Monetary Stimulus and Bank Lending

Indraneel Chakraborty Itay Goldstein Andrew MacKinlay*

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Abstract

The U.S. Federal Reserve purchased both agency mortgage-backed securities (MBS) and Treasury securities to conduct quantitative easing (QE). Using micro-level data, we find that banks benefiting from MBS purchases increase mortgage origination, compared to other banks. At the same time, these banks reduce commercial lending and firms that borrow from these banks decrease investment. The effect of Treasury purchases is different: either positive or insignificant in most cases. Our results suggest that MBS purchases caused unintended real effects and that Treasury purchases did not cause a large positive stimulus to the economy through the bank lending channel.

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The recent crisis and recession has led central banks to conduct unconventional monetary policy in continuous attempts to revive their economies. Quantitative easing (QE) was a prominent tool used in the U.S., Japan, Europe, and elsewhere in this spirit. With this tool, central banks purchase financial assets such as Treasuries or mortgage-backed securities (MBS), hoping to reduce yields, boost lending, and stimulate economic activities. Banks and their lending decisions are thought to play a key role in the transmission mechanism. A key question in academic and policy circles following these events is whether QE was successful in its stated goals. Some think that QE helped revive the economy, and the recession would have been much worse without it. Others think that QE might have had no effect. Others still even consider the possibility that it had negative effects by inflating bubbles and distorting the allocation of resources.

Over the years, a large literature attempted to identify the impact of traditional monetary policy via the bank lending channel. While the effects of QE may be similar in some respects, there are also meaningful distinctions given the unprecedented magnitude of intervention and the nature of the tool. Like traditional monetary policy, identifying the effect of QE is difficult because changes that follow the intervention could be attributed to other changes in the economy around the same time. In this paper, we follow the logic of Kashyap and Stein (2000) and others by exploiting the heterogeneity across banks to assist with identification. The usual idea is that some banks are expected to be more affected by the policy than others, and so their different actions following monetary policy shocks can speak to the causal effect of monetary policy.

This idea is sharpened in the context of QE. In the U.S., the Federal Reserve bought particular types of assets (specifically Treasury and MBS) in varying quantities in multiple rounds of QE. Within the bank lending channel, the typical mechanism through which this policy is thought to have an effect is through capital gains. Specifically, the large-scale asset purchases (LSAPs) lower yields and increase prices of banks' current asset holdings, thereby improving the condition of their balance sheets and leading to more lending in multiple sectors. Indeed, Fed officials often framed the impact of QE through these price effects (Yellen, 2012; Bernanke, 2012). Thus, one would expect that banks that held more of the purchased assets (Treasury and MBS) and related securities benefitted more from such asset purchases.

A less discussed but related mechanism within the bank lending channel is the origination channel in the specific context of MBS purchases: banks that securitize mortgages into agency MBS are strongly affected by these asset purchases because these banks directly sell such products to the Federal Reserve as a part

of QE. The Federal Reserve chose to implement the MBS purchases through the to-be-announced (TBA) market. In this market, the main parameters of the contract (coupon, maturity, issuer, settlement date, face value, and price) are agreed upon in advance. However, the exact pool of mortgages satisfying these terms is determined at settlement, which is typically one to three months in the future. As the TBA market primarily focuses on new mortgages, banks have a strong incentive to originate and securitize mortgages to fulfill these contracts. Existing legacy MBS or mortgage holdings on the banks' balance sheet will not be a candidate for selling to the Federal Reserve via these asset purchases.

We use two measures to capture the exposure of banks to these MBS purchases and the underlying mechanisms: (1) the amount of MBS holdings on the banks' balance sheet and (2) those high-MBS banks which actively securitize other assets. Ideally, we would disentangle banks that are only exposed to MBS-related capital gains from those which are also affected by the origination incentive. In practice, we cannot completely do so. While the banks which actively securitize assets and have high MBS holdings undoubtedly are strongly incentivized by the origination channel, many high-MBS banks may still be active originators without participating in securitization. Balance sheet data does not provide a way to separate these banks further. However, we can compare these banks to banks which are more exposed to Treasury purchases, as there is only a capital gains mechanism in that case. As a measure of exposure to Treasury purchases, we use the amount of Treasuries and other non-MBS securities on the banks' balance sheet.

To shed light on the effects of QE, we analyze the behavior of banks after rounds of asset purchases and compare it to that of banks that were expected to be less affected by these two components within the bank lending channel. Moreover, our richly detailed data enables us to track the effect from asset purchases, through the affected banks, to the firms that are connected to these banks, and thereby directly examine the real effects of QE. Given that firms are sometimes connected to different banks, this also allows for clean identification. In particular, we inspect the borrowing of a given firm from different banks which are differentially affected by QE. This approach removes any concerns that the effects might be driven by firms' demand for borrowing instead of banks' lending decisions.

Asset purchases in the U.S. had three different rounds. In QE1 and QE3, the Federal Reserve bought MBS and Treasuries. In QE2, it bought primarily Treasuries. Although these three rounds were the impetus for much of the asset purchases, the Federal Reserve also made purchases between rounds of QE in response

to maturing securities and to maintain the size of its balance sheet. A related program, the Maturity Extension Program (MEP), consisted of buying long-maturity Treasuries and selling short-maturity Treasuries. This program occurred between QE2 and QE3.

We start by investigating the patterns in bank mortgage lending following MBS purchases by the Federal Reserve. In this case, both capital gains and origination components of the bank lending channel have effects in the same direction. As expected, we show that banks that were more exposed to the MBS market increased their mortgage lending following MBS purchases more than the less exposed banks. For every dollar of MBS purchased, these banks loaned 4.43 cents more in terms of mortgages. For the total purchase of approximately $1.75 trillion worth of MBS, this suggests additional lending of $77.5 billion. This is a reassuring confirmation that QE indeed had a direct, positive effect. As intended, the Federal Reserve improved the attractiveness of mortgage lending, inducing banks exposed to this market to increase their activity in it.

More surprisingly, however, we show that the more exposed banks slowed their commercial and industrial (C&I) lending following these MBS purchases. Hence, there seems to be a negative indirect effect, which amounts to the crowding out of other types of loans not directly targeted by the MBS purchases in QE. As QE1 and QE3 focused on the housing market by purchasing large amounts of MBS assets, they indeed encouraged exposed banks to lend more in this market. However, this came at the expense of other types of lending, such as C&I lending for those affected banks. The magnitude of this crowding out is large: for every dollar of additional MBS purchases under QE, we estimate a reduction of 1.20 cents in C&I lending. Scaled in terms of additional mortgage lending stimulated by QE, this is a 27 cent reduction in commercial lending for each dollar of additional mortgage lending. The mechanism is likely a result of a substitution effect: while banks benefit from capital gains, the origination component dominates, and good opportunities for banks in one line of business (mortgages) shift resources away from other lines of business (C&I loans). While it is likely that such crowding out took place in other markets as well (e.g., consumer credit), this paper focuses on C&I lending. Consistent with this argument, we find a larger effect for the more financially constrained banks within this group. This reduction is strongest in the period through QE1, where the banking sector as a whole was most constrained. In line with a crowding-out effect, we find that the profitability of those commercial loans extended by the exposed banks increases in response to MBS

purchases. The logic behind the crowding-out behavior resembles that featured in the internal-capital markets literature (e.g., Stein, 1997; Scharfstein and Stein, 2000), where constrained firms are expected to shift resources across divisions to respond to the most attractive investment opportunities.

Investigating further the implications of the crowding-out behavior following MBS purchases, we use DealScan and Compustat data to trace the behavior of firms connected to affected banks. We demonstrate the real effect of crowding out of C&I loans by banks affected by MBS purchases. In particular, firms that have relationships with these banks had to cut their investment following these rounds of QE. For every dollar of additional mortgage lending stimulated through MBS purchases, firms reduce investment by 6 cents. As expected, this behavior is observed mostly for more financially constrained firms. In interpreting these results, one might be concerned that the decrease in C&I loan growth and investment reflects a decrease in demand from firms rather than a decrease in supply from banks. We address this issue in several ways. Most notably, we conduct analysis for firms that borrow from multiple banks, some of which are strongly affected by MBS purchases and some of which are not. We show that, after controlling for firm-time fixed effects, a given firm saw a decrease in loan size from affected banks relative to the loan size from non-affected banks.

While MBS purchases increased mortgage origination and decreased C&I lending for affected banks, Treasury purchases did not have a negative effect on C&I lending or firm investment. This is important because, in the case of Treasuries, only the capital gains mechanism is at work. The relatively insignificant real effects of Treasury purchases suggest that the capital gains mechanism is relatively weak compared to the origination mechanism.

Overall, our paper demonstrates that the type of asset being purchased is very important in designing QE. Through its choice of assets purchased, beyond providing overall stimulus, the Federal Reserve directly affected credit allocation within the economy. The unintended negative consequences of MBS purchases on C&I lending and, ultimately, firm investment are due to the less-discussed origination mechanism. This general message has broader implications, given that other countries have experimented with purchases of other assets: the European Central Bank has been purchasing corporate debt, while the Japanese Central Bank has purchased equities. It would be interesting to investigate their differential effects as well.

Our results contribute to the debate about which channels were most salient for the transmission of QE. Krishnamurthy and Vissing-Jørgensen (2013), for example, discuss several channels through which QE

could have had a role. Our paper shows that the incentive of banks to originate mortgages (the origination channel) is particularly important. Indeed, it appears to dominate any positive spillovers from the capital gains channel in markets, such as commercial lending, where the effects are opposite in direction. In general, the capital gains channel, whether for MBS or Treasury securities, appears to be relatively weak.

There is a recent small literature on QE and bank lending. The closest paper to ours is Rodnyanski and Darmouni (2016). They also exploit heterogeneity at the bank level due to differences in holdings of MBS in order to investigate the effect of QE on bank lending. Their main focus is on mortgage lending. While C&I lending is not central in their paper, their analysis does touch on it and does not uncover the crowding-out effect that MBS purchases had on the C&I lending of exposed banks, which we show here. This is because of key differences in the research design. Rodnyanski and Darmouni (2016) utilize the timing of QE rounds as the only source of exogenous variation by using three time-dummies for the QEs. In other words, they compare lending patterns before and after the three QE rounds, effectively assuming that the only aggregate variation during and after the financial crisis was the introduction of the three QE episodes. This leads to the commingling of the effect of a QE round with that of *any* policy or aggregate variation that coincides with that timing. For example, the Housing and Economic Recovery Act of 2008—which sought to insure $300 billion in new mortgages—was introduced in the same time period as QE1 and disproportionately affected the treatment group (i.e., banks with high MBS holdings). Similarly, the timing of QE2 and QE3 coincide with the introduction of many other non-QE measures. In contrast to time-dummies for the QEs, we use quarter-by-quarter observations of monetary stimulus so that we can control for unobserved aggregate economic conditions and changing regulatory policy during the period by including year-quarter fixed-effects. In addition, we explicitly use the amount of MBS purchases and the amount of Treasury purchases by the Federal Reserve in every quarter as the direct measure of monetary stimulus and its intensity.[1] These two differences in our research design allow us to tease out the effects of monetary shocks from other confounding policy changes and economic conditions. Finally, a fundamental difference between our papers is that we explore the truly real effects of QE by looking at firms' investments and bank-firm specific lending relationships, whereas Rodnyanski and Darmouni (2016) only look at banks' general lending patterns.

[1] See, for example, Morais, Peydró, and Ruiz (2017) who use the amounts of assets purchased to measure the effects of QE.

In addition to Rodnyanski and Darmouni (2016), two other contemporary papers investigate separate aspects of QE and bank lending and complement our findings. Di Maggio, Kermani, and Palmer (2016) examine how unconventional monetary policy affected the volume of new mortgages issued. They find that financial institutions originated more mortgages of the type that were eligible for purchase by the Federal Reserve (GSE-eligible mortgages). During QE1, this led to $600 billion of refinancing which led to equity extraction and consumption of an additional $76 billion. Kandrac and Schulsche (2016) assess the effect of QE-induced reserve accumulation on bank-level lending and risk-taking activity. The authors find that bank reserves created by the Federal Reserve led to higher total loan growth and more risk taking within banks' loan portfolios.

Outside the recent QE literature, our paper relates to the broader literature that explores the impact of traditional monetary policy on the economy through the bank lending channel. This literature shows that shocks to financial institutions affect their ability to lend and end up impacting the firms that borrow from them (Bernanke, 1983; Stein, 1998; Kashyap and Stein, 2000). The impact of monetary policy on firms assumes that banks and firms are financially constrained to some extent (this literature also includes Kashyap and Stein, 1995; Peek and Rosengren, 1995; Holmstrom and Tirole, 1997; Bolton and Freixas, 2006, among others), which is a basic premise of our paper as well. The phenomenon of the crowding out of bank lending from one sector of the economy by another sector is related to the theory in Farhi and Tirole (2012) and the empirical evidence in Chakraborty, Goldstein, and MacKinlay (2016). Chakraborty, Goldstein, and MacKinlay (2016) find that during the U.S. housing boom, banks in stronger housing markets reduced commercial lending in favor of more mortgage activity, and firms that borrowed from these banks had to reduce investment as a result. Our paper shows that after the boom ended, a different phenomenon crowds out capital from firms: MBS purchases in quantitative easing led benefiting banks to increase real estate lending and reduce C&I lending.

Finally, our paper ties into a far more general literature on the effects of monetary stimulus on the economy. A recent part of this literature investigates the connection between lower interest rates and bank activity (e.g., Maddaloni and Peydró, 2011; Jiménez, Ongena, Peydró, and Saurina, 2014; Dell'Ariccia, Laeven, and Marquez, 2014), negative interest rates and bank risk (Heider, Saidi, and Schepens, 2016), and pass-through to consumer credit (Agarwal, Chomsisengphet, Mahoney, and Stroebel, 2017). Another

related strand looks at the effects of QE on asset prices (e.g., Krishnamurthy and Vissing-Jørgensen, 2011, 2013; Bekaert, Hoerova, and Duca, 2013; Hanson and Stein, 2015).

The remaining sections are organized as follows: Section I describes the data used for the analysis and how we determine bank exposure to asset purchases; Section II reports the effects of asset purchases on mortgage lending, commercial lending, firm investment, and firm loan activity. Section III provides additional evidence in support of the crowding-out effect; Section IV explores additional effects related to QE; and Section V concludes.

I Data

This paper considers the effect of asset purchases on the mortgage origination and commercial lending activity of banks, and how changes in bank activity affect lending to firms and their real activity. We combine mortgage origination data from the Home Mortgage Disclosure Act (HMDA) with bank commercial lending data from Call Report. We also use the Call Report data for other information about the bank's balance sheet and to measure its exposure to asset purchases. To establish firm-bank relationships and consider lending to specific firms, we use DealScan data combined with Compustat data for additional firm information. Our asset purchase data comes from the New York Federal Reserve. Given our focus on asset purchases made by the Federal Reserve, we consider the period from the fourth quarter of 2005 through the fourth quarter of 2013.[2] Section I.A covers the Federal Reserve's asset purchase programs in more detail. As our identification strategy utilizes the differential impact of these asset purchases based on bank exposure to them, Section I.B discusses some features of the agency MBS market and how we measure bank exposure. Section I.C discusses the bank data in more detail, and Section I.D discusses how we determine firm-bank lending relationships, along with the relevant firm and loan data.

I.A Federal Reserve Asset Purchases

Critical to our analysis are the amounts of MBS and Treasury securities purchased by the New York Federal Reserve under their permanent Open Market Operations programs. Historical data for these Treasury pur-

[2]The third quarter of 2005 is the first quarter with any asset purchase data, and the fourth quarter of 2013 is the most recent quarter for which all our data sources can be matched.

chases begin in August 2005. In November 2008, the Federal Reserve announced a plan to purchase up to $100 billion in direct obligations of government-sponsored or government-owned enterprises (GSEs/GOEs) and up to $500 billion in MBS purchases, which started in early 2009.[3] In March 2009, the program expanded with an additional $750 billion in agency MBS purchases, $300 billion in Treasury purchases, and continued until June 2010. This initial round of purchases became known as QE1.

