_S - cost\ of\ capital = 0.$$

Consider a bank with relatively high cost of capital. From the first order condition for reserves, assuming that returns on loans and cost of capital are exogenously given, it follows that such a bank finds it optimal to have relatively lower reserves (higher v_R). Also, for given return on bank loans and loans outstanding, such a bank will have a higher v_L and therefore fewer loans to satisfy the second first order condition.

The introduction of the tiering system for a bank with low reserve holdings and unused exemptions is equivalent to an increase in the marginal interest rate on reserves, $r(reserves)$. Given the properties of v and u, and for given cost of capital, such a bank will increase its reserve holdings to satisfy its first order condition (lower v_R). An increase in reserves implies an increase in the marginal benefit of issuing loans and a decrease in the marginal benefit of holding securities ($v_L \uparrow \; u_S \downarrow$). Thus, given our assumptions on v and u, the first order conditions imply that a bank with *ex ante* low reserve holdings and unused exemptions will rebalance its portfolio from securities towards loans.

While securities can be held by unregulated financial intermediaries, reserves must be obtained from other banks that have high reserve holdings and have presumably reached their satiation point, which consistently with the design of the policy, we assume to be well above the exemptions granted by the tiering. Banks that have reached their satiation point are indifferent on the amount of reserves (and securities) to hold (v_R and u_S do not depend on the level of reserves). They will thus be willing to transfer reserves to banks with *ex ante* low reserve holdings and unused exemptions.

Note that the simple framework also implies that banks that have high reserve holdings and have reached their satiation point are expected to have low (marginal) cost of capital, which makes it optimal for them to hold excess reserves even if they have low returns and marginal benefits.

In what follows, we test whether the rebalancing of banks' portfolios occurs in a way that is consistent with our conceptual framework and whether banks whose reserve holdings increase indeed expand the supply of credit.

5. The Redistribution of Reserves Following the Tiering System

5.1 Changes in Reserve Holdings

Changes in a bank's liquidity holdings are typically endogenous and reflect bank-specific shocks, complicating any empirical assessment of the role of reserve holdings on banks' behavior. This section shows that the tiering system, however, introduced exogenous variation in the reallocation of reserves across banks.

To maximize the value of the exemptions introduced with the tiering system, all banks needed to hold at least as much liquidity as is exempt from paying negative rates. The marginal value of liquidity thus increased only for banks with unused exemptions, which became inclined to hold more reserves even if they faced higher cost of capital. Not only the marginal returns on reserves did not change for banks with *ex ante* high liquidity holdings, but the incentives to hold more reserves created by the tiering system for banks with unused exemptions were arguably orthogonal to shocks to the demand for credit.

Figure 2 provides evidence that unused allowances are indeed associated with an increase in banks' reserve holdings. It describes how the distribution of excess liquidity relative to exemptions changed immediately after the tiering adoption. Unused exemption allowances declined swiftly to low levels as banks attracted sufficient reserves from banks over-fulfilling the

allowance.[5] Since the exemptions are a multiple of the required reserve holdings, they reflect the liquidity needs of banks with different sizes and capital structure. The figure thus shows that after the tiering adoption the reserve distribution became more even, because reserves were reallocated towards banks with higher liquidity needs. Importantly, changes in the distribution of liquidity before November 2019 were minimal, indicating that banks' unused exemptions in October 2019 largely reflect their excess liquidity holdings before the tiering system was announced.

The descriptive evidence also holds up when we control for banks' CDS spread, bank fixed effects and country specific shocks in Table 2. We consider banks holding on average less excess liquidity than their tiering allowance in October 2019, when the tiering was introduced, as more exposed to the tiering system because they have a higher marginal return on reserve holdings than other banks and therefore stronger incentives to acquire liquidity. We also compute a notional exposure in March 2019, when the tiering was first discussed to evaluate to what extent banks started to adapt earlier. Specifically, since the amount of excess reserves that were exempt from negative rates under the tiering system were evaluated based on the average reserve holdings between the monetary policy meetings of the ECB's Governing Council, the so-called maintenance periods, we compute excess liquidity holdings during the maintenance periods preceding President Draghi's speech in March 2019 (from 30 January to 12 March) as well as the one before the actual implementation of the tiering system as of the end of October 2019 (from 18 September to 29 October).

Table 2 shows that banks with lower liquidity holdings and consequently higher unused exemptions in expectation increase their holdings of excess liquidity during the period between

[5] Banks "compliance" with the tiering system was near-universal. At the end of the first maintenance period after the implementation of the tiering banks' unused allowance were only 0.9%, an amount that declined to 0.8% at the end of the following maintenance period.

March and October 2019. A one-standard-deviation (1.5 percentage points, pp) increase in (prospective) unused exemptions is associated with an increase in excess liquidity holdings by close to 12bps of total assets. The increase in holdings of excess liquidity is three times larger after the tiering system was finally implemented in November 2019.

This evidence suggests that unused exemptions granting a higher marginal return on liquidity exogenously increased the demand for reserves of banks with *ex ante* low reserve holdings. In what follows, we shed more light on *how* the banks with unused allowances attracted the additional reserve holdings using money market data. We also show that banks decreased their security holdings, as is consistent with our conceptual framework.

5.2 *Reserve Holdings and the Money Market*

This section shows that after the introduction of the tiering, banks with low reserve holdings filled their unused exemptions (also) borrowing through the money market. We consider both the secured and the unsecured money market segments.[6]

Before the introduction of the tiering, excess liquidity was largely held by banks in Germany, France, and the Netherlands. There was sporadic trading with the banks with lower liquidity holdings, mostly located in countries that were more affected by the sovereign debt crisis (Baldo et al., 2017; Eisenschmidt, Kedan, and Tietz, 2018). Facing relatively higher interest rates, low-excess-liquidity banks had limited ability to ensure liquidity risks through the money market. We ask whether synergies on banks' balance sheets are such that this constrained lending.

[6] Since the global financial crisis, trading in the euro area had shifted from the unsecured to the secured money market segment reflecting the greater regulatory costs of unsecured transactions as well as a stronger sensitivity to counterparty risk.

5.2.1. Descriptive Evidence

Figure 3 shows how net borrowing in the money market changed following the tiering-related announcements distinguishing between the secured (Panel A) and unsecured (Panel B) market segments. The announcement of a new series of TLTROs as well as expectations for a restart of net asset purchases over the course of 2019 had reduced banks' need to trade in the money market for funding purposes (ECB 2021) and had led to a decline in trading activity in the secured market over the summer of 2019. Activity in both the secured and unsecured money market segments increased markedly in the period leading up to and following the actual implementation of the tiering system at the end of October 2019, especially for banks that needed to acquire additional reserves to fill their tiering allowances. While net borrowing by banks with unused allowances in the unsecured market increased gradually following the announcement of the tiering system in September, there was a much sharper increase in the secured market around October 30, when the exemptions became effective.[7]

Relating the increase in banks' money market borrowing to the change in their reserve holdings shows that the redistribution of liquidity was primarily intermediated through the secured and unsecured markets. Figure 4 illustrates the change in banks' reserve holdings relative to the day of the announcement of the tiering system, distinguishing between banks with and without unused allowances. Banks with unused allowances increased their reserve holdings by 55% in November 2019 (the first month of the introduction of the tiering system) compared to August (the

[7] Banks with unused allowances, on average, more than quadrupled their net borrowing in the secured segment from EUR 1 billion (bn) to EUR 4.5bn between October and November 2019. In aggregate terms, this amounted to additional net borrowing of EUR 44.8bn by this group of banks. In contrast, banks without unused exemptions increased their net lending in the secured money market from EUR 2.4bn to EUR 4.2bn on average, or by EUR 56.9bn in aggregate terms. In the unsecured market, banks with unused allowances increased their net exposure from EUR 9.2bn to EUR 9.6bn on average from October to November, or by around EUR 5.6bn in the aggregate; banks without unused exemptions reduced their net borrowing marginally from EUR 9.5bn to EUR 9.2bn, or around EUR 11bn in the aggregate.

month before its announcement). 71% of that increase was matched by higher net money market borrowing, especially in the secured segment. In contrast, banks without unused allowances shed around 14% of their reserve holdings, 62% of which can be linked to additional net lending in the money market. Neither group of banks significantly raised or lowered their borrowing from the ECB over the same period, suggesting that the money market was the primary conduit for the reallocation of liquidity following the introduction of the tiering system.

The redistribution of reserves and the increase in money market borrowing by banks with unused exemptions did not go along with a notable increase in money market interest rates. At the aggregate level, this reflected the ECB's intention to keep a sufficient amount of excess liquidity subject to the DFR to ensure that key money market rates would continue to be firmly anchored. But also at the individual bank level, interest rates on the flow of money market transactions hardly budged in response to the expansion in trading volumes, neither for banks with nor for banks without unused tiering allowances (Figure 5). It appears that banks with unused exemptions, which were facing higher interest rates in the money market, optimally held low levels of reserves before the tiering introduction. These banks became more inclined to borrow from banks with high excess liquidity, thanks to the higher returns on the excess reserves guaranteed by the exemptions. Thus, the tiering, by increasing the marginal returns on reserves for banks with unused exemptions, favored the reallocation of liquidity from banks that had presumably reached their satiation point to banks with higher liquidity needs.

5.2.2. Multivariate Analysis

To provide systematic evidence on how banks adjusted their liquidity positions in the money market, we analyse a daily panel, based on the transaction-level MMSR dataset.

Specifically, we estimate the following specification:

$$\begin{aligned}\text{Money Market Activity}_{ictm} &= \beta_1\left(\text{Interim}_t \times \text{Exposure}_i^{Feb\ 2019}\right) \\ &+ \beta_2\left(\text{Implementation}_t \times \text{Exposure}_i^{Oct\ 2019}\right) + \beta_3 CDS_{it} + \alpha_i \\ &+ \alpha_m + \alpha_{cm} + u_{ictm}\end{aligned} \tag{3}$$

where $\text{Money Market Activity}_{ictm}$ represents one of six alternative indicators of bank i's from country c trading in the money market on day t in maintenance period m: gross borrowing, gross lending, or net borrowing, in either the secured or unsecured segment. Each of the variables is scaled by banks' minimum reserve requirements to express the coefficients in terms of the units of the tiering allowance. Interim_t is a binary indicator for the period after the March speech but before the actual implementation of the tiering system. The treatment variable $\text{Exposure}_i^{Feb\ 2019}$ is defined as bank i's unused allowance, relative to total assets, $max\left(\frac{\text{Allowance}_i - \text{Excess liquidity}_i}{\text{Total assets}_i}, 0\right)$, during the first maintenance period of 2019, before President Draghi's speech in March. Implementation_t captures the period during which the tiering system has been in place, and $\text{Exposure}_i^{Oct\ 2019}$ is bank i's unused allowance in the last maintenance period before the implementation of the tiering system.

We include banks' CDS_{it} spreads to control for credit risk and allow for bank (α_i) as well as country-maintenance period (α_m, α_{cm}) fixed effects. Given the frequency at which the tiering benefits accrue, we expect correlation in the average money market activity of banks during a maintenance period and for this reason we cluster standard errors at the bank and maintenance period level.

