

Large Excess Reserves in the U.S.: A View from the Cross-Section of Banks*

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Abstract

Bank reserves in the United States increased dramatically at the end of 2008 and have undergone another significant increase between November 2010 and June 2011. These increases in reserves required major adjustments in banks' balance sheets. We study the evolution of reserve holdings across banks since the fall of 2008 and how some of the other main components of banks' balance sheets changed concurrently. Motivated by the potential implications for monetary policy of operating with a high level of reserves, we investigate the situation of those banks holding significant quantities of reserves. We find that those banks have increased their total liquidity holdings and that a large fraction of the reserves is held by banks with sufficient capital to increase lending without confronting binding capital requirements.

1 Introduction

In the final months of 2008, the quantity of bank reserves in the U.S. increased by more than a factor of ten. Reserves fluctuated between 0.97 and 1.2 trillion dollars through 2010. From December 2010 to June 2011 the Federal Reserve undertook a new program of asset purchases for \$600 billion, with a corresponding increase in the level of reserves. These and other facts about the behavior of aggregate reserves are well-known. Much less attention has been devoted to the distribution of reserves across banks. How was the initial large increase in reserves distributed? How has the distribution of reserves subsequently evolved? What are the characteristics of banks that hold high reserves, and how have bank balance sheets been transformed as the quantity of reserves has increased? We address these and other related questions, both to understand the mechanics of the unprecedented increase in reserves and to gain some perspective on the possible importance of reserves for monetary policy in the current regime, in which the Fed pays interest on reserves.

An important line of thinking argues that the quantity of bank reserves is irrelevant if the Federal Reserve is able to pay a near-market interest rate on reserves, as it has since the fall of 2008. We discuss this issue in detail in Section 2. In addition, public communication by the Federal Reserve regarding recent monetary policy actions (such as, for example, Chairman Bernanke's *Washington Post* op-ed piece on November 4, 2010), as well as most academic research, has paid little attention to the behavior of reserves. The emphasis

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has instead been on the consequences of Fed actions for the maturity composition of Treasury and mortgage-related securities held by the public.¹ These views notwithstanding, we believe that it is important to investigate the behavior of reserves across banks during the last few years.

As part of a complete description of the financial crisis and the great recession, it is pertinent to simply document how the massive increase in reserves was accommodated on bank balance sheets. In addition, our view is that there are conditions under which the quantity of reserves may matter for monetary policy, even under a regime of interest on reserves or with zero nominal interest rates. First, a large quantity of reserves makes a strengthening economy more sensitive to ex-post policy errors. Second, absent other changes in the real economy, continuous large increases in the quantity of reserves could have expansionary or contractionary effects. We are agnostic on whether these effects would come through changes in the price level or real activity. However, in both cases the way in which reserves are distributed across banks is an element in the process through which reserves would matter for policy. Policy considerations thus are an additional motivation for our analysis of the behavior of reserves, helping to point us toward particular details of the cross-sectional distribution of reserves. We acknowledge though, that the significance of reserves for policy is still an unresolved issue. We hope that studying the actual behavior of reserves across banks may help shed some light on this significance.

The paper is organized as follows. In Section 2 we discuss in more detail the policy issues that serve as part of the motivation for our study. In Section 3, we begin the empirical discussion with some background on the behavior of aggregate reserves and the various Fed programs that affected the quantity of reserves starting in the fall of 2008 (prior to that point, the effect of credit programs on reserves was offset by sales of securities and by the Treasury’s Supplementary Financing Program). In Section 4, we provide a basic description of how the large increase in reserves was reflected in the distribution of reserves across banks. This information is relevant for understanding the effect on the banking system (and potentially the economy overall) of large and relatively sudden increases in the quantity of aggregate reserves. Furthermore, some of the findings can help us better understand the terms on which banks are holding the large levels of excess reserves. For this, we investigate where the large injections of reserves initially resided (in which segments of the banking system) and how reserve holdings evolved to their distribution as of the second quarter of 2011, which represents the completion of the Fed’s Large Scale Asset Purchases (“QE2”).²

In Section 5, we address the substitution of reserves for other liquid assets and, in Section 6, the relationship between banks’ capital positions and their reserve holdings (ratio to assets). In Section 7, we turn our attention to the characteristics of institutions holding relatively high and low ratios of reserves to assets; by studying these institutions we hope to be able to learn more about, for example, the circumstances that would transpire if banks as a group attempt to shed reserves - which would require either adjustments in asset returns, goods prices, or the quantity of currency held by the public. Finally, Section 8 provides a brief conclusion.

2 The quantity of reserves and monetary policy

The fact that the Federal Reserve has the ability (as of late 2008) to adjust the interest rate paid on reserves (i.o.r) clearly alters the nature of reserves as an instrument or indicator of monetary policy. In fact, the prevailing view among monetary economists is that with i.o.r. as an instrument, the quantity of reserves has become virtually irrelevant (see, for example, Hall and Woodward (2009)).

