Different strokes for different banks: a heterogeneity analysis of Fed QE on bank lending*

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February 23, 2024

Abstract

Though unconventional monetary policy is still new, already there is a conventional wisdom that the impact of monetary policy is related to the composition of the asset mix. This turns out to be incomplete and potentially misleading. In this paper, we find more complex effects on bank lending from Quantitative Easing (QE) introduced by the Federal Reserve following the global financial crisis of 2007-09. We show that the impact on similarly QE-exposed banks crucially depends on banks' solvency and liquidity exposures. More specifically, we find that only banks at the "extremes" of the risk spectrum increase lending. Banks "in the middle" decrease lending. Our results highlight a potential dilemma for policy makers when deciding on unconventional monetary policies. They point to the need of taking heterogeneity of exposure into account when assessing the effects of QE.

Keywords: large-scale asset purchases, Federal Reserve, quantitative easing, heterogeneity, liquidity, solvency

JEL codes: E52, E58, G21

*We thank seminar participants at the Sveriges Riksbank for their helpful comments and suggestions. The views expressed in this paper are the sole responsibility of the authors and should not be interpreted as reflecting the views or policies of Sveriges Riksbank or the Swedish National Debt Office.

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1 Introduction

In the wake of the global financial crisis of 2007-09, the Federal Reserve (Fed) began large-scale asset purchase programs (LSAPs), commonly known as "quantitative easing" (QE). With QE, the central bank expands its balance sheet by creating money in the form of bank reserves and use them to buy government bonds and other financial assets from the private sector. The Fed - as well as other major central banks - adopted QE because cuts in the monetary policy rates near to their floor of zero were deemed insufficient to counter the deflationary and contractionary forces brought about by the crisis.

The stated aim of QE policies was to reduce the cost of borrowing money over the long-term, supporting and stabilizing the economy by making it easier for households to borrow money and for firms to stay in business, invest and safeguard the labor market. Under QE, the Fed bought a combined amount of $4.5 trillion of assets thereby expanding its balance sheet considerably. In 2017, the Fed started to unwind and reverse its QE with quantitative tightening (QT). The policy was paused in 2019. The COVID-19 pandemic pushed the Fed (and other central banks) to increase monetary expansion. The Fed restarted QT as late as in June 2022. The pace of QT is more cautious than the expansion of QE during the crisis. As a result, it may take time to restore central banks' balance sheet back to pre-crisis levels.

Fifteen years from the Fed's first QE program, it has been hard to assess the impact of unconventional monetary policies. Researchers have studied the effects of QE programs on financial conditions and yield curve as well as on macroeconomic outcomes such as output and inflation extensively. The impact of QE on bank lending has been much less researched though, and with mixed results. Rodnyansky and Darmouni (2017) find that banks with large exposures of mortgage backed securities (MBS) benefited from QE policies proportionally more than other banks. Fed's MBS purchases increased bank lending significantly whereas Treasuries purchases did not, amounting to what one could call an asset-mix composition effect. On the other hand, Chakraborty et al. (2020) show that, following the QE purchases, banks with larger MBS exposures increased mortgage lending but, at the same time, lowered consumer and industrial (C&I) lending. As a result, the impact of QE on total bank lending was relatively weak. More broadly, the empirical literature on the effectiveness of QE on the economy has produced conflicting results (see Chen et al. (2012); Acharya et al. (2020) among others).

In this paper, we study the heterogeneous effects of large scale asset purchases on bank lending behaviour. While existing evidence shows mixed results on bank lending, our work takes a new approach by looking at banks' heterogeneity along with asset-mix composition during QE episodes in determining bank lending. To the best of our knowledge, this is the first study to provide empirical evidence on the role of bank heterogeneity in affecting

lending behaviour of banks during periods of unconventional monetary policy.

More specifically, our analysis contributes to the empirical literature on QE and bank lending in the following manner. First, we exploit the role of bank heterogeneity, particularly bank liquidity and capital ratios. Previous literature on bank heterogeneity has focused on conventional monetary policy (Kim and Sohn, 2017; Osborne et al., 2017). Molyneux et al. (2019) argue that banks that were less capitalized (low solvency), more reliant on deposit funding and more interest income-oriented had weaker lending. The role of liquidity in the broad literature on banking has been vastly investigated. Thornton and Di Tommaso (2020); Kim and Sohn (2017) show that better capitalized banks increased lending after they retain sufficient liquid assets. Berger and Sedunov (2017) finds that bank liquidity supports real economic growth. According to Gropp and Heider (2010), bank liquidity renders bank capital structure more robust. Brunnermeier and Yogo (2009) finds that it reduces investing risks by ensuring that a bank will be able to quickly react to market moves. We find that the impact of QE policies critically depends on the heterogeneity of the banking sector, over and above the asset-mix composition effect documented in two previous papers by Rodnyansky and Darmouni (2017) and Chakraborty et al. (2020), respectively.

Second, we find that only weaker banks expanded lending following QE MBS purchases. We speculate that riskier banks may have had a stronger incentive of "bargaining" their way out from their weak position by increasing lending when cheap liquidity from the Fed QE program was made available. Third, we confirm that the asset-mix effect matters, but we show that it is not uniform. It strongly depends on bank heterogeneity.

We study the distributional effects of QE within the balance sheets of financial intermediaries using a sample of U.S. bank-holding companies from 2006:Q1-2014:Q4. To capture the asset-mix composition, we use several definitions of MBS-to-total assets as well as Treasuries-to-total assets *prior* to QE to classify banks into treatment and control groups and capture the differential effects of the policy across banks. We adopt a Difference-in-Difference-in-Difference (DDD) approach to get a consistent estimate of the interaction between QE purchases, bank's exposure to specific QE-asset purchases and bank heterogeneity.

Finally, our results may help reconcile the mixed results found in the literature on the impact of QE on the economy. They also highlight a dimension that has been overlooked in Chakraborty et al. (2020) and that may possibly contribute explaining their partly conflicting results with Rodnyansky and Darmouni (2017). More broadly, our findings highlight the need of taking into account bank heterogeneity when assessing the transmission of unconventional monetary policy to the real economy. They may be important for policy makers in need of understanding the way in which future QE policies may impact on the banking system.

The paper is organised as follows. Section 2 gives an account of the Fed QE program. Section 3 describes the data and the identification strategy. In Section 4 we present the estimation results. Section 5 shows the robustness of our results and Section 6 concludes.

2 The Fed's QE programs

The QE programs differed substantially in terms of the type and volume of securities that the Fed purchased as well as the timing. Between November 2008 and October 2014 the Fed launched three QE rounds.[1] The total amount of securities purchased under the QE program reached $4.5 trillion, close to 30 percent of GDP.[2] The first QE program (QE1) began on November 25, 2008. The Fed announced a program to buy up to 100 billion in US dollars of debt obligations issued by Fannie Mae and Freddie Mac and $500 billion of agency MBS. In March 2010, the program was extended and expanded and, by the end of QE1 in March 2010, the Fed had bought $1.25 trillion in MBS, $175 billion US dollar in federal agency debt, and $300 billion in U.S. Treasury securities. At that point, the Fed's market share of agency MBS had reached approximately 25 percent of MBS total outstanding. The purchase of long-term government bonds was meant to exert pressure on the general level of interest rates whereas the purchases of debt obligations and agency debt was meant to provide support to mortgage lending and housing markets and to improve overall conditions in private credit markets. Such purchases were completed by March 2010.

In mid-2010 concerns about deflationary pressures and a possible protracted loss of economic growth led to a second round of QE (QE2) that was officially implemented in November 2010. Before that, in August 2010, to help support the waning economic recovery the Fed had decided to keep constant the Federal Reserve's holdings of securities by reinvesting principal payments from agency debt and agency mortgage-backed securities in longer-term Treasury securities. The Fed also decided to continue to roll over the Federal Reserve's holdings of Treasury securities as they were to mature. QE2 purchases entailed a total purchases of $778 billion in long-term Treasury securities, which included $600 billion in announced program purchases and $178 billion as reinvestment of principal payments from Fed's agency debt and MBS holdings. This second round of QE lasted until end of June 2011 at a pace of about $75 billion per month.[3]

[1] The Federal Reserve Act restricts the Fed to purchase only government-guaranteed debt.

[2] Throughout the QE program only fixed-rate agengy MBS guaranteed by Fannie Mae, Freddie Mac and Ginnie Mae were eligible assets for purchases. In terms of Treasuries, the Fed could conduct purchases in nominal coupon securities, bills, Treasury Inflation-Protected Securities (TIPS), and Floating Rate Notes (FRNs).

[3] From September 2011 through 2012, the Fed conducted purchases within a program of maturity extension (MEP) of Treasury securities that had already purchased, known also as Operation Twist. Operation

Finally, the Fed announced a third round of quantitative easing (QE3) in September 2012, calling for monthly purchases of $40 billion in agency MBS and, starting in January 2013, $45 billion in U.S. Treasury securities as well. The QE3 program was largely unanticipated. In December of that year the total amount of purchases dropped to 75 billion from 85 billion. The major novelty of the QE3 program was its state-contingency and open-end feature. It continued until October 2014, when no further purchases were made. In total, during the third purchase round, the Fed purchased $790 billion in Treasury securities and $823 billion in agency MBS. Figure 1 shows the amounts of MBS and Treasury securities purchased during the implementation of each QE episode.

3 Data and Methodology

3.1 Data

This section describes the data we use for our analysis. We employ quarterly Consolidated Financial Statements for Bank Holding Companies (BHCs) in the United States, which are available from the Federal Reserve Bank of Chicago. All BHCs are subject to regulation by the Federal Reserve Board of Governors under the Bank Holding Company Act of 1956 and Regulation Y. Our data covers the sample period from 2006:Q1 to 2014:Q4 and include detailed information on the financial conditions of the BHCs, including on and off-balance sheet exposures and statistics on different types of loans. Our sample consist of 7,124 unique BHCs, after cleaning and omitting the BHCs with missing total assets values.[4] In each QE round the Fed purchased different types of assets.[5] For a thorough analysis, we collect data on the actual amounts of MBS and Treasuries security purchases by the Fed and match this data with the BHCs balance sheet data.[6]

Twist involved the sale of short-term Treasury securities and a purchase of long-term Treasury securities of equivalent amount. The program was intended to contribute to a broad easing in financial market conditions and provide support for the economic recovery by exerting further downward pressure on long term interest rates without altering the total amount of securities purchased by the Fed (balance sheet neutral). Overall, it included purchases of $667 billion in Treasury securities with maturity between 6 and 30 years. Operation Twist also saw a change in the reinvestment policy. The reinvestment of principal payments from agency debt and agency MBS was shifted into agency MBS rather than Treasury securities.

[4]It is to be noted that parent companies of large BHCs and parent companies for small BHCs report data differently and as a result the number of BHCs varies across quarters. On average, 1,200 BHCs report data in all quarters whereas 5,500 BHCs report only bi-annually (in Q2 and Q4). Further, we control for any merger activity by excluding banks that have more than 10% of asset growth from one quarter to the other.

