Money Markets and Bank Lending: Evidence from the Tiering Adoption

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Exploiting the introduction of the ECB's tiering system for remunerating excess reserve holdings, we document the importance of money market access for bank lending. We show that the two-tier system produced positive wealth effects for banks with excess reserves and encouraged banks with unused exemptions to increase their participation in the money market to obtain liquidity. This ultimately decreased money market fragmentation and enhanced the transmission of monetary policy. We provide evidence that stronger money market relationships reduce the precautionary behavior of financially constrained banks with unused allowances, which consequently extend more credit than other banks, including those with excess liquidity whose valuations increased the most.

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1. Introduction

A number of theories emphasize the importance of the smooth functioning of money markets and the reallocation of liquidity for bank lending (Caballero and Krishnamurthy, 2008; Allen, Carletti, and Gale, 2009; Diamond and Rajan, 2011; Bolton, Santos and Scheinkman, 2011). However, shocks affecting the functioning of the money market may also affect the demand for credit, making it hard to identify the actual importance of money markets in empirical studies, especially outside crisis periods.

This paper aims to shed light on the importance of the smooth functioning of the money market for bank lending by exploiting a quasi-natural experiment created by a policy of the European Central Bank (ECB), which increased banks' incentives to trade in the money market and consequently reduced market segmentations. The euro area is an ideal setting to explore the consequences of frictions in the money market because, following the global financial crisis, money market segmentations and rate dispersion had raised concerns regarding the transmission of monetary policy, especially because trading between banks with high and low liquidity holdings, located in different countries of the euro area, was limited (Corradin et al., 2020; Eisenschmidt, Kedan, and Tietz, 2018).

Specifically, in 2019, the ECB introduced a tiering system for the remuneration of central bank reserves held by commercial banks. The ultimate goal of the tiering system was mitigating the potential side effects associated with negative interest rate policies (NIRPs), by exempting a share of excess liquidity holdings from the application of the negative deposit facility rate (DFR). This intervention was therefore expected to have a positive direct effect on the profitability of banks, as they avoided being "taxed" on the exempt part of their liquidity holdings. As we show,

the valuations of banks with more excess liquidity, which could expect larger savings from the tiering system, indeed increased to a larger extent in expectation of the tiering system adoption.

The policy however also increased money market activity by strengthening the incentives of low-excess-liquidity banks to borrow from high-excess-liquidity banks. The ECB intervention thus reduced money market segmentations by spurring the reallocation of excess liquidity to banks with *ex ante* low liquidity holdings. Enhanced access to the money market for banks with *ex ante* low liquidity holdings in turn appears to support bank lending to the real sector.

The specific sequence of communication on the introduction of the tiering system in the euro area facilitates the identification of the policy's effectiveness. While the possible introduction of a tiering mechanism was already anticipated in March 2019, the decision to introduce a tiering system was formally announced in September 2019 and became effective at the end of October of the same year. Markets considered an informal discussion in a March 2019 speech by the ECB's president to be a credible signal about the possible adoption of a tiering system, as bank valuations substantially increased in the immediacy of the announcement, but the actual exemptions and the reallocation of liquidity occurred only at the end of October.[1]

We show that following the first discussion on the tiering, banks with relatively high liquidity holdings *ex ante* – whose savings would be higher *ex post* – experienced higher abnormal returns. However, we observe positive effects on bank lending only after the actual implementation of the tiering system. We also show that the effects are not positively associated with the increases in banks' net wealth, but rather work through a reduction in money market segmentations.

[1] The March 2019 informal announcement also contained a signalling component because the possible implementation of the two-tier system was interpreted by market participants as opening the possibility for protracting the negative interest rate policy for a more extended period.

Specifically, the expected value of liquidity increased for banks with "unused allowances", i.e., for those institutions holding *ex ante* less liquidity than they could exempt from negative rates. Accordingly, we observe that after the implementation of the tiering system, banks with unused allowances established new trading relationships with high-excess-liquidity banks and increased their net borrowing in the money market. Contextually, these banks increased the supply of credit They also granted loans at lower rates and with longer maturity. We obtain these results controlling for demand shocks throughout the analysis either using interactions of firm and time fixed effects, following Khwaja and Mian (2008), or interactions of industry location, borrower size, and time fixed effects. We also evaluate alternative mechanisms associated with the tiering adoption and the response of banks with high excess liquidity and high tiering savings. We find no evidence that other banks, including those with higher tiering savings, change their lending policies.

To interpret our results, we conjecture that a decline in money market fragmentation reduced banks' precautionary behavior and increased lending. Such a conjecture would be consistent with evidence that relationships in the interbank markets allow banks to insure liquidity risk in the presence of market frictions (Cocco, Gomez and Martins, 2009; Brauning and Fecht, 2017).

We provide several additional pieces of evidence consistent with this hypothesis. First, if money market fragmentations had indeed created financial frictions that reduced the credit supply, the banks with unused exemptions that responded more to the tiering implementation should have been financially constrained. We show that our results are indeed driven by banks with high unused allowances, which were more likely to face financial frictions in accessing the money market before the implementation of the tiering. These include banks with higher borrowing rates prior to

the implementation of the tiering, banks with low capitalizations, and banks with high CDs spreads. We further show that banks with unused exemptions that experienced an increase in the number of money market relationships grant more loans, but this is not the case for banks with unused exemptions whose access to the money market did not improve.

Second, we show that financially constrained banks with unused exemptions commit more credit lines. The latter imply hard to predict liquidity needs for the lender suggesting that banks' precautionary behavior is reduced thanks to better access to the money market. In addition, banks with unused allowances also reduced their government bond holdings.[2] Since liquid sovereign bonds can be mobilized as collateral in secured money market transactions, net bond sales suggest a decrease in precautionary behavior as they are evidence that banks hoarded less collateral.

Our paper contributes to evaluate the importance of money market access in a non-crisis period. Most of the papers studying the money market consider the effects of negative shocks on the interbank market, without studying the implications for bank lending. For instance, Afonso, Kovner and Schoar (2011) show that counterparty risk hampered the functioning of the US money markets after the Lehman collapse, while Acharya and Merrouche (2013) highlight how precautionary liquidity hoarding negatively affected the UK money market during the 2007-2008 global financial crisis. We show that in normal times, an increase in the benefits of reallocating liquidity reduces segmentations in the money market and, most importantly, we consider the consequences for lending to the real sector. In this respect, our paper is closest to Iyer, Peydro, da-Rocha-Lopes, and Schoar (2014) and Cingano, Manaresi, and Sette (2016), who show that banks that were borrowing more through the money market contracted lending to a larger extent during the global financial crisis. We explore an intervention that increases banks' incentives to transact

[2] In contemporaneous work, Baldo et al. (2022) study how banks adjusted their balance sheets to achieve higher liquidity holdings and provide evidence consistent with our findings.

in the money market and show how interbank relationships and the banks' consequent ability to obtain liquidity affect credit provision. In this respect, we contribute to an emerging literature (see, e.g., Correa, Du and Liao, 2022; Afonso, Duffie, Rigon, and Shin, 2022) exploring the importance of the reserves (excess liquidity) distribution across banks. We show that it matters not only for the functioning of the money market, but also for bank lending.

Besides evaluating the role of the money market, our paper contributes to understand the transmission mechanism of monetary policy below the zero lower bound. Monetary policy accommodation in low-interest-rate environments requires breaking the zero lower bound on nominal interest rates (Rogoff, 2016; 2017). This might generate positive real economic effects by incentivizing firms to invest more to avoid paying negative rates on their bank deposits (Altavilla, Burlon, Giannetti, and Holton, 2022). However, NIRPs raise concerns about the stability of the banking system if banks are not able to pass through negative rates to deposits because they fear a flight to paper currency (Eggertsson, Juelsrud, Summers, and Wold, 2019) and because regulation limits their ability to charge negative rates, especially on retail deposits (Heider, Saidi, Schepens, 2019). In the extreme case, due to their negative effects on banks' net interest income, negative rates may become recessive as banks cut lending if their net wealth decreases (Brunnermeier and Koby, 2016; Ulate, 2021).[3] By reducing the cost of holding excess liquidity, the tiering system supports bank profits and can ultimately lead banks to expand their balance sheets and lend more.

Implications, however, are ambiguous. One mechanism through which negative policy rates are believed to be transmitted to the real economy involves banks' attempt to avoid paying negative rates on their excess reserves. While aggregate excess reserve holdings in the banking

[3] The overall effects of the negative interest rates policy on bank profitability should also consider the positive general equilibrium effects from the increased monetary accommodation, both through higher intermediation volumes and improved borrower creditworthiness (see Altavilla, Boucinha, Peydró, 2018).

system as a whole are fixed, individual banks have been shown to increase lending in the attempt to decrease their excess liquidity (Bottero, Minoiu, Peydró, Polo, Presbitero, and Sette, 2021).

In this context, the introduction of a tiering system affects banks' incentives. On the one hand, banks that have unfulfilled exemption allowances may have weaker incentives to lend, undermining the transmission of monetary policy. On the other hand, after the introduction of the tiering system, banks with unused exemptions have stronger incentives to establish relationships in the money market and may thus find it easier to insure liquidity risk. The consequent reduction in banks' precautionary behavior may support lending. Which of these mechanisms prevails remains an empirical question. We show that the introduction of a tiering system helps reduce segmentation in the money market and spurs lending by banks with unused exemptions.