The Fed’s ability to adjust i.o.r. indeed means that appropriate policy can convince banks to “sit on” whatever level of reserves the Fed supplies.³ Thus, a large quantity of reserves is not necessarily an indicator

¹See for example Gagnon et al. (2011), Hamilton and Wu (2010), Krishnamurthy and Vissing-Jorgensen (2010) and D’Amico and King (2010).

²As we stress below, stability of the distribution of reserves does not imply that reserves are “stuck” at particular institution; a stationary distribution is consistent with nontrivial gross flows of reserves, and that is indeed what we find.

³Our language is loose here. What we mean is that for any level of reserves, there exists some level of i.o.r. such that banks will be content to hold those reserves without any other adjustments to their balance sheets. Otherwise, attempts by all banks to shed reserves will result in some combination of an increase in currency outstanding, an increase in the quantity of deposits,

of expansionary monetary policy. Relatedly, to the extent that a fixed i.o.r. (or zero nominal rates) makes reserves a close substitute for very-short-term Treasury securities, open market purchases of those Treasuries with reserves do not necessarily have any effect on real variables or the price level. However, in both of these dimensions, “irrelevance” of reserves relies on special assumptions which we have reason to believe do not always hold. The remainder of this section elaborates on these points.

2.1 Falling behind the curve with a large quantity of reserves

The claim that a large quantity of reserves does not indicate expansionary policy is valid provided the Fed is able to accurately time the adjustment of the i.o.r. However, monetary policy is conducted under uncertainty about current and future states. Testimony to this is the fact that FOMC members do not always agree about the appropriate time for the Fed to reverse its policy stance. Determining when to adjust monetary policy is a difficult question and hence the possibility of policy being (on occasion) behind the curve is likely to be a real one.

This policy risk, of course, is not limited to a situation with i.o.r. When targeting a fixed short-term interest rate, the central bank is committed to providing reserves perfectly elastically at that rate. Thus, the risk of falling behind the curve exists regardless of the level of (excess) reserves and regardless of whether or not the Fed pays interest on reserves.⁴

However, large quantities of (excess) reserves in the banking system may exacerbate the potential problems associated with untimely policy adjustment. With i.o.r. and a high level of reserves, banks do not need the Fed and the interbank market to intermediate the process of loan and deposit expansion – banks already hold the reserves they need to expand their activities. In Ennis and Wolman (2010) we argued that, therefore, the current massive holdings of reserves by banks may have changed the “elasticity” of the economy to an ex-post policy mistake (i.e., delay), making such a mistake more significant and costly. In this sense, the high levels of reserves present new challenges for the conduct of timely monetary policy.⁵

Some observers have argued that there is no substantial difference between the monetary policy problem with or without large amounts of excess reserves (see, for example, Dudley, 2011). This view relies in large part on the premise that the interbank market is able to reallocate funding capacity across banks in an almost perfect manner.⁶ If frictions exist in the interbank market, then they are likely to interfere with the reallocation of funding capacity, especially if this funding is to be dedicated to financing long-term loans. As the behavior of the Fed funds rate since the fall of 2008 suggests, frictions seem to play some role in the functioning of the interbank market (Gertler and Kiyotaki, 2010). Whether those frictions are large enough to cause a material difference between situations with high and low reserves remains an open question.

If reserves are low and frictions are large, any required reallocation of newly created reserves to banks with profitable investment opportunities may take time, slowing down the economy’s adjustment to shocks.⁷ Once excess reserves are large, however, and to the extent that those reserves are already well spread out across banks, the aforementioned reason for delays is no longer present and the economy can react more quickly to

and an increase in the price of goods and assets other than reserves.

⁴See Dudley (2009) on interest rate targeting and the commitment to supply reserves. On the possibility of monetary policy getting behind the curve, see Levin and Taylor (2009) and Plosser (2009, 2011).

⁵In a situation with large excess reserves, the fact that the Fed is not an integral part of the credit creation process eliminates one of the Fed’s sources of information about the state of the economy. This new situation may then call for shifting attention to economic indicators that otherwise play a secondary role. For example, the proportion of required to excess reserves, or short term changes in aggregate bank lending may be especially useful indicators when conducting monetary policy with high levels of reserves. See Ennis and Wolman (2010) for further discussion of this issue.

⁶As Dudley (2011) writes “In terms of the ability to expand credit rapidly, it makes no difference whether the banks have lots of excess reserves on their own balance sheets or can source whatever reserves they need from the fed funds market at the fed funds rate.”

⁷As an example, in September 2010 AIG began selling municipal bonds and accumulating cash in anticipation of making an offer in December 2010 for the bonds that the NY Fed held in one of its Maiden Lane vehicles. This story, as reported by Serena Ng in the WSJ (21 March 2011), supports the idea that financial institutions (in this case AIG) may take time to acquire the cash (liquid funds) to fund certain investments (like buying securities). AIG does not have an account with the Fed and hence cannot hold reserves. But, if it could and if it had in fact owned a large amount of reserves, then it could potentially have made the offer in September, when the decision to buy the securities was initially made.

changes in economic conditions. This logic helps to motivate our study of the distribution of reserves across banks in recent years, emphasizing the relationship between banks' reserve holdings, components of their balance sheets, and other bank characteristics.

