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# Quantitative easing and bank risk taking: evidence from lending

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**ABSTRACT**

We empirically assess the effect of reserve accumulation as a result of quantitative easing (QE) on bank-level lending and risk taking activity. To overcome the endogeneity of bank-level reserve holdings to banks' other portfolio decisions, we employ instruments made available by a regulatory change that strongly influenced the distribution of reserves in the banking system. Consistent with theories of the portfolio substitution channel in which the transmission of QE depends in part on reserve creation itself, we document that reserves created in two distinct QE programs led to higher total loan growth and an increase in the share of riskier loans, such as commercial real estate, construction, C&I, and consumer loans, within banks' loan portfolios.

**JEL classification:** G21, E52, E58, G28

**Keywords:** QE, bank lending, reserve balances, monetary policy, Federal Reserve, risk-taking channel, LSAP, portfolio substitution effect

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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-Jørgensen (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), Krishnamurthy and Vissing-Jørgensen (2013), and Di Maggio et al. (2016)).[1] Largely ignored, however, have been the effects stemming from the simultaneous 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 lending and 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 implement the unconventional monetary policy. We achieve two main results that demonstrate economically meaningful effects of changes in bank-level reserve balances on lending and risk-taking activity. First, we show that lending activity accelerates in response to increases in reserves. Second, we document that, in addition to inducing loan growth, higher reserves also led to a shift toward riskier loans, such

[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)).

as commercial real estate, construction, C&I, and consumer loans, *within* banks' loan portfolios. 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.

To estimate the causal effect of reserves on bank lending, a significant endogeneity challenge must be overcome. This is because, 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. Indeed, we find that simple OLS estimates that do not account for this endogeneity produce substantially attenuated estimates, implying that a correlational study of the effect of reserves on lending and risk taking would likely fail to detect any meaningful relationship.

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 (DIF). Specifically, Dodd-Frank required that the FDIC fee be transitioned from a deposit-based assessment to an assessment based on assets minus tangible equity. This increased the net costs of holding reserve balances for banks, which were predominantly funded using non-deposit wholesale borrowing.

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. In particular, branches and agencies of foreign banks established after December 19, 1991 do not receive deposit insurance and are thus exempt from any FDIC assessment. In addition, 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 bankers' banks and banks with a custodial business.

As a result, under the new assessment rule, depository institutions that were exempted from the FDIC fee faced a lower cost of holding reserves than those that were subject to the FDIC assessment on reserves. Therefore, the exempt institutions took up a disproportionately large share of the newly-created reserves. Dummy variables indicating 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.

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 with scarce reserves. Furthermore, the change in the assessment base mandated by Dodd-Frank was unexpected and altered the previous policy of assessing DIF fees based on domestic deposits, a policy that had been in place since 1935. Lastly, we note that in this instrumental variables framework, wherein exogenous instruments are based simply on the type and timing of a bank's charter as well as the classification as either a bankers' bank or custodial bank, the application of the instruments is independent of loan demand.

Institutions that are assessed the FDIC fee comprise domestic banks, U.S. chartered subsidiaries of foreign banks, and branches and agencies of foreign banks established before December 19, 1991. Because some foreign-owned banks are assessed the FDIC fee, we are able to include country-specific fixed effects in our regressions. These controls, and the presence of domestic bankers' banks and custodial banks in our sample, ensure that our instruments identify only the difference in banks' treatment status under the FDIC fee and not the foreignness of the exempt branches and agencies.

To support the validity of our instruments for reserves, we conduct a placebo test that shows that there is no explanatory power of our instruments in reduced form regressions estimated during a QE program carried out prior to the FDIC's regulatory change when no first stage is present. This test offers strong evidence that the exclusion restriction is not violated. In a series of robustness checks, we demonstrate that our results are not caused by differential risk aversion and lending opportunities arising from the European sovereign debt crisis, or differences in institutional characteristics between assessed and exempt banks such as bank size or the type of lending activity. Lastly, we use loan-level data from a proprietary U.S. credit register to show that the borrowers of insured and uninsured/reserves-exempt institutions drew down their outstanding credit lines at similar rates during our sample period. This result limits the possibility that the difference in lending growth that we observe is driven by differences in loan demand between assessed and unassessed institutions.

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. 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, Andrés 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. The low level of reserves in the banking system and the negligible variation in reserves prior to the financial crisis did not allow for reasonable statistical inference and may help explain the paucity of empirical studies on the impact of an increase in reserves on bank behavior. A notable exception is Christensen and Krogstrup (2016), wherein the authors examine three unique episodes in which the Swiss National Bank expanded reserves by purchasing only short-term debt securities. Christensen and Krogstrup (2016) 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.

In addition, our paper contributes to the literature on the impact of monetary policy on banks' investment decisions (Bernanke and Gertler (1995) and Kashyap and Stein (2000)), particularly as it relates to risk-taking effects caused by monetary policy. Much of the existing literature focuses on risk taking by financial institutions in low interest rate environments (see, for example, Maddaloni and Peydró (2011), Jiménez et al. (2014), Ioannidou et al. (2015), Di Maggio and Kacperczyk (2016), and Dell'Ariccia et al. (2016)) and in an environment with negative rates (Heider et al. (2016)), while our study is the first to provide evidence that QE-induced reserve expansion per se affects banks' risk-taking activity. Finally, our paper is related to the recent

[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.

work that assesses the impact of unconventional monetary policy in the form of large-scale asset purchases on banks' investment decisions (Chakraborty et al. (2016), Acharya et al. (2016), and Di Maggio et al. (2016), among others).

The remainder of this paper proceeds as follows: Section 2 reviews the transmission mechanism by which reserves affect bank behavior and details our identification strategy. Section 3 discusses the Federal Reserve's main QE programs and describes 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 shows the findings from a number of robustness checks. Section 7 concludes.

## 2. Reserve-Induced Portfolio Substitution Effects

### 2.1. Transmission Mechanism

Quantitative easing is characterized by large-scale asset purchases by the central bank. In the United States, the Federal Reserve implements QE by purchasing securities from authorized Primary Dealers, crediting reserve balances to the accounts of banks associated with each dealer counterparty. If the ultimate seller of the securities to the Federal Reserve is a bank, these reserve balances are effectively swapped for securities on the bank's balance sheet. If non-banks are the ultimate sellers of the securities to the Federal Reserve, reserves will still increase by the precise value of the securities purchased, but bank deposits will, at least temporarily, also rise. Regardless of the ultimate seller, the reserves created through QE must be held by banks and, as discussed in more detail in Section 2.2, will ultimately reside with the banks that face the lowest cost of holding those reserves. Throughout the QE programs in the United States, overnight wholesale borrowing costs have typically been below remuneration rates on reserves. Consequently, reserve balances have been funded predominantly through wholesale deposits, which did not require a reduction in holdings of other assets, as documented in McCauley and McGuire (2014) and discussed further in the next subsection.

The mechanism by which reserve creation affects financial and real markets is captured by theories of portfolio substitution that rely on the imperfect substitutability of reserves and other assets. According to Friedman and Schwartz (1963), following the creation of reserves, banks will have larger reserves than were deemed optimal, and will then seek to increase investments in securities and loans at a greater rate.[3] Similarly, Tobin (1969) also argues that a change in the supply of any asset will affect the entire structure of rates of return so that the public is induced to hold the new supply. Importantly, Tobin (1969) recognizes that 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.

As banks are forced to hold the higher supply of reserves, the marginal benefit of the reserves in banks' asset portfolios will decrease. Consequently, prices on various securities will be bid up, and additional loans will be made until the marginal benefit of the assets in banks' portfolios are restored to balance. Additionally, as longer term rates get pushed down by low policy rates, forward guidance, and QE programs, many securities banks are permitted to hold become closer substitutes for reserves. Thus, in the context of QE, banks are even more likely to look beyond liquid securities when evaluating which alternative assets to accumulate.[4]

We note that this transmission mechanism does not necessarily depend on a net increase in bank assets, nor does it depend on the ultimate seller of the securities purchased by the central bank.[5] Rather, the forced increase in reserves disturbs the bank's optimal portfolio allocation,

[3]Bianchi and Bigio (2014), in a general equilibrium framework, derive similar preditions for the aggregate banking system. In their model, as banks face a tradeoff between making profitable loans and liquidity risk, the injection of reserves into the banking system reduces banks' liquidity risk, which, in turn, induces banks to engage in additional lending.

[4]Gagnon et al. (2011), D'Amico and King (2013), and Kandrac and Schlusche (2013), for example, document a statistically significant increase in the prices of Treasuries and their close substitutes as a result of the Federal Reserve's Treasury purchases.