Notwithstanding many central banks have introduced tiering systems for reserve remuneration, there are few studies on their effectiveness. 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 tend to charge higher loan spreads and take less risk and that banks obtained liquidity by increasing the interest rate on deposits, effectively lowering the pass-through. Their study captures the wealth effects of tiering systems. Our paper, instead, focusing on the larger and segmented money market of the euro area shows that tiering systems, by increasing the benefits of trading, can reduce market segmentations and stimulate bank lending.

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, which allows us to identify the supply of credit. 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, providing 3,087,276 industry-location-size-month clusters. The large number of clusters available will help 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 bank 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. Most prominently, the MMSR dataset is the basis for computing the euro short-term rate (€STR), the successor to EONIA and the key benchmark interest rate reflecting the wholesale euro unsecured overnight borrowing costs of

banks located in the euro area. More than 50 large banks from across the euro area are required to submit a detailed list of all money market transactions on a daily basis.[4]

The dataset has been collected since July 2016 and covers all secured and unsecured transactions by the reporting banks with other banks and non-banks that have an initial maturity of up to twelve months. The resulting dataset provides the most granular account of euro area-money markets (Chiu et al. 2019), comprising 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.[5]

Table 1 provides variable definitions and summary statistics.

3. Implementation of the Tiering in the Euro Area

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 when

[4] The initial set of banks that were required to report under the MMSR Regulation (EU) No 1333/2014 are: ABN AMRO Bank N.V., Allied Irish Banks plc, Banca IMI S.p.A., Banca Monte dei Paschi di Siena S.p.A., Banco Bilbao Vizcaya Argentaria, S.A., Banco de Sabadell, S.A., Banco BPM S.p.A., Banco Santander, S.A., Bankia, S.A., Banque fédérative du crédit mutual, Bayerische Landesbank, Belfius Banque SA, BNG Bank N.V., BNP Paribas, BNP Paribas Fortis SA, BPCE, Caisse des dépôts et consignations - section générale, Caisse Fédérale de Crédit Mutuel, CaixaBank, S.A, Cassa Depositi e Prestiti S.p.A., Commerzbank Aktiengesellschaft, Coöperatieve Rabobank U.A., Crédit Agricole Corporate and Investment Bank, Crédit Agricole S.A., Crédit Lyonnais, DekaBank Deutsche Girozentrale, Deutsche Bank Aktiengesellschaft, Dexia crédit local, DZ Bank AG Deutsche Zentral-Genossenschaftsbank, Hamburg Commercial Bank AG, HSBC France, ING Bank N.V., ING Belgique SA, ING-DiBa AG, Intesa Sanpaolo S.p.A., KBC Bank NV, Kreditanstalt für Wiederaufbau, La Banque Postale, Landesbank Baden-Württemberg, Landesbank Hessen-Thüringen Girozentrale, Natixis, Norddeutsche Landesbank -Girozentrale-Nordea Bank Abp, NRW.BANK, Piraeus Bank, S.A., Société Générale, UniCredit Bank AG, UniCredit Bank Austria AG, UniCredit, S.p.A.

[5] Some banks report so-called "evergreening" transactions – outstanding transactions that could in principle be adjusted before their maturity on every day of the life of the transactions. Treating each of those transactions separately when aggregating the stock of outstanding transactions would incorrectly inflate the total exposure. We therefore exclude the interim reporting of evergreening transactions, keeping only the initially reported transaction.

policy rates move into negative territory. For this reason, the adoption of NIRPs has been accompanied in many jurisdictions by tiering systems limiting the direct costs of NIRPs for the banking system. For instance, Denmark adopted negative rates in July 2012, and its banks benefited from the possibility to keep part of their liquidity in current accounts with zero interest rates. Similarly, the Swedish Riksbank, which introduced negative interest rates in early 2015, absorbed a certain amount of excess liquidity by issuing certificates of deposit with a higher (though for a period still negative) rate.[6] Finally, the Swiss National Bank introduced negative interest rates in January 2015, together with a two-tier system exempting an amount of banks' central bank deposits proportional to their customer deposits; exemptions were further increased in November 2019.

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 ECB watchers conference. After almost five years of negative interest rates, analysts had increasingly begun to voice concerns about the possible adverse side effects on bank profitability and, by extension, an impairment of the bank-based monetary policy transmission channel. The speech by Draghi represented the first mention of specific measures to contain potential side effects by an ECB policymaker in the run-up to its eventual implementation: "*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.*"[7]

[6] The Bank of Japan's system is somewhat more complex and includes three tiers. The "policy balance" is the fraction of banks' total reserve holdings to which negative policy rates are applied. The other two tiers include the "basic balance", defined as the average balance of banks' current accounts in 2015, which is remunerated at a positive interest rate. Finally, the "macro add-on balance", defined monthly by the Bank of Japan to maintain a low charge for banks as well as an adequate transmission to market rates, is remunerated at zero.

[7] The introduction of a tiering system had previously been discussed by the ECB's Governing Councill in 2016, but it was ultimately discarded to avoid sending unintended policy signals. See the transcript of the ECB's press conference on March 10, 2016.

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.[8] This information triggered a sharp market reaction: As shown in Figure 1 using high frequency data, European bank stocks jumped by almost 3% upon the news release, considerably outperforming a broader market index.

The discussion of an exemption scheme from the negative deposit facility rate (DFR) was also perceived by market participants to signal a more accommodative monetary policy stance. The daily change in yields at different maturities derived from instantaneous forward Eonia contracts in Figure 2 shows a peak effect of about 10bps for maturities of three years, indicating that discussions, and then the introduction, of the tiering system were perceived to signal an intention to maintain current (or lower) interest rate levels for a longer period of time.

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%. In its current configuration, the tiering system exempts excess liquidity holdings of up to six times banks' minimum reserve requirements (MRR) from the application of the negative DFR.

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 remains subject to negative interest rates – was sufficiently large to avoid upward pressure on money market rates. Put differently, the aggregate exempt amount of excess liquidity was set such that the DFR would continue to anchor money market rates, thus ensuring that the monetary policy stance was not tightened. In this manner, central banks introducing a tiering system intend not to

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

impair the transmission of monetary policy to money market interest rates and, if anything, to enhance it, because reducing the costs of banks' reserve holdings mitigates the negative effects of the NIRP on intermediation margins.

The ECB's tiering system started to be operational on October 30, 2019, in accordance with the September announcement. In what follows, we dissect how the tiering system affected banks and the money markets with the aim of highlighting the effects on the transmission mechanism.

4. Direct Effects on Bank Net Wealth

By exempting a portion of banks' excess liquidity from negative rates, tiering systems should have a positive direct effect on banks' profitability. This effect should be particularly strong for banks with high excess liquidity holdings, which are expected to fully use their tiering exemptions.

We thus test whether the valuations of banks with higher excess liquidity benefitted more when the adoption of a tiering system became more likely. We perform a cross-sectional event study to explore how the tiering affected banks with different characteristics. Following Sefcik and Thompson (1986), we start by estimating banks' abnormal returns associated with the discussion, announcement and implementation of the tiering using a Fama-French three-factor model. In particular, for each bank in our sample, we estimate the following model:

$$R_{i,t} = \alpha_i + \beta_{m,i}R_{m,t} + \beta_{HML,i}R_{HML,t} + \beta_{SMB,i}R_{SMB,t} + \sum_e \lambda_{i,e} D_{e,t} + \varepsilon_{i.t} \quad (1)$$

where $R_{i,t}$ is the daily stock return of bank i on day t, while $R_{m,t}$, $R_{HML,t}$, and $R_{SMB,t}$ are the excess return on the market portfolio, the value vs. growth factor (i.e., the return on a portfolio long high market-to-book firms and short low market-to-book firms), and the size factor (i.e., the

return on a portfolio long small firms and short large firms), respectively.[9] The abnormal daily returns are then computed by using the estimated coefficient of the three dummy variables, $D_{e,t}$, which are equal to 1 in the 2-day window around each of the three relevant event dates, e, and equal to 0 otherwise.

The three relevant event dates are: March 27, 2019 (ECB watchers conference, when the tiering system was first unofficially discussed), September 12, 2019 (official announcement of the tiering), and October 30, 2019 (when the two-tier system was introduced). While the actual implementation date on October 30, 2019 was known to market participants in advance, we include it in the event study because money markets contracts (and prices) have very short maturity (predominantly overnight) and market participants learnt about the actual effects of the measures only around the implementation date.

To explore cross-sectional variation in individual banks' stock market reactions to the announcement of the two-tier system, we estimate the following (cross-sectional) regression:

$$\overline{\lambda_i} = \alpha + \beta \text{Tiering benefit}_i + \Gamma X_i + u_i \quad (2)$$

where the dependent variable is the average daily abnormal return of bank *i* over the event window, estimated from equation (1). We also distinguish the effects of the Tiering benefits across the three events, by estimating the following equation:

$$\lambda_{i,e} = \alpha_i + \alpha_e + \sum_e \beta_e \text{Tiering benefit}_{i,e} \times D_e + \Gamma X_{i,e} + u_{i,e},$$

where α_i and α_e are bank and event fixed effects, respectively, and $\text{Tiering benefit}_{i,e} \times D_e$ is the interaction between bank-specific tiering benefits calculated right before the event and a dummy that identifies the event itself

[9] We obtain the European factors from Ken French's website.