In November 2010, the Fed announced a second round of purchases (QE2), totaling up to $600 billion in Treasury purchases, which concluded in June 2011. The third round of quantitative easing (QE3), ran from September 2012 through October 2014, initially at purchase rates of $40 billion per month for agency MBS and $45 billion per month for Treasury securities. The total increase to the Fed's balance sheet after the completion of three rounds of QE totaled about $1.75 trillion in MBS holdings and $1.68 trillion in Treasury holdings.

While the net and gross purchases yield similar empirical results, we use gross purchases as a measure of amount of assets purchased each quarter. Using gross purchases allows us to capture the Maturity Extension Program (MEP)—when the Federal Reserve purchased long-term Treasuries and sold short-term Treasuries to reduce long-term bond yields—as part of the treatment. Figure 1 presents the total purchases by the Open Market Operations desk on a quarterly basis. Over this window, there are periods where there are predominantly MBS purchases (e.g., 2008q4 through 2009q3), Treasury purchases (e.g., 2010q3 through 2011q3), and a mix of both security types (e.g., 2012q1 through 2012q4).[4]

I.B Bank Exposure to the MBS and Treasury Markets

The agency MBS market is composed of two distinct markets: a specified pool (SP) market, where specific MBS are traded, and a to-be-announced (TBA) market. In the TBA market, the buyer and seller agree on six parameters of the contract: coupon, maturity, issuer, settlement date, face value, and price. The exact pool of mortgages that fits these parameters is determined at settlement, which is typically one to three months in the future (Gao, Schultz, and Song, 2017). The majority of agency MBS purchases undertaken by the Federal Reserve occurred in the TBA market, and the Fed mainly bought 15-year and 30-year MBS

[3] The Federal Reserve made purchases of GSE/GOE obligations in September and December 2008. We include these purchases in our broader MBS category, but our results are similar if we exclude them from our analysis.

[4] In our analysis, we use the log of the dollar amount of MBS or Treasuries purchased in a year-quarter in millions. Year-quarters without purchases take on a zero value.

at coupons close to current mortgage rates.

Banks have two avenues to transform mortgages into agency MBS: (1) sell the loans individually to the government agency for cash, which the agency may include in an MBS pool, or (2) organize their mortgages into a MBS pool and have the GSE/GOE certify it as an agency MBS. The second method, referred to as a swap transaction, requires the bank to have an additional pool purchase contract with the agency. These swapped MBS remain on the bank's own balance sheet as MBS assets until they are sold or mature.

An important point of differentiation among banks is their level of involvement in the secondary mortgage market. We try to capture this in two ways: the first is a measure of how much of the bank's total assets are MBS. Because MBS holdings arise, in part, as an intermediate step in these swap transactions, banks holding more MBS are more likely to be active in the secondary market. In our analysis, we treat the top tercile of banks by MBS holdings as most exposed to the secondary mortgage market and the bottom tercile of banks by MBS holdings as least exposed. The second variable we use to capture secondary market involvement is a refinement of our MBS holdings variable. Specifically, we focus on the subset of top-tercile MBS banks that report non-zero net securitization income (denoted as *Securitizers*).[5] Those banks that not only engage in transactions with GSEs/GOEs, but also securitize other non-agency loans, are more likely to be involved in the secondary mortgage market. Whereas more than 80% of our bank observations report some MBS holdings on their balance sheets, only 3% of banks in our sample report non-zero securitization income at some point.

Although not our central focus, we construct a similar exposure variable for Treasury purchases. Unlike MBS, banks do not originate new Treasury securities. However, changes in Treasury yields driven by Federal Reserve purchases can affect banks through changes in the value of their own Treasury holdings or related securities. Given the central role of Treasuries in determining the value of many securities, we separate banks into terciles by the amount of non-MBS securities held.[6] Those banks which are in the

[5]To ensure that we are correctly identifying banks which are large and active enough to participate in the secondary mortgage market, we additionally require the bank to have at least $100 million in assets and a 0.2 basis-point share of the national mortgage origination market. Our results are similar if we omit these additional filters.

[6]Non-MBS securities include: Treasury securities, other U.S. government agency or sponsored-agency securities, securities issued by states and other U.S. political subdivisions, other asset-backed securities (ABS), other debt securities, and investments in mutual funds and other equity securities. While the average bank in our sample holds 14.5% of assets in these non-MBS securities, 8.5% of assets on average are held in just Treasury and other U.S. government securities (see Table I). A possible argument is that Treasury purchases have a larger effect on government securities compared to other asset classes. Hence, as an alternative measure of securities holdings, in Appendix C.1 we restrict securities holdings to Treasury and other U.S. government securities and find similar results.

highest tercile of securities holdings are likely to be more affected by Treasury purchases than banks in the lowest tercile of securities holdings through this capital gains channel.

I.C Bank Mortgage Origination and Commercial Lending Activity

As discussed above, the Federal Reserve conducted their MBS purchases through the TBA market, mainly at 15-year and 30-year maturities and coupons close to current mortgage rates. Such purchases incentivize banks to originate new conforming mortgages which can be packaged and sold in the TBA market. To capture banks' mortgage origination activity, we incorporate data from HMDA. Available on an annual basis, we use the origination data from 2005–2013. Specifically, we calculate the annual mortgage origination growth for each bank, at the holding company level. We use this data as opposed to relying on the bank's balance sheet data because it captures both the mortgages that remain on the bank's balance sheet and those that are sold to other parties. Given the manner in which QE was undertaken, banks most affected by the MBS purchases should be actively selling mortgages or packaging mortgages into agency MBS and subsequently selling them to the Federal Reserve. Disentangling the new origination activity from the subsequent MBS conversions and sales is difficult if only considering the amount of unsecured real estate loans on the bank's balance sheet. Summary statistics are included in Panel A of Table I.

In addition to mortgage origination growth, we include a few additional variables from HMDA. At the state level, we calculate the average APR of originated mortgages for each bank. This variable is reported as a spread above the equivalent maturity Treasury rate and is only provided for a certain subset of the mortgage market.[7]

We use Call Report data to construct our measure of commercial and industrial (C&I) loan growth, C&I loan profitability, the exposure measures discussed in Section I.B, and our other bank-level control variables. These variables include the bank's size, equity ratio, net income, and cost of deposits. We also calculate the change in the unemployment rate in the bank's states and use the bank's amount of demand deposits as a measure of constraints. The summary statistics for these variables are presented in Panel A of Table I and specific variable definitions can be found in Table A.1 in the Appendix.

[7]Specifically, through 2008 banks were only required by HMDA to report those mortgage rates that exceeded the current maturity-matched Treasury rate by 3 percentage points or more. Starting in 2009, banks are now required to report mortgage rates which exceed the the "Average Prime Offer Rate" (the rate on the same type of mortgage when given to prime borrowers—https://www.ffiec.gov/ratespread/aportables.htm) by 1.5 percentage points or more.

I.D Banks and Commercial Lending Relationships

An important component of our analysis is the effect of the asset purchases on firm real activity through the bank lending channel. We determine firm-bank relationships using loan-level data from DealScan with firm-level data from Compustat.[8] The duration of the relationship is defined as follows: it begins in the first year-quarter that we observe a loan being originated between the firm and bank, and it ends when the last loan observed between the firm and bank matures, according to the original loan terms. Following Chakraborty, Goldstein, and MacKinlay (2016), we use a link table which matches DealScan lenders to their bank holding companies in the Call Report data. In our sample period, we match 555 DealScan lenders to 138 bank holding companies in the Call Report data. These matches are determined by hand using the FDIC's Summary of Deposits data and other available data of historical bank holding company (BHC) structures. Throughout our analysis, all bank activity is investigated at the holding company level, so we refer to BHCs as "banks" for simplicity. Panel B of Table I provides statistics on the duration and number of relationships. Additional details on how relationships are determined and on the loan terms are provided in Appendix A.

We also use DealScan for loan amounts, to calculate loan growth at a firm-bank level, and for other contract terms. From Compustat, we use several firm-specific variables in our analysis. These variables include investment, market-to-book ratio, cash flow, firm size, and Altman's Z-score.[9] As we focus on how financial intermediaries affect borrowing firms' investment decisions, we exclude any borrowing firms that are financial companies. Panel B of Table I includes the summary statistics for our loan and firm variables.

II Bank Lending and the Real Effects of QE

This section presents our key findings: while QE asset purchases stimulated mortgage lending as intended, they also led banks to reduce their credit supply to firms. This lending reduction had real effects as firms which borrowed from these banks reduced investment. Sections II.A and II.B investigate the impact of asset purchases on bank lending in the mortgage market and commercial and industrial loan market, respectively.

[8] We link borrowers from DealScan to Compustat data using the link file from Chava and Roberts (2008).

[9] All firm and bank variables that are ratios are winsorized at the 1 and 99 percentiles, with the exception of the cash flow variable. The cash flow variable is winsorized at the 2.5 and 97.5 percentiles because of more extreme outliers. The main results are robust to winsorizing the cash flow variable at the 1 and 99 percentiles.

Section II.C looks at the impact of asset purchases on firm investment. To rule out any firm-demand factors that could be affecting our results, Section II.D utilizes within-firm loan-level evidence from different banks to analyze the impact of QE on bank lending.

II.A Mortgage Lending and Asset Purchases

As discussed in Section I.B, the Federal Reserve attempted to stimulate new mortgage activity through MBS purchases in the TBA market. In our analysis, we focus on the growth in banks' overall mortgage originations, rather than just the mortgage holdings that remain on banks' balance sheets. This choice is motivated by this origination channel component of QE: banks are incentivized to originate new mortgages, package them as agency MBS, and sell them to the Federal Reserve in the TBA market.

Specifically, we investigate the mortgage origination growth rate of banks in a specific year in response to MBS purchases, depending on the banks' exposure to the MBS market. Our first measure of a bank's exposure is based on the bank's MBS holdings as a fraction of assets: banks in the top tercile of MBS holdings are considered more exposed and are compared to banks in the lowest tercile of MBS holdings. The second measure refines the first measure and classifies the subset of high-MBS banks that securitize assets as the most exposed. We include year and bank fixed effects to ensure that aggregate conditions and bank-specific time-invariant characteristics are not driving the changes in origination activity. The specification for bank j in year t is as follows:

$$\begin{aligned}\text{Mort Orig Growth Rate}_{jt} = \alpha_j + \gamma_t + \beta_1 \text{MBS Purch}_{t-1} + \beta_2 \text{Bank Exposure}_{jt-1} \\ + \beta_3 \text{Bank Exposure}_{jt-1} \times \text{MBS Purch}_{t-1} + \beta_4 \text{Bank Vars}_{jt-1} + \varepsilon_{jt}. \quad (1)\end{aligned}$$

In this specification, as we are looking at the annual growth rate of mortgages, all lagged variables $(t-1)$ are from the fourth quarter of the prior year. We specifically focus on β_3, the interaction of the amount of asset purchases with the exposure of the bank to the MBS market.[10] Throughout our analysis, we use the logarithm of the dollar amount of the purchases. Because we include year fixed effects, the coefficient for the MBS asset purchases (β_1) is absorbed. All specifications include the following bank-level characteristics:

[10] Because we use bank fixed effects in our specifications, the coefficient for bank exposure as a standalone variable (β_2) is not very economically meaningful. This is because not many banks switch between the high and low classifications of the exposure measures.

size (excluding loans since the dependent variable is based on loan activity), equity ratio, net income, and cost of deposits. These variables capture differences in the scale and financial position of banks that might affect lending activity.[11] We include the change in unemployment rate across the bank's states of operation based on its deposits as a measure of local economic conditions faced by the bank.

Table II reports the results. Since the growth rate is scaled by 100, Column 1 shows that a 1% increase in MBS purchases increases mortgage origination by about 0.914 basis points (bps). This increase is for the more exposed (high-MBS) banks compared to the less exposed (low-MBS) banks, and the inclusion of year fixed effects removes any other factors that could affect origination activity. A different concern is that banks with high MBS holdings may have other characteristics that drive the response of the banks in terms of mortgage origination. In other words, it is not MBS holdings but—for example—banks with high net income that respond more to the incentives provided by the Federal Reserve through MBS purchases. To address this concern, we next refine our approach of grouping banks based on MBS holdings. We estimate the amount of MBS holdings that can be explained by other bank characteristics (specifically size, equity ratio, net income, and cost of deposits), and then calculate the residual MBS holdings for each bank. This term is thus the bank's MBS holdings orthogonalized to other bank characteristics. We then refine the terciles of banks by MBS holdings, using the orthogonalized MBS holdings. Column 2 reports the results. The coefficient point estimate drops by a fifth, but the result remains statistically and economically significant: banks with higher MBS holdings lend more in response to MBS purchases.

Since the mechanism is that MBS asset purchases by the Federal Reserve in the TBA market encourage mortgage lending, we next use our second measure of the exposure of banks to MBS purchases to test the mechanism more directly. Column 3 focuses on the mortgage lending growth rate for high-MBS securitizer banks following MBS asset purchases. For the sake of comparison, we maintain the same sample to compare securitizers to non-securitizers as in columns 1 and 2. Comparing column 3 with column 1, we find that the effects are more than twice as strong in this case. A 1% increase in MBS purchases leads to an increase of about 2.275 bps in mortgage lending growth for the high-MBS securitizer banks. As a back of the envelope calculation, we determine that for an additional dollar of MBS purchases by the Federal Reserve, high-MBS securitizer banks provide an additional 4.43 cents in mortgage lending. For the $1.75 trillion increase

[11] See, e.g., Gatev, Schuermann, and Strahan (2009); Ivashina and Scharfstein (2010); Cornett, McNutt, Strahan, and Tehranian (2011); Berger and Bouwman (2013).

in the Fed's balance sheet from MBS purchases over the QE period, we estimate approximately $77.5 billion in additional mortgage lending from these banks. The details of these calculations are provided in Appendix B. Thus, in response to MBS asset purchases, benefiting banks engaged in more mortgage lending. This evidence shows that the mortgage origination channel is significant for the transmission of QE.

II.B Unintended Effects of Asset Purchases on Commercial Lending

This section discusses the effect of asset purchases by the Federal Reserve on commercial and industrial (C&I) lending. The argument as to why MBS purchases may crowd out C&I lending is as follows: to implement quantitative easing, the Federal Reserve announced its intention to purchase MBS. As discussed in Section I.B, the majority of the Fed's agency MBS purchases were in the forward (TBA) market. Therefore banks—knowing that the Federal Reserve is purchasing TBA MBS—respond by shifting resources away from new C&I lending into mortgage origination and MBS creation. To test whether such crowding out indeed took place, we focus on new loan activity in the C&I lending market. We utilize quarterly C&I loan growth as our measure of interest. As before, specifications include the following bank-level characteristics: size, equity ratio, net income, and cost of deposits. We address persistent heterogeneity among banks by including bank-level fixed effects. We also include year-quarter fixed effects to control for changes in aggregate economic conditions, and changes in the unemployment rate across the bank's states of operation to control for local economic conditions faced by the bank. Although not our main focus, we also include the amount of Treasuries purchased by the Federal Reserve and a measure of bank exposure to these purchases. These additional variables allow us to disentangle the separate effects of MBS and Treasury purchases on bank commercial lending.

Table III reports the growth in C&I lending as a response to MBS and Treasury purchases. Columns 1–4 identify the effects on credit supply depending on whether the bank is in the top or bottom tercile of MBS holdings as a fraction of assets. Columns 5 and 6 focus on high-MBS securitizer banks to identify the effect of MBS purchases on credit supply. All columns use the exposure measure based on whether the bank is in the top or bottom tercile of non-MBS securities holdings to identify the effect of Treasury purchases on lending at the bank level. As discussed in Section I.B, banks with higher securities holdings will benefit more from Treasury purchases lowering yields on these securities.