The risk being discussed here takes as a premise that the large outstanding stocks of excess reserves constitute an extra source of liquidity for banks. The payment of interest on reserves has made reserves a relatively close substitute for short-term Treasuries and other short-term securities. In principle, then, it could be that the observed increase in reserves since 2008 only represented a substitution of reserves for other liquid assets on bank balance sheets. We will take a stand on a particular definition of liquidity and ask: Did banks maintain a high level of total liquid assets even after the strains in financial markets subsided?

If reserves did not simply substitute for other liquid assets on banks' balance sheets, there may nonetheless be mitigating factors that limit the risks of untimely monetary policy. In particular, the degree of those risks and how they could materialize will depend on how the reserves are distributed across the banking system and on the characteristics of banks that are holding reserves. Suppose that reserves are concentrated in institutions with binding regulatory capital requirements. In that case, banks would have limited ability to quickly expand lending or purchases of longer-term securities, and there would likely be a low degree of "behind the curve" risks associated with the large stock of reserves.

We find in this paper that reserves did not simply substitute for other forms of liquidity on banks' balance sheets, and that reserves are not highly concentrated in banks that face binding capital requirements. Our measure of aggregate liquid assets held by banks increased dramatically at the end of 2008 and has not fallen appreciably. At the level of institutions, there is little evidence that individual banks actively substituted reserves for other liquid assets. With regard to capital, we find little evidence that banks holding high levels of reserves tend to be banks with low levels of capital.

2.2 The effects of increasing reserves at a fixed interest rate floor

In a situation where nominal interest rates are far from zero, and where the Fed does not pay interest on reserves, it is generally agreed that a policy of massively expanding the quantity of bank reserves would affect the price level and perhaps real activity. Such a policy would require the Fed to let short-term interest rates fall in order to equilibrate the market for reserves. If the Fed does pay interest on reserves and holds that interest rate fixed—or if the Fed Funds rate is close to zero – a significant fall in short-term interest rates is unlikely to occur. In principle, then, a fixed i.o.r. or near-zero nominal rates implies that increases in reserves could have little or no effect on prices or quantities. However, we will discuss here the possibility that some of the distinctive characteristics of reserves, compared to Treasury securities, may undermine such logic.⁸

Like Treasury securities, reserves are a form of government liability. Unlike Treasury securities, though, reserves can be held only by banks, and represent a means of settlement among banks. Reserves also differ from Treasury securities in that they represent a standing commitment by the Fed to create currency; put another way, holding reserves means holding an option, the exercise of which will increase the quantity of currency outstanding.⁹ Thus, even with i.o.r. or zero short-term rates, open market purchases of Treasury securities using reserves do not simply represent changes in the duration of government liabilities held by the public.

When the Fed conducts open market purchases, financial institutions on the Fed's list of Primary Dealers sell securities to the Fed. In return, the Fed credits the reserve accounts of commercial banks with whom the Primary Dealers have accounts, and the Fed takes securities onto its own balance sheet—the reserves becoming a liability for the Fed. If the Primary Dealer is selling securities on behalf of a client that is a reserve-holding institution, or if the Primary Dealer is itself a reserve holding institution selling securities

⁸See also Ireland (2011) for a New Keynesian model in which the level of reserves is inextricably linked to the price level even when the central bank can pay interest on reserves, and Kocherlakota (2010) for a discussion of how large excess reserves can pave the way for a self-fulfilling increase in prices. Kashyap and Stein (2011) discuss monetary policy when the central bank can pay interest on reserves and reserve requirements are binding.

⁹When nominal interest rates are positive and there is no i.o.r., there is an obvious additional difference between reserves and Treasuries: reserves bear zero interest.

from its own account, then the open market purchase simply represents a change in the composition of assets on the banking system's balance sheet. Otherwise (if the securities are sold on behalf of a non-bank institution) the size of the banking system's balance sheet increases: deposits increase on the liability side, and reserves increase on the asset size.

Let us concentrate attention on the case in which open market purchases result in expansions of bank balance sheets. This situation seems especially relevant to us for two reasons. In practice, U.S. banks have not reduced the quantities of securities on their balance sheets in recent years, and in principle, if open market purchases were conducted in large enough quantities, they would eventually have to increase bank assets.

The expansion of bank assets must be consistent with statutory requirements mandating that banks hold a certain ratio of capital to assets. In addition, banks currently pay deposit insurance fees on their assets net of capital. For both these reasons, large open market purchases have the potential to increase the tax burden imposed on banks. Conceivably banks would attempt to counteract these effects. Depending on how the process of adjustment unfolds, it could inflict either contractionary or expansionary forces on general economic activity.