Our main explanatory variable, "Tiering benefit", is related to the magnitude of the savings each bank expects to realize due to the exemption scheme. In September 2019, the ECB chose to exempt holdings of excess liquidity equal to six times the MRR. We thus compute tiering benefits as $[\min\{0, DFR \times (EL - MRR \times 6)\} - DFR \times EL]/Equity$; that is, dividing a bank's tiering savings by its equity, we measure the contribution of the tiering savings to the ROE.

The benefit corresponds to the difference between the cost paid without the tiering scheme ($DFR \times EL$) and that paid with the scheme. The latter corresponds to the DFR applied to the difference between excess reserves (EL) and the tiering allowance ($MRR \times 6$), because tiering benefits are capped at $MRR \times 6$. We use excess reserves throughout the analysis because the legally mandated minimum reserve holdings were always exempt from the negative DFR.

One point of note is that the precise definition and calibration of the exemption allowances was not known before the announcement of the scheme. However, based on the design of schemes introduced in other jurisdictions, it could be expected that exemptions would be based on the volume of *MRR*, which in turn depends on banks' customer deposits, a measure of bank size which is not easy to manipulate.[10] Uncertainty on the specific calibration of the tiering multiplier in March 2019 makes the coefficient on the dummy capturing the first event hard to interpret. To account for this, we also consider how the tiering benefits affected banks' stock market reactions to the two subsequent events.

Table 2 reports the results of an event study examining average daily abnormal returns in the 2-day event window around the tiering announcements. The results suggest that the increase in banks' valuations was more pronounced for banks with relatively large excess liquidity holdings, and thus expected higher savings. This is the case in column (1) where we consider cross-

[10] The tiering schemes applied by both the Swiss National Bank and the Denmark's central bank are based on the volume of deposits. The scheme applied by the Bank of Japan also depends on bank size.

sectional differences in banks' abnormal returns across the three different announcement dates, as well as in the rest of the table in which we consider a panel including the abnormal returns of each bank for each of the three announcements.

In column (1), in which the estimated magnitude of the coefficient on the tiering savings is clouded by the uncertainty on the specific multiple of the MRR in March 2019, the coefficient on the variable capturing the (ex post) unexempted excess liquidity holdings is negative and significant, consistent with notion that the market was aware of the cap on the exemptions.

In columns (2) to (4), we find statistically significant cross-sectional differences in returns between banks also around the actual implementation on October 30, 2019, when banks with higher tiering savings exhibited substantially higher stock returns. The effects are also economically significant. An increase in tiering savings by one standard deviation, corresponding to a 30bps contribution to ROE, was associated with close to 70bps higher abnormal stock returns during the tiering events on average (column (1) of Table 2). In column (2), we decompose the reaction to each event, without making assumptions on the expected tiering benefits in March 2019. Since we include bank fixed effects, the bank reaction to the September and October events can be thought as relative to the March reaction. The impact of the October event is higher than the previous announcement for a bank with given tiering benefits. Banks' characteristics related to profitability, balance sheet strength and funding structure appear to be unrelated to the tiering announcement returns.

5. Effects on the Money Market

5.1 Institutional Features of the Euro Area Money Market

The euro money market had undergone deep structural changes since the global financial crisis. In 2020, the outstanding amount of repo trades, on average, reached EUR 3.3tn, whereas the outstanding amount of unsecured transactions came up to only around EUR 0.3tn (ECB 2021).[11] This stands in stark contrast to the market structure prevailing before the financial crisis, when unsecured transaction volumes accounted for around one third of overall money market transactions.

The shift from the unsecured to the secured money market segment reflects the greater regulatory costs of unsecured transactions as well as a stronger sensitivity to counterparty risk following the financial crisis. In addition, the significant injection of liquidity through the ECB's regular refinancing operations – which have been conducted as fixed-rate full-allotment tenders since the financial crisis – and, later on, through non-standard measures, such as the 3-year long-term refinancing operations (LTROs), the targeted longer-term refinancing operations (TLTROs) and the asset purchase programs, reduced banks' need to trade in the unsecured money market. As a result, trading activity in the unsecured money market shifted away from interbank trading towards transactions between banks and non-banks without access to the ECB's standing facilities, such as money market funds or insurance companies.

Rising levels of excess liquidity also tended to mute activity in the secured money market (ECB 2021). The announcement of a new series of TLTROs as well as expectations for a restart of net asset purchases over the course of 2019 led to a further decline in trading activity over the summer of 2019.

In sum, the money market activities of many banks had become relatively dormant in the decade following the financial crisis, especially in the unsecured segment. While this could simply

[11] Including FX and interest rate swaps, the outstanding amount reached around EUR 6tn on average during 2020.

reveal that banks had no need to participate in the interbank market, money market segmentations nevertheless raised concerns. Excess liquidity was largely held by banks in Germany, France, the Netherlands, and Belgium and was accompanied by a drop in the extent of cross-border trading and sporadic relationships with the banks with lower liquidity holdings, mostly located in Italy and Portugal (Eisenschmidt, Kedan, and Tietz, 2018). Having sporadic relationships and facing relatively higher interest rates, low-excess-liquidity banks had limited ability to insure liquidity risks through the money market. Since banks are believed to fear stigma associated with the reliance on LTRO and TLTRO funding, money market segmentations could increase the precautionary behavior of low-excess-liquidity banks.

5.2 Descriptive Evidence

The introduction of the tiering system strengthened banks' incentives to reallocate excess liquidity and participate in the money market. To maximize the value of the exemptions introduced with the tiering system, all banks would need to hold at least as much liquidity as would eventually be exempt from paying negative rates. The expected value of liquidity thus increases for banks with unused exemptions, which may be willing to borrow even if they faced relatively higher interest rates. Similarly, banks with excess liquidity, which were previously unwilling to lend, may find new counterparties willing to borrow at higher interest rates. These changes may have helped to spur activity in the money market and to reduce money market segmentations.

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) segments. 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.

The documented increase in net borrowing by banks with unused tiering allowances is quantitatively meaningful. Banks with unused allowances, on average, more than quadrupled their net borrowing in the secured segment from EUR 1bn 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. This relatively smaller change in the unsecured segment compared to the secured market during the narrow window around the start of the tiering system partly reflects that banks had already started to gradually adjust their unsecured borrowing over the summer of 2019.

Market activity by banks with unused exemptions strengthened not only along the intensive margin in terms of volumes, but also along the extensive margin in terms of active trading relationships. Figure 4 shows the number of active trading relationships by banks with and without unused tiering allowances before and after the introduction of the tiering system. Banks with unused exemptions added on average nine counterparties to their trading network from which they

borrowed in the unsecured market during the implementation phase of the tiering system. In contrast, the number of counterparties from which banks without unused exemptions borrowed did not change.[12]

The opposite picture emerges for lending relationships. The number of counterparties to which banks with unused tiering allowances lent funds did not increase; in contrast, banks with liquidity holdings exceeding their tiering allowance on average started to lend to seven additional counterparties following the start of the tiering system. The size of trading networks in the secured segment of the money market did not change meaningfully. However, this is unsurprising given that the vast majority of secured money market transactions in the euro area are intermediated through central counterparties (CCPs).

Importantly, the increase in the number of counterparties in the unsecured market was accompanied by a decrease in the segmentations along the national borders. As is evident from Figure 5, banks sourced the additional liquidity primarily from foreign counterparties. Average daily unsecured borrowing of banks with unused tiering allowances from foreign banks and non-banks rose by around EUR 150mn after the start of the tiering system, compared to only around EUR 50mn from domestic counterparties, closing the gap to the average daily unsecured borrowing volumes by banks without unused allowances.

Overall, it appears that an increase in the gains from trade helped reducing segmentations in the unsecured money market and decreased segmentations along the national borders. Importantly, the reintegration of banks into the money market did not go along with a notable increase in interest rates. At the aggregate level, this reflected the ECB's intention to keep a

[12] The reporting requirements under the MMSR regulation were amended over time. Reporting banks have been required to report the legal entity identifier (LEI) code of their counterparts only since March 2019, which limits the comparability of the number of distinct counterparties shown in Figure 4 for the prior period.

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 6). It appears that banks with unused exemptions, which were already facing higher interest rates in the money market, became more inclined to borrow from banks with high excess liquidity, thanks to the higher returns on the excess liquid holdings guaranteed by the exemptions.

As we show below, the enhanced participation in the money market and the consequent ability to insure liquidity risks associated with more numerous and arguably more intense money market relationships may then have reduced the precautionary behavior of banks with low excess liquidity and affected their policies.

5.3 Multivariate Analysis

To provide more systematic evidence on how banks adjusted their liquidity position in the money market, we analyse a daily panel, based on the transaction-level MMSR dataset. Banks' compliance with the legally mandated minimum reserve holdings in their central bank accounts is evaluated based on the average reserve holdings between the monetary policy meetings of the ECB's Governing Council, the so-called maintenance periods.[13] Because banks need to comply only on average, they can make up for a temporary shortfall in reserve holdings with temporary overcompliance later on (and vice versa). The relevant excess liquidity holdings that are subject to the NIRP and, by extension, the amount of excess reserves that are exempt from negative rates under the tiering system, must therefore also be computed as averages during a maintenance

[13] More specifically, a new maintenance period starts on the settlement date of the first main refinancing operation following a monetary policy meeting of the Governing Council at which any interest rate decision takes effect.

period.

