Quantitative easing and bank risk taking: evidence from lending

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ABSTRACT

A defining property of quantitative easing (QE) is the expansion of the monetary base through the creation of bank deposits—or reserves—by the central bank. In this paper, we assess the effect of this QE-induced reserve accumulation on bank-level lending and risk-taking activity. However, although banks must hold all reserves created by QE in aggregate, the observed distribution of reserves across banks is an outcome of private transactions. To overcome the inherent endogeneity of individual banks' reserve balances, we exploit instruments made available by a regulatory change that strongly influenced the distribution of newly-created reserves in the banking system. Our results show that bank reserves created by the Federal Reserve in two distinct QE programs led to higher total loan growth. Furthermore, we find that higher reserve balances induced increased risk taking within banks' loan portfolios, as indicated by both ex-ante and ex-post measures of risk-taking. These findings are consistent with theories of the portfolio substitution channel in which the transmission of QE depends in part on reserve creation itself.

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1. Introduction

Nearly a decade after the financial crisis, central banks in developed economies around the world continue to rely on large-scale asset purchases—also known as quantitative easing, or QE—in an effort to fulfill their mandates. This unprecedented use of unconventional stimulus by monetary authorities has catalyzed an empirical literature examining the effects of QE in order to develop a more complete understanding of how such policies are transmitted throughout the economy. Thus far, most studies have focused on transmission mechanisms that work through policy signalling (see, e.g., Bauer and Rudebusch (2014) and Krishnamurthy and Vissing-Jorgensen (2011)) or the prices and yields of widely traded financial assets, as in Gagnon et al. (2011), D'Amico and King (2013), and Gilchrist and Zakrajšek (2013). One important contribution of these studies is the demonstration that different types of assets purchased by central banks have potentially differential effects (see, e.g., Swanson (2011) and Krishnamurthy and Vissing-Jorgensen (2013)).[1] Largely ignored, however, have been the effects stemming from the accumulation of bank deposits—or "reserves"—at the central bank, even though the expansion of reserves is a defining characteristic of QE (Bernanke and Reinhart (2004)).

In this study, we shed new light on the transmission of QE by isolating the effect of QE-induced reserve expansion. Specifically, we conduct a bank-level analysis of the risk-taking response to reserve accumulation in two distinct QE programs. By conducting our analysis at the bank level, we are able to disentangle the effects of a higher supply of reserves from the effects owing to the types of assets purchased in order to carry out unconventional monetary policy. We achieve several results that demonstrate the effects of changes in bank-level reserve balances on lending and risk-taking activity. First, we show that absolute lending growth accelerates in response to increases in reserves. Second, we document that, in addition to the growth in lending, higher reserves also induce increased risk-taking *within* banks' loan portfolios using both

[1] In fact, because of the importance of the types of assets purchased by central banks, these programs are often referred to as large-scale asset purchases (LSAPs) rather than QE, since QE has traditionally been used to describe an expansion of a central bank's liabilities with little consideration for the composition of the assets acquired (Bernanke (2009)).

ex-ante and ex-post measures of risk-taking. Thus, our findings support the notion that QE can stimulate lending and risk-taking simply by increasing the supply of reserves in the banking system. Importantly, the QE transmission channel described here can operate alongside other, previously identified channels to stimulate economic activity.

However, although the total supply of reserves is determined by the central bank, the distribution of those reserves across the banking system is determined by individual trading of reserves amongst the banks themselves. Consequently, relating bank-level outcomes to bank-level reserve balances presents endogeneity and simultaneity issues, which confound the ability to make causal inferences regarding the effects of the reserves created by QE.

To overcome the inherent endogeneity issues when estimating the effect of the accumulation of reserve balances during QE, we employ an instrumental-variables approach and exploit a regulatory change in April 2011 that strongly influenced the distribution of reserves in the banking system. The Dodd-Frank Wall Street Reform and Consumer Protection Act (henceforth, Dodd-Frank), passed in the summer of 2010, included a provision that required the Federal Deposit Insurance Corporation (FDIC) to implement a change in the insurance fee levied on banks in order to fund the FDIC's Deposit Insurance Fund. Specifically, Dodd-Frank required that the FDIC fee be transitioned from a deposit-based assessment to an assessment based on assets minus tangible equity, increasing the net costs of holding reserve balances. Importantly, however, some depository institutions are either exempt from the FDIC fee altogether, or were given a specific exemption for reserve balances in the final rule establishing the new insurance assessment base. The differential treatment of banks under the FDIC assessment rule can thus be used to instrument for reserve accumulation in QE programs conducted after the regulatory change.

To support the validity of our instrument for reserves, we conduct a placebo test that shows that the effects of reserves on our lending and risk taking measures that we observe in QE programs after the implementation of the new assessment base are not present in the QE program carried out prior to the FDIC's regulatory change.

Few empirical studies have investigated the impact of QE-supplied reserves *per se* on bank behavior although, as we have noted, the accumulation of reserves represents the defining characteristic of QE, as explained in Bernanke and Reinhart (2004). This stands in contrast to the relatively rich history of theoretical predictions of the influence that reserve creation can have on other assets through portfolio substitution effects. For instance, Friedman and Schwartz (1963) explain that the creation of reserves by the central bank implies that banks will have larger reserves than were previously regarded as sufficient, and will thus seek to increase investments in securities and loans at a greater rate. Tobin (1969) also argues that a change in the supply of any asset will affect the structure of rates of return in a manner that will induce the public to hold the new supply. Importantly, when an asset's price is fixed, as in the case of reserves, the entire adjustment process must take place through increases in the prices of other assets. Thus, a higher supply of bank reserves implies that prices on securities will rise and additional loans will be made until the marginal benefit of the assets in banks' portfolios are restored to balance. More recently, Bernanke and Reinhart (2004) describe a similar mechanism in outlining the transmission channels of QE, stating that "large increases in the money supply will lead investors to seek to rebalance their portfolios, raising prices and reducing yields on alternative, non-money assets." More formally, Andres et al. (2004) embed the Tobin (1969) framework in a DSGE model to demonstrate that, in addition to influencing the expected path of short-term rates, central banks can affect the relative prices of alternative financial securities, thereby exerting additional effects on yields outside of the purchased assets and further stimulating aggregate demand. Of course, these arguments rely on the imperfect substitutability of reserves and other financial assets, which, as Krugman (1998) points out, may break down when nominal interest rates are at or near zero—precisely the conditions that induce central banks to engage in QE.[2]

Despite this long history establishing a theoretical basis for the effect of expanded reserves on investment decisions, empirical studies linking the effects of QE to reserve accumulation alone remain scarce. A notable exception is Christensen and Krogstrup (2015), wherein the authors

[2] We note that because the Federal Reserve now pays interest on reserves (IOR), additional base money created by QE may be more likely to be seen by banks as a substitute for other assets. Absent perfect-substitutability, however, the theoretical analysis in the studies referenced above remains valid as it only requires a fixed interest rate for reserves.

examine three unique episodes in which the Swiss National Bank expanded reserves by purchasing only short-term debt securities. Christensen and Krogstrup (2015) show that although the supply of long-term Swiss government bonds and their closest substitutes remained unchanged, long-term yields on benchmark Swiss Confederation bonds fell following the QE announcements. Furthermore, the authors show that the fall in rates could not be explained by a lower expected path of short-term interest rates, thereby ruling out a signalling channel and concluding that the anticipated creation of reserves alone was responsible for the fall in longer-term yields.

The remainder of this paper proceeds as follows: Section 2 describes our exogenous instrument(s) for reserve accumulation over the course of QE programs. Section 3 describes the Federal Reserve's main QE programs and details the increase in banks' reserve balances during each program, and Section 4 outlines the data used in our analysis. Section 5 presents our empirical methods and discusses the results, and section 6 concludes.