[5]If the ultimate seller of securities to the Federal Reserve is a bank, reserves are swapped for securities on the bank's balance sheet. If the ultimate seller is a non-bank, which Carpenter et al. (2015) show to be the case for different QE programs implemented by the Federal Reserve, the correspondent bank would see an increase in reserves on the asset side and an increase in deposits held by the non-bank. In either case, reserves at the bank involved in the transaction—either as the seller of its own securities or as the correspondent for a non-bank—increase. For details on the accounting framework for the Federal Reserve's securities transactions, see Ihrig et al. (2017).

simultaneously altering its net interest margin as well as the liquidity profile and the duration of its assets, and therefore induces banks to engage in portfolio reallocation.

Although the reserve-induced portfolio substitution effects described above do not require QE, we focus on the large variation in reserve balances that occurred during these periods. Our ultimate goal 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. Moreover, changes in reserves in periods outside of QE were minimal and, often, transient. In Section 3, 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.

### 2.2. Identification

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. However, 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. The lack of a reserve-rich monetary policy regime prior to the recent financial crisis may help explain the relative paucity of empirical research on the effects of a higher supply of reserves on broader 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, to empirically study reserve-induced portfolio substitution effects.

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 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 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 a comprehensive 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, and was a significant factor motivating reserve accumulation. 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 funding 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.[6] Thus, depending on the date of establishment, some foreign branches and agencies are subject to FDIC deposit insurance, although most 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, bankers' banks and banks with a custodial business were permitted to exclude their low risk, liquid assets including reserves from the calculation of their applicable assessment base (FDIC (2011)).[7]

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

[6] 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.

[7] 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, bankers' 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.

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.[8] In fact, the accumulation of reserves happened somewhat before the implementation for two reasons. First, the new FDIC assessment base was 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. This pattern is consistent with the reasoning above, whereby reserves should accumulate at those institutions that have the lowest net costs of holding reserves.

As instruments for reserves, we use two separate dummy variables indicating that a de-

[8]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 bankers' banks and custodial banks.

pository 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.[9] 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. Lastly, we note that in this instrumental variables framework, wherein exogenous instruments are based simply on the type and timing of a bank's charter as well as the classification as either a bankers' bank or custodial bank, the application of the instruments is independent of loan demand.

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

[9] 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.

adjustments.[10] 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 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). In the following, we outline the primary large-scale asset purchase programs that the Federal Reserve carried out since 2008 (QE1, QE2, the maturity extension program (MEP), and QE3) and explain each program's effects on reserves in the banking system.

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.[11] By the end of the first quarter of 2010, QE1 purchases had concluded,

[10] In Appendix A, we demonstrate that the higher overall cost of funding imposed by the FDIC fee on assessed institutions cannot explain the results we achieve in Section 5.

[11] 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)).

totalling $172 billion of agency debt, $1.25 trillion of MBS, and $300 billion of Treasury securities.[12]

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 Market 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.

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

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

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 2.2, 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.[13] 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.

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 of agency MBS per month. 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.

Figure 1 shows that reserves expanded more during QE3 than in any previous QE program. Although the par value of securities purchases was roughly the same as in 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.

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

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 2.2. 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.[14]

## 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.[15] 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. In the first row, we report the average assets of each group. Uninsured institutions are larger than assessed institutions on average, and average assets of reserves-exempt banks are substantially larger than both groups. However, the distribution of bank assets is highly right-skewed. Comparing the median assets of the three groups reveals a similar ordering of the groups, but less severe differences. Specifically, as of 2010 Q4, assessed, reserves-exempt, and uninsured institutions have median assets of \$0.4, \$3.0, and

[14] 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.

[15] Almost half of the foreign banking organizations are headquartered in Asia and Australia, and roughly thirty percent are headquartered in Europe. The remaining twenty percent of institutions are evenly distributed between Canada, South America, and the Middle East and Africa.

$0.7 billion, respectively.[16] 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 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. Next, we report a measure of liquidity, calculated as the ratio of securities to total assets.

In addition to these bank-level characteristics, Table 1 reports reserves as a share of assets, which is calculated from banks' filings by using their reported assets due from the Federal Reserve.[17] 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 characterize 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 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

[16] In the robustness checks included in Section 6, we show that our results are robust to a more restrictive asset size filter for FDIC-assessed institutions that results in a value of median assets that is very similar to uninsured institutions.

[17] 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.

those that do not can test the theories put forth by Friedman and Schwartz (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 through 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. This is because, for any given interest rate, banks will first choose the lending opportunities with the highest risk adjusted return. Thus, if banks reach further into their lending opportunity set as a consequence of portfolio substitution, this would likely 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 bankers' 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 bankers' banks.[18]

Although Table 1 reveals some differences in observable characteristics such as total assets between the groups, lending patterns evolved in a similar fashion prior to the change in the FDIC assessment base. In Figure 5, we plot the time path of total lending, averaged across institutions according to their treatment under the FDIC assessment rule. We see that lending activity clearly began to diverge after the announcement of the change in the FDIC assessment fee and during QE-induced reserve injection, with those institutions that accumulated most reserves witnessing a substantially faster pace of expansion in their loan portfolios. Prior to the announcement, lending and risk-taking behavior did not exhibit divergent patterns. While this figure is consistent with the description of a reserves-induced transmission channel for QE described in Section 2, we present a more formal analysis of the relationship between reserve accumulation and lending activity in the following section.

# 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:

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

$$\left( \frac{\Delta Reserves_i}{Assets_i} \right) = \alpha + \gamma_1 \cdot \text{Uninsured}_i + \gamma_2 \cdot \text{Reserves Exempt}_i + \boldsymbol{\Phi' x_i} + \eta_i. \tag{2}$$

where the outcome variable $\Delta y_i$ 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. These bank-level covariates include the log of total assets, the capital-to-asset ratio, the lending Hirschman-

[18] 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 bankers' banks).

Herfindahl Index (HHI), the ratio of securities to total assets as a liquidity measure, and core deposits scaled by total liabilities. In some specifications, we also include home country fixed effects as additional controls. Because we estimate equation (1) only in the cross section for each QE program, our country fixed effects absorb the differential behavior of foreign institutions driven by home effects, such as financial conditions, the stance of monetary policy, or financial regulation. Moreover, although there is an insufficient number of home countries to cluster errors along this dimension, the inclusion of country dummies ensures unbiased standard errors, as described in Petersen (2009), obviating the need for clustering.

The change in reserves relative to assets for each bank is the endogenous variable of interest for which we instrument. As discussed in Section 2.2, 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. As shown in equation (2), the first instrument (Uninsured) denotes the FDIC insurance status of a bank, while the second instrument (Reserves Exempt) identifies a bank's status as either a custodial or bankers' bank.

We prefer to use two separate instruments, because banks that qualify as custodial or bankers' 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, $\rho$ can be calculated using the Wald formula as follows:

$$\rho = \frac{\mathbb{E}\left[\Delta y_i | D_i = 1\right] - \mathbb{E}\left[\Delta y_i | D_i = 0\right]}{\mathbb{E}\left[\frac{\Delta Reserves_i}{Assets_i} | D_i = 1\right] - \mathbb{E}\left[\frac{\Delta Reserves_i}{Assets_i} | D_i = 0\right]} . \tag{3}$$

Equation (3) reveals that the Wald estimate of the effect of reserve accumulation on an outcome variable ($\rho$) equals the difference-in-differences (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 differences 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 2SLS results including various exogenous independent covariates to evaluate the robustness of our estimates. 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 between 2010 Q4 and 2012 Q3, as well as the QE3 purchases between 2012 Q3 and 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.[19] For all regressions, we order the magnitudes of the dependent variable and drop 0.25% of observations from the top and bottom, while also excluding banks that did not hold any reserve balances at the end of the QE programs. Jointly, these filters exclude relatively few banks, and the results are not qualitatively sensitive to the precise values used to filter banks.

Turning to our first dependent variable, Table 2 reports results for regressions of the

[19] 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.

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 bankers'/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. Relatively large $F$-statistics reported at the bottom of each panel indicate strong instruments. Notwithstanding the inclusion of individual country dummies in the final specifications, which load for all FDIC-uninsured institutions, the $F$-statistics are still high, offering strong evidence that the assessment status of the institutions, and not simply the foreignness of the branches and agencies, is a reliable predictor of reserve accumulation.

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 risks to financial stability are commonly cited as a potential 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, which can be understood by recognizing that the NPL ratios in QE3 would reflect lending decisions made during *both* QE2/MEP and QE3. The full specifications in the QE3 period show that the estimated effect of a one percentage point increase in reserves relative to beginning assets corresponds to a roughly 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 outright 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.

The OLS estimates reported in the first columns of Tables 2-4 attest to significant attenuation bias when not accounting for the endogeneity of reserve holdings. Point estimates are either statistically not different from zero, or substantially smaller than the 2SLS estimates. Consequently, a correlational analysis of the effect of bank reserves on lending and risk-taking activity would be unlikely to identify a meaningful relationship.