Banks could try to counter the expansion of their balance sheets (caused by the open market purchases) by reducing their rate of loan origination. Such a response could bring about contractionary effects. Alternatively, banks might attempt to shed assets and liabilities by inducing depositors to withdraw currency. The ultimate effects of such a reaction seem hard to disentangle. For example, if the public were to convert some of the resulting currency holdings into durable goods, then this behavior could create expansionary pressures and potentially inflation.¹⁰

The type of effects we have discussed here are, of course, speculative. Yet, it seems to us premature and unwise to rule them out a priori. The fact that these effects work mainly through adjustments in the banking system provides additional motivation for our study. Understanding the way banks accommodated the large increases in reserves since 2008 is an integral step in sorting out the implications of such policies more generally.

3 Aggregate reserves

Prior to the autumn of 2008, the total quantity of reserves had been fluctuating between approximately \$40 billion and \$60 billion, and for the previous five years required reserves had never accounted for less than 80 percent of total reserves. Starting in September of 2008 this situation changed dramatically. An initial increase in aggregate reserves of \$134 billion occurred from mid-September 2008 – the time of the Lehman bankruptcy – to mid-October. Then, from mid-October until the beginning of 2009, reserves increased a further \$721 billion, to \$900 billion. From early 2009 until mid 2011, reserves fluctuated in a range between \$670 billion and \$1.7 trillion, and required reserves did not account for more than 9.3 percent of total reserves. Figure 1 displays time series for required reserves and excess reserves over the period in question.

¹⁰More generally, the expansion of bank assets (reserves) corresponds to an expansion of non-bank assets (deposits) that can be immediately converted into currency. If open market purchases were to continue indefinitely, it seems likely that at some point the nonbank private sector would choose to adjust its portfolio in order to reduce the proportion of real bank deposits. This would require an increase in the price level.

Aggregate Required and Excess Reserves

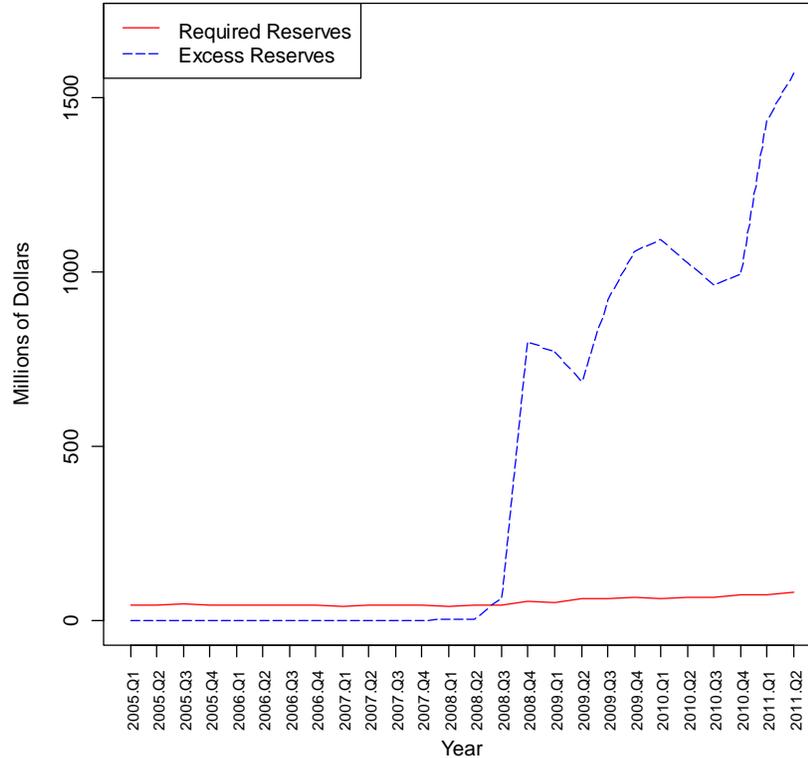


Figure 1

The initial increase in reserves in September of 2008 occurred in an environment of falling market interest rates on low-risk debt, and amid crisis conditions in financial markets. This combination of factors meant that there was both a lower opportunity cost and a higher perceived benefit of holding excess reserves. In mid-October 2008, the Federal Reserve began to pay interest on all reserve balances held by depository institutions, and since mid-November 2008 the interest rate paid on reserves has been essentially equal to the target for the Federal Funds rate.¹¹ With i.o.r close to the federal funds rate most costs of holding reserves are eliminated. Thus, the Fed was able to increase the quantity of reserves to the high levels seen since January 2009. Keister and McAndrews (2009) explain how the large quantity of reserves can be viewed as an artifact of the credit programs and asset purchases that the Fed has undertaken since late 2008.