2. Identification: The 2011 Change in the FDIC Assessment Base

In the years before the recent financial crisis, total reserves in the U.S. banking system were closely managed by the Federal Reserve in order to maintain the target federal funds rate set by the FOMC (see Hamilton (1997), Carpenter and Demiralp (2006), and Judson and Klee (2010), among others), producing relatively little variation in reserve balances, as demonstrated in Figure 1. However, our aim is to measure the effects of the expansion of reserve balances in the context of QE, which by definition requires increasing reserve balances beyond the level necessary to maintain a near-zero short-term policy rate. Though the Federal Reserve determines the aggregate level of bank reserves, the distribution of reserves *within* the banking system is determined by banks engaging in arms-length transactions. Therefore, other asset portfolio decisions can be affected by the same factors that cause individual banks to hold more reserves, or even influence the optimal amount of reserves banks wish to hold. For this reason, any effort to directly relate bank-level reserve accumulation to other portfolio-choice outcomes such as lending—a primary goal of this study—is subject to potential simultaneity and endogeneity concerns.

To overcome this identification challenge, we employ a research design that achieves identification through instrumental variables. The exogenous instruments we exploit are made available by a provision in the Dodd-Frank financial reform legislation that required a change to the quarterly FDIC fee (calculated as the product of the assessment rate and a bank's assessment base) levied on banks to fund the FDIC's Deposit Insurance Fund (DIF). Specifically, the assessment base for each bank was changed from one based on domestic deposits, as it had been since 1935, to one based on average consolidated total assets minus average tangible equity (FDIC (2011)).

In an excellent review of the effects of this mandated change in the FDIC assessment base, Kreicher et al. (2013) explain that, while not explicitly a tax on banks, expanding the assessment base to include all managed liabilities may be viewed as a Pigouvian tax increase on non-core liabilities along the lines suggested by Shin (2010). Indeed, banks subject to the expansion of the FDIC assessment base would be less likely to fund themselves with the newly-assessed liabilities on the margin. By simultaneously changing the assessment rate, the new FDIC fee was designed to keep the total DIF collections nearly unchanged.

In addition to altering the relative costs of bank liabilities, the new FDIC assessment rule also had significant implications for banks' desire to hold reserves. In the years prior to the implementation of the change in the fee levied by the FDIC, the Federal Reserve had completed its first large-scale asset purchase program (described in detail in the following section), ultimately adding roughly $1 trillion to banks' aggregate reserve balances. Prior to the expansion of the assessment base, banks could accommodate these additional reserves by, for example, increasing wholesale borrowing in order to deposit the proceeds with the Federal Reserve, thereby earning the 25 basis points paid as interest on reserves (IOR). Prevailing borrowing rates in the market for federal funds (as well as eurodollars) were notably below IOR, largely as a consequence of the particular market microstructure, as discussed in Bech and Klee (2011). This rate differential presented a potential arbitrage opportunity that could be exploited by depository institutions with access to IOR. However, the introduction of the FDIC's expanded assessment base increased the costs of holding reserves for these same institutions, thereby disrupting the arbitrage that banks had previously enjoyed, causing demand for wholesale lending to decrease and short-term rates to fall further, as described in Kreicher et al. (2013).

Importantly for our purposes, however, not all banks are subject to the FDIC assessment fee on reserves. For most of these institutions, this is a consequence of a total exemption from the FDIC DIF assessment as a result of not being covered by U.S. deposit insurance. In particular, pursuant to the Foreign Bank Supervision Enhancement Act, branches and agencies of foreign banks established after December 19, 1991 do not receive deposit insurance and are thus exempt from any FDIC assessment.[3] Thus, depending on the date of establishment, some foreign branches and agencies are subject to FDIC deposit insurance, although many are not. In addition to an outright exemption from the FDIC fee, the FDIC's regulatory change explicitly allowed for the exclusion of low risk, liquid assets from total assets used in the calculation of the assessment base for certain institutions. Specifically, banker's banks and custodial banks were permitted to exclude low risk, liquid assets including reserves from the calculation of their applicable assessment base (FDIC (2011)).[4]

Depository institutions that were neither exempt from FDIC insurance entirely nor able to exclude reserves from the new assessment base therefore faced a higher total cost of holding reserves. For banks not subject to the FDIC assessment on reserves, however, the all-in cost of reserves remained unchanged, and these banks could thus be expected to take up a disproportionately large share of newly-created reserves subsequent to the implementation of the regulatory change. As detailed in Kreicher et al. (2013), this accumulation of reserves in banks exempt from the FDIC fee is precisely what occurred.[5] In fact, the accumulation of reserves happened somewhat before the implementation for two reasons. First, the new FDIC assessment base was

[3]Edge Act corporations, another type of foreign banking institution, may also be exempt from FDIC insurance, but there are relatively few currently operating in the United States and, as we discuss in Section 4, we do not include Edge Act corporations in our sample due to their primary activities of financing international projects and providing international payment services.

[4]The FDIC identifies custodial banks based on minimum thresholds for either the amount of custody assets held by a bank or the amount of revenue generated by a bank's custodial activities. Analogously, banker's banks must be engaged primarily in providing services to or for other depository institutions, and conduct at least 50 percent of their business with non-affiliated institutions.

[5]We note that Kreicher et al. (2013) only considered banks that were not covered by FDIC insurance. However, these institutions far outnumber those that qualified as banker's banks and custodial banks.

levied on *averages* over the quarter, which led banks to begin adjusting their balance sheets well in advance of the implementation date of April 1, 2011. Second, prior to receiving details from the FDIC regarding the proposed change to the assessment base, many banks expected a universal exemption of reserve balances. However, on November 9, 2010, the FDIC Board's proposal for the implementation of the Dodd-Frank assessment changes was released, at which point it became clear that reserves would indeed be assessed for all banks except those with the explicit exemptions mentioned above. The FDIC Board's proposal for the new assessment base was released just a few weeks prior to the start of the Federal Reserve's QE2 program.

To demonstrate the distributional effects of the reserve increases depicted in Figure 1, Figure 2 shows the fraction of net reserves created during QE1, QE2, and QE3 that were absorbed by assessed banks compared with uninsured and reserves-exempt institutions. Alternately, Figure 3 presents the changes in banks' reserves (normalized by beginning-of-period assets) by reserves-assessment status for each of the three major increases in reserve balances implemented by the Federal Reserve (each of which is described in detail in the following section). Uninsured and reserves-exempt banks saw substantially larger increases in reserve holdings after the announcement and implementation of the change in the FDIC assessment base, as demonstrated by the outsized increases both in the share of reserves and in reserves relative to assets during QE2 and QE3.

As instruments for reserves, we use two separate dummy variables indicating that a depository institution is either (1) not subject to FDIC insurance or (2) granted an exemption for reserve balances. The ability of a bank to avoid the FDIC assessment on reserve balances was strongly related to banks' accumulation of additional reserves created by QE for the reasons explained above and is clearly demonstrated in Figures 2 and 3. The exogeneity of our instruments is highly plausible, because a bank's exemption status is necessarily unrelated to the bank's behavior in response to large-scale injections of reserves, as each bank's organizational structure was determined in a monetary regime that operated with a minimal amount of excess reserves.[6] Furthermore, the change in the assessment base mandated by Dodd-Frank altered the previous policy of assessing DIF fees based on domestic deposits, a policy that had been in place since 1935.

Another requirement for the validity of our instruments concerns the conditional exclusion restriction. In this regard, we note that the change in the FDIC fee did indeed affect the liability side of banks' balance sheets, as those subject to the FDIC fee would seek to shift their funding mix away from wholesale borrowing. However, a move to more stable liabilities—namely, domestic deposits—could actually bias the results against higher lending in reserve-accumulating banks, as standard bank lending channel dynamics might induce more lending in the institutions acquiring more deposits. More importantly, however, the Federal Reserve has conducted several distinct QE programs, the last of which began about two years after the announcement of the change in the assessment base—a time period that more than allowed for banks to readjust their funding mix to the new assessment base. Thus, to the extent that we observe similar effects of reserve accumulation for a QE program far removed from the period during which banks readjusted their funding profile, we can have confidence that our results are not driven by concurrent liability adjustments. Additionally, while it is impossible to directly test an exclusion restriction, we are able to provide suggestive evidence that the exclusion restriction holds by taking advantage of the timing of the first QE program, which was completed well before both the announcement of the change in the assessment base and the passage of Dodd-Frank. If the exclusion restriction fails and the FDIC insurance status of banks affects loan growth through a channel other than reserve accumulation, we would expect to observe a significant coefficient on our instruments in a reduced form regression during the first QE program (i.e., in a regression of lending or risk-taking on FDIC insurance status, banks' status would load significantly). As we will show, however, we

[6] In fact, the Federal Reserve often operated a structural deficit of reserve balances, and temporary operations were conducted in order to add reserves as needed to maintain the targeted federal funds rate.

are unable to detect consistent explanatory power of our instruments in reduced form regressions estimated during a QE program for which no first stage can exist.