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 transition dynamics in banks' liabilities. In Appendix A, we further discuss the effects of the FDIC fee on banks' liabilities, and demonstrate that these effects are unlikely to generate our results.

However, we are able to offer even stronger 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). Although the QE1 purchases were announced just after the peak of the height of the financial crisis, the asset purchases began somewhat later and continued well into 2010. For this reason, our QE1 sample period runs from 2008 Q4 until 2010 Q3. Despite the unique financial environment that existed very early in the sample period, most of our QE1 sample covers a period after the end of the U.S. recession when financial markets were functioning more normally.

In Panel A of Table 5, we report IV regression results for the QE1 period 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. Furthermore, the first-stage $F$-statistics for regressions of reserve accumulation on our instruments are very low on average—well below the standard threshold of 10. As indicated in the memorandum item, the $F$-statistics for the most basic specification with no additional control variables are also very low. This stands in contrast to our main results, and offers further support that reserve accumulation in QE1 was unrelated to banks' FDIC assessment status. Therefore, we conclude that no first stage existed during QE1.

Turning to the reduced form estimates for each dependent variable in Panel B, we see that all coefficient estimates for the instruments are not statistically 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 should be more generalizable.

## 6. Robustness

In the subsections below, we offer several robustness checks in order to rule out alternate possible explanations of the results achieved above.

### 6.1. Matched Sample

As shown in Table 1, the reserves-exempt and uninsured institutions differ in some respects from the sample of assessed institutions. In our first robustness check, we aim to limit the sample to the most comparable institutions in our sample. Specifically, we use a propensity score matching technique to identify FDIC-assessed nearest neighbors of each uninsured and reserves-exempt institution. In order to combat the efficiency loss that stems from IV techniques and still maintain a similar comparison group, we select two assessed institutions for every uninsured and reserves-exempt institution. The matched sample predominantly includes insured branches and agencies of foreign banks, insured subsidiaries of foreign banks, and large domestic institutions that are not categorized as custodial or banker's banks.[20] With this sample, we then proceed by estimating a series of 2SLS regressions, as above.

For both QE2 and QE3, we match on beginning-of-period total assets, liquidity, capital-to-asset ratios, lending HHI, core deposits as a share of liabilities, repo borrowing as a share of liabilities, loans-to-asset ratios, and the share of total lending composed of each of the following five types of loans: residential real estate, construction and development, commercial and industrial, commercial real estate, and loans to financial institutions. Although our instruments are exogenous to loan demand, the nature of lending by larger banks or banks that primarily engage in a particular type of lending (e.g. real estate lending rather than lending to financial institutions) could potentially be correlated with our instruments. Consequently, matching on these variables limits the concern that our results are driven by variation that simply emanates from structural differences in the types of lending between our instrumented institutions and the FDIC-assessed institutions.

The outcome for this exercise is reported in Table 6.1. Although the $F$-statistics decrease somewhat, the strength of our instruments is still apparent. Moreover, the pattern of the point estimates is similar to the full-sample results and the estimates generally achieve conventional levels of statistical significance in spite of the relatively small sample size. Thus, our main findings cannot be explained by differences in institutional characteristics such as bank size or the type of lending activity.

### 6.2. Size Differential

In our second robustness check, we perform an alternative sample selection criteria by imposing a higher minimum asset filter on the assessed institutions. As mentioned in Section 4, dropping the smallest 50% of domestically-chartered U.S. banks still results in a median bank that is smaller

[20] As a result of the matching algorithm, all insured branches and agencies are matched to uninsured institutions.

than the median uninsured institution ($0.4 billion versus $0.7 billion at the beginning of the sample). If we instead limit the sample to the top 25% of domestic banks by assets, the median bank in this sample is only 3% smaller than the median uninsured institution. This exercise could potentially reveal if we have merely picked up a size effect that, perhaps due to nonlinearities, is inadequately controlled for by including the natural log of assets.

The outcome of this exercise is reported in Panel A of Table 7. For brevity, we present only our most basic specifications with both instruments, but the results are very similar across other specifications and yield identical conclusions. The results in Panel A show point estimates similar to those achieved when including smaller domestic banks, ruling out a size-based explanation of our conclusions.

### 6.3. European Sovereign Debt Crisis

In our next robustness check, we consider the possible spillover effects associated with the European sovereign debt crisis from 2010-2012 (Lane (2012)). Since many of the banks exempt from the FDIC fee are foreign-affiliated institutions, shocks related to the crisis could be correlated with our instrument. Although the debt crisis does not overlap with the QE3 sample period, it does coincide with the QE2/MEP sample period, and the effects of the crisis on branches and agencies of foreign banks operating in the United States could be affected by the home-country developments (see Correa et al. (2016)). It is also possible that effects of the sovereign debt crisis produced lasting effects that could in some way taint our QE3 estimates.

If the debt crisis sparked a broad reduction in foreign banks' lending and risk taking in their U.S. affiliates, as shown in Ivashina et al. (2015), the key results reported in Tables 2-3 would be underestimates of the effect of reserves on risk-taking. Conversely, if domestic lending opportunities dried up for Eurozone banks during the debt crisis, they could possibly be more eager to expand lending and take more risk in markets abroad, including the United States. Under this scenario, our results could be overstated.

To rule out the European debt crisis as a significant factor in our results, we exclude all

Eurozone banks from our sample and report the new estimates in Panel B of Table 7.[21] About one fourth of all FDIC-exempt institutions are owned by foreign banks headquartered in the Eurozone. The results are similar to the full-sample results, with most of the coefficient estimates lying above those estimated using the full sample. We can therefore conclude that, if anything, the effects of the Eurozone debt crisis bias against our main results.

### 6.4. Foreign Agency Exclusion

Another possible concern relates to the types of foreign banking institutions included in our sample, and how different in nature these institutions are from the FDIC-insured institutions. Specifically, we include both branches and agencies of foreign banking organizations in our sample. However, foreign agencies engage in more commercial lending related to international transactions, while only accepting relatively short-term deposits related to these transactions. Alternatively, foreign branches are able to readily accept deposits, and the foreign branch structure also permits a full range of banking services and types of lending. For these reasons, the scope of banking activities undertaken by branches is much more similar to domestic banks. Thus, the presence of foreign agencies may bias the results if they are substantially different from assessed institutions in a way that is related to their particular type of commercial lending rather than their reserve accumulation alone.

Although foreign branches outnumber agencies over 5-to-1 in our sample, we nevertheless drop foreign agencies, and produce estimates in Panel C of Table 7. The point estimates, significance, and $F$-statistics are all very similar to the main results, suggesting that no bias is introduced as a result of including the agencies of foreign banking organizations in our set of uninsured and unassessed institutions.

[21] The results are very similar if we limit the exclusion to the banks based in the peripheral countries of Greece, Ireland, Italy, Portugal, and Spain.

### 6.5. Alternate Endogenous Regressor

In the final panel of Table 7, we consider an alternate formulation of our endogenous regressor. Specifically, we account for the possibility that banks that accumulated the most reserves over each program may have also increased their assets by a substantial amount, holding their reserves-to-assets ratio roughly constant over the QE period. Thus, we consider the *change* in banks' reserves-to-assets ratio over each program, where assets are (as reserves) measured at the beginning and end of each QE program:

$$\Delta\left(\frac{Reserves_i}{Assets_i}\right) \tag{4}$$

As seen in Panel D, $F$-statistics remain high for this formulation of the endogenous regressor, and the coefficient estimates remain positive and significant throughout, with a similar ordering of the magnitudes.

### 6.6. Loan Demand

In a final robustness test, we investigate whether uninsured and reserves-exempt institutions faced meaningful differences in loan demand during the QE programs. Although the matched-sample exercise above offers some evidence that factors relating to loan demand do not drive our results, the exercise below aims to bring more direct evidence to bear on the possibility that differences in loan demand could undermine the interpretation of our results.

To measure loan demand, we use a large, proprietary data set of outstanding credit lines. In particular, we focus on drawdowns of existing lines of credit, rather than the creation of new credit lines, which are affected by loan supply. Credit line drawdowns are an important means for borrowers to satisfy their funding needs and therefore changes in drawdowns are reflective of changes in loan demand (Black and Rosen (2016)). For example, although credit supply contracted during the onset of the financial crisis, borrowers drew heavily on their credit lines to meet their liquidity needs amidst concerns about their access to funding, which in turn resulted in an increase in lending on banks' books (Ivashina and Scharfstein (2010)).