[5]As described in the previous section, during the first and third rounds of QE the central bank purchased both MBS and Treasury securities, while in the second round it purchased mainly Treasury securities. Apart from the three rounds, the Fed also implemented the Maturity Extension Program (MEP) between 2011-12. We do not explicitly identify MEP.

[6]Data for outright purchases of MBS and Treasury securities have been downloaded from https://www.newyorkfed.org/markets/programs-archive/large-scale-asset-purchases.

To identify and differentiate banks that were more likely to benefit from QE from those that were less, we resort to an identification strategy that relies on the interaction of cross-sectional variation among banks in their MBS or Treasuries holdings and the amount of security purchases by the Fed. More specifically, we compute the MBS-QE exposure as the share of MBS holdings to total assets for each bank in the period *before* the QE program started, i.e., in 2007:Q4 in order to reduce potential endogeneity concerns to QE rounds' anticipation. We define treatment and control groups based on quartiles, i.e., banks in the top 25% of the MBS-to-total assets distribution are defined as treated banks and the ones in the bottom 25% of this distribution are control banks.[7] In robustness checks, we also use alternative definitions of the treatment and control variables based on decile values of MBS-to-total assets as well as a continuous measure of the ratio to allow for the entire sample of banks. Additionally, as part of the robustness checks, we also implement the treatment definition in the corresponding quarters just before each of the QE rounds instead of choosing the the MBS-QE exposure measures fixed at its value as in 2007:Q4. We obtain results qualitatively similar to our baseline.

Next, we compute a Treasuries exposure measure which, similar to the MBS exposure measure, is based on information of bank-by-bank securities holdings. In particular, for the Treasury-QE (TSY-QE) exposure measure we only include Treasuries security, other US government agency or sponsored agency securities, securities issued by states and other US political subdivisions. This makes our measure relatively conservative compared to, for example, Chakraborty et al. (2020)'s preferred Treasuries exposure measure which also includes non-government securities information such as information on private sector asset-backed securities (ABS) and structured products, other private debt securities, investment and mutual funds and equity securities.[8] We compute the MBS-QE as well as TSY-QE exposure measures on a quarter-by-quarter basis.

Figure 2 shows the evolution of MBS-to-total assets (Figure 2a) and Treasuries as a share of total assets (Figure 2b) for treated and control banks. There is a clear difference in the trends of securities that were purchased under QE for treated and control banks. Notably, the share of MBS holdings starts to decline immediately after QE1 for treated banks whereas the control group sees an increase in MBS holdings to total assets. On the other hand, for treated banks the Treasuries exposure measure only starts to decline after QE2, while it increased for control banks in the same period. This is consistent with the trend

[7] Choosing the quartiles as a threshold results in a reasonable distinction between banks that were QE-exposed versus the ones that were not. More importantly though, the two groups are sufficiently stable over time, i.e. while banks move within the category tend to not change group over time.

[8] Also, Chakraborty et al. (2020) use a much broader definition of mortgage lending that pulls together MBS holdings and new mortgages that originated and eventually were sold in the to-be-announced (TBA) market to third parties. In the TBA market, the identity of the securities to be delivered to the buyer are not specified until delivery. In addition, Chakraborty et al. (2020) specification is at yearly frequency whereas our measure is at quarterly frequency.

in Treasuries as it was during QE2 that the Fed purchases largely focused on Treasury securities.

3.2 Estimation approach

The aim of our empirical analysis is to assess whether and how QE purchases affected the lending outcomes of banks that were QE-exposed, with a specific focus on bank liquidity and solvency. In order to estimate the impact of asset purchases on bank lending, we use a difference-in-difference (DiD) approach based on QE-exposed banks versus non QE-exposed banks augmented with an interaction with bank-specific exposure to solvency and liquidity risk on our outcome variable.[9] The triple interaction captures the potential differential impact of QE-exposed banks depending on the level of banking sector heterogeneity. This specification allows us to test whether the path of lending outcomes for banks with distinct bank heterogeneity is systematically different in the presence of QE intervention. More specifically, we estimate the following regression based on a triple Difference-in-Difference (DDD) approach with a full set of interaction terms (Olden and Møen, 2022; Imbens and Wooldridge, 2009; Gruber, 1994):

$$\begin{aligned} Y_{i,t} = \alpha_i + \beta_{j,t} + \gamma_1 AssetPurchases_{t-4} + \gamma_2 Treat_i + \gamma_3 Heterogeneity_i^j + \\ \gamma_4 Treat_i \times AssetPurchases_{t-4} + \gamma_5 Heterogeneity_i^j \times AssetPurchases_{t-4} + \\ \gamma_6 Treat_i \times Heterogeneity_i^j + \gamma_7 Treat_i \times AssetPurchases_{t-4} \times Heterogeneity_i^j + \\ \delta' X_{i,t} + \epsilon_{i,t}. \end{aligned} \tag{1}$$

$Y_{i,t}$ denotes the dependent variable as measured by the logarithm of total loans or real estate loans or commercial and industrial (C&I) loans for bank i in quarter t. $Treat_i$ is a dummy variable that takes the value of one if a bank belongs to the treatment group and zero otherwise. $AssetPurchases_{t-4}$ are the amounts of MBS and Treasury (TSY) securities that are purchased by the Fed in each quarter. We take 4 lags (one year) as the effects of policy may follow a significant time lag. $Treat_i \times AssetPurchases_{t-4}$ is an interaction term between a bank's treatment status and security amount purchased during our sample period.

[9]The DiD approach is well established in economics, public policy, health research, management and other fields. It has been around since the middle of the nineteenth century when John Snow showed with his DiD study that cholera was transmitted through polluted water rather than air, making a breakthrough for controlling and eventually winning over the disease.
In its simplest form the DiD estimate is equivalent to calculating the after-before difference in the so-called treatment group, i.e the target group of a certain public policy intervention, for example, and subtracting from this difference the after-before difference of the control group, i.e. the group that was not affected by the policy.

$Heterogeneity_i^j$ is an indicator variable that captures the heterogeneity of each bank i in terms of j. We differentiate banks according to the two key dimensions of liquidity and solvency (capital ratios). We approximate the liquidity of a bank based on their liquid assets holdings. More specifically, we categorize banks as high (low risk) liquid banks if they are in top quartiles of the distribution of liquid assets to total assets ratio prior to the implementation of QE, i.e., 2007Q4. Similarly, we classify banks as low (high) solvency and therefore high (low) risk if their Tier I risk-based capital ratio is in the lowest (highest) quartile of this distribution.[10]

Vector $X_{i,t}$ includes a series of lagged bank-level controls such as bank size, ratio of cash to assets, loan-to-deposits ratio and return on assets (measures as net income-to-total assets). We include these controls where appropriate in the specification, i.e., we exclude cash-to-assets ratio in liquidity-specific regressions and similarly capital measures in the capital-specific regressions. The bank-level control variables capture differences in characteristics that would affect their activities and also account for the extent to which a bank absorbs potential losses. We interact the vector of bank-level controls with $AssetPurchases_{t-4}$ and $Treat_i$, as to control for possible effect that Fed's asset purchases may have had on control variables. Thus the vector $X_{i,t}$ include control variables and all double and triple interaction terms between the control variables, the QE-exposure and Fed asset purchases measures. Table 1, reports summary statistics of the key variables employed in the analysis and we provide definitions and construction of each variable in Appendix A. We present summary statistics for the treated and control groups in Table 1. The mean of the ratio of MBS-to-total assets for treated banks is around 0.2, while that of control group is close to 0. Similarly, for the ratio of Treasuries to total assets, the mean values for treated group is 0.2, while for control group is 0.1.

We include bank fixed effects (α_i) to control for fixed differences among banks, and state-quarter fixed effects ($\beta_{j,t}$) to control for residual inter-temporal differences in common shocks, for example the implementation of regulation related to the Dodd-Frank Act and Basel Accord (including stress testing). The state-quarter fixed effects control for possible variation in bank lending demand and risk.

Our hypothesis is that banks that may be similarly exposed to asset purchases may have a significant differential response according to differences in liquidity and capital ratios. The main variable of interest in our baseline model of Equation 1 is therefore the coefficient γ_7 that captures interaction between asset purchases, bank's exposure to the MBS or TSY purchases and bank heterogeneity.

[10]More specifically, we define liquid assets as the sum of cash and balances due from depository institutions and federal funds sold. We use the ratio of Tier I capital to risk-weighted assets as our measure of solvency. In robustness checks we provide alternative measures of solvency and liquidity. In addition, in robustness checks we choose the lowest and highest decile values to classify banks according to the two chosen heterogeneity dimensions and obtain similar results in qualitative terms.

One advantage of specification as in Equation 1 is that it minimises the potential loss of information of simpler DiD approaches (Olden and Møen, 2022). Notably, it provides an estimate of potential "spillover" effects, i.e. γ_4, which is the effect of $Heterogeneity_i^j$ equal to 0 for MBS-exposed (or TSY-exposed) banks after the Fed started asset purchases. In addition, the point estimate of γ_7 is unbiased because it calculates the time change in means for highly liquid banks in the QE-exposed group by netting out both the change in means for highly liquid banks that were not QE-exposed (control group) and the change in means for low liquid banks that were QE-exposed. In other words, the specification as in Equation 1 ensures the consistency of γ_7 by exploiting the triple differences and removing all the confounding trends both within the heterogeneity dimension, between QE-exposed and non QE-exposed banks, and across the heterogeneity dimension in the treated group of QE-exposed banks. In particular, this specification accounts for two possible confounding trends (Wooldridge, 2010). First a trend due to changes across QE-exposed and non QE-exposed banks due to heterogeneity status and unrelated to the Fed asset purchases, and changes in the bank lending outcomes of banks that are not QE-exposed possibly due to changes in the economy that affects all banks, whether or not highly liquid (or highly solvent). In robustness checks, we estimate an alternative estimation, a classical DiD model where we divide banks into two groups along the two dimensions of liquidity and capital.

In Figure 3 we show the lending behaviour of banks that are in the highest 25% of the MBS-to-total assets distribution (treatment group), relative to banks in the bottom 25% of the distribution (control group). The right vertical axis measures the MBS holdings (green dashed line) as well as the Treasury securities holdings (orange dashed line) from 2008:Q1 to 2014:Q4. In Table 2 we report the number of QE-exposed banks, high solvency and high liquid banks. The table shows that bank heterogeneity and exposure to asset purchases overlap only partly and that, as a result, bank heterogeneity is likely to have exerted a non trivial impact on the response of bank lending to Fed's QE. There are 43 treated banks in our sample that are highly liquid, while 74 are well-capitalized.

4 Estimation Results

4.1 Results for the baseline model

Table 3 - 4 present the results of our baseline model as in Equation 1 according to the two dimensions of bank heterogeneity, i.e. solvency and liquidity.