3. The Federal Reserve's QE Programs

Until the recent financial crisis, the Federal Reserve operated within a monetary framework that required relatively few excess reserve balances on banks' balance sheets (see Figure 1). The lack of a reserve-rich monetary policy regime may help explain the relative paucity of empirical research on the effects of a higher supply of reserves on financial markets or banking activity. However, the rapid expansion of reserves engendered by multiple QE programs in the years following the crisis offers several natural experiments in which reserve balances were increased to carry out previously-announced securities purchases. Thus, although the reserve-induced portfolio substitution effects described in Friedman and Schwartz (1963) and Tobin (1969) do not require QE, we focus on the large variation in reserve balances that occurred during these periods. Moreover, our ultimate aim is to test the Bernanke and Reinhart (2004) claim that the efficacy of QE can depend, at least in part, on these reserve-induced portfolio substitution effects, and so examining banks' lending responses to reserve accumulation during these programs is most appropriate. In the subsections below, we outline the primary large-scale asset purchase programs that the Federal Reserve initiated since 2008—dubbed QE1, QE2, the maturity extension program (MEP), and QE3—and explain the effects of each on banks' reserve balances.

3.1. QE1

In response to the acute financial crisis and deepening recession, the Federal Reserve announced its first QE program on November 25, 2008, as indicated in Figure 1, with securities purchases beginning in the following month. Initially, purchases were authorized for "up to" $100 billion in direct obligations of government-sponsored enterprises (GSEs) and $500 billion in mortgage-backed securities (MBS) guaranteed by Fannie Mae, Freddie Mac, and Ginnie Mae. Later, at its March 2009 meeting, the FOMC increased these figures to $200 billion and $1.25 trillion, respectively, while also stating an intention to purchase up to $300 billion of longer-term Treasury securities.[7] By the end of the first quarter of 2010, QE1 purchases had concluded, totalling $172 billion of agency debt, $1.25 trillion of MBS, and $300 billion of Treasury securities.[8]

In Panel (a) of Figure 4, we present simplified T-accounts for both the Federal Reserve System and the banking sector to demonstrate the impact of QE1. The purchases of the various types of securities by the Open Markets Desk at the Federal Reserve Bank of New York (the Desk) were completed by crediting reserves to the accounts of banks associated with the Primary Dealers with whom the Desk transacted. Of course, the ultimate distribution of reserves throughout the banking sector will be determined by banks' private trading activity subsequent to the QE purchases (see Ennis and Wolman (2015) for a comprehensive analysis of the ultimate distribution of reserves after early QE programs), while the aggregate amount of reserves in the system is determined by the value of the securities purchased by the Desk. If non-banks are the ultimate sellers of the securities to the Federal Reserve, reserves will still increase by the precise amount injected by the Federal Reserve, but bank deposits will also rise. Lastly, we note that although our stylized example shows the increase in reserves as if QE1 purchases were carried out instantaneously, the actual amount of reserves in the banking system did not increase by this amount over the fifteen-month implementation period of QE1. This discrepancy can be explained by reserve-draining factors, such as the reduction in liquidity facilities initiated during the crisis, the principal payments on MBS, and the growth in currency. Nevertheless, as clearly evident in Figure 1, total reserve balances held by banks increased substantially as a result of QE1.

Finally, we note that the regulatory change that we exploit to instrument for banks' reserve balances was not yet implemented during QE1. Thus, although we are unable to make reliable inferences regarding the effects of reserves during this program, QE1 provides the ideal setting for us to demonstrate the absence of a first stage in our instrumental variables approach when applied to bank-level reserve accumulation prior to the change in the FDIC's regulation.

[7] The focus on the particular assets purchased with the expanded monetary base generates a slight distinction from strict QE, and has sometimes been referred to as "credit easing" (Bernanke (2009)).

[8] Note that these figures refer to the par value of the purchased securities only.

3.2. QE2 and the MEP

In order to address the continued weakness of the U.S. economy that persisted well after QE1, the FOMC announced another large-scale asset purchase program on November 3, 2010 that came to be known as QE2. Under QE2, the FOMC directed the Desk to purchase a further $600 billion of longer-term Treasury securities by the end of the second quarter of 2011. As shown in Figure 1, total reserve balances again increased markedly during QE2 as the Desk purchased Treasury securities at a pace of roughly $75 billion per month. In contrast to QE1, the expansion of reserves caused by securities purchases was not partially offset by other reserve-draining factors, as the vast majority of the emergency liquidity facilities initiated during the crises had wound down. Rather, the relatively sizable premiums on purchased securities and a reduction in the Treasury's balances at the Federal Reserve contributed to an increase in reserves that was a bit above $600 billion over the course of the program. Abstracting from these confounding factors, however, we present simplified T-accounts that summarize the hypothetical instantaneous effect of QE2 on the balance sheets of both the banking sector and the Federal Reserve System in Panel (b) of Figure 4.

Just prior to the commencement of QE2's Treasury purchases, the FDIC released a proposal for the regulatory change that would take effect in early 2011. As discussed in Section 2, the nature of the regulatory change induced some banks to acquire the bulk of the newly-created reserves. Furthermore, the nature of the change in regulation led banks to adjust their portfolios well before the regulation's effective date. Consequently, our instruments—which depend completely on this regulatory change—is valid for the bulk of the QE2 program.

Shortly after the conclusion of QE2, the FOMC judged that additional monetary stimulus was called for to support a stronger economic recovery and ensure inflation returned to mandate-consistent levels. To this end, the FOMC announced the maturity extension program (MEP) on September 21, 2011, less than three months after the completion of QE2 purchases. The aim of the MEP was to extend the average maturity of the Federal Reserve's Treasury securities holdings thereby putting downward pressure on longer-term interest rates. Specifically, the FOMC instructed the Desk to purchase $400 billion of par-valued Treasury securities with remaining maturities of 6 years or more, while selling an equivalent amount of securities with remaining maturities of 3 years or less. Eventually, the MEP was expanded to include an additional $267 billion of Treasury securities.

Unlike QE1 and QE2, the goal of the MEP was to change the composition of the Federal Reserve's System Open Market Account (SOMA) portfolio, while leaving the overall size roughly unchanged. Nevertheless, MEP transactions did have a reserve-expanding property. In particular, falling interest rates in the years leading up to the MEP ensured that most seasoned Treasury securities were trading at a premium.[9] Because longer-duration securities were purchased and shorter-duration securities were sold, premiums on the purchased securities were typically far higher than premiums on the low-duration securities held in the SOMA. Consequently, net premiums on Federal Reserve securities increased by about $76 billion on the MEP transactions. As before, we present T-accounts to summarize the transactions conducted as part of the MEP in Panel (c) of Figure 4.

3.3. QE3

The most recent QE program undertaken by the Federal Reserve, QE3, was announced at the September 2012 FOMC meeting, and initially entailed the purchase of $40 billion per month of agency MBS. Most notably, the FOMC for the first time left the ultimate size of the QE program unstated, opting instead for open-ended purchases that would continue until the outlook for the labor market improved substantially. Beginning in January 2013, the FOMC expanded QE3 by purchasing $45 billion of Treasury securities per month in addition to the ongoing MBS purchases. The pace of securities purchases began to decrease gradually in January 2014, concluding in October of that year.

[9] The Federal Reserve is barred from outright purchases of Treasury securities at Treasury auctions, and must conduct all QE purchases in the secondary market.

Figure 1 shows that reserves expanded more during QE3 than in any previous QE program. Although the par value of securities purchases were roughly the same as QE1 (see Panel (d) of Figure 4), the FOMC instituted a practice of reinvesting principal payments on SOMA MBS holdings shortly after the conclusion of QE1, which contributed to the preservation of much of the QE3-induced reserve expansion.