The variables of interest are the bank-level interaction terms with the amounts of MBS and Treasury purchases. Column 1 shows that banks which are in the top tercile of MBS holdings, and hence benefit more from MBS purchases, have lower C&I loan growth in response to MBS purchases by the Federal Reserve. Since the dependent variable is quarterly and scaled by 100, column 1 reports that a 1% increase in MBS purchases reduces loan growth by about 0.059 bps. Column 2 shows that banks with higher holdings of securities reacted positively to Treasury purchases in terms of C&I lending.[12] 1% additional Treasury purchases leads to 0.093 bps additional C&I loan growth. Column 3 includes both MBS and Treasury purchases and finds that the effects from columns 1 and 2 remain similar in magnitude and statistical significance. If a capital gains channel is the main cause for the positive effect of Treasury purchases on C&I lending, this suggests that the negative impact of the mortgage origination channel on commercial lending must dominate any analogous positive capital gains channel for MBS holdings.

As in Section II.A, a possible concern is that banks with high MBS holdings may have other characteristics driving their C&I lending. Hence, we calculate the MBS holdings of a bank beyond what is predicted by observable bank characteristics. This orthogonalizes banks' MBS holdings to other bank characteristics. We perform an analogous procedure for the securities holdings as well. Column 4 reports that the results remain statistically and economically significant: banks with higher MBS holdings provide fewer new C&I loans compared to banks with lower MBS holdings.

Columns 5 and 6 focus on high-MBS securitizers to confirm that the observed effects are stronger for banks that benefit more from MBS purchases. We find effects approximately six times stronger in column 5 compared to column 1. A 1% increase in MBS purchases leads to about 0.357 bps lower C&I loan growth for securitizing banks. Detailed in Appendix B, we calculate that for each dollar of additional MBS purchases by the Federal Reserve, high-MBS securitizer banks reduced C&I lending by 1.20 cents. Comparing this estimate from column 5 with estimates obtained from column 3 in Table II (the corresponding specification), we find that for each dollar of additional mortgage lending due to QE MBS purchases, C&I lending by securitizer banks went down by 27 cents. Column 6 shows that controlling for bank exposure to Treasury purchases does not change the results obtained in column 5.

While the impact of asset purchases on C&I lending is not the main focus of Rodnyanski and Darmouni

[12]Table C.2 in Appendix C.1 finds similar results using a narrower definition of securities most likely affected by Treasury purchases.

(2016), they find some evidence that C&I lending remained flat or grew during QE1 and QE3. Our results differ because, as discussed before, the authors use the timing of QEs as the source of exogenous variation. Therefore, *any* policy or aggregate variation that coincides with the timing of QEs is utilized as part of the source of variation in their analysis.[13] Further, because Rodnyanski and Darmouni (2016) use three QE time-period indicators as their treatment, they cannot differentiate between the impacts of Treasury and MBS purchases during QE1 and QE3.

II.C Unintended Real Effects on Firm Investment

The third question that we address is whether there are unintended real effects of QE on firm investment. Our approach evaluates the impact of monetary policy on the real economy. To do so, we trace the impact of asset purchases by the Federal Reserve through banks' balance sheets onto firms that have financing relationships with those banks. Thus, the aggregate impact of asset purchases is identified using micro-data at the firm-level.

An identification challenge is that there is an inherent endogeneity in the choice of lending relationships between firms and banks. It is possible that firms with different capital demands pair with banks which have different exposures to these asset purchases. We address this possibility in three ways: in all specifications, we include firm-bank pair fixed effects, which remove any time-invariant differences across lending relationships (α_{ij}). Second, it is possible that firm-demand for capital and investment changes over time in a manner that is correlated with the lending bank's holdings. For example, local economic conditions may drive firm investment decisions and bank MBS holdings decisions. Hence, in addition to standard firm-level controls, in all specifications we include firm's state by year-quarter fixed effects (γ_{s_it}). These fixed effects remove any common economic shocks to all firms headquartered in a given state, regardless of their lending bank's location. Third, to address time-variant matching between banks and firms that may be correlated with MBS or securities holdings of the bank, we include interaction terms between firm characteristics and the high-MBS exposure measure, the high-MBS securitizer exposure measure, and the high-securities exposure measure.

[13] Examples include the Housing and Economic Recovery Act of 2008 which was introduced in the same time period as QE1 and sought to insure $300 billion in new mortgages. Duchin and Sosyura (2012) and Berger and Roman (2015) investigated the $205 billion TARP investment in banks, which happened mostly between November 2008 and December 2009, at the same time as QE1. Many of the banks that received TARP support were in distress due to real estate market exposure.

Focusing on the bank lending channel, we consider the investment of firm i in quarter t which borrows from bank j:

$$\text{Investment}_{ijt} = \beta_1 \text{Asset Purch}_{t-1} + \beta_2 \text{Bank Exposure}_{jt-1} + \beta_3 \text{Bank Exposure}_{jt-1} \times \text{Asset Purch}_{t-1} + \beta_4 \text{Firm Vars}_{it-1} + \beta_5 \text{Bank Vars}_{jt-1} + \alpha_{ij} + \gamma_{s_it} + \varepsilon_{ijt}. \quad (2)$$

As before, the coefficients of interest are the interaction variables that capture the heterogeneous impact of Treasury and MBS purchases depending on the exposure of the lending bank to these purchases. The firm's state by year-quarter fixed effects absorb the coefficients for *MBS Purchases* and *Treasury Purchases*. We continue to use the exposure measures based on dividing banks into terciles based on MBS and non-MBS securities holdings. We also consider the group of high-MBS banks that report securitization income. These banks, based on our mechanism, should be the most affected by QE.[14]

All specifications include the following firm-level characteristics: contemporaneous firm cash flow, Tobin's Q as measured by the lagged market-to-book value, the financial health of the firm as measured by the Altman Z-Score, and firm size. The same bank-level controls as in Sections II.A and II.B are included as well. Table IV reports results for investment regressions for firms that have an active lending relationship with at least one bank in a given year-quarter. The unit of observation in this panel is, therefore, a firm-bank-year-quarter observation.

Noting the coefficient of the interaction term in column 1, we find that firms that borrowed from banks with higher MBS holdings decreased investment following higher MBS purchases from the Federal Reserve. 1% additional MBS purchases leads to a reduction of 0.052 bps of investment as a fraction of PP&E for firms that borrow from the high-MBS banks. The coefficient of the interaction term *High Securities Holdings* $\times$ *TSY Purchases* in column 2 is statistically insignificant. This suggests that the impact of asset purchases on firm investment through the bank lending channel is asymmetric for Treasury and MBS purchases: while MBS purchases have a negative effect, Treasury purchases do not. Column 3 combines the two types of asset purchases and finds similar results. As in previous sections, column 4 calculates the residual MBS holdings and residual non-MBS securities holdings after controlling for other bank characteristics. The coefficient

[14] We present similar specifications that instead use continuous versions of the MBS and securities holdings variables over the full sample in Appendix C.2.

of the interaction term for banks in the highest orthogonalized MBS holdings tercile and MBS purchases is statistically and economically similar to the coefficients in columns 1 and 3.[15] In investment regressions, measurement error of investment opportunities is an important concern (Erickson and Whited, 2000, 2012). We utilize the cumulant estimator from Erickson, Jiang, and Whited (2014) in our column 5 to address the errors-in-variables issue for market-to-book as a proxy for investment opportunities.[16] The impact of MBS purchases as part of QE on firm investment remains similar under this approach.

Columns 6 and 7 test our mechanism further by focusing on banks that are securitizers and are in the highest tercile of MBS holdings. In both columns we find that firms which borrow from high-MBS securitizer banks invest less in response to MBS asset purchases. Using the estimates from column 6, in Appendix B we calculate that for an additional dollar of MBS purchases by the Federal Reserve, firms borrowing from high-MBS securitizer banks reduce their investment by 0.267 cents. Scaling the reduction in investment by the additional mortgage lending stimulated through MBS purchases by the Federal Reserve (4.43 cents as discussed in Section II.A), we find that firms reduce their investment by 6 cents for each dollar increase in mortgage lending by securitizing banks.

These results show the unintended real effects of MBS purchases during QE: there is a negative effect of MBS purchases on firm investment through the bank lending channel. We do not find statistically significant evidence that Treasury purchases affect firm investment through its lending bank, suggesting that Treasury purchases and MBS purchases are dissimilar instruments for transmitting economic stimulus.[17]

II.D Additional Evidence of the Effect of Asset Purchases on Commercial Lending

To address the concern that firm-level demand for capital, rather than changes in credit supply, was the reason for the decline in C&I lending in response to MBS purchases, this section conducts two additional tests. The identification strategy in the tests is to compare the loan amounts or loan growth from multiple

[15] The coefficient for *High MBS Holdings* in column 4 is absorbed by the firm-bank fixed effects, as none of the orthogonalized MBS tercile banks switch between the top and bottom tercile in this sample.

[16] Specifically, we use a third-order cumulant estimator to treat the measurement error in the market-to-book variables.

[17] An alternative approach to conduct the analysis in this section is to aggregate the characteristics of all banks lending to a firm in a given quarter into those of one "average" bank. Our results are generally robust in this case as well. We prefer our framework because we can explicitly control for differences in specific lending relationships with firm-bank fixed effects. For example, the nature of a bank's relationship with an established multinational firm may be very different from its relationship with a young smaller firm (see Petersen and Rajan, 1994; Karolyi, 2017, for example, regarding the importance of lending relationships). Our identification is then obtained within a firm-bank relationship: specifically, how the treatment of monetary stimulus affects a firm through a specific bank over the course of their relationship.

banks to the same firm. While this approach reduces the sample size to a set of firms that borrow frequently from multiple banks, it allows us to most exhaustively control for any firm demand factors.

II.D.1 Loan Amount Evidence

We first investigate the loan amounts obtained by firms following asset purchases. As mentioned above, we do so by focusing on the subset of firms that obtain loans from different lenders at the same point in time. We use firm by year-quarter fixed effects (θ_{it}) to remove any variation specific to a given firm in a given quarter. Any remaining differences in loan sizes, therefore, will not be driven by differences in firm demand for capital.

We estimate the impact of the asset purchases on the loan amount in year-quarter t for firm i that borrows from bank j as follows:

$$\begin{aligned}\text{Loan Amount}_{ijt} = {} & \beta_1 \text{Asset Purch}_{t-1} + \beta_2 \text{Bank Exposure}_{jt-1} + \beta_3 \text{Bank Exposure}_{jt-1} \times \text{Asset Purch}_{t-1} \\ & + \beta_4 \text{Bank Vars}_{jt-1} + \beta_5 \text{Loan Controls}_{ijt} + \alpha_j + \theta_{it} + \varepsilon_{ijt}. \end{aligned} \tag{3}$$

The coefficients of interest are, as before, β_3. Table V reports the results. Columns 1–4 use the exposure variable based on MBS holdings and columns 5 and 6 use the exposure variable based on high-MBS securitizers. All columns which include Treasury purchases use the exposure measure based on non-MBS securities holdings.[18] Columns 5 and 6 focus on the high-MBS securitizer banks. In addition to controls that have been discussed in prior sections, the specifications also include the following loan-level controls: indicators for whether the facility is for takeover purposes, whether it is a revolving credit line, or whether it is a term loan.

Column 1 provides the estimate of the impact of MBS purchases by the Federal Reserve on the credit supply of banks with higher MBS holdings. An increase in MBS purchases in the prior quarter leads to lower loan amounts for firms when the bank is in the top tercile of MBS holdings. Column 2 does not find statistically significant effects for Treasury purchases. Column 3, which includes both types of asset purchases, shows that the negative effect of MBS purchases on loan amounts from banks with higher MBS

[18] Because none of the banks in this subsample switch between the high and low classifications for our different exposure measures, the standalone coefficients (β_2) are absorbed by the bank fixed effects α_j.

holdings is present as in column 1. In contrast, loan amounts increase due to Treasury purchases. As before, in column 4 we calculate the MBS and securities holdings for each bank orthogonalized to the bank's characteristics. This alternative method of classifying banks with high MBS or securities holdings leads to larger effects for MBS and Treasury purchases. Columns 5 and 6 investigate high-MBS securitizer banks and find that MBS purchases led to a negative effect in this case as well. Column 6 finds that Treasury purchases have a positive effect in the case of banks with high securities holdings. These results support the observation that MBS and Treasury purchases have different effects.

Overall, we find that when controlling for firm demand factors by comparing loans given to the same firm in the same year-quarter, banks which have higher exposure to MBS purchases (whether measured by high MBS holdings or active securitization) respond by reducing the amount of capital to borrowing firms.

II.D.2 Loan Growth Evidence

The prior section compared loan amounts from different banks to the same firm in the same period to most exhaustively control for firm-specific demand effects. A complementary approach is to track changes in the individual syndicate loan shares of specific banks to a given firm before and after asset purchases. As in Section II.D.1, while the sample of firms that borrow from multiple banks over a short period of time is small, this approach allows us to most robustly address firm demand concerns.

Following Khwaja and Mian (2008) and Lin and Paravisini (2012), among others, this section investigates the firm-bank pair loan growth after controlling for firm characteristics and aggregate economic conditions. Using loan-level data from DealScan, we first create a measure for the total supply of credit by each bank to each firm in Compustat, similar to a credit registry. This panel documents the credit supply of banks active in the commercial lending market to the firms in our sample. We then calculate firm-bank pair level loan growth. Specifically, when a new loan is initiated, we compare that amount (including any additional loans in the subsequent three quarters) to the amount borrowed in the prior year.[19] Aggregating loan data over multiple periods is helpful as new loans are not initiated every period between each bank and firm. The regression specification that estimates the impact of the asset purchases on commercial lending in

[19]Here we consider other syndicate banks in addition to the lead agent. The loan allotment is determined by dividing the loan amount by the number of syndicate members.

year t for firm i which borrows from bank j is:

$$\text{Loan Growth}_{ijt} = \beta_1 \text{Asset Purch}_{t-1} + \beta_2 \text{Bank Exposure}_{jt-1} + \beta_3 \text{Bank Exposure}_{jt-1} \times \text{Asset Purch}_{t-1} + \beta_4 \text{Bank Vars}_{jt-1} + \alpha_j + \theta_{it} + \varepsilon_{ijt}. \quad (4)$$

We include bank fixed effects (α_j) in all specifications. We also include firm-year fixed effects (θ_{it}) to control for any firm demand explanations. Identification in this case is obtained over the cross-section of banks lending to the same firm in the same period of time.

Table VI reports the results. Column 1 shows that syndicate banks that are in the top tercile of MBS holdings have lower loan growth for individual firms in response to additional MBS purchases, suggesting that a reduction in firm demand cannot explain our results. Column 2 considers the impact of Treasury purchases and finds a statistically insignificant effect. Column 3 includes the interaction terms for the exposure of banks to both types of asset purchases. The point estimate of the interaction of MBS purchases with bank exposure (β_3) remains similar to that in column 1. The effect of Treasury purchases on exposed banks remains insignificant.

As in prior sections, we refine the MBS and securities holdings measures by orthogonalizing these holdings to other bank characteristics and ranking them based on the refined measures (Column 4). We find a negative effect that is significant at the 10% level. Columns 5 and 6 focus on high-MBS securitizers. Column 5 shows that, similar to banks with high MBS holdings, higher MBS purchases by the Federal Reserve lead to less firm-level loan growth for securitizing banks. Column 6 includes Treasury purchases and reports effects that are similar in magnitude to those in column 5.

III Constraints at the Bank and Firm Level

The presence of constraints for firms and banks is an important component of the bank lending channel (Holmstrom and Tirole, 1997). Section III.A considers how asset purchases affect commercial lending growth depending on bank-level constraints. Section III.B compares more and less constrained firms and how their investment responds to asset purchases. Section III.C provides further evidence that the reduction in lending to firms is due to banks cutting lending and not due to firms demanding less credit.