In Table 3 columns 1 through 3 we present the results concerning the lending outcomes between banks with relatively low and high MBS holdings and liquidity pooled across the entire QE period. It is worth to note here that while most of the purchases occurred during

QE rounds (QE1, QE2, and QE3), the Fed continued to buy MBS and Treasury securities in sizeable amounts also outside the rounds to replace maturing securities, see Figure 1. Column (1) shows the effect on total lending, while columns (2) and (3) show the results for real estate lending and commercial and industrial (C&I) loans, respectively.

We find that highly liquid banks, i.e. banks that are above the 75^{th} percentile of the distribution of liquid assets to total assets, and with high exposure to the Fed MBS purchases tend to decrease total, real estate as well as C&I lending. Banks that are similarly exposed to Fed MBS purchases but have instead a low liquidity tend to increase lending (coefficients for γ_4). In contrast, banks with a high TSY-exposure (low credit risk) and high liquidity tend to increase lending (columns 4-6). In other words, we find that QE impact on bank lending crucially depends on the interaction of bank liquidity with the QE-exposure measure.

Next, we show the lending results of the Fed QE purchases for highly and low capitalized banks. Giansante et al. (2020) argue that if banks are not adequately capitalised, QE might coincide with adverse investment incentives in the presence of risk-weighted capital requirements. In addition, they find very little or no increase in lending for UK banks following the Bank of England QE. Joyce and Spaltro (2014) suggest a positive impact of the first round of QE on bank lending in UK. They also find that the low level of bank capital may have limited the effectiveness of QE. In Table 4 we show our results. We find that banks with a level of Tier I capital ratio above the 75^{th} percentile of the distribution and high exposure to MBS purchases tend to reduce total and real estate. However, Treasuries purchases appear to have led to an increase in total and real estate lending for TSY-exposed and high solvency banks. We do not find an impact for C&I lending. In contrast, banks that had a high exposure to Fed Treasuries securities purchases but had a low level of bank capital reduce lending (total, real estate and C&I lending). Once again, it is evident that the impact of QE on bank lending is highly dependent on the type of asset purchased but also, crucially, on bank heterogeneity.

In summary, banks' MBS/TSY exposure and the interaction of the exposure measure with bank liquidity and solvency appear to play a key role for understanding the effectiveness of QE interventions. Our results point to a significant non-linear impact of QE on bank lending depending on the QE-exposure of banks and their solvency and liquidity status. In particular, banks that were most and least 'vulnerable', i.e. banks with high MBS-exposure (credit risk) and high liquidity/solvency risk and those with low credit risk (TSY-exposed) and low liquidity/solvency risk increased lending whereas the banks that are 'in the middle' decreased lending.

One possible explanation for our distinct findings is related to banks' assessment of overall portfolio risk and a balance sheet re-balancing following QE. Giansante et al. (2020) find

that UK banks used the additional liquidity created by the Bank of England QE to buy low risk securities (government bonds). We find that banks that were MBS-exposed and therefore had a relatively higher credit risk in some instances reduced lending. It is reasonable to assume that they diverted funds from lending and used the Fed liquidity to invest in other types of assets, including government bonds. However, low liquid banks that were also MBS-exposed had an incentive to further increase lending and, by so doing, their expected returns.[11] On the other hand, banks that had a higher exposure to Treasuries and thus a relatively lower credit risk and at same time low solvency risk were least "vulnerable" and increased lending.

The non-linear impact of QE and bank heterogeneity on bank lending shown in our results may help explain, at least partly, the mixed empirical evidence found in the literature on the effect of QE on bank lending.

4.2 Timing of the effects

The estimations of the DDD model in Equation 1 require the parallel trend assumption to hold to return unbiased estimates of the causal effect of the QE implementation. The parallel trend assumption states that, conditional on the control variables, treated banks (QE-exposed banks that benefited from QE purchases) would have followed similar trends in the lending outcomes as the non-treated banks (non QE-exposed banks that did not benefited from QE purchases), distinguishing by liquidity and solvency (capital). This assumption is not directly testable because we cannot observe the counterfactual evolution of the outcomes. However, it can be supported by testing if liquid and non-liquid banks in the treated and control groups followed parallel trends before QE.

To further corroborate our results and the causal relationships between bank lending, QE and bank heterogeneity, we check that there is no significant "treatment" effect before QE implementation by examining the dynamic relationship between the treatment group and bank lending. The dynamic specification reduces concerns that banks in the control and treatment group were experiencing different pre-existing trends in lending prior to QE implementation. More specifically, we estimate the model as in Equation 2, which applies the DiD approach to data including pre-QE period and add to the specification interaction terms between each pre-QE period (quarter) and the treatment group indicators:

$$Y_{i,j,t} = \alpha_i + \beta_{j,t} + \sum_t \gamma_t D_t + \sum_t \theta_t D_t \times Treat_i \times Heterogeneity_i^j + \delta' X_{i,t} + \epsilon_{i,t}, \qquad (2)$$

[11] Based on euro area data, Albertazzi et al. (2021) finds a similar mechanism at country-level. For a sample of euro area countries, they show that following QE the portfolio reallocation is concentrated in 'vulnerable' economies, resulting in more credit-risk taking.

where, as before, $Y_{i,j,t}$ is the lending outcome, α_i and $\beta_{j,t}$ are bank and state-time fixed effects, respectively. $Treat_i$ is a dummy that equals one for banks in top quartile of the combined MBS and TSY-to-total assets distribution, and zero for banks in the 25^{th} percentile and D_t is a vector of dummy variables for each $t \in \{2007Q1, 2007Q2, ..., 2014Q4\}/\{2008Q3\}$, with 2008Q3 taken as the benchmark period.

$D_t \times Treat_i \times Heterogeneity_i^j$ represents an interaction term between the time indicators, bank's treatment status and bank heterogeneity. The main parameters of interest are θ_t as they capture the difference between treated and control group banks over time. $X_{i,t}$ is a vector of control variables that includes bank size, ratio of liquid assets to total assets, ratio of equity to total assets and return on assets, all introduced as lagged variables in the specification and interacted with $Treat_i$ and .

The quarter-by-quarter dynamic effect of QE is shown in Figure 4 and 5. Figure 4 shows the estimated coefficients for the triple interaction term for the pre-treatment and post-treatment period for the liquidity dimension of $Heterogeneity_i^j$, with 90% confidence intervals around them. Figure 5 shows the effect for capital, the second dimension of $Heterogeneity_i^j$. Figure 4a, 4b and 4c are plots for three types of lending relate to liquidity. Figure 5a, 5b and 5c relate to capital. The figures illustrate several important points. First, the treated and control group banks in the pre-QE period show no robust differences, reducing the concern that differences in the pre-existing trends between the groups are driving the results. Second, more significant exposure to QE is significantly related to an increase in bank lending in the post-QE period only for the banks that were more liquid or had a higher solvency. Third, as would be consistent with a gradual impact of QE on bank lending, the figures also show that, while there is some oscillations in the results between QE1 and QE2, most of the impact for both real estate and C&I loans as well as total lending comes consistently after the implementation of QE2. Finally both figures show that the larger impact of QE on bank lending happened during the QE3 round. The latter result is in line with previous findings in the literature.

4.3 Alternative specifications of the baseline model

In Table 5 and 6 we present estimates for our first alternative specification of our baseline in Equation 1. This new specification follows Rodnyansky and Darmouni (2017) closely as we use a dummy variable for each of the QE rounds instead of a continuous variable of QE purchases. As in the baseline model, also in this new specification the dependent variable is bank lending for three aggregates: total lending, real estate and C&I loans. In addition, similarly to the model in Equation 1, we introduce a triple interaction term to determine the impact of bank heterogeneity of QE-exposed banks on bank lending. In contrast to the Equation 1 model specification, the new specification in Equation 3 captures the impact of

each round of QE separately. This new model is as follows:

$$\begin{aligned} Y_{i,t} = \alpha_i + \beta_{j,t} + \gamma_1 QE_t + \gamma_2 Treat_i + \gamma_3 Heterogeneity_i^j + \\ \gamma_4 Treat_i \times QE_t + \gamma_5 Heterogeneity_i^j \times QE_t + \\ \gamma_6 Treat_i \times Heterogeneity_i^j + \gamma_7 Treat_i \times QE_t \times Heterogeneity_i^j + \\ \delta' X_{i,t} + \epsilon_{i,t}. \end{aligned} \tag{3}$$

where the new variable QE_t is a dummy variable that takes value 1 for each QE round and zero otherwise such that $QE_t = \{QE1_t, QE2_t, QE3_t\}$ and γ_7 is the coefficient of the new triple interaction term we discuss above. All other variables are as in Equation 1, including fixed effects and MBS/TSY-exposure measures $Treat_i$.

Similarly to previous studies, the new estimates show that each round of QE had a differential impact on bank lending. In particular, Table 5 reports bank lending increased during QE1 and QE3 rounds whereas the effects tend to be weaker for QE2.[12] More importantly though, our results highlight the importance of also considering bank heterogeneity when assessing the impact of QE. In fact our estimates show a significant differential impact of QE rounds for bank heterogeneity on bank lending. In particular, MBS-exposed banks with high liquidity diminish their lending during both QE1 (for total lending) and QE3. When the Fed bought mostly Treasury securities as during QE2, banks that had relatively larger Treasury holdings increased their lending. The results are stronger for solvency specifications in Table 6.

As a second alternative specification, we estimate

$$\begin{aligned} Y_{i,t} = \alpha_i + \beta_{j,t} + \gamma_1 AssetPurchases_{t-4} + \gamma_2 Treat_i + \\ \gamma_3 Treat_i \times AssetPurchases_{t-4} + \delta' X_{i,t} + \epsilon_{i,t}. \end{aligned} \tag{4}$$

but divide banks into two groups along two dimensions: liquidity and capital. The results presented in Table 7 and 8 are in line with the baseline model results discussed in Section 4.1. Thus, the baseline results are robust also to the alternative specification.

5 Other robustness checks

In this section, we discuss a series of robustness tests to further support our empirical findings with respect to (i) varying definitions of treatment and control groups, (ii) alternative measures of liquidity and capital, and (iii) defining treatment and control banks on a rolling-basis to investigate the differential impact of the policy across banks.

[12] In a specification where we do not include the triple interaction term, we obtain coefficient estimates that are close to Rodnyansky and Darmouni (2017).

5.1 Alternative definitions of treatment and control group

In addition to our treatment and control variables constructed based on quartile values of mortgage-backed securities and treasury securities (both scaled by total assets), we now re-define our treatment variable, first based on decile values of MBS-to-total assets as well as for treasury securities. We define treated group as banks that are in the top 90th percentile of the MBS-to-total assets distribution, while control group in the bottom 10th percentile of this distribution. The results for treatment variable constructed based on deciles are reported in Figure 6 and 7 for liquidity and capital, respectively. Consistent with our main results, we find that the three-way interaction terms for treatment, securities purchases (MBS in Panel 6a and 7a, while TSY in Panel 6b and 7b) and heterogeneity are qualitatively similar to the baseline regressions and we find largely unchanged results in terms of statistical significance.