In line with the descriptive evidence, Table 3, Panel A shows that banks with unused tiering allowances started to borrow more once the system was implemented. Specifically, in column (3),

a one-percentage point larger unused allowance (expressed as a share of total assets) is associated with an increase in net secured borrowing amounting to 1.7 times the banks' reserve requirement after the actual implementation of the system. We do not observe significant changes in gross borrowing, and the adjustment in gross lending is significant only at the 10 percent level, indicating that different banks achieved the desired increase in excess liquidity adjusting on different margins. Consequently, the tiering system was not associated with significant changes in banks' capital structure.

Importantly, we observe no changes in net borrowing in the secured market for banks with more unused allowances during the interim period. Columns (4)-(6) show that similar developments took place in the unsecured market, albeit at somewhat smaller magnitude, in line with the descriptive evidence in Figure 3.

The effects we document are economically meaningful. As outlined in Section 2, each eligible bank received a tiering allowance exempting excess liquidity holdings up to six times their MRR from the application of the negative DFR. The average treatment effect of between 0.7-1.7 times banks' MRR thus implies that banks with a one percentage point higher unused exemptions increased their net borrowing in the money market by around one sixth of their total allowance *more* than banks without unused allowances. The average treatment effect is also substantial relative to the stock of outstanding money market transactions during the sample period, which amounts to around 2.2 times MRR in the secured segment and around 7.3 times MRR in the unsecured segment (see Table 1, panel C).

Panel B suggests that the additional borrowing by banks with unused exemptions was met by an elastic supply of liquidity because it carried neither systematically higher interest rates (columns 1 and 2), nor did it lead to meaningful maturity rationing (columns 3 and 4). These

findings hold both in the secured and in the unsecured segment of the money market.

Overall, these results suggest that following the tiering implementation, the willingness and ability to borrow reserves increased for banks with unused exemptions, due to their ability to store liquidity at a non-negative rate. To sharpen the identification of the demand for reserves, we construct a relationship-level daily dataset of money market transactions and focus on the unsecured market, because the prevalence of transactions with the central counterparty in the secured market limits our ability to observe bilateral flows. In this context, we can use high-dimensional fixed effects to control for shocks that may have affected the supply of credit of banks' counterparties (Khwaja and Mian, 2008).

Panel C controls for the supply of short-term funding by including interactions of lender (counterparty) and maintenance period fixed effects. The results show that unsecured borrowing from the same counterparty rose significantly more for banks with more unused exemptions than for banks without unused exemptions. This finding is robust if we control for characteristics of the relationships by including the interaction between borrowing bank and lending counterparty fixed effects or shocks to the country of the borrowers that may drive the demand for liquidity. In line with the results in Panel B, the additional borrowing volumes did not require a significantly higher borrowing rate, as shown in column (4), supporting the conclusion that the supply of liquidity was elastic for banks with unused exemptions.

We also explore which counterparties provided more liquidity to banks with unused exemptions for the subset of transactions in the bank-to-bank market. To do so, we include in the specification in column 3 of Panel C, a triple interaction term between Implementation_t, a bank's to the tiering system, $\text{Exposure}_i^{Oct\ 2019}$, and the counterparty's excess liquidity holdings above its allowance relative to its total assets during the maintenance period before the implementation of

the tiering.[8] Figure 6 shows how the net borrowing of a bank with positive average unused exemptions varied with the counterparty's excess liquidity. The increasing slope of the coefficient implies that banks with unused allowances borrowed more from other banks with higher excess liquidity. This finding supports the interpretation that liquidity flowed from high excess liquidity banks to banks with high unused exemptions and led to a more even distribution of reserves.

5.3. Bond Holdings

Our conceptual framework implies that banks that can more efficiently insure against liquidity shocks with higher reserve holdings have incentives to rebalance away from securities, such as government bonds. Doing so, they can also generate liquidity complementing their money market borrowing. We therefore apply the empirical framework outlined above to banks' government securities holdings to understand the relevance of this empirical prediction of our conceptual framework.

Table 4 shows that consistent with our simple framework, banks with unused allowances decreased their holdings of government securities relative to their assets after the implementation of the tiering system. A one-standard-deviation increase in a bank's *ex ante* unused allowances is associated with a decrease in the holdings of government securities by close to 4bps of total assets (corresponding to just under 10% of the standard deviation of this variable).

6. The Effects of the Tiering System on Loan Supply

6.1 Methodology and Main Results

Ultimately, our objective is to explore whether the increase in excess holdings by banks

[8] By definition, this restricts the sample to the interbank market, i.e., to transactions in which both the borrowing and lending counterparty can hold central bank reserves.

with *ex ante* low reserves fosters bank lending. Because actual changes in liquidity are typically endogenous and could be related to loan demand, we exploit banks' exposure to the tiering system through unused exemptions to test whether a plausibly exogenous reallocation of reserves towards banks with higher liquidity needs increases credit supply. Specifically, we estimate the following equation:

$$Loan_{f,i,t} = \beta_1\left(\text{Interim}_t \times \text{Exposure}_i^{Feb\ 2019}\right) + \beta_2\left(\text{Implementation}_t \times \text{Exposure}_i^{Oct\ 2019}\right) \quad (4)$$
$$+ \beta_3 X_{i,t} + \gamma_{f,t} + \delta_{i,f} + \varepsilon_{f,i,t},$$

where the dependent variable is the outstanding credit of bank *i* to firm *f* during month *t*. In determining the credit exposure of bank *i* to firm *f*, we aggregate all credit facilities that firm *f* has obtained from bank *i*, including drawn credit lines.[9] The indicator variables $Interim_t$ and $Implementation_t$ capture the different phases of the process that led to the introduction of the tiering. The exposure variables are defined as the unused exemptions in the maintenance periods just before the first mentioning of tiering in then-President Draghi's speech and before the tiering implementation, respectively, and are expressed in percentage of a bank's assets. Focusing on unused exemptions, the exposure variables capture exogenous increases in excess liquidity because the unused exemptions were nearly entirely filled after the implementation of the tiering system.

The matrix $X_{i,t}$ consists of bank level controls including the bank's CDS spread, (contemporaneous) excess liquidity, holdings of government bonds, deposit ratio, and use of TLTRO funds. In the most stringent specifications, we include interactions of bank and firm fixed effects, capturing time-invariant aspects of the relationships.

[9] If anything, our results are stronger if we exclude drawn credit lines, which we include to be in line with standard statistics on the volume of credit. Borrowers started to abnormally draw down credit lines only after the end of our sample period, when the Covid pandemic erupted.

The granularity of Anacredit allows us to control for loan demand and identify the supply of credit by including either interactions of firm and time fixed effects (Khwaja and Mian, 2008) or interactions of industry, location, size decile, and time fixed effects (Acharya et al., 2019; Degryse et al., 2019). In practice, we test the extent to which banks with different exposures to the tiering supply credit to the same borrower or to borrowers that are expected to experience similar demand shocks because they are in the same cluster defined by their city, industry, and size group.

The estimates in Table 5 show that banks with unused exemptions extended more credit than other banks after the implementation of the tiering system. The estimated effects are qualitatively similar when we absorb shocks to the demand for credit using interactions of country and time effects in column (1), interactions of industry, location, size decile, and time fixed effects in column (2), and increase in magnitude when we include interactions of firm and time fixed effects in column (3). A one-percentage-point increase in exemption allowances (which is close to a one standard deviation of this variable) corresponds to an increase in credit to a given firm by 4-7%, depending on the fixed-effects included.

The cumulative impact of the increase in excess liquidity for banks with unused allowances on aggregate credit growth is sizeable. The increase in excess liquidity for banks with unused allowances after the implementation of the tiering, according to the conservative estimate in column (2) of Table 5, would have translated into an increase in loan volumes to firms of 4.7% (the reported coefficient multiplied by the average exposure of 1.18% within the subsample of banks with unused allowances), which implies an increase of around EUR 31 bn if applied to the volume of loans for banks with unused allowances in our regression sample (EUR 662 bn). For a comparison, the cumulated cost of the tiering over its period of activity until July 2022 was about EUR 12 bn.

Importantly, we find that differences in lending before the implementation period are limited as the interaction between the *Interim* dummy and the *Exposure* proxy is not statistically significant across different specifications. This indicates that the actual reallocation of liquidity is an important driver of the cross-sectional differences in bank lending and that our estimates are unlikely to capture pre-existing trends.

Figure 7 provides further evidence to address concerns that pre-existing differences in lending of banks with unused exemptions may be driving our findings. We plot how the coefficient on $\text{Exposure}_i^{Oct\ 2019}$ varies over our sample period. The coefficient is positive and statistically significant only in the months following the implementation of the tiering system, confirming the importance of the actual reallocation of liquidity.

In our interpretation, unused exemptions capture the exogenous increase in a bank's excess liquidity arising from the introduction of the tiering. In Table 6, we explore whether controlling for other relevant functions of a bank's excess reserves alters our findings. In column (1), we run a "horse race" among the exposure variables capturing the magnitude of a bank's unused exemptions and the bank's tiering savings, computed as $[\min\{0, DFR \times (ExcessLiquidity - MRR \times 6)\} - DFR \times ExcessLiquidity]/Assets$ upon the introduction of the tiering system and before the redistribution of reserves. Banks with higher tiering savings are banks with higher excess liquidity that on average transferred reserves to banks with unused exemptions. Tiering savings do not appear to affect bank lending policies, suggesting that the lending policies of banks with high excess reserves are unaffected by a drop in reserves. In addition, this result indicates that the tiering system did not affect the transmission of monetary policy through its effects on bank profits, which is unsurprising because the magnitude of this effect was probably too small. Similarly, in column 2, we find no differences in lending between banks with different *ex ante*

levels of excess liquidity holdings. Also in this case, we do not find that banks with high excess liquidity lent less after the introduction of the tiering, supporting our conjecture that higher reserve holdings stimulate bank lending only for banks with unused exemptions, which having low liquidity had not reached their satiation point.

In Table 7, we consider that the tiering system was announced in September 2019 at the same time as several other policy changes. Specifically, the interest rate on the policy facility rate was decreased by 10 basis points to -0.50% and the widely expected continuation of the APP and an easing of the TLTRO conditions were announced. The concern arises that banks with unused exemptions may have been exposed to these changes. We control for the exposures to these policies by including in our specifications a bank's excess liquidity and deposit ratio, which account for the exposure to the interest rate cut below the zero lower bound (Bottero et al. 2022; Heider et al., 2019); the holdings of government bonds, which account for a bank's direct exposure to the APP (Acharya et al., 2019), and the use of TLTRO funds. In addition, we show that our results are robust to the inclusion of interactions of bank and time fixed effects. Furthermore, in Table 7, our results are qualitatively and quantitatively invariant if we interact all bank level controls with the post implementation dummy.

Taken together, these results suggest that banks with unused exemptions were more willing to extend credit after increasing their reserve holdings, while the lending behavior of banks with ex ante higher excess liquidity holdings was unaffected. Such an interpretation is also consistent with the finding that the supply of credit by banks with high unused allowances increased only after November 2019, when the money markets started to reallocate liquidity.