Our sample of credit lines is obtained from the Shared National Credit (SNC) database. The SNC database is a confidential credit register maintained by the Board of Governors of the Federal Reserve System, the Federal Deposit Insurance Corporation, and the Office of the Comptroller of the Currency. SNC data contain information on all U.S. syndicated loans or loan commitments exceeding $20 million at origination that are shared by at least three unaffiliated supervised institutions.[22] Loans meeting these criteria are reviewed each year in May using loan information as of December 31 of the prior year or, in some cases, as of March of the same year. Committed and utilized amounts by syndicate participants can be tracked over time for each loan, in contrast to other syndicated loan databases such as DealScan. Lending reported in the SNC database accounts for a large share of the C&I loans on banks' balance sheets. In 2009, loan commitments (including credit lines and term loans) reported in the SNC database totaled $2.9 trillion, of which about half were drawn. Banking organizations operating in the United States held almost 80 percent of the total loan commitments. This compares with total C&I loans on commercial banks' balance sheets of around $1.5 trillion in the same year. Revolving lines of credit, which are held almost entirely by banks, composed the majority of loan commitments, but total utilization was smaller than that of term loans (Aramonte et al. (2015)).

We extract a sample of credit lines that includes revolving and non-revolving lines of credit between 2008 and 2014. We restrict our sample to credit lines that were originated prior to the beginning of our QE sample periods to eliminate loan supply effects that may confound the analysis. Further, we limit the sample to include only those loans that remained in existence throughout the QE sample periods. In some specifications, only credit lines that were drawn upon during the respective sample periods are considered. For each lender-loan-year triple, we compute drawdowns as the share of the drawn loan amount to the committed loan amount, and winsorize these drawdowns at the $99^{th}$ percentile. Finally, we merge these data with information on banks' FDIC status from our main dataset.

[22]General information on the SNC program is available at `https://www.newyorkfed.org/banking/reportingforms/shared_national_credits.html` and `https://www.federalreserve.gov/supervisionreg/snc.htm`. Aramonte et al. (2015) and Irani and Meisenzahl (2017) contain detailed descriptions of the SNC database.

To test for differences in loan demand that may explain our results above, we use a difference-in-differences framework and estimate ordinary least-squares regressions of the following form:

$$Drawdown_{i,j,t} = \alpha + \boldsymbol{\beta' (year_t \times treat_{i,j})} + year_t + \psi_i + \varepsilon_{i,j,t}, \tag{5}$$

where the outcome variable $Drawdown_{i,j,t}$ is the ratio of the utilized loan amount to the committed loan amount for bank $i$'s holding of loan $j$, times 100; $year_t$ are year dummies; and $treat_{i,j}$ is a dummy that equals one if bank $i$ is an uninsured or reserves-exempt institution. Finally, we include a full complement of bank fixed effects, denoted $\psi_i$. The coefficients of interest, $\boldsymbol{\beta}$, correspond to yearly treatment effects, and measure the difference in loan demand between our uninsured and reserves-exempt banks (the treatment group) and assessed banks (the control group). Finding a null result for the treatment effects would demonstrate that credit demand was similar across institutions regardless of FDIC assessment status, and thus offer strong evidence in support of the supply-driven interpretation of the main results.

The analysis is conducted separately for the QE1 sample period and the period after the change in the FDIC assessment, spanning the years of the QE2/MEP and QE3 programs. The results for the two sample periods are shown on the left- and right-hand side of Table 8, as indicated. In Panel A, the treatment group comprises uninsured institutions only. For the QE1 period, coefficient estimates on the interaction terms are all insignificant when considering the entire sample of credit lines. Similar results are obtained for the sample of only credit lines that were drawn upon. Turning to the right hand side of Table 8, we do not find any differences in drawdowns between assessed and unassessed banks for the QE2/MEP & QE3 period. Panel B shows the analogous results for regressions in which the treatment group comprises both uninsured and reserves-exempt institutions. As before, the point estimates of annual differences in loan demand are very small and statistically insignificant in all cases.

In sum, insured and uninsured/reserves-exempt institutions experienced the same drawdown intensity in our sample. These results suggest that the difference in lending activity reported in our main analysis is unlikely to be driven by differences in loan demand between the borrowers of assessed and unassessed institutions. Rather, the lending response to reserve accumulation identified earlier seems to be a result of banks' credit supply decision.

## 7. 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 can 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 transmission of monetary policy. 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 increase in the share of riskier loans 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 the newly created base money, we show that QE's financially stimulative effects can also arise simply as a result of the reserve creation itself.

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# Appendix

## Appendix A. The FDIC fee, banks' funding costs, and loan supply

In this appendix, we consider the possibility that the change in banks' funding costs engendered by the change in the FDIC fee could affect loan supply in such a way as to generate the results achieved in Sections 5 and 6. In other words, it may be that the partial effect of the increase in costs of non-deposit liabilities can explain the lending and risk-taking patterns we observe. However, this explanation seems implausible for two reasons:

First, the FDIC assessment fee is very low relative to the interest rate on loans, and is not likely to play a crucial role in the difference in loan supply. Moreover, banks fund loans with deposit liabilities on the margin, which were assessed the FDIC fee prior to the change. Consequently, the assessment of non-deposit liabilities should not play a significant role in the determination of a bank's loan supply schedule.

Second, under reasonable assumptions, a comparative statics exercise using a stylized model of lending shows that any additional cost of funding loans as a result of the FDIC fee would, if anything, lead to a downward bias in our estimates of the effects of reserves *per se* on loan supply. Consider a model of lending that is described by the following equations for loan demand ($L^D$) and loan supply ($L^S$):

$$L^D = L\Big(\underset{-}{i}, \Gamma\Big) \tag{6}$$

$$L^S = L\Big(\underset{+}{i}, \underset{-}{c}, \Psi\Big) \tag{7}$$

In the above equations, $i$ represents the risk-adjusted interest rate on loans, $c$ is banks' funding cost, and $\Gamma$ and $\Psi$ subsume other factors affecting loan demand and supply, respectively. To the extent that the FDIC fee implies higher funding costs, $c$, for assessed institutions, relative to unassessed institutions, the two groups' loan supply schedules can be represented as in Figure A1. A bank not assessed an FDIC fee would supply more loans for a given $i$, shown by $L_1^S$ in Figure A1. Alternatively, an assessed institution's loan supply curve is depicted by $L_0^S$.

Over the course of QE3—selected for illustrative purposes since it represents a sample period well after the change in the FDIC fee—we see that loan demand increases from $L^D_{PreQE3}$ to $L^D_{PostQE3}$, as indicated by the red arrow in Figure A1. The outright increase (rightward shift) of loan demand during QE3 is supported in the data. For example, the Federal Reserve's Senior Loan Officer Opinion Survey on Bank Lending Practices (SLOOS) reports a robust increase in commercial lending demand over this period.

The volume of lending in this stylized example increases by the same amount for each bank. However, since we measure the percent change in lending over each QE program, the higher base of the unassessed institution ($L_{1,PreQE3} > L_{0,PreQE3}$) implies that the loan supply differential resulting from the difference in the application of the FDIC fee leads to a *smaller* percent increase in lending over the course of the QE program. Thus, this would bias *against* the results reported in Sections 5 and 6.

In Figure A1, we assume, for simplicity, that both assessed and unassessed banks face the same demand curve; however, since our lending outcome variables are percent changes, this analysis only requires a similar increase in loan demand. This assumption seems reasonable as additional data in the SLOOS point to similar growth in C&I loan demand for foreign and domestic banks in each quarter during our QE3 sample. In any case, our instruments—which are based on the type and timing of each banks' charter and the classification of a bank as either a custodial or bankers bank—are exogenous to individual banks' loan demand during 2013-2014.

