

# Mixing QE and Interest Rate Policies at the Effective Lower Bound: Micro Evidence from the Euro Area<sup>\*</sup>

Christian Bittner<sup>1</sup>

Alexander Rodnyansky<sup>2</sup>

Farzad Saidi<sup>3</sup>

Yannick Timmer<sup>4</sup>

June 27, 2022

## Abstract

This paper studies jointly the roles of expansionary rate-based monetary policy and quantitative easing, in spite of their concurrent implementation around the world. We exploit the introduction of negative monetary-policy rates in a fragmented euro area, alongside cross-sectional heterogeneity in banks' balance sheets, to show that banks that are more exposed to asset-purchase programs reduce their credit supply relatively more when they incur higher funding costs. Given a zero lower bound (ZLB) on retail deposit rates, an asset swap between securities and reserves reduces banks' net worth as the cost of holding reserves cannot be matched with a reduction in their cost of funding. Using administrative data from Germany, with deposit rates close to the ZLB, we also uncover that German banks rebalance their interbank lending from safe to risky countries, and that quantitative easing would have been more successful in increasing employment in the absence of a ZLB on deposit rates.

*JEL Codes:* E44, E52, E58, E63, F45, G20, G21

*Keywords:* Negative Interest Rates, Quantitative Easing, Unconventional Monetary Policy, Bank Lending Channel

---

<sup>\*</sup>We thank Damien Capelle, Nigel Chalk, Marie Hoerova, Amir Kermani, Yann Koby, Yiming Ma, Jochen Mankart, Ralf Meisenzahl, Phurichai Rungcharoenkitkul, Mauricio Ulate, Skander Van den Heuvel, as well as conference and seminar participants at the 2021 OFCE/Sciences Po Workshop on Empirical Monetary Economics, the 1<sup>st</sup> International Conference "Frontiers in International Finance and Banking," the 4<sup>th</sup> CEMLA Conference on Financial Stability, the 2022 MFA Meeting, the 2022 Danmarks Nationalbank Workshop on Empirical Banking, the 2022 Ghent University Workshop on Empirical Macroeconomics, University of Groningen, and Deutsche Bundesbank for comments. Saidi gratefully acknowledges funding by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany's Excellence Strategy (EXC 2126/1 – 390838866). This research was conducted under Bundesbank research project number 2018\0002. The views expressed herein are those of the authors and should not be attributed to the Ukrainian government, Deutsche Bundesbank, the Eurosystem, the Federal Reserve Board, or the Federal Reserve System, and do not reflect the views of any country, organization, or other entity mentioned herein.

<sup>1</sup>Deutsche Bundesbank and Goethe University Frankfurt

<sup>2</sup>Presidential Office of Ukraine, University of Cambridge, and CEPR

<sup>3</sup>University of Bonn and CEPR

<sup>4</sup>Federal Reserve Board

# 1 Introduction

The policy space for conventional, rate-based monetary stimulus has become increasingly limited in the post-crisis era. Central banks around the world have since employed unconventional monetary policies to fulfill their mandates.<sup>1</sup> Most prominently, they have implemented large-scale asset purchases, or quantitative easing (QE), to inject liquidity into the economy. As asset-purchase programs predominantly take place in low-rate environments, when the limit of conventional monetary stimulus has been reached, quantitative easing and rate-setting monetary policy seem inextricably linked at the effective lower bound. This renders it unclear how lower rates and quantitative easing interact, and whether they substitute or complement each other ([Brunnermeier and Koby, 2018](#)).

In this paper, we approach this question through the lens of a bank-based transmission channel of monetary policy. We do so by focusing on the euro area where monetary-policy rates broke through what was believed to be the zero lower bound (ZLB) in 2014—a clear expression of nearing the limits of conventional monetary stimulus—prior to the implementation of quantitative easing. While rate pass-through is an important determinant of the effectiveness of QE ([Beraja, Fuster, Hurst, and Vavra, 2018](#); [Di Maggio, Kermani, and Palmer, 2019](#)), it may be impaired for some asset classes in a low-rate environment. We provide empirical evidence that banks that see only a weak pass-through of monetary policy to their funding costs and that are at the same time strongly exposed to QE reduce their credit supply to the real economy relatively more.

How do conventional monetary policy and QE interact, and what changes under negative monetary-policy rates? Under QE, the European Central Bank (ECB) expands its balance sheet by accumulating securities on the asset side, which are funded by reserves on the liability side. Since reserves can only be held by euro area banks, QE mechanically increases their reserves. Conventional monetary policy affects the rate on these same reserves. Cutting interest rates below zero effectively taxes newly created reserves at the central bank. In a frictionless world, banks would pass through these negative rates on their assets to their liability side. Such a scenario resembles the transmission of lower but still positive monetary-policy rates during QE. However, banks have been shown to be reluctant, or unable, to pass on negative rates to their depositors ([Heider, Saidi, and Schepens, 2019](#); [Eggertsson, Juelsrud, Summers, and Wold, 2019](#)). This gives rise to cross-sectional heterogeneity in the pass-through of lower, negative monetary-policy rates.

---

<sup>1</sup>See [Bernanke \(2020\)](#) for a synthesis of the new tools of monetary policy and their effectiveness since 2008.

Under negative monetary-policy rates, high-deposit banks incur higher funding costs in comparison to banks whose cost of funding is more aligned with the monetary-policy rate. When quantitative easing is implemented, pass-through of lower monetary-policy rates to banks' asset side remains strong, or becomes even stronger, as long-term assets are replaced with central-bank reserves. The net worth of low-deposit banks is relatively shielded because they continue to see a pass-through of lower, even negative, monetary-policy rates to their funding costs. In contrast, high-deposit banks do not only yield negative rates on central-bank reserves on their asset side but also incur relatively higher funding costs, which in turn inhibits their ability to lend out funds to the non-financial sector.<sup>2</sup>

We disentangle the effect of banks' exposure to asset purchases from the transmission of monetary policy by exploiting variation in the pass-through of negative monetary-policy rates to banks' funding costs across countries and banks. First, since the European sovereign debt crisis, banks' funding costs vary significantly across euro area countries, especially so for local deposit markets.<sup>3</sup> When the respective rates are closer to the ZLB in a given country, the pass-through of monetary-policy rates to banks' funding costs is more likely to be impaired. Second, when banks' funding costs are already close to the ZLB, the pass-through of even lower, negative monetary-policy rates is impaired primarily for retail deposits rather than other types of funding, such as wholesale market funding. This allows us to define banks' exposure to negative monetary-policy rates as a function of their funding structure, as the ZLB on retail deposit rates implies that deposit-funded banks incur relatively higher funding costs than do otherwise-funded banks.

To test how banks' exposure to negative monetary-policy rates and QE affects their credit supply, we use granular data on syndicated lending by euro area banks. These data allow us to compare the lending behavior of differentially treated banks to the same borrower. Moreover, the cross-country dimension enables us to compare banks with each other that are located in different countries where retail deposit rates may be either far away or closer to the ZLB. While syndicated loans account for a sizable portion of total bank lending, they do not necessarily capture overall bank lending behavior in the euro area. Therefore, in addition to using syndicated-loan data, we conduct further analyses using microdata from Germany where many banks do not benefit from lower funding costs due to a binding ZLB on retail deposit rates.

To capture banks' exposure to negative monetary-policy rates, we use information on their

---

<sup>2</sup>This is consistent with the rationale laid out by [Repullo \(2020\)](#), in that banks' funding costs determine their response to counteract what would otherwise constitute an adverse shock to their profitability.

<sup>3</sup>See, for instance, [Bittner, Bonfim, Heider, Saidi, Schepens, and Soares \(2022\)](#).

funding structure, in particular their customer deposit share (Heider, Saidi, and Schepens, 2019). This reflects the rationale that high-deposit banks, in comparison to low-deposit banks, incur higher funding costs during the negative interest-rate period. To measure banks' exposure to QE during that period, we use the ex-ante relative prevalence of securities on their balance sheets (Rodnyansky and Darmouni, 2017). Finally, we interact the resulting distinction between high- vs. low-deposit and high- vs. low-security banks with time variation in the ECB's asset purchases.

Irrespective of how we define the ECB's asset purchases to spill over to euro area banks' balance sheets, we find that banks whose asset portfolios are more exposed to QE reduce their credit supply relatively more when they rely more on deposit funding. We obtain our results controlling for time-invariant unobserved heterogeneity at the bank level, time-varying unobserved heterogeneity at the level of the countries in which these banks are incorporated, and also for time-varying unobserved heterogeneity at the firm level by including firm-time fixed effects. This within-firm estimator controls sufficiently well for overall credit demand and can rule out negative credit demand shocks as a driver of our results (Khwaja and Mian, 2008; Jiménez, Ongena, Peydró, and Saurina, 2014). In this manner, we find that a bank with a both ten-percentage-point higher security and deposit ratio lends up to 8.55% less in response to a one-standard-deviation increase in asset purchases.

How do large-scale asset purchases exert an influence on banks' proclivity to lend when the central bank also pursues rate-setting monetary policy? One line of argumentation is centered on a positive effect on banks' net worth, which sets in when asset purchases positively impact security prices as the newly injected reserves may reduce term premia (Christensen and Krogstrup, 2019). This price effect, in turn, increases the marked-to-market value of banks' security holdings and, thus, raises banks' net worth—a mechanism also known as “stealth recapitalization” (Brunnermeier and Sannikov, 2014).

However, in the presence of negative monetary-policy rates, any such price-driven effect on bank net worth is confounded by a negative force on bank earnings. The QE purchases by the ECB mechanically increase central-bank reserves on banks' balance sheets, so that the amount of reserves in the system is controlled by the ECB. The negative interest rates on reserve balances therefore must be paid by banks in the euro area, and are associated with a reduction in net worth if banks' funding costs do not drop accordingly. This is the case when retail deposit rates are close to the ZLB and banks rely heavily on this funding source.<sup>4</sup> We confirm that the asset purchases

---

<sup>4</sup>Acharya and Rajan (2022) show theoretically that the creation of commercial-bank liabilities following QE can

lead to relatively lower net worth and less credit supply in low-rate environments such as the core of the euro area, while this does not apply in other countries of the euro area where sovereign yields (and deposit rates) are higher (Bittner, Bonfim, Heider, Saidi, Schepens, and Soares, 2022).

For the largest economy in the euro area, Germany, we can zoom in on this mechanism by means of rich administrative data from the Bundesbank. We first establish that the newly created reserves are disproportionately held by banks that have high security and high deposit ratios, as their securities are swapped for reserves and their ability to reduce their balance sheet is compromised due to costly and sticky customer deposits. Using credit-registry data, we, then, corroborate our headline finding that banks with higher security and deposit ratios reduce their credit supply to firms relatively more when QE is implemented. This confirms that the negative credit-supply effects are not limited to syndicated loans, but also extend to private credit attained by a wider and more representative range of firms. Economically, we find comparable but larger effects for Germany than for the whole panel of euro area banks, consistent with the idea that German deposit rates are constrained by the ZLB.

Combining the German credit-registry data with more detailed balance-sheet data than are available for the panel of euro area banks allows us to differentiate between household deposits, the rates on which face a hard ZLB, and corporate deposits, which see a stronger pass-through of negative monetary-policy rates (Heider, Saidi, and Schepens, 2019; Altavilla, Burlon, Giannetti, and Holton, 2022). This enables us to compare banks with similar deposit ratios that differ only in the source of their deposits. In this manner, we find that banks with higher security and deposit ratios reduce their credit supply only if they are funded by household deposits, reaffirming the importance of the ZLB on retail deposit rates.

Second, we use data on German banks' security holdings to examine their trading of securities around the large-scale asset purchases. We show that banks with ex-ante more securities sell more of them during the QE period, but their purchases are not significantly different from banks with fewer security holdings. Using the net sales of securities as an alternative measure of banks' exposure to QE, we corroborate our findings that banks that are more exposed to QE and have a higher deposit ratio reduce their credit supply by more. This also addresses the potential concern that the pre-existing security ratio does not proxy well for banks' exposure to QE and, as such, may be driven by other bank-specific factors unrelated to the asset purchases.

---

be contractionary for lending growth if banks see a convenience yield to liquid reserves during times of stress. This would be a separate mechanism for why central bank balance-sheet expansions might not always stimulate the real economy.

We conclude our analysis of banks’ credit-supply response by analyzing the transmission of affected banks’ credit contraction to firms’ real outcomes. We find that around the implementation of QE, German firms in lending relationships with banks that have high security and high deposit ratios see relatively weaker employment growth than their counterparts. A simple back-of-the-envelope calculation suggests that the adverse interaction of QE and negative monetary-policy rates in the presence of a ZLB on deposit rates eradicates any positive employment effects stemming from QE, such as those documented for the U.S. (Foley-Fisher, Ramcharan, and Yu, 2016; Luck and Zimmermann, 2020). Therefore, our results provide a rationale for why QE has been potentially more successful in spurring employment in the U.S. than in the euro area.

Having shown that affected banks reduce their lending, with repercussions for the real sector, we consider the possibility that they rebalance their asset side by, instead, increasing their portion of liquid assets. Unlike corporate loans, interbank loans help to transfer and redistribute reserves, but do not lead to the creation of costly deposits elsewhere in the system. To evaluate this, we scrutinize German banks’ interbank positions and find that high-deposit banks that are more exposed to QE increase their interbank lending, with possible implications for the distribution of interbank liquidity in the euro area. Using bilateral country-level banking flows, we present evidence that lends support to the idea that financial dependence of periphery banks from the core may have increased during the ECB’s large-scale asset purchases.

**Related literature.** Our paper contributes to various strands of the literature. First, we contribute to the literature on the effects of negative interest rates in general and their bank-based transmission in particular. Brunnermeier and Koby (2018) show theoretically that when interest rates drop below a “reversal rate,” a decline in interest rates can be contractionary. Ulate (2021) studies the effects of negative rates in a DSGE model where banks intermediate the transmission of monetary policy.<sup>5</sup> Heider, Saidi, and Schepens (2019) show that banks with higher deposit ratios reduce their syndicated lending by more in response to the introduction of negative monetary-policy rates in the euro area. Eggertsson, Juelsrud, Summers, and Wold (2019) show that retail household deposit rates in Sweden are subject to a lower bound and that once this bound is reached, the pass-through to lending rates and credit volumes is substantially lower, and bank equity values decline in response to further policy-rate cuts. Bottero, Minoiu, Peydró, Polo, Presbitero, and Sette (2021) show that negative interest-rate policies can have expansionary

---

<sup>5</sup>A separate strand of the literature studies the medium- to long-term effects of interest rate changes on banks’ lending behavior and the economy more broadly (Bernanke and Blinder, 1988; Christiano and Eichenbaum, 1992; Stein, 2012; Gomez, Landier, Sraer, and Thesmar, 2021).

effects on bank credit supply and firm-level outcomes through a portfolio rebalancing channel. [Bubeck, Maddaloni, and Peydró \(2020\)](#) show that banks with higher deposit ratios invest more in higher-yielding securities in response to the introduction of negative monetary-policy rates. [Ampudia and Van den Heuvel \(2018\)](#) uncover that during the period of negative interest rates in the euro area, stock prices of banks declined in response to accommodative monetary-policy announcements, and even more so for banks with a greater reliance on deposit funding.

In comparison to this literature on the transmission of negative monetary-policy rates,<sup>6</sup> we explore its interaction with large-scale asset purchases, or QE. [Krishnamurthy and Vissing-Jørgensen \(2011\)](#) study the effect of QE on interest rates in the United States. [Kojien, Koulischer, Nguyen, and Yogo \(2021\)](#) show that banks sold purchase-eligible government bonds during QE. Using bank-level data, [Paludkiewicz \(2021\)](#) finds that German banks that see a stronger yield decline on their securities portfolio induced by QE are more likely to sell (eligible) bonds and increase their lending to the real sector. [Rodnyansky and Darmouni \(2017\)](#) define banks' exposure to QE by measuring the relative prevalence of mortgage-backed securities on their books, and show that U.S. banks that were strongly exposed to QE increased their lending. [Di Maggio, Kermani, and Palmer \(2019\)](#) find that after the first round of QE in the U.S., the origination of mortgages qualifying for inclusion in eligible securities for Fed purchases increased significantly more than did those of non-qualifying mortgages. On the other hand, [Chakraborty, Goldstein, and MacKinlay \(2020\)](#) document that more exposed banks increased mortgage lending at the expense of their commercial lending. [Luck and Zimmermann \(2020\)](#) study the employment effects of the transmission of QE to bank lending in the U.S. Other papers have adopted similar approaches to investigate the effects of unconventional monetary policies in Europe (see, for instance, [Acharya, Eisert, Eufinger, and Hirsch, 2019](#); [Grosse-Rueschkamp, Steffen, and Streitz, 2019](#); [Crosignani, Faria-e Castro, and Fonseca, 2020](#); [Benetton and Fantino, 2021](#); [Carpinelli and Crosignani, 2021](#); [Peydró, Polo, and Sette, 2021](#)).

Recent theoretical work examines the relationship between unconventional monetary policy and the real economy. [Acharya and Rajan \(2022\)](#) analyze the consequences of central bank balance-sheet expansions, and argue that the offsetting liabilities that are created following an influx of reserves at commercial banks dampen the potential stimulative effects on lending growth, especially during a crisis. [De Fiore, Hoerova, and Uhlig \(2018\)](#) and [Corradin, Eisenschmidt, Hoerova, Linzert, Schepens, and Sigaux \(2020\)](#) show that asset purchases give rise to a scarcity effect,

---

<sup>6</sup>See [Heider, Saidi, and Schepens \(2021\)](#) for an overview of this literature.



which induces money market frictions and can have adverse effects on lending. [Bianchi and Biagio \(2022\)](#) argue that purchases of liquid assets (the ones we study) can be ineffective, whereas purchases of more illiquid assets (such as loans) can be more effective. [Diamond, Jiang, and Ma \(2021\)](#) show that the central-bank reserve creation through QE crowds out bank lending, consistent with our findings. In contrast to most papers in this literature, we specifically study whether the credit-supply response of banks to QE varies with the extent to which banks are exposed to the transmission of monetary-policy rates. Furthermore, while most of the QE literature focuses on the announcement effects of QE, we study its implementation during its run-time.

One of the few exceptions in the literature that studies the interaction between negative interest rates and QE is [Brunnermeier and Koby \(2018\)](#), who posit that QE should be employed only after the room for lowering rates is exhausted. When the central bank reduces interest rates, capital gains on banks' securities increase, and banks with large security holdings benefit disproportionately from these capital gains. [Brunnermeier and Koby \(2018\)](#) argue that as QE mechanically reduces securities on banks' balance sheets, the benefits of cutting interest rates are lower after QE is conducted, as banks benefit less from higher security prices. Empirically, we find that high-security banks gain less when they also rely heavily on deposit funding that sees no monetary-policy pass-through prior to QE due to the ZLB on retail deposit rates. This adverse interaction suggests that the potential complementarities between QE and policy-rate adjustments at the ZLB are limited at best (as previously conjectured by [Sims and Wu, 2020, 2021](#)).

## 2 Data

### 2.1 Bank Lending and Balance-Sheet Data

In the first part of the paper, we analyze credit supply by euro area banks using data on syndicated-loan transactions from DealScan. For a syndicated loan, different banks form a syndicate and then lend to firms. The lead arranger in a syndicate is usually responsible for monitoring the loan and various other tasks associated with risk management ([Ivashina and Scharfstein, 2010](#)). Lead arrangers tend to hold on to their loan shares, while other syndicate members (participants) can and do sell their shares in the secondary market. In the DealScan data, one only sees the facility amount, the banks that participate in the syndicate, and whether they act as lead arrangers or other participants. However, banks' individual contributions are not properly recorded most of



the time. We therefore follow the literature, and split two-thirds vs. one-third of the total loan amount equally among all lead arrangers and other participants, respectively.<sup>7</sup>

We then merge the syndicated-loan data with balance-sheet characteristics of euro area banks from Moody’s Analytics BankFocus. In particular, we use data on banks’ total security holdings, their customer deposits, as well as various other control variables. Finally, we use bank stock-price data from the same database.

## 2.2 German Microdata

We complement our analysis of syndicated lending in the euro area with administrative credit-registry data (BAKIS-M) from Germany ([Schmieder, 2006](#)). Banks domiciled in Germany are required to report all loans exceeding €1 million.<sup>8</sup> The dataset contains the loan amount outstanding to the respective borrower on a quarterly basis.

In addition, we use the Securities Holdings Statistics, SHS-Base plus,<sup>9</sup> formerly known as WpInvest ([Blaschke, Sachs, and Yalcin, 2020](#)). The database covers all securities held by German banks on their own behalf (full census). Banks report the holdings amount on a security-by-security basis.<sup>10</sup> We enrich this dataset with security master data from the Centralised Securities Database (CSDB)<sup>11</sup> ([Bade, Flory, Gomolka, and Schnellbach, 2018](#)). The purpose of the CSDB is to cover all securities likely to be held or transacted by euro area residents. With its high-quality coverage of more than ten million securities per time stamp, we incur almost no loss of observations from merging our datasets.

Furthermore, we use the monthly balance-sheet statistics (BISTA)<sup>12</sup> with coverage of banks’ asset and liability positions ([Gomolka, Schäfer, and Stahl, 2020](#)). This allows us, in particular, to construct banks’ deposit ratios (deposits over total assets) and security ratios (securities over total assets).

Finally, we merge the Bundesbank data with firm-level balance-sheet data from BvD Orbis.

---

<sup>7</sup>See, for example, [Chodorow-Reich \(2014\)](#). The results are robust to other choices.

<sup>8</sup>In January 2015 the reporting threshold was reduced from formerly €1.5 million. Note that this reporting requirement applies to all borrowers, including those with less credit exposure, as long as the total loan amount of a given borrower’s parent and all affiliated units is equal to or exceeds the threshold at any point in time during the reporting period.