6.2 Additional evidence on the mechanism

Table 8 provides more direct evidence on our conjecture that the redistribution of reserves was the driving force behind the increase in credit supply. Our conceptual framework implies that if the positive effect of high unused tiering allowances on the supply of credit reflected banks' incentives to increase their reserve holdings in the post-implementation period, the increase in credit supply should be driven by banks with higher financing costs. We identify these banks as those that faced higher borrowing interest rates in the secured money market before the tiering implementation. In columns (1) and (2), we split the sample considering banks with borrowing rates above and below the median. The estimates show that banks with unused exemptions lent more only if they faced an interest rate above the median when borrowing in the money market. This finding supports our conjecture that the tiering system facilitates monetary transmission through banks that *ex ante* found it too costly to have higher reserve holdings. Column (3) confirms that the differences in lending behavior between banks are statistically significant. We also find some evidence that all banks with unused exemptions, regardless of the interest rate they faced, may have expanded the credit supply already when the tiering was first hinted in March 2019, albeit to a lower extent. This effect is not consistent across specifications (as seen in Table 9) but could suggest that reallocation of liquidity had slowly started when the introduction of the tiering became more likely.

Table 9 provides additional evidence on the cross-sectional differences in bank lending after the introduction of the tiering. In columns (1) and (2), we consider two alternative proxies for banks' *ex ante* funding costs, specifically bank capitalization and CDS spreads. Consistent with our earlier findings, the positive effects of the tiering system on bank lending appear to be driven by banks that had unused exemptions and low capitalizations or high CDS spreads. These findings

further support our hypothesis that the tiering by increasing the return of holding bank reserves increased low-excess-liquidity banks' ability to withstand liquidity shocks, which in turn made them more inclined to lend.

Concerns have been raised that high reserves holdings may lead to excessive risk taking (Acharya and Rajan, 2022). In the remainder of Table 9, we thus explore whether high risk or less efficient borrowers obtained more credit. We observe that the increase in the supply of credit by banks with high unused exemptions was similarly distributed across borrowers with different risk, size, profitability, and productivity, even though firms with high leverage may have benefitted more (column (6)). Overall, the increase in credit does not seem to have brought to excessive risk taking or inefficient allocation of credit.

6.3 Loan characteristics

Anacredit allows us to explore other aspects of loan supply. Table 10 shows that on average, the introduction of the two-tier system did not have a significant impact on lending rates, suggesting that banks largely internalised the change in the average remuneration of their liquidity holdings rather than passing it on to clients. However, there are important differences between banks. Banks with high unused exemptions that faced high *ex ante* interest rates in the money market not only increased the supply of credit, but also decreased loan rates.

Furthermore, in Table 11, we find that the implementation of the system translated into an increase in the maturity of bank loans by banks with more unused exemptions. The impact is expressed in days, so that every percentage point increase in unused exemptions translates into 25 days longer loan maturity. This is consistent with an improvement of the transmission mechanism associated with expectations of a prolonged low interest rate environment, which in turn enabled

banks to lengthen the maturity of their loan portfolio, despite the low margins. Importantly, the effect is driven by banks with *ex ante* more unused exemptions suggesting that more reserves and the consequent ability to ensure potential cash shortfalls made banks more inclined to commit to lend for longer periods.

Also, with respect to loan maturities, we find that the increase in loan maturity is driven by banks with unused exemptions that faced higher borrowing rates in the money market in October 2019, before the tiering implementation. These *ex ante* financially constrained banks with high unused exemptions not only increased the supply of credit, but also extended their average loan maturity and decreased loan rates. Banks that faced borrowing rates below the median in October 2019 and whose demand for reserves was unlikely to be depressed by high funding costs before the tiering introduction, if anything, decreased their loan maturity.

If the tiering system, by increasing reserve holdings for banks that would potentially make use of them, indeed allowed banks to hold illiquid assets, it should also allow them to provide more insurance. We should thus observe that banks with unused exemptions, incentivised to hold more excess reserves, are also more inclined to take liquidity risk by extending credit lines after the implementation of the tiering system (in line with the conjecture by Acharya et al., 2023). Table 12 shows that banks with unused exemptions indeed extended more credit lines after the implementation of the tiering system. Both drawn (column (1)) and undrawn (column (2)) credit lines increased, leading to an overall increase in granted credit lines (column (3)). This increase was driven by banks with unused exemptions, which had stronger incentives to increase their reserve holdings, as captured by the interest rate these banks faced in the money market before the implementation period (columns (4) to (6)). As larger credit lines are associated with more and unpredictable future liquidity needs for a lender, this evidence is in line with our conjecture that

the transmission mechanism is enhanced by the implementation of the tiering system because higher reserves reduced banks' precautionary behavior.

7. Conclusions

We show that central bank liquidity affects the transmission of monetary policy. More specifically, a policy that incentivizes a redistribution of excess reserves towards banks with higher liquidity needs can effectively strengthen monetary policy transmission. The tiered reserve remuneration systems increased the gains from trading excess liquidity which, in turn, led to a redistribution of reserves towards banks with higher liquidity needs. These banks were subsequently more likely to use their reserve holdings for credit creation.

Our results imply that banks' decisions to hold low levels of liquidity, even if optimally taken at the individual level, may have undesirable aggregate effects. Banks that find it too costly to hold excess reserves may end up having uninsured future liquidity needs and may choose to limit lending. The tiering system, by increasing banks' incentives to hold liquidity, decreased banks' precautionary behavior, thus benefitting the supply of credit to the real economy.

Our findings highlight the challenges that central banks engaging in quantitative tightening face when liquidity is asymmetrically distributed across banks. While a reduction of reserves that mostly affects banks that have high liquidity holdings and have reached their satiation point is not expected to have sizable negative effects on bank lending, a similar decrease in reserves affecting less liquid banks can have large contractionary effects, making the consequences of shrinking central banks' balance sheets hard to predict.

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Figures

Figure 1: Stock market reaction to the first news about a tiering system (March 27, 2019)

The chart shows the intraday development in the broad EuroStoxx50 index, as well as the narrow EuroStoxx Banks index on March 27, 2019, normalised to 100 at the start of trading at 9am. Former ECB president Draghi's speech containing a reference to "mitigating measures" to address the possible side effects of negative interest rates on bank profitability was released at 9:00 am in the morning and followed by an uptick in the EuroStoxx banks index of around 1% , while the broader index remained largely unchanged. The release of a news bulletin reporting that the ECB was working on a tiering system at 13:25 was followed by an additional increase in banks' equity prices by around 2.5%, compared to a rise of 0.7% in the broader equity index.

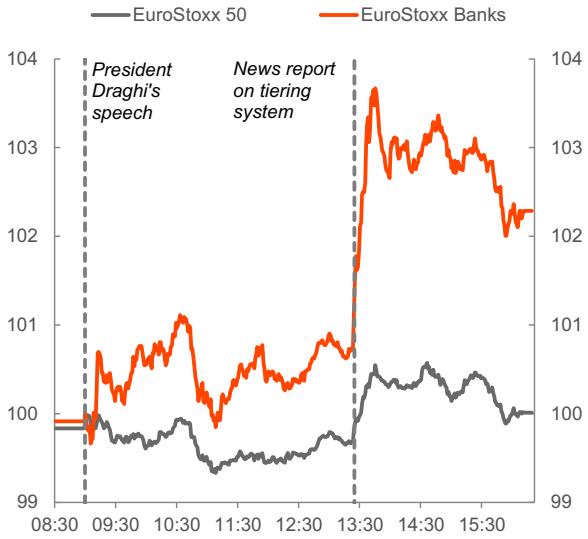


Figure 2: The distribution of excess liquidity between banks before and after the tiering

The figure plots the distribution of the ratio of a bank's excess liquidity relative to the bank's exemptions equal to six times the MMR in the two maintenance periods before (MP5 and MP6) the tiering implementation and the two after (MP7 and MP8).

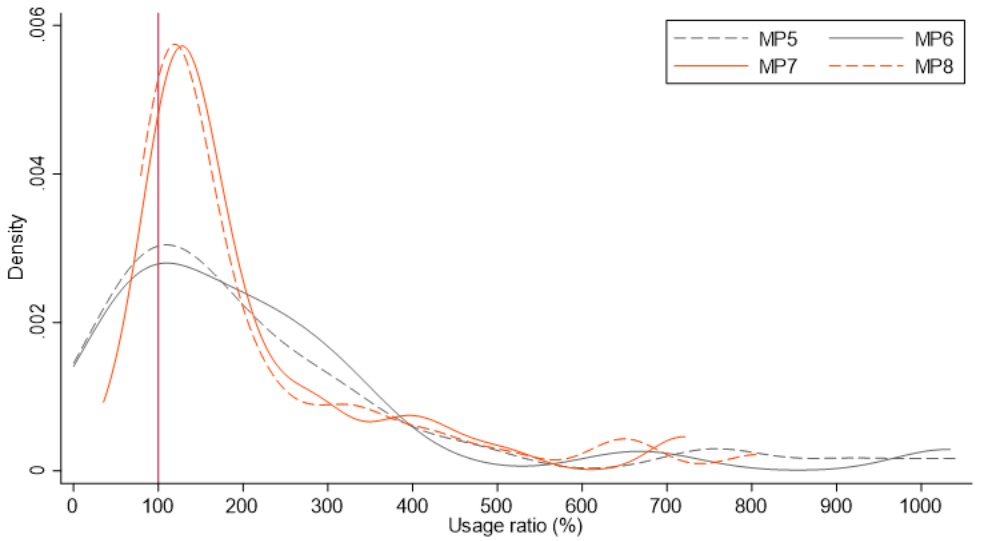
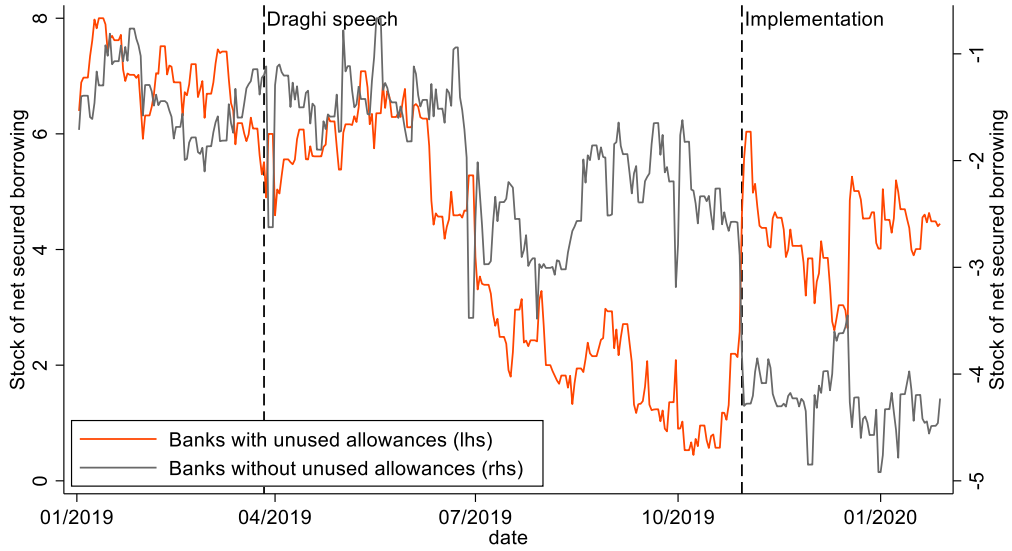


Figure 3: Net borrowing in the money market

The figure shows the average outstanding stock of net borrowing by banks in EUR billion. The stock of net borrowing is defined as the volume of outstanding borrowing transactions at the end of the day minus the volume of outstanding lending transactions. Panel A is based on transactions in the secured money market segment, and Panel B is based on transactions in the unsecured segment. The data is split between banks with unused tiering allowances (red line, left-hand side axis) and without (grey line, right-hand side axis) during the maintenance period immediately preceding the start of the tiering system at the end of October 2019. Vertical lines mark the speech by President Draghi on March 27, 2019, which first referred to the possibility of introducing a tiering system, as well as to the eventual start of the system on October 30, 2019.