The average 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) thus determine the treatment variables in our empirical models. We classify banks holding on average less excess liquidity than their tiering allowance as more exposed to the tiering system.

In order to capture potential changes in bank behaviour during the interim period between Draghi's March speech and the actual implementation of the system, as well as thereafter, we estimate the following difference-in-differences equation with two separate treatment periods and exposure variables:

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

where $\text{Money Market Activity}_{ictm}$ represents one of six alternative indicators of banks' i's activity 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 and $\text{Exposure}_i^{Feb\ 2019}$ 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 introduction 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.

Table 3, Panel A shows in a multivariate setting 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 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. We observe no significant 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 segment of the euro money market, albeit at somewhat smaller magnitude, in line with the descriptive evidence in Figure 3.

These effects 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 exemption 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 amount 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).

These results suggest that following the tiering implementation, the willingness to borrow increased for banks with unused exemptions, thanks to their ability to store liquidity at a non-negative rate. To be able to interpret these results as bank demand-driven, we use high-dimensional fixed effects to control for shocks that may have affected the banks (Khwaja and Mian, 2008). We focus on the unsecured market, because the prevalence of CCP transactions in the secured market limits our ability to observe bilateral flows.

Panel B 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 by a bank with more unused exemptions rises significantly more than for a bank without unused exemptions borrowing from the same counterparty. This finding is robust if we control for characteristics of the relationships by including interaction between borrowing bank and lending counterparty fixed effects or shocks to the country of the borrowers that may drive the demand for liquidity independently from the unused allowances. Specifically, controlling for shocks to the country of the borrower allow us to control for the fact that demand for corporate credit may have increased in the country of the borrowing bank contextually to the tiering adoption.

We also explore which counterparties provided more liquidity to banks with excess 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 B, a triple interaction term between Implementation_t, a bank's Exposure_i to the tiering system and the counterparty's excess liquidity holdings above its allowance relative to its total assets.[14] Figure 7 shows how the net borrowing of a bank with positive average level of unused exemptions (as measured by the bank's exposure to the tiering system) varies with the counterparty's excess liquidity. The estimates support the interpretation that liquidity flows from high excess liquidity banks to high unused exemptions banks.

We do not find that banks borrow at significantly higher interest rates, even though banks with unused exemptions faced ex ante higher interest rates. We therefore conclude that the tiering system has led to an exogenous increase in money market participation for banks with unused exemptions by increasing their returns on excess liquidity.

5.4. Excess Liquidity and Bond Holdings

The changes in money market activity are mirrored by changes in the composition of bank assets. Table 4 explores how banks with different ex ante holdings of excess liquidity change their holdings of excess liquidity. Expected returns on the holdings of excess liquidity increase when the possibility of the adoption of a tiering system was announced in March 2019. Thus, banks with lower liquid holdings and consequently higher unused exemptions in expectation increase their holdings of excess liquidity during the period between March and October 2019. A one-standard-deviation (1.5pp) increase in 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 is finally implemented in November 2019. These findings indicate

[14] By definition, this restricts the sample to the interbank market, i.e. transactions in which both the borrowing and lending counterparty are banks with access to the ECB's balance sheet where they can hold central bank reserves.

that the tiering adoption contributed to make excess liquid holdings less concentrated in few banks. This pattern is effectively visualized in Figure 7, which shows how the distribution of excess liquidity relative to exemptions changed immediately after the tiering adoption.

Table 5 considers banks' holdings of government securities. Government securities are often used as collateral to borrow in the money market. We expect them to be particularly high in periods of high uncertainty. It appears that banks decrease their holdings of government securities after the implementation of the tiering system, when uncertainty about the ability to obtain liquidity through the money market abates. Following the implementation of the two-tier 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 4 basis points of total assets (corresponding to just under 10% of the standard deviation of this variable).

6. The Effects of the Tiering System on the Transmission Mechanism

6.1 Main results

This section investigates whether the tiering system affects the bank-based transmission of monetary policy. There are several mechanisms through which a tiering system may matter. First, as we have shown, the introduction of the tiering system affects bank net wealth and the value of excess liquidity. Specifically, banks with excess liquidity, whose net wealth improves to a larger extent, may become more inclined to lend. Second, the higher value of excess liquidity may lead lenders with unused exemptions to extend less credit. Third, the introduction of the tiering system appears to have improved the functioning of money markets. In this respect, banks whose access to money markets improves, facing less uncertainty on their ability of accessing the money market in the future, may become more inclined to lend.

Different mechanisms associated with the introduction of the tiering have different implications on the effects of excess liquidity on bank lending when exemptions increase. The net wealth channel, as well as the channel that goes through the marginal value of excess liquidity, would imply that the credit supply of banks with high unused exemptions is less affected. Mechanisms that rely on excess liquidity becoming a "hot potato" in periods with negative rates would even imply that banks with unused exemptions may become less prone to lend. In contrast, if an improvement in the functioning of the money market spurs lending, we expect that banks that were *ex ante* negatively affected by market segmentations lend more. These relatively financially constrained banks can be identified as those with ex ante less excess liquidity and therefore substantial unused tiering allowances.

To evaluate which channels are more relevant, we investigate how the lending policies of firms with different levels of excess liquidity, and higher unused exemptions in particular, differ from those of other banks. The granularity of Anacredit, the euro area countries' harmonised credit register, allows us to identify the supply of credit by exploring how different banks extend credit to the same borrower.

Specifically, we estimate the following equation:

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

where the dependent variable is either the amount of the loan or another loan characteristic that bank *b* extends to firm *f* during month *t*. In determining the credit exposure of bank *b* to firm *f*, we aggregate all credit facilities that firm *f* has obtained from bank *b*, including drawn credit lines.[15]

[15] 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 dummy 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 months just before the first mentioning of the tiering in President Draghi's speech and before the tiering implementation, respectively. In other specifications, we also consider banks' exposure through excess liquidity or tiering savings before the first mentioning of the tiering in President Draghi's speech and before the tiering implementation. Finally, $X_{b,t}$ 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. Importantly, in the most stringent specifications, we control for loan demand using interactions of firm and time fixed effects as well as interactions of bank and firm fixed effects, capturing time-invariant aspects of the relationships.

Table 6 starts by exploring the different mechanisms through which the introduction of the tiering may affect banks' lending policies. Specifically, we run a "horse race" among the exposure variables capturing the magnitude of a bank's unused exemptions, the bank's tiering savings, and its excess liquidity. Tiering savings do not appear to affect bank lending policies, suggesting that the tiering system does not facilitate the transmission of monetary policy through banks' wealth effects. This is intuitive because the accrued savings upon implementation may be too small to affect banks' lending policies.

Similarly, we find no differences in lending between banks with different levels of excess liquidity holdings. This indicates that the incentives of banks with high excess liquidity to lend in periods of negative interest rates policies highlighted in work by Botter et al. (2022), Sette are not affected by the introduction of the tiering.

It rather appears that banks with unused exemptions extend more credit than other banks

to the same borrower after the implementation of the tiering system. The positive effect of unused exemptions on bank lending suggests that the improvements in the access to the money market spurs banks' lending. Specifically, banks that after the implementation of the tiering have stronger motives to borrow and establish money market relationships appear to exhibit less precautionary behaviour and extend more corporate loans because they expect to be able to fund any liquidity shortfalls through the money market more easily than before the implementation of the tiering system

Table 7 explores the robustness of the effect of the unused credit exemptions on bank lending following the implementation of the tiering. The estimates do not appear to be driven by the fact that Table 6 identifies differences in lending policies from borrowers with multiple lenders. 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 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 loans to firms by 4-7% depending on the fixed-effects included, with the impact decreasing to 1% when accounting also for the extensive margin of bank lending in column (5), where we use the inverse hyperbolic sine function, instead of the logarithmic transformation, to include the observations (as zero) for banks that do not lend to a given borrower during a month.

The cumulative impact of the tiering through the money market channel on aggregate credit growth is sizeable. To see this, consider that a one-standard-deviation increase in exemptions (computed from the standard deviation of exposure in Panel B, Table 1) implies an additional cost of tiering for the ECB of around €1.7 bn in the aggregate. Using the conservative estimates in

column (5) of Table 7, the corresponding increase in loan growth of 0.8% translates in an increase in credit of €40 bn, when applied to the aggregate credit to non-financial corporations of banks in the euro area (about €5 trn). Thus, we estimate a multiplier of 24 for the cost of the tiering. This is a large number considering that the estimated multiplier for TLTRO, which differently from the tiering was explicitly targeted to increase bank lending, was 30 (Altavilla, Barbiero, Boucinha, and Burlon, 2023).

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 either not statistically significant or smaller in size 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.