III.A Commercial Lending and Bank Constraints

This paper argues that the negative C&I growth result is driven by the mortgage origination channel related to QE. Our argument requires us to show that the mortgage originating banks are responding to MBS purchases by increasing mortgage lending activity. The results from Section II.A provide evidence of this.

In addition, it is also necessary that the banks were sufficiently constrained that they needed to substitute away from other types of lending, and C&I lending in particular.[20] To test this, in Table VII, we split banks into more constrained and less constrained subsamples based on deposit financing (Ivashina and Scharfstein, 2010). Specifically, if the bank is above the median bank in terms of demand deposits as a fraction of assets, we classify it as less constrained. Banks below the median bank in terms of access to demand deposit financing are considered more constrained.

The coefficient of the interaction term *High MBS Holdings*×*MBS Purchases* in column 1 shows that when the Federal Reserve purchases MBS assets, banks with less access to demand deposit financing and high MBS holdings have statistically-significant lower C&I loan growth. Thus, constrained banks are reducing credit supply to firms in response to MBS purchases. Column 2 reports that less constrained banks with high MBS holdings do not significantly reduce their loan growth in respose to MBS purchases. The difference between the coefficients of the interaction terms in columns 1 and 2 is statistically significant at the 10% level. Column 3 shows that banks that are high-MBS securitizers but have less access to demand deposit financing respond approximately five times more strongly to MBS purchases by reducing C&I loan growth (comparing the interaction coefficients of columns 1 and 3). The less constrained securitizers also have a negative point estimate in column 4, but the larger standard error leads to no statistical significance. The difference between more constrained and less constrained securitizers is also not statistically significant. This may suggest that even the securitizer banks with more demand deposits were sufficiently affected by the origination channel that the reduction in C&I lending was not confined to the more constrained securitizer banks.

Part of the reason for this reduction is that engaging in additional mortgage lending ties up what capital these more constrained banks have available. Even for banks which are originating mortgages with the sole purpose to quickly distribute them as MBS, Demyanyk and Loutskina (2016) estimate that for more active

[20] Bernanke (1983), Khwaja and Mian (2008), Paravisini (2008), and Schnabl (2012) provide empirical evidence on financial constraints faced by banks and their effect on lending.

banks, the temporary mortgage holdings would lead to 1% higher capital requirements. At the same time, Ivashina and Scharfstein (2010) and Cornett, McNutt, Strahan, and Tehranian (2011) find that banks with less demand deposit financing are most likely to be constrained as alternative financing options became more scarce. For banks that cannot access additional financing, it is understandable that they would cut back on other types of lending that carry larger capital requirements. As C&I loans generally carry a 100% risk weight, reducing new C&I lending is an effective way to offset the capital costs from new mortgage activity.

Considering the evidence above, along with the evidence presented in Sections II.A and II.B, the origination channel drives up mortgage lending at the expense of C&I lending. The unintended negative consequence is most significant for the most constrained banks that are active in the mortgage market. Even for the less constrained banks, the net effect of the capital gains channel and the origination channel does not create a positive stimulus to commercial lending,

III.B Constrained Firms and Asset Purchases

The analysis so far has focused mainly on the heterogeneity among banks. However, for the reduction in firm investment to be driven by banks reducing commercial lending, the firms must face some capital constraints. Otherwise, these firms would simply move to another source of capital, such as another bank or public debt markets. Typically, sufficient frictions exist that firms are not able to fully substitute for lost capital (see, e.g., Faulkender and Petersen, 2006; Sufi, 2009; Leary, 2009; Chava and Purnanandam, 2011).

Table VIII divides firms by their likelihood of facing financing constraints based on size (Hadlock and Pierce, 2010).[21] In columns 1 and 2, we split the firms based on firm size and interact the amount of MBS and Treasury purchases with the lending bank's exposure to the respective asset purchases. Column 1 reports the results for the smallest tercile of firms and column 2 reports the results for the largest tercile of firms. We find negative investment effects for smaller firms that borrow from banks with higher MBS holdings following MBS purchases. The effect on larger firms is not statistically significant. This is consistent with small firms—which are likely to be more constrained—being less able to replace lost capital from exposed banks and reducing investment as a result.

Columns 3 and 4 focus on the sample of firms that have a relationship with a high-MBS securitizer

[21] There is no estimated coefficient for *High MBS Holdings* in columns 2 and 4 because none of these banks move between the highest and lowest MBS terciles in this sample. The variable is absorbed by the firm-bank fixed effect.

bank. Again, we note that when the Federal Reserve purchases MBS, firms in the bottom tercile by size that borrow from securitizing banks face large real effects in terms of reduced investment (column 3). Column 4 shows that firms in the top tercile by size which borrow from securitizer banks also face a negative real effect, although the negative effect is not as strong as in column 3. The difference in the effect between the two samples is significant at the 10% level. Given that securiziting banks are most exposed to the origination channel, they reduce commercial lending more, and even large firms are unable to completely substitute to other sources of financing.

The impact of Treasury purchases is negligible in both categories when we split the sample by firm-level constraints. This result suggests that Treasury purchases do not positively affect firm investment decisions and is in line with our investment results in Section II.C.

III.C Profitability of Commercial Lending and Asset Purchases

Section II.B provides evidence that commercial lending growth is reduced in response to MBS purchases. Section II.D addresses the concern that our results are driven by a reduction in firm demand for credit. Another approach to address this concern is to consider the profitability of commercial lending in response to MBS purchases. If MBS purchases crowd out commercial lending, then banks should ration the credit supply of the less profitable commercial loans (see, e.g., Stiglitz and Weiss, 1981). In contrast, if firms demand less credit and the reduction in commercial lending is driven by lower firm demand, then the profitability of commercial lending should not increase in response to MBS purchases.

Table IX reports the results. The dependent variable is the change in quarterly C&I profitability of a bank, in percentage points. The rest of the specification follows the specification used in Section II.B. The coefficient of the interaction term in column 1 suggests that banks which are in the top tercile of MBS holdings experience a higher increase in the profitability of commercial lending in response to MBS purchases than banks in the bottom tercile. Column 2 focuses on Treasury purchases. In this case, we find asymmetric results: the C&I profitability of banks with high securities holdings declines with Treasury purchases by the Federal Reserve. This result is consistent with the evidence in Section II.B that also suggests that higher Treasury purchases allow exposed banks to expand their credit supply. Column 3 includes both MBS and Treasury purchases and finds similar results to those in columns 1 and 2. Column 4 utilizes the residual MBS

and securities holdings that cannot be explained by other bank characteristics and uses these orthogonalized holdings as measures of the bank's exposure to asset purchases. Results remain similar to those reported for column 3.

Since high-MBS securitizer banks are the biggest beneficiaries of the origination channel and reduce their commercial credit supply the most, we should expect them to experience stronger profitability gains. Column 5 suggests this is the case: comparing the coefficients of column 5 with those of column 1, we note that securitizing banks experience an approximately four times larger increase in C&I profitability for the same amount of MBS purchases. Column 6 includes Treasury purchases and finds similar results.

Taken together, we find banks that are more exposed to MBS purchases increase mortgage originations, decrease commercial lending, and the profitability of the remaining commercial lending increases as a result. This evidence, combined with the loan-relationship level evidence in Section II.D and constraint-based subsamples in Sections III.A and III.B, are consistent with MBS purchases crowding out commercial lending and investment through the bank lending channel.

IV Additional Effects of Monetary Stimulus

This section explores whether the impact of asset purchases differed over the QE period and across different states. Section IV.A looks at how commercial lending is affected by asset purchases in the early and later parts of the QE period. Section IV.B reports the change in the state-level market share of banks in response to MBS purchases as an alternative measure of mortgage lending. Section IV.C investigates how mortgage rates offered by banks changed in response to MBS purchases during QE.

IV.A Commercial Lending in Different QE Periods

In Section II.B, we show that banks particularly exposed to the Federal Reserve's MBS purchases reduce their commercial loan growth. In Section III.A, we further find that the effects are strongest for those banks which are the most constrained. A related question is whether the effects varied over the QE period. Specifically, the banking sector as a whole was most constrained during the financial crisis and the period through QE1. While QE2 and QE3 were implemented to further improve economic conditions, the banking sector was no longer in as dire straits.

In Table X, we split our main interaction variables into two parts: the effect of MBS and Treasury purchases through QE1 and the effect of MBS and Treasury purchases post-QE1. Column 1 presents the MBS and securities holdings terciles and column 2 presents the orthogonalized versions. We find that for banks with high MBS holdings, the effect of MBS purchases is concentrated in the period through QE1. This is consistent with banks being, on average, more constrained during that period and therefore more likely to cut commercial lending when increasing mortgage lending to alleviate capital charges. At the same time, the strongest effects for Treasury purchases on commercial lending appear after QE1. Although banks are benefiting from the capital gains channel across both periods, the banks did not actively convert those gains into more commercial lending through QE1. This may be because from a capital requirements standpoint, Treasuries and other government agency debts carry a 0% risk weight. If banks were already constrained, selling these types of securities and increasing their commercial lending (which carries a 100% risk weight) would be particularly costly.

Column 3 of Table X looks at the effect of MBS purchases on high-MBS securitizer banks depending on the time period. In this case, both the period through QE1 and after QE1 show strong negative effects. The origination channel of QE is sufficiently strong for these particular banks such that, throughout the QE period, they see mortgage origination and MBS production as the focus of their additional lending activity at the continued expense of new commercial lending.

IV.B Mortgage Lending Market Share

As an alternative measure for mortgage activity, we consider how the market share of banks changes in response to MBS purchases.[22] We investigate the change in mortgage origination market share of banks at a state level. This allows us to more finely control for differences in local economic conditions and confirm that our mortgage loan growth results are not driven by a particular region.

Before reporting the regression analysis, Figure 2 shows the average market share at the state level for securitizer banks in years not following MBS purchases and years immediately following MBS purchases. For the securitizer banks, which are likely to be the most active in secondary mortgage markets, we see significant increases in their average state-level market share following government MBS purchases. This

[22] Recent papers that utilize market share in analysis include Scharfstein and Sunderam (2016), Bord, Ivashina, and Taliaferro (2017), and Cortés and Strahan (2017).

effect is consistent across the majority of states.[23]

The specification for bank j active in state s in year t is as follows:

$$\begin{aligned}\text{Mort Orig Mkt Share}_{jst} = \alpha_j + \gamma_{st} + \beta_1 \text{MBS Purch}_{t-1} + \beta_2 \text{Bank Exposure}_{jt-1} \\ + \beta_3 \text{Bank Exposure}_{jt-1} \times \text{MBS Purch}_{t-1} + \beta_4 \text{Bank Vars}_{jt-1} + \varepsilon_{jst}. \quad (5)\end{aligned}$$

To control for local economic factors unrelated to MBS purchases, we include state by year fixed effects (γ_{st}) for each state where the bank has some market share. We also include bank fixed effects (α_j) to ensure that bank-specific time-invariant characteristics are not driving the changes in market share.

Table XI reports the results. Column 1 shows that an increase in MBS purchases in the final quarter of the prior year leads to a gain in terms of MBS origination market share for a bank with high MBS holdings. As in previous sections, we refine the terciles of banks by MBS holdings using the orthogonalized MBS holdings and conduct a similar analysis. Column 2 reports the results. The coefficient point estimate drops but the result remains statistically and economically significant: banks with higher MBS holdings lend more in response to asset purchases. Column 3 focuses on the gain in market share of high-MBS securitizer banks following MBS asset purchases. Comparing with column 1, we find that the effect is approximately seven times stronger in this case. Across all our specifications, we find that in response to MBS purchases, benefiting banks increased their share of mortgage lending.

IV.C Rates for New Mortgages

Supporting housing and mortgage markets was a stated objective of QE. Section II.A shows that MBS purchases led to more mortgage lending by the banks most exposed to these purchases. We now investigate if banks with higher MBS exposure offered lower rates to consumers.[24]

As discussed in Section I.C, HMDA only includes rate data if the mortgage APR is higher than the benchmark rate by a certain amount.[25] For the subsample of loans with rate data, we consider if banks that

[23] Figure C.1 in the Appendix repeats the analysis for the non-securitizer banks. In this case, there is no significant difference in average state-level market share in response to MBS purchases.

[24] Related, Scharfstein and Sunderam (2016) investigate how the market power of banks affects the transmission of monetary policy.

[25] Through 2008 banks were only required by HMDA to report those mortgage rates that exceeded the current maturity-matched Treasury rate by 3 percentage points or more. Starting in 2009, banks are now required to report mortgage rates which exceed

were in a better position to take advantage of the MBS purchases offered different mortgage rates than their peers.

Columns 1–3 of Table XII focus on the dollar-weighted average interest rate spread charged by banks Column 1 reports that banks with higher MBS holdings offered a lower rate in response to MBS purchases. Column 2 re-conducts the analysis using the MBS holdings for each bank orthogonalized with respect to other bank characteristics and finds similar results. Column 3 finds that high-MBS securitizing banks also lowered their average interest rate spread following MBS purchases. On average, MBS purchases led to lower interest rates for individuals which borrowed from the more exposed banks.

V Conclusion

Much research focuses on the negative effects of large downturns in the economy and the benefits of monetary policy support. In this paper, we consider the impact of quantitative easing on bank lending and firm investment.

We find that banks that benefit from MBS asset purchases increase mortgage lending. However, an important unintended consequence is that these banks reduce commercial lending. The reduced lending has real effects. Firms which borrow from these banks decrease investment as a result. Treasury purchases do not lead to the same response. A separate finding is that the positive impact of Treasury purchases during quantitative easing through the bank lending channel on private investment seems to be small.

Policymakers have argued for the need to support important asset markets in order to increase consumer wealth, consumer demand, and real economic activity. When considering intervention in certain asset markets, such as the housing and Treasury markets, it is important to consider the potential asymmetric effects on banks and firms.

the prime rate by 1.5 percentage points or more. Since we include state by year fixed effects and identify our effects based on cross-sectional differences among banks, we include both periods in the analysis.

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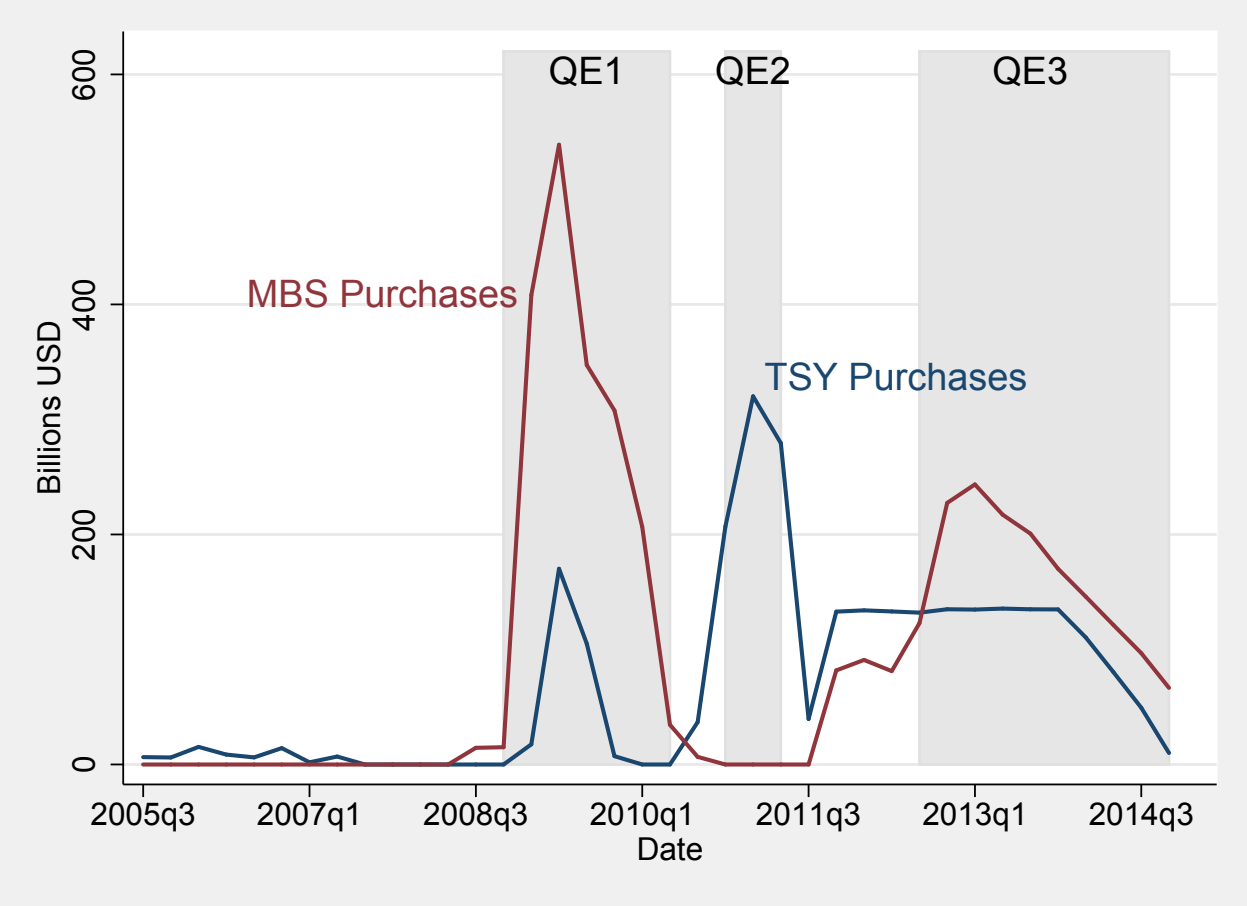

Figure 1: Quarterly totals of Treasury (TSY) and mortgage-backed security (MBS) purchases by the Federal Reserve. The MBS purchases include direct GSE/GOE obligations purchased in 2008. Source: New York Federal Reserve.