<sup>9</sup>Data ID: 10.12757/Bbk.SHSSBaseplus.05122006

<sup>10</sup>See also [Timmer \(2018\)](#).

<sup>11</sup>Data ID: 10.12757/Bbk.CSDB.200903-201912.01.01

<sup>12</sup>Data ID: 10.12757/Bbk.BISTA.99Q1-19Q4.01.01

### 3 Stylized Facts

We start with graphical evidence suggesting which balance-sheet characteristics determine the extent to which euro area banks are affected by quantitative easing, bearing in mind that the ECB's preceding introduction of negative monetary-policy rates in 2014 may have affected the transmission channels of quantitative easing thereafter.

Figure 1 shows that when the ECB initiated its asset-purchase programs in 2015, banks' security holdings declined substantially. In 2013 and 2014 security holdings of banks were relatively stable, but once the ECB started purchasing assets at a large scale, security holdings of banks declined significantly, while at the same time the ECB's security holdings increased sharply. The ECB's security holdings increased by around €1,400 billion, and security holdings of euro area banks accounted for almost one-fifth of the sales, based on approximately €250 billion sold.

Interestingly, at least in observational data, the ECB interventions are not associated with a strong increase in prices. In Figure 2 (and Figure A1 - Figure A3 in the Online Appendix), which plots the price indices of several targeted euro area sovereign bonds before and after the large-scale asset purchases, the response of those price series to QE is not striking in terms of either magnitude or persistence. While we do not and cannot interpret this evidence as causal, the relatively small increase in prices suggests that any effects of higher security prices on bank net worth are potentially complemented with additional forces inducing banks to sell these securities.

The asset purchases of the ECB (or the respective central banks) induced an asset swap of securities held by banks, which sold them to the ECB, for central-bank reserves. Figure 3 confirms that most banks saw an increase in their reserves between 2013 and 2016. The figure plots the relationship between the share of reserves out of total assets in 2013 and 2016. Banks on the 45-degree line have an equal share of reserves on their balance sheet in 2013 and in 2016. Banks that have a larger share of reserves in 2016 than in 2013 are above the 45-degree line and marked in green, while those that have a smaller share of reserves are below the 45-degree line and marked in red. The size of the bubble reflects the size of the reserves. The graph shows that most banks have a larger share of reserves in 2016, which yield negative interest rates, than in 2013, when the ECB's deposit facility rate was still zero.

This increase in reserves was stronger for banks with greater exposure to QE due to higher (pre-determined) security ratios, consistent with the idea that asset purchases lead to a swap of securities for reserves on banks' balance sheets, as can be seen in the upper left panel of Figure 4.

Banks that had more securities in 2013 were more exposed to QE and sold more securities in the course of the QE implementation, leading to a stronger reduction in security holdings, as shown in the bottom right panel. We label such banks with higher pre-determined security ratios as “treated” more heavily by the ECB’s asset-purchase programs.<sup>13</sup> The remaining panels of [Figure 4](#) also show that banks that had higher pre-existing security ratios increased their interbank lending and the sum of interbank lending and reserves by more.

Taken together, our evidence suggests that high-security banks end up holding more negative interest-rate bearing assets relative to banks with less exposure to QE. In addition, liquid securities are not only replaced by central-bank reserves on affected banks’ balance sheets, but the respective banks also become more active in (liquid) interbank lending. This raises the question to what extent high-security banks’ treatment under QE affects their credit provision to the non-financial sector, to which we turn next.

## 4 Evidence from Syndicated Lending

### 4.1 Empirical Setup

In this section, we analyze syndicated lending by banks in the euro area. In particular, we study the lending behavior of banks that are differentially exposed to the negative interest-rate policy and asset-purchase programs.

As pointed out by, among others, [Brunnermeier and Koby \(2018\)](#), [Heider, Saidi, and Schepens \(2019\)](#), and [Eggertsson, Juelsrud, Summers, and Wold \(2019\)](#), banks tend to face a zero lower bound on retail deposit rates, as they are either reluctant, or it is impossible for them, to lower deposit rates to below zero in spite of the monetary-policy rate having crossed that threshold. If banks set a rate below a “reversal rate” (such as zero), customers may withdraw their deposits. As this friction is not present for wholesale funding sources, banks that rely more on retail deposit funding are more likely to be adversely affected by negative interest rates on central-bank reserves. Consequently, following [Heider, Saidi, and Schepens \(2019\)](#), we capture banks’ exposure to negative monetary-policy rates by their deposits-to-assets ratio.

At the same time, as argued before, banks that have a high security ratio are more exposed to asset-purchase programs. First, they are more likely to benefit from asset-price appreciation than

---

<sup>13</sup>In [Section 6](#), we provide more direct evidence for German banks, and thereby confirm, that pre-existing security holdings predict well the sales of securities when QE is implemented.

banks with lower security ratios (Brunnermeier and Sannikov, 2016). Second, banks with high security ratios are more affected through a substitution of securities with central-bank reserves. If central-bank reserves, in turn, yield negative rates and banks are unable to pass on negative interest rates to their funding costs, greater exposure to asset-purchase programs can reduce bank profitability and, thus, lead to a reduction in credit supply.

Figure 5 plots euro area banks' security ratios on the y-axis against their deposit ratios on the x-axis. The size of the dots reflects the total assets of each bank in 2013. The average security ratio is just above 20%, as indicated by the dotted line on the y-axis. The average deposit ratio is significantly higher, at around 50%, as indicated by the dotted line on the x-axis. The correlation coefficient between the security ratio and the deposit ratio is only -0.03 and statistically insignificant, suggesting that banks with higher deposit ratios, which are more exposed to negative monetary-policy rates, are not necessarily more exposed to asset purchases and vice versa. The scatter plot also illustrates that there exists notable variation within each size category. While, on average, larger banks have lower deposit ratios, both large and small banks exhibit similar variation in terms of their exposure to asset purchases.

To test whether banks that are more exposed to both QE and negative monetary-policy rates react differently in terms of their credit supply, we estimate the following regression specification at the transaction level using our syndicated-loan data:

$$\begin{aligned} \ln(Lending_{i(l),j(l),t(l)}) = & \beta_1 QE \times Security\ Ratio_i + \beta_2 QE \times Deposit\ Ratio_i \\ & + \beta_3 QE \times Security\ Ratio_i \times Deposit\ Ratio_i \\ & + \mu_i + \theta_{j,m(t)} + \phi_{c(i),m(t)} + \epsilon_{i,j,t}, \end{aligned} \quad (1)$$

where  $Lending_{i(l),j(l),t(l)}$  is the amount lent by bank  $i$  (incorporated in country  $c$ ) to borrower  $j$  at date  $t$  in loan package  $l$ .  $QE$  is a time-varying measure of the ECB's asset purchases, which we standardize to have a 0 mean and a standard deviation of 1 throughout (unless indicated otherwise).  $Security\ Ratio_i$  is the share of securities over assets of bank  $i$  in 2012, and  $Deposit\ Ratio_i$  is the share of deposits over assets of bank  $i$  in 2012. The sample spans the time period from the introduction of negative monetary-policy rates in 2014 to 2020. Standard errors are clustered at the bank level.

Importantly, besides bank fixed effects,  $\mu_i$ , we include borrower by month-year fixed effects,  $\theta_{j,m(t)}$ , and (banks') country by month-year fixed effects,  $\phi_{c(i),m(t)}$ , to control for firm-level deter-

minants of credit demand and time-varying unobserved heterogeneity at the level of the country  $c$  in which a given bank  $i$  is incorporated.

## 4.2 Baseline Results

[Table 1](#) shows the results from estimating (3).<sup>14</sup> All specifications yield a negative estimate of  $\beta_3$ , indicating that banks that are more exposed to both QE and negative monetary-policy rates lend less in response to asset-purchase programs than their less exposed counterparts.

This result is robust to different definitions of  $QE$ . In columns 1 and 2, we define  $QE_{c(i),m(t)}$  as the amount of government bond purchases of country  $c$ , where bank  $i$  is incorporated, by the ECB in a given month-year  $m(t)$ , divided by the respective country’s banks’ total security holdings in 2012. This can be seen as a measure of the absorption of securities relative to a pre-existing stock. This “flow” measure of QE constitutes our baseline measure.<sup>15</sup> In column 3, instead of scaling the asset purchases of government bonds with the 2012 securities held by banks in the respective country, we scale the purchases by the one-month lagged security holdings of the same banks.

Our estimate of  $\beta_3$  is virtually invariant across the first three columns, where we additionally vary the set of fixed effects. In column 1, we control for bank and borrower by month-year fixed effects. The latter are included so as to capture time-varying unobserved heterogeneity at the borrower level, including but not limited to loan demand ([Jiménez, Ongena, Peydró, and Saurina, 2014](#); [Khawaja and Mian, 2008](#)). Effectively, we identify our effect using firms that borrow from different banks in the same month. Thus, to the extent that credit demand does not vary across banks as a function of their exposure to negative monetary-policy rates and QE, any difference in lending can be attributed to credit supply rather than demand. To estimate  $\beta_3$  in the presence of such borrower-time fixed effects, we implicitly restrict our sample to firms that borrow from at least two banks at the same time. However, as we focus on syndicated loans, which by definition are made by a syndicate of banks, this restriction is innocuous. In all remaining columns, we also include bank  $i$ ’s country by month-year fixed effects, which control for time-varying unobserved heterogeneity associated with a given bank’s country  $c$ .

In columns 4 and 5, we use the natural logarithm of the monthly purchases in country  $c$  and overall, respectively, instead of the scaled monthly purchases. In columns 6 and 7, we use the

<sup>14</sup>[Table 1](#) only displays the coefficient on the triple interaction, as the double-interaction terms are difficult to interpret when the triple interaction is included. For completeness, we present the estimated coefficients on the double-interaction terms in [Table A1](#) of the Online Appendix.

<sup>15</sup>[D’Amico and King \(2013\)](#) show that there are both flow and stock effects of QE.

natural logarithm of holdings rather than purchases, i.e., a stock measure of QE rather than a flow measure, in country  $c$  and overall, respectively. Across all specifications, our coefficient ranges from -0.95 to -0.62. In terms of economic magnitude, a bank with a 50% security and a 50% deposit ratio (0.25) relative to a bank with a 40% security and a 40% deposit ratio (0.16) lends between 8.55% ( $= (0.25 - 0.16) \times 0.95$ ) and 5.58% ( $= (0.25 - 0.16) \times 0.62$ ) less in response to a one-standard-deviation increase in asset purchases. To measure an average effect on credit supply, we redefine  $QE$  in column 8 to be an indicator variable that equals 1 during the quantitative-easing period. The respective coefficient on the triple interaction implies 18% less lending.

Figure 6 illustrates the result from column 2 in Table 1 graphically. It plots the coefficient  $\beta_3$  multiplied with the amount of  $QE_{c(i),m(t)}$  conducted in each month, which we normalize to be between 0 (no purchases) and 1 (maximum amount of purchases) for this purpose. Banks that are strongly exposed to QE and negative rates supplied less credit when the ECB started purchasing securities amounting to €60 billion per month in March 2015. When purchases were ramped up to €80 billion between April 2016 and March 2017, credit supply of exposed banks declined even more. In April 2017 the ECB started tapering the amount of monthly asset purchases to €60 billion, in January 2018 to €30 billion, and in October 2018 to €15 billion. Once the ECB started to taper, the credit supply of exposed banks converged back to that of banks that had been less exposed to QE and negative rates.

One concern regarding the identification of these estimates could be that banks that are strongly exposed to both QE and negative rates are also different in terms of other characteristics that may govern bank lending over time. To investigate this, in Table A2 of the Online Appendix, we regress bank characteristics in 2012 on the interaction between the security ratio and the deposit ratio in the cross-section of euro area banks. Affected banks, i.e., those with high security and high deposit ratios, do not differ substantially in terms of other important bank characteristics, such as total assets, capitalization, or profitability. As such, it does not come as a surprise that our estimates in Table 1 are robust to including interaction terms of (all variants of) our  $QE$  measure with the above-mentioned control variables (see Table A3 in the Online Appendix).

Figure 7 plots the coefficient on the interaction of  $Security\ Ratio_i$  and  $Deposit\ Ratio_i$  annually between 2010 and 2020. Before the introduction of negative monetary-policy rates, there is no discernible difference in credit supply as a function of banks' exposure to negative monetary-policy rates and QE. This absence of a pre-trend, combined with a strong decline in the coefficient once negative monetary-policy rates (red vertical line) and QE (purple dashed line) are introduced,

lends support to our identifying assumption that banks more exposed to QE and negative rates would not have been on different trajectories absent the introduction of these policies.

In [Table 2](#), we re-estimate our baseline specification for a longer time period (starting in 2010, as in [Figure 7](#)) and replace the *QE* treatment variable with an indicator variable,  $Post_t$ , that equals 1 starting with the introduction of negative monetary-policy rates in the euro area (June 11, 2014). Given that the QE and negative interest-rate periods roughly coincide, we effectively replace our QE treatment-intensity variable with a dummy variable for non-zero asset purchases by the ECB, similarly to column 8 of [Table 1](#). In spite of incorporating a significantly longer pre-period, comprising the reduction of the deposit facility rate to zero in July 2012, the results remain similar: banks that are more exposed through their balance sheet (higher deposit and security ratios) to both negative interest rates and QE lend less during the negative interest-rate period than before compared to less exposed banks. This holds also after including our most restrictive set of control variables, including borrower by month-year and country by month-year fixed effects.

Instead of comparing a (long) pre-negative-rates period ( $Post_t = 0$ ) with a post-negative-rates period ( $Post_t = 1$ ), one can also estimate the effect of each (additional) rate cut into negative territory. For this purpose, we replace the indicator variable  $Post_t$  with the actual deposit facility rate,  $Deposit\ Facility_t$ . As the latter was actually zero in 2012, we start the sample period then.<sup>16</sup> The results are in [Table 3](#). In line with our estimates in [Table 2](#), the coefficient on the triple interaction is positive, implying that lower, negative deposit facility rates are associated with less lending by banks that are more exposed to both negative interest rates and QE.

These results raise the question whether negative monetary-policy rates would have led to reduced credit supply by banks with high deposit and security ratios even absent QE. To test this, we explore further heterogeneity in terms of the response to negative interest-rate cuts before and after QE was introduced, by estimating a staggered difference-in-differences specification. For this purpose, we split our sample into four periods: (1) a pre-period starting in 2010, (2) an *NIRP CUT BEFORE QE<sub>t</sub>* period, (3) a *QE<sub>t</sub>* period, and (4) an *NIRP CUT AFTER QE<sub>t</sub>* period comprising further rate cuts by the ECB (with the first one after the announcement of QE taking place on December 9, 2015 and the last one on September 18, 2019). The estimates in [Table 4](#) show that banks that are more exposed to QE and negative monetary-policy rates do not lend less than their counterparts after the first cut into negative territory without QE implemented at the same

---

<sup>16</sup>Our results are robust to including the deposit facility rates from 2010 and 2011, which were positive and both increased and decreased during that time period.



time. When in addition to negative rates QE is implemented, treated banks lend less than their counterparts, and the effect remains statistically significant when the ECB cuts the deposit facility rate further into negative territory, i.e., after both negative monetary-policy rates and QE have already been introduced.

## 5 Equity Returns

In this section, we estimate the reaction of bank stock returns in response to asset purchases. As equity returns measure expected future discounted bank profits, their variation can be indicative of profitability (English, Van den Heuvel, and Zakrajšek, 2018). To study the changes in equity returns of high-deposit and high-security banks relative to other banks in response to asset purchases during a period of low interest rates, we estimate the following regression model:

$$\begin{aligned} Return_{i,m} = & \beta_1 QE_{c(i),m} \times Security\ Ratio_i + \beta_2 QE_{c(i),m} \times Deposit\ Ratio_i \\ & + \beta_3 QE_{c(i),m} \times Security\ Ratio_i \times Deposit\ Ratio_i + \mu_i + \delta_m + \epsilon_{i,m}, \end{aligned} \quad (2)$$

where  $Return_{i,m}$  is the percent change in the equity prices of bank  $i$  between month-year  $m$  and  $m - 1$ .  $QE_{c(i),m}$  is the amount of government bond purchases (by the ECB in month-year  $m$ ) of country  $c$  that bank  $i$  is incorporated in, divided by the respective country's banks' total security holdings in 2012, which we standardize to have a 0 mean and a standard deviation of 1.  $Security\ Ratio_i$  is the share of securities over assets of bank  $i$  in 2012, and  $Deposit\ Ratio_i$  is the share of deposits over assets of bank  $i$  in 2012.  $\mu_i$  and  $\delta_m$  denote bank and month-year fixed effects, respectively. The sample period runs from 2010 to 2020. Standard errors are clustered at the bank level.

Table 5 shows the results from estimating (2). Banks with higher security and deposit ratios exhibit lower stock returns during QE. Estimating (2) without fixed effects allows us to predict stock returns of banks with varying degrees of deposit and security ratios in response to a one-standard-deviation increase in QE ( $QE_{c(i),m} = 1$ ). Figure 8 plots these predicted stock returns. For example, the most exposed bank in our sample with a deposit ratio of 89% and a security ratio of 54% is estimated to have a stock return of -11.53% in response to a one-standard-deviation increase in asset purchases. In contrast, the stock return of the least exposed bank with a security ratio of 2% and a deposit ratio of 7% is virtually insensitive to variations stemming from QE.

In Figure 9, we visualize predicted stock returns of two hypothetical banks over time: one

that has a high security and a high deposit ratio (both at the 75<sup>th</sup> percentile) relative to a bank that has a low security and a low deposit ratio (both at the 25<sup>th</sup> percentile). The time variation is given by  $QE_m$ , which is the average of  $QE_{c(i),m}$  (as defined in (2)) across countries in a given month-year. By construction, prior to QE stock returns of banks with differential exposure to the unconventional monetary-policy tools implemented by the ECB move in parallel. However, once the national central banks in the euro area start buying government bonds, stocks of banks with a high exposure underperform significantly. Banks that are highly exposed to QE and negative monetary-policy rates have persistently lower returns of less than -4% during the active QE and negative interest-rates period, while less exposed banks, as they have a larger wholesale funding base and fewer securities on their balance sheet, have stable returns hovering between -1% and -2%.

Negative monetary-policy rates are not passed through to banks' funding costs to the same extent across countries in the euro area, as despite a common nominal interest rate on interbank funds, customer deposit rates vary widely (Heider, Saidi, and Schepens, 2021; Bittner, Bonfim, Heider, Saidi, Schepens, and Soares, 2022). In countries where government bond yields are perceived as relatively risky, the overall level of interest rates (including on customer deposits) is also higher, as government bonds and bank deposits can be seen as substitutes (Krishnamurthy and Vissing-Jørgensen, 2015; Li, Ma, and Zhao, 2021). Consequently, we would expect the adverse effect of negative monetary-policy rates on the funding costs of deposit-reliant banks to be more emphasized in countries where the zero lower bound on deposit rates is binding.

In Table 6, we exploit heterogeneity in countries' distance to the ZLB on deposit rates. In column 1, we confirm that the adverse effect on banks' stock returns is stronger in Germany, a low-deposit-rate country, than in other countries in the euro area. That is, during QE high-security banks' reliance on deposits affects their funding costs and net worth under a negative interest-rate policy only when the ZLB on retail deposit rates is binding. Alternatively, when using an exposure index that we construct to be decreasing in the level of deposit rates prior to the introduction of negative monetary-policy rates, as in Bittner, Bonfim, Heider, Saidi, Schepens, and Soares (2022), we see that banks with high security and high deposit ratios in countries that have a low index value see almost no negative reaction in stock returns (column 2). Such banks in GIIPS countries (Greece, Italy, Ireland, Portugal, and Spain), which tend to have higher deposit rates, also see a smaller decline in stock returns, but the effect is not statistically significant (column 3). In the last column, we show that the stock returns of banks with high security and high deposit

ratios in countries that have higher ex-ante bond yields also suffer less. This suggests that the net-worth channel is less important for banks in these countries than for banks in countries that already have low deposit rates before and where an increase in bond prices does not recapitalize banks as much. Thus, QE is more likely to have expansionary effects when the transmission of monetary-policy rates is not impaired, which is the case for banks—regardless of their funding structure—in high-rate environments.

Next, we zoom in on Germany, where deposit rates are close to the ZLB and negative monetary-policy rates, thus, give rise to relatively higher funding costs for deposit-reliant banks.

## 6 Micro Evidence from Germany

### 6.1 Effect on Banks' Balance Sheets

The administrative data from the Bundesbank provide us with the possibility to observe not only credit relationships with different counterparties—firms and other banks—over time but also bank-level balance-sheet characteristics, decomposed to a greater level of detail, at the quarterly frequency.<sup>17</sup> In particular, this enables us to observe which countries' sovereign bonds are held by German banks, and to refine our baseline measure of QE accordingly by defining  $QE_q$  as the amount of German government bonds purchased by the ECB in quarter-year  $q$  divided by all German banks' total German sovereign bond holdings in 2012. In [Table 7](#), we use these features of our data to test whether banks more exposed to both the ECB's asset-purchase programs and the negative interest-rate policy wind up with more central-bank reserves.

When the ECB implements QE, it expands its balance sheet by increasing security positions on the asset side. The increase in security holdings must be matched by a corresponding increase in liabilities. The liability side of central banks consists mainly of bank reserves and currency in circulation. Holding currency in circulation fixed in response to QE, central-bank reserves of commercial banks must increase in aggregate. This implies that the size of the central bank's operation determines the amount of reserves in the system ([Keister and McAndrews, 2009](#)), imposing a tax on banks that hold these reserves when the deposit facility rate is negative.