3.1 Fed policy and the sources of reserves

The large increase in reserves took place through two main channels: loans and asset purchases. While the Fed mainly conducts asset transactions with a limited number of counterparties (primary dealers), the programs that the Fed used to loan reserves were more widely available to the universe of banks. If the interbank market is not a perfect channel for the reallocation of reserves, then the way reserves were introduced might have affected the allocation and the dynamics of the distribution of reserves over time. We will assess this possibility using our cross-sectional data below.

¹¹The effective fed funds rate has generally been below IOR. It is widely believed that this reflects the fact that the GSEs cannot earn interest on reserves and only deal with a small set of counterparties, which are not willing to expand their balance sheets enough to compete away the spread. See Bech and Klee (2009).

Our conjecture is that newly injected reserves only slowly find their way through the system to banks that hold them in the medium term as part of their desired portfolio. Especially after major interventions by the Fed, it may take time for banks to fully adjust their balance sheets. The speed of such adjustment is likely to be linked to the way that the reserves are introduced into the system.¹²

Sources of Reserves

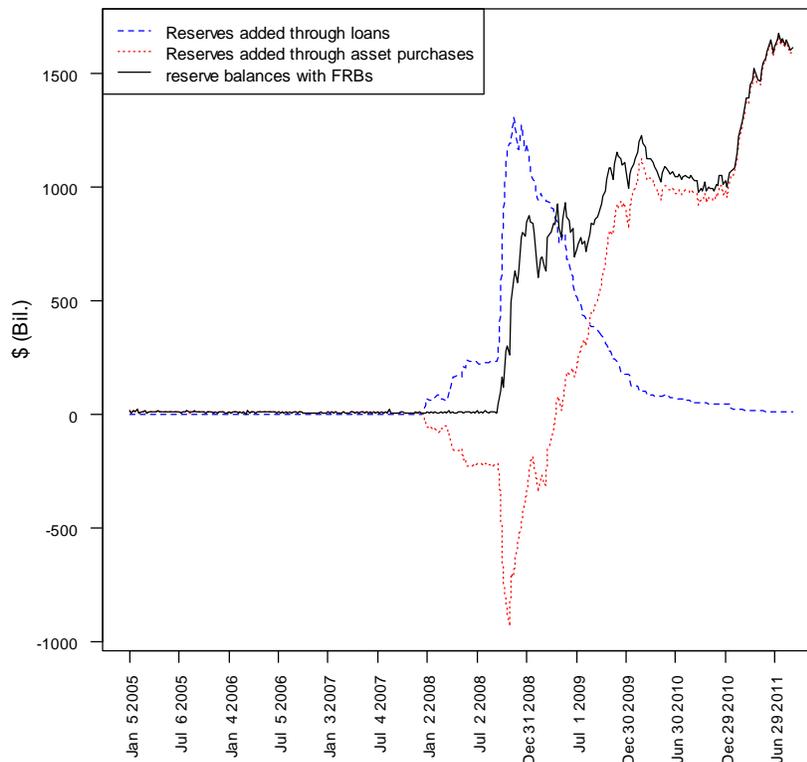


Figure 2

As a response to the crisis, during the first part of 2008, the Fed made sterilized loans to banks – offsetting the effect on reserves by open market sales of securities. Reserves did not change in any significant amount during that time. In October 2008, with the introduction of interest on reserves, the level of reserves in the system increased substantially in a short period of time. The bulk of this initial increase in reserve balances was the consequence of Fed loans to depository institutions via the discount window and the Term Auction Facility, and indirect loans via the liquidity swap lines with foreign central banks (see Figure A1 in the appendix). Indeed, between October and year-end 2008 total central bank lending increased from less than \$300 billion to more than \$1 trillion (see Figure 2).¹³ By the beginning of 2009 and during the entire year, the main source of reserves became asset purchases (instead of loans). In fact, while the level of reserve

¹²The issue discussed here also arises when considering alternative strategies for reducing the level of reserves outstanding. In fact, in preparation for the eventuality of having to absorb large quantities of reserves, the Fed expanded its list of counterparties for reverse repurchase agreements in September 2010.

¹³We construct the figure using data from the Board of Governors Table H.4. We calculate Reserves added through direct loans as the sum of Term Auction Credit, all Other Loans in Reserve Bank Credit, and Central Bank Liquidity Swaps. To calculate Reserves added through asset purchases we first take all Total Factors Supplying Reserve Funds and subtract Reserves added through direct loans. The result is the sum of what we call Other RBC and Other factors. Then we subtract Total Factors Absorbing Reserve Funds (other than reserve balances) from that sum. Note that we are implicitly treating fluctuations in reserves due to Treasury actions as Reserves added through asset purchases.

balances increased further and stayed at high levels during 2009, total central bank lending trended down to reach very low levels by the end of year.¹⁴

The way that reserves are introduced into the system may also directly influence the state of banks' balance sheets. Securities purchased (and sold) by the Fed, for example, could be absorbing assets that were held by the non-bank private sector or by the banking system itself. If the securities were held by the non-bank private sector, the Fed swapped assets previously held by non-bank entities for an asset that can only be held by banks (reserves), increasing the banking system's balance sheet. In this way, securities purchases could put pressure on banks to control the expansion of their balance sheet as they get closer to binding leverage ratios. Using the cross-sectional data, we will investigate this and related issues further in Section 3 below.