Taken together, these results confirm that the effect of the tiering system on bank lending is not driven by the net wealth channel: The effects on profitability that we capture over our sample period may be too small for banks' capital buffers to affect lending policies. The findings also do not support concerns that a higher return of excess liquidity may discourage bank lending and suggest that banks with unused exemptions benefit from an improved functioning of the money market. Such an interpretation is also consistent with the finding that the supply of credit by banks with high unused allowances increased only in 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 access to the money market is the driving force of the effects of the tiering. If the positive effect of high unused tiering

allowances on the supply of credit reflected banks' improved access to the money market in the post-implementation period, the increase in credit supply should be driven by banks that encountered more difficulties in obtaining liquidity through the money market before the introduction of the tiering. 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 lend 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 facilitates monetary transmission through banks with ex ante more difficult access to the money market.

Column (3) confirms that the differences in lending behaviour of banks with high unused exemptions in the post-implementation period are statistically significant and depend on the interest rate that banks faced in the money market before the implementation period.

Column (4) considers a bank's borrowing rates in the month right before the interim and the implementation periods, without the interaction with banks' unused exemptions. A higher ex ante borrowing rate is associated with increased credit extension only in the post-implementation period, confirming that the reallocation of liquidity through the money market and banks' ability to borrow matter. All banks with higher borrowing rates lend more on average (columns (4) and (5)), but banks that have higher borrowing rates *and* higher unused exemptions lend even more, possibly because having low liquidity they faced more uncertainty about access to the credit market before the tiering implementation.

Overall, this evidence indicates that the tiering system, by reducing segmentations in the money market, increases the supply of credit to non-financial corporations. The findings also

mitigate concerns that the cross-sectional differences in banks' willingness to extend credit may be driven by the decrease in the policy rate, contextual to the tiering announcement. While the further decrease in the DFR may have been particularly costly for banks with high excess liquidity, in Table 6, we do not find that these banks lend less, calling into question the merit of this alternative explanation. More importantly, even if banks with unused exemptions might be viewed to suffer less from a decrease in the DFR, there is no reason why this alternative mechanism would translate in an increase in lending only for those banks that are revealed to have more difficult access to the money market by a higher borrowing rate.

Table 9 provides additional evidence that ex ante financial constraints help explaining the cross-sectional differences in bank lending after the introduction of the tiering. Our conjecture is that banks with unused exemptions and high ex ante borrowing interest rates in the money market lend more post implementation because having increased and strengthened their money market relationships, they fear less the possibility of future liquidity shortfalls. Hence, they are more willing to extend corporate loans to borrowers. In column (1), we shed direct light on these mechanism for the banks for which we observe the change in the number of counterparties in the unsecured money market between the average over the interim period and the average over the implementation period through MMSR. Even though this is a noisy proxy of the reductions in market fragmentations because it does not consider the secured market, the results are consistent with our earlier findings. We observe that the banks with unused exemptions that extend more loans to corporate borrowers after the implementation of the tiering are precisely those that experience an increase in money market relationships above the median.

In columns (2) and (3), we consider other two measures of banks' ex ante financial constraints, specifically bank capitalization and CDS spreads. Consistent with our earlier findings

we find that the positive effects of the tiering system on bank lending are driven by banks with low capitalization and high CDS spreads.

Overall, these findings support our hypothesis that an improvement in the functioning of the money market due to the tiering system decreases financially constrained banks' precautionary behaviour and expands the supply of credit.

The remainder of Table 9 shows that the increase in the supply of credit by banks with high unused exemptions were similarly distributed across borrowers with different risk, size, profitability, and productivity even though firms with high leverage may have benefitted more (column (4)). This indicates that the financially constrained banks with unused credit exemptions did not allocate loans to zombie firms.

6.3 Loan characteristics

Anacredit allows us to explore other aspects of the loan supply. Considering changes in loan characteristics in turn helps us to shed further light on the mechanisms through which the tiering enhanced the transmission mechanism.

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 them on to clients. However, there are important differences between banks, depending on their ex ante access to the money market. 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.

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 more unused exemptions indicating that the enhanced access to the money market and the consequent ability to insure potential cash shortfalls makes banks more willing to extend the maturity of their bank loans.

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 presumably had better access to the money market, if anything, decreased their loan maturity. Overall, this evidence confirms that the benefits of the tiering system on the transmission mechanism arise from improved access to the money market. The finding that banks with unused exemptions extend loan maturity also suggests that better access to the money market decreases banks' precautionary behaviour and allows them to commit to lend for longer periods.

If the restored access to the money market indeed decreases banks' precautionary behaviour and allows them to provide more insurance, we should also observe that banks with unused exemptions are more inclined to take liquidity risk by extending credit lines after the implementation of the tiering. Table 12 shows that banks with unused exemptions indeed extend more credit lines after the implementation of the tiering system. Both drawn (column (1)) and undrawn (column (2)) credit lines increase, leading to an overall increase in granted credit lines

(column (3)). This increase is driven by banks that experienced an improvement in their access to the money market 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 our conjecture that the transmission mechanism is enhanced by the implementation of the tiering because improved access to the money market reduced banks' precautionary behaviour and spurred lending.

7. Conclusions

We show that access to the money market matters for bank lending. Tiered reserve remuneration systems can enhance the gains from trading excess liquidity which, in turn, helps decrease segmentations in the money market. Overall, by increasing the gains from reallocating excess liquidity, these systems can enhance the monetary policy transmission mechanism.

We highlight these mechanisms in the context of the euro area. The sharp increase in excess liquidity in the euro area due to the ample monetary policy accommodation following the financial crisis has led to an increase in the aggregate cost of holding excess liquidity. Coupled with a negative interest rate policy, this had the potential to put pressure on bank intermediation capacity with negative consequences for the bank-based transmission of monetary policy. The introduction of the two-tier system for reserve remuneration countered this risk by improving banks' net wealth. In addition, it enhanced the transmission mechanism not only by empowering the removal of non-negativity restrictions on future expected short rates and contributing to lengthen loan maturity, but mostly because it revived banks' activity in the money markets. This in turn decreased banks' precautionary behavior, thus benefitting the supply of credit to the real economy.

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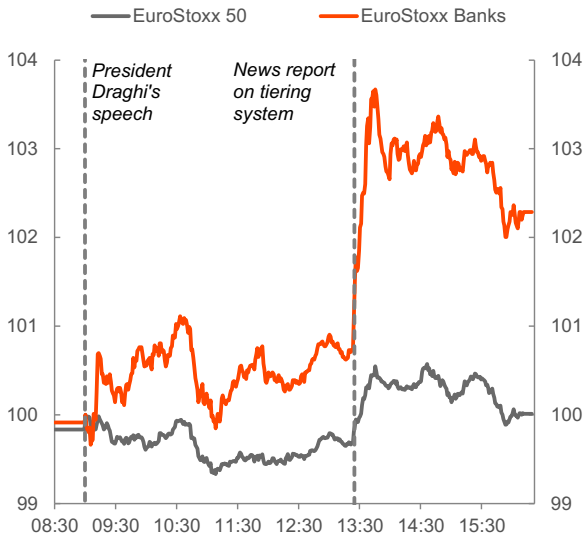
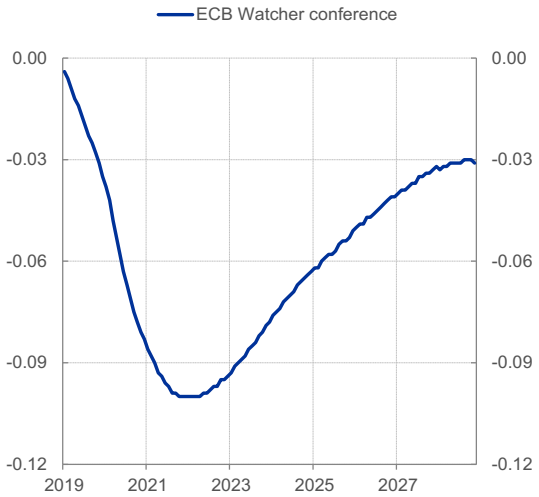
Figures

Figure 1: European stock market reaction around the first news about a tiering system (March 27, 2019)



Note: 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: Yield curve movements around the ECB Watchers Conference (27-03-2019)

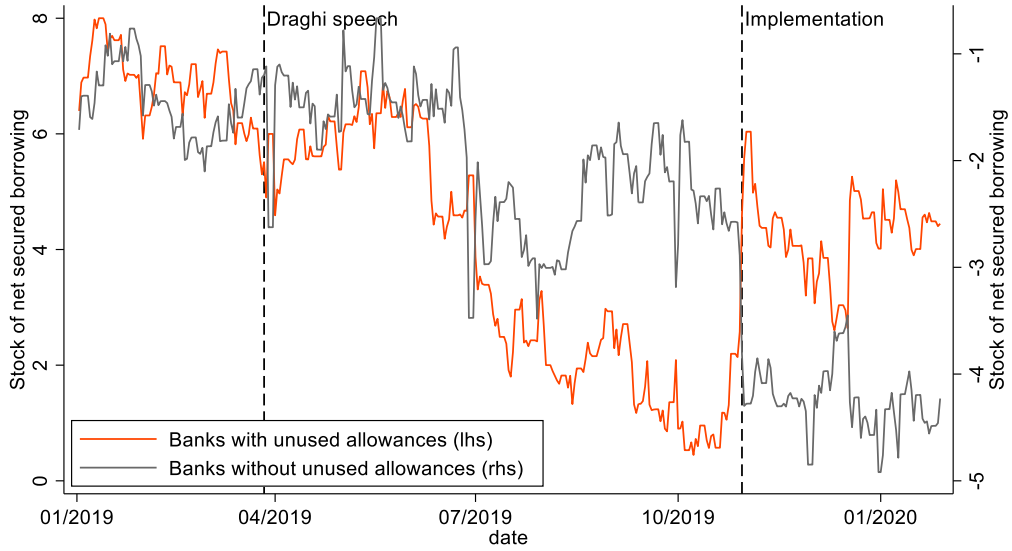


Note: The chart shows the change in the instantaneous forward curve as of 27-03-2019.