After selling off securities to the ECB, an individual (high-security) bank may attempt to avoid paying negative rates on its newly created reserves, but this would require the ability to

---

<sup>17</sup>We provide summary statistics in [Table A4](#) of the Online Appendix.

reduce the liability side of its balance sheet. However, banks have been either unwilling or unable to reduce the interest rate on (household) deposits to below zero (Heider, Saidi, and Schepens, 2021), preventing a drain in deposits. In contrast, otherwise-funded banks experience a stronger pass-through of monetary-policy rates to their cost of funding.

Column 1 of Table 7 shows that German banks that have both a high security and a high customer deposit ratio have higher central-bank reserves when QE is conducted. The estimate implies that a bank with a 50% security and a 50% deposit ratio relative to a bank with a 40% security and a 40% deposit ratio sees an increase in its reserves-to-assets ratio of 0.27 percentage points ( $= (0.25 - 0.16) \times 0.03$ ) following a one-standard-deviation increase in asset purchases, which is sizable given that reserves-to-assets ratios of German banks hover around 7%. This increase is not attenuated much by central-bank borrowing (column 2), so that the estimate in column 3 is similar to that in column 1. Moreover, banks with high security and high deposit ratios do not see an outflow of deposits, as deposit rates are close to, and eventually stuck at, the ZLB in Germany (column 4).<sup>18</sup> Therefore, these banks face an adverse shock to their net worth stemming from holding more negative interest-rate bearing reserves while incurring higher funding costs, in line with our evidence in Table 6.

To show that this negative net-worth effect stems from an asset swap of securities for central-bank reserves, on which banks pay a negative rate since June 2014, we document that our exposure measure for QE—i.e., banks' security ratio—is actually correlated with changes in security holdings as a function of the ECB's asset purchases. In Table 8, we use granular data on German banks' security holdings from the Securities Holdings Statistics database. In columns 1 and 2, we find a significant average effect on security holdings for all high-security banks, as we also visualize in Figure A4 of the Online Appendix. This validates our approach that relies on measuring banks' exposure to QE by means of their security ratio (as in Rodnyansky and Darmouni, 2017). However, in the remaining columns of Table 8, we see that among high-security banks, only large banks, which we define as banks with total assets exceeding €50 billion, with presumably better access to market makers, sell off securities from their balance sheets (columns 3 and 4).

Why do banks sell these securities if swapping the latter for reserves has a negative effect on their net worth? In principle, asset purchases by central banks should not affect prices if the assets in question are valued only for their pecuniary returns (Wallace, 1981; Cúrdia and Woodford,

---

<sup>18</sup>Commercial banks can also sell the securities of their customers, which would lead to an additional increase in deposits for them.

2011). However, the banking sector as a whole may have a preference to hold longer-term bonds, resulting in asset-price movements induced by QE due to a segmentation of the term structure (Vayanos and Vila, 2021). This would imply that security prices of targeted assets would need to increase for the market to clear and the ECB to purchase the targeted amount of securities. We do not find strong asset-price effects of QE (cf. Figure 2 and Figure A1 - Figure A3 in the Online Appendix), which indicates that banks were willing to sell their securities without a large adjustment in prices. The following explanations could rationalize these findings.

Under both quantitative easing and negative monetary-policy rates, large banks, particularly those engaging in repo transactions, sold their government security holdings more aggressively and reduced their lending to firms the most. This observation is consistent with two distinct mechanisms that could be at play simultaneously.

The first channel is a form of “reverse” financial repression,<sup>19</sup> whereby banks that sell government bonds to the ECB do so because of moral suasion. After all, banks came under pressure to buy additional domestic government debt during the European sovereign debt crisis in 2011 (Ongena, Popov, and Van Horen, 2019). It would be reasonable to expect the same kind of channel to be operative in reverse. In particular, providing elastic supply of bonds by selling bonds to the ECB during episodes of quantitative easing despite a weak price response could be reciprocated in the future. A bank’s incentives to cooperate with the central bank should be higher the more dependent it is on future directives. For instance, large euro area banks may be more likely to fall under that category if they are active in repo markets and the prospect of not having access to an ECB repo facility would be detrimental to their business lines.

Second, affected banks engage in a wide range of distinct activities—such as wholesale banking, retail banking, and investment banking—and exhibit a large degree of organizational complexity. In decentralized banks, frictions across operating units can emerge when funds need to be reallocated, as each agent seeks to maximize the expected gross output from the assets under her control due to private benefits proportional to gross output (Stein, 2002). In our context, it is possible that fixed-income traders maximize their private benefits by fulfilling their market-maker function without internalizing the negative pecuniary externality that the additionally created reserves may impose for other parts of the bank.

---

<sup>19</sup>Chari, Dovis, and Kehoe (2020) present a model of financial repression that shows under which conditions policies that force banks to hold government debt can be optimal.

## 6.2 Credit Supply

Having established that large banks with a higher security ratio in Germany are actually more prone to swapping their securities for central-bank reserves in the course of the ECB’s large-scale asset purchases, we turn to estimating their differential credit-supply response as a function of their funding structure. In [Table 9](#), we use our credit-registry data at the bank-firm-quarter level  $(i,j,q)$ , and estimate analogous regressions to those in our baseline [Table 1](#). In this manner, we can test the effect on German banks’ intensive margin of lending by estimating the following regression specification:

$$\begin{aligned} \ln(Lending_{i,j,q}) = & \beta_1 QE_q \times Security\ Ratio_i + \beta_2 QE_q \times Deposit\ Ratio_i \\ & + \beta_3 QE_q \times Security\ Ratio_i \times Deposit\ Ratio_i + \chi_{i,j} + \theta_{j,q} + \epsilon_{i,j,q}, \end{aligned} \quad (3)$$

where  $Lending_{i,j,q}$  is the euro amount outstanding between firm  $j$  and bank  $i$  in quarter-year  $q$ .  $QE_q$  is the amount of German government bonds purchased by the ECB in quarter-year  $q$  divided by all German banks’ total German sovereign bond holdings in 2012, and is standardized to have a 0 mean and a standard deviation of 1.  $Security\ Ratio_i$  is the share of securities over assets of bank  $i$  in 2012, and  $Deposit\ Ratio_i$  is the share of deposits over assets of bank  $i$  in 2012. The sample period spans the first time negative monetary-policy rates are introduced (2014q3) up until 2018q4. Standard errors are clustered at the bank level.

The granularity of the data allows us to track a given bank  $i$ ’s loan exposure to firm  $j$  over time. As such, we can estimate the effect of banks’ exposure to QE and negative rates, while controlling for both time-invariant unobserved heterogeneity at the bank-firm match level and time-varying unobserved heterogeneity at the firm level by including, respectively, bank-firm fixed effects,  $\chi_{i,j}$ , and firm by quarter-year fixed effects,  $\theta_{j,q}$ .

Despite the fact that the inclusion of firm-time fixed effects forces our identification to come from German firms in relationships with multiple banks, the estimated triple-interaction effect is similar in size to that in column 2 of [Table 1](#), where firm-time fixed effects rather capture the fact that multiple banks come together to provide a syndicated loan. This holds, however, only for the subset of large banks in column 1 of [Table 9](#), but not for the remaining banks in column 2. In column 3, we use the pooled sample and find that the difference in the triple-interaction effect is significantly different (at the 1% level) for these two groups of banks. In columns 4-6, we estimate the same regressions, except that instead of by size, we distinguish banks by their access to the

repo market. Banks with access to the repo market behave like large banks, in that they reduce their lending when they are exposed to both QE and negative rates through the securities on their asset side and their reliance on deposit funding. Large banks, in turn, make for the vast majority of banks participating in the syndicated-loan market, where we have documented similar credit contraction across the euro area in [Section 4](#).

Our findings attest to the idea that banks' exposure to QE is contingent on their ability to sell off securities that are purchased by the ECB. This is the case primarily for large banks. We can leverage the German microdata to fine-tune the treatment variable and, hence, sharpen our identification. In particular, we can replace banks' exposure to  $QE_q$  as a function of their pre-determined *Security Ratio*<sub>*i*</sub> by their actual change in security holdings over the course of one year, without having to limit our analysis to large banks in an attempt to proxy for banks' ability to sell off securities in general.

Doing so, we confirm in column 1 of [Table 10](#) that high-deposit banks lend less following a drop in their security holdings during the ECB's asset purchases. In column 2, we use the granularity of the German microdata to distinguish between household deposits and deposits from non-financial corporations. This is motivated by the fact that the ZLB is more binding for households than for corporate deposits.<sup>20</sup> In this manner, we can compare similarly deposit-reliant banks that source their deposits from different customers. Reflecting the hard ZLB on rates for household depositors, we find that the negative effect on credit supply is confined to banks relying on household deposits, rather than those of non-financial corporations. Finally, our results are broadly robust to replacing annual changes in banks' security holdings with quarterly changes (see columns 3 and 4).

In [Table 11](#), we estimate (almost) the same specifications as in the first two columns of [Table 10](#), but limit the variable reflecting security changes to sales (columns 1 and 3) or purchases (columns 2 and 4). In line with high-deposit banks reducing their credit supply only when their securities are swapped for central-bank reserves, we find a statistically and economically significant coefficient on the relevant interaction term only for security sales and not for purchases.

### 6.3 Firm-level Real Effects

So far, we have established that banks that are more exposed to QE and negative monetary-policy rates reduce their credit supply by more when QE is conducted and affected banks are

---

<sup>20</sup>See, among others, [Heider, Saidi, and Schepens \(2019\)](#) and [Altavilla, Burlon, Giannetti, and Holton \(2022\)](#).



constrained by the ZLB on retail deposit rates. Ultimately, the potency of monetary policy hinges on whether the relative reduction in credit supply is also transmitted to the real economy. In this subsection, we analyze the real effects of combining negative monetary-policy rates with quantitative easing. We exploit cross-sectional variation in firms' pre-existing relationships with banks that are differentially exposed to these unconventional monetary policies. In particular, we test whether firms that are more dependent on banks that reduced their credit supply compared to their counterparts in response to QE and negative monetary-policy rates differ in terms of their capital investment and employment decisions.

To this end, we estimate the following regression specification:

$$\Delta \ln(y_j) = \beta \text{Security \& Deposit Exposure}_j + \gamma \text{Security Exposure}_j + \delta \text{Deposit Exposure}_j + \theta_{k(j)} + \epsilon_j, \quad (4)$$

where  $\Delta \ln(y_j)$  is the difference in the natural logarithm of German firm  $j$ 's average total wage bill, number of employees, or tangible fixed assets in 2015 – 2016 (during QE, the post-period) vs. 2013 – 2014 (before QE, the pre-period), and  $\text{Security \& Deposit Exposure}_j$  is the average value of  $\text{Security Ratio}_i \times \text{Deposit Ratio}_i$  (measured in 2012) of all German banks with which firm  $j$  contracts (as of 2014), weighted by firm  $j$ 's credit exposure to each bank  $i$ .  $\text{Security Exposure}_j$  and  $\text{Deposit Exposure}_j$  are defined accordingly using  $\text{Security Ratio}_i$  and  $\text{Deposit Ratio}_i$ , respectively.  $\theta_{k(j)}$  is a set of fixed effects based on firm  $j$ 's NACE industry segment, NUTS-3 region, and/or firm-size categories according to the European Union's guidelines. As the level of observation in specification (4) is the result of a first difference within firms,  $\theta_{k(j)}$  captures time-varying unobserved heterogeneity at the respective levels (as would industry-time, region-time, and size-time fixed effects without first-differencing). Standard errors are clustered at the firm level, which is the level of observation.

In columns 1-6 of [Table 12](#), the coefficient on the interaction term  $\text{Security \& Deposit Exposure}_j$  is negative and almost always statistically significant. Firms that rely more heavily on banks that have a high security ratio and a high deposit ratio, and are therefore more exposed to QE and negative monetary-policy rates, reduce their employment and wage bill by more. In columns 7-9 where we test for differential behavior in terms of capital expenditure, the interaction term is also negative but not statistically significant at conventional levels.

A key difficulty in using cross-sectional heterogeneity to quantify the real effects of monetary-policy transmission through banks is that general-equilibrium effects are differenced out ([Naka-](#)

mura and Steinsson, 2018). In the following, we assume that banks with no deposits and no securities are unaffected by negative rates and QE, respectively. This, however, neglects that lower interest rates can stimulate demand and credit supply for all banks. This, in turn, leads to potentially underestimating the total positive effects of QE and negative rates. Ignoring such confounding credit-demand effects of QE and rate-setting monetary policy, we compute the aggregate effects of QE and negative rates solely due to the credit-supply channel.

Interpreting the coefficient on firms' security exposure and that on their deposit exposure as the effect of QE and conventional rate-based policy, respectively, we can decompose how much of the employment growth rate can be attributed to the policies separately and their interaction. This allows us to compare the employment growth rate of 4.3% in our sample<sup>21</sup> with a counterfactual scenario in which only negative policy rates were implemented. We derive the counterfactual growth rate by estimating (4) (column 6 of Table 12) and applying the following procedure.

We start out with the observed employment growth rate,  $\Delta \ln(\text{Employment}_j)$ , which represents firm  $j$ 's employment growth in the post-period following both the introduction of negative monetary-policy rates and the announcement of QE in the euro area. The fact that the ECB implemented large-scale asset purchases only after introducing negative monetary-policy rates motivates our counterfactual: what would have been total employment growth in the absence of QE? To answer this question, we assume that in the absence of QE, banks' security ratios are irrelevant for the transmission of rate-based monetary policy. In addition, we assume that because of it, there is no effect stemming from the interaction between banks' security and deposit ratios. We thus compute the counterfactual employment growth rate as

$$\Delta \ln(\text{Employment}_j) - \hat{\beta} \text{Security \& Deposit Exposure}_j - \hat{\gamma} \text{Security Exposure}_j. \quad (5)$$

To yield each firm  $j$ 's counterfactual employment in the post-period, we multiply 1 plus the above growth rate with each firm  $j$ 's employment in the pre-period. We then aggregate up both employment in the pre-period and counterfactual employment in the post-period across all firms  $j$ , and compute the aggregate employment growth rate of the counterfactual scenario. Based on this procedure, the counterfactual employment growth rate without QE is 4.24% and, as such, almost indistinguishable from the actual employment growth rate of 4.3%. This leads us to conclude

---

<sup>21</sup>The employment growth rate in our sample is close to the total employment growth rate of 4.1% reported by the German statistical office. This partly reflects the representative nature of our sample of firms, which captures 34% of total employment in Germany.

that any positive employment effects of the credit-supply channel of QE are eradicated by the negative interaction of QE and negative monetary-policy rates in the presence of a ZLB on deposit rates. Previous studies document that QE had strong positive employment effects through the bank lending channel in the U.S. (Foley-Fisher, Ramcharan, and Yu, 2016; Luck and Zimmermann, 2020). Our results provide a rationale for why QE has been potentially more successful in spurring employment in the U.S. than in the euro area, which is consistent with the observation that the U.S. experienced a stronger recovery during our period of study.

## 6.4 Interbank Lending

As affected banks see a drop in their net worth and subsequently reduce their lending to non-financial corporations, this opens up the possibility that they rebalance their loan or asset portfolios, in particular by increasing their portion of liquid assets. While corporate lending leads to the creation of costly deposits elsewhere in the system, interbank loans are a means of transferring and redistributing reserves among banks, without increasing the total amount of reserves in the system (Diamond, Jiang, and Ma, 2021).

For this purpose, we consider the interbank portion of the German credit registry, i.e., banks lending to other banks, rather than firms, excluding intra-group lending. In columns 1 and 3 of Table 13, we estimate analogous specifications to those in columns 1 and 2 of Table 9. Large banks that are more exposed to QE and negative rates, which we have shown to reduce their credit supply to non-financial corporations, instead expand their supply of interbank loans. In column 2, the effect is somewhat stronger, albeit insignificantly so, for interbank lending to high-yield countries. In the last two columns, we replace  $QE_q \times Security Ratio_i$  by the actual change in security holdings over the course of one year, and find that high-deposit banks that sold off their securities during the QE period lent more to other banks in high-yield countries (column 6), but not on average (column 5).

These estimates suggest that affected banks at least partially replace illiquid corporate loans with liquid interbank loans. When doing so, they possibly reach for yield so as to counteract the adverse shock to their net worth. In Table 14, we differentiate interbank lending by large and small banks within (columns 1 and 3) and outside the euro area (columns 2 and 4). The differential lending response is confined to large affected banks and their lending to other euro area banks. In columns 5 and 6, we test whether the lending response is significantly different for large vs. small banks, and this is the case only for interbank lending within the euro area (column 5).

## 7 Cross-Border Interbank Flows

We next zoom in on the implications of QE under negative policy rates for the distribution of interbank liquidity in the euro area. The micro-level results in [Table 13](#) and [Table 14](#) suggest that while German banks with greater exposure to QE and negative rates reduce their credit supply to the real sector, they expand their lending to other banks, and especially in the euro area. To investigate whether this loan-portfolio rebalancing has any meaningful explanatory power for interbank flows between the core and the periphery in the euro area, we use aggregate data from the Bank for International Settlements covering the euro area during the negative interest-rate period from 2014 to 2018, and estimate the following regression specification at the country-pair level:

$$Flow_{c,j,q} = \beta_1 QE_{c,q} \times GIIPS_j + \beta_2 QE_{c,q} \times Core_c \times GIIPS_j + \chi_{c,j} + \gamma_{c,q} + \psi_{j,q} + \epsilon_{c,j,q}, \quad (6)$$

where  $Flow_{c,j,q}$  is the percent change in bank claims of country (lender)  $c$  to country (borrower)  $j$  in quarter-year  $q$ .  $QE_{c,q}$  is the amount of government bond purchases of country  $c$  by the ECB in quarter-year  $q$ , divided by the respective country's banks' total security holdings in 2012, and then standardized to have a 0 mean and a standard deviation of 1.  $Core_c$  is an indicator variable for whether the lender country  $c$  is Germany, Finland, the Netherlands, or Austria.  $GIIPS_j$  is an indicator variable for whether the borrower country  $j$  is Greece, Italy, Ireland, Portugal, or Spain.  $\chi_{c,j}$ ,  $\gamma_{c,q}$ , and  $\psi_{j,q}$  denote country pair, lender country by quarter-year, and borrower country by quarter-year fixed effects, respectively. Standard errors are double-clustered at the lender-country and borrower-country levels.

[Table 15](#) shows the results from estimating (6) with and without borrower country by quarter-year fixed effects. When QE is conducted, core banks—not only in Germany—lend more to GIIPS banks (columns 1 and 4). Similar results are obtained when replacing  $GIIPS_j$  by other measures of the riskiness of borrower country  $j$  as in [Table 6](#). This correlation is also reflected in [Figure 10](#), which plots the share of borrowing of GIIPS banks from core banks alongside the ECB bond holdings of core countries. This suggests that QE during the negative interest-rate policy period may have led to greater financial dependence of periphery banks on financial institutions from the core euro area.

## 8 Conclusion

This paper studies the interaction of large-scale asset purchases and rate-setting monetary policy. To do so, we exploit variation in the pass-through of negative monetary-policy rates to banks' funding costs in the euro area. We provide evidence that absorbing a large amount of securities from the banking sector in the presence of a zero lower bound on retail deposit rates reduces credit supply by deposit-reliant banks that are exposed to both QE and higher funding costs. Our results point to important policy implications for the conduct of accommodative monetary policy. QE is more likely to have expansionary effects if the pass-through of lower monetary-policy rates to bank funding costs is not impaired. If it is, QE can exacerbate the detrimental effects of higher funding costs on banks' profitability. Affected banks may counteract this adverse shock to their net worth by reaching for yield in the liquid interbank market.

We present suggestive evidence that this may have led to interbank flows from the core to the periphery in the euro area during the ECB's large-scale asset purchases. The potential ramifications of greater financial dependence of the periphery from the core in a fragmented euro area can be far-reaching. For instance, it could have given rise to greater misallocation, manifesting itself in increased dispersion of the return to capital and lower total factor productivity, because capital was directed to less productive firms ([Gopinath, Kalemli-Özcan, Karabarbounis, and Villegas-Sanchez, 2017](#)). Evaluating whether this was the case constitutes a fruitful avenue for future research.

## References

- ACHARYA, V. V., T. EISERT, C. EUFINGER, AND C. HIRSCH (2019): "Whatever It Takes: The Real Effects of Unconventional Monetary Policy," *Review of Financial Studies*, 32(9), 3366–3411.
- ACHARYA, V. V., AND R. G. RAJAN (2022): "Liquidity, Liquidity Everywhere, Not a Drop to Use—Why Flooding Banks with Central Bank Reserves May Not Expand Liquidity," CEPR Discussion Paper.
- ALTAVILLA, C., L. BURLON, M. GIANNETTI, AND S. HOLTON (2022): "Is There a Zero Lower Bound? The Effects of Negative Policy Rates on Banks and Firms," *Journal of Financial Economics*, 144(3), 885–907.