Panel A. Secured



Panel B. Unsecured

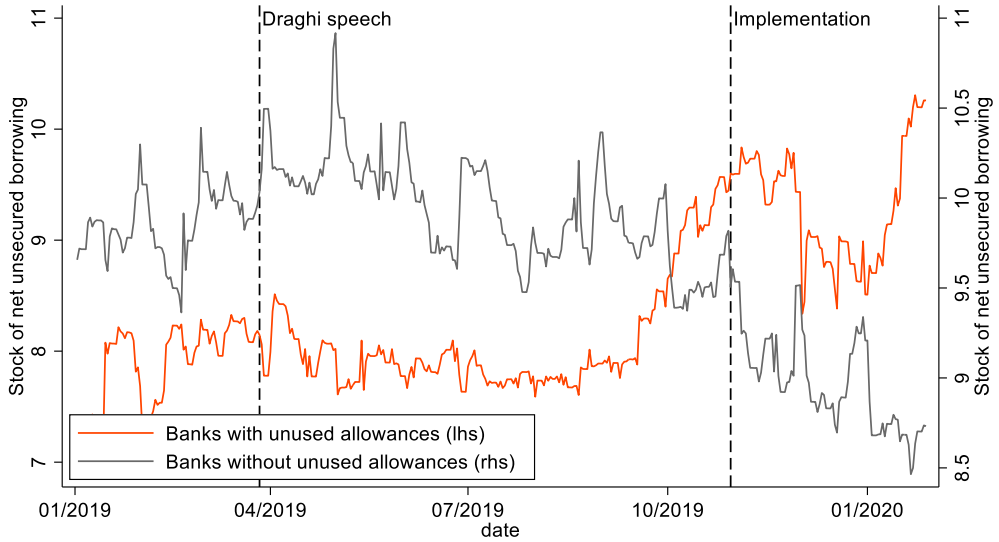


Figure 4: Change in reserve holdings, money market net borrowing, and central bank borrowing

The figure shows the change in reserve holdings, net borrowing in the money market, and borrowing from the central bank by banks with (left panel) and without (right panel) unused allowances around the introduction of the two-tier system. All series are normalized to banks' reserve holdings on September 12, 2019, the date at which the introduction of the two-tier system was formally announced (first vertical dashed line). The second vertical line indicates the start of the tiering system implementation (October 30, 2019). The residual change in reserve holdings can be attributed to other sources of banks' liquidity management, such as the purchase or sale of securities.

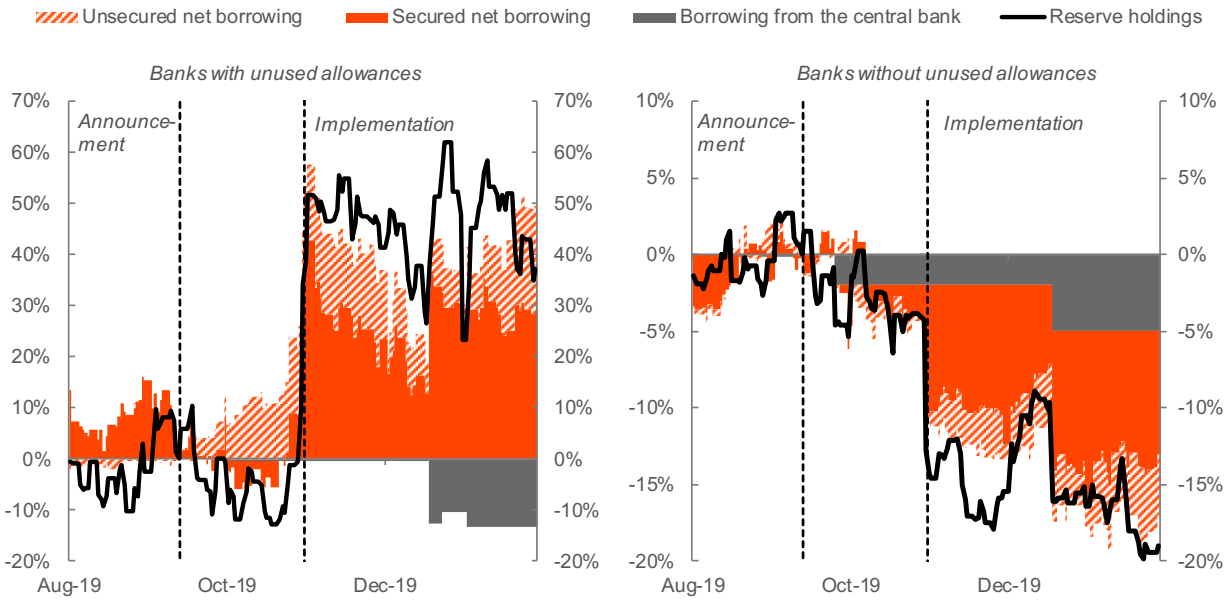


Figure 5: Money market interest rates

The figure shows the volume-weighted average interest rates on the flow of new money market transactions by reporting banks per day, expressed as a spread over the prevailing DFR. The average is computed across all reporting banks and maturities. The red line indicates the values for banks with unused allowances, and the grey line banks without unused allowances under the tiering system. The vertical lines indicate the date when the reduction of the DFR took effect (September 18, 2019) and the start of the tiering system implementation (October 30, 2019).

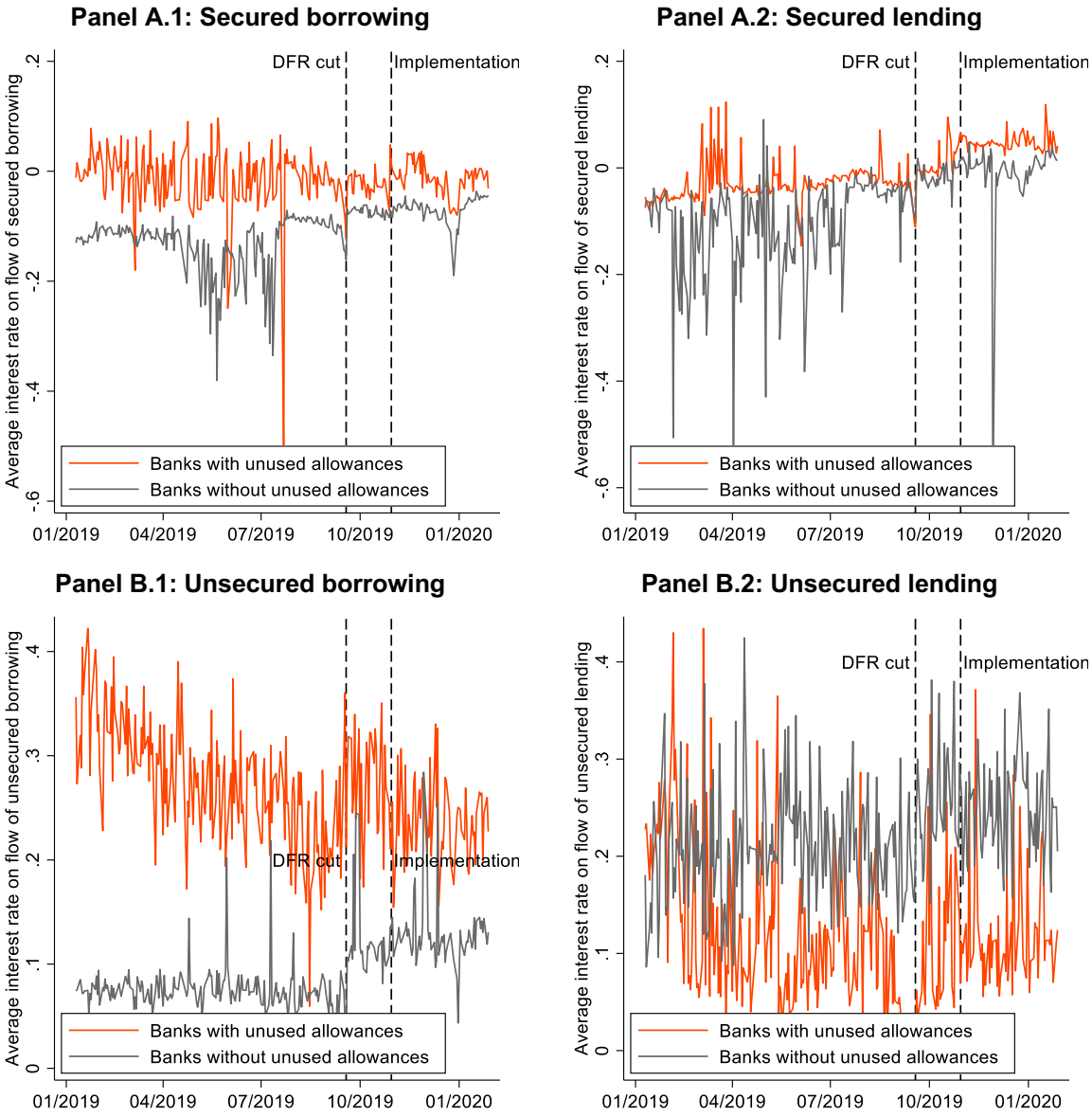


Figure 6: Increase in net unsecured borrowing conditional on unused allowances and counterparty' excess liquidity

The figure shows the effect of the two-tier system on banks' bilateral net borrowing in the unsecured market, conditional on the borrowing bank having unused allowances equal to the sample average, and conditional on the counterparty having liquidity holdings in excess of its tiering allowance as indicated on the horizontal axis. Specifically, the chart plots the change in net borrowing of a bank with average unused exemptions above zero after the implementation of the tiering as a function of the excess liquidity of the counterparty (above the tiering allowance and in percent of total assets): $\boldsymbol{\beta_2}\overline{\textbf{Exposure}^{Oct\ 2019}} + \boldsymbol{\beta_4}\overline{\textbf{Exposure}^{Oct\ 2019}} \times \textbf{Counterparty Excess Liquidity}_{jt}$. We vary the counterparty's excess tiering allowances ranging from 0% to 50% of total assets. Dashed lines indicate the 90% confidence interval, dotted lines the 95% confidence interval.