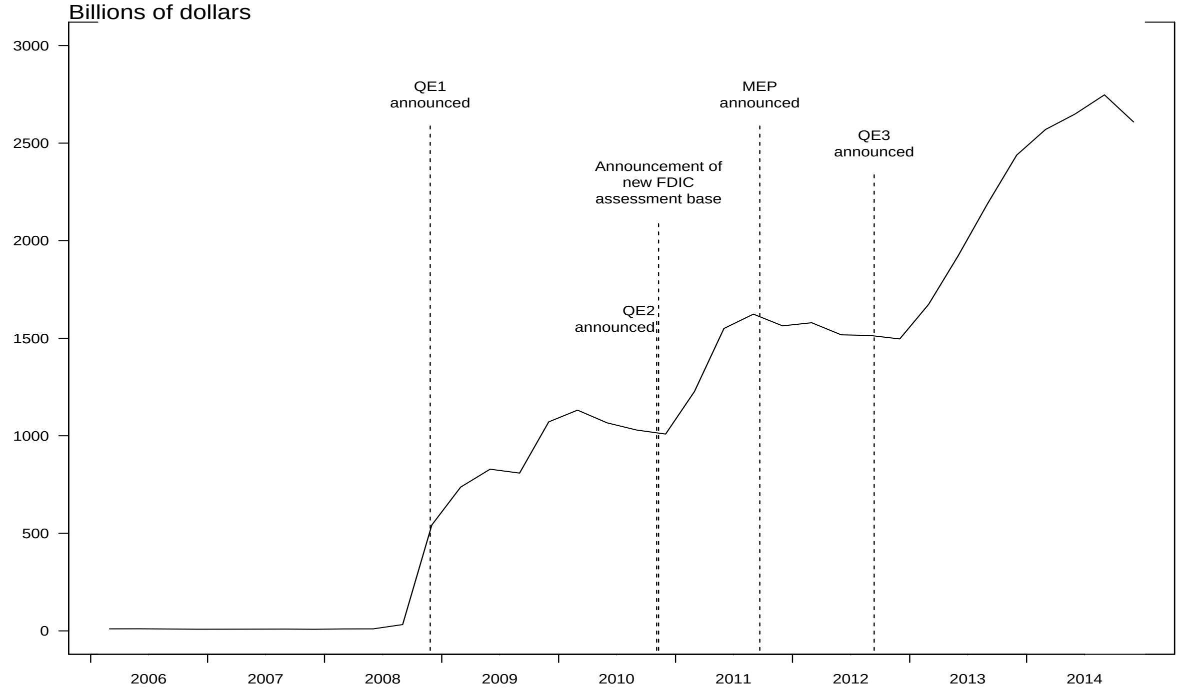


**Figure 1. Total Reserves**. This figure plots the evolution of total reserve balances from 2006 through 2014. The dashed vertical lines indicate the announcement dates for the new FDIC assessment base and for various QE programs and the maturity extension program (MEP).

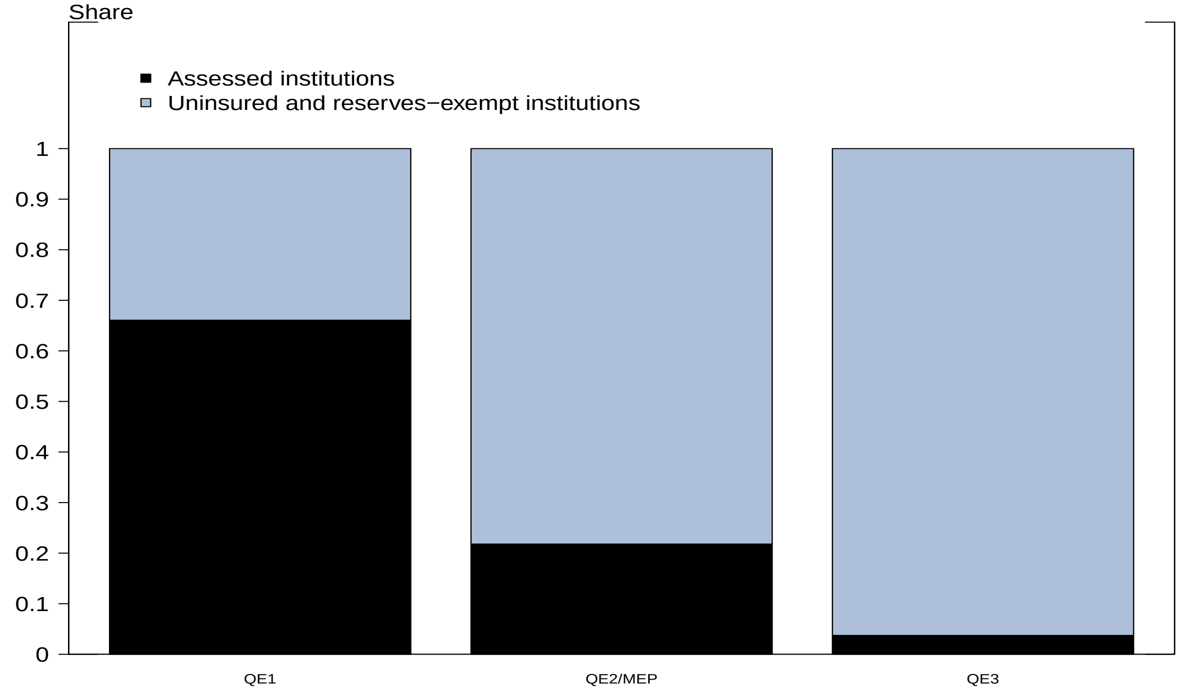


**Figure 2. Share of Reserve Accumulation**. This figure shows the shares of reserve accumulation by reserve-assessment status relative to the increases in reserve balances associated with QE1,QE2/MEP, and QE3.

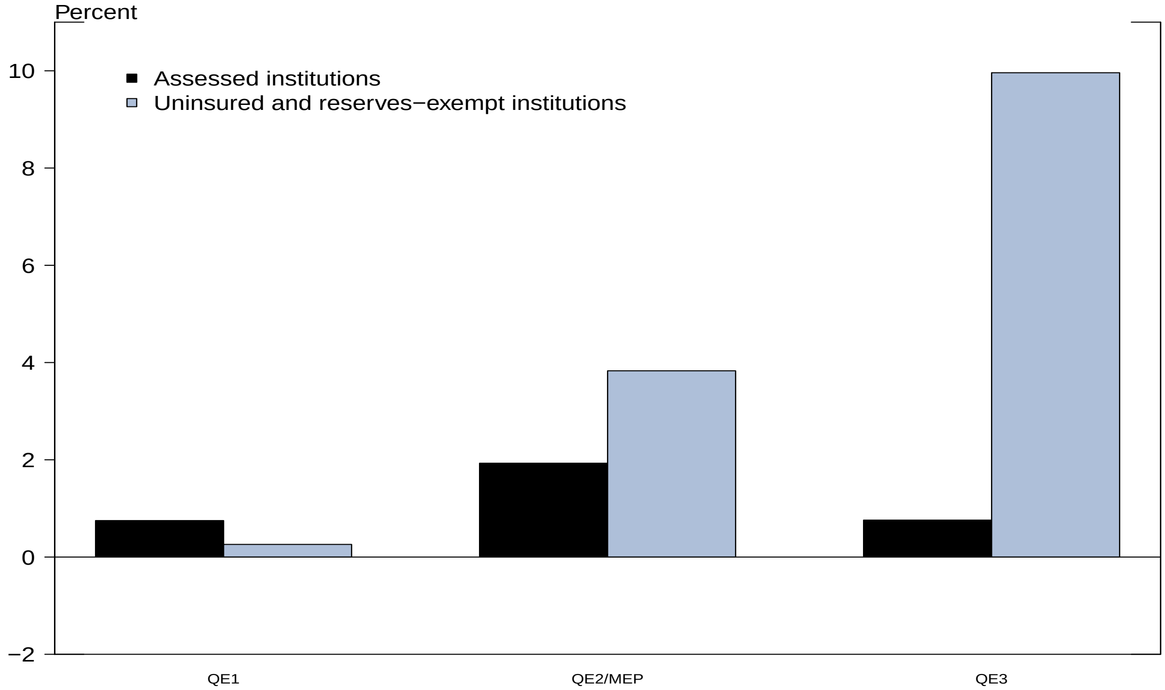


**Figure 3. Change in Reserves**. This figure shows the changes in banks' reserves scaled by beginning assets by reserve-assessment status for the increases in reserve balances associated with QE1,QE2/MEP, and QE3.