- AMPUDIA, M., AND S. VAN DEN HEUVEL (2018): “Monetary Policy and Bank Equity Values in a Time of Low Interest Rates,” ECB Working Paper.
- BADE, M., J. FLORY, M. GOMOLKA, AND F. SCHNELLBACH (2018): “Centralised Securities Database (CSDB), Data Report 2018-10–Metadata Version 1.1,” Discussion paper, Deutsche Bundesbank, Research Data and Service Centre.
- BENETTON, M., AND D. FANTINO (2021): “Targeted Monetary Policy and Bank Lending Behavior,” *Journal of Financial Economics*, 142(1), 404–429.
- BERAJA, M., A. FUSTER, E. HURST, AND J. VAVRA (2018): “Regional Heterogeneity and the Refinancing Channel of Monetary Policy,” *Quarterly Journal of Economics*, 134(1), 109–183.
- BERNANKE, B. S. (2020): “The New Tools of Monetary Policy,” *American Economic Review*, 110(4), 943–83.
- BERNANKE, B. S., AND A. S. BLINDER (1988): “Credit, Money, and Aggregate Demand,” *American Economic Review*, 78(2), 435–439.
- BIANCHI, J., AND S. BIGIO (2022): “Banks, Liquidity Management, and Monetary Policy,” *Econometrica*, 90(1), 391–454.
- BITTNER, C., D. BONFIM, F. HEIDER, F. SAIDI, G. SCHEPENS, AND C. SOARES (2022): “The Augmented Bank Balance-Sheet Channel of Monetary Policy,” CEPR Discussion Paper.
- BLASCHKE, J., K. SACHS, AND E. YALCIN (2020): “Securities Holdings Statistics Base Plus, Data Report 2020-14–Metadata Version 3-1,” Discussion paper, Deutsche Bundesbank, Research Data and Service Centre.
- BOTTERO, M., C. MINOIU, J.-L. PEYDRÓ, A. POLO, A. F. PRESBITERO, AND E. SETTE (2021): “Expansionary Yet Different: Credit Supply and Real Effects of Negative Interest Rate Policy,” *Journal of Financial Economics*.
- BRUNNERMEIER, M. K., AND Y. KOBAYASHI (2018): “The Reversal Interest Rate,” NBER Working Paper.
- BRUNNERMEIER, M. K., AND Y. SANNIKOV (2014): “A Macroeconomic Model with a Financial Sector,” *American Economic Review*, 104(2), 379–421.
- (2016): “The I Theory of Money,” Working Paper.

- BUBECK, J., A. MADDALONI, AND J.-L. PEYDRÓ (2020): “Negative Monetary Policy Rates and Systemic Banks’ Risk-taking: Evidence from the Euro Area Securities Register,” *Journal of Money, Credit and Banking*, 52(S1), 197–231.
- CARPINELLI, L., AND M. CROSIGNANI (2021): “The Design and Transmission of Central Bank Liquidity Provisions,” *Journal of Financial Economics*, 141(1), 27–47.
- CHAKRABORTY, I., I. GOLDSTEIN, AND A. MACKINLAY (2020): “Monetary Stimulus and Bank Lending,” *Journal of Financial Economics*, 136(1), 189–218.
- CHARI, V., A. DOVIS, AND P. J. KEHOE (2020): “On the Optimality of Financial Repression,” *Journal of Political Economy*, 128(2), 710–739.
- CHODOROW-REICH, G. (2014): “The Employment Effects of Credit Market Disruptions: Firm-Level Evidence from the 2008–9 Financial Crisis,” *Quarterly Journal of Economics*, 129(1), 1–59.
- CHRISTENSEN, J. H., AND S. KROGSTROP (2019): “Transmission of Quantitative Easing: The Role of Central Bank Reserves,” *Economic Journal*, 129(617), 249–272.
- CHRISTIANO, L. J., AND M. EICHENBAUM (1992): “Liquidity Effects and the Monetary Transmission Mechanism,” *American Economic Review*, 82(2), 346–353.
- CORRADIN, S., J. EISENSCHMIDT, M. HOEROVA, T. LINZERT, G. SCHEPENS, AND J.-D. SIGAUX (2020): “Money Markets, Central Bank Balance Sheet and Regulation,” ECB Working Paper.
- CROSIGNANI, M., M. FARIA-E CASTRO, AND L. FONSECA (2020): “The (Unintended?) Consequences of the Largest Liquidity Injection Ever,” *Journal of Monetary Economics*, 112, 97–112.
- CÚRDIA, V., AND M. WOODFORD (2011): “The Central-Bank Balance Sheet as an Instrument of Monetary Policy,” *Journal of Monetary Economics*, 58(1), 54–79.
- DE FIORE, F., M. HOEROVA, AND H. UHLIG (2018): “Money Markets, Collateral and Monetary Policy,” NBER Working Paper.
- DI MAGGIO, M., A. KERMANI, AND C. J. PALMER (2019): “How Quantitative Easing Works: Evidence on the Refinancing Channel,” *Review of Economic Studies*, 87(3), 1498–1528.
- DIAMOND, W., Z. JIANG, AND Y. MA (2021): “The Reserve Supply Channel of Unconventional Monetary Policy,” Working Paper.



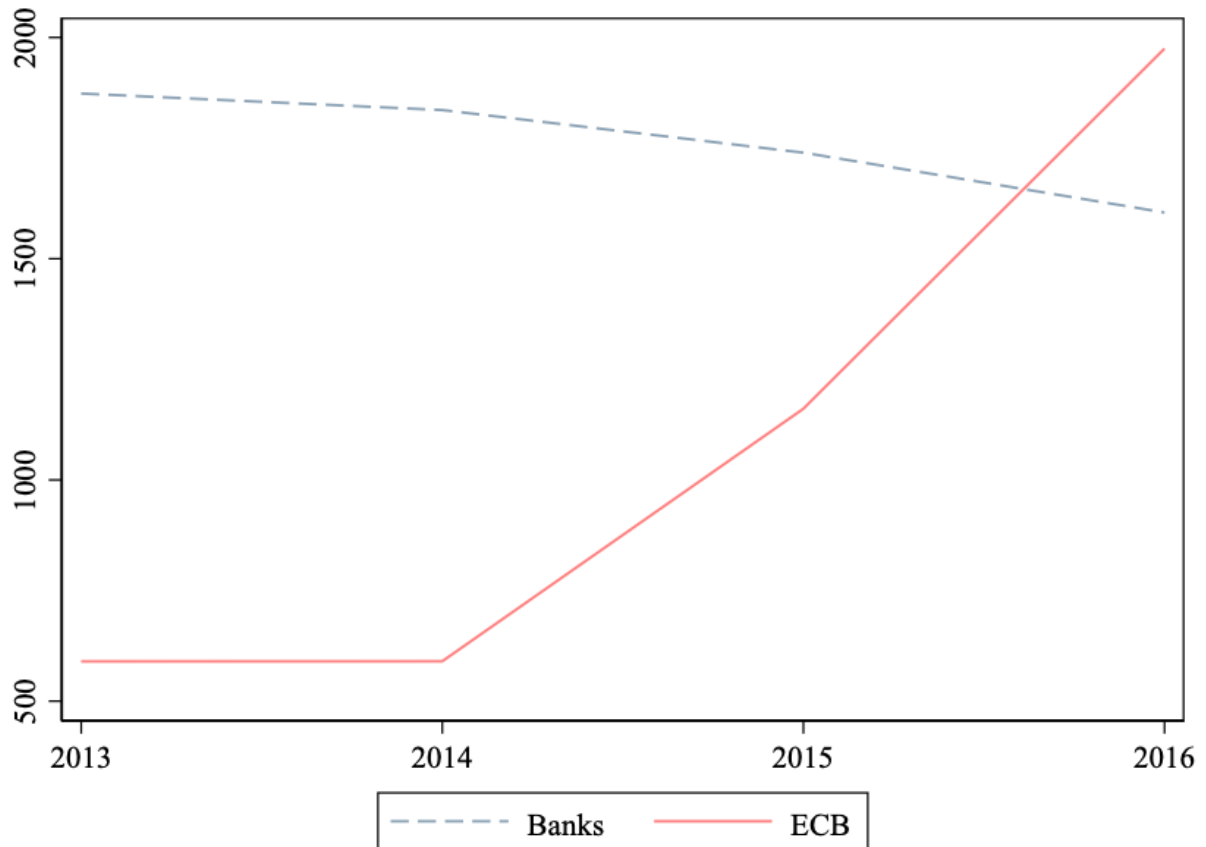
- D'AMICO, S., AND T. B. KING (2013): "Flow and Stock Effects of Large-Scale Treasury Purchases: Evidence on the Importance of Local Supply," *Journal of Financial Economics*, 108(2), 425–448.
- EGGERTSSON, G. B., R. E. JUELSRUD, L. H. SUMMERS, AND E. G. WOLD (2019): "Negative Nominal Interest Rates and the Bank Lending Channel," NBER Working Paper.
- ENGLISH, W. B., S. J. VAN DEN HEUVEL, AND E. ZAKRAJŠEK (2018): "Interest Rate Risk and Bank Equity Valuations," *Journal of Monetary Economics*, 98, 80–97.
- FOLEY-FISHER, N., R. RAMCHARAN, AND E. YU (2016): "The Impact of Unconventional Monetary Policy on Firm Financing Constraints: Evidence from the Maturity Extension Program," *Journal of Financial Economics*, 122(2), 409–429.
- GOMEZ, M., A. LANDIER, D. SRAER, AND D. THESMAR (2021): "Banks' Exposure to Interest Rate Risk and the Transmission of Monetary Policy," *Journal of Monetary Economics*, 117, 543–570.
- GOMOLKA, M., M. SCHÄFER, AND H. STAHL (2020): "Monthly Balance Sheet Statistics (BISTA), Data Report 2020-04–Metadata Version BISTA-Doc-v2-0," Discussion paper, Deutsche Bundesbank, Research Data and Service Centre.
- GOPINATH, G., Ş. KALEMLİ-ÖZCAN, L. KARABARBOUNIS, AND C. VILLEGAS-SANCHEZ (2017): "Capital Allocation and Productivity in South Europe," *Quarterly Journal of Economics*, 132(4), 1915–1967.
- GROSSE-RUESCHKAMP, B., S. STEFFEN, AND D. STREITZ (2019): "A Capital Structure Channel of Monetary Policy," *Journal of Financial Economics*, 133(2), 357–378.
- HEIDER, F., F. SAIDI, AND G. SCHEPENS (2019): "Life Below Zero: Bank Lending Under Negative Policy Rates," *Review of Financial Studies*, 32(10), 3728–3761.
- (2021): "Banks and Negative Interest Rates," *Annual Review of Financial Economics*, 13(1), 201–218.
- IVASHINA, V., AND D. SCHARFSTEIN (2010): "Bank Lending During the Financial Crisis of 2008," *Journal of Financial Economics*, 97(3), 319–338.
- JIMÉNEZ, G., S. ONGENA, J.-L. PEYDRÓ, AND J. SAURINA (2014): "Hazardous Times for Monetary Policy: What Do Twenty-Three Million Bank Loans Say About the Effects of Monetary Policy on Credit Risk-Taking?," *Econometrica*, 82(2), 463–505.

- KEISTER, T., AND J. J. McANDREWS (2009): “Why Are Banks Holding So Many Excess Reserves?,” Federal Reserve Bank of New York Staff Report.
- KHWAJA, A. I., AND A. MIAN (2008): “Tracing the Impact of Bank Liquidity Shocks: Evidence From an Emerging Market,” *American Economic Review*, 98(4), 1413–42.
- KOIJEN, R. S., F. KOULISCHER, B. NGUYEN, AND M. YOGO (2021): “Inspecting the Mechanism of Quantitative Easing in the Euro Area,” *Journal of Financial Economics*, 140(1), 1–20.
- KRISHNAMURTHY, A., AND A. VISSING-JØRGENSEN (2011): “The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy,” *Brookings Papers on Economic Activity*, 42(2), 215–287.
- (2015): “The Impact of Treasury Supply on Financial Sector Lending and Stability,” *Journal of Financial Economics*, 118(3), 571–600.
- LI, W., Y. MA, AND Y. ZHAO (2021): “The Passthrough of Treasury Supply to Bank Deposit Funding,” Working Paper.
- LUCK, S., AND T. ZIMMERMANN (2020): “Employment Effects of Unconventional Monetary Policy: Evidence from QE,” *Journal of Financial Economics*, 135(3), 678–703.
- NAKAMURA, E., AND J. STEINSSON (2018): “Identification in Macroeconomics,” *Journal of Economic Perspectives*, 32(3), 59–86.
- ONGENA, S., A. POPOV, AND N. VAN HOREN (2019): “The Invisible Hand of the Government: Moral Suasion During the European Sovereign Debt Crisis,” *American Economic Journal: Macroeconomics*, 11(4), 346–79.
- PALUDKIEWICZ, K. (2021): “Unconventional Monetary Policy, Bank Lending, and Security Holdings: The Yield-Induced Portfolio-Rebalancing Channel,” *Journal of Financial and Quantitative Analysis*, 56(2), 531–568.
- PEYDRÓ, J.-L., A. POLO, AND E. SETTE (2021): “Monetary Policy at Work: Security and Credit Application Registers Evidence,” *Journal of Financial Economics*, 140(3), 789–814.
- REPULLO, R. (2020): “The Reversal Interest Rate: A Critical Review,” CEPR Discussion Paper.

- RODNYANSKY, A., AND O. M. DARMOUNI (2017): “The Effects of Quantitative Easing on Bank Lending Behavior,” *Review of Financial Studies*, 30(11), 3858–3887.
- SCHMIEDER, C. (2006): “The Deutsche Bundesbank’s Large Credit Database (BAKIS-M and MiMiK),” *Schmollers Jahrbuch*, 126(4), 653–663.
- SIMS, E., AND J. C. WU (2020): “Are QE and Conventional Monetary Policy Substitutable?,” *International Journal of Central Banking*, 16(1), 195–230.
- (2021): “Evaluating Central Banks’ Tool Kit: Past, Present, and Future,” *Journal of Monetary Economics*, 118, 135–160.
- STEIN, J. C. (2002): “Information Production and Capital Allocation: Decentralized versus Hierarchical Firms,” *Journal of Finance*, 57(5), 1891–1921.
- (2012): “Monetary Policy as Financial Stability Regulation,” *Quarterly Journal of Economics*, 127(1), 57–95.
- TIMMER, Y. (2018): “Cyclical Investment Behavior across Financial Institutions,” *Journal of Financial Economics*, 129(2), 268–286.
- ULATE, M. (2021): “Going Negative at the Zero Lower Bound: The Effects of Negative Nominal Interest Rates,” *American Economic Review*, 111(1), 1–40.
- VAYANOS, D., AND J.-L. VILA (2021): “A Preferred-Habitat Model of the Term Structure of Interest Rates,” *Econometrica*, 89(1), 77–112.
- WALLACE, N. (1981): “A Modigliani-Miller Theorem for Open-Market Operations,” *American Economic Review*, 71(3), 267–274.

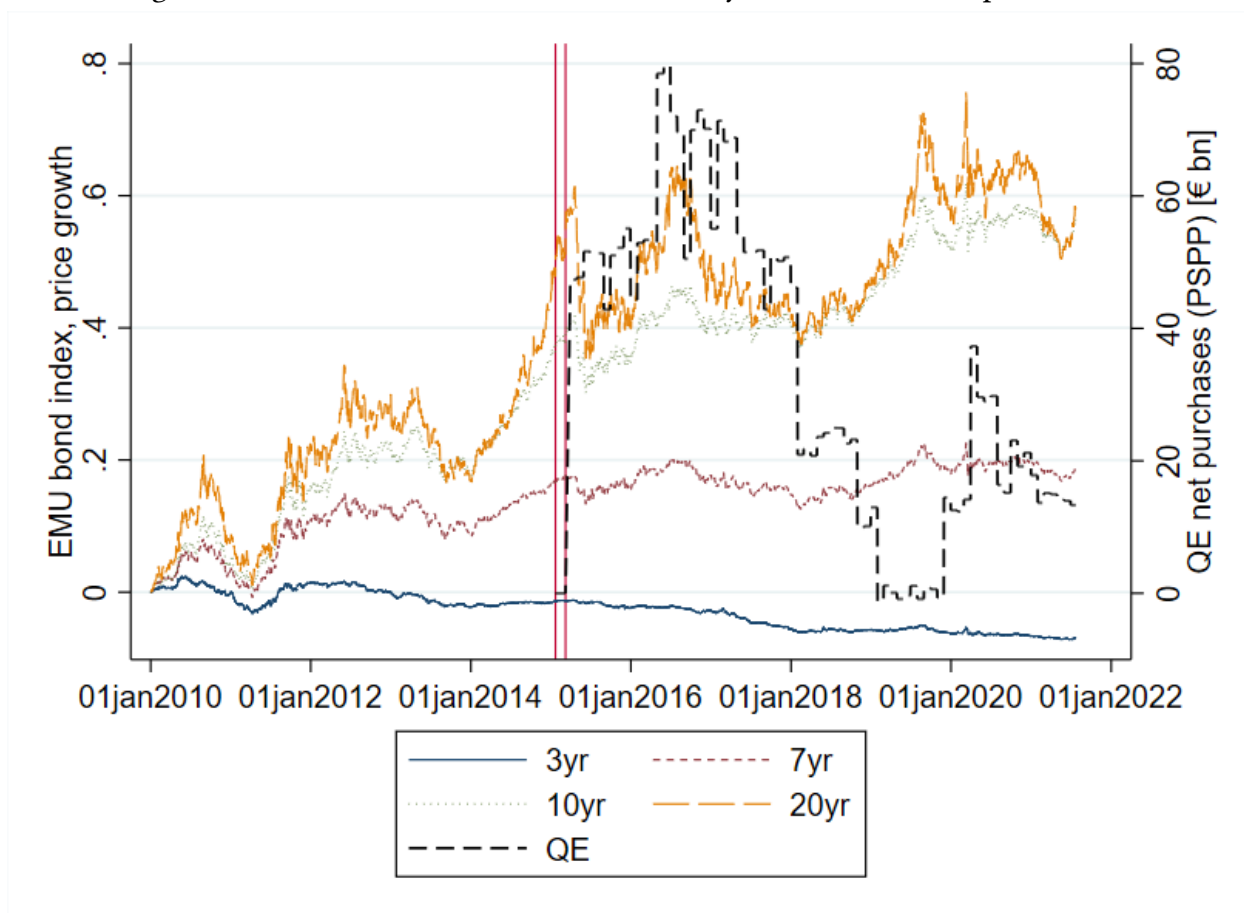
## Figures

Figure 1: Security Holdings



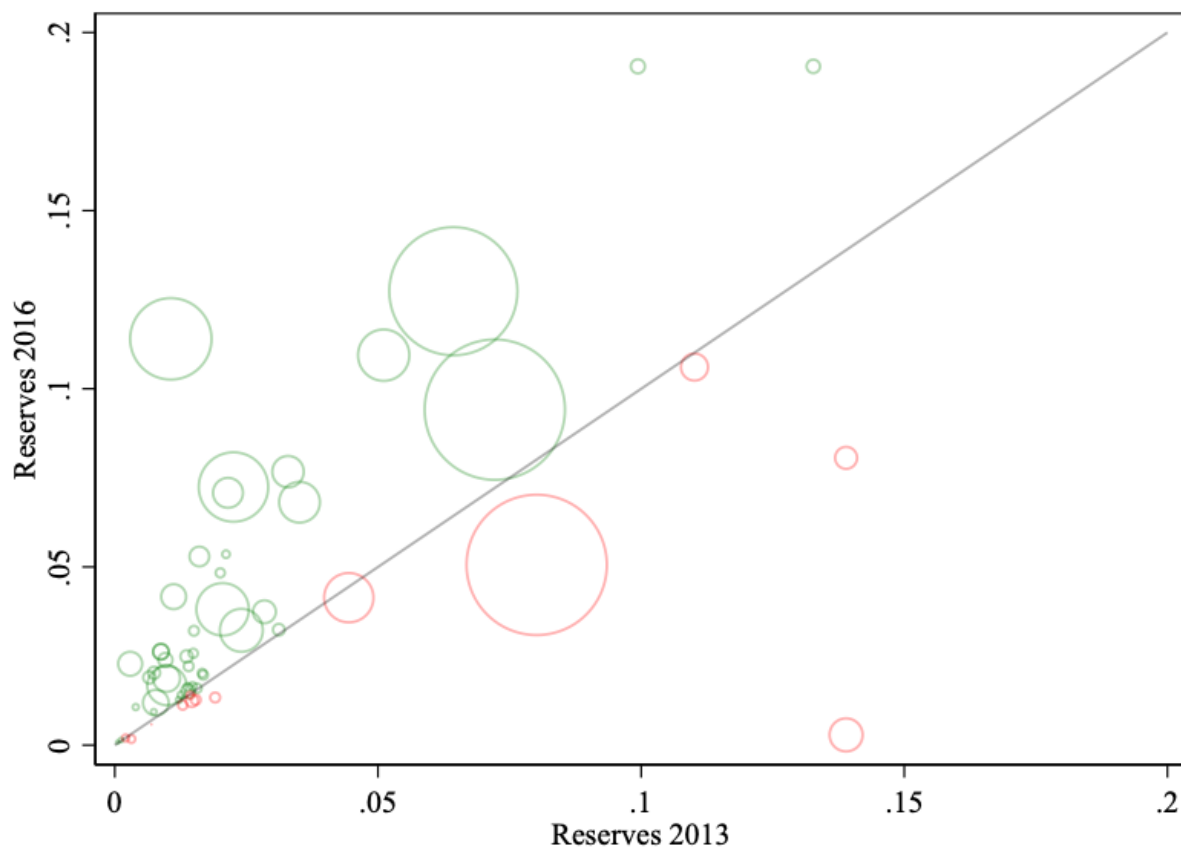
Notes: This graph shows the security holdings of euro area banks (dashed blue line) and of the ECB (solid red line) in € billions.