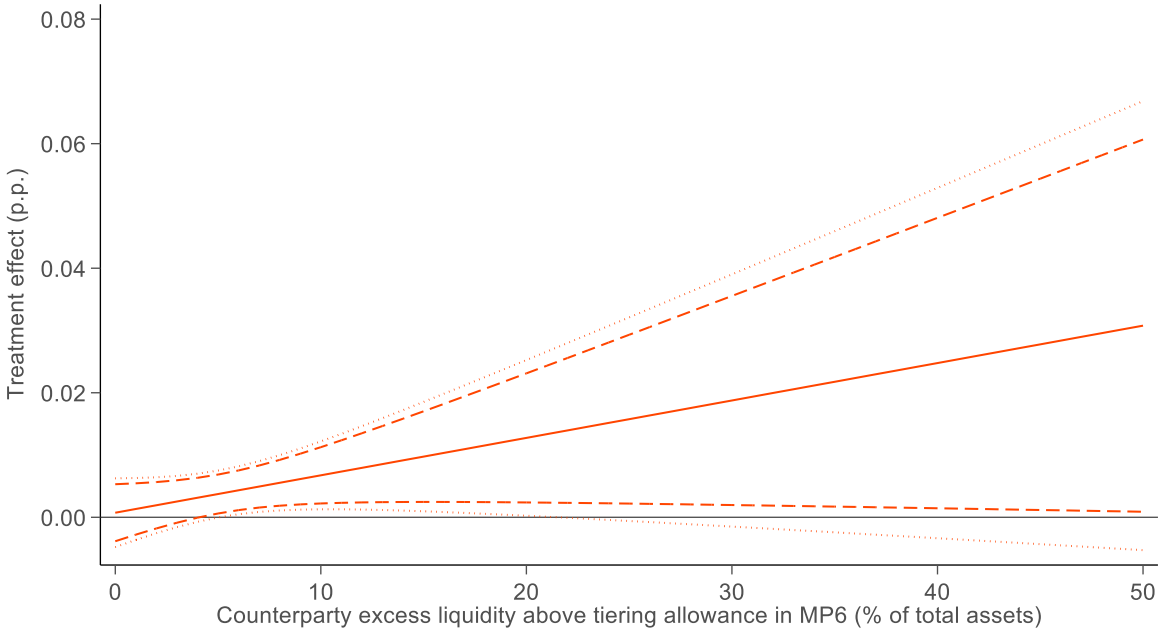
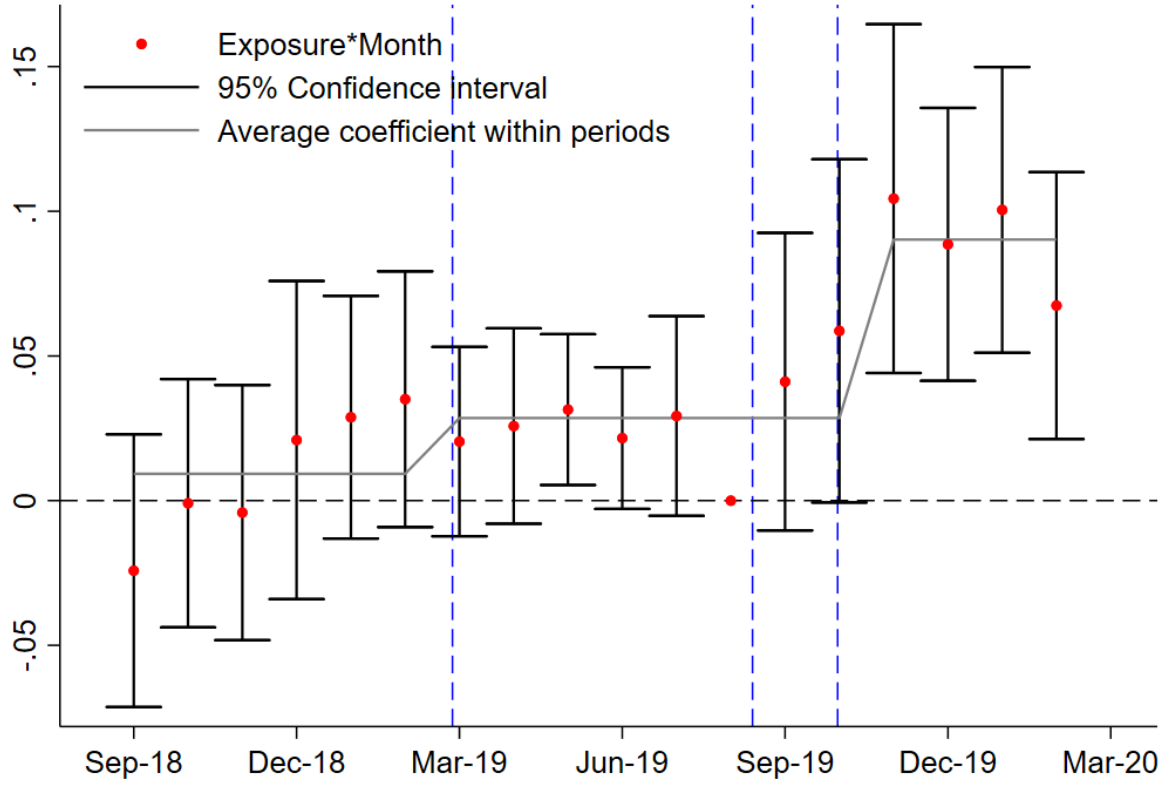


Figure 7: Dynamic effects of unused exemptions on bank loan supply

In order to test whether our results may be driven by pre-existing trends, we estimate a specification analogous to that in column 3 of Table 7, in which instead of including the terms Exposure(Feb 2019)*Interim(Mar-Oct 2019) and Exposure(Oct 2019)*Implementation (Nov 2019-Feb 2020), we interact Exposure(Oct 2019) with time dummies. The figure reports the estimate coefficients on each of these interactions and the 95% confidence interval.



Tables

Table 1: Summary statistics

Panel A summarizes the bank level dataset. We report observations at the bank and month level. Our sample consists of a panel of 128 banks from January 2014 to February 2020 (74 months). Panel B summarizes the Anacredit sample. We report observations at the bank, firm and month level. The Anacredit sample consists of a panel of 122 banks and 2,624,856 firms, for a total of 3,439,580 bank-firm relations, from September 2018 to February 2020 (18 months). Firms are distributed across 19 countries (AT, BE, CY, DE, EE, ES, FI, FR, GR, IE, IT, LT, LU, LV, MT, NL, PT, SI, SK), 89 2-digit NACE industries and 1,055 NUTS2 locations, providing 3,087,276 industry-location-size-month fixed effects. Panel C summarizes the MMSR sample.

Panel A. Bank level sample

Variable name	Units	Definition	Obs.	Mean	St.Dev.
Monthly change in excess liquidity	p.p.	Monthly change in ratio of excess liquidity (current account plus deposit facility minus minimum reserve requirements) over assets	9,325	0.103	1.333
Monthly change in holdings of government securities	p.p.	Monthly change in ratio of holdings of government bonds over assets.	9,325	-0.012	0.418
Exposure (Feb 2019)	%	Unused exemption allowance, i.e., the difference of 6-fold the minimum reserve requirement and the excess liquidity holdings of bank *i* in February 2019 if such difference is positive, and zero otherwise. It is expressed in percentage of main assets.	9,325	0.879	1.480
Exposure (Oct 2019)	%	Unused exemption allowance, i.e., the difference of 6-fold the minimum reserve requirement and the excess liquidity holdings of bank *i* in October 2019 if such difference is positive, and zero otherwise. It is expressed in percentage of main assets.	9,325	0.841	1.446
Interim (Mar-Oct 2019)	Cat.	Dummy variable equal to 1 between March 2019 and October 2019, 0 otherwise.	9,325	0.110	0.313
Implementation (Nov 2019-Feb 2020)	Cat.	Dummy variable equal to 1 between November 2019 and February 2020, 0 otherwise.	9,325	0.055	0.227
CDS	p.p.	5-years credit default swaps, in percentage points. One month lag.	9,325	1.356	2.072

Panel B. Bank-firm-month level sample

Variable name	Units	Definition	Obs.	Mean	St.Dev.
Volume of NFC loans	log(EUR mln)	Logarithm of outstanding amounts (in EUR million) of loans between a bank and a firm in a given month.	36,163,821	-2.318	1.954
Exposure(Feb 2019)	p.p.	Unused exemption allowance, i.e., difference of 6-fold the minimum reserve requirement and the excess liquidity holdings of a bank in February 2019 if such difference is positive, and zero otherwise. It is expressed in percentage of main assets.	52,814,649	0.648	1.130
Exposure(Oct 2019)	p.p.	Unused exemption allowance, i.e., difference of 6-fold the minimum reserve requirement and the excess liquidity holdings of a bank in October 2019 if such difference is positive, and zero otherwise. It is expressed in percentage of main assets.	52,814,649	0.520	0.913
Interim(Mar-Oct 2019)	0/1	Dummy variable equal to 1 between March 2019 and October 2019, 0 otherwise.	52,814,649	0.438	0.496
Implementation(Nov 2019-Feb 2020)	0/1	Dummy variable equal to 1 between November 2019 and February 2020, 0 otherwise.	52,814,649	0.228	0.420
Tiering Benefits (Feb 2019)	p.p.	Savings that would have stemmed from holdings of excess liquidity in February 2019 under the tiering, expressed as a ratio of assets, that is, $100 \times [\min\{0, DFR \times (EL - MRR \times 6)\} - DFR \times EL]/\text{Assets}$.	52,814,649	0.023	0.021
Tiering Benefits (Oct 2019)	p.p.	Savings that would have stemmed from holdings of excess liquidity in October 2019 under the tiering, expressed as a ratio of assets, that is, $100 \times [\min\{0, DFR \times (EL - MRR \times 6)\} - DFR \times EL]/\text{Assets}$.	52,814,649	0.024	0.019
CDS	p.p.	5-years credit default swaps, in percentage points. One month lag.	52,814,649	1.050	1.182
Excess liquidity	%	Ratio of excess liquidity (current account + deposit facility - minimum reserve requirements) over main assets. One month lag.	52,814,649	4.705	3.754
Holdings of government securities	%	Ratio of holdings of securities issued by general governments over main assets. One month lag.	52,814,649	6.613	4.826
Deposit ratio	%	Ratio of deposits from NFCs and households over main liabilities. One month lag.	52,814,649	37.724	21.050
TLTRO funds	%	Ratio of TLTRO uptake over main assets. One month lag.	52,814,649	4.212	4.169
Lending rate	% p.a.	Lending rate on outstanding amounts (in % per annum) on loans between a bank and a firm in a given month.	36,163,821	3.129	3.729
Maturity	Days	Residual maturity of loans between a bank and a firm in a given month.	36,163,821	1316	1665
Drawn credit lines	log(EUR mln)	Logarithm of drawn credit lines (in EUR million) between a bank and a firm in a given month.	21,321,876	-3.707	2.674
Undrawn credit lines	log(EUR mln)	Logarithm of granted but undrawn credit lines (in EUR million) between a bank and a firm in a given month.	18,085,424	-4.032	2.546
Overall credit lines	log(EUR mln)	Logarithm of granted (drawn and undrawn) credit lines (in EUR million) between a bank and a firm in a given month.	25,174,025	-3.003	2.362