**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: $\Delta$ 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.

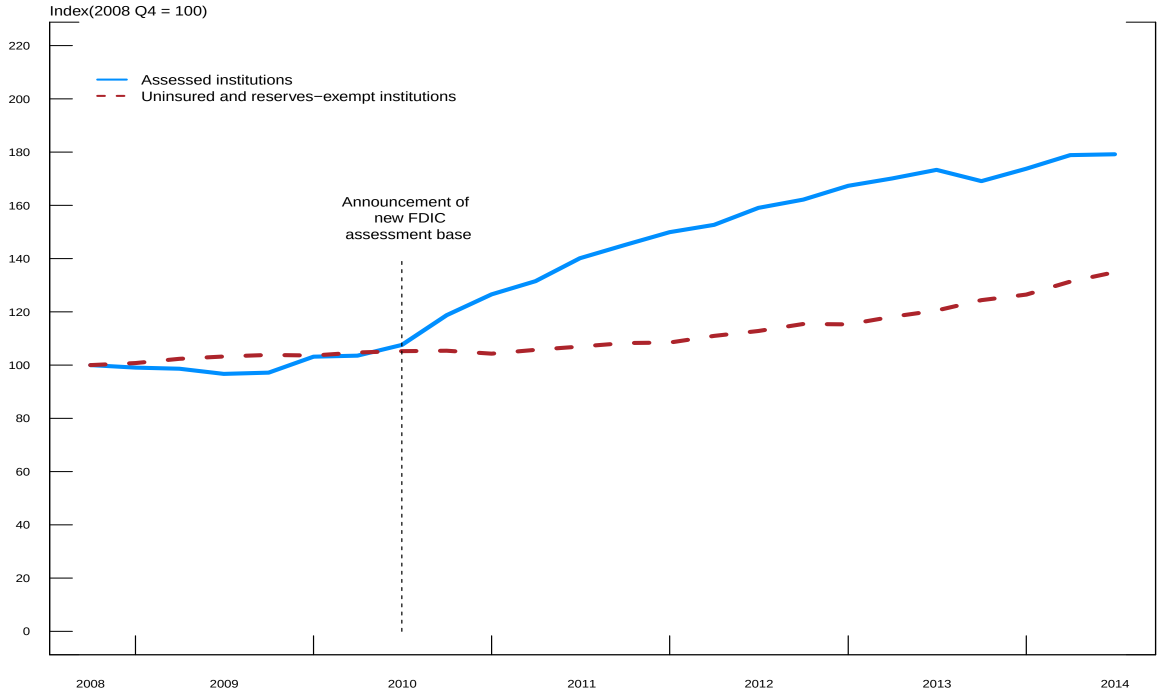


**Figure 5. Total Loan Growth by Reserve-Assessment Status**. This figure shows the evolution of total loans by reserve-assessment status from 2008 Q4 through 2014 Q3. Total loans are indexed to equal 100 at the beginning of the sample.

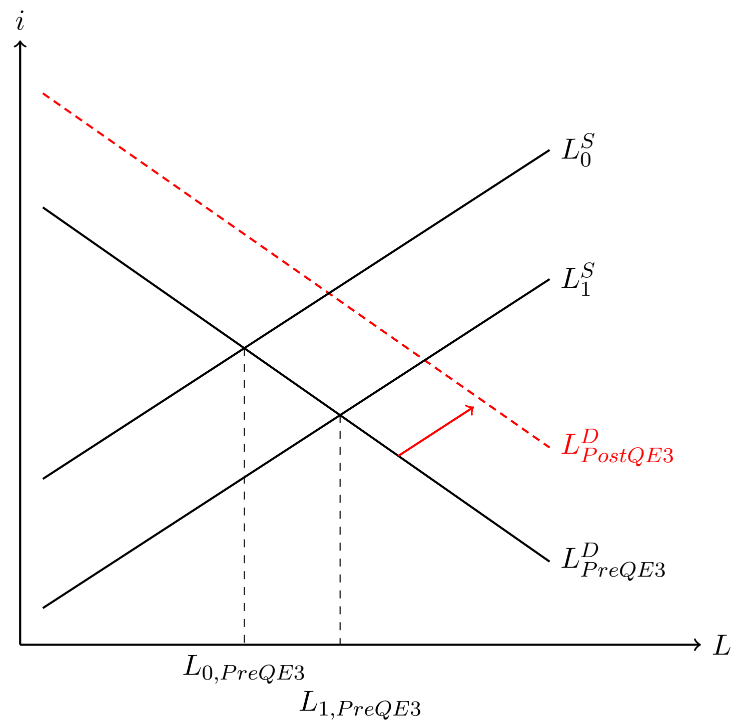


**Figure A1. Loan Supply and Demand.** This figure depicts loan demand pre- and post-QE3 and loan supply schedules for assessed and unassessed institutions.

**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) | 1.3 | 7.3 | 1.5 | 8.7 | 1.8 | 10.8 |
| Capital/Assets (%) | 10.1 | 3.8 | 10.8 | 3.0 | 10.9 | 3.3 |
| Lending HHI | 0.4 | 0.1 | 0.4 | 0.1 | 0.4 | 0.1 |
| Liquidity/Assets (%) | 20.1 | 13.3 | 22.6 | 14.5 | 22.7 | 14.5 |
| Core Deposits/Liabilities (%) | 71.1 | 15.9 | 76.5 | 11.2 | 77.9 | 11.9 |
| Reserves/Assets (%) | 3.9 | 5.0 | 4.7 | 5.7 | 3.7 | 5.0 |
| Loans/Assets (%) | 65.7 | 13.4 | 63.0 | 14.0 | 64.9 | 14.4 |
| High-Risk Loans/Total Loans (%) | 52.0 | 19.7 | 51.3 | 19.8 | 51.7 | 20.1 |
| NPL/Total Loans (%) | 3.7 | 4.3 | 2.8 | 3.4 | 1.6 | 2.2 |
| Observations | 3206 | | 3025 | | 2769 | |

**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 | | | |
| | OLS | 2SLS | | | OLS | 2SLS | | |
| | | (1) | (2) | (3) | | (1) | (2) | (3) |
| Change in Reserves | 0.09*** | 0.58*** | 0.50*** | 0.24 | 0.09*** | 0.21*** | 0.31* | 0.73* |
| | (0.02) | (0.08) | (0.08) | (0.17) | (0.02) | (0.08) | (0.18) | (0.42) |
| ln(assets) | | | 1.34** | 2.53*** | | | 3.09*** | 4.24*** |
| | | | (0.57) | (0.58) | | | (0.58) | (0.63) |
| CAR | | | 0.41** | 0.95*** | | | 0.82*** | 0.64*** |
| | | | (0.19) | (0.23) | | | (0.22) | (0.21) |
| Lending HHI | | | 3.15 | 11.4*** | | | -6.72 | -1.29 |
| | | | (4.54) | (3.90) | | | (5.03) | (4.67) |
| Liquidity | | | 0.20*** | 0.19*** | | | -0.06 | -0.02 |
| | | | (0.05) | (0.04) | | | (0.04) | (0.04) |
| Core Deposits | | | -0.08** | -0.01 | | | -0.01 | 0.01 |
| | | | (0.04) | (0.03) | | | (0.06) | (0.06) |
| Country fixed effects | — | — | — | ✓ | — | — | — | ✓ |
| Observations | 3,090 | 3,090 | 3,090 | 3,090 | 2,816 | 2,816 | 2,816 | 2,816 |
| Wu-Hausman ($p$-value) | | 0.00 | 0.00 | 0.05 | | 0.10 | 0.09 | 0.12 |
| First-stage $F$-statistic | | 215.6 | 260.6 | 65.0 | | 264.4 | 53.0 | 13.3 |

**Panel B: Uninsured and reserves-exempt dummy instruments**

| | Dependent Variable: Total loans (percent change) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | QE2/MEP | | | | QE3 | | | |
| | OLS | 2SLS | | | OLS | 2SLS | | |
| | | (1) | (2) | (3) | | (1) | (2) | (3) |
| Change in Reserves | 0.09*** | 0.59*** | 0.50*** | 0.14 | 0.09*** | 0.21*** | 0.36** | 0.90** |
| | (0.02) | (0.08) | (0.08) | (0.17) | (0.02) | (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 | 3,135 | 2,859 | 2,859 | 2,859 | 2,859 |
| Wu-Hausman ($p$-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 $\chi^2$ ($p$-value) | | 0.37 | 0.84 | 0.09 | | 0.23 | 0.00 | 0.00 |

Notes: This table reports ordinary least-squares (OLS) and two-stage least-squares (2SLS) 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. The sample periods are 2010 Q4 - 2012 Q3 for QE2/MEP and 2012 Q3 - 2014 Q3 for QE3. 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 | | | |
| | OLS | 2SLS | | | OLS | 2SLS | | |
| | | (1) | (2) | (3) | | (1) | (2) | (3) |
| Change in Reserves | 0.20*** | 1.27*** | 2.55*** | 1.90*** | 0.04 | 0.22** | 0.38* | 2.00** |
| | (0.04) | (0.20) | (0.38) | (0.53) | (0.03) | (0.11) | (0.23) | (0.91) |
| ln(assets) | | | -0.40 | 1.44 | | | 2.36*** | 3.58*** |
| | | | (1.26) | (1.05) | | | (0.84) | (1.01) |
| CAR | | | 2.71*** | 2.38*** | | | 1.02*** | 0.97*** |
| | | | (0.41) | (0.33) | | | (0.33) | (0.35) |
| Lending HHI | | | 9.45 | 18.55** | | | 5.12 | 5.59 |
| | | | (10.1) | (7.79) | | | (7.52) | (8.61) |
| Liquidity | | | 0.26** | 0.21*** | | | -0.16** | -0.15** |
| | | | (0.10) | (0.08) | | | (0.06) | (0.07) |
| Core Deposits | | | 0.14 | 0.10 | | | 0.05 | 0.09 |
| | | | (0.09) | (0.07) | | | (0.08) | (0.10) |
| Country fixed effects | — | — | — | ✓ | — | — | — | ✓ |
| Observations | 3,082 | 3,082 | 3,082 | 3,082 | 2,806 | 2,806 | 2,806 | 2,806 |
| Wu-Hausman ($p$-value) | | 0.00 | 0.00 | 0.00 | | 0.09 | 0.12 | 0.02 |
| First-stage $F$-statistic | | 193.6 | 84.5 | 43.6 | | 271.1 | 64.0 | 16.4 |