Figure 2: Bond Prices: Economic and Monetary Union of the European Union



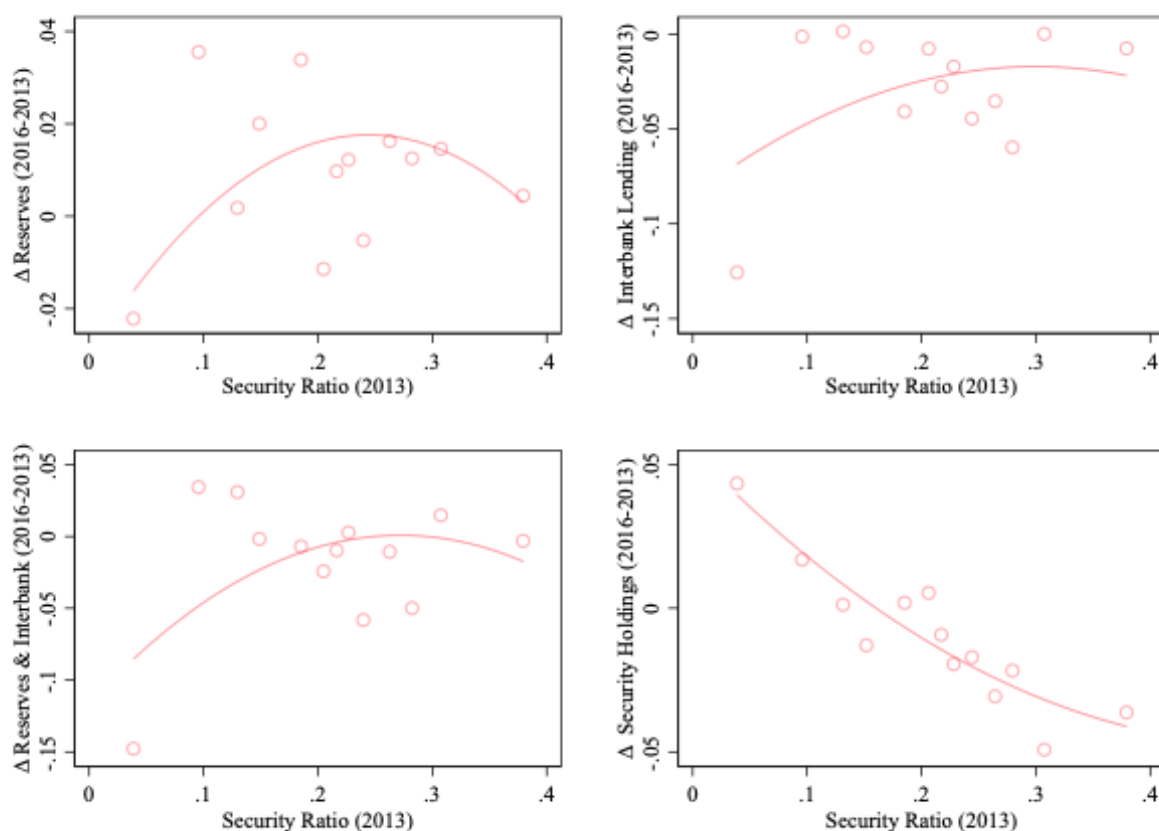
Notes: This graph shows the price development of bond indices for the European Monetary Union (EMU) with different maturities and the net purchases by the ECB under the public sector purchase program (PSPP) in € billions. The bond indices for the EMU with maturities of 3, 7, 10, and 20 years are plotted as growth rates relative to the beginning of 2010 (left y-axis). The net purchases (PSPP) by the ECB are shown in the dashed black line referring to the right y-axis. The first vertical red line represents the announcement of the PSPP (January 22, 2015), and the second one marks its implementation (March 9, 2015).

Figure 3: Reserves Before and After QE



Notes: This graph plots the share of euro area banks' reserves out of total assets in 2013 (x-axis) against the same share in 2016 (y-axis). The green (red) circles reflect banks that increased (decreased) their reserve share, while the size of the circle reflects the size of the reserves in 2013.

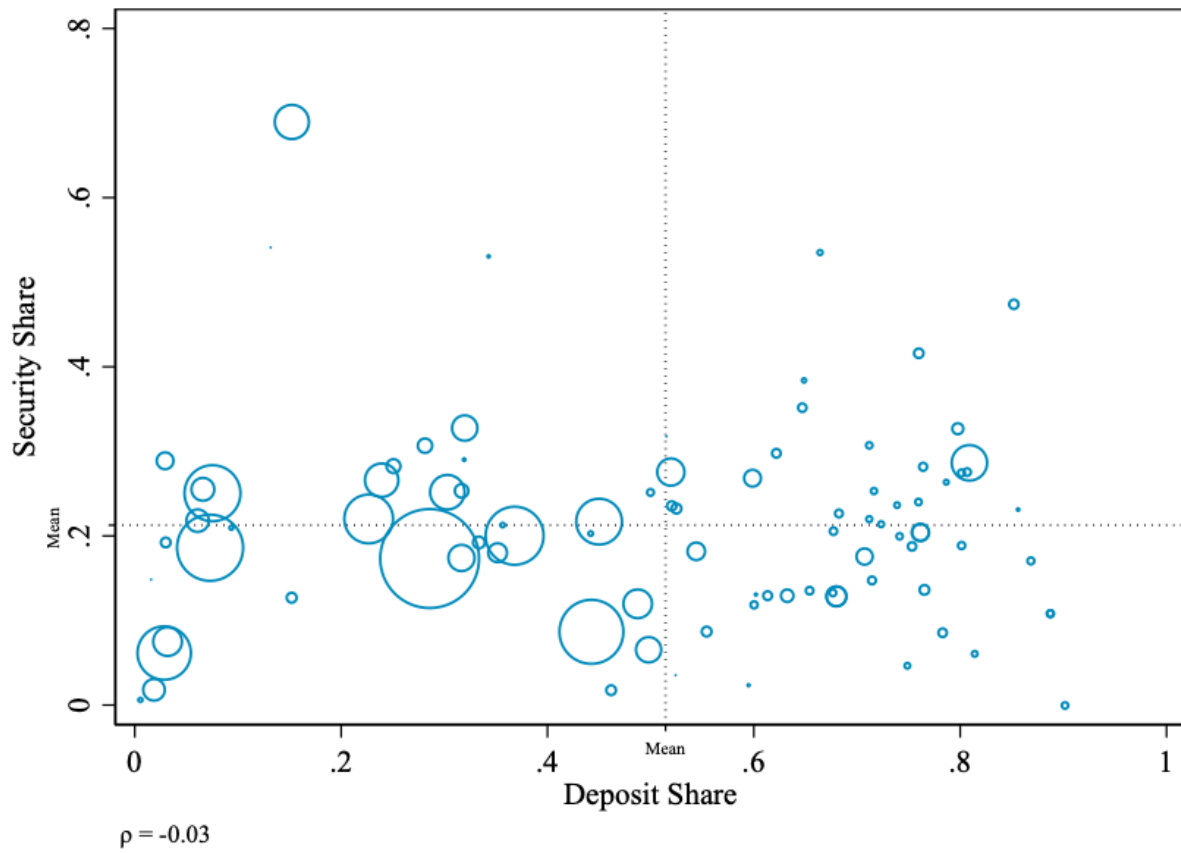
Figure 4:  $\Delta$  Bank Variables against Security Ratio



Notes: The upper left panel shows a bin-scatter plot of the change in euro area banks' reserves over total assets between 2013 and 2016 against their security ratio in 2013. The upper right panel shows their change in interbank lending over total assets against their security ratio in 2013. The bottom left panel shows the change in their reserves and interbank lending over total assets against their security ratio in 2013. The bottom right panel shows their change in security holdings over total assets against their security ratio in 2013.

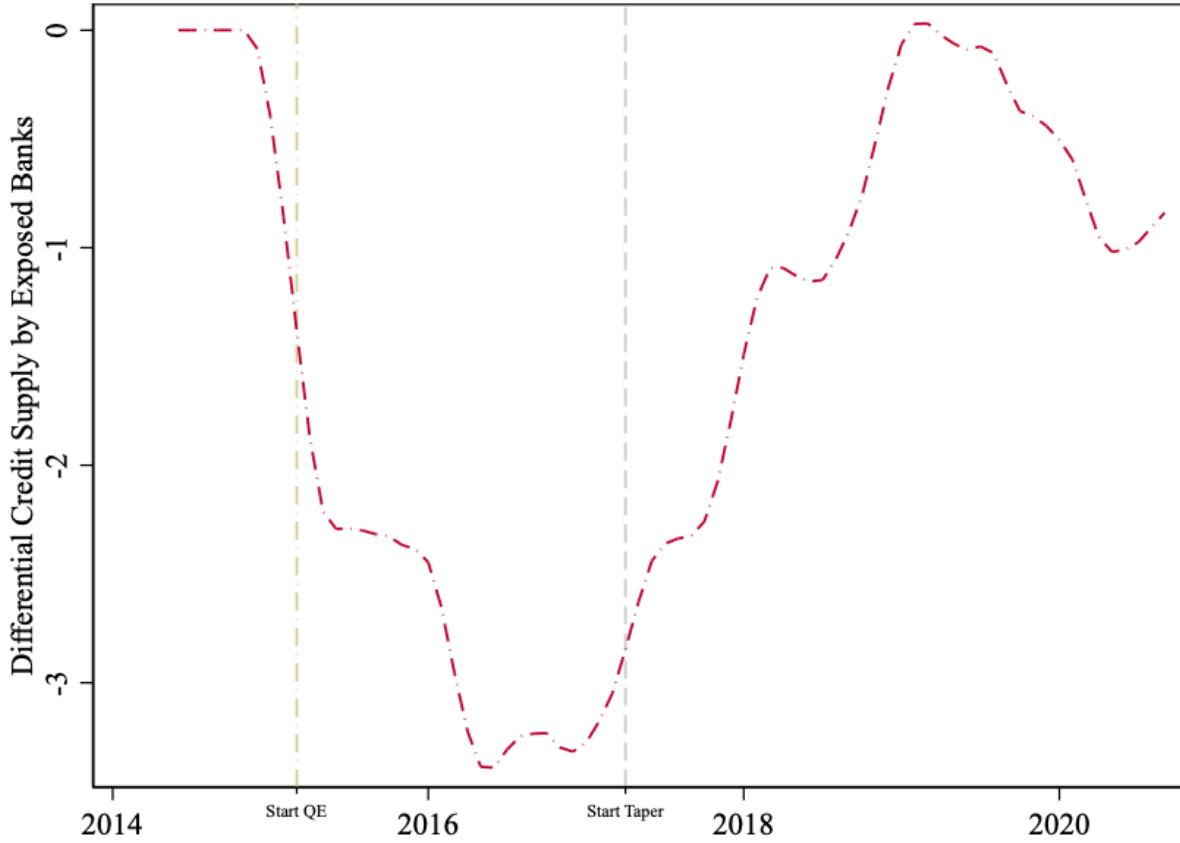


Figure 5: Correlation between Deposit and Security Ratios



Notes: This graph shows a scatter plot of euro area banks' security ratio in 2012 against their deposit ratio in 2012. The size of the dots reflects the size of the respective bank in terms of total assets in 2013.  $\rho$  is the correlation coefficient between the security and deposit ratios. The dotted lines reflect their mean values.

Figure 6: Estimated Credit Supply by Differentially Exposed Banks

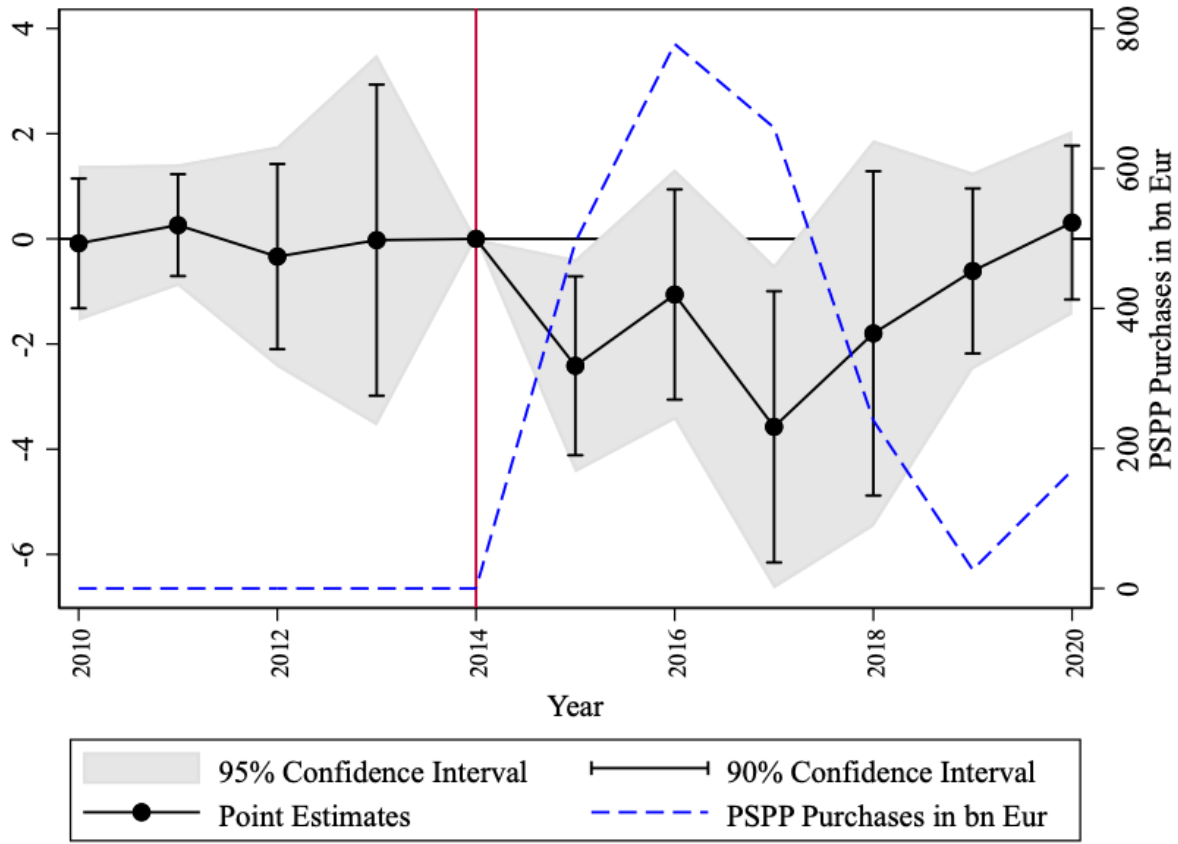


Notes: This graph shows the predicted differential effect on the credit supply by exposed euro area banks over time. In particular, it plots the estimates of  $\beta_3 \times QE_{c(i),m(t)}$ , based on the following regression specification:

$$\ln(Lending_{i(l),j(l),t(l)}) = \beta_1 QE_{c(i),m(t)} \times Security\ Ratio_i + \beta_2 QE_{c(i),m(t)} \times Deposit\ Ratio_i \\ + \beta_3 QE_{c(i),m(t)} \times Security\ Ratio_i \times Deposit\ Ratio_i + \mu_i + \theta_{j,m(t)} + \phi_{c(i),m(t)} + \epsilon_{i,j,t},$$

where  $QE_{c(i),m(t)}$  is the amount of government bond purchases (by the ECB in month-year  $m(t)$ ) of country  $c$  that bank  $i$  is incorporated in, divided by the respective country's banks' total security holdings in 2012, and then rescaled between 0 (no purchases) and 1 (maximum amount of purchases).

Figure 7: Time-varying Coefficients

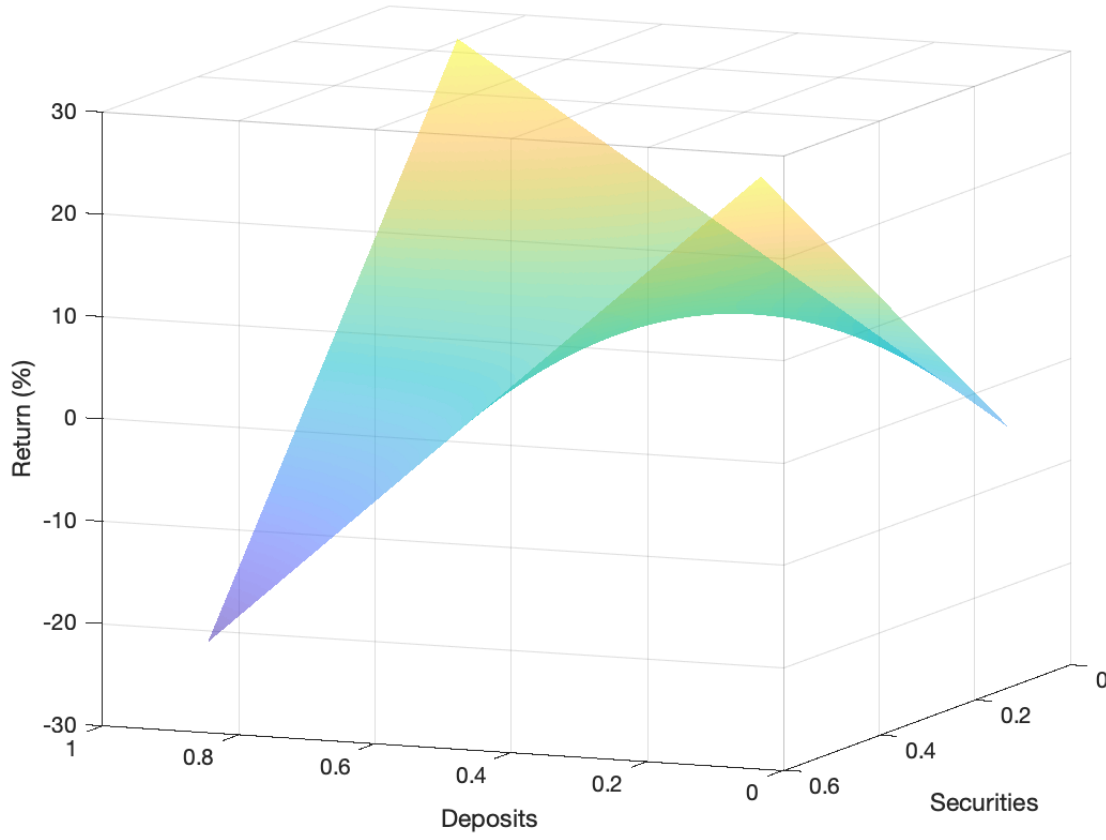


Notes: This figure plots the estimates of  $\beta_{3,\tau}$  (left y-axis) from the following regression:

$$\begin{aligned} \ln(Lending_{i(l),j(l),t(l)}) = & \sum_{\tau \neq 2014} \beta_{1,\tau} \times Security\ Ratio_i \times \mathbb{1}_{[t=\tau]} + \sum_{\tau \neq 2014} \beta_{2,\tau} \times Deposit\ Ratio_i \times \mathbb{1}_{[t=\tau]} \\ & + \sum_{\tau \neq 2014} \beta_{3,\tau} \times Security\ Ratio_i \times Deposit\ Ratio_i \times \mathbb{1}_{[t=\tau]} \\ & + \mu_i + \theta_{j,m(t)} + \phi_{c(i),m(t)} + \epsilon_{i,j,t}. \end{aligned}$$

The blue dashed line shows the net purchases by the ECB under the public sector purchase program (PSPP) in € billions (right y-axis).

Figure 8: Stock-return Response to QE Purchases

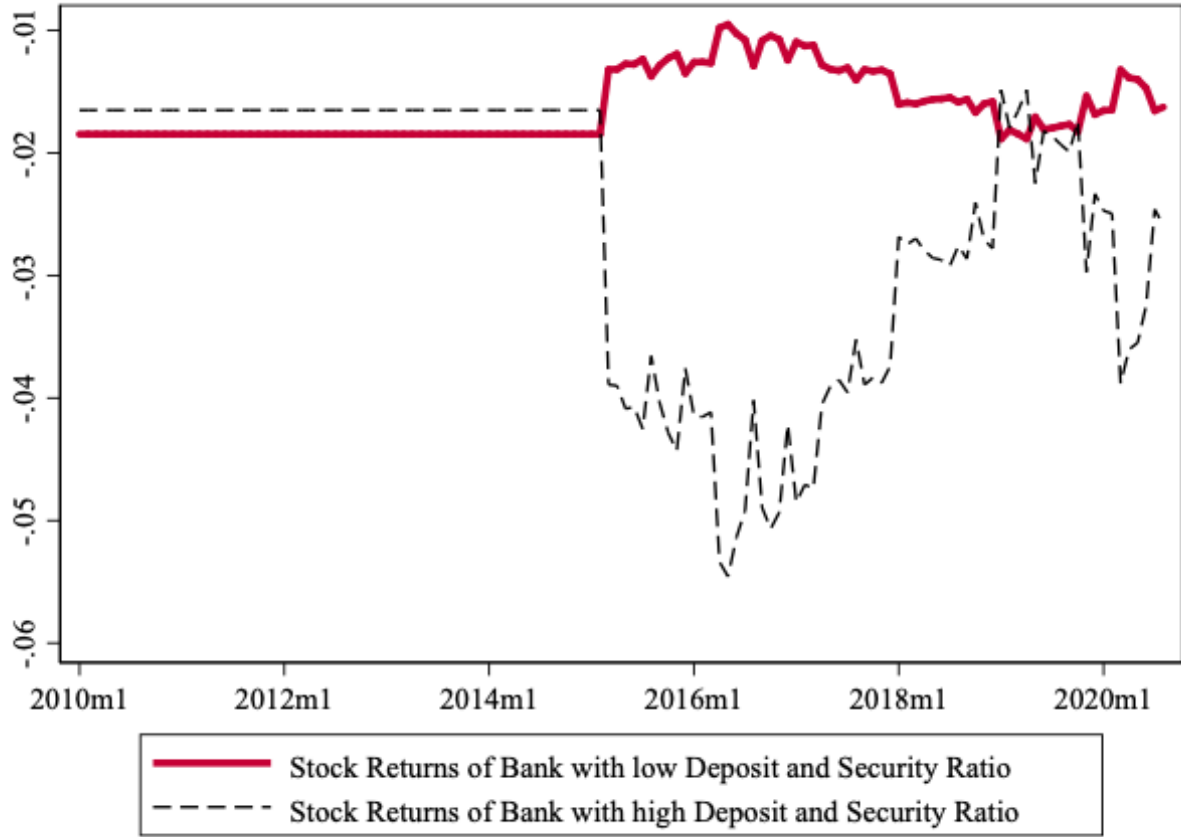


Notes: This graph shows the predicted stock returns as a function of euro area banks' security ratio and their deposit ratio, based on the following regression specification:

$$\begin{aligned} \text{Return}_{i,m} = & \alpha + \gamma_1 QE_{c(i),m} + \gamma_2 \text{Security Ratio}_i + \gamma_3 \text{Deposit Ratio}_i \\ & + \gamma_4 \text{Security Ratio}_i \times \text{Deposit Ratio}_i + \gamma_5 \text{Security Ratio}_i \times QE_{c(i),m} \\ & + \gamma_6 \text{Deposit Ratio}_i \times QE_{c(i),m} + \gamma_7 \text{Security Ratio}_i \times \text{Deposit Ratio}_i \times QE_{c(i),m} + \epsilon_{i,m}. \end{aligned}$$

Returns are then predicted using a one-standard-deviation increase in asset purchases, i.e.,  $QE_{c(i),m} = 1$ .