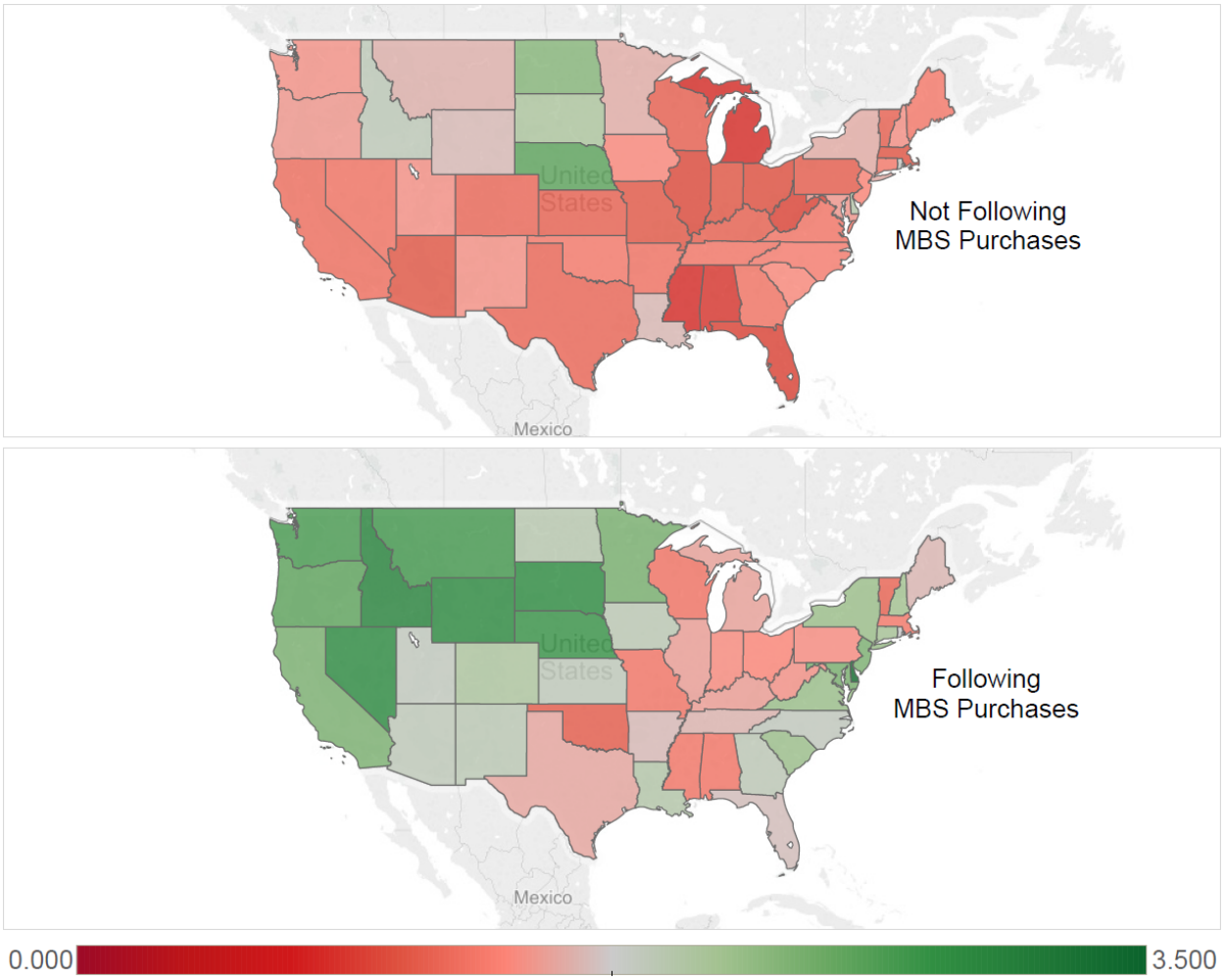

Figure 2: Average state-level mortgage origination market share for securitizer banks, in percentage points. Top panel includes years not following fourth-quarter MBS purchases (2006, 2007, 2008, 2009, 2012). Bottom panel includes years following fourth-quarter MBS purchases (2010, 2011, 2013).

Table I: Summary Statistics

This table presents the summary statistics of the merged sample of bank holding companies and borrowing firms as obtained from Call Report, HMDA, Dealscan, and Compustat databases. Our sample period runs from 2005q4 through 2013q4. All variables are at a quarterly frequency, with the exception of the mortgage origination, market share, and interest rate variables, which are at an annual frequency. The variable definitions are provided in Table A.1.

Panel A: Bank Variable and Asset Purchase Statistics						
	Mean	Std Dev	25th Pctile	Median	75th Pctile	# Obs.
Bank Variables						
MBS Holdings	7.02	8.33	0.21	4.03	10.8	160,518
Securities Holdings	14.5	11.5	5.77	11.9	20.5	160,518
US Gov. Securities Holdings	8.27	8.95	1.71	5.50	11.7	160,518
C&I Loan Growth (%)	1.44	13.4	-4.89	0.28	6.25	160,518
Change in C&I Loan Profitability (%)	-0.65	27.0	-11.4	-0.49	10.3	160,518
Bank's Size	12.2	1.36	11.3	12.0	12.9	160,518
Bank's Equity Ratio	10.3	2.74	8.59	9.82	11.5	160,518
Bank's Net Income	0.49	0.68	0.21	0.48	0.86	160,518
Bank's Cost of Deposits	1.07	0.82	0.43	0.82	1.54	160,518
Bank's Demand Deposits	12.0	7.01	6.89	11.0	15.6	160,518
Securitizer	0.0079	0.089	0	0	0	160,518
Change in Unemp. Rate, Bank's State(s)	0.046	0.48	-0.20	0	0.20	160,518
Mortgage Origination Growth (%)	23.4	80.8	-23.2	3.21	43.0	21,909
State-Level Mortgage Orig. Market Share (bps)	26.2	123.1	0.16	0.99	6.47	69,408
Average Rate, State Level (bps)	352.0	127.0	245.5	350.6	428.4	34,358
Asset Purchase Variables						
TSY Purchases (Bil. USD)	70.3	88.0	1.88	15.3	134.0	33
MBS Purchases (Bil. USD)	95.3	142.8	0	6.65	200.8	33

Table I—*Continued*

Panel B: Relationship, Loan, and Firm Variable Statistics						
	Mean	Std Dev	25th Pctile	Median	75th Pctile	# Obs.
Relationships Characteristics						
Bank Holding Companies per Borrower	1.59	0.91	1	1	2	4,363
Duration of Relationship (years)	6.84	4.27	4.75	5	8.50	6,920
Number of Loan Facilities	2.84	2.67	1	2	3	8,675
Loan Characteristics						
Loan Amount (% of lagged assets)	18.6	19.4	5.91	12.2	25.3	6,814
All In Drawn Spread (bps)	193.3	137.7	100	175	250	6,814
Maturity (months)	51.8	19.8	38	60	60	6,814
Takeover Loan (indicator)	0.18	0.39	0	0	0	6,814
Revolving Credit Line (indicator)	0.70	0.46	0	1	1	6,814
Term Loan (indicator)	0.26	0.44	0	0	1	6,814
Firm Loan Growth (%)	5.17	24.4	-6.80	4.31	19.0	3,539
Firm Variables						
Investment (% of lagged PP&E)	5.74	5.34	2.59	4.33	7.13	66,887
Cash Flow	0.12	0.32	0.032	0.084	0.19	66,887
Lagged Market-to-Book	1.66	0.89	1.12	1.41	1.89	66,887
Lagged Z-Score	0.59	1.41	0.26	0.75	1.21	66,887
Lagged Firm Size	7.42	1.73	6.27	7.40	8.56	66,887

Table II: Mortgage Origination Growth

Columns 1 through 3 are panel fixed effect regressions. *Mortgage Origination Growth* is the annual mortgage origination growth rate for each bank, scaled by 100. *High MBS Holdings* takes a value of 1 if the lending bank is in the top tercile by MBS securities to total assets, and a value of 0 if in the bottom tercile. *MBS Purchases* is the quarterly log-dollar amount of gross Federal Reserve MBS purchases from the fourth quarter of the prior year. *Securitizer* takes a value of 1 if a high-MBS bank reported non-zero securitization income and 0 otherwise. *Orthog. MBS Holdings* refers to whether the MBS terciles have been orthogonalized to other bank characteristics. Standard errors are clustered by bank.

	Mortgage Origination Growth		
	(1)	(2)	(3)
High MBS Holdings	-1.602	0.0152	
	(4.484)	(5.158)	
High MBS Holdings × MBS Purchases	0.914***	0.728***	
	(0.248)	(0.266)	
Securitizer			-24.40
			(18.19)
Securitizer × MBS Purchases			2.275***
			(0.802)
Bank's Size	-8.505	-8.314	-8.260
	(6.231)	(7.077)	(6.287)
Bank's Equity Ratio	2.990***	3.160***	2.991***
	(0.796)	(0.843)	(0.798)
Bank's Net Income	-0.373	-0.645	-0.239
	(1.596)	(1.795)	(1.599)
Bank's Cost of Deposits	-9.128***	-7.905**	-9.188***
	(3.241)	(3.807)	(3.250)
Change in Unemp. Rate, Bank's State(s)	-3.784***	-4.095***	-3.881***
	(1.326)	(1.376)	(1.335)
Orthog. MBS Holdings	No	Yes	No
Bank Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Observations	14253	12381	14253
Adjusted R^2	0.0692	0.0848	0.0682

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Table III: C&I Loan Growth

Columns 1 through 6 are panel fixed effect regressions. *C&I Loan Growth* is the growth rate in C&I loans between the current and prior quarter, scaled by 100. *High MBS Holdings* takes a value of 1 if the lending bank is in the top tercile by MBS securities to total assets, and a value of 0 if in the bottom tercile. *High Securities Holdings* takes a value of 1 if the lending bank is in the top tercile by all non-MBS securities to total assets, and a value of 0 if in the bottom tercile. *MBS Purchases* is the lagged quarterly log-dollar amount of gross Federal Reserve MBS purchases. *TSY Purchases* is the lagged quarterly log-dollar amount of gross Federal Reserve TSY purchases. *Securitizer* takes a value of 1 if a high-MBS bank reported non-zero securitization income and 0 otherwise. *Orthog. MBS/Sec. Holdings* refers to whether the MBS and securities terciles have been orthogonalized to other bank characteristics. Standard errors are clustered by bank.

	C&I Loan Growth					
	(1)	(2)	(3)	(4)	(5)	(6)
High MBS Holdings	0.298		0.410	0.651		
	(0.466)		(0.464)	(0.522)		
High MBS Holdings × MBS Purchases	-0.0586***		-0.0566***	-0.0691***		
	(0.0199)		(0.0199)	(0.0220)		
Securitizer					2.233	2.176
					(1.359)	(1.346)
Securitizer × MBS Purchases					-0.357***	-0.354***
					(0.101)	(0.0998)
High Securities Holdings		1.030*	1.035*	1.116*		1.023*
		(0.570)	(0.570)	(0.653)		(0.569)
High Securities Holdings × TSY Purchases		0.0933***	0.0921***	0.0977***		0.0933***
		(0.0300)	(0.0300)	(0.0323)		(0.0300)
Bank's Size	0.0491	-0.189	-0.211	-0.0497	0.0955	-0.172
	(0.317)	(0.331)	(0.332)	(0.362)	(0.315)	(0.330)
Bank's Equity Ratio	0.860***	0.844***	0.849***	0.805***	0.859***	0.847***
	(0.0624)	(0.0621)	(0.0620)	(0.0707)	(0.0626)	(0.0622)
Bank's Net Income	0.241*	0.249*	0.252*	0.304*	0.235	0.246*
	(0.144)	(0.143)	(0.143)	(0.169)	(0.144)	(0.143)
Bank's Cost of Deposits	-1.052***	-1.093***	-1.097***	-1.291***	-1.062***	-1.108***
	(0.310)	(0.310)	(0.310)	(0.352)	(0.309)	(0.309)
Change in Unemp. Rate, Bank's State(s)	-0.0219	-0.0383	-0.0362	0.0554	-0.0223	-0.0370
	(0.159)	(0.159)	(0.159)	(0.181)	(0.159)	(0.159)
Orthog. MBS/Sec. Holdings	No	No	No	Yes	No	No
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	77980	77980	77980	64408	77980	77980
Adjusted R^2	0.0519	0.0522	0.0523	0.0490	0.0519	0.0523

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Table IV: Impact of Monetary Stimulus on Firms

Columns 1 through 7 are panel fixed effect regressions. *Investment* is the firm's quarterly capital expenditures divided by lagged PPE, scaled by 100. *High MBS Holdings* takes a value of 1 if the lending bank is in the top tercile by MBS securities to total assets, and a value of 0 if in the bottom tercile. *High Securities Holdings* takes a value of 1 if the lending bank is in the top tercile by all non-MBS securities to total assets, and a value of 0 if in the bottom tercile. *Securitizer* takes a value of 1 if a high-MBS bank reported non-zero securitization income and 0 otherwise. *MBS Purchases* is the lagged quarterly log-dollar amount of gross Federal Reserve MBS purchases. *TSY Purchases* is the lagged quarterly log-dollar amount of gross Federal Reserve TSY purchases. *Additional Firm Interactions* include the firm variables (*Cash Flow, Lagged Market-to-Book, Lagged Z-Score, Lagged Firm Size*) interacted with *High MBS Holdings*, *High Securities Holdings*, or *Securitizer* variables, depending on the specification. *Orthog. MBS/Sec. Holdings* refers to whether the MBS and securities terciles have been orthogonalized to other bank characteristics. *Cumulant Estimation* treats the *Lagged Market-to-Book* variables as potentially mismeasured regressors. Standard errors are clustered by firm and bank.