Besides the considerable increase in reserve balances during QE3, another important feature of the program for the present study is that it was announced and implemented well after the change in the FDIC assessment base in early 2011. For this reason, QE3 offers an exogenous increase in reserves at a time well after banks had fully adjusted to the regulatory change described in Section 2. Consequently, QE3 provides an ideal setting to test the robustness of causal effects estimated during QE2, because no potentially confounding effects resulting from banks' shifting liability structure in response to the regulatory change were present.[10]

4. Data

Our data are primarily composed of depository institutions' Federal Financial Institutions Examination Council (FFIEC) quarterly filings. Specifically, we use merger-adjusted Consolidated Reports of Condition and Income, or Call Reports, for domestically chartered institutions, and form FFIEC 002—also known as the Report of Assets and Liabilities—for branches and agencies of foreign banking organizations. Table 1 reports descriptive statistics aggregated to the top holder level for several key variables at the beginning of our sample (2010 Q4), the beginning of QE3 (2012 Q3), and the end of QE3 purchases (2014 Q3). Summary statistics for those institutions assessed an FDIC fee are reported in Panel A (and limited to those with above-median assets in order to eliminate very small community banks), while reserves-exempt and uninsured institutions are summarized in Panels B and C, respectively. We also report banks' total capital-to-assets ratio, which increased notably between 2010 Q4 and 2012 Q3, but then remained relatively steady. For branches and agencies of foreign banks, which are not subject to

[10]As discussed above, we believe any possible effects working through banks' changing liability structure in response to the FDIC's regulatory change would bias *against* the results we report below.

standard capital adequacy requirements, we instead calculate the ratio of the capital equivalency deposit (a required contribution by foreign banks to their branch or agency) to total assets. The lending Hirschman-Herfindahl Index (HHI) takes values between zero and one, and measures the concentration of banks' lending activities, such that banks that primarily engage in a single type of lending report higher HHIs. The categories of lending used to calculate the HHI are residential real estate, consumer, commercial and industrial (C&I), commercial real estate, agricultural, and financial loans. Lastly, we report a measure of liquidity, calculated as the ratio of securities to total assets.

In addition to these bank-level characteristics, Table 1 also reports reserves as a share of assets, which is calculated from banks' filings by using their reported assets due from the Federal Reserve.[11] Comparing the changes in reserves-to-assets ratios between QE programs reveals the higher concentration of reserves among reserves-exempt and uninsured institutions (Panels B and C) relative to banks assessed an FDIC fee (Panel A). Using institutions' reported levels of reserves at the Federal Reserve precludes the inclusion of thrifts in our sample, because the Thrift Financial Reports filed in lieu of Call Reports prior to 2012 did not require banks to report assets due from the Federal Reserve. Similarly, we drop any non-deposit trust companies from our sample.

In order to estimate the effect of an increase in bank reserves on banks' loan portfolios, we choose several outcome variables, which we summarize in the final three rows of Table 1. First, we measure the effect of reserves on total lending growth itself. As banks accumulate QE-created reserves, the securities purchased by the Federal Reserve and their close substitutes may see a rise in price that makes marginal lending opportunities comparatively more attractive. Thus, comparing the total loan growth of banks that accumulate large reserve balances during QE programs with those that do not can test the theories put forth by Friedman and Schwartz

[11] Banks may have non-reserve assets due from the Federal Reserve, such as funds invested in the Term Deposit Facility. Compared with reserve balances, however, other assets due from the Federal Reserve are minimal.

(1963), Tobin (1969), and Bernanke and Reinhart (2004) wherein the forced accumulation of reserve balances makes loans and other risk assets relatively more attractive.

Second, we attempt to examine the riskiness of banks' lending portfolios by assessing the effects of reserves on the riskiest types of loans: consumer loans, C&I loans, commercial real estate loans, and construction loans. These categories of loans have witnessed relatively high delinquency rates historically, and carry regulatory risk weights of at least 100%. One might expect this subset of lending activity to pick up in response to reserve accumulation if, for example, depository institutions wish to protect their net interest margins (NIMs). Similar to one of the mechanisms commonly cited in the literature examining the risk-taking effects of monetary policy (see, for example, Rajan (2005), Borio and Zhu (2012), Maddaloni and Peydró (2011), Jiménez et al. (2014), Altunbas et al. (2014), and Aramonte et al. (2015)), banks could offset a NIM-reducing influx of low-rate reserves by searching for yield in lending origination. In this way, the *composition* of banks' loan portfolios could change as well as total lending activity. Third, we consider the change in non-performing loans as a share of total loans in order to assess an ex-post measure of bank risk-taking (Jiménez et al. (2013)). If reserves in fact induce banks to expand their loan portfolios through portfolio-balance effects, it is probable that the riskiness of the marginal lending opportunities available to banks is greater than the overall risk of banks' loan portfolios. Thus, if banks reach further into their lending opportunity set as a consequence of portfolio substitution, this would be reflected in measures of loan portfolio risk-taking.

To generate our instruments, we first identify the uninsured depository institutions that are not affected by the change in the FDIC assessment base in 2011. Uninsured institutions comprise FFIEC 002 filers that were established after December 19, 1991 (per the Foreign Bank Supervision Enhancement Act). Secondly, in order to identify those depository institutions classified as either banker's banks or custodial banks, we are able to take advantage of the requirement that these institutions self-report their status on the Call Report. In total, at the beginning of our sample, there are 247 FDIC uninsured depository institutions that are completely unaffected by the change to the DIF assessment calculation. Institutions that are granted at least a partial reserve exemption from their assessment base comprise 41 custodial banks and 15 banker's banks.[12]

5. Empirical Methods and Results

In order to evaluate the causal effects of reserves on bank loan portfolios, we rely on an instrumental variables (IV) approach and estimate regressions of the following general form:

$$\Delta y_i = \alpha + \rho \cdot \left(\frac{\Delta Reserves_i}{Assets_i}\right) + \boldsymbol{\Phi' x_i} + \varepsilon_i, \tag{1}$$

where the outcome variable Δy_i is a measure of the change in lending activity and/or risk taking over the course of a QE program, and $\boldsymbol{x_i}$ is a vector of exogenous covariates. The change in reserves relative to assets for each bank is the endogenous variable of interest for which we instrument. As discussed in Section 2, the bank-level decision to accumulate reserves may be affected by other variables that simultaneously influence lending decisions, or lending activity itself could affect banks' desired amount of reserves. For these reasons, we instrument for reserve accumulation using two different dummy instruments. The first instrument denotes the FDIC insurance status of a bank, while the second instrument identifies a bank's status as either a custodial or banker's bank. We prefer to use two separate instruments, because banks that qualify as custodial or banker's banks may only receive a partial exemption of reserves from the FDIC's DIF assessment base, whereas uninsured depository institutions do not pay the DIF fee and were therefore not affected by the change in the FDIC assessment base. In our regression specifications, we present results using either a single uninsured dummy instrument or both the uninsured and reserves-exempt instruments.

In the special case of the general specification described by equation (1) in which there is only a single dummy instrument and no exogenous covariates, ρ can be calculated using the

[12] As indicated in Table 1, when aggregated to the top holder level, there are 208 FDIC uninsured institutions, and a total of 50 reserves-exempt institutions (35 custodial banks, and 15 banker's banks).

Wald formula as follows:

$$\rho = \frac{\mathbb{E}\left[\Delta y_i | D_i = 1\right] - \mathbb{E}\left[\Delta y_i | D_i = 0\right]}{\mathbb{E}\left[\frac{\Delta Reserves_i}{Assets_i} | D_i = 1\right] - \mathbb{E}\left[\frac{\Delta Reserves_i}{Assets_i} | D_i = 0\right]} . \tag{2}$$

Equation (2) reveals that the Wald estimate of the effect of reserve accumulation on an outcome variable (ρ) equals the difference-in-difference (DD) reduced form divided by the DD first stage. In other words, the Wald estimator measures the average change in lending outcomes for uninsured banks minus the change in lending outcomes for insured banks (which are subject to the expanded assessment base), divided by the difference in the difference of reserve holdings by these two groups of institutions. In this respect, the IV estimate of the effect of reserves on banks' lending portfolios can accommodate a constant difference in lending patterns between uninsured and insured institutions.