Figure 9: Estimated Stock Returns

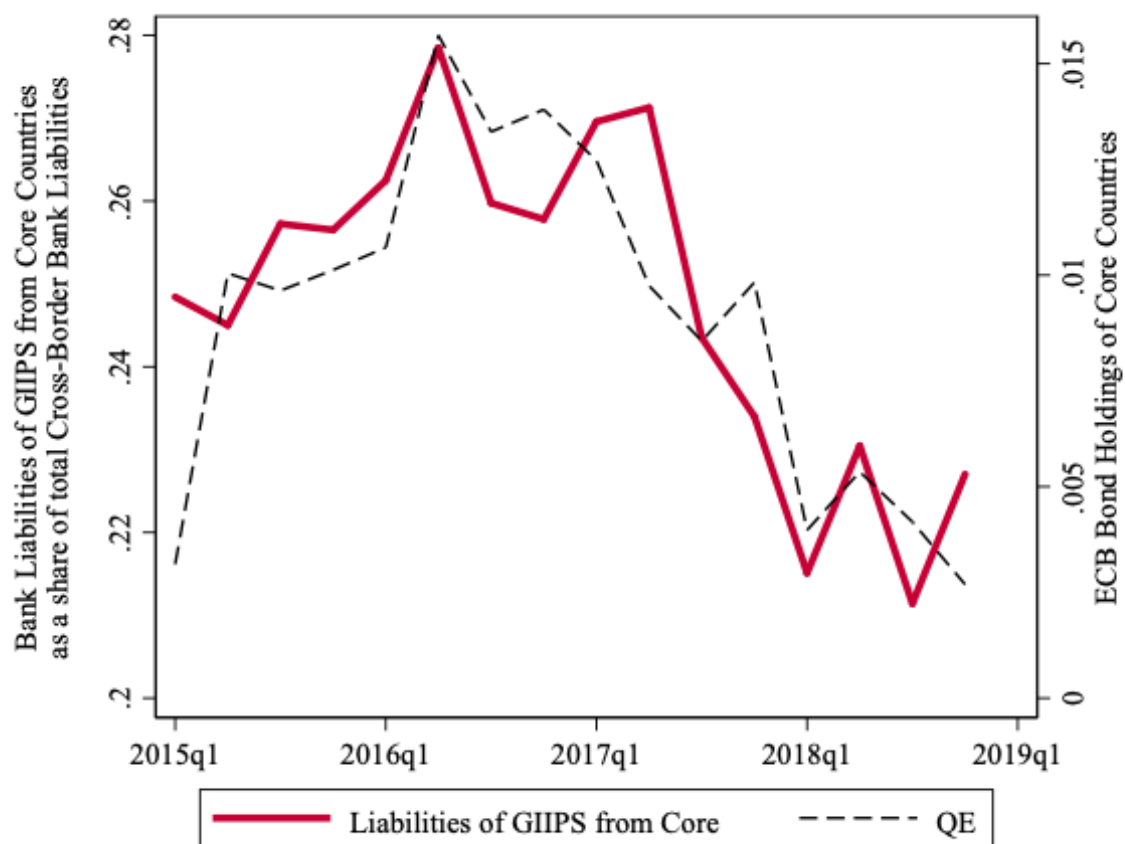


Notes: This graph shows the predicted stock returns for a euro area bank with a low (high) deposit and a low (high) security ratio, both at the 25<sup>th</sup> (75<sup>th</sup>) percentile of the respective distribution, based on the following regression specification:

$$\begin{aligned}
 Return_{i,m} = & \alpha + \gamma_1 QE_{c(i),m} + \gamma_2 Security\ Ratio_i + \gamma_3 Deposit\ Ratio_i \\
 & + \gamma_4 Security\ Ratio_i \times Deposit\ Ratio_i + \gamma_5 Security\ Ratio_i \times QE_{c(i),m} \\
 & + \gamma_6 Deposit\ Ratio_i \times QE_{c(i),m} + \gamma_7 Security\ Ratio_i \times Deposit\ Ratio_i \times QE_{c(i),m} + \epsilon_{i,m}.
 \end{aligned}$$

Returns are then predicted using  $QE_m$ , which is the average value of  $QE_{c(i),m}$  (as defined in (2)) across all euro area countries, over time (measured in months).

Figure 10: Cross-border Banking Flows



Notes: This graph shows the capital flows from the banking sector in core countries to that in GIIPS countries along with the ECB bond holdings of core countries over time.

## Tables

Table 1: Syndicated-lending Response by Banks with Different Exposure to QE and Negative Rates

	Dependent Variable: Lending							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
QE $\times$ Security Ratio $\times$ Deposit Ratio	-0.815** (0.309)	-0.938** (0.448)	-0.950** (0.468)	-0.949*** (0.347)	-0.954*** (0.332)	-0.633** (0.286)	-0.622** (0.273)	-2.006** (0.804)
R-squared	0.975	0.976	0.976	0.975	0.975	0.976	0.976	0.976
N	6,382	6,311	6,311	5,913	5,863	6,311	6,311	6,311
Bank FE	✓	✓	✓	✓	✓	✓	✓	✓
Borrower $\times$ Month-year FE	✓	✓	✓	✓	✓	✓	✓	✓
Country $\times$ Month-year FE	—	✓	✓	✓	✓	✓	✓	✓
Specification	$\frac{App_{c(i),m(t)}}{BSecH_{c(i),2012}}$	$\frac{App_{c(i),m(t)}}{BSecH_{c(i),2012}}$	$\frac{App_{c(i),m(t)}}{BSecH_{c(i),m(t)-1}}$	$\ln(App_{c(i),m(t)})$	$\ln(App_{m(t)})$	$\ln(H_{c(i),m})$	$\ln(H_{m(t)})$	$QEDummy$

Notes: The level of observation is a syndicated loan to firm  $j$  by euro area bank  $i$  in country  $c$  on date  $t$ . The sample period is 2014 to 2020. The dependent variable is the natural logarithm of the euro amount of debt issued between firm  $j$  and bank  $i$  on date  $t$ .  $QE$  measures the implementation of the public sector purchase program (PSPP) of the ECB, and is always standardized to have a 0 mean and a standard deviation of 1. In columns 1-2,  $QE_{c(i),m(t)}$  is the amount of government bond purchases (by the ECB in month-year  $m(t)$ ) of country  $c$  that bank  $i$  is incorporated in, divided by the respective country's banks' total security holdings in 2012. In column 3,  $QE_{c(i),m(t)}$  has the same numerator, but is now scaled by country  $c$ 's banks' total security holdings in the previous month-year. In column 4,  $QE_{m(t)}$  is the natural logarithm of the amount of government bonds of country  $c$  purchased by the ECB in month-year  $m(t)$ . In column 5,  $QE_{m(t)}$  is the natural logarithm of the amount of all government bonds purchased by the ECB in month-year  $m(t)$ . In column 6,  $QE_{c(i),m(t)}$  is the natural logarithm of the amount of country  $c$  government bonds *held* by the ECB in month-year  $m(t)$ . In column 7,  $QE_{m(t)}$  is the natural logarithm of the amount of all government bonds *held* by the ECB in month-year  $m(t)$ . In column 8,  $QE_{m(t)}$  is a dummy equal to 1 after March 2015.  $SecurityRatio_i$  is the share of securities over assets of bank  $i$  in 2012, and  $DepositRatio_i$  is the share of deposits over assets of bank  $i$  in 2012. The various double interactions between the three variables  $SecurityRatio_i$ ,  $DepositRatio_i$  and  $QE_{c(i),m(t)}$ , and their levels (if not absorbed by fixed effects) are included in the regressions, but are not reported in the table. Standard errors are clustered at the bank level.



Table 2: Syndicated-lending Response by Banks with Different Exposure to QE—Before vs. After Introduction of Negative Rates

	Dependent Variable: Lending		
	(1)	(2)	(3)
Post $\times$ Security Ratio $\times$ Deposit Ratio	-1.136** (0.473)	-1.190** (0.551)	-1.517** (0.617)
R-squared	0.977	0.978	0.978
N	10,278	10,148	10,116
Bank FE	✓	✓	✓
Borrower $\times$ Month-year FE	✓	✓	✓
Country $\times$ Month-year FE	-	✓	✓
Interacted Controls	-	-	✓

Notes: The level of observation is a syndicated loan to firm  $j$  by euro area bank  $i$  in country  $c$  on date  $t$ . The sample period is 2010 to 2020. The dependent variable is the natural logarithm of the euro amount of debt issued between firm  $j$  and bank  $i$  on date  $t$ .  $Post_t$  is a dummy that equals 1 after the ECB introduced negative monetary-policy rates (June 11, 2014).  $Security Ratio_i$  is the share of securities over assets of bank  $i$  in 2012, and  $Deposit Ratio_i$  is the share of deposits over assets of bank  $i$  in 2012. The double interactions between  $Post_t$  and the two variables  $Security Ratio_i$  and  $Deposit Ratio_i$  are included in the regressions, but are not reported in the table. Column 3 includes the interactions between  $Post_t$  and the following bank-level control variables as of 2012: (1) the natural logarithm of total assets, (2) the simple capital ratio, (3) the tier 1 capital ratio, (4) the return on assets, and (5) the return on capital. Standard errors are clustered at the bank level.

Table 3: Syndicated-lending Response by Banks with Different Exposure to QE—Interaction with Deposit Facility Rate

	Dependent Variable: Lending		
	(1)	(2)	(3)
Deposit Facility $\times$ Security Ratio $\times$ Deposit Ratio	3.154* (1.704)	3.516 (2.105)	4.571** (2.239)
R-squared	0.975	0.976	0.976
$N$	8,311	8,213	8,181
Bank FE	✓	✓	✓
Borrower $\times$ Month-year FE	✓	✓	✓
Country $\times$ Month-year FE	-	✓	✓
Interacted Controls	-	-	✓

Notes: The level of observation is a syndicated loan to firm  $j$  by euro area bank  $i$  in country  $c$  on date  $t$ . The sample period is 2012 to 2020. The dependent variable is the natural logarithm of the euro amount of debt issued between firm  $j$  and bank  $i$  on date  $t$ .  $Deposit Facility_t$  is the ECB's deposit facility rate.  $Security Ratio_i$  is the share of securities over assets of bank  $i$  in 2012, and  $Deposit Ratio_i$  is the share of deposits over assets of bank  $i$  in 2012. The double interactions between  $Deposit Facility_t$  and the two variables  $Security Ratio_i$  and  $Deposit Ratio_i$  are included in the regressions, but are not reported in the table. Column 3 includes the interactions between  $Deposit Facility_t$  and the following bank-level control variables as of 2012: (1) the natural logarithm of total assets, (2) the simple capital ratio, (3) the tier 1 capital ratio, (4) the return on assets, and (5) the return on capital. Standard errors are clustered at the bank level.

Table 4: Syndicated-lending Response by Banks with Different Exposure to QE—Staggered Implementation of Negative Rates

	Dependent Variable: Lending		
	(1)	(2)	(3)
1 NIRP CUT BEFORE QE $\times$ Security Ratio $\times$ Deposit Ratio	0.039 (0.656)	-0.079 (0.924)	-0.072 (0.922)
2 QE $\times$ Security Ratio $\times$ Deposit Ratio	-2.404*** (0.804)	-2.278* (1.239)	-2.461* (1.243)
3 NIRP CUT AFTER QE $\times$ Security Ratio $\times$ Deposit Ratio	-1.191** (0.576)	-1.280** (0.534)	-1.264** (0.533)
R-squared	0.977	0.978	0.978
N	10,278	10,148	10,116
Bank FE	✓	✓	✓
Borrower $\times$ Month-year FE	✓	✓	✓
Country $\times$ Month-year FE	-	✓	✓
Interacted Controls	-	-	✓

Notes: The level of observation is a syndicated loan to firm  $j$  by euro area bank  $i$  in country  $c$  on date  $t$ . The sample period is 2010 to 2020. The dependent variable is the natural logarithm of the euro amount of debt issued between firm  $j$  and bank  $i$  on date  $t$ . *NIRP CUT BEFORE QE<sub>t</sub>* is a dummy that equals 1 after negative monetary-policy rates were introduced and before QE was implemented. *QE<sub>t</sub>* is a dummy that equals 1 after QE was implemented and before further interest-rate cuts (with QE) were implemented. *NIRP CUT AFTER QE<sub>t</sub>* is a dummy that equals 1 after further interest-rate cuts (with QE) were implemented. *Security Ratio<sub>i</sub>* is the share of securities over assets of bank  $i$  in 2012, and *Deposit Ratio<sub>i</sub>* is the share of deposits over assets of bank  $i$  in 2012. The various double interactions between the three variables *Security Ratio<sub>i</sub>*, *Deposit Ratio<sub>i</sub>*, and the *QE* indicators are included in the regressions, but are not reported in the table. Column 3 includes the interactions between the *QE* indicators and the following bank-level control variables as of 2012: (1) the natural logarithm of total assets, (2) the simple capital ratio, (3) the tier 1 capital ratio, (4) the return on assets, and (5) the return on capital. Standard errors are clustered at the bank level.

Table 5: Effect on Profitability of Banks with Different Exposure to QE and Negative Rates

	Dependent Variable: Stock Return				
	(1)	(2)	(3)	(4)	(5)
QE $\times$ Security Ratio $\times$ Deposit Ratio	-0.341** (0.160)	-0.327** (0.145)	-0.314** (0.130)	-0.342*** (0.104)	-0.374** (0.166)
R-squared	0.010	0.025	0.323	0.337	0.342
N	2,013	2,013	2,013	2,013	1,925
Bank FE	-	✓	-	✓	✓
Time FE	-	-	✓	✓	✓
Interacted Controls	-	-	-	-	✓

Notes: The level of observation is the monthly stock return of euro area bank  $i$  in country  $c$  in month-year  $m$ . The sample period is 2010 to 2020. The dependent variable is the difference in the natural logarithm of the equity prices of bank  $i$  between month-year  $m$  and  $m - 1$ .  $QE_{c(i),m(t)}$  is the amount of government bond purchases (by the ECB in month-year  $m(t)$ ) of country  $c$  that bank  $i$  is incorporated in, divided by the respective country's banks' total security holdings in 2012, and is standardized to have a 0 mean and a standard deviation of 1.  $Security\ Ratio_i$  is the share of securities over assets of bank  $i$  in 2012, and  $Deposit\ Ratio_i$  is the share of deposits over assets of bank  $i$  in 2012. The various double interactions between the three variables  $Security\ Ratio_i$ ,  $Deposit\ Ratio_i$  and  $QE_{c(i),m(t)}$ , and their levels (if not absorbed by fixed effects) are included in the regressions, but are not reported in the table. Column 5 includes the interactions between  $QE_{c(i),m(t)}$  and the following bank-level control variables as of 2012: (1) the natural logarithm of total assets, (2) the simple capital ratio, (3) the tier 1 capital ratio, (4) the return on assets, and (5) the return on capital. Standard errors are clustered at the bank level.

Table 6: Effect on Profitability of Banks with Different Exposure to QE and Negative Rates—Heterogeneity across Countries

	Dependent Variable: Stock Return			
	(1)	(2)	(3)	(4)
QE $\times$ Security Ratio $\times$ Deposit Ratio	-3.352*** (0.428)	-1.296** (0.494)	-0.380** (0.159)	-1.970*** (0.538)
QE $\times$ Security Ratio $\times$ Deposit Ratio $\times$ Risky	3.011*** (0.490)	1.000** (0.391)	0.663 (0.550)	0.542* (0.289)
R-squared	0.343	0.343	0.343	0.366
$N$	1,925	1,925	1,925	1,673
Bank FE	✓	✓	✓	✓
Time FE	✓	✓	✓	✓
Interacted Controls	✓	✓	✓	✓
Risky	Not Germany	Low Index	GIIPS	Bond Yields

Notes: The level of observation is the monthly stock return of euro area bank  $i$  in country  $c$  in month-year  $m$ . The sample period is 2010 to 2020. The dependent variable is the difference in the natural logarithm of the equity prices of bank  $i$  between month-year  $m$  and  $m - 1$ .  $QE_{c(i),m(t)}$  is the amount of government bond purchases (by the ECB in month-year  $m(t)$ ) of country  $c$  that bank  $i$  is incorporated in, divided by the respective country's banks' total security holdings in 2012, and is standardized to have a 0 mean and a standard deviation of 1.  $Security Ratio_i$  is the share of securities over assets of bank  $i$  in 2012, and  $Deposit Ratio_i$  is the share of deposits over assets of bank  $i$  in 2012.  $Risky_c$  captures the riskiness of the country that bank  $i$  is incorporated in.  $Risky_c$  is defined as all countries except for Germany in column 1, a dummy for a low (below-median) [Bittner, Bonfim, Heider, Saidi, Schepens, and Soares \(2022\)](#) index in column 2, indicating a greater distance to the ZLB, a dummy for a GIIPS (Greece, Italy, Ireland, Portugal, or Spain) country in column 3, and the government bond yield of country  $c$  in 2014 in column 4. The various remaining interactions between  $Deposit Ratio_i$ ,  $Security Ratio_i$ ,  $QE_{c(i),m(t)}$ , and  $Risky_c$  are included in the regressions, but are not reported in the table. Standard errors are clustered at the bank level.

Table 7: Effect on Balance Sheets of Banks with Different Exposure to QE and Negative Rates

	CB assets Assets (1)	CB liabilities Assets (2)	CB net assets Assets (3)	Deposits Assets (4)
QE $\times$ Security Ratio $\times$ Deposit Ratio	0.030** (0.014)	0.001 (0.005)	0.024* (0.014)	0.013 (0.009)
R-squared	0.648	0.721	0.661	0.953
N	19,285	19,285	19,091	19,283
Bank FE	✓	✓	✓	✓
Time FE	✓	✓	✓	✓

Notes: The level of observation is German bank  $i$  in quarter-year  $q$ . The sample period spans the first time negative monetary-policy rates are introduced (2014q3) up until 2018q4. The dependent variable in column 1 is central-bank assets of bank  $i$  in quarter-year  $q$  divided by total assets of bank  $i$  in 2012. The dependent variables in columns 2-4 are constructed similarly, where the numerator is central-bank liabilities of bank  $i$  in quarter-year  $q$  in column 2, central-bank assets minus liabilities of bank  $i$  in quarter-year  $q$  in column 3, and deposits of bank  $i$  in quarter-year  $q$  in column 4.  $QE_q$  is the amount of German government bonds purchased by the ECB in quarter-year  $q$  divided by all German banks' total German sovereign bond holdings in 2012, and is standardized to have a 0 mean and a standard deviation of 1.  $Security Ratio_i$  is the share of securities over assets of bank  $i$  in 2012, and  $Deposit Ratio_i$  is the share of deposits over assets of bank  $i$  in 2012. The various double interactions between  $QE_q$  and the two variables  $Security Ratio_i$  and  $Deposit Ratio_i$  are included in the regressions, but are not reported in the table. Standard errors are clustered at the bank level. Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, balance-sheet statistics (BISTA).

Table 8: Security Holdings of Banks with Different Exposure to QE and Negative Rates

	Dependent Variable: Security Holdings					
	(1)	(2)	(3)	(4)	(5)	(6)
QE $\times$ Security Ratio	-0.150*** (0.047)	-0.162*** (0.046)	-0.266*** (0.077)	-0.290*** (0.075)	-0.112 (0.094)	-0.135 (0.099)
R-squared	0.952	0.974	0.932	0.950	0.955	0.985
N	3,625,419	3,602,180	1,797,212	1,787,733	1,825,439	1,814,447
Bank FE	✓	-	✓	-	✓	-
Security FE	✓	-	✓	-	✓	-
Time FE	✓	✓	✓	✓	✓	✓
Bank $\times$ Security FE	-	✓	-	✓	-	✓
Sample	Full	Full	Large Banks	Large Banks	Small Banks	Small Banks

Notes: The level of observation is German bank  $i$ 's holdings in security  $s$  in quarter-year  $q$ . The sample period spans the first time negative monetary-policy rates are introduced (2014q3) up until 2018q4. The dependent variable is the natural logarithm of the euro amount held in security  $s$  by bank  $i$  in quarter-year  $q$ .  $QE_q$  is the amount of German government bonds purchased by the ECB in quarter-year  $q$  divided by all German banks' total German sovereign bond holdings in 2012, and is standardized to have a 0 mean and a standard deviation of 1.  $SecurityRatio_i$  is the share of securities over assets of bank  $i$  in 2012. Bank  $i$  is considered to be a large bank if its total assets exceed €50 billion in 2012. Otherwise, the bank is a small bank. Standard errors are double-clustered at the bank and security levels. Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Security Holdings Statistics (SHS), and balance-sheet statistics (BISTA).