The sub-category "Other borrowings" in the category "Other borrowed money" of banks liabilities (as reported in the Call Report filings) is a natural component to look at when exploring these issues. This sub-category is where loans from the Fed are accounted for. In particular, banks report "Other borrowing with a remaining maturity of one year or less," where most (if not all) central bank lending is included. We call this sub-category OSTB (other short-term borrowings). Figure 3 plots the sum of OSTB across all insured institutions in our dataset, together with the time series for reserves created through loans, net of the liquidity swaps, which we constructed using the Board of Governors Table H.4 (see footnote 13). In the figure, we can see that total OSTB increased significantly during the year 2008 and then decreased during 2009, just as Fed lending was winding down. In interpreting this figure, it is important to keep in mind that some foreign bank affiliates had access to Fed lending which is not included in our aggregate measure of OSTB. This is why Fed lending can sometimes be higher than aggregate OSTB. Also, it is clear from the pre-2008 data that OSTB includes various types of borrowings, not just Fed lending. The main message from this figure then, is just that changes in OSTB during 2008-2009 are likely to be associated with the changes in Fed lending that took place during that period.

The other major sub-category of "Other borrowed money" on the liability side of banks' balance sheet is "FHLB advances;" i.e., loans from the Federal Home Loan Banks. Banks use FHLB advances as a back-up source of liquidity. It is well known that loans from the FHLBs were heavily used during the period under consideration here (Ashcraft, et al. 2010). FHLB loans involve transfers of reserves, but the link between FHLB borrowings and end-of-quarter reserve holdings is not obvious. The issue deserves careful study but we do not (yet) pursue it here.

¹⁴While currency in circulation increased rapidly in the last quarter of 2008 and the first half of 2009, the increase is not very significant relative to the other factors absorbing reserves. It is possible that some of the banks taking direct loans held some of the funds obtained in the form of cash, or used the funds to pay out to depositors who then kept cash in their pockets. We are subtracting this increase in cash in circulation from the Reserves added through asset purchases, but perhaps it would be more appropriate to subtract at least some of that increase (not the level, though) from Reserves added through direct loans. But this alternative adjustment would not make a big difference in the numbers. It is important to realize that reserve balances with FRBs does not include vault cash. Vault cash is included in Currency in Circulation and hence we subtracted it from Factors Supplying Reserves when we subtracted Factors Absorbing Reserves.

Fed Lending and Other Short-Term Borrowing

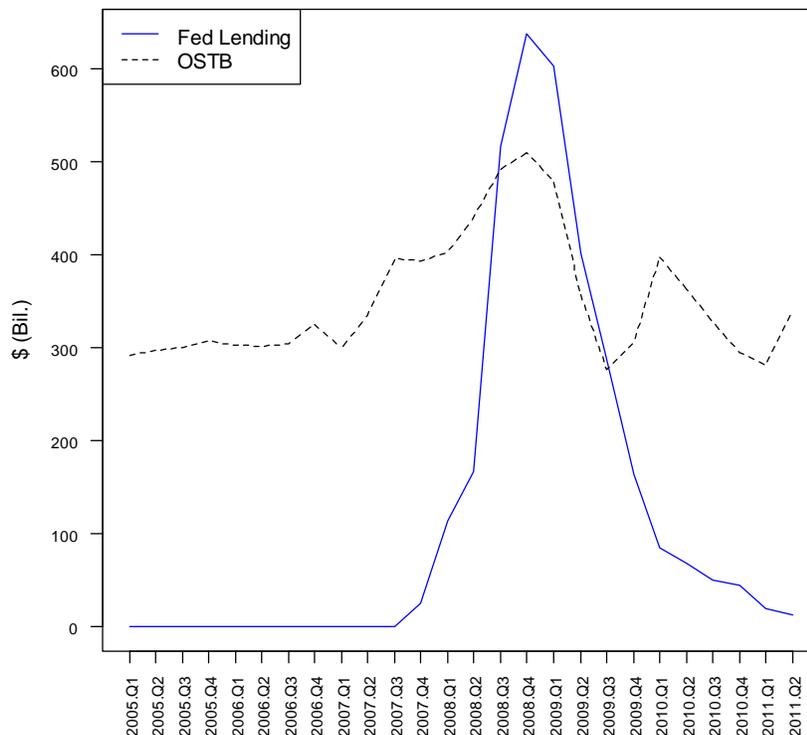


Figure 3

3.2 The banking system balance sheet

Taking the banking system as an aggregate, the massive changes in reserves shown in Figure 1 had to induce important concurrent changes to other components of the system's balance sheet. For the group of domestic insured institutions in our dataset, we plot in Figure 4 aggregate values for some of the main components of their balance sheets. We see that total assets in the banking system were growing until 2008q3 and after that stalled. This is also true for aggregate loans. Aggregate deposits, instead, continue growing at roughly the same rate in the entire period covered by our study. Notably, at the same time that reserve balances held by banks were increasing considerably (see Figure 1), so were bank holdings of securities (aggregate securities and capital are measured on the right axis in Figure 4). This fact is, perhaps, surprising. It suggests that in aggregate, reserves did not substitute for securities on the asset side of banks balance sheets.