Figure 3. Net borrowing in the money market

The figure shows banks' 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

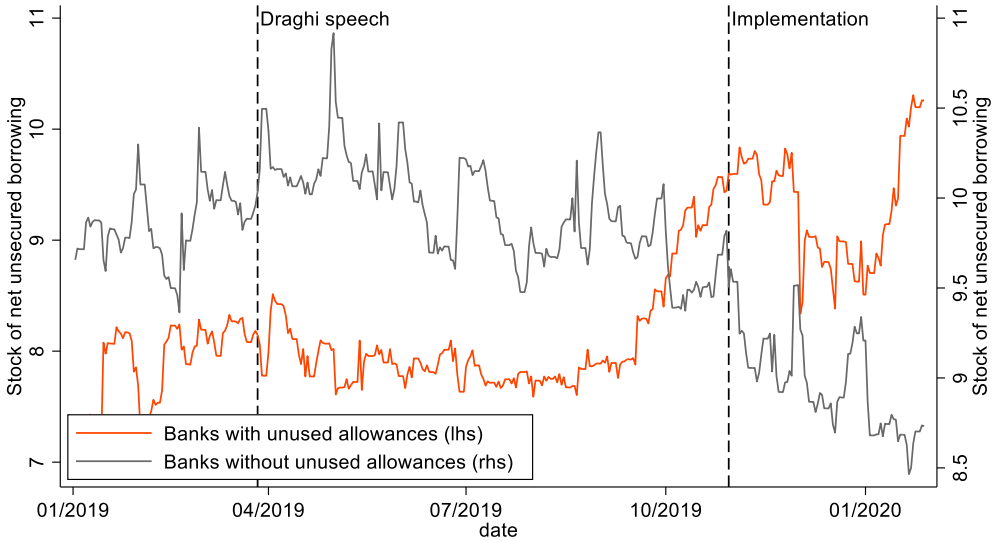
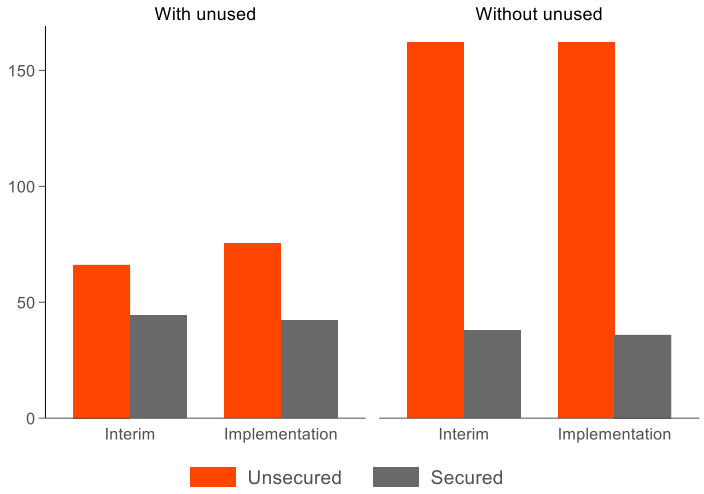


Figure 4. Trading networks in the money market

The figure plots the average number of active money market trading relationships by banks during the period following President Draghi's speech hinting at a tiering system on March 27, 2019 and the eventual implementation of the system ("Interim"), as well as in the period following the start of the system on October 30, 2019 ("Implementation"). Active trading relationships are the number of counterparties with which the banks in the sample had an outstanding transaction. The red bars represent the number of active trading relationships in the unsecured segment, while the grey bars indicate the number of active trading relationships in the secured money market. The data is furthermore split into banks with unused tiering allowances during the maintenance period preceding the implementation of the tiering system (left), and into banks without unused allowances (right). Panel A considers the number of counterparties from which banks had active borrowing transactions, and Panel B the number of counterparties to which banks were lending funds.

Panel A: Borrowing relationships



Panel B: Lending relationships

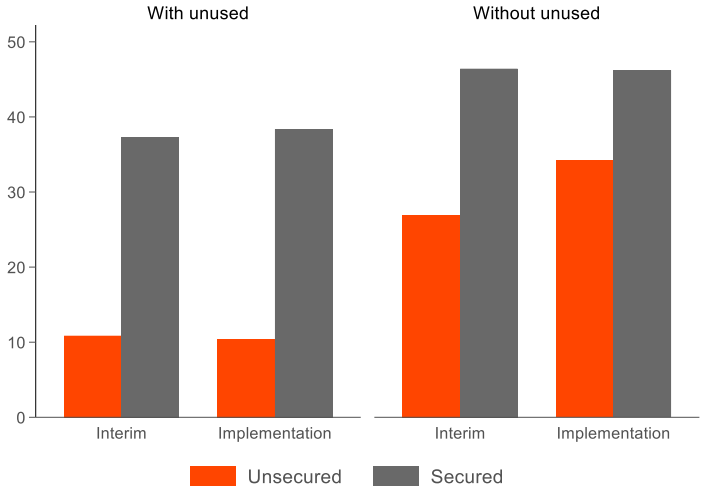


Figure 5: Composition of unsecured borrowing transactions

The figure shows banks' average daily unsecured borrowing transaction flows, split by counterparty sector (banks vs. non-banks) and location (domestic meaning same jurisdiction as the reporting bank, foreign meaning different jurisdiction as the reporting bank). Panel A shows the daily unsecured borrowing transactions in absolute values (EUR billion). The data is split between banks with unused tiering allowances (red line) and without (grey line) during the maintenance period immediately preceding the start of the tiering system at the end of October 2019. Panel B shows for the group of banks with unused allowances the share of the domestic and foreign bank and non-bank counterparties. The vertical lines mark the start of the tiering system on October 30, 2019.

Panel A: Average daily unsecured transaction flows by counterparty sector and location (EUR billion)

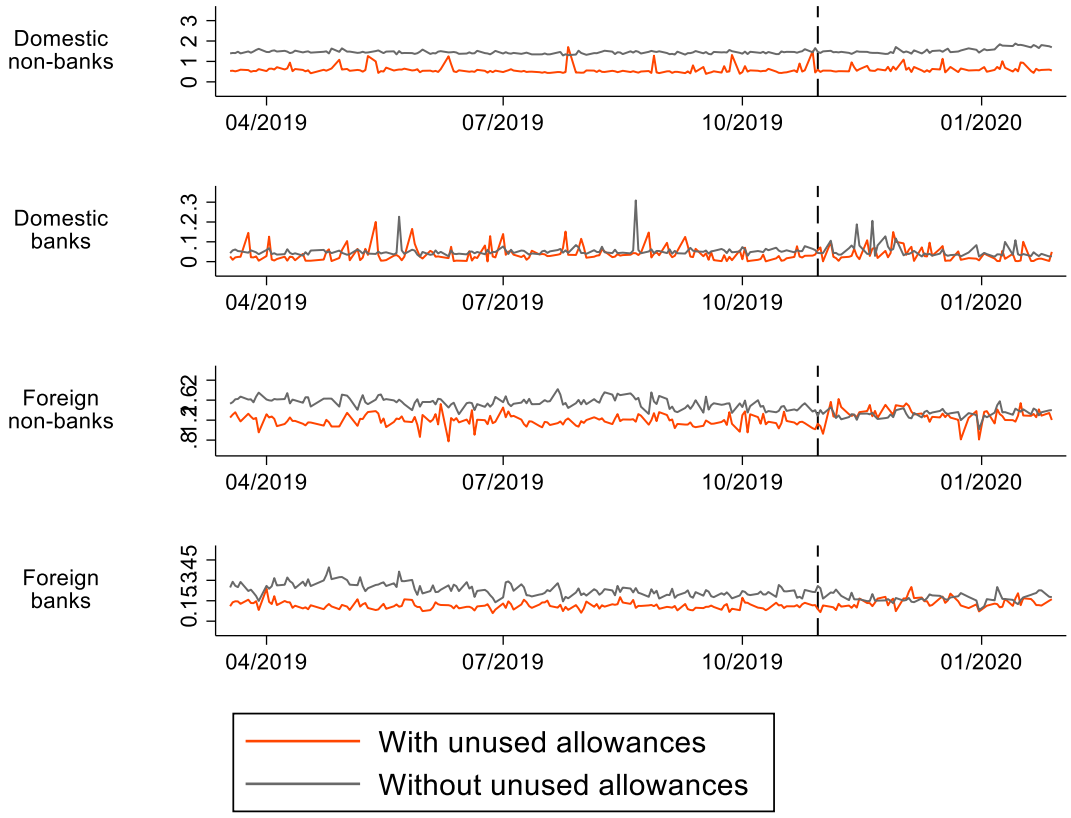


Figure 6: Money market interest rates

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.