Table 9: Credit-supply Response by Banks with Different Exposure to QE and Negative Rates—Credit-registry Evidence

	Dependent Variable: Lending					
	(1)	(2)	(3)	(4)	(5)	(6)
QE $\times$ Security Ratio $\times$ Deposit Ratio	-2.071** (0.720)	0.036 (0.057)	0.036 (0.058)	-3.166*** (0.333)	0.079 (0.062)	0.075 (0.064)
Large Bank $\times$ QE $\times$ Security Ratio $\times$ Deposit Ratio			-2.113*** (0.802)			
Repo Bank $\times$ QE $\times$ Security Ratio $\times$ Deposit Ratio						-3.665*** (0.369)
R-squared	0.920	0.945	0.934	0.917	0.946	0.934
N	353,363	1,272,435	1,963,138	307,312	1,342,966	1,963,138
Bank $\times$ Firm FE	✓	✓	✓	✓	✓	✓
Firm $\times$ Time FE	✓	✓	✓	✓	✓	✓
Sample	Large Banks	Small Banks	Full	Repo Banks	Non-repo Banks	Full

Notes: The level of observation is credit to German firm  $j$  by German bank  $i$  in quarter-year  $q$ . The sample period spans the first time negative monetary-policy rates are introduced (2014q3) up until 2018q4. The dependent variable is the natural logarithm of the euro amount outstanding between firm  $j$  and bank  $i$  in quarter-year  $q$ .  $QE_q$  is the amount of German government bonds purchased by the ECB in quarter-year  $q$  divided by all German banks' total German sovereign bond holdings in 2012, and is standardized to have a 0 mean and a standard deviation of 1. *Security Ratio<sub>i</sub>* is the share of securities over assets of bank  $i$  in 2012, and *Deposit Ratio<sub>i</sub>* is the share of deposits over assets of bank  $i$  in 2012. Bank  $i$  is considered to be a large bank if its total assets exceed €50 billion in 2012. Otherwise, the bank is a small bank. Bank  $i$  is a repo bank if the bank conducts repo transactions. Otherwise, the bank is a non-repo bank. The various remaining interactions between *Deposit Ratio<sub>i</sub>*, *Security Ratio<sub>i</sub>*,  $QE_q$ , *Large Bank<sub>i</sub>*, and *Repo Bank<sub>i</sub>* are included in the regressions, but are not reported in the table. Standard errors are clustered at the bank level. Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, German credit register (BAKIS-M), and balance-sheet statistics (BISTA).



Table 10: Credit-supply Response by Banks with Different Exposure to QE and Negative Rates—Robustness

	Dependent Variable: Lending			
	(1)	(2)	(3)	(4)
Deposit Ratio $\times \Delta \ln$ securities (one year)	0.127* (0.070)			
Deposit Ratio HH $\times \Delta \ln$ securities (one year)		0.130* (0.076)		
Deposit Ratio NFC $\times \Delta \ln$ securities (one year)		0.089 (0.229)		
Deposit Ratio $\times \Delta \ln$ securities (one quarter)			0.125 (0.082)	
Deposit Ratio HH $\times \Delta \ln$ securities (one quarter)				0.168** (0.081)
Deposit Ratio NFC $\times \Delta \ln$ securities (one quarter)				-0.456** (0.205)
R-squared	0.938	0.938	0.938	0.938
N	1,671,560	1,671,560	1,714,208	1,714,208
Bank $\times$ Firm FE	✓	✓	✓	✓
Firm $\times$ Time FE	✓	✓	✓	✓

Notes: The level of observation is credit to German firm  $j$  by German bank  $i$  in quarter-year  $q$ . The sample period spans the first time negative monetary-policy rates are introduced (2014q3) up until 2018q4. The dependent variable is the natural logarithm of the euro amount outstanding between firm  $j$  and bank  $i$  in quarter-year  $q$ .  $\Delta \ln \text{ securities}_{i,q}$  is the change in logged security holdings of bank  $i$  from  $q$  to  $q$  minus one year (or one quarter in the last two columns), and is always controlled for separately.  $\text{Deposit Ratio}_i$  is the share of deposits over assets of bank  $i$  in 2012. The numerator of said ratio is further decomposed into household deposits ( $\text{Deposit Ratio HH}_i$ ) and deposits from non-financial corporations ( $\text{Deposit Ratio NFC}_i$ ). Standard errors are clustered at the bank level. Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, German credit register (BAKIS-M), and balance-sheet statistics (BISTA).

Table 11: Credit-supply Response by Banks with Different Exposure to QE and Negative Rates—Robustness, Buying vs. Selling

	Dependent Variable: Lending			
	(1)	(2)	(3)	(4)
Deposit Ratio $\times \Delta \ln$ securities (one year)	0.201** (0.080)	0.023 (0.059)		
Deposit Ratio HH $\times \Delta \ln$ securities (one year)			0.202** (0.088)	0.029 (0.056)
Deposit Ratio NFC $\times \Delta \ln$ securities (one year)			0.188 (0.277)	-0.067 (0.334)
R-squared	0.943	0.949	0.943	0.949
N	780,780	633,571	780,780	633,571
Bank $\times$ Firm FE	✓	✓	✓	✓
Firm $\times$ Time FE	✓	✓	✓	✓
Change in securities	Sell	Buy	Sell	Buy

Notes: The level of observation is credit to German firm  $j$  by German bank  $i$  in quarter-year  $q$ . The sample period spans the first time negative monetary-policy rates are introduced (2014q3) up until 2018q4. The dependent variable is the natural logarithm of the euro amount outstanding between firm  $j$  and bank  $i$  in quarter-year  $q$ .  $\Delta \ln \text{ securities}_{i,q}$  is the change in logged security holdings of bank  $i$  from  $q$  to  $q$  minus one year, and is always controlled for separately.  $\text{Deposit Ratio}_i$  is the share of deposits over assets of bank  $i$  in 2012. The numerator of said ratio is further decomposed into household deposits ( $\text{Deposit Ratio HH}_i$ ) and deposits from non-financial corporations ( $\text{Deposit Ratio NFC}_i$ ). The analysis is run separately for banks selling securities ( $\Delta \text{ securities}_{i,q} < 0$ , columns 1 and 3) and banks buying securities ( $\Delta \text{ securities}_{i,q} > 0$ , columns 2 and 4). Standard errors are clustered at the bank level. Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, German credit register (BAKIS-M), and balance-sheet statistics (BISTA).

Table 12: Real Effects of Bank Credit Supply

	$\Delta \ln(\text{Wage bill})$			$\Delta \ln(\text{Employment})$			$\Delta \ln(\text{Tangible fixed assets})$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Security & Deposit Exposure	-0.233*** (0.068)	-0.199** (0.080)	-0.142 (0.092)	-0.265*** (0.077)	-0.222** (0.088)	-0.177* (0.103)	-0.019 (0.150)	-0.071 (0.178)	-0.235 (0.209)
Security Exposure	0.118*** (0.025)	0.099*** (0.030)	0.093*** (0.034)	0.076*** (0.029)	0.055* (0.033)	0.051 (0.038)	0.010 (0.058)	0.024 (0.068)	0.059 (0.077)
Deposit Exposure	0.054*** (0.013)	0.053*** (0.015)	0.054*** (0.017)	0.076*** (0.015)	0.076*** (0.016)	0.073*** (0.019)	0.012 (0.030)	0.021 (0.035)	0.045 (0.039)
R-squared	0.046	0.169	0.223	0.033	0.158	0.208	0.024	0.141	0.205
N	6,098	5,791	5,163	6,145	5,840	5,208	6,109	5,804	5,171
Industry FE	✓	-	-	✓	-	-	✓	-	-
Region FE	✓	-	-	✓	-	-	✓	-	-
Size FE	✓	-	-	✓	-	-	✓	-	-
Industry $\times$ Region FE	-	✓	-	-	✓	-	-	✓	-
Industry $\times$ Size FE	-	✓	-	-	✓	-	-	✓	-
Industry $\times$ Region $\times$ Size FE	-	-	✓	-	-	✓	-	-	✓

Notes: The level of observation is German firm  $j$ . The dependent variable in columns 1-3 is the difference in the natural logarithm of borrower firm  $j$ 's average total wage bill in 2015 – 2016 vs. 2013 – 2014. The dependent variable in columns 4-6 is the difference in the natural logarithm of borrower firm  $j$ 's average number of employees in 2015 – 2016 vs. 2013 – 2014. The dependent variable in columns 7-9 is the difference in the natural logarithm of borrower firm  $j$ 's tangible fixed assets in 2015 – 2016 vs. 2013 – 2014. *Security & Deposit Exposure<sub>j</sub>* is the average value of *Security Ratio<sub>i</sub>*  $\times$  *Deposit Ratio<sub>i</sub>* (measured in 2012) of all German banks with which firm  $j$  contracts (as of 2014), weighted by firm  $j$ 's credit exposure to each bank  $i$ . *Security Exposure<sub>j</sub>* and *Deposit Exposure<sub>j</sub>* are defined accordingly using *Security Ratio<sub>i</sub>* and *Deposit Ratio<sub>i</sub>*, respectively. Fixed effects are based on firm  $j$ 's NACE industry segment, NUTS-3 region, and/or firm-size categories according to the European Union's guidelines. Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, German credit register (BAKIS-M), balance-sheet statistics (BISTA), and BvD Orbis.

Table 13: Interbank Lending by Banks with Different Exposure to QE and Negative Rates

	Dependent Variable: Lending					
	(1)	(2)	(3)	(4)	(5)	(6)
QE $\times$ Security Ratio $\times$ Deposit Ratio	4.334* (2.021)	4.890* (2.248)	-0.096 (0.114)	-0.035 (0.186)		
QE $\times$ Security Ratio $\times$ Deposit Ratio $\times$ Yield		0.129 (0.662)		-0.046 (0.126)		
$\Delta \ln \text{ securities (one year)} \times \text{Deposit Ratio}$					0.045 (0.181)	0.132 (0.184)
$\Delta \ln \text{ securities (one year)} \times \text{Deposit Ratio} \times \text{Yield}$						-0.086** (0.041)
R-squared	0.881	0.881	0.893	0.893	0.894	0.894
N	40,794	40,794	524,170	524,170	514,486	514,486
Bank (lender) $\times$ Bank (borrower) FE	✓	✓	✓	✓	✓	✓
Bank (borrower) $\times$ Time FE	✓	✓	✓	✓	✓	✓
Sample	Large Banks	Large Banks	Small Banks	Small Banks	Full	Full

Notes: The level of observation is credit to bank (borrower)  $j$  by German bank (lender)  $i$  in quarter-year  $q$ . The sample period spans the first time negative monetary-policy rates are introduced (2014q3) up until 2018q4. The dependent variable is the natural logarithm of the euro amount outstanding between bank  $j$  (borrower) and bank  $i$  (lender) in quarter-year  $q$ .  $QE_q$  is the amount of German government bonds purchased by the ECB in quarter-year  $q$  divided by all German banks' total German sovereign bond holdings in 2012, and is standardized to have a 0 mean and a standard deviation of 1.  $Security\ Ratio_i$  is the share of securities over assets of bank  $i$  in 2012, and  $Deposit\ Ratio_i$  is the share of deposits over assets of bank  $i$  in 2012.  $Yield_c$  is the yield of long-term (10-year) government bonds of the borrower's country prior to the introduction of negative monetary-policy rates.  $\Delta \ln \text{ securities}_{i,q}$  is the change in logged security holdings of bank (lender)  $i$  from  $q$  to  $q$  minus one year. A bank (lender)  $i$  is considered to be a large bank if its total assets exceed €50 billion in 2012. Otherwise, the bank is a small bank. The various remaining interactions between  $Deposit\ Ratio_i$ ,  $Security\ Ratio_i$ ,  $QE_q$ ,  $Yield_c$  and  $\Delta \ln \text{ securities}_{i,q}$ , and their levels (if not absorbed by fixed effects) are included in the regressions, but are not reported in the table. Standard errors are clustered at the bank (lender) level. Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, German credit register (BAKIS-M), and balance-sheet statistics (BISTA).

Table 14: Interbank Lending by Banks with Different Exposure to QE and Negative Rates—Euro Area vs. Rest of World

	Dependent Variable: Lending					
	(1)	(2)	(3)	(4)	(5)	(6)
QE $\times$ Security Ratio $\times$ Deposit Ratio	5.387* (2.423)	2.910 (2.246)	-0.145 (0.124)	0.080 (0.197)	-0.140 (0.123)	0.102 (0.196)
Large Bank $\times$ QE $\times$ Security Ratio $\times$ Deposit Ratio					4.390* (2.258)	2.698 (1.978)
R-squared	0.882	0.879	0.893	0.884	0.892	0.884
N	25,508	15,286	419,618	104,552	449,130	121,014
Bank (lender) $\times$ Bank (borrower) FE	✓	✓	✓	✓	✓	✓
Bank (borrower) $\times$ Time FE	✓	✓	✓	✓	✓	✓
Sample	Large Banks	Large Banks	Small Banks	Small Banks	Full	Full
Scope	EA	Non-EA	EA	Non-EA	EA	Non-EA

Notes: The level of observation is credit to bank (borrower)  $j$  by German bank (lender)  $i$  in quarter-year  $q$ . The sample period spans the first time negative monetary-policy rates are introduced (2014q3) up until 2018q4. The dependent variable is the natural logarithm of the euro amount outstanding between bank (borrower)  $j$  and bank (lender)  $i$  in quarter-year  $q$ .  $QE_q$  is the amount of German government bonds purchased by the ECB in quarter-year  $q$  divided by all German banks' total German sovereign bond holdings in 2012, and is standardized to have a 0 mean and a standard deviation of 1.  $Security Ratio_i$  is the share of securities over assets of bank (lender)  $i$  in 2012.  $Deposit Ratio_i$  is the share of deposits over assets of bank (lender)  $i$  in 2012. A bank (lender)  $i$  is considered to be a large bank if its total assets exceed €50 billion in 2012. Otherwise, the bank is a small bank. In columns 1, 3, and 5 only lending to banks (borrowers) within the euro area (EA) is considered, whereas in columns 2, 4, and 6 only lending to banks (borrowers) outside the euro area (non-EA) is considered. The various remaining interactions between  $Deposit Ratio_i$ ,  $Security Ratio_i$ ,  $QE_q$ , and  $Large Bank_i$  are included in the regressions, but are not reported in the table. Standard errors are clustered at the bank (lender) level. Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, German credit register (BAKIS-M), and balance-sheet statistics (BISTA).

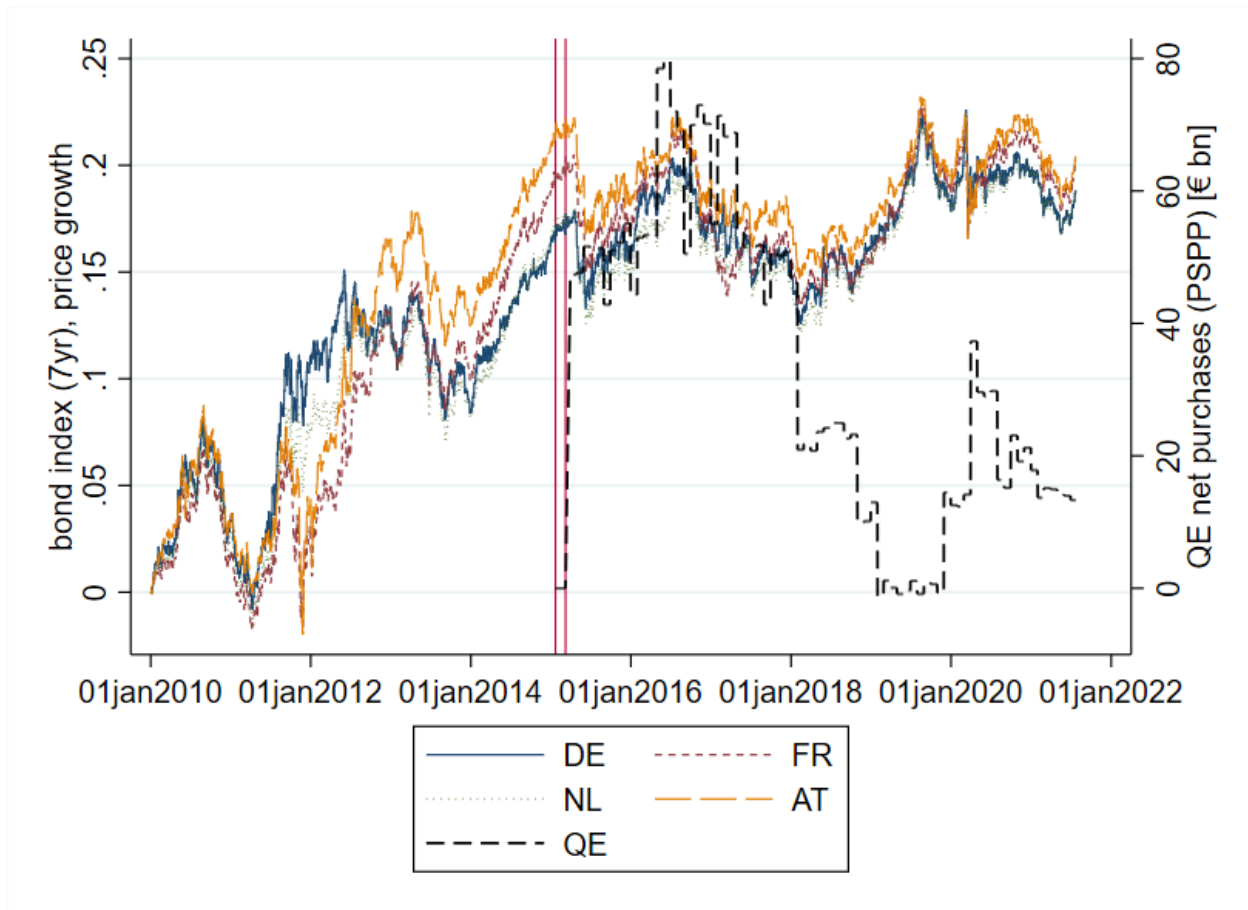
Table 15: Cross-border Banking Flows

	Dependent Variable: Bilateral Cross-Border Bank Lending					
	(1)	(2)	(3)	(4)	(5)	(6)
QE $\times$ Core $\times$ GIIPS	0.005*** (0.001)			0.004*** (0.000)		
QE $\times$ Core $\times$ High Yield		0.006* (0.003)			0.008*** (0.003)	
QE $\times$ Core $\times$ Low Index			0.005 (0.004)			0.004 (0.004)
R-squared	0.054	0.054	0.054	0.127	0.127	0.127
N	65,533	65,533	65,533	65,441	65,441	65,441
Lender $\times$ Borrower FE	✓	✓	✓	✓	✓	✓
Lender $\times$ Time FE	✓	✓	✓	✓	✓	✓
Borrower $\times$ Time FE	-	-	-	✓	✓	✓

Notes: The level of observation is the bilateral banking flow from country (lender)  $c$  to country (borrower)  $j$  in the euro area in quarter-year  $q$ . The dependent variable is the percent change in bank claims of country  $c$  to country  $j$ . The sample period is 2014 to 2020.  $QE_{c,q}$  is the amount of government bond purchases of country  $c$  by the ECB in quarter-year  $q$ , divided by the respective country's banks' total security holdings in 2012, and is standardized to have a 0 mean and a standard deviation of 1.  $Core_c$  is a dummy for whether the lender country  $c$  is Germany, Finland, the Netherlands, or Austria.  $GIIPS_j$  is a dummy for whether the borrower country  $j$  is Greece, Italy, Ireland, Portugal, or Spain.  $High\ Yield_j$  is a dummy for whether the borrower country  $j$  has a high (above median) sovereign yield in 2014.  $Low\ Index_j$  is a dummy for a low (below-median) [Bittner, Bonfim, Heider, Saidi, Schepens, and Soares \(2022\)](#) index, indicating a greater distance to the ZLB in borrower country  $j$ . The double interactions between  $QE_{c,q}$  and the three variables  $GIIPS_j$ ,  $High\ Yield_j$ , and  $Low\ Index_j$  are included in the regressions, but are not reported in the table. Standard errors are double-clustered at the lender-country and borrower-country levels.