Second, we also employ continuous measure of MBS-total assets and Treasury securities to total assets distribution. The results are reported in Table 9 and 10 pertaining to liquidity and capital, respectively. The magnitude and statistical significance of the coefficients is stronger across all specifications.

5.2 Alternative measures of liquidity and capital

We run robustness tests by taking alternative measures for bank liquidity and capital and find similar results. While, in our main results, we measure liquidity as the ratio of cash balances and federal funds sold to total assets, in our robustness checks, we only take the ratio of cash balances to total assets as a measure for liquidity. Since cash is the most liquid assets out of all the liquid asset class, we believe this measure will closely measure a bank's liquidity. The results are presented in Table 11 and are largely consistent with our main analysis as we find statistically significant coefficients on the effects of Fed's quantitative easing policy on liquid banks.

We also employ the ratio of equity to total assets as an alternative measure for bank capital and find the results are qualitatively similar. While tier I risk-based capital ratio compares bank equity to their risk-weighted assets that are specified under the Basel III accord, equity to assets ratio takes total assets as a whole in the denominator. The results are presented in Table 12 and are qualitatively similar to our baseline findings.

5.3 Constructing treatment and control groups on rolling-basis

The choice of time period 2007:Q4, that is well before the QE policy interventions reduces concerns about potential endogeneity. The MBS threshold is defined in a particular quarter

so that we are able to track the effects for the same set of banks over time. However, in our robustness check we take the lag of MBS-to-total assets and TSY-to-total assets for each year and construct the treatment and control groups based on top 25% and bottom 25% respectively. We follow Chakraborty et al. (2020) and construct our treatment variables on rolling basis as opposed to prior to the implementation of QE, i.e., 2007Q4. Table 13 and Table 14 relates to taking treatment and control group on rolling basis for liquidity and solvency, respectively. Taking treatment definitions in alternative quarters yields similar results qualitatively.

6 Conclusions

In this paper, we provide empirical evidence on the crucial role of bank heterogeneity in affecting lending behaviour of banks during periods of unconventional monetary policy. We took advantage of the exact timing of the QE program implementation and distinguished QE-exposed from non QE-exposed banks in order to estimate the impact of such policy interventions and bank heterogeneity on bank lending outcomes. We use a triple difference-in-difference approach (DDD) to get a consistent estimate of the interaction between asset purchases, bank's exposure to the MBS or TSY purchases and bank heterogeneity. To the best of our knowledge, this is the first study to provide such evidence.

We find that in the treated group (QE-exposed banks), the Fed asset purchases led to an increase in bank lending only for banks falling into the "extremes" of their risk distribution. More specifically, only high MBS QE-exposed and low liquidity/solvency banks and banks with high TSY QE-exposure and high capital and solvency expand lending. By contrast, banks "in the middle' ground, such as those with low QE MBS-exposure and low solvency/liquidity risk and banks with low QE MBS-exposure and high solvency risk decreased lending.

These results are novel and fill a gap in the previous literature. In particular, the results of our analysis on safest banks show that bank lending increases following QE policies, thereby adding to previous results found in the literature on conventional monetary policy and the positive interaction between bank lending and bank capital. The results of unconventional monetary policy and riskier banks are new. Riskier banks increase lending following QE interventions. We speculate that riskier banks may have had a stronger incentive of "bargaining" their way out of their weak position by expanding lending when cheap liquidity from the Fed QE program was made available.

The differential impact of QE and bank heterogeneity on bank lending shown in our results may help explain the partly conflicting empirical results found in the literature on the effects of QE asset-mix on bank lending as well as help somewhat make sense of the mixed evidence in the broader literature of the impact of unconventional monetary policy on the economy. More importantly, our findings shed light on the critical role that bank heterogeneity plays for reinforcing or offsetting effects following QE and for understanding the transmission of unconventional monetary policy and its possible redistribution effects. For policy makers they may matter for help interpreting the effects of unconventional monetary policy and, more broadly, the transmission of future monetary policies and their potential effect in determining lending outcomes by bank.

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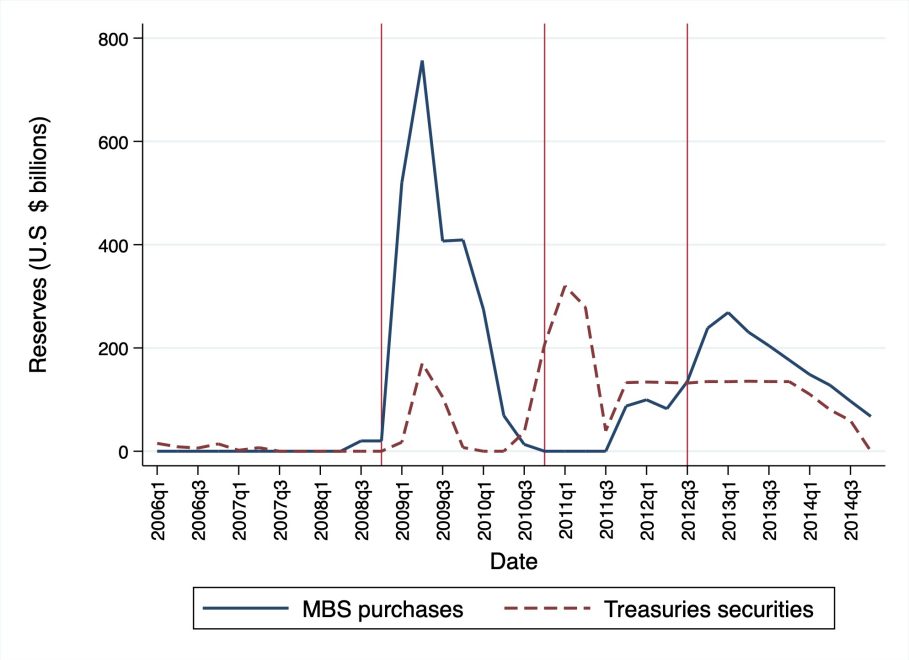
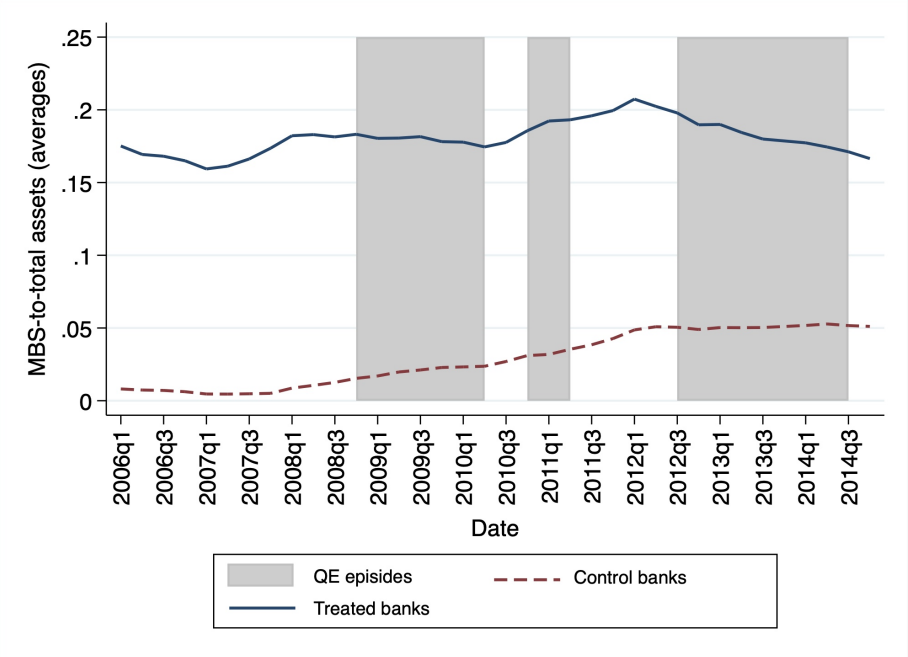
Figures

Figure 1: MBS and Treasury securities purchases amounts

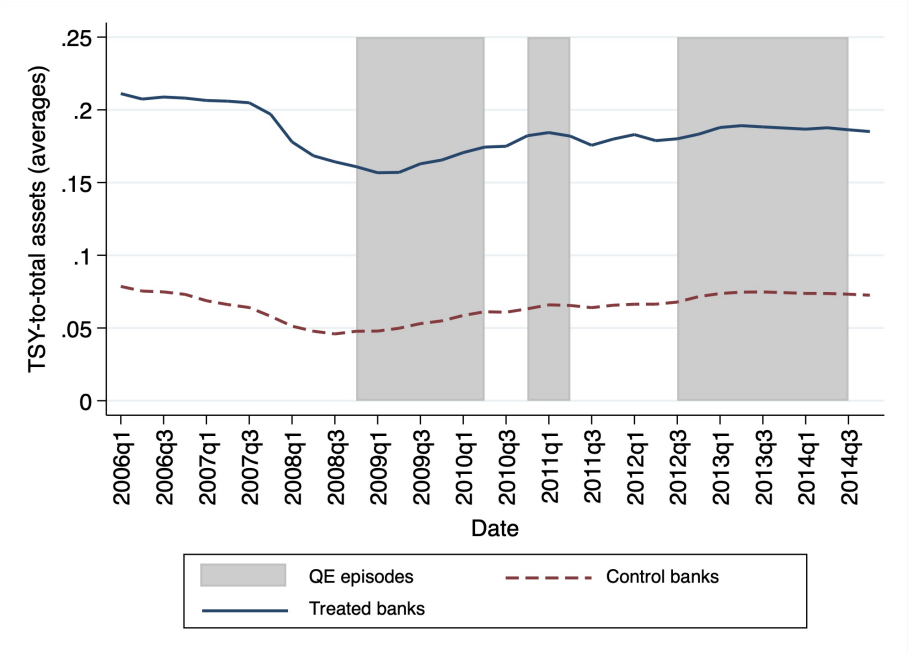


Notes: Quarterly purchase of MBS and Treasury securities by the Fed. The figure shows the quarterly amount of mortgage-backed securities (solid line) and Treasury securities (dashed line) purchased by the Fed. The vertical lines indicate the commencement of the three rounds of quantitative easing.