	Investment						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
High MBS Holdings	-1.829		-2.177		-8.183***		
	(1.339)		(1.480)		(2.352)		
High MBS Holdings × MBS Purchases	-0.0524***		-0.0667***	-0.0477**	-0.0921***		
	(0.0131)		(0.0143)	(0.0241)	(0.0231)		
Securitizer						-1.579	-2.059
						(1.416)	(1.826)
Securitizer × MBS Purchases						-0.0455**	-0.0514**
						(0.0221)	(0.0212)
High Securities Holdings		0.0810	0.155	-0.346	-0.429		-0.128
		(0.648)	(0.629)	(0.659)	(0.704)		(0.505)
High Securities Holdings × TSY Purchases		0.00751	-0.00209	0.00966	0.00374		-0.00446
		(0.0152)	(0.0161)	(0.0200)	(0.0326)		(0.0168)
Cash Flow	0.883***	0.289	0.692***	0.574	-0.0248	0.858***	0.662**
	(0.0772)	(0.274)	(0.267)	(0.442)	(0.389)	(0.216)	(0.267)
Lagged Market-to-Book	1.293***	1.020***	1.089***	1.163***	3.996***	1.406***	1.217***
	(0.171)	(0.0986)	(0.172)	(0.131)	(0.916)	(0.157)	(0.123)
Lagged Z-Score	0.441***	0.343***	0.335***	0.655***	0.216	0.603***	0.488***
	(0.103)	(0.123)	(0.0599)	(0.138)	(0.171)	(0.0876)	(0.105)
Lagged Firm Size	0.0393	-0.544	0.0859	-0.198	1.294**	-0.00769	0.0473
	(0.275)	(0.409)	(0.301)	(0.404)	(0.571)	(0.312)	(0.352)
Bank's Size	0.257	0.0867	0.268	1.637***	0.136	0.156	0.189
	(0.205)	(0.233)	(0.181)	(0.519)	(0.557)	(0.198)	(0.184)
Bank's Equity Ratio	0.00482	0.00692	-0.00550	-0.305***	-0.00822	0.00913	0.0105
	(0.0536)	(0.0352)	(0.0448)	(0.106)	(0.0740)	(0.0462)	(0.0411)
Bank's Net Income	-0.0295	-0.0343	-0.0382	-0.0205	-0.109	-0.0412	-0.0511
	(0.128)	(0.169)	(0.131)	(0.317)	(0.151)	(0.136)	(0.141)
Bank's Cost of Deposits	-0.213	-0.173	-0.104	0.188	-0.244	-0.303	-0.244
	(0.245)	(0.259)	(0.239)	(0.838)	(0.385)	(0.251)	(0.251)
Change in Unemp. Rate, Bank's State(s)	-0.416	-0.307	-0.412	-0.696*	-0.540	-0.360	-0.357
	(0.272)	(0.279)	(0.278)	(0.400)	(0.421)	(0.256)	(0.257)
Additional Firm Interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Orthog. MBS/Sec. Holdings	No	No	No	Yes	No	No	No
Firm-Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm State by Year-Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cumulant Estimation	No	No	No	No	Yes	No	No
Observations	32743	32743	32743	14227	32743	32743	32743
Adjusted R^2	0.492	0.492	0.493	0.538	0.481	0.493	0.493

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Table V: Loan Amounts for Firms with Multiple Lenders

Columns 1 through 6 are panel fixed effect regressions. *Loan Amount* is the dollar amount of the facility divided by the lagged total assets of the firm and scaled by 100. *High MBS Holdings* takes a value of 1 if the lending bank is in the top tercile by MBS securities to total assets, and a value of 0 if in the bottom tercile. *High Securities Holdings* takes a value of 1 if the lending bank is in the top tercile by all non-MBS securities to total assets, and a value of 0 if in the bottom tercile. *MBS Purchases* is the lagged quarterly log-dollar amount of gross Federal Reserve MBS purchases. *TSY Purchases* is the lagged quarterly log-dollar amount of gross Federal Reserve TSY purchases. *Securitizer* takes a value of 1 if a high-MBS bank reported non-zero securitization income and 0 otherwise. *Loan Controls* include indicators for whether the facility is for takeover purposes, is a revolving credit line, or is a term loan. *Orthog. MBS/Sec. Holdings* refers to whether the MBS and securities terciles have been orthogonalized to other bank characteristics. Standard errors are clustered by bank.

	Loan Amount					
	(1)	(2)	(3)	(4)	(5)	(6)
High MBS Holdings × MBS Purchases	-0.0866***		-0.233***	-0.904***		
	(0.0263)		(0.0582)	(0.237)		
Securitizer × MBS Purchases					-0.190***	-0.332***
					(0.0676)	(0.0984)
High Securities Holdings × TSY Purchases		0.0544	0.257***	0.426***		0.328***
		(0.0417)	(0.0804)	(0.140)		(0.117)
Bank's Size	-1.011	-1.044	-1.353	72.64***	-2.274	-3.615**
	(1.377)	(1.323)	(1.121)	(15.90)	(1.548)	(1.530)
Bank's Equity Ratio	0.404***	0.303**	0.0478	3.270***	0.633***	0.325**
	(0.133)	(0.121)	(0.0985)	(1.040)	(0.192)	(0.134)
Bank's Net Income	1.799**	2.023***	2.200***	-1.334	1.953**	2.725***
	(0.744)	(0.648)	(0.551)	(3.207)	(0.887)	(0.733)
Bank's Cost of Deposits	-2.876	-2.637	-3.563*	-26.44***	-3.561**	-4.552***
	(1.793)	(1.771)	(1.868)	(6.918)	(1.541)	(1.550)
Change in Unemp. Rate, Bank's State(s)	3.426	5.175*	6.599**	20.38***	5.370*	11.99***
	(2.576)	(2.934)	(3.061)	(7.054)	(2.870)	(4.152)
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes
Orthog. MBS/Sec. Holdings	No	No	No	Yes	No	No
Firm by Year-Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	400	400	400	274	400	400
Adjusted R^2	0.443	0.443	0.440	0.839	0.443	0.440

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Table VI: Firm-Level Loan Growth

Columns 1 through 6 are panel fixed effect regressions. *Firm Loan Growth* is the loan growth for a specific bank lending to a specific firm, expressed as a quarterly percentage. *High MBS Holdings* takes a value of 1 if the lending bank is in the top tercile by MBS securities to total assets, and a value of 0 if in the bottom tercile. *High Securities Holdings* takes a value of 1 if the lending bank is in the top tercile by all non-MBS securities to total assets, and a value of 0 if in the bottom tercile. *Securitizer* takes a value of 1 if a high-MBS bank reported non-zero securitization income and 0 otherwise. *MBS Purchases* is the lagged quarterly log-dollar amount of gross Federal Reserve MBS purchases. *TSY Purchases* is the lagged quarterly log-dollar amount of gross Federal Reserve TSY purchases. *Orthog. MBS/Sec. Holdings* refers to whether the MBS and securities terciles have been orthogonalized to other bank characteristics. Standard errors are clustered by bank.

	Firm Loan Growth					
	(1)	(2)	(3)	(4)	(5)	(6)
High MBS Holdings				20.17***		
				(5.115)		
High MBS Holdings × MBS Purchases	-1.621***		-1.684***	-1.213*		
	(0.613)		(0.607)	(0.667)		
Securitizer					-0.328	-1.566
					(4.995)	(5.052)
Securitizer × MBS Purchases					-2.781***	-2.721***
					(0.776)	(0.776)
High Securities Holdings		29.22***	29.16***	-2.158		28.46***
		(7.092)	(5.517)	(7.550)		(7.096)
High Securities Holdings × TSY Purchases		-0.411	-0.0532	0.550		-0.507
		(0.346)	(0.268)	(0.580)		(0.363)
Bank's Size	-18.87*	-14.11	-14.20	-24.09**	-20.70*	-16.15
	(11.44)	(13.09)	(12.42)	(11.06)	(11.66)	(12.78)
Bank's Equity Ratio	-0.792	-0.930	-0.916	2.759	-1.154	-1.217*
	(0.769)	(0.709)	(0.715)	(1.906)	(0.752)	(0.692)
Bank's Net Income	0.384	-1.431	-1.002	4.430	-0.129	-1.448
	(2.802)	(2.742)	(2.620)	(5.301)	(2.848)	(2.701)
Bank's Cost of Deposits	8.492***	9.744***	9.535***	1.045	8.311***	9.299***
	(2.757)	(2.822)	(2.686)	(6.253)	(2.870)	(2.836)
Change in Unemp. Rate, Bank's State(s)	-20.55**	-26.17**	-21.58**	-13.83	-21.19**	-23.42**
	(8.562)	(10.45)	(8.722)	(11.26)	(8.811)	(9.098)
Orthog. MBS/Sec. Holdings	No	No	No	Yes	No	No
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm by Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	941	941	941	470	941	941
Adjusted R^2	0.730	0.726	0.731	0.767	0.727	0.728

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Table VII: C&I Loan Growth and Bank Constraints

Columns 1 through 4 are panel fixed effect regressions. *C&I Loan Growth* is the growth rate in C&I loans between the current and prior quarter, scaled by 100. The *More Constrained* sample are those banks that are below the median by *Bank's Demand Deposits* and the *Less Constrained* sample are those banks that are above the median. *High MBS Holdings* takes a value of 1 if the lending bank is in the top tercile by MBS securities to total assets, and a value of 0 if in the bottom tercile. *High Securities Holdings* takes a value of 1 if the lending bank is in the top tercile by all non-MBS securities to total assets, and a value of 0 if in the bottom tercile. *Securitizer* takes a value of 1 if a high-MBS bank reported non-zero securitization income and 0 otherwise. Standard errors are clustered by bank.

	C&I Loan Growth			
	Subsampled by Demand Deposits			
	(More Constrained)	(Less Constrained)	(More Constrained)	(Less Constrained)
	(1)	(2)	(3)	(4)
High MBS Holdings	-1.202	1.429**		
	(0.756)	(0.629)		
High MBS Holdings × MBS Purchases	-0.0715**	-0.00173		
	(0.0290)	(0.0296)		
Securitizer			1.957	2.283
			(1.503)	(2.193)
Securitizer × MBS Purchases			-0.368***	-0.180
			(0.110)	(0.209)
High Securities Holdings	2.637***	0.0924	2.725***	0.00101
	(0.978)	(0.754)	(0.979)	(0.752)
High Securities Holdings × TSY Purchases	0.0391	0.0978**	0.0399	0.0965**
	(0.0454)	(0.0421)	(0.0454)	(0.0422)
Bank's Size	0.0234	0.811	0.119	0.705
	(0.466)	(0.517)	(0.465)	(0.512)
Bank's Equity Ratio	0.958***	0.685***	0.976***	0.673***
	(0.0913)	(0.0874)	(0.0926)	(0.0874)
Bank's Net Income	0.229	0.190	0.219	0.202
	(0.187)	(0.214)	(0.187)	(0.215)
Bank's Cost of Deposits	-1.554***	-0.771	-1.584***	-0.771
	(0.424)	(0.495)	(0.425)	(0.495)
Change in Unemp. Rate, Bank's State(s)	-0.282	0.125	-0.283	0.120
	(0.246)	(0.216)	(0.246)	(0.216)
Bank Fixed Effects	Yes	Yes	Yes	Yes
Year-Quarter Fixed Effects	Yes	Yes	Yes	Yes
Observations	38690	38833	38690	38833
Adjusted R^2	0.0976	0.0367	0.0974	0.0365

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Table VIII: Investment and Firm Constraints

Columns 1 through 4 are panel fixed effect regressions. *Investment* is the firm's quarterly capital expenditures divided by lagged PPE, scaled by 100. Dividing firms by size, *More Constrained* firms are in the smallest tercile and *Less Constrained* firms are in the largest tercile. *High MBS Holdings* takes a value of 1 if the lending bank is in the top tercile by MBS securities to total assets, and a value of 0 if in the bottom tercile. *High Securities Holdings* takes a value of 1 if the lending bank is in the top tercile by all non-MBS securities to total assets, and a value of 0 if in the bottom tercile. *Securitizer* takes a value of 1 if a high-MBS bank reported non-zero securitization income and 0 otherwise. *Additional Firm Interactions* include the firm variables (*Cash Flow, Lagged Market-to-Book, Lagged Z-Score, Lagged Firm Size*) interacted with *High MBS Holdings*, *High Securities Holdings*, or *Securitizer* variables, depending on the specification. Standard errors are clustered by firm and bank.

	Investment			
	Subsampled by Firm Size			
	(More Constrained)	(Less Constrained)	(More Constrained)	(Less Constrained)
	(1)	(2)	(3)	(4)
High MBS Holdings	-2.808			
	(4.431)			
High MBS Holdings × MBS Purchases	-0.0902**	-0.00544		
	(0.0444)	(0.00745)		
Securitizer			-3.241	
			(5.328)	
Securitizer × MBS Purchases			-0.105**	-0.0162**
			(0.0520)	(0.00827)
High Securities Holdings	0.588	0.132	-0.408	0.0386
	(2.595)	(0.601)	(2.201)	(0.676)
High Securities Holdings × TSY Purchases	0.0110	-0.00906	0.00396	-0.0110
	(0.0413)	(0.00624)	(0.0396)	(0.00848)
Cash Flow	-0.224	1.026***	-0.0115	1.081***
	(0.457)	(0.117)	(0.279)	(0.113)
Lagged Market-to-Book	1.282***	0.651***	1.234***	0.626***
	(0.281)	(0.132)	(0.292)	(0.153)
Lagged Z-Score	0.480***	1.252***	0.593***	1.312***
	(0.149)	(0.131)	(0.135)	(0.147)
Lagged Firm Size	-1.199	0.387*	-1.066	0.238
	(0.892)	(0.229)	(1.120)	(0.317)
Bank's Size	0.631***	-0.621	0.726***	-0.655
	(0.234)	(0.505)	(0.240)	(0.474)
Bank's Equity Ratio	0.122	-0.154***	0.167*	-0.152***
	(0.101)	(0.0331)	(0.0874)	(0.0329)
Bank's Net Income	0.0663	-0.230***	0.0458	-0.208***
	(0.253)	(0.0711)	(0.232)	(0.0734)
Bank's Cost of Deposits	-0.447	-0.287	-0.555	-0.367
	(0.341)	(0.295)	(0.353)	(0.297)
Change in Unemp. Rate, Bank's State(s)	-0.675	0.521**	-0.693	0.488**
	(0.490)	(0.218)	(0.490)	(0.244)
Additional Firm Interactions	Yes	Yes	Yes	Yes
Firm-Bank Fixed Effects	Yes	Yes	Yes	Yes
Firm's State by Year-Quarter Fixed Effects	Yes	Yes	Yes	Yes
Observations	10076	10267	10076	10267
Adjusted R^2	0.466	0.640	0.467	0.640

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Table IX: Change in C&I Loan Profitability

Columns 1 through 6 are panel fixed effect regressions. *Change in C&I Loan Profitability* is the difference in the profitability of C&I loans for the current and prior quarter, scaled by 100. *High MBS Holdings* takes a value of 1 if the lending bank is in the top tercile by MBS securities to total assets, and a value of 0 if in the bottom tercile. *High Securities Holdings* takes a value of 1 if the lending bank is in the top tercile by all non-MBS securities to total assets, and a value of 0 if in the bottom tercile. *MBS Purchases* is the lagged quarterly log-dollar amount of gross Federal Reserve MBS purchases. *TSY Purchases* is the lagged quarterly log-dollar amount of gross Federal Reserve TSY purchases. *Securitizer* takes a value of 1 if a high-MBS bank reported non-zero securitization income and 0 otherwise. *Orthog. MBS/Sec. Holdings* refers to whether the MBS and securities terciles have been orthogonalized to other bank characteristics. Standard errors are clustered by bank.