In addition to the Wald estimate of the effect of reserves on each outcome variable, we also report IV results including various exogenous independent covariates to evaluate the robustness of our results. Moreover, we estimate the effects of reserves over two separate QE programs since the November 2010 announcement of the FDIC's proposed change to the assessment base. Specifically, we examine outcomes resulting from the QE2/MEP purchases from 2010 Q4 to 2012 Q3, as well as the QE3 purchases from 2012 Q3 to 2014 Q3. Although QE2 purchases were completed by the start of the third quarter of 2011, we extend our sample beyond this window to allow for the distribution of reserves to stabilize (which may take some time, as noted in Ennis and Wolman (2015)), and so that there is sufficient time to observe meaningful variation in slower-moving outcomes such as total lending growth and delinquencies. Thus, the QE2 sample period includes the overwhelming majority of the MEP as well. The QE3 sample period is similar in length to the QE2/MEP sample period, beginning just before purchases associated with QE3 began to settle and ending just before the announcement of the cessation of asset purchases in October 2014.[13]

[13] The reduction in the pace of QE3 asset purchases—also referred to as the "taper"—was announced in December 2013. After this announcement, QE3 purchases steadily declined and were relatively small by the middle of 2014.

Turning to our first dependent variable, Table 2 reports results for regressions of the percentage change in loans on the change in reserves relative to assets and other covariates. Panel A of the table instruments for reserve accumulation using the uninsured dummy instrument only, while Panel B uses both the uninsured and banker's/custodial bank dummies as instruments for reserve growth. The QE2/MEP and QE3 sample periods are reported separately on the left- and right-hand side of each panel, as indicated. Consistently large F-statistics reported at the bottom of each panel indicate relatively strong instruments. The results show a fairly robust positive effect of reserves on loan growth. Among uninsured institutions only (Panel A), we see that a one percentage point change in reserves relative to beginning assets increased loan growth by between 0.2 and 0.6 percentage points during the QE2/MEP period and between 0.2 and 0.7 percentage points during the QE3 period. Using the average increase in reserves relative to assets for uninsured banks during QE2/MEP and QE3, these coefficient estimates imply that excess reserves caused annualized rates of loan growth at these institutions to be about 5.5 percentage points higher on average during these QE programs, all else equal.

Examining the composition of loan growth, Table 3 reports results for the growth in banks' stock of higher-risk loans, comprising commercial real estate, construction, C&I, and consumer loans. The generally larger coefficients than reported in Table 2 indicate that banks' assumed more ex-ante risk in their loan portfolios by shifting to types of lending with traditionally higher rates of delinquency. The more rapid increase in risky lending activity may reflect a search for yield among banks that face reductions in NIMs as a consequence of an influx of reserves. Although the possibility of risks to financial stability is a commonly cited cost of QE, observing higher risk-taking among the banks most directly affected by reserve-creating monetary policy is not necessarily a drawback of unconventional policy. Rather, as Bernanke (2012) notes, "one objective of both traditional and nontraditional policy during recoveries is to promote a return to productive risk-taking." In this sense, these results reflect a transmission of QE operating as intended during both the QE2/MEP and QE3 periods.

Turning next to a measure of ex-post risk taking within banks' loan portfolios, Table 4 presents results for the percentage change in banks' non-performing loan (NPL) ratios. Point estimates of the effect of reserves on NPL ratios are positive in each specification for each QE regime, though the magnitudes of these coefficients are relatively large when home country fixed effects are included. This is especially true for the QE3 period, for which the estimated effect of a one percentage point increase in reserves relative to beginning assets corresponds to a 30-percent increase in the NPL ratio, all else equal. However, we note that NPL ratios were low and declining during this period (see Table 1) for insured and uninsured banks alike. Moreover, the strong negative association of assets with NPL changes indicates that the largest NPL increases were witnessed by smaller institutions. Thus, the volume of loans affected by higher delinquencies is much lower than would otherwise be the case.

In total, the results reported above support the portfolio substitution mechanism suggested by Friedman and Schwartz (1963), Tobin (1969), and Bernanke and Reinhart (2004). Nevertheless, our estimates of the local average treatment effect (LATE) rely on a conditional exclusion restriction whereby the change in the FDIC assessment rule affects our outcome variables through reserve accumulation alone. For example, as discussed earlier, depository institutions also adjusted their liability mix in response to the change in the assessment base, but this transition occurred relatively soon after the announcement of the proposed rule in 2010. Because QE3 began well after this adjustment took place, observing similar effects across the two QE programs conducted after the announcement of the regulatory change lends credence to the notion that the differential lending behavior cannot be explained by the liability effects.

However, we are able to offer even stronger suggestive evidence that the exclusion restriction is valid by turning to a QE program that was conducted well before the announcement of the regulatory change to the FDIC assessment rule. In particular, because we would not expect a first stage for our instrument(s) during QE1, a violated exclusion restriction (i.e., if there is something particular to uninsured and reserves-exempt banks that would generate divergent rates of lending growth) would produce similarly consistent results for a reduced form regression of the dependent variables on our instrument(s). In Table 5, we first report IV regressions in Panel A using both instruments and the full specification. As can be see in the top row, there is no measurable effect of reserves on lending outcomes. Moreover, the first-stage F-statistics for regressions of reserve accumulation on our instrument(s) are very low on average—well below the standard threshold of 10. Turning to the reduced form estimates for each dependent variable in Panel B, we see that all coefficient estimates for the instruments are statistically no different from zero during QE1, with most point estimates actually negative. Thus, the timing of QE1 relative to the change in the FDIC assessment base has allowed us to demonstrate that when no first stage is present in our IV regressions, there is also no direct effect of the instruments on the outcome variables. Although this analysis is conducted for a QE program outside of those considered earlier, evidence of a violation of the exclusion restriction is not present.

Finally, we turn to the external validity of our results, which are only local to those banks that acquire extra reserves as a result of their differential treatment under the FDIC assessment rule. This ostensibly narrow LATE may in fact be more generalizable, because a first-order effect of the FDIC assessment fee after the regulatory change is to alter banks' costs of holding reserve balances. In the results reported above, we showed that those banks with lower costs of holding reserves due to their treatment under the FDIC assessment rule accumulated a disproportionate share of reserves in the QE programs implemented after the change in regulation. Because the ultimate holders of QE-created reserves will be determined by the differential costs—however defined—of holding those reserves, our results may be more generalizable.

6. Conclusion

In spite of the long theoretical history describing the role of reserves in the transmission of monetary policy through portfolio substitution effects, relatively little empirical work has investigated this link. This gap may in part be explained by monetary regimes that did not historically rely on large increases in reserve balances. However, liquidity creation by major central banks has ballooned since the onset of the financial crisis, raising the question of the role of reserves *per se* in the monetary transmission mechanism. To this end, this study aims to deepen the understanding of QE transmission by empirically assessing the effect of bank-level reserve accumulation on lending activity and risk taking.

Using instruments for reserve accumulation made available by a regulatory change, we are able to overcome the endogeneity of bank-level reserve increases to other portfolio decisions such as lending activity. We find that reserves created by the Federal Reserve as a result of two QE programs led to higher total loan growth and an increased incidence of higher-risk lending activity within banks' loan portfolios. These results support theories of the portfolio substitution channel of monetary policy that allows for transmission of monetary actions through reserves in and of themselves, as posited in the literature dating back at least to Friedman and Schwartz (1963) and Tobin (1969).

Thus, although there exists strong evidence that the overall efficacy of QE can depend on the types of assets purchased with newly created monetary base, we show that QE's financially stimulative effects can also arise simply as a result of the reserve creation itself.