**Panel B: Uninsured and reserves-exempt dummy instruments**

| | Dependent Variable: Higher-Risk Loans (percent change) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | QE2/MEP | | | | QE3 | | | |
| | OLS | 2SLS | | | OLS | 2SLS | | |
| | | (1) | (2) | (3) | | (1) | (2) | (3) |
| Change in Reserves | 0.20*** | 1.27*** | 2.48*** | 1.58*** | 0.05 | 0.22** | 0.27 | 1.69** |
| | (0.04) | (0.20) | (0.37) | (0.49) | (0.03) | (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 | 3,126 | 2,849 | 2,849 | 2,849 | 2,849 |
| Wu-Hausman ($p$-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 $\chi^2$ ($p$-value) | | 0.99 | 0.52 | 0.09 | | 0.87 | 0.24 | 0.21 |

Notes: This table reports ordinary least-squares (OLS) and two-stage least-squares (2SLS) 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. The sample periods are 2010 Q4 - 2012 Q3 for QE2/MEP and 2012 Q3 - 2014 Q3 for QE3. 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 | | | |
| | OLS | 2SLS | | | OLS | 2SLS | | |
| | | (1) | (2) | (3) | | (1) | (2) | (3) |
| Change in Reserves | 0.05 | 6.79*** | 6.01*** | 10.94*** | 2.05* | 10.82*** | 10.69 | 27.51* |
| | (0.38) | (1.82) | (2.32) | (4.18) | (1.11) | (3.68) | (6.93) | (15.8) |
| ln(assets) | | | -36.97*** | -37.87*** | | | -25.23*** | -24.28*** |
| | | | (7.86) | (8.59) | | | (9.31) | (9.24) |
| CAR | | | 1.91 | 0.32 | | | 0.08 | 0.65 |
| | | | (2.62) | (2.70) | | | (3.34) | (3.32) |
| Lending HHI | | | -18.44 | -5.13 | | | 88.41 | 29.91 |
| | | | (62.7) | (64.4) | | | (70.98) | (78.43) |
| Liquidity | | | -0.04 | -0.07 | | | 1.32** | 0.98 |
| | | | (0.63) | (0.63) | | | (0.62) | (0.68) |
| Core Deposits | | | -1.83*** | -1.96*** | | | -0.84 | -1.18 |
| | | | (0.56) | (0.54) | | | (1.00) | (0.99) |
| Country fixed effects | — | — | — | ✓ | — | — | — | ✓ |
| Observations | 2,908 | 2,908 | 2,908 | 2,908 | 2,616 | 2,616 | 2,616 | 2,616 |
| Wu-Hausman ($p$-value) | | 0.00 | 0.00 | 0.01 | | 0.01 | 0.16 | 0.09 |
| First-stage $F$-statistic | | 149.2 | 89.0 | 63.5 | | 266.5 | 75.4 | 21.5 |

**Panel B: Uninsured and reserves-exempt dummy instruments**

| | Dependent Variable: Non-Performing Loans as a Share of Total Loans (percent change) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | QE2/MEP | | | | QE3 | | | |
| | OLS | 2SLS | | | OLS | 2SLS | | |
| | | (1) | (2) | (3) | | (1) | (2) | (3) |
| Change in Reserves | 0.05 | 6.64*** | 5.78** | 9.87** | 1.98* | 10.75*** | 10.71 | 33.15* |
| | (0.38) | (1.80) | (2.26) | (4.05) | (1.08) | (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 | 2,945 | 2,654 | 2,654 | 2,654 | 2,654 |
| Wu-Hausman ($p$-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 $\chi^2$ ($p$-value) | | 0.22 | 0.92 | 0.87 | | 0.40 | 0.79 | 0.90 |

Notes: This table reports ordinary least-squares (OLS) and two-stage least-squares (2SLS) 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. The sample periods are 2010 Q4 - 2012 Q3 for QE2/MEP and 2012 Q3 - 2014 Q3 for QE3. 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**

| | Δ Loans | Δ Risky Loans | Δ NPL |
|---|---|---|---|
| Change in Reserves | -0.28 | -1.72 | 91.45 |
| | (0.69) | (1.89) | (109.65) |
| ln(assets) | -0.89* | -0.20 | -25.58 |
| | (0.55) | (0.99) | (25.21) |
| CAR | 0.86*** | 2.48*** | -075 |
| | (0.17) | (0.46) | (17.47) |
| Lending HHI | 0.08 | 38.28*** | 281.17 |
| | (3.97) | (6.39) | (338.53) |
| Liquidity | 0.21*** | 0.32*** | 6.12 |
| | (0.05) | (0.09) | (3.83) |
| Core Deposits | 0.04 | -0.07 | -5.89* |
| | (0.07) | (0.09) | (3.65) |
| Country fixed effects | ✓ | ✓ | ✓ |
| Observations | 3,147 | 3,138 | 2,937 |
| First-stage $F$-statistic | 8.0 | 4.6 | 1.6 |
| Memo: | | | |
| First-stage $F$-statistic for basic specification | 7.7 | 5.2 | 2.0 |

**Panel B: Reduced-form regression results**

| | Δ Loans | Δ Risky Loans | Δ NPL |
|---|---|---|---|
| Uninsured | -2.59 | -10.93 | 347.63 |
| | (6.35) | (9.90) | (376.06) |
| Reserves Exempt | -1.63 | -9.79 | -51.10 |
| | (4.48) | (6.98) | (214.31) |
| ln(assets) | -0.77 | 0.48 | -25.05 |
| | (0.50) | (0.78) | (23.26) |
| CAR | 0.82*** | 2.10*** | 13.52 |
| | (0.15) | (0.26) | (8.64) |
| Lending HHI | -0.34 | 37.53*** | 491.51*** |
| | (3.75) | (5.92) | (174.09) |
| Liquidity | 0.22*** | 0.37*** | 3.38* |
| | (0.04) | (0.06) | (1.93) |
| Core Deposits | 0.01 | -0.15** | -3.13 |
| | (0.05) | (0.07) | (2.11) |
| Country fixed effects | ✓ | ✓ | ✓ |
| Observations | 3,147 | 3,138 | 2,937 |

Notes: This table reports two-stage least-squares estimates for regressions of the dependent variables considered in Tables 2-4 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). Standard errors are reported in parentheses. The last rows in Panel A shows the first-stage $F$-statistics for the joint significance of the coefficients on the instruments for the reported specification, as well as a memorandum noting the $F$-statistics for the most basic specification with no covariates. The QE1 sample period is 2008 Q4 - 2010 Q3. Statistical significance: $^{***}$ $p < 0.01$,$^{**}$ $p < 0.05$,$^{*}$ $p < 0.10$.

**Table 6**
**IV Regression Results: Matched Sample**

**Panel A: Uninsured dummy instrument**

| | QE2/MEP | | | QE3 | | |
|---|---|---|---|---|---|---|
| | Δ Loans | Δ Risky Loans | Δ NPL | Δ Loans | Δ Risky Loans | Δ NPL |
| Change in Reserves | 0.49** | 3.14** | 12.4 | 0.62** | 0.58** | 10.3 |
| | (0.24) | (1.55) | (8.30) | (0.28) | (0.27) | (7.09) |
| Observations | 504 | 490 | 349 | 424 | 409 | 250 |
| Wu-Hausman ($p$-value) | 0.04 | 0.02 | 0.09 | 0.11 | 0.07 | 0.15 |
| First-stage $F$-statistic | 20.8 | 16.8 | 12.9 | 25.1 | 25.4 | 25.2 |

**Panel B: Uninsured and reserves-exempt dummy instruments**

| | QE2/MEP | | | QE3 | | |
|---|---|---|---|---|---|---|
| | Δ Loans | Δ Risky Loans | Δ NPL | Δ Loans | Δ Risky Loans | Δ NPL |
| Change in Reserves | 0.38* | 2.93** | 14.7** | 0.47** | 0.44* | 10.3* |
| | (0.21) | (1.26) | (7.17) | (0.24) | (0.25) | (5.52) |
| Observations | 661 | 647 | 468 | 581 | 565 | 380 |
| Wu-Hausman ($p$-value) | 0.09 | 0.01 | 0.02 | 0.20 | 0.19 | 0.07 |
| First-stage $F$-statistic | 15.3 | 12.3 | 9.1 | 16.5 | 16.7 | 19.0 |
| Sargan $\chi^2$ ($p$-value) | 0.67 | 0.80 | 0.53 | 0.45 | 0.74 | 0.46 |

Notes: This table reports two-stage least-squares estimates for robustness checks to our main results. Each column corresponds to one of the dependent variables considered in Tables 2-4 for the QE2/MEP sample (left) and the QE3 sample (right), as indicated. The sample is attained by propensity score matching, using the twelve variables described in Subsection 6.1. 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. The sample periods are 2010 Q4 - 2012 Q3 for QE2/MEP and 2012 Q3 - 2014 Q3 for QE3. Statistical significance: $^{***}$ $p < 0.01$,$^{**}$ $p < 0.05$,$^{*}$ $p < 0.10$.