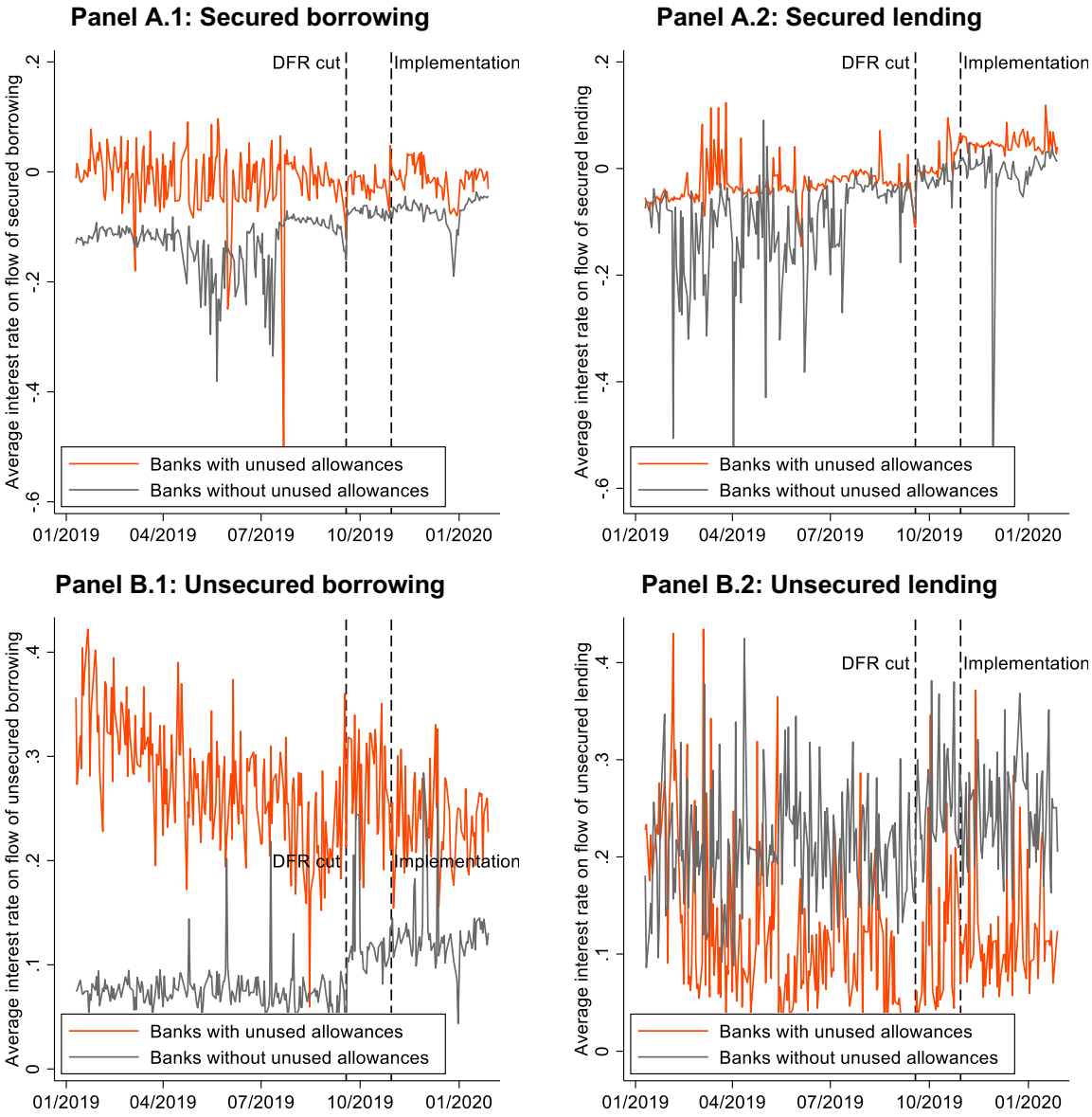


Figure 7: Increase in net unsecured borrowing conditional on prior exposure of bank and counterparty

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 excess 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 exemptions above zero after the implementation of the tiering as a function of the excess liquidity of the counterparty: $\boldsymbol{\beta_2}\overline{\mathbf{Exposure}^{Oct\ 2019}} + \boldsymbol{\beta_4}\overline{\mathbf{Exposure}^{Oct\ 2019}} \times \mathbf{Counterparty\ Excess\ allowance_{jt}}$. 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.

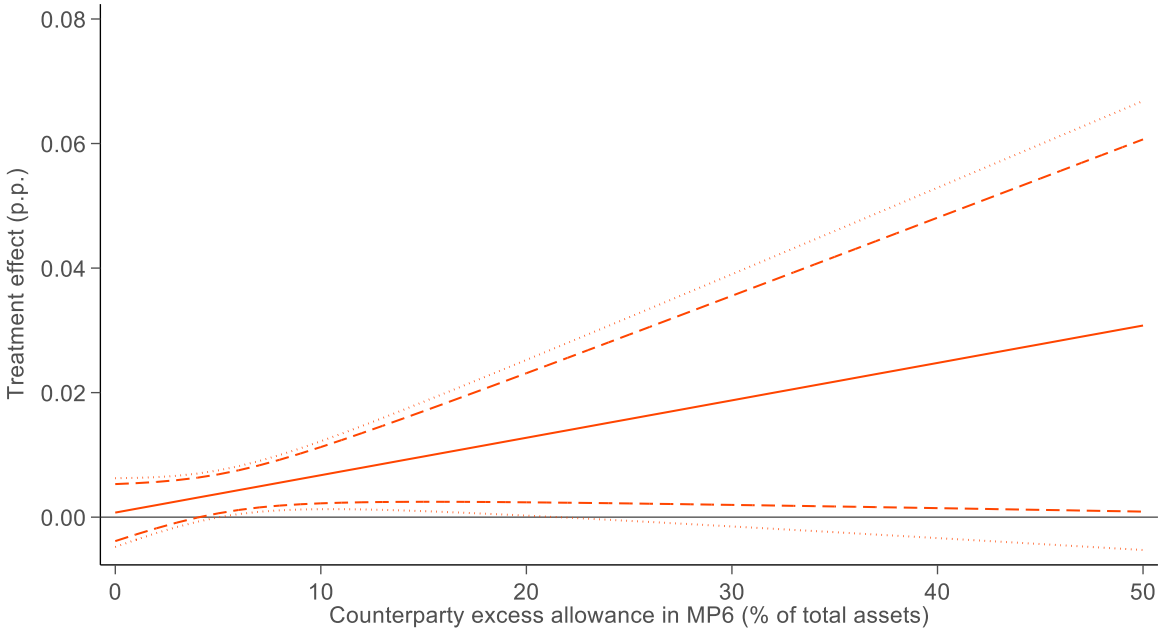
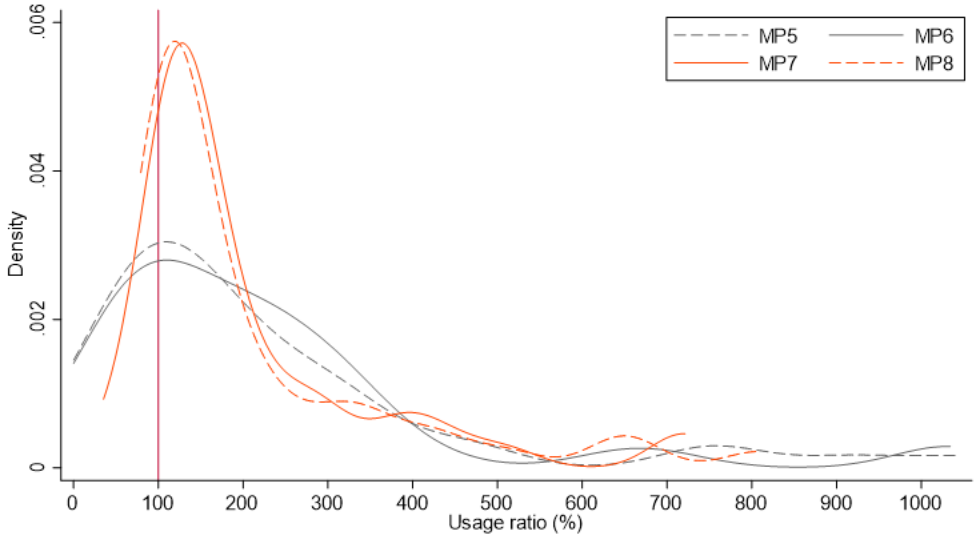


Figure 8: Excess Liquidity across Euro Area Banks Before and After the Tiering

We plot 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).