It is also interesting to see in Figure 4 that aggregate bank capital continue growing at roughly the same rate during the entire period under consideration, with some slight acceleration in the period immediately following the peak of the crisis. Combined with the behavior of aggregate deposits and assets, we can conclude that total bank liabilities stopped growing after 2008q3 and, in fact, bank liabilities not accounted for by deposits actually decreased during and after the crisis.

Time Series for Bank Balance Sheet Aggregates

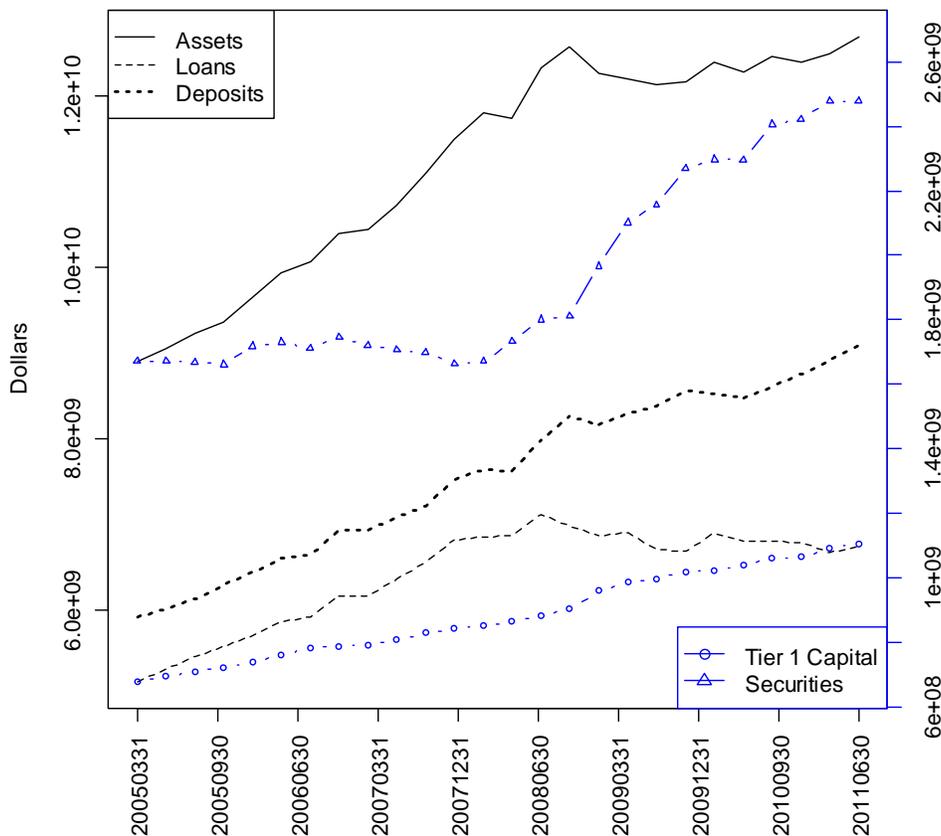


Figure 4

4 Distribution of reserves across banks

Our data covers commercial banks, savings banks and trust companies, as well as uninsured branches and agencies of foreign banks. These institutions file quarterly supervisory reports, Call Reports, which are our primary data source. Our study does not cover credit unions and some thrift institutions; they do not report reserve holdings in their regulatory filings. In the most recent quarter there were approximately 2200 institutions with reserve accounts, 219 of which fall into the uninsured foreign affiliates category.¹⁵

¹⁵There are approximately 7000 banks in the U.S. The 4800 or so that do not have reserve accounts are small banks who hold their reserves with correspondent banks. The correspondents report their respondents' reserves together with their own reserves. Thus, we have a measurement issue. With the Call Report data alone it is not possible to resolve this issue, but the non account-holding banks hold a very small amount of assets – approximately five percent – so we are not too concerned about this source of mismeasurement.