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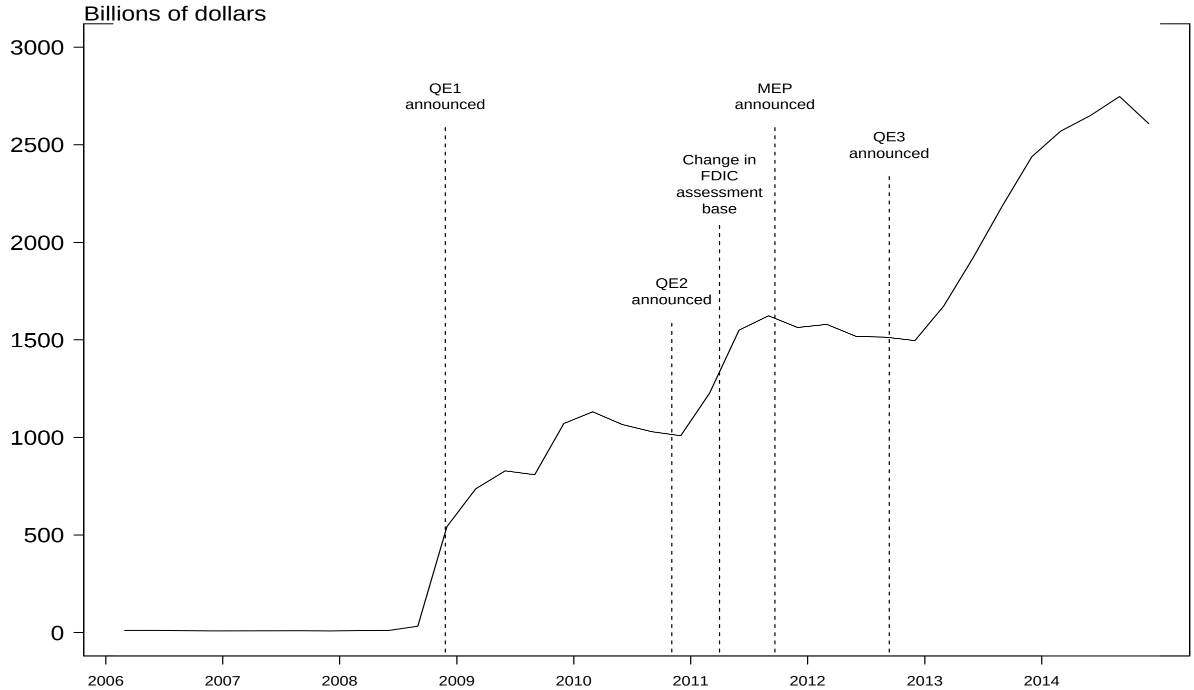

Figure 1. Total Reserves. This figure plots the evolution of total reserve balances from 2003 through 2014. The dashed vertical lines indicate the effective date for the change in the FDIC assessment base and the announcement dates for various QE programs and the maturity extension program (MEP).

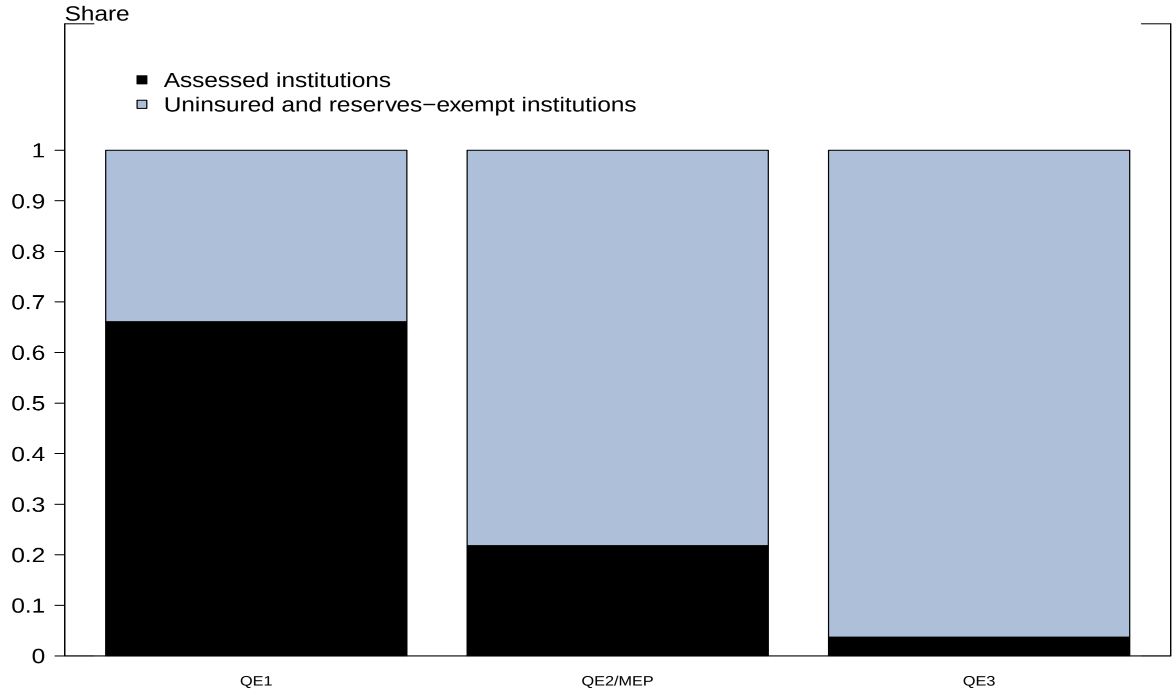

Figure 2. Share of Reserve Accumulation. This figure shows the shares of reserve accumulation by reserve-assessment status relative to the increase in reserve balances associated with QE1,QE2/MEP, and QE3.

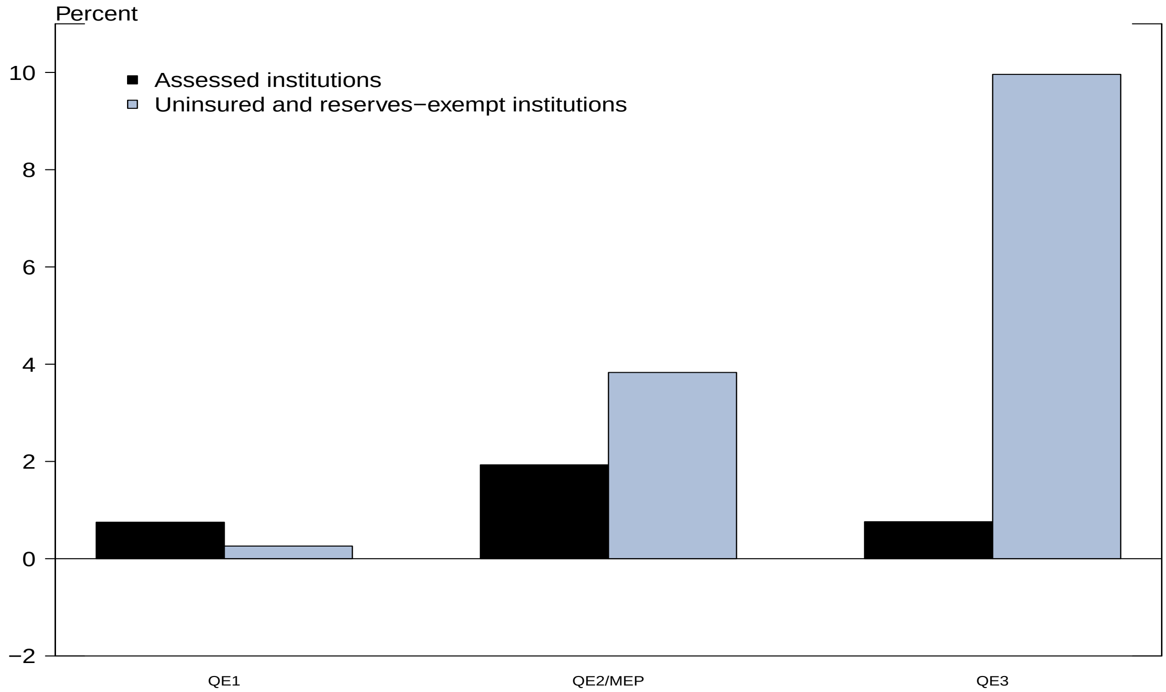

Figure 3. Change in Reserves. This figure shows the changes in banks' reserves scaled by beginning assets by reserve-assessment status for the increases in reserve balances associated with QE1,QE2/MEP, and QE3.

Federal Reserve System

Assets		Liabilities	
Agency Debt	+$172	Reserves	+$1,722
Agency MBS	+$1,250		
Treasuries	+$300		

Banking System

Assets		Liabilities	
Reserves	+$1,722		
Agency Debt	-$172		
Agency MBS	-$1,250		
Treasuries	-$300		

(a) QE1 Program

Federal Reserve System

Assets		Liabilities	
Treasuries	+$600	Reserves	+$600

Banking System

Assets		Liabilities	
Reserves	+$600		
Treasuries	-$600		

(b) QE2 Program

Federal Reserve System

Assets		Liabilities	
ST Treasuries	-$667	Reserves	+$76
LT Treasuries	+$667		
Net Premiums	+$76		

Banking System

Assets		Liabilities	
Reserves	+$76		
ST Treasuries	-$667		
LT Treasuries	+$667		
Memo: Δ MTM	-$76		

(c) Maturity Extension Program

Federal Reserve System

Assets		Liabilities	
Agency MBS	+$823	Reserves	+$1,613
Treasuries	+$790		

Banking System

Assets		Liabilities	
Reserves	+$1,613		
Agency MBS	-$823		
Treasuries	-$790		

(d) QE3 Program

Figure 4. Simplified T-Accounts. This figure presents simplified T-accounts for the Federal Reserve System and the banking sector. The numbers are in billions of dollars.