Panel C. Bank daily panel of the money market transactions

Variable name	Units	Definition	Obs.	Mean	St.Dev.
Stock of outstanding secured borrowing transactions / MRR	Ratio	Stock of outstanding borrowing in the secured money market relative to a bank's minimum reserve requirement.	44,269	11.976	16.613
Stock of outstanding secured lending transactions / MRR (ratio)	Ratio	Stock of outstanding lending in the secured money market relative to a bank's minimum reserve requirement.	44,269	9.776	17.967
Stock of outstanding secured net borrowing transactions / MRR (ratio)	Ratio	Stock of net borrowing in the secured money market, defined as gross borrowing minus gross lending, relative to a bank's minimum reserve requirement.	44,269	2.200	13.076
Stock of outstanding unsecured borrowing transactions / MRR (ratio)	Ratio	Stock of outstanding borrowing in the unsecured money market relative to a bank's minimum reserve requirement.	44,269	9.168	12.338
Stock of outstanding unsecured lending transactions / MRR (ratio)	Ratio	Stock of outstanding lending in the unsecured money market relative to a bank's minimum reserve requirement.	44,269	1.912	4.684
Stock of outstanding unsecured net borrowing transactions / MRR (ratio)	Ratio	Stock of net borrowing in the unsecured money market, defined as gross borrowing minus gross lending, relative to a bank's minimum reserve requirement.	44,269	7.257	13.375
CDS spread (percentage points)	p.p.	5-years credit default swaps, in percentage points. Equal to domestic sovereign CDS spread for state-owned banks without issuer-specific CDS.	44,269	1.017	1.719
Interim period (26 Mar 2019 - 29 Oct 2019)	0/1	Dummy variable equal to 1 between 26 March 2019 and 29 October 2019, 0 otherwise.	44,269	0.197	0.398
Implementation (30 Oct 2019 - 28 Jan 2020)	0/1	Dummy variable equal to 1 between 30 October 2019 and 28 January 2019, 0 otherwise.	44,269	0.082	0.275
Exposure in Feb 2019	0/1	Dummy variable equal to 1 for banks with unused allowances between 30 January and 12 March 2019, 0 otherwise.	44,269	0.237	0.426
Exposure in Oct 2019	0/1	Dummy variable equal to 1 for banks with unused allowances between 18 September and 29 October 2019, 0 otherwise.	44,269	0.288	0.453

Table 2: Changes in excess liquidity

The table shows results from difference-in-differences regressions of banks' excess liquidity on exposure to the tiering system. The dependent variable in all columns is the bank's monthly change in the ratio of excess liquidity over assets. "Exposure(Feb 2019)" is equal to the unused exemption allowance (as a percentage of main assets) of bank *i* in February 2019 if such difference is positive, and to zero otherwise. "Exposure(Oct 2019)" is defined in the same way, but as of October 2019. The "Interim (Mar-Oct 2019)" variable is an indicator for the time between the speech by former ECB President Draghi on March 27, 2019, in which he hinted at the introduction of a tiering system for the first time, and the eventual implementation of the system as of October, 30 2019. "Implementation (Nov 2019-Feb 2020)" is an indicator variable for the time after October 30, 2019, i.e., the time since the tiering system has been in place. "CDS" represents banks' CDS spread (in percentage points); for state-owned banks in the sample, this is measured as the domestic sovereign CDS spread. The observation frequency in all regressions is monthly, and the sample period ranges from July 2007 to February 2020. Standard errors are clustered at the bank and country-time level. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Dependent Variable: Monthly change in excess liquidity	(1)	(2)	(3)
Exposure(Feb 2019)	-0.059*		
	(0.031)		
Exposure(Feb 2019)*Interim(Mar-Oct 2019)	0.078**	0.078**	0.078**
	(0.030)	(0.030)	(0.030)
Exposure(Oct 2019)	0.035		
	(0.038)		
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)	0.224***	0.224***	0.224***
	(0.066)	(0.066)	(0.066)
CDS			0.023
			(0.015)
Country-month FE	Yes	Yes	Yes
Bank FE	-	Yes	Yes
Observations	9,325	9,325	9,325
R-squared	0.166	0.178	0.178

Table 3: Money market volumes around the tiering introduction

Panel A. Bank-level regressions

The table shows results from difference-in-differences regressions of banks' money market activities on the exposure to the tiering system. The dependent variable in all columns is the banks' stock of borrowing, lending, or net borrowing, scaled by their minimum reserve requirements. "Exposure (Feb 2019)" is equal to the maximum of the unused exemption allowance (as a percentage of total assets) of bank *i* and zero between January 30 and March 12, 2019, the last maintenance period before the speech by former ECB President Draghi on March 27, 2019, in which he hinted at the introduction of a tiering system for the first time. "Exposure (Oct 2019)" is defined in the same way, but for the period between September 18 and October 29, 2019, the last maintenance period before the actual implementation of the tiering system. The "Interim (Mar-Oct 2019)" variable is an indicator for the time between the Draghi's speech and the eventual implementation of the system as of October 30, 2019. "Implementation (Nov 2019-Feb 2020)" is an indicator variable for the time between October 30, 2019 and January 28, 2020, i.e., the maintenance periods in which the tiering system was implemented before the pandemic accelerated in early 2020. "CDS" represents banks' CDS spread (in percentage points); for state-owned banks in the sample, this is measured as the domestic sovereign CDS spread. All regressions include bank fixed effects as well as country-maintenance period fixed effects. The observation frequency in all regressions is daily, and the sample period ranges from January 1, 2017 to January 28, 2020. Robust standard errors (reported in parentheses) are clustered at the bank and maintenance period level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	Secured			Unsecured		
	Borrowing	Lending	Net	Borrowing	Lending	Net
	(1)	(2)	(3)	(4)	(5)	(6)
Exposure (Feb 2019) x Interim (Mar-Oct 2019)	-0.195	-0.635	0.440	-0.030	-0.039	0.009
	(0.466)	(0.394)	(0.498)	(0.207)	(0.053)	(0.202)
Exposure (Oct 2019) x Implementation (Nov 2019-Feb 2020)	0.588	-1.136*	1.724**	0.551*	-0.135	0.687**
	(0.429)	(0.583)	(0.658)	(0.321)	(0.100)	(0.272)
CDS	-0.766	-0.412	-0.354	1.707	0.067	1.641
	(0.592)	(0.672)	(0.996)	(1.765)	(0.090)	(1.696)
Country-MP fixed effects	Y	Y	Y	Y	Y	Y
Bank fixed effects	Y	Y	Y	Y	Y	Y
Observations	44,269	44,269	44,269	44,269	44,269	44,269
No. Banks	42	42	42	42	42	42
R2	0.920	0.910	0.878	0.802	0.939	0.837
R2 (within)	0.002	0.002	0.004	0.006	0.001	0.005

Panel B. Bank-level regressions on money market borrowing' contractual features

The table shows results from difference-in-differences regressions of banks' money market activities on the exposure to the tiering system. The dependent variable in columns (1) and (2) is the volume-weighted average interest rate on banks' borrowing in the secured and unsecured money market, respectively, expressed as a spread over the prevailing DFR. In columns (3) and (4), the dependent variable is the volume-weighted average maturity of the outstanding borrowing in the secured and unsecured segment, respectively. All other variables are defined as explained in notes to Panel A. All regressions include bank fixed effects as well as country-maintenance period fixed effects. The observation frequency in all regressions is daily, and the sample period ranges from January 1, 2017 to January 28, 2020. Robust standard errors (reported in parentheses) are clustered at the bank and maintenance period level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	Borrowing rate		Borrowing maturity	
	Secured	Unsecured	Secured	Unsecured
	(1)	(2)	(3)	(4)
Exposure (Feb 2019) x Interim (Mar-Oct 2019)	-0.006	0.014	3.981	-2.787
	(0.007)	(0.023)	(2.670)	(3.803)
Exposure (Oct 2019) x Implementation (Nov 2019-Feb 2020)	0.001	0.042	1.885	-4.815
	(0.012)	(0.027)	(1.759)	(5.380)
CDS	0.032	0.004	8.685	-0.574
	(0.020)	(0.018)	(6.213)	(4.218)
Country-MP fixed effects	Y	Y	Y	Y
Bank fixed effects	Y	Y	Y	Y
Observations	42527	44016	42527	44016
No. Banks	42	42	42	42
R2	0.696	0.938	0.767	0.714
R2 (within)	0.003	0.010	0.025	0.002

Panel C. Relationship-level regressions

The table shows results from difference-in-differences regressions of banks' unsecured net borrowing on exposure to the tiering system at the bank-counterparty level. The dependent variable in columns (1)-(3) is the banks' stock of outstanding net borrowing per counterparty, and in column (4) the volume-weighted borrowing rate on the outstanding stock of borrowing per counterparty. Variables are defined as explained in notes to Panel A. Column (1) includes bank fixed effects as well as bank's country-maintenance period fixed effects. Column (2) includes bank fixed effects and counterparty-maintenance period fixed effects. Column (3) contains bank-counterparty fixed effects, counterparty-maintenance period fixed effects, and lender's country-maintenance period fixed effects. The observation frequency in all regressions is daily, and the sample period ranges from January 1, 2017 to January 28, 2020. Robust standard errors (reported in parentheses) are clustered at the bank and maintenance period level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Dependent variable:	Unsecured net borrowing volumes			Unsecured borrowing rate
	(1)	(2)	(3)	(4)
Exposure (Feb 2019) x Interim (Mar-Oct 2019)	-0.002*	0.0199*	0.012	-0.003
	(0.001)	(0.011)	(0.009)	(0.004)
Exposure (Oct 2019) x Implementation (Nov 2019-Feb 2020)	0.002*	0.016*	0.009***	-0.005
	(0.001)	(0.008)	(0.003)	(0.003)
CDS	0.007	0.009	0.018	0.002
	(0.006)	(0.011)	(0.016)	(0.004)
Bank's country-MP fixed effects	Y	-	Y	Y
Bank fixed effects	Y	Y	-	-
Counterparty-MP fixed effects	-	Y	Y	Y
Bank-counterparty fixed effects	-	-	Y	Y
Observations	23,337,146	23,333,780	23,333,780	2,450,325
No. Banks	42	42	42	42
R2	0.021	0.231	0.761	0.976
R2 (within)	0.001	0.001	0.001	0.001