Figure 2: MBS and Treasury purchases for treated and control banks



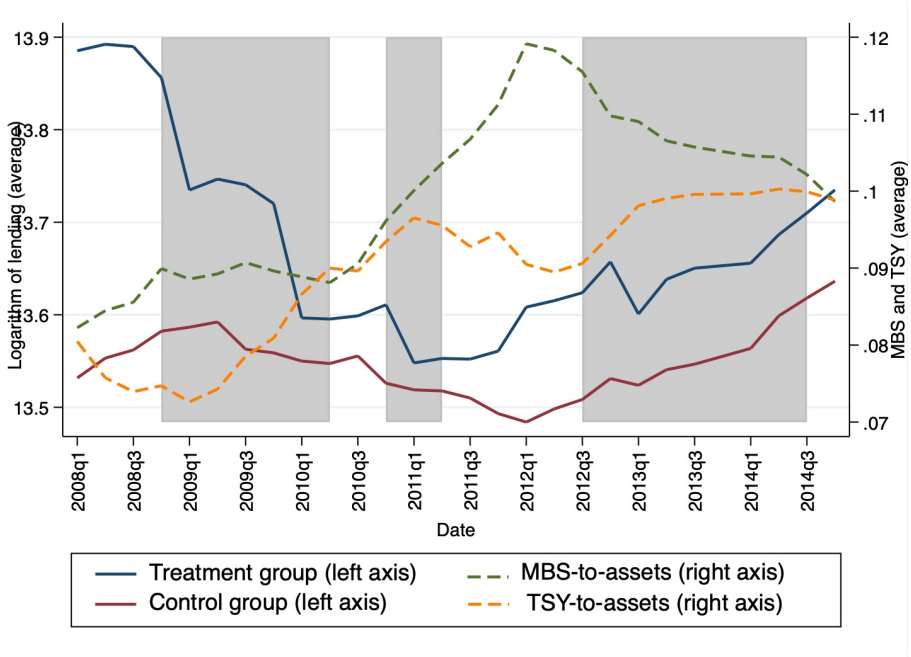
(a) MBS-to-total assets for treated and control banks



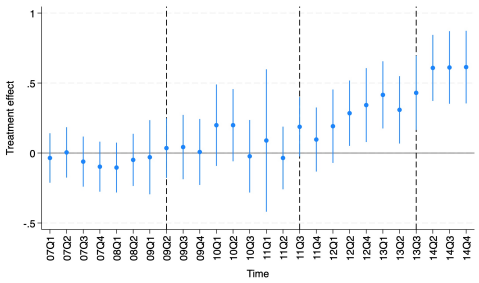
(b) Treasury securities-to-total assets for treated and control banks

Notes:The figure maps the evolution of the ratio of MBS-to-total assets in Panel (a) and ratio of treasury securities to total assets in Panel (b) for treated and control banks. In Panel (a), treated banks are banks in the top 25th quartile of MBS-to-total assets ratio in 2007Q4, while control are in the bottom 25th quartile. In Panel (b), treated banks are banks in the top 25th quartile of treasury securities-to-total assets ratio in 2007Q4, while control are in the bottom 25th quartile. Shaded areas highlight the three episodes of QE.

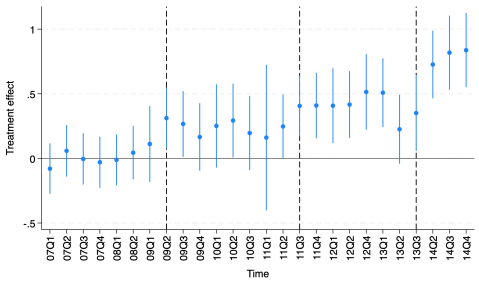
Figure 3: Quantitative Easing and Bank Lending



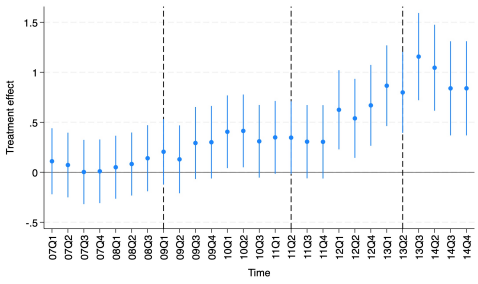
Notes: The figure shows average lending amounts for treatment and control group on the left axis. The figure also shows the average amounts of mortgage backed securities (green dashed line) and treasury securities (orange dashed line) held by U.S. BHCs from 2008:Q1 to 2014:Q4. The shaded areas indicate the three rounds of quantitative easing.



(a) Total Lending

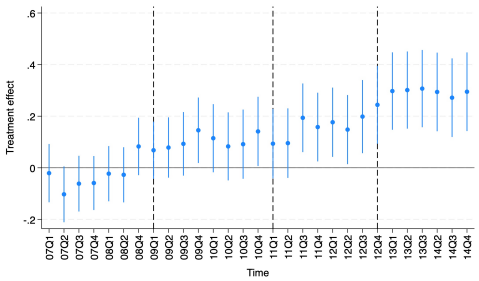


(b) RE Lending

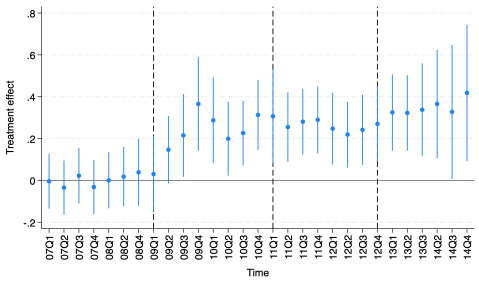


(c) C&I Lending

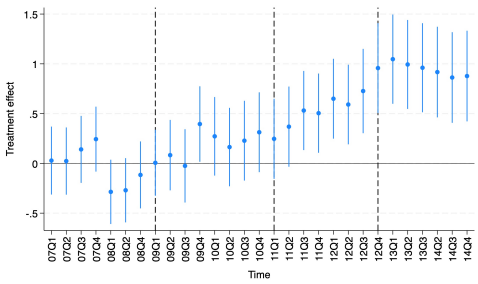
Figure 4: Timing of effects.
The figure shows coefficient plots for the parameters θ in Eq. 2 for liquidity with 90% confidence intervals. The vertical lines indicate the start of each episode of quantitative easing.



(a) Total Lending



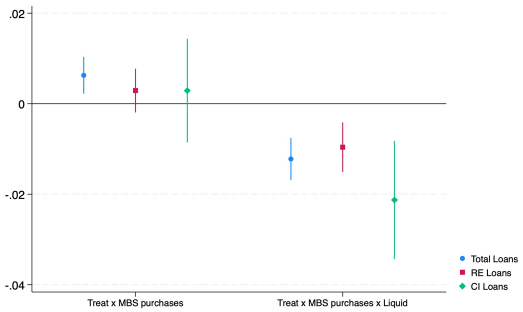
(b) RE Lending



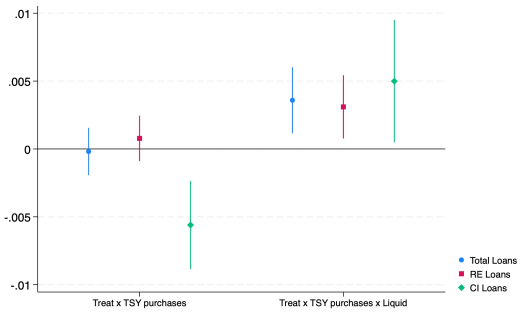
(c) C&I Lending

Figure 5: Timing of effects.
The figure shows coefficient plots for the parameters θ in Eq. 2 for capital with 90% confidence intervals. The vertical lines indicate the start of each episode of quantitative easing.

Figure 6: Robustness (Liquidity): Treatment variable based on Deciles

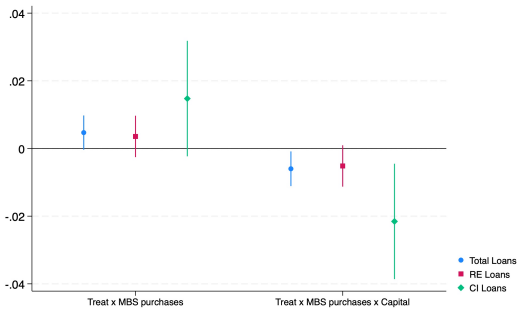


(a) MBS purchases

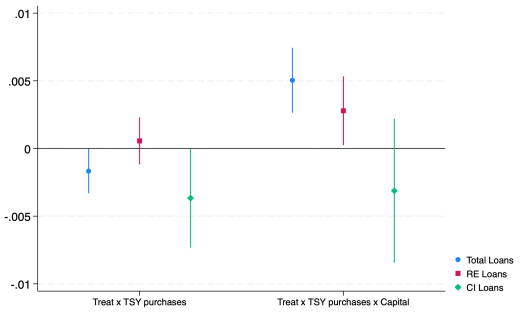


(b) TSY purchases

Figure 7: Robustness (Capital): Treatment variable based on Deciles



(a) MBS purchases



(b) TSY purchases

Tables

Table 1: Summary Statistics

	Obs	Mean	Std.D.	p10	Median	p90
Treatment Group						
$\left(\frac{MBS}{TotalAssets}\right)_i$	7,343	0.2	0.1	0.1	0.2	0.3
$\left(\frac{Treasury}{TotalAssets}\right)_i$	7,343	0.2	0.1	0.0	0.1	0.2
log(Total Loans)	7,343	14.0	1.4	12.6	13.7	15.9
log(RE Loans)	7,332	13.7	1.4	12.3	13.4	15.4
log(C&I Loans)	7,332	11.9	1.9	10.0	11.6	14.4
Asset Size	7,343	13.6	1.5	12.2	13.2	15.5
Liquidity	7,343	0.1	0.1	0.0	0.0	0.1
Tier 1 Risk-based Capital Ratio	7,312	13.7	19.3	9.1	12.8	19.1
Net Income/Total Assets	7,343	0.0	0.0	-0.0	0.0	0.0
Cash/ Total Assets	7,343	0.0	0.0	0.0	0.0	0.1
Loans to Deposit ratio	6,942	0.8	0.6	0.5	0.8	1.0
Control Group						
$\left(\frac{MBS}{TotalAssets}\right)_i$	7,312	0.0	0.0	0.0	0.0	0.1
$\left(\frac{Treasury}{TotalAssets}\right)_i$	7,312	0.1	0.1	0.0	0.1	0.2
log(Total Loans)	7,303	13.5	0.9	12.6	13.4	14.5
log(RE Loans)	7,268	13.2	0.9	12.3	13.1	14.3
log(C&I Loans)	7,291	11.3	1.2	10.1	11.3	12.7
Asset Size	7,312	12.5	1.1	11.4	12.4	13.7
Liquidity	7,312	0.1	0.1	0.0	0.1	0.2
Tier 1 Risk-based Capital Ratio	7,308	12.9	24.2	8.1	11.9	17.5
Net Income/Total Assets	7,312	0.4	19.5	-0.0	0.0	0.0
Cash/ Total Assets	7,312	0.1	0.1	0.0	0.0	0.1
Loans to Deposit ratio	6,918	36.4	1,302.0	0.7	0.9	1.1

Summary statistics recorded from 2006Q1 to 2014Q4 for all U.S. BHCs. All variables are at quarterly frequency. The statistics for $\left(\frac{Treasury}{TotalAssets}\right)_i$ is based on the TSY-QE exposed treatment and control group.