	Change in C&I Loan Profitability					
	(1)	(2)	(3)	(4)	(5)	(6)
High MBS Holdings	-1.743***		-1.889***	-2.218***		
	(0.653)		(0.651)	(0.795)		
High MBS Holdings × MBS Purchases	0.0898**		0.0870**	0.0771**		
	(0.0349)		(0.0349)	(0.0385)		
Securitizer					0.279	0.358
					(1.999)	(2.001)
Securitizer × MBS Purchases					0.347**	0.342**
					(0.147)	(0.146)
High Securities Holdings		-1.179	-1.265	-1.207		-1.171
		(0.990)	(0.989)	(1.210)		(0.990)
High Securities Holdings × TSY Purchases		-0.142**	-0.142**	-0.173**		-0.143**
		(0.0641)	(0.0641)	(0.0683)		(0.0641)
Bank's Size	-1.932***	-1.543***	-1.567***	-1.902***	-1.920***	-1.557***
	(0.510)	(0.530)	(0.534)	(0.613)	(0.504)	(0.530)
Bank's Equity Ratio	-0.173*	-0.145	-0.161*	-0.304***	-0.157*	-0.145
	(0.0937)	(0.0937)	(0.0939)	(0.103)	(0.0935)	(0.0937)
Bank's Net Income	-0.633***	-0.632***	-0.639***	-0.630**	-0.625***	-0.631***
	(0.231)	(0.232)	(0.231)	(0.271)	(0.231)	(0.232)
Bank's Cost of Deposits	-1.712***	-1.622***	-1.629***	-0.801	-1.693***	-1.609***
	(0.510)	(0.511)	(0.512)	(0.580)	(0.509)	(0.511)
Change in Unemp. Rate, Bank's State(s)	0.00845	0.0347	0.0295	-0.0191	0.0109	0.0322
	(0.363)	(0.362)	(0.362)	(0.408)	(0.363)	(0.362)
Orthog. MBS/Sec. Holdings	No	No	No	Yes	No	No
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	76622	76622	76622	63288	76622	76622
Adjusted R^2	0.00403	0.00414	0.00424	0.00410	0.00395	0.00415

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Table X: C&I Loan Growth over the QE Period

Columns 1 through 3 are panel fixed effect regressions. *C&I Loan Growth* is the growth rate in C&I loans between the current and prior quarter, scaled by 100. *High MBS Holdings* takes a value of 1 if the lending bank is in the top tercile by MBS securities to total assets, and a value of 0 if in the bottom tercile. *High Securities Holdings* takes a value of 1 if the lending bank is in the top tercile by all non-MBS securities to total assets, and a value of 0 if in the bottom tercile. *MBS Purchases* is the lagged quarterly log-dollar amount of gross Federal Reserve MBS purchases. *TSY Purchases* is the lagged quarterly log-dollar amount of gross Federal Reserve TSY purchases. *Securitizer* takes a value of 1 if a high-MBS bank reported non-zero securitization income and 0 otherwise. *Orthog. MBS/Sec. Holdings* refers to whether the MBS and securities terciles have been orthogonalized to other bank characteristics. Standard errors are clustered by bank.

	C&I Loan Growth		
	(1)	(2)	(3)
High MBS Holdings	0.367	0.604	
	(0.461)	(0.520)	
High MBS Holdings × MBS Purchases, through QE1	-0.101***	-0.110***	
	(0.0238)	(0.0264)	
High MBS Holdings × MBS Purchases, post QE1	-0.0107	-0.0289	
	(0.0238)	(0.0264)	
Securitizer			1.834
			(1.346)
Securitizer × MBS Purchases, through QE1			-0.319***
			(0.113)
Securitizer × MBS Purchases, post QE1			-0.335***
			(0.0918)
High Securities Holdings	1.152**	1.213*	1.181**
	(0.572)	(0.656)	(0.570)
High Securities Holdings × TSY Purchases, through QE1	-0.0122	-0.00482	-0.00734
	(0.0387)	(0.0420)	(0.0386)
High Securities Holdings × TSY Purchases, post QE1	0.145***	0.149***	0.138***
	(0.0314)	(0.0337)	(0.0312)
Bank's Size	-0.160	0.00548	-0.149
	(0.332)	(0.361)	(0.330)
Bank's Equity Ratio	0.847***	0.806***	0.850***
	(0.0617)	(0.0705)	(0.0618)
Bank's Net Income	0.230	0.273	0.233
	(0.143)	(0.169)	(0.143)
Bank's Cost of Deposits	-1.154***	-1.347***	-1.153***
	(0.309)	(0.351)	(0.309)
Change in Unemp. Rate, Bank's State(s)	-0.0316	0.0609	-0.0520
	(0.159)	(0.181)	(0.159)
Orthog. MBS/Sec. Holdings	No	Yes	No
Bank Fixed Effects	Yes	Yes	Yes
Year-Quarter Fixed Effects	Yes	Yes	Yes
Observations	77980	64408	77980
Adjusted R^2	0.0527	0.0494	0.0526

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Table XI: Mortgage Market Share

Columns 1 through 3 are panel fixed effect regressions. *Mortgage Origination Market Share* is the state-level market share (in basis points) for a given bank in a particular state and year. *High MBS Holdings* takes a value of 1 if the lending bank is in the top tercile by MBS securities to total assets, and a value of 0 if in the bottom tercile. *MBS Purchases* is the quarterly log-dollar amount of gross Federal Reserve MBS purchases from the fourth quarter of the prior year. *Securitizer* takes a value of 1 if a high-MBS bank reported non-zero securitization income and 0 otherwise. *Orthog. MBS Holdings* refers to whether the MBS terciles have been orthogonalized to other bank characteristics. Standard errors are clustered by bank.

	Mortgage Orig Market Share		
	(1)	(2)	(3)
High MBS Holdings	-3.039	-3.683*	
	(2.162)	(1.881)	
High MBS Holdings × MBS Purchases	0.644***	0.438**	
	(0.227)	(0.177)	
Securitizer			-38.89
			(30.58)
Securitizer × MBS Purchases			4.699**
			(1.949)
Bank's Size (excl. loans)	9.640***	6.127***	8.250***
	(2.935)	(1.919)	(2.729)
Bank's Equity Ratio	0.694	0.297	0.528
	(0.528)	(0.522)	(0.497)
Bank's Net Income	0.772	1.513	1.215
	(1.126)	(1.008)	(1.028)
Bank's Cost of Deposits	-6.385**	-3.689	-5.188*
	(2.872)	(3.128)	(2.769)
Change in Unemp. Rate, Bank's State(s)	-0.702	-1.426	-0.533
	(1.173)	(1.030)	(1.110)
Orthog. MBS Holdings	No	Yes	No
Bank Fixed Effects	Yes	Yes	Yes
State by Year Fixed Effects	Yes	Yes	Yes
Observations	45415	39897	45415
Adjusted R^2	0.512	0.291	0.513

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Table XII: Mortgage Market Interest Rates

Columns 1 through 3 are panel fixed effect regressions. *Average Rate* is the dollar-weighted average rate spread (in basis points over equivalent-maturity Treasury security) for the bank in a specific state. *MBS Purchases* is the quarterly log-dollar amount of gross Federal Reserve MBS purchases from the fourth quarter of the prior year. *Securitizer* takes a value of 1 if a high-MBS bank reported non-zero securitization income and 0 otherwise. *Orthog. MBS Holdings* refers to whether the MBS terciles have been orthogonalized to other bank characteristics. Standard errors are clustered by bank.

	Average Rate		
	(1)	(2)	(3)
High MBS Holdings	23.05***	24.76**	
	(8.789)	(10.40)	
High MBS Holdings × MBS Purchases	-0.854**	-0.869**	
	(0.345)	(0.360)	
Securitizer			-10.65
			(9.529)
Securitizer × MBS Purchases			-1.624**
			(0.644)
Bank's Size	5.751	3.702	4.905
	(5.190)	(5.012)	(5.068)
Bank's Equity Ratio	-0.391	-0.169	-0.728
	(1.069)	(1.115)	(1.111)
Bank's Net Income	-2.763	-3.265*	-2.937*
	(1.694)	(1.785)	(1.718)
Bank's Cost of Deposits	13.11***	8.478*	11.49**
	(4.653)	(5.097)	(4.631)
Change in Unemp. Rate, Bank's State(s)	0.674	4.191	0.622
	(2.712)	(2.600)	(2.742)
Orthog. MBS Holdings	No	Yes	No
Bank Fixed Effects	Yes	Yes	Yes
State by Year Fixed Effects	Yes	Yes	Yes
Observations	21658	18495	21658
Adjusted R^2	0.663	0.654	0.662

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Appendix: For Review and Online Publication Only

A Loan Data and Firm-Bank Lending Relationships

We use DealScan data to establish lending relationships between firms and banks. We consider the presence of any loan between the bank and borrowing firm to be evidence of a relationship. In the case of syndicated loans with multiple lenders, following Bharath, Dahiya, Saunders, and Srinivasan (2011) and Chakraborty, Goldstein, and MacKinlay (2016), we consider the relationship bank to be the one which serves as lead agent on the loan.[26] The duration of the relationship is defined as follows: it begins in the first year-quarter that we observe a loan being originated between the firm and bank, and it ends when the last loan observed between the firm and bank matures, according to the original loan terms. Firms and banks are considered in an active relationship both in year-quarters that new loans are originated and year-quarters in which no new loan originations occur with that bank.

DealScan provides loan origination information, which gives us information on the borrower, the lender (or lenders in the case of a loan syndicate), and the terms of the loan facility, including the size, interest rate, maturity, and type of loan being originated. The median relationship last five years and involves two loans. For those observations without sufficient maturity data to determine the relationship duration, we assume the median sample relationship duration of five years.

For our bank balance sheet variables, we use Call Report data from each quarter, aggregated to the bank holding company (BHC) level, using the RSSD9348 variable. We also aggregate the HMDA mortgage data to the BHC-level in a similar manner. To address mergers between banks over our sample period, we update the current holding company for lenders over time. Similar to Chakraborty, Goldstein, and MacKinlay (2016), we use Summary of Deposits data and historical press releases about different mergers between banks to do this. We assume that the relationship between a borrower and lender continues under the new bank holding company for the duration of the loan, and any subsequent loans under that same DealScan lender.

[26] To determine the lead agent, we use the following ranking hierarchy from Chakraborty, Goldstein, and MacKinlay (2016): 1) lender is denoted as "Admin Agent", 2) lender is denoted as "Lead bank", 3) lender is denoted as "Lead arranger", 4) lender is denoted as "Mandated lead arranger", 5) lender is denoted as "Mandated arranger", 6) lender is denoted as either "Arranger" or "Agent" and has a "yes" for the lead arranger credit, 7) lender is denoted as either "Arranger" or "Agent" and has a "no" for the lead arranger credit, 8) lender has a "yes" for the lead arranger credit but has a role other than those previously listed ("Participant" and "Secondary investor" are also excluded), 9) lender has a "no" for the lead arranger credit but has a role other than those previously listed ("Participant" and "Secondary investor" are also excluded), and 10) lender is denoted as a "Participant" or "Secondary investor". For a given loan package, the lender with the highest title (following the ten-part hierarchy) is considered the lead agent.

B Back of the Envelope Calculations

This section provides a simple calculation of the impact of the Fed's MBS purchases on bank lending in terms of mortgage origination and commercial loans. To further trace out the bank lending channel, we also calculate the effect on firm investment. We also calculate the bank's relative substitution between mortgage and commercial lending, and the sensitivity of firm investment to the reduction in commercial lending. Finally, to provide some aggregate numbers, we use the Fed's balance sheet expansion of $1.75 trillion in MBS over the three QEs.

B.1 Mortgage Origination

Table I reports that the mean MBS purchases per quarter in our sample period is 95.3 billion. Data from FHFA shows that the average single-family conventional mortgage originations from 2001–2005 are approximately $2,854 billion per year.[27] We use this period to establish a baseline amount of origination activity that is not affected by the QE treatment and also avoids the strongest boom years and the financial crisis itself. We use single-family conforming loans as these can be packaged readily into agency MBS which the Federal Reserve was purchasing as part of QE.

Column 3 of Table II reports a coefficient of 2.275. Since the dependent variable, annual mortgage origination growth rate, is scaled by 100, this means for 1% additional MBS purchases, there is a 0.02275 percentage point (pp) increase in mortgage origination growth for the high-MBS securitizer banks. Using HMDA data, we estimate that high-MBS securitizers originated approximately 26% of mortgages. Hence, we calculate 0.1688 billion ($26\% \times 2,854\text{B} \times 0.02275 \times 0.01$) of additional originations for a 1% increase in MBS purchases at the mean, using our pre-QE baseline origination averages. In dollar terms, a 1% increase in annual MBS purchases at the mean is 3.812 billion ($1\% \times 95.3\text{B/quarter} \times 4$).

The last two numbers allow us to calculate a dollar for dollar number: for each $1 of additional MBS purchases, securitizing banks originate 4.43 cents ($0.1688/3.812$) of additional mortgages. For the Fed's balance sheet expansion of $1.75 trillion in MBS, we obtain an estimate of $77.5 billion of additional originations by high-MBS securitizer banks that benefited from QE.

[27] See `https://www.fhfa.gov/DataTools/Downloads/Pages/Current-Market-Data.aspx` for the file titled "Single-Family Mortgage Originations."

B.2 Commercial Loans

The average quarterly commercial lending for the banks from Call Report data is $912.89 billion. Similar to the mortgage origination calculations above, we use the period of 2001–2005 to calculate this number which avoids the strongest boom years and the financial crisis itself when banks were treated with QE.

Column 5 of Table III reports a coefficient of -0.357. The dependent variable is scaled by 100 and is quarterly. This means that 1% additional MBS purchases leads to a 0.00357 pp reduction in commercial loan growth. As our baseline aggregate quarterly commercial lending is $912.89 billion, and approximately 35% of the market share is controlled by the high-MBS securitizers, a 0.00357 pp decrease in commercial loans translates to a decrease of $0.0114 billion ($35\% \times 912.89\text{B} \times -0.00357 \times 0.01$). As the mean MBS purchases per quarter in our sample period is 95.3 billion, 1% additional quarterly MBS purchases at the mean is $953 million.

Dollar for dollar, for every $1 of additional MBS purchases, we note a reduction of 1.20 cents ($-0.0114/0.953$) in terms of commercial loans extended. We can compare the commercial lending reduction with the mortgage lending increase as well: for each dollar of additional mortgage lending, securitizing banks substitute away from commercial lending by 27 cents ($1.20/4.43$). For the Fed's total balance sheet expansion of $1.75 trillion, this translates to a reduction in commercial lending of $21 billion.

B.3 Firm Investment

The average quarterly investment by Compustat firms with banking relationships is $91.8 billion. Similar to the mortgage and commercial loans calculations above, we use the period of 2001–2005 to calculate this number.

Column 6 of Table IV reports a coefficient of -0.0455. Since the dependent variable is scaled by 100 and is quarterly, this means that 1% additional MBS purchases at the mean (953 million per quarter) leads to a 0.000455 pp reduction in firm investment as a fraction of property, plant, and equipment (PP&E). Given the mean investment rate of 5.74% of PP&E per quarter, this translates to 0.00793 pp ($0.000455/0.0574$) in terms of investment. Given the market share of securitizers is 35% for commercial lending, 0.00793 pp in reduced firm investment translates to a $0.00255 billion ($35\% \times 91.817\text{B} \times 0.00793 \times 0.01$) reduction in firm investment for a 1% increase in MBS purchases.

Dollar for dollar, for every $1 of additional MBS purchases, we calculate a reduction of 0.267 cents

$(-0.00255/0.953)$ in terms of reduced firm investment. Thus, for each dollar of commercial lending cut by high-MBS securitizer banks because of MBS purchases, firms that borrow from these banks reduce firm investment by 22 cents $(0.267/1.20)$. Scaled differently, for every dollar of additional mortgage lending stimulated through MBS purchases, firms reduce investment by 6 cents $(.267/4.43)$.

C Additional Robustness Tests

C.1 Alternative Security Exposure Variable

Table III shows that commercial lending increased when Treasuries were purchased by the Federal Reserve. To calculate the impact of Treasury purchases, we calculate the exposure of banks to non-MBS securities that include Treasury securities, other U.S. government agency or sponsored-agency securities, securities issued by states and other U.S. political subdivisions, other asset-backed securities (ABS), other debt securities, and investments in mutual funds and other equity securities. The average bank in our sample holds 14.5% of assets in these non-MBS securities. 8.5% of assets on average are held in just Treasury and other U.S. federal government securities.