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 NFC loans	p.p.	Monthly change in ratio of NFC loans over assets.	9,325	-0.004	0.878
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
Monthly assets growth	%	Monthly percentage change in assets.	9,325	0.123	4.858
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
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
Volume of NFC loans with inverse hyperbolic sine function	IHSF(EUR mln)	Inverse hyperbolic sine function of outstanding amounts (in EUR million) of loans between a bank and a firm in a given month, with missing values of the balanced sample substituted with nil value.	36,163,821	-2.318	1.954
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 stock of 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: Average daily abnormal returns around tiering announcements

This table reports an event study examining average daily abnormal returns in the two-day event window around the tiering announcements (27 March, 12 September and 30 October 2019). Column (1) considers a cross-sectional regression in which the abnormal returns associated with the three events are cumulated. In the rest of the table, we consider a panel in which for each bank we have the two-day cumulative abnormal return of each event as dependent variable. Abnormal returns are computed using a Fama-French three-factor model over an estimation period that goes from January 2014 to June 2020. P-values based on robust standard errors are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Dependent Variable:	(1) Abnormal returns average across events	(2) Abnormal returns in each event	(3) Abnormal returns in each event	(4) Abnormal returns in each event
Exposure to Tiering Savings in March 2019	2.387**			
	(0.973)			
Tiering Savings in September 2019		0.874	0.868	1.552
		(1.193)	(1.262)	(1.186)
Tiering Savings in October 2019		1.069*	1.323*	1.655*
		(0.568)	(0.752)	(0.844)
Unexempted excess liquidity holdings	-0.124**		-0.055	0.027
	(0.060)		(0.116)	(0.102)
NPL ratio	-0.015		-0.081	-0.082
	(0.011)		(0.120)	(0.117)
Holdings of government securities	0.009		0.654***	0.669***
	(0.033)		(0.227)	(0.232)
Deposit ratio	-0.003		0.085	-0.116
	(0.009)		(0.087)	(0.160)
TLTRO funds	-0.002		-0.374	-0.413
	(0.036)		(0.251)	(0.272)
Assets				-9.407
				(5.902)
ROE				0.047
				(0.037)
Constant	-0.063			
	(0.310)			
Event FE	-	Yes	Yes	Yes
Bank FE	-	Yes	Yes	Yes
Observations	50	150	150	149
R-squared	0.113	0.382	0.462	0.479

Table 3: Money market volumes around the introduction of the two-tier system

Panel A. Bank level regressions

The table shows results from differences-in-difference 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 30 January and 12 March 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 30 October 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 01 January 2017 to 28 January 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. Controlling for shocks to the supply of short-term funding

The table shows results from differences-in-difference regressions of banks' unsecured net borrowing on exposure to the tiering system at the bank-counterparty level. The dependent variable in all columns is the banks' stock of outstanding net 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 01 January 2017 to 28 January 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	(1)	(2)	(3)
Exposure (Feb 2019) x Interim (Mar-Oct 2019)	-0.002* (0.001)	0.0199* (0.011)	0.012 (0.009)
Exposure (Oct 2019) x Implementation (Nov 2019-Feb 2020)	0.002* (0.001)	0.016* (0.008)	0.009*** (0.003)
CDS	0.007 (0.006)	0.009 (0.011)	0.018 (0.016)
Bank's country-MP fixed effects	Y	-	Y
Bank fixed effects	Y	Y	-
Counterparty-MP fixed effects	-	Y	Y
Bank-counterparty fixed effects	-	-	Y
Observations	23,337,146	23,333,780	23,333,780
No. Banks	42	42	42
R2	0.021	0.231	0.761
R2 (within)	0.001	0.001	0.001

Table 4: Changes in excess liquidity

The table shows results from differences-in-difference regressions of banks' excess liquidity on exposure to the tiering system. The dependent variable in all columns is banks' 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 27 March 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 30 October 2019. "Implementation (Nov 2019-Feb 2020)" is an indicator variable for the time after 30 October 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 5: Changes in government bond holdings

The table shows results from differences-in-difference regressions of banks' government bond holdings on exposure to the tiering system. The dependent variable in all columns is banks' 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 27 March 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 30 October 2019. "Implementation (Nov 2019-Feb 2020)" is an indicator variable for the time after 30 October 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 6: Effects of the Tiering 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 in all columns is the logarithm of loans by bank *b* to a non-financial corporation *i* 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 27 March 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: Volume of NFC loans	(1) Log	(3) Log
Exposure(Feb 2019)*Interim(Mar-Oct 2019)	0.011	0.015
	(0.009)	(0.012)
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)	0.068***	0.075***
	(0.019)	(0.023)
Tiering Savings(Feb 2019)*Interim(Mar-Oct 2019)	-0.013	
	(0.051)	
Tiering Savings(Oct 2019)*Implementation(Nov 2019-Feb 2020)	0.030	
	(0.076)	
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	-0.044	-0.043
	(0.034)	(0.033)
Excess liquidity	0.006	0.006
	(0.004)	(0.004)
Holdings of government securities	0.037**	0.037**
	(0.017)	(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	10,225,016	10,256,326
R-squared	0.935	0.935

Table 7: Changes in lending to firms

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 *b* to a non-financial corporation *i* in month *t* in columns 1 to 4. In column 5, we consider the inverse hyperbolic sine function transformation to include observation for lenders to firm *i* that do no extend a new loan during a month. "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 27 March 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)	(5)
Volume of NFC loans	Log	Log	Log	Log	Inverse hyperbolic sine function
Exposure(Feb 2019)*Interim(Mar-Oct 2019)	0.012	0.007	0.013	0.011	0.002
	(0.011)	(0.006)	(0.010)	(0.009)	(0.002)
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)	0.066***	0.040***	0.074***	0.066***	0.009*
	(0.025)	(0.012)	(0.017)	(0.019)	(0.005)
CDS	-0.049	-0.021	-0.034	-0.045	-0.002
	(0.040)	(0.020)	(0.032)	(0.033)	(0.004)
Excess liquidity	0.010**	0.002	0.009**	0.006	0.001
	(0.005)	(0.002)	(0.005)	(0.004)	(0.001)
Holdings of government securities	0.055***	0.026***	0.047***	0.038**	0.004*
	(0.016)	(0.009)	(0.016)	(0.016)	(0.002)
Deposit ratio	0.000	-0.000	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**	0.001**
	(0.002)	(0.001)	(0.002)	(0.001)	(0.000)
Bank FE	Yes	Yes	Yes	-	-
Country-Month FE	Yes	-	-	-	-
Industry-Location-Size-Month FE	-	Yes	-	-	-
Firm-Month FE	-	-	Yes	Yes	Yes
Bank-Firm FE	-	-	-	Yes	Yes
Observations	35,356,355	34,338,371	10,353,666	10,256,326	17,903,543
R-squared	0.084	0.719	0.697	0.935	0.927

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

The table shows results from differences-in-difference 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. In columns (4) and (5), each bank's money market rate is included as a continuous variable to estimate the interaction terms. "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 27 March 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 30 October 2019. "Implementation (Nov 2019-Feb 2020)" is an indicator variable for the time after 30 October 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: Changes in lending to firms by lender and borrower characteristics

The table shows results from differences-in-difference regressions of banks' lending to firms on the banks' exposure to the tiering system. Each column reports two separate regressions, one for above and one for 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 above and below median subsamples. "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. In column 1, the change in the number of unsecured money market trading relationships of a bank is defined between the average over the interim period and the average over the implementation period. 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)	(8)
Sample splits by:	Change in money market relations	Bank capital	Bank CDS	Firm PD	Firm size	Firm ROA	Firm leverage	Firm productivity
Above median:								
Exposure(Feb 2019)*Interim(Mar-Oct 2019)	-0.004	-0.005	0.015	0.001	0.009	0.008	0.009	0.013
	(0.004)	(0.004)	(0.012)	(0.012)	(0.008)	(0.008)	(0.008)	(0.008)
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)	0.128***	0.003	0.081***	0.051***	0.058***	0.067**	0.071***	0.064***
	(0.035)	(0.007)	(0.022)	(0.017)	(0.020)	(0.028)	(0.022)	(0.022)
Below median:								
Exposure(Feb 2019)*Interim(Mar-Oct 2019)	0.030	0.009	0.002	0.017	0.003	0.006	0.005	-0.000
	(0.025)	(0.007)	(0.011)	(0.012)	(0.008)	(0.007)	(0.008)	(0.008)
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)	-0.016	0.068***	0.006	0.072**	0.070**	0.059***	0.052**	0.062**
	(0.026)	(0.023)	(0.018)	(0.029)	(0.029)	(0.019)	(0.023)	(0.026)
F-test: Above median = Below median								
Exposure(Feb 2019)*Interim(Mar-Oct 2019)	1.85	3.19*	0.71	2.34	2.62	0.56	1.45	5.51**
Exposure(Oct 2019)*Implementation(Nov 2019-Feb 2020)	10.91***	7.61***	7.04***	0.88	0.98	0.79	12.56***	0.04
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank-Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 10: Changes in lending rates

The table shows results from differences-in-difference regressions of the lending rates on banks' exposure to the tiering system. In column (1) the dependent variable is the lending rate for a loan from bank *b* 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. In column (5), each bank's money market rate is included as a continuous variable to estimate the interaction terms. "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, 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 30 October 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 differences-in-difference regressions of the loan maturity on banks' exposure to the tiering system. In column (1) the dependent variable is the maturity for a loan from bank *b* 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. In column (5), each bank's money market rate is included as a continuous variable to estimate the interaction terms. "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, 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 30 October 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: Increase in drawn and undrawn credit lines and banks' improved access to money markets

The table shows results from differences-in-difference regressions of banks' credit lines (drawn in columns 1, 4 and 7, undrawn in columns 2, 5 and 8, and overall in columns 3, 6 and 9) 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, 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 30 October 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