Table 2: Number of treated banks based on bank heterogeneity

Category	**Number of banks**
(Liquid= 1); (Capital != 1); (Treatment !=1)	238
(Liquid= !1); (Capital = 1); (Treatment !=1)	232
(Liquid= 1); (Capital != 1); (Treatment =1)	43
(Liquid= !1); (Capital = 1); (Treatment =1)	74
(Liquid= 1); (Capital = 1); (Treatment =1)	20

Bank heterogeneity is constructed based on quartile. Particularly, $Liquid = 1$ represents banks in the top 25% of ratio of liquid assets to total assets prior to the implementation of QE, while $Capital = 1$ banks in the top 25% of Tier-1 capital risk-based ratio prior to the implementation of QE. $Treatment = 1$ represents banks in the top 25th percentile of the MBS-to-total assets ratio in 2007Q4.

Table 3: The impact of MBS and TSY purchases on lending: effect of bank liquidity

	Total Loans (1)	**RE Loans** (2)	**C & I Loans** (3)	**Total Loans** (4)	**RE Loans** (5)	**C & I Loans** (6)
$MBSpurchases_{t-4} \times Treat_i^{MBS^Q}$	0.0425***	0.0482**	-0.0378**			
	(0.0152)	(0.0182)	(0.0151)			
$MBSpurchases_{t-4} \times Treat_i^{MBS^Q} \times Liquidity_i^Q$	-0.0073***	-0.0065**	-0.0088**			
	(0.0021)	(0.0024)	(0.0038)			
$TSYpurchases_{t-4} \times Treat_i^{TSY^Q}$				-0.0101	-0.0019	0.0249
				(0.0089)	(0.0055)	(0.0244)
$TSYpurchases_{t-4} \times Treat_i^{TSY^Q} \times Liquidity_i^Q$				0.0058**	0.0043**	0.0052**
				(0.0025)	(0.0020)	(0.0020)
Observations	5,524	5,490	5,806	10,761	10,726	10,723
R-squared	0.2110	0.2020	0.0567	0.0387	0.0434	0.0616
Bank-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
$Treat_i^Q \times$Asset purchases$_{t-4} \times BankControls$	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State X Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable in columns (1) and (4) is log of Total lending, in columns (2) and (5) is the log of real estate loans and in columns (3) and (6) is the log of C&I loans. $Treat_i^{MBS}$ is a dummy that takes the value one for banks in the top 25th percentile of the MBS-to-total assets ratio, and zero for banks in the bottom 25th percentile. $Treat_i^{TSY}$ is a dummy that takes the value one for banks in the top 25th percentile of the treasury securities-to-total assets ratio, and zero for banks in the bottom 25th percentile of the distribution. $MBSpurchases_{t-4}$ and $TSYpurchases_{t-4}$ is the lagged quarterly log-dollar amount of Federal Reserve MBS and Treasury (TSY) purchases, respectively. $Liquidity_i^Q$ is a dummy variable that equals one for banks in the top 25% of ratio of liquid assets to total assets prior to the implementation of QE (liquid banks), i.e., 2007Q4, zero for banks in the bottom 25% of the distribution (illiquid banks). Bank-level controls includes bank size, Tier I risk-based capital ratio, loan to deposits ratio and return on assets. Constant terms included, but not reported. Robust standard errors clustered at year, shown in parentheses. ***, **, * represent significance at the 1%, 5% and 10%, respectively.

Table 4: The impact of MBS and TSY purchases on lending: effect of capital

	Total Loans (1)	**RE Loans** (2)	**C & I Loans** (3)	**Total Loans** (4)	**RE Loans** (5)	**C & I Loans** (6)
$MBSpurchases_{t-4} \times Treat_i^{MBS^Q}$	0.0202	0.0219***	0.0122**			
	(0.0162)	(0.0054)	(0.0050)			
$MBSpurchases_{t-4} \times Treat_i^{MBS^Q} \times Capital_i^Q$	-0.0029*	-0.0040**	-0.0076			
	(0.0016)	(0.0017)	(0.0059)			
$TSYpurchases_{t-4} \times Treat_i^{TSY^Q}$				-0.0171*	-0.0080***	-0.0520*
				(0.0085)	(0.0027)	(0.0255)
$TSYpurchases_{t-4} \times Treat_i^{TSY^Q} \times Capital_i^Q$				0.0038**	0.0030*	0.0013
				(0.0018)	(0.0017)	(0.0025)
Observations	5,540	5,510	5,535	11,420	10,839	11,384
R-squared	0.2312	0.2210	0.0177	0.1731	0.0688	0.0355
Bank-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
$Treat_i^Q \times$Asset purchases$_{t-4} \times BankControls$	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State X Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable in columns (1) and (4) is log of Total lending, in columns (2) and (5) is the log of real estate loans and in columns (3) and (6) is the log of C&I loans. $Treat_i^{MBS}$ is a dummy that takes the value one for banks in the top 25th percentile of the MBS-to-total assets ratio, and zero for banks in the bottom 25th percentile. $Treat_i^{TSY}$ is a dummy that takes the value one for banks in the top 25th percentile of the treasury securities-to-total assets ratio, and zero for banks in the bottom 25th percentile of the distribution. $MBSpurchases_{t-4}$ and $TSYpurchases_{t-4}$ is the lagged quarterly log-dollar amount of Federal Reserve MBS and Treasury (TSY) purchases, respectively. $Capital_i^Q$ is a dummy variable that equals one for banks in the top 25% of Tier I risk-based capital ratio prior to the implementation of QE (well-capitalized banks), i.e., 2007Q4, zero for banks in the bottom 25% of the distribution (under-capitalized banks). Bank-level controls includes bank size, cash-to-assets ratio, loan to deposits ratio and return on assets. Constant terms included, but not reported. Robust standard errors clustered at year, shown in parentheses. ***, **, * represent significance at the 1%, 5% and 10%, respectively.

Table 5: Alternative identification strategy: taking QE_t as time dummies: role of liquidity

	Total Loans (1)	**RE Loans** (2)	**C & I Loans** (3)	**Total Loans** (4)	**RE Loans** (5)	**C & I Loans** (6)	**Total Loans** (7)	**RE Loans** (8)	**C & I Loans** (9)
$QE_1 \times Treat_i^{MBS}$	0.0838***	0.0623**	0.0872**						
	(0.0196)	(0.0234)	(0.0373)						
$QE_1 \times Treat_i^{MBS} \times Liquidity_i^Q$	-0.0386***	0.0230	0.0279						
	(0.0133)	(0.0294)	(0.0426)						
$QE_2 \times Treat_i^{TSY}$				0.0019	0.0226	-0.9113***			
				(0.0903)	(0.0716)	(0.1385)			
$QE_2 \times Treat_i^{TSY} \times Liquidity_i^Q$				0.0399***	0.0431***	0.0519*			
				(0.0068)	(0.0085)	(0.0277)			
$QE_3 \times Treat_i^{MBS}$							0.2784	0.3664**	-0.5927
							(0.1671)	(0.1704)	(0.4182)
$QE_3 \times Treat_i^{MBS} \times Liquidity_i^Q$							-0.1041**	-0.0925***	-0.2414***
							(0.0383)	(0.0289)	(0.0592)
Observations	5,885	5,839	5,874	11,962	11,916	11,262	5,885	6,251	5,866
R-squared	0.7383	0.6114	0.1488	0.2284	0.1803	0.1052	0.3255	0.1253	0.1633
Bank-level Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$Treat_i^Q \times$QE$_t \times BankControls$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State $\times TimeFixedEffects$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable in columns (1), (4) and (7) relate to log of Total lending, while columns (2), (5) and (8) is the log of real estate loans and columns (3), (6) and (9) relate to the log of C&I loans. $Treat_i^{MBS}$ is a dummy that takes the value one for banks in the top 25th percentile of the MBS-to-total assets ratio, and zero for banks in the bottom 25th percentile. $Treat_i^{TSY}$ is a dummy that takes the value one for banks in the top 25th percentile of the treasury securities-to-total assets ratio, and zero for banks in the bottom 25th percentile of the distribution. $Liquidity_i^Q$ is a dummy variable that equals one for banks in the top 25% of ratio of liquid assets to total assets prior to the implementation of QE (liquid banks), i.e., 2007Q4, zero for banks in the bottom 25% of the distribution (illiquid banks). QE_1, QE_2, QE_3 are dummies for each QE wave. Bank-level controls includes bank size, Tier I risk-based capital ratio, loan to deposits ratio and return on assets. Constant terms included, but not reported. Robust standard errors clustered at year, shown in parentheses. ***, **, * represent significance at the 1%, 5% and 10%, respectively.

Table 6: Alternative identification strategy: taking QE_t as time dummies: role of capital

	Total Loans (1)	**RE Loans** (2)	**C & I Loans** (3)	**Total Loans** (4)	**RE Loans** (5)	**C & I Loans** (6)	**Total Loans** (7)	**RE Loans** (8)	**C & I Loans** (9)
$QE_1 \times Treat_i^{MBS}$	0.0183**	0.0820***	0.0444						
	(0.0077)	(0.0170)	(0.0361)						
$QE_1 \times Treat_i^{MBS} \times Capital_i^Q$	-0.0517**	-0.1786***	-0.1035**						
	(0.0227)	(0.0254)	(0.0390)						
$QE_2 \times Treat_i^{TSY}$				-0.6192***	-0.4382**	-0.8266***			
				(0.1330)	(0.2125)	(0.1501)			
$QE_2 \times Treat_i^{TSY} \times Capital_i^Q$				0.3215***	0.2133**	0.1390***			
				(0.0594)	(0.1046)	(0.0372)			
$QE_3 \times Treat_i^{MBS}$							0.0673***	0.0493***	0.3650***
							(0.0105)	(0.0129)	(0.0390)
$QE_3 \times Treat_i^{MBS} \times Capital_i^Q$							-0.0321**	-0.0135	-0.1858***
							(0.0128)	(0.0237)	(0.0383)
Observations	6,910	7,293	7,313	14,296	14,261	14,236	6,910	6,859	7,313
R-squared	0.7319	0.4545	0.1569	0.6743	0.3574	0.2289	0.7732	0.4118	0.0485
Bank-level Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$Treat_i^Q \times \text{QE}_t \times BankControls$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State $\times TimeFixedEffects$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable in columns (1), (4) and (7) relate to log of Total lending, while columns (2), (5) and (8) is the log of real estate loans and columns (3), (6) and (9) relate to the log of C&I loans. $Treat_i^{MBS}$ is a dummy that takes the value one for banks in the top 25th percentile of the MBS-to-total assets ratio, and zero for banks in the bottom 25th percentile. $Treat_i^{TSY}$ is a dummy that takes the value one for banks in the top 25th percentile of the treasury securities-to-total assets ratio, and zero for banks in the bottom 25th percentile of the distribution. $Capital_i^Q$ is a dummy variable that equals one for banks in the top 25% of Tier I risk-based capital ratio prior to the implementation of QE (well-capitalized banks), i.e., 2007Q4, zero for banks in the bottom 25% of the distribution (under-capitalized banks). QE_1, QE_2, QE_3 are dummies for each QE wave. Bank-level controls includes bank size, cash-to-assets ratio, loan to deposits ratio and return on assets. Constant terms included, but not reported. Robust standard errors clustered at year, shown in parentheses. ***, **, * represent significance at the 1%, 5% and 10%, respectively.