Table 1
Descriptive Statistics

Panel A: Assessed institutions

	2010 Q4		2012 Q3		2014 Q3	
	mean	std. dev.	mean	std. dev.	mean	std. dev.
Assets (billions)	4.1	53.2	4.7	58.0	5.7	65.0
Capital/Assets (%)	9.8	5.5	10.5	5.3	10.6	5.4
Lending HHI	0.5	0.2	0.5	0.2	0.4	0.2
Liquidity/Assets (%)	19.5	14.0	21.8	15.1	21.7	15.0
Core Deposits/Liabilities (%)	67.3	22.0	72.4	23.8	73.5	20.9
Reserves/Assets (%)	4.5	7.6	5.8	9.6	5.3	10.9
Loans/Assets (%)	64.2	16.5	61.5	17.0	63.2	17.8
High-Risk Loans/Total Loans (%)	53.0	20.8	52.3	21.1	52.8	21.4
NPL/Total Loans (%)	3.6	4.4	2.8	3.5	1.5	2.3
Observations	3453		3262		2996	

Panel B: Reserves-exempt institutions

	2010 Q4		2012 Q3		2014 Q3	
	mean	std. dev.	mean	std. dev.	mean	std. dev.
Assets (billions)	161	411	181	440	195	471
Capital/Assets (%)	13.8	13.5	14.5	13.0	16.1	17.5
Lending HHI	0.4	0.2	0.4	0.2	0.4	0.2
Liquidity/Assets (%)	19.2	18.6	21.3	18.3	19.3	12.5
Core Deposits/Liabilities (%)	57.6	28.5	66.4	27.1	66.4	26.4
Reserves/Assets (%)	11.1	13.7	12.9	14.6	14.3	13.7
Loans/Assets (%)	49.6	24.4	46.3	23.9	43.8	23.4
High-Risk Loans/Total Loans (%)	52.8	21.6	51.1	22.6	53.5	21.5
NPL/Total Loans (%)	3.4	3.4	3.0	4.5	1.7	3.1
Observations	50		48		48	

Panel C: Uninsured institutions

	2010 Q4		2012 Q3		2014 Q3	
	mean	std. dev.	mean	std. dev.	mean	std. dev.
Assets (billions)	9.0	19.8	10.5	23.9	13.5	28.2
Capital/Assets (%)	6.1	16.3	5.8	17.2	5.2	15.3
Lending HHI	0.7	0.2	0.7	0.2	0.7	0.2
Liquidity/Assets (%)	10.0	18.4	9.0	17.5	7.1	14.2
Core Deposits/Liabilities (%)	10.0	22.9	12.1	58.4	10.9	23.7
Reserves/Assets (%)	13.4	21.3	21.3	26.8	27.4	30.3
Loans/Assets (%)	43.9	34.5	42.2	34.2	41.8	35.5
High-Risk Loans/Total Loans (%)	68.7	31.2	69.7	32.2	69.3	32.8
NPL/Total Loans (%)	1.7	5.2	1.5	4.8	0.6	2.6
Observations	208		200		190	

Notes: This table reports descriptive statistics, aggregated to the top holder, for several key variables. The columns show the means and standard deviations, respectively, at the beginning of the sample (2010 Q4), the beginning of QE3 (2012 Q3), and the end of QE3 purchases (2014 Q3).

Table 2
IV Regression Results: Total Loans

Panel A: Uninsured dummy instrument

	Dependent Variable: Total loans (percent change)					
	QE2/MEP			QE3		
	(1)	(2)	(3)	(1)	(2)	(3)
Change in Reserves	0.58***	0.50***	0.19	0.21***	0.36**	0.74*
	(0.08)	(0.08)	(0.18)	(0.08)	(0.17)	(0.42)
ln(assets)		1.45***	2.30***		2.30***	3.12***
		(0.52)	(0.51)		(0.54)	(0.56)
CAR		0.42**	0.86***		0.76***	0.62***
		(0.17)	(0.18)		(0.21)	(0.20)
Lending HHI		3.11	10.9***		-6.00	-1.40
		(4.51)	(3.80)		(5.00)	(4.66)
Liquidity		0.20***	0.19***		-0.05	-0.01
		(0.05)	(0.04)		(0.04)	(0.04)
Core Deposits		-0.08**	0.00		0.01	0.03
		(0.03)	(0.03)		(0.06)	(0.06)
Country fixed effects	—	—	✓	—	—	✓
Observations	3,135	3,135	3,135	2,859	2,859	2,859
Wu-Hausman test (p-value)	0.00	0.00	0.12	0.10	0.09	0.13
First-stage F-statistic	217.5	248.8	62.6	267.6	55.9	19.6

Panel B: Uninsured and reserves-exempt dummy instruments

	Dependent Variable: Total loans (percent change)					
	QE2/MEP			QE3		
	(1)	(2)	(3)	(1)	(2)	(3)
Change in Reserves	0.59***	0.50***	0.14	0.21***	0.36**	0.90**
	(0.08)	(0.08)	(0.17)	(0.08)	(0.17)	(0.43)
ln(assets)		1.45***	2.25***		2.30***	3.12***
		(0.52)	(0.51)		(0.54)	(0.58)
CAR		0.42**	0.89***		0.76***	0.63***
		(0.17)	(0.18)		(0.21)	(0.20)
Lending HHI		3.12	10.9***		-5.97	-1.76
		(4.51)	(3.78)		(5.00)	(4.81)
Liquidity		0.20***	0.19***		-0.05	-0.01
		(0.05)	(0.04)		(0.04)	(0.05)
Core Deposits		-0.08**	0.00		0.01	0.04
		(0.03)	(0.03)		(0.06)	(0.06)
Country fixed effects	—	—	✓	—	—	✓
Observations	3,135	3,135	3,135	2,859	2,859	2,859
Wu-Hausman test (p-value)	0.00	0.00	0.19	0.10	0.09	0.05
First-stage F-statistic	109.0	124.6	32.0	133.8	28.0	9.9
Sargan χ^2-test (p-value)	0.37	0.84	0.09	0.23	0.00	0.00

Notes: This table reports two-stage least-squares estimates for different specifications of regressions of the percentage change in total loans on the change in reserves scaled by beginning assets and other covariates. In Panel A, the instrument for reserve accumulation is the uninsured dummy; in Panel B, both the uninsured and reserves-exempt dummies are used as instruments. Standard errors are reported in parentheses. The bottom rows show the p-values for the tests of endogeneity, the first-stage F-statistics for the joint significance of the coefficients on the instruments, and, if applicable, the p-values for the test of overidentifying restrictions, respectively. Statistical significance: $^{***}\ p < 0.01,^{**}\ p < 0.05,^{*}\ p < 0.10$.