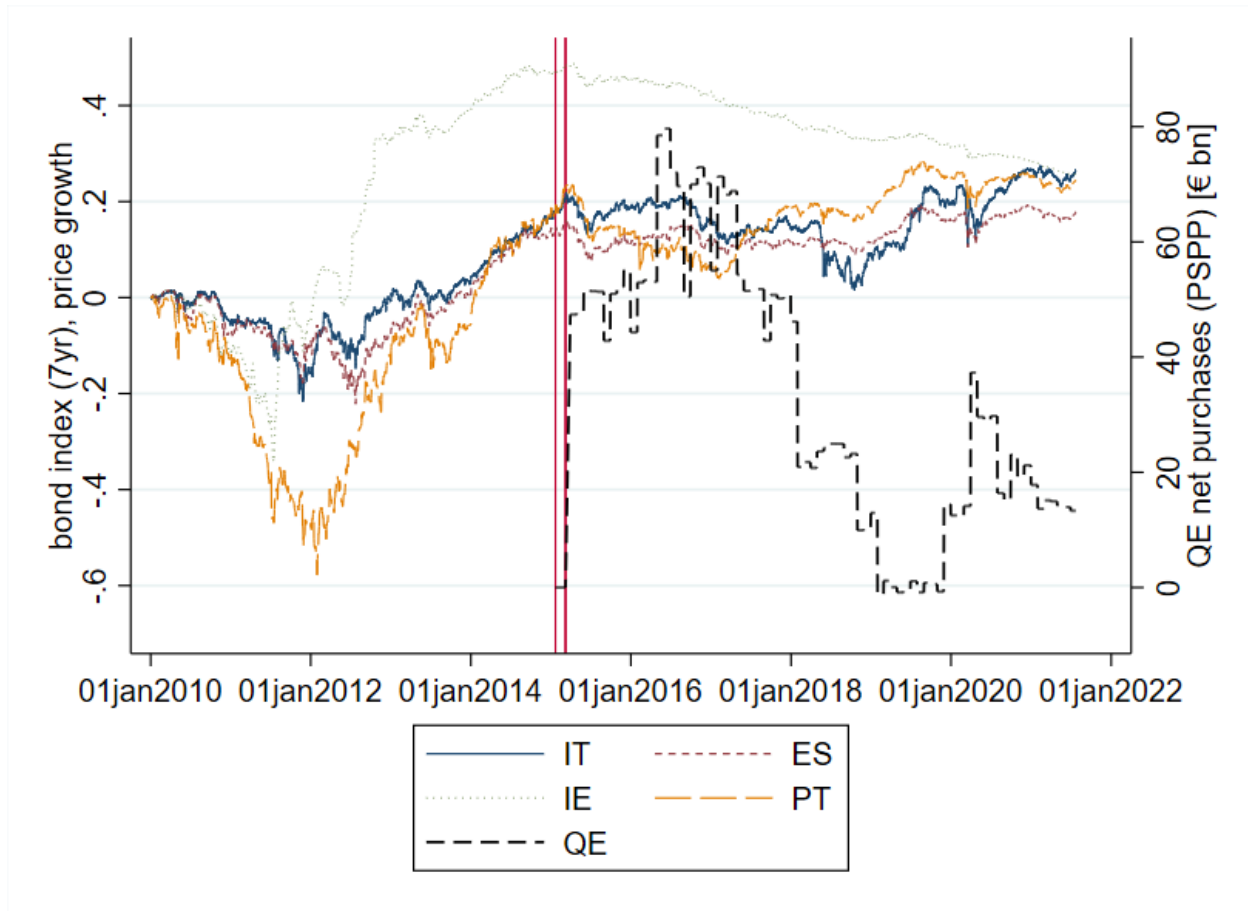
# ONLINE APPENDIX—NOT FOR PUBLICATION

Figure A1: Bond Prices: Core Countries



Notes: This graph shows the price development of European bond indices and the net purchases by the ECB under the public sector purchase program (PSPP) in € billions. The bond indices for Germany, France, Netherlands, and Austria with a maturity of 7 years each are plotted as growth rates relative to the beginning of 2010 (left y-axis). The net purchases (PSPP) by the ECB are shown in the dashed black line referring to the right y-axis. The first vertical red line represents the announcement of the PSPP (January 22, 2015), and the second one marks its implementation (March 9, 2015).

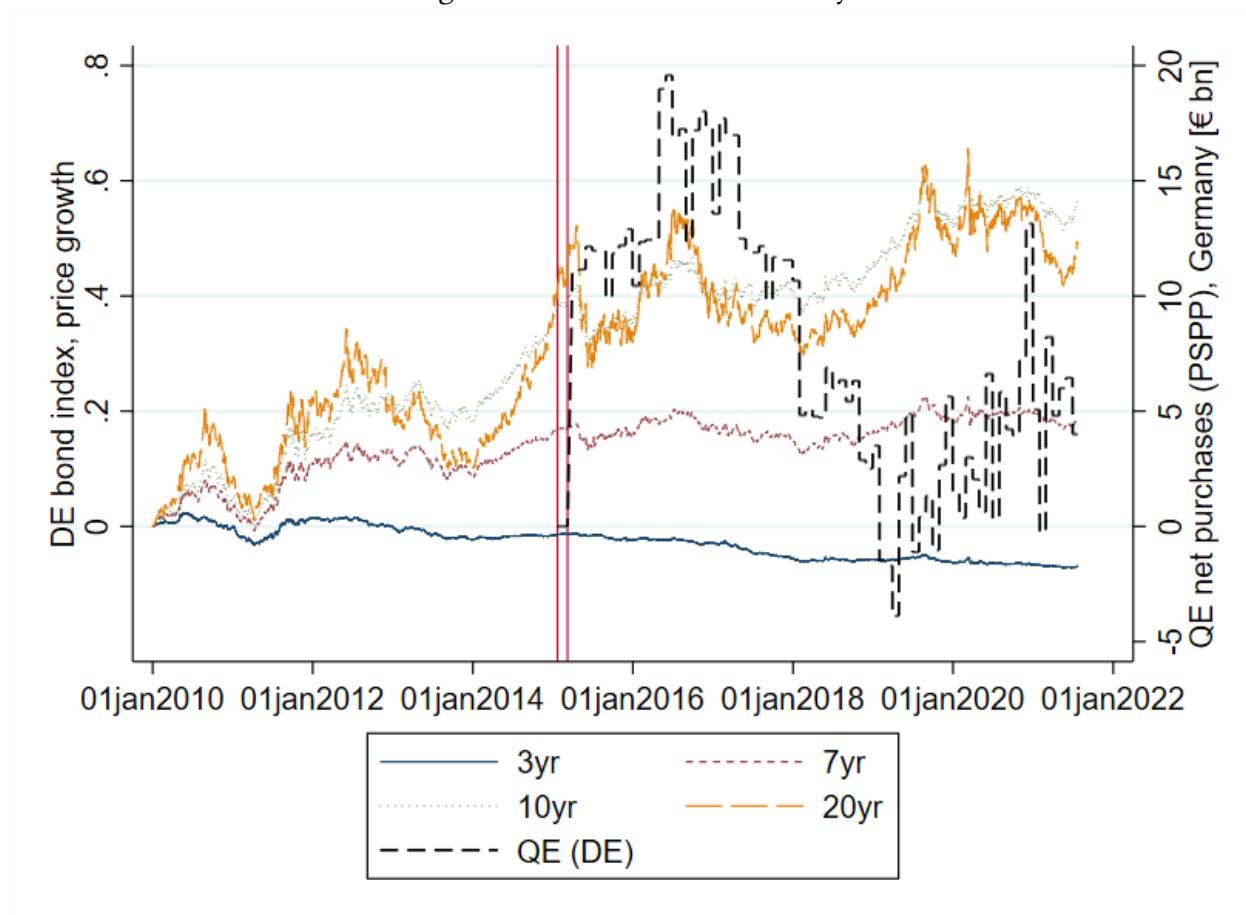
Figure A2: Bond Prices: Periphery Countries



Notes: This graph shows the price development of European bond indices and the net purchases by the ECB under the public sector purchase program (PSPP) in € billions. The bond indices for Italy, Spain, Ireland, and Portugal with a maturity of 7 years each are plotted as growth rates relative to the beginning of 2010 (left y-axis). The net purchases (PSPP) by the ECB are shown in the dashed black line referring to the right y-axis. The first vertical red line represents the announcement of the PSPP (January 22, 2015), and the second one marks its implementation (March 9, 2015).

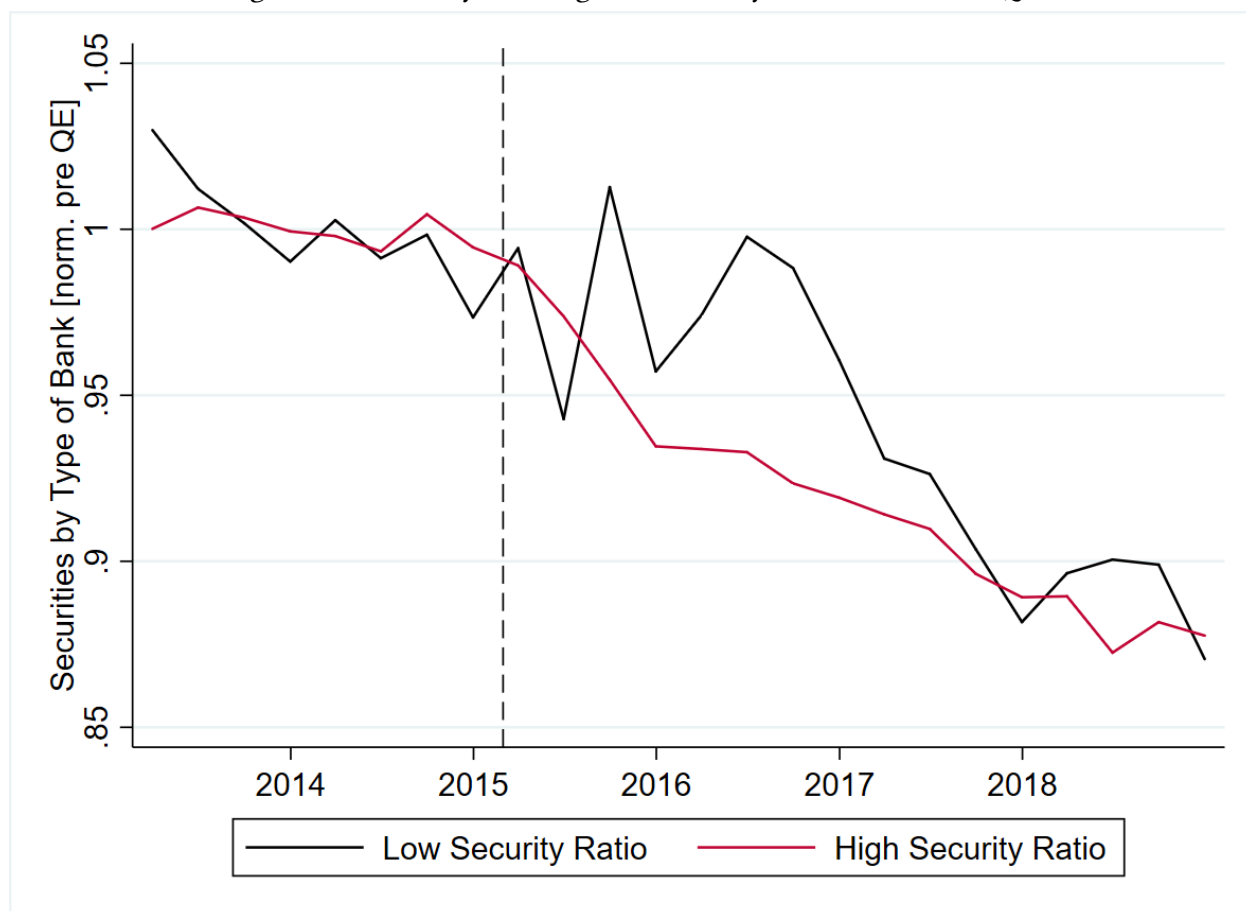


Figure A3: Bond Prices: Germany



Notes: This graph shows the price development of German bond indices with different maturities and the net purchases by the ECB under the public sector purchase program (PSPP) in € billions. The bond indices for Germany with maturities of 3, 7, 10, and 20 years are plotted as growth rates relative to the beginning of 2010 (left y-axis). The net purchases (PSPP) of German bonds by the ECB are shown in the dashed black line referring to the right y-axis. The first vertical red line represents the announcement of the PSPP (January 22, 2015), and the second one marks its implementation (March 9, 2015).

Figure A4: Security Holdings in Germany Before and After QE



Notes: This graph shows the development of security holdings by German banks with high and low security ratios (separated by the median as of 2012) between 2013 and 2019. Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Security Holdings Statistics (SHS), and balance-sheet statistics (BISTA).

Table A1: Syndicated-lending Response by Banks with Different Exposure to QE and Negative Rates—Double Interactions

	Dependent Variable: Lending							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
QE $\times$ Security Ratio	-0.018 (0.057)	-0.135 (0.089)	-0.132 (0.093)	-0.059 (0.090)	-0.054 (0.082)	-0.017 (0.085)	-0.020 (0.082)	-0.067 (0.223)
QE $\times$ Deposit Ratio	-0.014 (0.019)	0.026 (0.023)	0.024 (0.023)	0.037 (0.026)	0.031 (0.030)	0.015 (0.026)	0.017 (0.027)	0.069 (0.080)
R-squared	0.975	0.976	0.976	0.975	0.975	0.976	0.976	0.976
N	6,382	6,311	6,311	5,913	5,863	6,311	6,311	6,311
Bank FE	✓	✓	✓	✓	✓	✓	✓	✓
Borrower $\times$ Month-year FE	✓	✓	✓	✓	✓	✓	✓	✓
Country $\times$ Month-year FE	—	✓	✓	✓	✓	✓	✓	✓
Specification	$\frac{App_{c(i),m(t)}}{BSecH_{c(i),2012}}$	$\frac{App_{c(i),m(t)}}{BSecH_{c(i),2012}}$	$\frac{App_{c(i),m(t)}}{BSecH_{c(i),m(t)-1}}$	$\ln(App_{c(i),m(t)})$	$\ln(App_{m(t)})$	$\ln(H_{c(i),m})$	$\ln(H_{m(t)})$	QEDummy

Notes: The level of observation is a syndicated loan to firm  $j$  by euro area bank  $i$  in country  $c$  on date  $t$ . The sample period is 2014 to 2020. The dependent variable is the natural logarithm of the euro amount of debt issued between firm  $j$  and bank  $i$  on date  $t$ . QE measures the implementation of the public sector purchase program (PSPP) of the ECB, and is always standardized to have a 0 mean and a standard deviation of 1. In columns 1-2,  $QE_{c(i),m(t)}$  is the amount of government bond purchases (by the ECB in month-year  $m(t)$ ) of country  $c$  that bank  $i$  is incorporated in, divided by the respective country's banks' total security holdings in 2012. In column 3,  $QE_{c(i),m(t)}$  has the same numerator, but is now scaled by country  $c$ 's banks' total security holdings in the previous month-year. In column 4,  $QE_{m(t)}$  is the natural logarithm of the amount of government bonds of country  $c$  purchased by the ECB in month-year  $m(t)$ . In column 5,  $QE_{m(t)}$  is the natural logarithm of the amount of all government bonds purchased by the ECB in month-year  $m(t)$ . In column 6,  $QE_{c(i),m(t)}$  is the natural logarithm of the amount of country  $c$  government bonds held by the ECB in month-year  $m(t)$ . In column 7,  $QE_{m(t)}$  is the natural logarithm of the amount of all government bonds held by the ECB in month-year  $m(t)$ . In column 8,  $QE_{m(t)}$  is a dummy equal to 1 after March 2015. *Security Ratio<sub>i</sub>* is the share of securities over assets of bank  $i$  in 2012, and *Deposit Ratio<sub>i</sub>* is the share of deposits over assets of bank  $i$  in 2012. The interaction between the three variables *Security Ratio<sub>i</sub>*, *Deposit Ratio<sub>i</sub>* and  $QE_{c(i),m(t)}$ , and their levels (if not absorbed by fixed effects) are included in the regressions, but are not reported in the table. Standard errors are clustered at the bank level.

Table A2: Correlation of Bank-level Exposure Variables with Other Balance-sheet Characteristics

	(1) ln(Assets)	(2) Capital Ratio	(3) T1 Capital Ratio	(4) RoA	(5) RoC
Security Ratio	3.228 (3.865)	0.003 (0.096)	-0.021 (0.064)	-0.048 (0.030)	93.280 (223.547)
Deposit Ratio	-2.028 (1.532)	0.031 (0.030)	0.044** (0.020)	-0.012 (0.012)	-27.462 (69.741)
Security Ratio $\times$ Deposit Ratio	-4.821 (6.988)	0.052 (0.153)	-0.004 (0.102)	0.085 (0.054)	47.590 (356.948)
R-squared	0.171	0.114	0.230	0.047	0.026
$N$	66	60	50	66	52

Notes: The level of observation is a euro area bank  $i$  in the year 2012. The dependent variable is (1) the natural logarithm of total assets, (2) the simple capital ratio, (3) the tier 1 capital ratio, (4) the return on assets, and (5) the return on capital.  $Security\ Ratio_i$  is the share of securities over assets of bank  $i$  in 2012, and  $Deposit\ Ratio_i$  is the share of deposits over assets of bank  $i$  in 2012.

Table A3: Syndicated-lending Response by Banks with Different Exposure to QE and Negative Rates—Robustness

	Dependent Variable: Lending							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
QE $\times$ Security Ratio $\times$ Deposit Ratio	-1.227** (0.462)	-1.100** (0.506)	-1.143** (0.532)	-1.141** (0.432)	-1.117** (0.433)	-0.808** (0.376)	-0.790** (0.360)	-2.434** (0.994)
R-squared	0.975	0.976	0.976	0.975	0.975	0.976	0.976	0.976
N	6,362	6,291	6,291	5,893	5,844	6,291	6,291	6,291
Bank FE	✓	✓	✓	✓	✓	✓	✓	✓
Borrower $\times$ Month-year FE	✓	✓	✓	✓	✓	✓	✓	✓
Country $\times$ Month-year FE	—	✓	✓	✓	✓	✓	✓	✓
Specification	$\frac{App_{c(i),m(t)}}{BSecH_{c(i),2012}}$	$\frac{App_{c(i),m(t)}}{BSecH_{c(i),2012}}$	$\frac{App_{c(i),m(t)}}{BSecH_{c(i),m(t)-1}}$	$\ln(App_{c(i),m(t)})$	$\ln(App_{m(t)})$	$\ln(H_{c(i),m})$	$\ln(H_{m(t)})$	$QEDummy$
Interacted Controls	✓	✓	✓	✓	✓	✓	✓	✓

Notes: The level of observation is a syndicated loan to firm  $j$  by euro area bank  $i$  in country  $c$  on date  $t$ . The sample period is 2014 to 2020. The dependent variable is the natural logarithm of the euro amount of debt issued between firm  $j$  and bank  $i$  on date  $t$ .  $QE$  measures the implementation of the public sector purchase program (PSPP) of the ECB, and is always standardized to have a 0 mean and a standard deviation of 1. In columns 1-2,  $QE_{c(i),m(t)}$  is the amount of government bond purchases (by the ECB in month-year  $m(t)$ ) of country  $c$  that bank  $i$  is incorporated in, divided by the respective country's banks' total security holdings in 2012. In column 3,  $QE_{c(i),m(t)}$  has the same numerator, but is now scaled by country  $c$ 's banks' total security holdings in the previous month-year. In column 4,  $QE_{m(t)}$  is the natural logarithm of the amount of government bonds of country  $c$  purchased by the ECB in month-year  $m(t)$ . In column 5,  $QE_{m(t)}$  is the natural logarithm of the amount of all government bonds purchased by the ECB in month-year  $m(t)$ . In column 6,  $QE_{c(i),m(t)}$  is the natural logarithm of the amount of country  $c$  government bonds *held* by the ECB in month-year  $m(t)$ . In column 7,  $QE_{m(t)}$  is the natural logarithm of the amount of all government bonds *held* by the ECB in month-year  $m(t)$ . In column 8,  $QE_{m(t)}$  is a dummy equal to 1 after March 2015.  $Security\ Ratio_i$  is the share of securities over assets of bank  $i$  in 2012, and  $Deposit\ Ratio_i$  is the share of deposits over assets of bank  $i$  in 2012. The various double interactions between the three variables  $Security\ Ratio_i$ ,  $Deposit\ Ratio_i$  and  $QE_{c(i),m(t)}$ , and their levels (if not absorbed by fixed effects) are included in the regressions, but are not reported in the table. All regressions include the interactions between  $QE_{c(i),m(t)}$  and the following bank-level control variables as of 2012: (1) the natural logarithm of total assets, (2) the simple capital ratio, (3) the tier 1 capital ratio, (4) the return on assets, and (5) the return on capital. Standard errors are clustered at the bank level.

Table A4: Descriptive Statistics: German Credit Registry

	Mean	SD	P25	P75	N
Lending	6.809	2.061	5.948	8.017	4,409,608
Security Ratio	0.162	0.105	0.073	0.214	4,409,608
Deposit Ratio	0.406	0.206	0.175	0.569	4,409,608
Deposit Ratio HH	0.326	0.198	0.093	0.483	4,409,608
Deposit Ratio NFC	0.080	0.046	0.056	0.089	4,409,608
QE	0.039	0.971	-0.844	0.501	4,409,608
$\Delta \ln \text{ securities (one year)}$	0.003	0.244	-0.102	0.078	4,355,468
$\Delta \ln \text{ securities (one quarter)}$	0.002	0.119	-0.037	0.030	4,356,233

Notes: The level of observation is credit to German firm  $j$  by German bank  $i$  in quarter-year  $q$ . The sample period spans the first time negative monetary-policy rates are introduced (2014q3) up until 2018q4.  $Lending_{i,j,q}$  is the natural logarithm of the euro amount outstanding between firm  $j$  and bank  $i$  in quarter-year  $q$ .  $Security Ratio_i$  is the share of securities over assets of bank  $i$  in 2012.  $Deposit Ratio_i$  is the share of deposits over assets of bank  $i$  in 2012. The numerator of said ratio is further decomposed into household deposits ( $Deposit Ratio HH_i$ ) and deposits from non-financial corporations ( $Deposit Ratio NFC_i$ ).  $QE_q$  is the amount of German government bonds purchased by the ECB in quarter-year  $q$  divided by all German banks' total German sovereign bond holdings in 2012, which we standardize to have a 0 mean and a standard deviation of 1.  $\Delta \ln \text{ securities}_{i,q}$  (one year) is the change in logged security holdings of bank  $i$  from  $q$  to  $q$  minus one year, accordingly for  $\Delta \ln \text{ securities}_{i,q}$  (one quarter). Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, German credit register (BAKIS-M), Security Holdings Statistics (SHS), and balance-sheet statistics (BISTA).