Table 7: The impact of MBS and TSY purchases on lending: based on bank liquidity

	Low Liquid banks			**High Liquid banks**		
	Total Loans	**RE Loans**	**C & I Loans**	**Total Loans**	**RE Loans**	**C & I Loans**
Panel A: MBS purchases	(1)	(2)	(3)	(4)	(5)	(6)
$MBSpurchases_{t-4} \times Treat_i^{MBS}$	-0.0046	-0.0010	0.1285***	-0.0274**	-0.0321**	-0.1201***
	(0.0077)	(0.0023)	(0.0217)	(0.0132)	(0.0145)	(0.0314)
Observations	2,490	2,492	2,486	2,624	2,586	2,623
R-squared	0.7254	0.6488	0.1831	0.7120	0.6421	0.3007
Bank-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
$Treat_i^Q \times$Asset purchases$_{t-4} \times BankControls$	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State X Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: TSY purchases						
$TSYpurchases_{t-4} \times Treat_i^{TSY}$	0.0769	-0.0104	0.0065	0.0250*	0.0044	0.0093*
	(0.0607)	(0.0137)	(0.0093)	(0.0124)	(0.0086)	(0.0050)
Observations	5,224	5,223	5,192	5,185	5,161	5,183
R-squared	0.1472	0.1842	0.0728	0.2122	0.1937	0.1307
Bank-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
$Treat_i^Q \times$Asset purchases$_{t-4} \times BankControls$	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State $\times TimeFixedEffects$	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable in Columns (1) and (4) is log of Total lending, in Columns (2) and (5) is the log of real estate loans and in Column (3) and (6) is the log of commercial and industrial loans. $Treat_i^{MBS}$ is a dummy that takes the value one for banks in the top 25th percentile of the MBS-to-total assets ratio, and zero for banks in the bottom 25th percentile. $Treat_i^{TSY}$ is constructed similarly. Liquidity is a dummy variable that equals one for banks in the top 25th percentile of the ratio of liquid assets to total assets prior to the implementation of QE, i.e., 2007Q4 (low liquid banks), zero for banks in the bottom 25th percentile of the ratio of liquid assets to total assets in 2007Q4 (high liquid banks). $TSYpurchases_{t-4}$ and $MBSpurchases_{t-4}$ are the lagged quarterly log-dollar amount of Federal Reserve Treasury (TSY) purchases and MBS purchases respectively. Bank-level controls includes bank size, Tier I risk-based capital ratio, loan to deposits ratio and return on assets. Constant terms included, but not reported. Robust standard errors clustered at year, shown in parentheses. ***, **, * represent significance at the 1%, 5% and 10%, respectively.

Table 8: The impact of MBS and TSY purchases on lending: based on bank capital

	Under-capitalized banks			Well-capitalized banks		
	Total Loans	**RE Loans**	**C & I Loans**	**Total Loans**	**RE Loans**	**C & I Loans**
Panel A: MBS purchases	(1)	(2)	(3)	(4)	(5)	(6)
$MBSpurchases_{t-4} \times Treat_i^{MBS}$	-0.0014	-0.0015	-0.0030	-0.0009*	-0.0016**	-0.0027
	(0.0009)	(0.0013)	(0.0029)	(0.0005)	(0.0007)	(0.0020)
Observations	2,216	2,216	2,216	5,467	5,433	5,463
R-squared	0.6963	0.5453	0.2576	0.6908	0.6128	0.1811
Bank-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
$Treat_i^Q \times$Asset purchases$_{t-4} \times BankControls$	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State x Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: TSY purchases						
$TSYpurchases_{t-4} \times Treat_i^{TSY}$	0.0032	0.0048	0.0088	0.0052***	0.0059***	0.0052**
	(0.0038)	(0.0043)	(0.0061)	(0.0015)	(0.0016)	(0.0025)
Observations	5,179	5,179	5,149	5,312	5,284	5,305
R-squared	0.0660	0.0787	0.0450	0.2223	0.2065	0.0234
Bank-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
$Treat_i^Q \times$Asset purchases$_{t-4} \times BankControls$	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State x Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable in Columns (1) and (4) is log of Total lending, in Columns (2) and (5) is the log of real estate loans and in Column (3) and (6) is the log of commercial and industrial loans. $Treat_i^{MBS}$ is a dummy that takes the value one for banks in the top 25th percentile of the MBS-to-total assets ratio, and zero for banks in the bottom 25th percentile. $Treat_i^{TSY}$ is constructed similarly. Liquidity is a dummy variable that equals one for banks in the top 25th percentile of the ratio of liquid assets to total assets prior to the implementation of QE, i.e., 2007Q4 (low liquid banks), zero for banks in the bottom 25th percentile of the ratio of liquid assets to total assets in 2007Q4 (high liquid banks). $TSYpurchases_{t-4}$ and $MBSpurchases_{t-4}$ are the lagged quarterly log-dollar amount of Federal Reserve Treasury (TSY) purchases and MBS purchases respectively. Bank-level controls includes bank size, cash-to-assets ratio, loan to deposits ratio and return on assets. Constant terms included, but not reported. Robust standard errors clustered at year, shown in parentheses. ***, **, * represent significance at the 1%, 5% and 10%, respectively.

Table 9: Continuous measure of MBS-to-total assets and TSY-to-total assets: effect of bank liquidity

	Total Loans (1)	**RE Loans** (2)	**C & I Loans** (3)	**Total Loans** (4)	**RE Loans** (5)	**C & I Loans** (6)
$MBSpurchases_{t-4} \times \frac{MBS}{Assets_i}$	-0.0135	-0.0286	0.1594*			
	(0.0563)	(0.0794)	(0.0807)			
$MBSpurchases_{t-4} \times \frac{MBS}{Assets_i} \times Liquidity_i^Q$	-0.0392***	-0.0289**	-0.0883***			
	(0.0111)	(0.0114)	(0.0242)			
$TSYpurchases_{t-4} \times \frac{TSY}{Assets_i}$				0.0933**	0.0933	-0.1247
				(0.0374)	(0.0603)	(0.0928)
$TSYpurchases_{t-4} \times \frac{TSY}{Assets_i} \times Liquidity_i^Q$				0.0144*	0.0185**	0.0350***
				(0.0082)	(0.0086)	(0.0114)
Observations	10,761	10,726	10,723	11,320	11,285	11,282
R-squared	0.1291	0.1355	0.0679	0.0945	0.0838	0.0336
Bank-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
$Treat_i^Q \times$Asset purchases$_{t-4} \times BankControls$	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State $\times TimeFixedEffects$	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable in columns (1) and (4) is log of Total lending, in columns (2) and (5) is the log of real estate loans and in columns (3) and (6) is the log of C&I loans. $\frac{MBS}{Assets_i}$ and $\frac{TSY}{Assets_i}$ is the ratio of MBS-to-total assets and treasury securities to total assets in 2007Q4. $MBSpurchases_{t-4}$ and $TSYpurchases_{t-4}$ is the lagged quarterly log-dollar amount of Federal Reserve MBS and Treasury (TSY) purchases, respectively. $Liquidity_i^Q$ is a dummy variable that equals one for banks in the top 25% of ratio of liquid assets to total assets prior to the implementation of QE (liquid banks), i.e., 2007Q4, zero for banks in the bottom 25% of the distribution (illiquid banks). Bank-level controls includes bank size, Tier I risk-based capital ratio, loan to deposits ratio and return on assets. Constant terms included, but not reported. Robust standard errors clustered at year, shown in parentheses. ***, **, * represent significance at the 1%, 5% and 10%, respectively.

Table 10: Continuous measure of MBS-to-total assets and TSY-to-total assets: effect of bank capital

	Total Loans (1)	**RE Loans** (2)	**C & I Loans** (3)	**Total Loans** (4)	**RE Loans** (5)	**C & I Loans** (6)
$MBSpurchases_{t-4} \times \frac{MBS}{Assets_i}$	0.0086***	0.0082***	0.0096***			
	(0.0008)	(0.0017)	(0.0019)			
$MBSpurchases_{t-4} \times \frac{MBS}{Assets_i} \times Capital_i^Q$	-0.0300***	-0.0196**	-0.0351*			
	(0.0083)	(0.0077)	(0.0191)			
$TSYpurchases_{t-4} \times \frac{TSY}{Assets_i}$				0.0435	-0.1263***	-0.9338***
				(0.0845)	(0.0288)	(0.0954)
$TSYpurchases_{t-4} \times \frac{TSY}{Assets_i} \times Capital_i^Q$				0.0239***	0.0426***	0.0692***
				(0.0079)	(0.0097)	(0.0246)
Observations	10,771	10,743	10,735	10,771	10,743	11,192
R-squared	0.2398	0.2107	0.0595	0.2343	0.0970	0.2046
Bank-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
$Treat_i^Q \times$Asset purchases$_{t-4} \times BankControls$	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State $\times TimeFixedEffects$	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable in columns (1) and (4) is log of Total lending, in columns (2) and (5) is the log of real estate loans and in columns (3) and (6) is the log of C&I loans. $\frac{MBS}{Assets_i}$ and $\frac{TSY}{Assets_i}$ is the ratio of MBS-to-total assets and treasury securities to total assets in 2007Q4. $MBSpurchases_{t-4}$ and $TSYpurchases_{t-4}$ is the lagged quarterly log-dollar amount of Federal Reserve MBS and Treasury (TSY) purchases, respectively. $Capital_i^Q$ is a dummy variable that equals one for banks in the top 25% of Tier I risk-based capital ratio prior to the implementation of QE (well-capitalized banks), i.e., 2007Q4, zero for banks in the bottom 25% of the distribution (under-capitalized banks). Bank-level controls includes bank size, cash-to-assets ratio, loan to deposits ratio and return on assets. Constant terms included, but not reported. Robust standard errors clustered at year, shown in parentheses. ***, **, * represent significance at the 1%, 5% and 10%, respectively.