Table 3
IV Regression Results: Higher-Risk Loans

Panel A: Uninsured dummy instrument

	Dependent Variable: Higher-Risk Loans (percent change)					
	QE2/MEP			QE3		
	(1)	(2)	(3)	(1)	(2)	(3)
Change in Reserves	1.27***	2.50***	1.75***	0.23**	0.27	1.58**
	(0.20)	(0.37)	(0.51)	(0.11)	(0.23)	(0.70)
ln(assets)		0.09	1.40		2.25***	2.98***
		(1.13)	(0.92)		(0.76)	(0.85)
CAR		2.55***	2.25***		0.74**	0.73**
		(0.39)	(0.31)		(0.30)	(0.31)
Lending HHI		10.15	18.49**		11.10	10.71
		(9.81)	(7.47)		(7.38)	(8.04)
Liquidity		0.27***	0.22***		-0.11*	-0.11
		(0.10)	(0.07)		(0.06)	(0.07)
Core Deposits		0.15*	0.11*		0.05	0.07
		(0.09)	(0.07)		(0.08)	(0.09)
Country fixed effects	—	—	✓	—	—	✓
Observations	3,126	3,126	3,126	2,849	2,849	2,849
Wu-Hausman test (p-value)	0.00	0.00	0.00	0.10	0.28	0.03
First-stage F-statistic	194.5	87.0	44.9	274.4	67.0	24.3

Panel B: Uninsured and reserves-exempt dummy instruments

	Dependent Variable: Higher-Risk Loans (percent change)					
	QE2/MEP			QE3		
	(1)	(2)	(3)	(1)	(2)	(3)
Change in Reserves	1.27***	2.48***	1.58***	0.22**	0.27	1.69**
	(0.20)	(0.37)	(0.49)	(0.11)	(0.23)	(0.70)
ln(assets)		0.09	1.41		2.25***	2.97***
		(1.12)	(0.90)		(0.76)	(0.86)
CAR		2.55***	2.26***		0.73**	0.75**
		(0.39)	(0.30)		(0.30)	(0.31)
Lending HHI		10.31	19.00***		11.16	10.12
		(9.77)	(7.28)		(7.38)	(8.12)
Liquidity		0.27***	0.22***		-0.11*	-0.11*
		(0.10)	(0.07)		(0.06)	(0.07)
Core Deposits		0.15*	0.10		0.04	0.08
		(0.09)	(0.06)		(0.08)	(0.09)
Country fixed effects	—	—	✓	—	—	✓
Observations	3,126	3,126	3,126	2,849	2,849	2,849
Wu-Hausman test (p-value)	0.00	0.00	0.00	0.10	0.29	0.02
First-stage F-statistic	97.7	43.8	23.4	137.2	33.5	12.3
Sargan χ^2-test (p-value)	0.99	0.52	0.09	0.87	0.24	0.21

Notes: This table reports two-stage least-squares estimates for different specifications of regressions of the percentage change in higher-risk loans on the change in reserves scaled by beginning assets and other covariates. In Panel A, the instrument for reserve accumulation is the uninsured dummy; in Panel B, both the uninsured and reserves-exempt dummies are used as instruments. Standard errors are reported in parentheses. The last three rows show the p-values for the tests of endogeneity, the first-stage F-statistics for the joint significance of the coefficients on the instruments, and, if applicable, the p-values for the test of overidentifying restrictions, respectively. Statistical significance: $^{***}\ p < 0.01,^{**}\ p < 0.05,^{*}\ p < 0.10$.

Table 4
IV Regression Results: Non-Performing Loans

Panel A: Uninsured dummy instrument

	Dependent Variable: Non-Performing Loans as a Share of Total Loans (percent change)					
	QE2/MEP			QE3		
	(1)	(2)	(3)	(1)	(2)	(3)
Change in Reserves	6.82***	5.81**	10.01**	10.87***	10.90	33.48*
	(1.81)	(2.28)	(4.14)	(3.66)	(7.00)	(18.90)
ln(assets)		-32.41***	-32.17***		-24.50***	-29.74***
		(7.01)	(7.56)		(8.99)	(8.93)
CAR		1.73	0.15		0.31	1.31
		(2.57)	(2.63)		(3.35)	(3.53)
Lending HHI		-15.58	1.05		78.98	0.77
		(61.38)	(62.37)		(71.64)	(89.43)
Liquidity		-0.02	-0.05		1.23**	0.70
		(0.62)	(0.61)		(0.62)	(0.76)
Core Deposits		-1.76***	-1.86***		-0.80	-0.99
		(0.55)	(0.54)		(0.97)	(1.06)
Country fixed effects	—	—	✓	—	—	✓
Observations	2,945	2,945	2,945	2,654	2,654	2,654
Wu-Hausman test (p-value)	0.00	0.01	0.02	0.01	0.16	0.07
First-stage F-statistic	149.6	91.34	62.5	259.9	71.9	15.3

Panel B: Uninsured and reserves-exempt dummy instruments

	Dependent Variable: Non-Performing Loans as a Share of Total Loans (percent change)					
	QE2/MEP			QE3		
	(1)	(2)	(3)	(1)	(2)	(3)
Change in Reserves	6.64***	5.78**	9.87**	10.75***	10.71	33.15*
	(1.80)	(2.26)	(4.05)	(3.66)	(6.96)	(18.67)
ln(assets)		-32.40***	-32.14***		-24.36***	-29.68***
		(7.01)	(7.54)		(8.97)	(8.90)
CAR		1.73	0.15		0.27	1.28
		(2.57)	(2.63)		(3.34)	(3.52)
Lending HHI		-15.38	1.63		79.87	1.74
		(61.32)	(62.19)		(71.52)	(88.90)
Liquidity		-0.03	-0.05		1.24**	0.71
		(0.62)	(0.61)		(0.62)	(0.76)
Core Deposits		-1.76***	-1.86***		-0.82	-1.01
		(0.55)	(0.53)		(0.97)	(1.05)
Country fixed effects	—	—	✓	—	—	✓
Observations	2,945	2,945	2,945	2,654	2,654	2,654
Wu-Hausman test (p-value)	0.00	0.01	0.02	0.01	0.17	0.07
First-stage F-statistic	75.3	46.3	32.7	130.1	36.3	7.8
Sargan χ^2-test (p-value)	0.22	0.92	0.87	0.40	0.79	0.90

Notes: This table reports two-stage least-squares estimates for different specifications of regressions of the percentage change in non-performing loans as a share of total loans on the change in reserves scaled by beginning assets and other covariates. In Panel A, the instrument for reserve accumulation is the uninsured dummy; in Panel B, both the uninsured and reserves-exempt dummies are used as instruments. Standard errors are reported in parentheses. The last three rows show the p-values for the tests of endogeneity, the first-stage F-statistics for the joint significance of the coefficients on the instruments, and, if applicable, the p-values for the test of overidentifying restrictions, respectively. Statistical significance: *** $p < 0.01$,** $p < 0.05$,* $p < 0.10$.

Table 5
Regression Results (uninsured and reserves-exempt dummy instruments): QE1

Panel A: IV regression results

	Total loans	Higher-risk loans	Non-performing loans
Change in Reserves	-0.27	-1.58	80.64
	(0.69)	(1.85)	(107.29)
ln(assets)	-0.87	-0.21	-19.28
	(0.54)	(0.98)	(25.20)
CAR	0.85***	2.52***	-8.25
	(0.17)	(0.46)	(18.51)
Lending HHI	0.38	36.14***	405.35
	(3.83)	(6.13)	(311.54)
Liquidity	0.22***	0.30***	8.33**
	(0.05)	(0.09)	(4.01)
Core Deposits	0.04	-0.08	-4.29
	(0.07)	(0.08)	(3.38)
Country fixed effects	✓	✓	✓
Observations	3,208	3,199	2,993
First-stage F-statistic	8.3	4.8	1.7

Panel B: Reduced-form regression results

	Total loans	Higher-risk loans	Non-performing loans
Uninsured	-2.52	-10.93	302.10
	(6.31)	(9.90)	(387.03)
Reserves Exempt	-1.33	-9.79	-52.72
	(4.45)	(6.98)	(220.76)
ln(assets)	-0.76	0.44	-19.14
	(0.50)	(0.78)	(23.88)
CAR	0.81***	2.16***	5.48
	(0.15)	(0.26)	(8.70)
Lending HHI	0.09	35.88***	571.59***
	(3.68)	(5.81)	(177.55)
Liquidity	0.23***	0.35***	5.68***
	(0.04)	(0.06)	(1.93)
Core Deposits	0.01	-0.15**	-2.07
	(0.04)	(0.07)	(2.15)
Country fixed effects	✓	✓	✓
Observations	3,208	3,199	2,993

Notes: This table reports two-stage least-squares estimates for regressions of the dependent variables on the change in reserves scaled by beginning assets and other covariates (Panel A) and reduced-form regression results of the dependent variables on the uninsured and reserves-exempt dummy instruments and other covariates (Panel B). The dependent variables are the percentage changes in total loans, in higher-risk loans, and in non-performing loans as a share of total loans. Standard errors are reported in parentheses. The last row in Panel A shows the first-stage F-statistics for the joint significance of the coefficients on the instruments. Statistical significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.