Table 4: Changes in government bond holdings

The table shows results from difference-in-differences regressions of banks' government bond holdings on exposure to the tiering system. The dependent variable in all columns is the bank's monthly change in the ratio of government bonds over assets. "Exposure(Feb 2019)" is equal to the unused exemption allowance (as a percentage of main assets) of bank *i* in February 2019 if such difference is positive, and to zero otherwise. "Exposure(Oct 2019)" is defined in the same way, but as of October 2019. The "Interim (Mar-Oct 2019)" variable is an indicator for the time between the speech by former ECB President Draghi on March 27, 2019, in which he hinted at the introduction of a tiering system for the first time, and the eventual implementation of the system as of October 30, 2019. "Implementation (Nov 2019-Feb 2020)" is an indicator variable for the time after October 30, 2019, i.e., the time since the tiering system has been in place. "CDS" represents banks' CDS spread (in percentage points); for state-owned banks in the sample, this is measured as the domestic sovereign CDS spread. The observation frequency in all regressions is monthly, and the sample period ranges from July 2007 to February 2020. Standard errors are clustered at the bank and country-time level. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Dependent Variable: Monthly change in holdings of government securities	(1)	(2)	(3)
Exposure(Feb 2019)	0.006		
	(0.005)		
Exposure(Feb 2019)*Interim(Mar-Oct 2019)	-0.021	-0.020	-0.021
	(0.012)	(0.013)	(0.013)
Exposure(Oct 2019)	-0.000		
	(0.005)		
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)	-0.026**	-0.026**	-0.026**
	(0.012)	(0.012)	(0.012)
CDS			-0.016
			(0.012)
Country-month FE	Yes	Yes	Yes
Bank FE	-	Yes	Yes
Observations	9,325	9,325	9,325
R-squared	0.208	0.217	0.217

Table 5: The effects of unused exemptions on bank lending

The table shows how banks' lending to firms changes after the announcement and implementation of the tiering depending on the banks' exposure to the tiering system. The dependent variable is the logarithm of loans by bank *i* to a non-financial corporation *f* in month *t* in columns 1 to 4. "Exposure(Feb 2019)" is equal to the unused exemption allowance (as a percentage of main assets) of bank *i* in February 2019 if such difference is positive, and to zero otherwise. "Exposure(Oct 2019)" is defined in the same way, but as of October 2019. The "Interim (Mar-Oct 2019)" variable is an indicator for the time between the speech by former ECB President Draghi on March 27, 2019, in which he hinted at the introduction of a tiering system for the first time, and the eventual implementation of the system as of October 30, 2019. "Implementation (Nov 2019-Feb 2020)" is an indicator variable for the time after October 30, 2019, i.e., the time since the tiering system has been in place. Control variables are as defined in Table 1, Panel B. The observation frequency in all regressions is monthly, and the sample period ranges from September 2018 to February 2020. Standard errors are clustered at the bank-time level. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Dependent Variable:	(1)	(2)	(3)	(4)
Volume of NFC loans	Log	Log	Log	Log
Exposure(Feb 2019)*Interim(Mar-Oct 2019)	0.012	0.007	0.013	0.011
	(0.011)	(0.006)	(0.010)	(0.009)
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)	0.066***	0.040***	0.074***	0.066***
	(0.025)	(0.012)	(0.017)	(0.019)
CDS	-0.049	-0.021	-0.034	-0.045
	(0.040)	(0.020)	(0.032)	(0.033)
Excess liquidity	0.010**	0.002	0.009**	0.006
	(0.005)	(0.002)	(0.005)	(0.004)
Holdings of government securities	0.055***	0.026***	0.047***	0.038**
	(0.016)	(0.009)	(0.016)	(0.016)
Deposit ratio	0.000	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
TLTRO funds	0.005*	0.002*	0.004**	0.003**
	(0.002)	(0.001)	(0.002)	(0.001)
Bank FE	Yes	Yes	Yes	-
Country-Month FE	Yes	-	-	-
Industry-Location-Size-Month FE	-	Yes	-	-
Firm-Month FE	-	-	Yes	Yes
Bank-Firm FE	-	-	-	Yes
Observations	35,356,355	34,338,371	10,353,666	10,256,326
R-squared	0.084	0.719	0.697	0.935

Table 6: Alternative channels

The table shows how banks' lending to firms changes after the announcement and implementation of the tiering depending on the banks' exposure to the tiering system. The dependent variable in all columns is the logarithm of loans by bank *i* to a non-financial corporation *f* in month *t*. "Exposure(Feb 2019)" is equal to the unused exemption allowance (as a percentage of main assets) of bank *i* in February 2019 if such difference is positive, and to zero otherwise. "Exposure(Oct 2019)" is defined in the same way, but as of October 2019. The "Interim (Mar-Oct 2019)" variable is an indicator for the time between the speech by former ECB President Draghi on March 27, 2019, in which he hinted at the introduction of a tiering system for the first time, and the eventual implementation of the system as of October 30, 2019. "Implementation (Nov 2019-Feb 2020)" is an indicator variable for the time after October 30, 2019, i.e., the time since the tiering system has been in place. Tiering benefits in February (October) 2019 are defined as $[\min\{0, DFR \times (EL - MRR \times 6)\} - DFR \times EL]/Assets)$ in February (October) 2019. Control variables are as defined in Table 1, Panel B. The observation frequency in all regressions is monthly, and the sample period ranges from September 2018 to February 2020. Standard errors are clustered at the bank-time level. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Dependent Variable: Volume of NFC loans	(1) Log	(3) Log
Exposure(Feb 2019)*Interim(Mar-Oct 2019)	0.012	0.015
	(0.010)	(0.012)
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)	0.069***	0.075***
	(0.020)	(0.023)
Tiering Benefits(Feb 2019)*Interim(Mar-Oct 2019)	0.553	
	(0.578)	
Tiering Benefits(Oct 2019)*Implementation(Nov 2019-Feb 2020)	0.970	
	(0.819)	
Excess liquidity(Feb 2019)*Interim(Mar-Oct 2019)		0.003
		(0.003)
Excess liquidity(Oct 2019)*Implementation(Nov 2019-Feb 2020)		0.005
		(0.004)
CDS	-0.043	-0.043
	(0.033)	(0.033)
Excess liquidity	0.006	0.006
	(0.004)	(0.004)
Holdings of government securities	0.037**	0.037**
	(0.016)	(0.016)
Deposit ratio	0.000	0.000
	(0.000)	(0.000)
TLTRO funds	0.003**	0.003**
	(0.001)	(0.001)
Firm-Month FE	Yes	Yes
Bank-Firm FE	Yes	Yes
Observations	10,256,326	10,256,326
R-squared	0.935	0.935

Table 7: Bank exposure to concurrent policies

The table shows a robustness check on how banks' lending to firms changes after the announcement and implementation of the tiering depending on the banks' exposure to the tiering system, considering changes in the relation between lending and other control variables. The dependent variable is the logarithm of loans by bank *i* to a non-financial corporation *f* in month *t* in columns 1 to 4. "Exposure(Feb 2019)" is equal to the unused exemption allowance (as a percentage of main assets) of bank *i* in February 2019 if such difference is positive, and to zero otherwise. "Exposure(Oct 2019)" is defined in the same way, but as of October 2019. The "Interim (Mar-Oct 2019)" variable is an indicator for the time between the speech by former ECB President Draghi on March 27, 2019, in which he hinted at the introduction of a tiering system for the first time, and the eventual implementation of the system as of October 30, 2019. "Implementation (Nov 2019-Feb 2020)" is an indicator variable for the time after October 30, 2019, i.e., the time since the tiering system has been in place. Control variables are as defined in Table 1, Panel B. The observation frequency in all regressions is monthly, and the sample period ranges from September 2018 to February 2020. Standard errors are clustered at the bank-time level. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Dependent Variable:	(1)	(2)	(3)	(4)
Volume of NFC loans	Log	Log	Log	Log
Exposure(Feb 2019)*Interim(Mar-Oct 2019)	0.014	0.014	0.020	0.018
	(0.018)	(0.009)	(0.017)	(0.016)
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)	0.061*	0.045***	0.070***	0.072**
	(0.033)	(0.016)	(0.025)	(0.028)
CDS	-0.051	-0.018	-0.039	-0.050
	(0.045)	(0.021)	(0.038)	(0.039)
Excess liquidity	0.011	-0.002	0.005	0.002
	(0.007)	(0.002)	(0.005)	(0.004)
Holdings of government securities	0.057***	0.024***	0.043***	0.035**
	(0.017)	(0.009)	(0.016)	(0.016)
Deposit ratio	-0.000	-0.000	-0.000	0.001
	(0.001)	(0.000)	(0.001)	(0.001)
TLTRO funds	0.003	0.002	0.003	0.004*
	(0.003)	(0.001)	(0.002)	(0.002)
CDS*Interim(Mar-Oct 2019)	-0.012	-0.007	-0.004	-0.005
	(0.013)	(0.007)	(0.012)	(0.010)
Excess liquidity*Interim(Mar-Oct 2019)	-0.006	0.005**	0.005	0.007*
	(0.007)	(0.002)	(0.004)	(0.004)
Holdings of government securities*Interim(Mar-Oct 2019)	-0.004	0.001	-0.000	0.002
	(0.006)	(0.003)	(0.005)	(0.005)
Deposit ratio*Interim(Mar-Oct 2019)	-0.000	0.000	0.000	-0.000
	(0.001)	(0.000)	(0.001)	(0.001)
TLTRO funds*Interim(Mar-Oct 2019)	-0.000	-0.001	-0.002	-0.003
	(0.004)	(0.002)	(0.004)	(0.004)
CDS*Implementation(Nov 2019-Feb 2020)	-0.036	-0.022	-0.067	-0.065
	(0.067)	(0.029)	(0.066)	(0.067)
Excess liquidity*Implementation(Nov 2019-Feb 2020)	-0.006	0.009**	0.003	0.009
	(0.010)	(0.004)	(0.006)	(0.006)
Holdings of government securities*Implementation(Nov 2019-Feb 2020)	-0.004	0.002	0.007	0.007
	(0.011)	(0.005)	(0.010)	(0.011)
Deposit ratio*Implementation(Nov 2019-Feb 2020)	0.002*	0.001**	0.000	-0.000
	(0.001)	(0.000)	(0.001)	(0.001)
TLTRO funds*Implementation(Nov 2019-Feb 2020)	0.010	0.002	0.009*	0.006
	(0.007)	(0.003)	(0.005)	(0.005)
Bank FE	Yes	Yes	Yes	-
Country-Month FE	Yes	-	-	-
Industry-Location-Size-Month FE	-	Yes	-	-
Firm-Month FE	-	-	Yes	Yes
Bank-Firm FE	-	-	-	Yes
Observations	35,356,355	34,338,371	10,353,666	10,256,326
R-squared	0.084	0.719	0.697	0.935