To address the argument that Treasury purchases have a larger or more direct effect on government securities compared to other asset classes, we now restrict securities holdings to just Treasuries and other U.S. federal government securities. Table C.2 reports the results for this alternative measure and finds that the results remain similar to Table III.

C.2 Continuous Balance Sheet Variables

Our main results on firm-level investment (Section II.C) are based on dividing banks into terciles on the basis of the exposure of banks' balance sheets to MBS and securities holdings. While the terciles approach simplifies the interpretation of the effect between the most and least exposed banks, in this section, we employ continuous variables to measure the exposure of banks to MBS and other non-MBS securities.

Table C.3 reports how firm investment responds to asset purchases conditional on the lending banks' holdings in terms of MBS and non-MBS securities holdings. All specifications, like in Table IV, show a negative and statistically significant impact of MBS purchases on firm investment if the MBS holdings of the lending bank are higher. Also similar to Table IV, the impact of Treasury purchases on investment is insignificant.

Table A.1: Variable Definitions

This table presents the data sources and the method of construction of the variables used in our analysis.

Variable Definitions		
	Definition	Data Sources
Bank Variables		
MBS Holdings	Balance sheet mortgage-backed securities (RCFD8639) plus trading asset mortgage-backed securities (RCFD G379 + G380 + G381 + K197 + K198) divided by total assets (RCFD2170). Scaled by 100.	Call Report
Securities Holdings	Total balance sheet securities (RCFD8641) minus balance sheet MBS holdings (RCFD8639), divided by total assets (RCFD2170). Scaled by 100.	Call Report
U.S. Gov. Securities Holdings	U.S. Treasury securities (RCFD0211 + RCFD1287 + RCON3531) plus U.S. government agency obligations (RCFD1289 + RCFD1294 + RCFD1293 + RCFD1298 + RCON3532), divided by total assets (RCFD2170). Scaled by 100.	Call Report
C&I Loan Growth	Quarterly growth in total commercial and industrial loans. Total C&I loans are the sum of balance sheet C&I loans (RCFD1766) and trading asset C&I loans (RCFDF614). Scaled by 100.	Call Report
Change in C&I Loan Profitability	Quarterly change in the profitability of C&I loans. Quarterly C&I loan profitability is the interest and fee income on commercial and industrial loans (RIAD4012) divided by commercial and industrial loans (RCFD1766). Scaled by 100.	Call Report
Bank's Size	Log of total assets (RCFD2170)	Call Report
Bank's Equity Ratio	Total equity capital (RCFD3210) divided by total assets (RCFD2170). Scaled by 100.	Call Report
Bank's Net Income	Net income (RIAD4340) divided by total assets (RCFD2170). Scaled by 100.	Call Report
Bank's Cost of Deposits	Interest on deposits (RIAD4170) divided by total deposits (RCFD2200). Scaled by 100.	Call Report
Bank's Demand Deposits	Total demand deposits (RCFD2210) divided by total assets (RCFD2170). Scaled by 100.	Call Report
Securitizer	Indicator that bank reports non-zero net securitization income (RIADB493) and is in the highest tercile of *MBS Holdings*.	Call Report
Change in Unemployment Rate, Bank's State(s)	Quarterly change in unemployment rate (as a %) where bank has deposits, weighted by most recently available summary of deposits.	Summary of Deposits, FRED
Mortgage Origination Growth	Bank's mortgage origination growth rate (nationwide). Scaled by 100.	HMDA
State-Level Mortgage Origination Market Share (bps)	Bank's share of the mortgage origination market, for a given state-level market. Measured annually in basis points.	HMDA
Average Rate, State Level (bps)	Dollar-weighted average APR of originated mortgages, for a given state-level market. APR is reported as spread over equivalent-maturity Treasury.	HMDA
Asset Purchase Variables		
TSY Purchases (Bil. USD)	Amount of Treasury securities purchased by the Federal Reserve in a given quarter.	New York Fed
MBS Purchases (Bil. USD)	Amount of MBS purchased by the Federal Reserve in a given quarter	New York Fed

Table A.1—*Continued*

Variable Definitions		
	Definition	Data Sources
Loan Characteristics		
Loan Amount	Loan facility amount divided by the borrowing firm's prior quarter's book assets. Scaled by 100.	Dealscan, Compustat
All In Drawn Spread (bps)	Basis point spread over LIBOR for each dollar of loan facility drawn.	Dealscan
Maturity (months)	Loan facility maturity (in months) at origination.	Dealscan
Takeover Loan	Indicator that loan purpose is an acquisition line, LBO, MBO, or takeover.	Dealscan
Revolving Credit Line	Indicator that loan facility is a revolving credit line.	Dealscan
Term Loan	Indicator that loan facility is a term loan.	Dealscan
Firm Loan Growth	Log difference in a bank's loan share to a given firm. Loan share is the sum of the total amount of lending between a firm and a bank in a year. Scaled as a quarterly percentage.	Dealscan
Firm Variables		
Investment	Quarterly capital expenditures divided by prior quarter's net PPE. Scaled by 100.	Compustat
Cash Flow	Quarterly income before extraordinary items plus depreciation and amortization divided by prior quarter's net PPE.	Compustat
Lagged Market-to-Book	Book assets plus closing stock price times shares outstanding minus common equity, all divided by book assets, all from prior quarter.	Compustat
Lagged Z-Score	Sum of 3.3 times pre-tax income, sales, 1.4 times retained earnings, 1.2 times the difference between current assets and current liabilities, all divided by book assets. All variables from prior quarter.	Compustat
Lagged Firm Size	Log of book assets from prior quarter.	Compustat

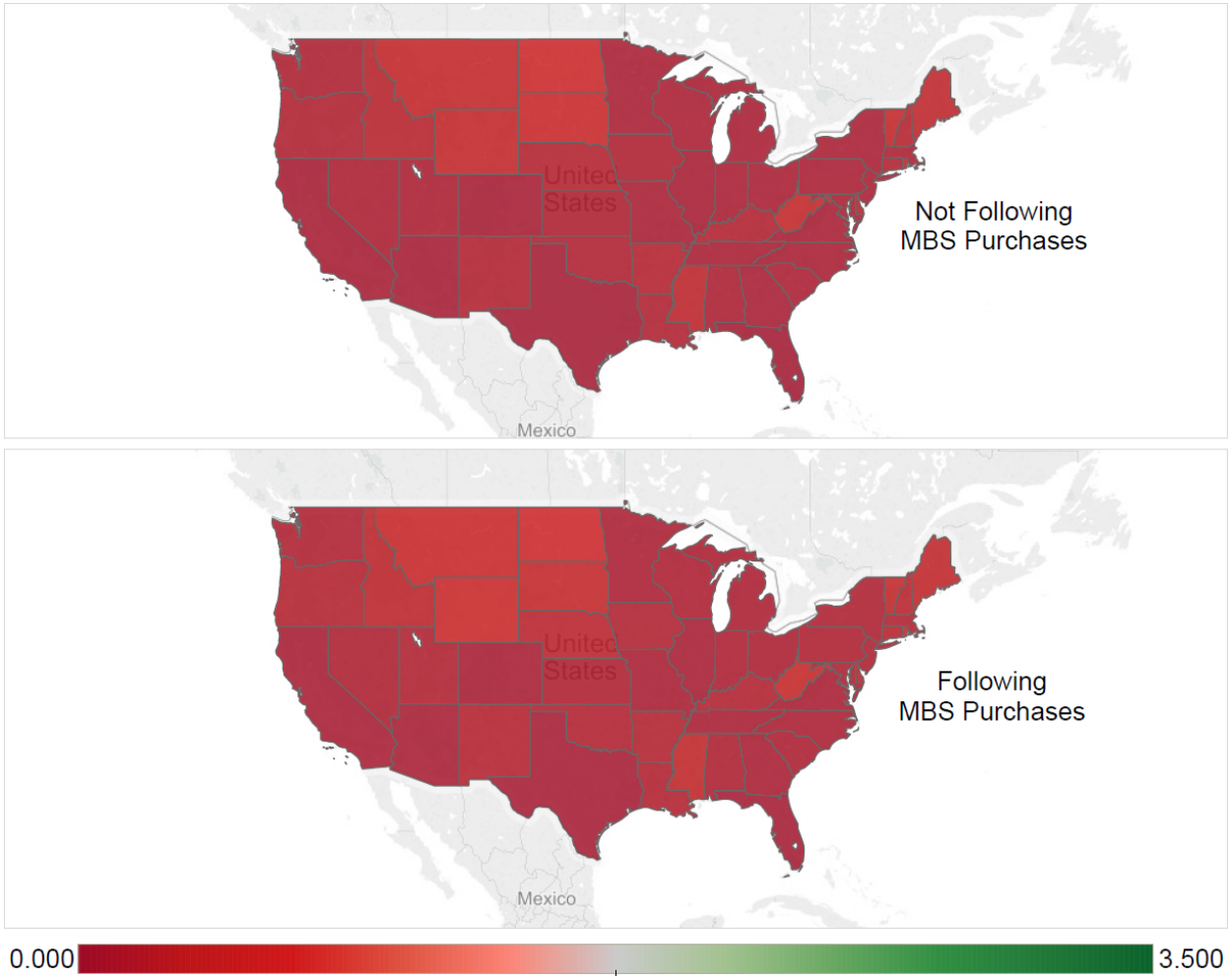

Figure C.1: Average state-level mortgage origination market share for non-securitizer banks, in percentage points. Top panel includes years not following fourth-quarter MBS purchases (2006, 2007, 2008, 2009, 2012). Bottom panel includes years following fourth-quarter MBS purchases (2010, 2011, 2013).

Table C.2: C&I Loan Growth, Using an Alternative Treasury Purchase Exposure Measure

Columns 1 through 6 are panel fixed effect regressions. *C&I Loan Growth* is the growth rate in C&I loans between the current and prior quarter, scaled by 100. *High MBS Holdings* takes a value of 1 if the lending bank is in the top tercile by MBS securities to total assets, and a value of 0 if in the bottom tercile. *High Gov. Securities Holdings* takes a value of 1 if the lending bank is in the top tercile by all U.S. federal government securities to total assets, and a value of 0 if in the bottom tercile. *MBS Purchases* is the lagged quarterly log-dollar amount of gross Federal Reserve MBS purchases. *TSY Purchases* is the lagged quarterly log-dollar amount of gross Federal Reserve TSY purchases. *Securitizer* takes a value of 1 if a high-MBS bank reported non-zero securitization income and 0 otherwise. *Orthog. MBS/Sec. Holdings* refers to whether the MBS and securities terciles have been orthogonalized to other bank characteristics. Standard errors are clustered by bank.

	C&I Loan Growth					
	(1)	(2)	(3)	(4)	(5)	(6)
High MBS Holdings	0.566		0.645	0.853		
	(0.481)		(0.483)	(0.558)		
High MBS Holdings × MBS Purchases	-0.0542***		-0.0510**	-0.0548**		
	(0.0207)		(0.0207)	(0.0227)		
Securitizer					2.047	2.071
					(1.268)	(1.267)
Securitizer × MBS Purchases					-0.351***	-0.350***
					(0.0930)	(0.0928)
High Gov. Securities Holdings		-0.0233	0.00363	0.576		-0.0174
		(0.432)	(0.435)	(0.504)		(0.432)
High Gov. Securities Holdings × TSY Purchases		0.0944***	0.0924***	0.0780***		0.0940***
		(0.0276)	(0.0276)	(0.0293)		(0.0276)
Bank's Size (excl. loans)	0.201	0.0968	0.0880	0.164	0.229	0.111
	(0.325)	(0.338)	(0.339)	(0.369)	(0.323)	(0.338)
Bank's Equity Ratio	0.902***	0.897***	0.904***	0.867***	0.898***	0.900***
	(0.0676)	(0.0676)	(0.0675)	(0.0776)	(0.0678)	(0.0676)
Bank's Net Income	0.220	0.236	0.237	0.296*	0.214	0.233
	(0.151)	(0.151)	(0.151)	(0.173)	(0.151)	(0.151)
Bank's Cost of Deposits	-1.438***	-1.454***	-1.455***	-1.337***	-1.449***	-1.467***
	(0.325)	(0.325)	(0.325)	(0.375)	(0.325)	(0.325)
Change in Unemp. Rate, Bank's State(s)	0.0866	0.0732	0.0735	0.0780	0.0871	0.0735
	(0.159)	(0.159)	(0.159)	(0.176)	(0.159)	(0.159)
Orthog. MBS/Sec. Holdings	No	No	No	Yes	No	No
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	75884	75884	75884	63247	75884	75884
Adjusted R^2	0.0516	0.0517	0.0518	0.0479	0.0516	0.0518

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Table C.3: Firm Investment, Using Alternative Exposure Measures

Columns 1 through 4 are panel fixed effect regressions. *Investment* is the firm's quarterly capital expenditures divided by lagged PPE, scaled by 100. *MBS Holdings* is the ratio of the bank's MBS securities to total assets from the prior quarter, scaled by 100. *Securities Holdings* is the ratio of the bank's non-MBS securities to total assets from the prior quarter, scaled by 100. *MBS Purchases* is the lagged quarterly log-dollar amount of gross Federal Reserve MBS purchases. *TSY Purchases* is the lagged quarterly log-dollar amount of gross Federal Reserve TSY purchases. *Orthog. MBS/Sec. Holdings* refers to whether the MBS and securities holdings have been orthogonalized to other bank characteristics. Standard errors are clustered by firm and bank.

	Investment			
	(1)	(2)	(3)	(4)
MBS Holdings	0.0381*		0.0382*	0.0359*
	(0.0211)		(0.0209)	(0.0211)
MBS Holdings × MBS Purchases	-0.00276***		-0.00271***	-0.00229**
	(0.000916)		(0.000966)	(0.000893)
Securities Holdings		0.00745	0.00357	0.0245
		(0.0300)	(0.0274)	(0.0334)
Securities Holdings × TSY Purchases		0.000194	0.000181	-0.00187
		(0.00122)	(0.00132)	(0.00176)
Cash Flow	0.00694***	0.00696***	0.00694***	0.00695***
	(0.00190)	(0.00189)	(0.00190)	(0.00190)
Lagged Market-to-Book	1.441***	1.449***	1.441***	1.441***
	(0.0615)	(0.0639)	(0.0614)	(0.0618)
Lagged Z-Score	0.433***	0.439***	0.433***	0.436***
	(0.0943)	(0.0960)	(0.0943)	(0.0946)
Lagged Firm Size	-0.516	-0.521	-0.516	-0.518
	(0.466)	(0.466)	(0.466)	(0.465)
Bank's Size	-0.0386	-0.0992	-0.0377	-0.0972
	(0.151)	(0.150)	(0.148)	(0.154)
Bank's Equity Ratio	0.0139	-0.0122	0.0148	0.0239
	(0.0341)	(0.0270)	(0.0333)	(0.0389)
Bank's Net Income	-0.0102	0.0423	-0.0159	0.0105
	(0.118)	(0.135)	(0.127)	(0.125)
Bank's Cost of Deposits	-0.349**	-0.395**	-0.347*	-0.409**
	(0.178)	(0.178)	(0.177)	(0.192)
Change in Unemp. Rate, Bank's State(s)	-0.304	-0.322	-0.311	-0.314
	(0.311)	(0.317)	(0.325)	(0.318)
Orthog. MBS/Sec. Holdings	No	No	No	Yes
Firm-Bank Fixed Effects	Yes	Yes	Yes	Yes
Firm State by Year-Quarter Fixed Effects	Yes	Yes	Yes	Yes
Observations	66887	66887	66887	66887
Adjusted R^2	0.472	0.472	0.472	0.472

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01