Table 11: Alternative measure of bank liquidity

	Total Loans (1)	**RE Loans** (2)	**C & I Loans** (3)	**Total Loans** (4)	**RE Loans** (5)	**C & I Loans** (6)
$MBSpurchases_{t-4} \times Treat_i^{MBS^Q}$	0.0310**	0.0639***	-0.1115***			
	(0.0121)	(0.0163)	(0.0257)			
$MBSpurchases_{t-4} \times Treat_i^{MBS^Q} \times Liquidity_i^Q$	-0.0045**	-0.0030*	-0.0053*			
	(0.0018)	(0.0017)	(0.0032)			
$TSYpurchases_{t-4} \times Treat_i^{TSY^Q}$				-0.0012**	-0.0006	-0.0089***
				(0.0005)	(0.0008)	(0.0027)
$TSYpurchases_{t-4} \times Treat_i^{TSY^Q} \times Liquidity_i^Q$				0.0052**	0.0044**	0.0086***
				(0.0025)	(0.0018)	(0.0028)
Observations	5,550	5,524	5,845	10,845	10,810	10,811
R-squared	0.1964	0.1621	0.1872	0.1007	0.1062	0.1244
Bank-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
$Treat_i^Q \times$Asset purchases$_{t-4} \times BankControls$	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State X Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable in columns (1) and (4) is log of Total lending, in columns (2) and (5) is the log of real estate loans and in columns (3) and (6) is the log of C&I loans. $Treat_i^{MBS}$ is a dummy that takes the value one for banks in the top 25th percentile of the MBS-to-total assets ratio, and zero for banks in the bottom 25th percentile. $Treat_i^{TSY}$ is a dummy that takes the value one for banks in the top 25th percentile of the treasury securities-to-total assets ratio, and zero for banks in the bottom 25th percentile of the distribution. $MBSpurchases_{t-4}$ and $TSYpurchases_{t-4}$ is the lagged quarterly log-dollar amount of Federal Reserve MBS and Treasury (TSY) purchases, respectively. $Liquidity_i^Q$ is a dummy variable that equals one for banks in the top 25% of ratio of *cash to total assets* prior to the implementation of QE (liquid banks), i.e., 2007Q4, zero for banks in the bottom 25% of the distribution (illiquid banks). Bank-level controls includes bank size, Tier I risk-based capital ratio, loan to deposits ratio and return on assets. Constant terms included, but not reported. Robust standard errors clustered at year, shown in parentheses. ***, **, * represent significance at the 1%, 5% and 10%, respectively.

Table 12: Alternative measure of bank capital

	Total Loans (1)	**RE Loans** (2)	**C & I Loans** (3)	**Total Loans** (4)	**RE Loans** (5)	**C & I Loans** (6)
$MBSpurchases_{t-4} \times Treat_i^{MBS^Q}$	-0.0322**	-0.0015*	-0.0431			
	(0.0140)	(0.0009)	(0.0308)			
$MBSpurchases_{t-4} \times Treat_i^{MBS^Q} \times Capital_i^Q$	-0.0022*	-0.0023*	-0.0073***			
	(0.0011)	(0.0013)	(0.0024)			
$TSYpurchases_{t-4} \times Treat_i^{TSY^Q}$				-0.0039	-0.0263**	-0.0290
				(0.0192)	(0.0100)	(0.0234)
$TSYpurchases_{t-4} \times Treat_i^{TSY^Q} \times Capital_i^Q$				0.0028**	0.0007	0.0008
				(0.0012)	(0.0012)	(0.0017)
Observations	4,354	4,029	4,350	10,859	10,830	10,826
R-squared	0.6126	0.5504	0.1469	0.1773	0.1726	0.1039
Bank-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
$Treat_i^Q \times$Asset purchases$_{t-4} \times BankControls$	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State X Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable in columns (1) and (4) is log of Total lending, in columns (2) and (5) is the log of real estate loans and in columns (3) and (6) is the log of C&I loans. $Treat_i^{MBS}$ is a dummy that takes the value one for banks in the top 25th percentile of the MBS-to-total assets ratio, and zero for banks in the bottom 25th percentile. $Treat_i^{TSY}$ is a dummy that takes the value one for banks in the top 25th percentile of the treasury securities-to-total assets ratio, and zero for banks in the bottom 25th percentile of the distribution. $MBSpurchases_{t-4}$ and $TSYpurchases_{t-4}$ is the lagged quarterly log-dollar amount of Federal Reserve MBS and Treasury (TSY) purchases, respectively. $Capital_i^Q$ is a dummy variable that equals one for banks in the top 25% of ratio of equity to total assets prior to the implementation of QE (well-capitalized banks), i.e., 2007Q4, zero for banks in the bottom 25% of the distribution (under-capitalized banks). Bank-level controls includes bank size, cash-to-assets ratio, loan to deposits ratio and return on assets. Constant terms included, but not reported. Robust standard errors clustered at year, shown in parentheses. ***, **, * represent significance at the 1%, 5% and 10%, respectively.

Table 13: MBS-to-total assets and TSY-to-total assets on rolling basis: effect of bank liquidity

	Total Loans (1)	**RE Loans** (2)	**C & I Loans** (3)	**Total Loans** (4)	**RE Loans** (5)	**C & I Loans** (6)
$MBSpurchases_{t-4} \times Treat_i^{MBS^Q}$	-0.0229	-0.0165	-0.0364			
	(0.0162)	(0.0176)	(0.0266)			
$MBSpurchases_{t-4} \times Treat_i^{MBS^Q} \times Liquidity_i^Q$	-0.0075**	-0.0037**	-0.0001			
	(0.0029)	(0.0016)	(0.0033)			
$TSYpurchases_{t-4} \times Treat_i^{TSY^Q}$				0.0291***	0.0274	0.0188
				(0.0103)	(0.0163)	(0.0174)
$TSYpurchases_{t-4} \times Treat_i^{TSY^Q} \times Liquidity_i^Q$				0.0036*	0.0046**	-0.0026
				(0.0020)	(0.0022)	(0.0032)
Observations	5,334	5,309	5,311	4,884	4,866	4,861
R-squared	0.1227	0.1427	0.0569	0.1370	0.1013	0.1686
Bank-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
$Treat_i^Q \times$Asset purchases$_{t-4} \times BankControls$	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State X Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable in columns (1) and (4) is log of Total lending, in columns (2) and (5) is the log of real estate loans and in columns (3) and (6) is the log of C&I loans. $Treat_i^{MBS}$ is a dummy that takes the value one for banks in the treatment group based on MBS-to-total assets ratio, and zero for control banks. Similarly, $Treat_i^{TSY}$ is a dummy that takes the value one for banks in the treatment group based on the treasury securities-to-total assets ratio, and zero for control banks. Both treatment variables are constructed on the rolling basis. $MBSpurchases_{t-4}$ and $TSYpurchases_{t-4}$ is the lagged quarterly log-dollar amount of Federal Reserve MBS and Treasury (TSY) purchases, respectively. $Liquidity_i^Q$ is a dummy variable that equals one for banks in the top 25% of ratio of liquid assets to total assets prior to the implementation of QE (liquid banks), i.e., 2007Q4, zero for banks in the bottom 25% of the distribution (illiquid banks). Bank-level controls includes bank size, Tier I risk-based capital ratio, loan to deposits ratio and return on assets. Constant terms included, but not reported. Robust standard errors clustered at year, shown in parentheses. ***, **, * represent significance at the 1%, 5% and 10%, respectively.

Table 14: MBS-to-total assets and TSY-to-total assets on rolling basis: effect of bank capital

	Total Loans (1)	**RE Loans** (2)	**C & I Loans** (3)	**Total Loans** (4)	**RE Loans** (5)	**C & I Loans** (6)
$MBSpurchases_{t-4} \times Treat_i^{MBS^Q}$	-0.0030	0.0002	0.0144			
	(0.0108)	(0.0136)	(0.0191)			
$MBSpurchases_{t-4} \times Treat_i^{MBS^Q} \times Capital_i^Q$	-0.0024*	-0.0045**	-0.0051			
	(0.0012)	(0.0016)	(0.0052)			
$TSYpurchases_{t-4} \times Treat_i^{TSY^Q}$				-0.0195***	-0.0267**	-0.0518***
				(0.0064)	(0.0128)	(0.0135)
$TSYpurchases_{t-4} \times Treat_i^{TSY^Q} \times Capital_i^Q$				0.0090***	0.0090***	0.0070*
				(0.0023)	(0.0028)	(0.0041)
Observations	5,307	5,215	5,221	5,224	5,202	5,121
R-squared	0.2113	0.1996	0.0757	0.2336	0.1796	0.0673
Bank-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
$Treat_i^Q \times$Asset purchases$_{t-4} \times BankControls$	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State X Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable in columns (1) and (4) is log of Total lending, in columns (2) and (5) is the log of real estate loans and in columns (3) and (6) is the log of C&I loans. $Treat_i^{MBS}$ is a dummy that takes the value one for banks in the treatment group based on MBS-to-total assets ratio, and zero for control banks. Similarly, $Treat_i^{TSY}$ is a dummy that takes the value one for banks in the treatment group based on the treasury securities-to-total assets ratio, and zero for control banks. Both treatment variables are constructed on the rolling basis. $MBSpurchases_{t-4}$ and $TSYpurchases_{t-4}$ is the lagged quarterly log-dollar amount of Federal Reserve MBS and Treasury (TSY) purchases, respectively. $Capital_i^Q$ is a dummy variable that equals one for banks in the top 25% of Tier I risk-based capital ratio prior to the implementation of QE (well-capitalized banks), i.e., 2007Q4, zero for banks in the bottom 25% of the distribution (under-capitalized banks). Bank-level controls includes bank size, cash-to-assets ratio, loan to deposits ratio and return on assets. Constant terms included, but not reported. Robust standard errors clustered at year, shown in parentheses. ***, **, * represent significance at the 1%, 5% and 10%, respectively.

A Variables employed: construction and corresponding definitions

Variable Name	Definition	Data Sources
Mortgage backed securities	Residential pass-through securities + other residential MBS + commercial MBS	FR-Y9C
Treasury Securities	U.S. Treasury securities + U.S. government agency obligations + securities issued by states and political subdivisions in the U.S.	FR-Y9C
Total lending	Logarithm of total loans	FR-Y9C
Real estate lending	Logarithm of loans secured by real estate	FR-Y9C
C & I lending	Logarithm of commercial and industrial loans to U.S. and non-U.S. addresses	FR-Y9C
Bank Size	Logarithm of total assets	FR-Y9C
Equity ratio	Total equity capital divided by total assets	FR-Y9C
Loan to deposit ratio	Total loans divided by Non-interest bearing deposits in domestic offices + interest-bearing deposits in domestic offices + non-interest bearing deposits in foreign offices	FR-Y9C
Liquidity	Cash and balances due from depository institutions: non interest bearing balances and currency and coin + federal funds sold divided by total assets	FR-Y9C
Return on assets	Ratio of net income to total assets	FR-Y9C
Treasury Purchases	Amount of Treasury securities purchased by the Federal Reserve in a given quarter	New York Fed
MBS Purchases	Amount of MBS purchased by the Federal Reserve in a given quarter	New York Fed

Notes: Table presents data sources and method of construction of variables used in analysis. FR-Y9C refers to balance sheet information of all BHCs from Federal Reserve Bank of Chicago. New York Fed refers to outright purchases and sales of MBS and treasury securities data during large-scale asset purchases between 2008 and 2014.