Table 8: Changes in lending and banks' ex ante money market borrowing rates

The table shows results from difference-in-differences regressions of banks' lending to firms on exposure to the tiering system. In columns (1) and (2), banks are split depending on whether their borrowing rate in the secured money market in October 2019 was above or below the median. In column (3), we test for differences in lending behavior for banks with borrowing rates above and below the median in a pooled sample. "Exposure(Feb 2019)" is equal to the unused exemption allowance (as a percentage of main assets) of bank *i* in February 2019 if such difference is positive, and to zero otherwise. "Exposure(Oct 2019)" is defined in the same way, but as of October 2019. The "Interim (Mar-Oct 2019)" variable is an indicator for the time between the speech by former ECB President Draghi on March 27, 2019, in which he hinted at the introduction of a tiering system for the first time, and the eventual implementation of the system as of October 30, 2019. "Implementation (Nov 2019-Feb 2020)" is an indicator variable for the time after October 30, 2019, i.e., the time since the tiering system has been in place. Control variables include CDS, excess liquidity, holdings of government securities, deposit ratio and TLTRO funds, and are as defined in Table 1, Panel B. The observation frequency in all regressions is monthly, and the sample period ranges from September 2018 to February 2020. Standard errors are clustered at the bank-time level. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Dependent Variable:	(1)	(2)	(3)
	Subsample Banks with borrowing rates		
Volume of NFC loans	Above median	Below median	All banks
Above median money market rate (Oct-2019):			
Exposure(Feb 2019)*Interim(Mar-Oct 2019)	0.010***		0.008**
	(0.002)		(0.003)
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)	0.152***		0.148***
	(0.016)		(0.009)
Below median money market rate (Oct-2019):			
Exposure(Feb 2019)*Interim(Mar-Oct 2019)		0.056*	0.044*
		(0.031)	(0.025)
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)		-0.005	-0.015
		(0.028)	(0.026)
Controls	Yes	Yes	Yes
Firm-Month FE	Yes	Yes	Yes
Bank-Firm FE	Yes	Yes	Yes
Observations	1,453,670	232,868	2,001,748
R-squared	0.938	0.957	0.942

Table 9: Bank and borrower cross-sectional differences

The table shows results from difference-in-differences regressions of banks' lending to firms on the banks' exposure to the tiering system. Each column reports two separate regressions. We report estimates for the subsamples above and below the median of the characteristic indicated in each column. The third panel in each column reports the value of the F test for the significance of the differences (resulting significance is indicated by the asterisks) between the coefficients in the regressions reported above. "Exposure(Feb 2019)" is equal to the unused exemption allowance (as a percentage of main assets) of bank *i* in February 2019 if such difference is positive, and to zero otherwise. "Exposure(Oct 2019)" is defined in the same way, but as of October 2019. The "Interim (Mar-Oct 2019)" variable is an indicator for the time between the speech by former ECB President Draghi on March 27, 2019, in which he hinted at the introduction of a tiering system for the first time, and the eventual implementation of the system as of October 30, 2019. "Implementation (Nov 2019-Feb 2020)" is an indicator variable for the time after October 30, 2019, i.e., the time since the tiering system has been in place. Control variables include CDS, excess liquidity, holdings of government securities, deposit ratio and TLTRO funds, and are as defined in Table 1, Panel B. The observation frequency in all regressions is monthly, and the sample period ranges from September 2018 to February 2020. Standard errors are clustered at the bank-time level. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Dependent Variable: Volume of NFC loans	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sample splits by:	Bank capital	Bank CDS	Firm PD	Firm size	Firm ROA	Firm leverage	Firm productivity
High:							
Exposure(Feb 2019)*Interim(Mar-Oct 2019)	-0.005	0.015	0.001	0.009	0.008	0.009	0.013
	(0.004)	(0.012)	(0.012)	(0.008)	(0.008)	(0.008)	(0.008)
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)	0.003	0.081***	0.051***	0.058***	0.067**	0.071***	0.064***
	(0.007)	(0.022)	(0.017)	(0.020)	(0.028)	(0.022)	(0.022)
Low:							
Exposure(Feb 2019)*Interim(Mar-Oct 2019)	0.009	0.002	0.017	0.003	0.006	0.005	-0.000
	(0.007)	(0.011)	(0.012)	(0.008)	(0.007)	(0.008)	(0.008)
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)	0.068***	0.006	0.072**	0.070**	0.059***	0.052**	0.062**
	(0.023)	(0.018)	(0.029)	(0.029)	(0.019)	(0.023)	(0.026)
F-test: High = Low							
Exposure(Feb 2019)*Interim(Mar-Oct 2019)	3.19*	0.71	2.34	2.62	0.56	1.45	5.51**
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)	7.61***	7.04***	0.88	0.98	0.79	12.56***	0.04
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank-Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 10: Changes in lending rates

The table shows results from difference-in-differences regressions of the lending rates on banks' exposure to the tiering system. The dependent variable is the lending rate for a loan from bank *i* to non-financial corporation *f* in month *t*. In columns (2) to (4), banks are split depending on whether their borrowing rate in the money market in October 2019 was above or below the median across banks. "Exposure(Feb 2019)" is equal to the unused exemption allowance (as a percentage of main assets) of bank *i* in February 2019 if such difference is positive, and to zero otherwise. "Exposure(Oct 2019)" is defined in the same way, but as of October 2019. The "Interim (Mar-Oct 2019)" variable is an indicator for the time between the speech by former ECB President Draghi on March 27, 2019, in which he hinted at the introduction of a tiering system for the first time, and the eventual implementation of the system as of October 30, 2019. "Implementation (Nov 2019-Feb 2020)" is an indicator variable for the time after October 30, 2019, i.e., the time since the tiering system has been in place. Control variables include CDS, excess liquidity, holdings of government securities, deposit ratio and TLTRO funds, and are as defined in Table 1, Panel B. The observation frequency in all regressions is monthly, and the sample period ranges from September 2018 to February 2020. Standard errors are clustered at the bank-time level. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Dependent Variable:	(1)	(2)	(3)	(4)
Interest rate on NFC loans	Overall	Above median	Below median	Pooled
Exposure(Feb 2019)*Interim(Mar-Oct 2019)	-0.017			
	(0.031)			
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)	0.041			
	(0.066)			
Above median money market rate (Oct-2019):				
Exposure(Feb 2019)*Interim(Mar-Oct 2019)		-0.013***		-0.015**
		(0.003)		(0.006)
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)		-0.048***		-0.046***
		(0.011)		(0.012)
Below median money market rate (Oct-2019):				
Exposure(Feb 2019)*Interim(Mar-Oct 2019)			0.195	0.156
			(0.235)	(0.159)
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)			0.372	0.312
			(0.401)	(0.315)
Controls	Yes	Yes	Yes	Yes
Firm-Month FE	Yes	Yes	Yes	Yes
Bank-Firm FE	Yes	Yes	Yes	Yes
Observations	10,256,326	1,453,670	232,868	2,001,748
	0.849	0.907	0.918	0.915

Table 11: Changes in loan maturity

The table shows results from difference-in-differences regressions of the loan maturity on banks' exposure to the tiering system. The dependent variable is the maturity expressed in days for a loan from bank *i* to non-financial corporation *f* in month *t*. In columns (2) to (4), banks are split depending on whether their borrowing rate in the money market in October 2019 was above or below the median across banks. "Exposure(Feb 2019)" is equal to the unused exemption allowance (as a percentage of main assets) of bank *i* in February 2019 if such difference is positive, and to zero otherwise. "Exposure(Oct 2019)" is defined in the same way, but as of October 2019. The "Interim (Mar-Oct 2019)" variable is an indicator for the time between the speech by former ECB President Draghi on March 27, 2019, in which he hinted at the introduction of a tiering system for the first time, and the eventual implementation of the system as of October 30, 2019. "Implementation (Nov 2019-Feb 2020)" is an indicator variable for the time after October 30, 2019, i.e., the time since the tiering system has been in place. Control variables include CDS, excess liquidity, holdings of government securities, deposit ratio and TLTRO funds, and are as defined in Table 1, Panel B. The observation frequency in all regressions is monthly, and the sample period ranges from September 2018 to February 2020. Standard errors are clustered at the bank-time level. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Dependent Variable:	(1)	(2)	(3)	(4)
Maturity	Overall	Above median	Below median	Pooled
Exposure(Feb 2019)*Interim(Mar-Oct 2019)	3.029			
	(3.925)			
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)	24.789***			
	(6.306)			
Above median money market rate (Oct-2019):				
Exposure(Feb 2019)*Interim(Mar-Oct 2019)		-4.593**		-4.142***
		(1.804)		(1.541)
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)		23.562***		26.843***
		(1.820)		(2.196)
Below median money market rate (Oct-2019):				
Exposure(Feb 2019)*Interim(Mar-Oct 2019)			-22.346	-18.934
			(18.546)	(11.534)
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)			-30.895*	-34.745**
			(17.645)	(13.077)
Controls	Yes	Yes	Yes	Yes
Firm-Month FE	Yes	Yes	Yes	Yes
Bank-Firm FE	Yes	Yes	Yes	Yes
Observations	10,256,326	1,453,670	232,868	2,001,748
R-squared	0.966	0.907	0.918	0.915

Table 12: Credit lines

The table shows results from difference-in-differences regressions of banks' credit lines (drawn in columns 1 and 4, undrawn in columns 2 and 5, and overall in columns 3 and 6) to firms on the banks' exposure to the tiering system. In columns (4) to (6), banks are split depending on whether their borrowing rate in the money market in October 2019 was above or below the median across banks. "Exposure(Feb 2019)" is equal to the unused exemption allowance (as a percentage of main assets) of bank *i* in February 2019 if such difference is positive, and to zero otherwise. "Exposure(Oct 2019)" is defined in the same way, but as of October 2019. The "Interim (Mar-Oct 2019)" variable is an indicator for the time between the speech by former ECB President Draghi on March 27, 2019, in which he hinted at the introduction of a tiering system for the first time, and the eventual implementation of the system as of October 30, 2019. "Implementation (Nov 2019-Feb 2020)" is an indicator variable for the time after October 30, 2019, i.e., the time since the tiering system has been in place. Control variables include CDS, excess liquidity, holdings of government securities, deposit ratio and TLTRO funds, and are as defined in Table 1, Panel B. The observation frequency in all regressions is monthly, and the sample period ranges from September 2018 to February 2020. Standard errors are clustered at the bank-time level. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	Drawn credit lines	Undrawn credit lines	Overall credit lines	Drawn credit lines	Undrawn credit lines	Overall credit lines
Exposure(Feb 2019)*Interim(Mar-Oct 2019)	-0.003	-0.009	-0.000			
	(0.007)	(0.008)	(0.006)			
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)	0.025**	0.020*	0.031***			
	(0.010)	(0.012)	(0.010)			
Above median money market rate (Oct-2019):						
Exposure(Feb 2019)*Interim(Mar-Oct 2019)				0.006*	-0.004	0.002
				(0.003)	(0.006)	(0.005)
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)				0.018**	0.020**	0.027***
				(0.007)	(0.008)	(0.008)
Below median money market rate (Oct-2019):						
Exposure(Feb 2019)*Interim(Mar-Oct 2019)				-0.016	0.099	-0.013
				(0.053)	(0.119)	(0.036)
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)				-0.041	0.186	0.046
				(0.056)	(0.125)	(0.031)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank-Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,936,816	3,910,966	5,779,814	929,340	724,860	1,143,426
R-squared	0.934	0.913	0.954	0.944	0.937	0.965