**Table 7**
**IV Regression Results: Robustness Checks**

**Panel A: Largest Domestic Banks Only (>75th %ile)**

| | QE2/MEP | | | QE3 | | |
|---|---|---|---|---|---|---|
| | Δ Loans | Δ Risky Loans | Δ NPL | Δ Loans | Δ Risky Loans | Δ NPL |
| Change in Reserves | 0.61*** | 1.62*** | 7.39*** | 0.18** | 0.21** | 12.52*** |
| | (0.12) | (0.29) | (1.72) | (0.09) | (0.11) | (2.45) |
| Observations | 1,605 | 1,595 | 1,477 | 1,475 | 1,465 | 1,345 |
| Wu-Hausman ($p$-value) | 0.00 | 0.00 | 0.00 | 0.63 | 0.07 | 0.00 |
| First-stage $F$-statistic | 52.8 | 47.6 | 38.1 | 71.5 | 68.3 | 74.1 |
| Sargan $\chi^2$ ($p$-value) | 0.69 | 0.96 | 0.32 | 0.11 | 0.79 | 0.56 |

**Panel B: Excluding Eurozone Banks**

| | QE2/MEP | | | QE3 | | |
|---|---|---|---|---|---|---|
| | Δ Loans | Δ Risky Loans | Δ NPL | Δ Loans | Δ Risky Loans | Δ NPL |
| Change in Reserves | 0.81*** | 1.61*** | 4.21*** | 0.41*** | 0.46*** | 64.12*** |
| | (0.08) | (0.19) | (1.43) | (0.11) | (0.16) | (19.13) |
| Observations | 3,085 | 3,075 | 2,915 | 2,771 | 2,804 | 2,630 |
| Wu-Hausman ($p$-value) | 0.00 | 0.00 | 0.01 | 0.01 | 0.02 | 0.00 |
| First-stage $F$-statistic | 140.0 | 125.9 | 112.3 | 106.6 | 107.9 | 14.5 |
| Sargan $\chi^2$ ($p$-value) | 0.55 | 0.90 | 0.25 | 0.28 | 0.98 | 0.33 |

**Panel C: Foreign Branches Only**

| | QE2/MEP | | | QE3 | | |
|---|---|---|---|---|---|---|
| | Δ Loans | Δ Risky Loans | Δ NPL | Δ Loans | Δ Risky Loans | Δ NPL |
| Change in Reserves | 0.49*** | 1.07*** | 6.79*** | 0.24*** | 0.23** | 10.08*** |
| | (0.08) | (0.21) | (1.78) | (0.08) | (0.11) | (3.38) |
| Observations | 3,115 | 3,109 | 2,939 | 2,838 | 2,831 | 2,649 |
| Wu-Hausman ($p$-value) | 0.00 | 0.00 | 0.01 | 0.03 | 0.09 | 0.01 |
| First-stage $F$-statistic | 107.2 | 90.4 | 78.1 | 143.6 | 142.2 | 154.6 |
| Sargan $\chi^2$ ($p$-value) | 0.31 | 0.94 | 0.22 | 0.23 | 0.87 | 0.41 |

**Panel D: Alternate Endogenous Regressor**

| | QE2/MEP | | | QE3 | | |
|---|---|---|---|---|---|---|
| | Δ Loans | Δ Risky Loans | Δ NPL | Δ Loans | Δ Risky Loans | Δ NPL |
| Change in Reserves | 2.54*** | 3.97*** | 29.91*** | 0.94** | 1.04** | 29.06*** |
| | (0.40) | (0.67) | (8.29) | (0.37) | (0.52) | (10.28) |
| Observations | 3,135 | 3,126 | 2,945 | 2,859 | 2,849 | 2,654 |
| Wu-Hausman ($p$-value) | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 |
| First-stage $F$-statistic | 103.8 | 96.8 | 57.2 | 112.8 | 119.4 | 47.2 |
| Sargan $\chi^2$ ($p$-value) | 0.44 | 0.90 | 0.17 | 0.21 | 0.82 | 0.31 |

Notes: This table reports two-stage least-squares estimates for robustness checks to our main results. Each column corresponds to one of the dependent variables considered in Tables 2-4 for the QE2/MEP sample (left) and the QE3 sample (right), as indicated. In this table, we report only the simplest specification (with no additional controls) with two instruments for brevity. Panel A excludes the smallest 75 percent of domestic banks, Panel B excludes Eurozone banks, Panel C excludes agencies of foreign institutions, and Panel D reports results using the change in the reserves-to-assets ratio as the main endogenous independent variable. 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 the $p$-values for the test of overidentifying restrictions, respectively. The sample periods are 2010 Q4 - 2012 Q3 for QE2/MEP and 2012 Q3 - 2014 Q3 for QE3. Statistical significance: $^{***}\ p < 0.01,^{**}\ p < 0.05,^{*}\ p < 0.10$.

**Table 8**
**Difference-In-Differences Regression Results: Credit Line Drawdowns**

**Panel A: Uninsured dummy instrument**

Dependent Variable:
Credit line drawdown (percent)

| | QE1 | | | QE2/MEP & QE3 | |
|---|---|---|---|---|---|
| | All CLs | Drawn CLs only | | All CLs | Drawn CLs only |
| 2009 × *treat* | 2.00 | 2.81* | 2011 × *treat* | -0.27 | 0.68 |
| | (1.46) | (1.61) | | (1.35) | (1.47) |
| 2010 × *treat* | -0.56 | -0.66 | 2012 × *treat* | -0.42 | 0.15 |
| | (2.25) | (1.41) | | (1.68) | (1.80) |
| | | | 2013 × *treat* | -2.93 | -2.4 |
| | | | | (2.03) | (2.12) |
| | | | 2014 × *treat* | -2.32 | -1.72 |
| | | | | (1.93) | (1.99) |
| Time FE | ✓ | ✓ | Time FE | ✓ | ✓ |
| Bank FE | ✓ | ✓ | Bank FE | ✓ | ✓ |
| Observations | 18,609 | 16,164 | Observations | 10,478 | 9,560 |

**Panel B: Uninsured and reserves-exempt dummy instruments**

Dependent Variable:
Credit line drawdown (percent)

| | QE1 | | | QE2/MEP & QE3 | |
|---|---|---|---|---|---|
| | All CLs | Drawn CLs only | | All CLs | Drawn CLs only |
| 2009 × *treat* | 0.81 | 1.56 | 2011 × *treat* | -0.06 | 0.20 |
| | (1.29) | (1.36) | | (0.88) | (0.90) |
| 2010 × *treat* | -0.48 | 0.11 | 2012 × *treat* | -0.02 | 0.04 |
| | (1.10) | (1.15) | | (1.14) | (1.16) |
| | | | 2013 × *treat* | -1.66 | -1.80 |
| | | | | (1.30) | (1.31) |
| | | | 2014 × *treat* | -0.31 | -0.21 |
| | | | | (1.36) | (1.32) |
| Time FE | ✓ | ✓ | Time FE | ✓ | ✓ |
| Bank FE | ✓ | ✓ | Bank FE | ✓ | ✓ |
| Observations | 40,082 | 34,791 | Observations | 24,287 | 22,262 |

Notes: This table reports ordinary least-squares (OLS) estimates for difference-in-differences regressions of credit line (CL) drawdowns in percent—100·(utilized amount/committed amount)—on interaction terms *year* × *treat*, which equal one for treated institutions in a particular year, as well as time and bank fixed effects. In Panel A, *treat* indicates observations for which the lender is an uninsured institution; in Panel B, *treat* indicates observations for which the lender is an uninsured or a reserves-exempt institution. The variable *year* denotes year dummies. Two samples of credit facilities are used, as indicated in the column headers: (1) all credit lines that were in existence throughout the respective sample periods and (2) only those credit lines that were in existence throughout the respective sample periods and were drawn upon. Standard errors (in parentheses) are clustered at bank level. The sample periods are 2008-2010 for QE1 (left) and 2010-2014 for QE2/MEP & QE3 (right). Statistical significance: *** $p < 0.01$,** $p < 0.05$,* $p < 0.10$.