Total Reserves and Our Sample

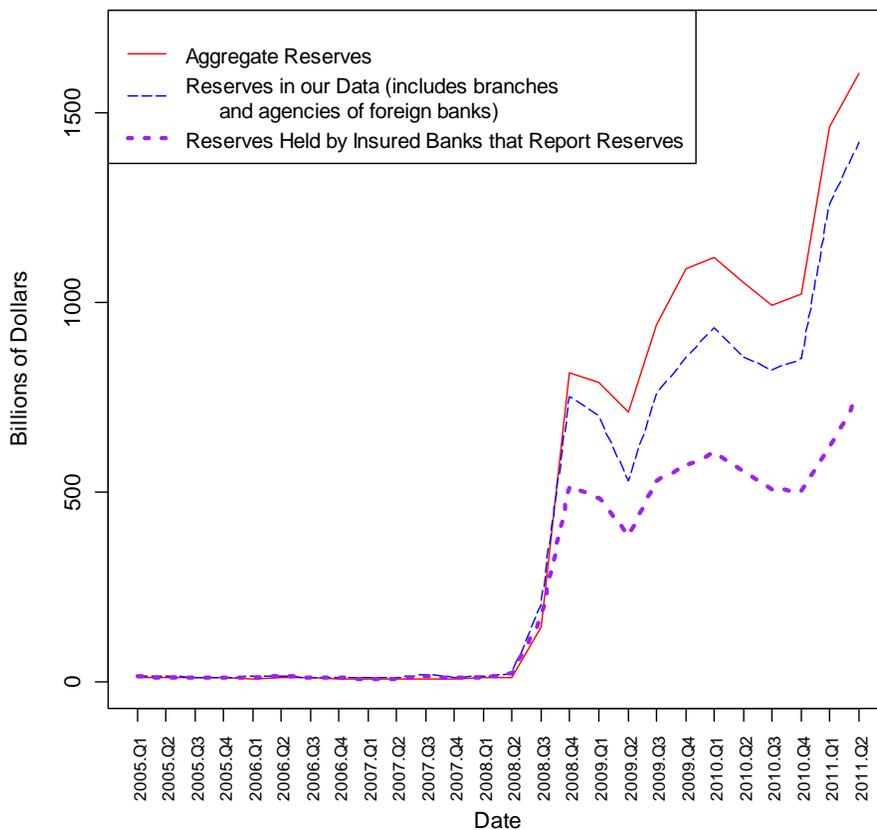


Figure 5

Figure 5 displays time series for aggregate reserves reported on the Federal Reserve’s H.3 release (solid line), reserves held by insured banks in our sample (dotted line), and total reserves in our sample (dashed line).¹⁶ The difference between the dashed and the dotted lines is the total reserves in uninsured affiliates of foreign banks. In 2011q2, total reserves were \$1.6 trillion; domestic banks in our sample held \$758 billion, and branches and agencies of foreign banks held \$667 billion. Thus, there is a gap of approximately \$180 billion between reserves covered in our data and aggregate reserves reported by the Fed’ H.3 report. We conjecture that this gap is accounted for mainly by reserve holdings of credit unions and some other thrift institutions not included in our data set.

To construct the time series for total reserves held by insured banks in our sample, we aggregate across those banks the entry “balances due from federal reserve banks” of the call reports, which includes required clearing balances. For comparison with the H.3 release we subtract from aggregate balances the total value of required clearing balances as reported in the Fed’s H.4 release. This adjustment is minor. Required clearing balances has been trending down and by the end of 2010 amounted to only \$2 billion in total. It is important to note that this adjustment is not possible at the level of individual banks and hence we simply used the call report item “balances due” to proxy for the reserve position of individual banks at each point in time.

¹⁶The Fed’s H.3 release typically does not cover the last day of the quarter. For this reason, such data can show some inconsistencies with the data in the Call Reports – our main data source. This is especially a factor during those periods when reserve balances change significantly from one day to the next, as was the case at the end of the third quarter of 2008.

Cash in the vaults of depository institutions is not included in our measure of total reserves. However, vault cash can be used to satisfy reserve requirements. Hence, to compute excess reserves for an individual bank one needs to subtract required reserves net of vault cash (used to satisfy required reserves) from total reserve holdings. We will make this adjustment when necessary throughout the paper.

4.1 Foreign bank affiliates

Like domestic depository institutions, U.S. branches and agencies of foreign banks may hold reserve accounts with the Fed. However, they have distinct characteristics and file a less-detailed report (FFIEC 002) than generic “banks,” so we will treat them separately in our analysis. These institutions are generally uninsured in the U.S.; the insured domestic bank subsidiaries of foreign banks are included with domestic depository institutions.

Foreign institutions’ reserves have increased by a factor of almost 1000 from the middle of 2008 to the present, going from \$690 million on June 30, 2008 to \$667 billion on June 30, 2011.¹⁷ Relative to total reserves, foreign institutions’ reserves increased from 6.3 percent to more than 40 percent. Relative to foreign institutions’ assets, their reserves rose from less than 0.03 percent to more than 30 percent over the same period. Thus the increase in reserve balances has entailed a dramatic balance sheet adjustment for foreign institutions. Furthermore, total assets in foreign related institutions rose by less than 2.5 percent during the period in question, so the increase in reserves has been accompanied by a significant reduction in the LEVELS of some other asset categories.

Table 1. Foreign institutions: selected asset categories (% of total assets)

	RCFD0090	RCFD2154	RCFDC036	RCFD2122	RCFDC419	
	Reserves	Net due from related depository institutions	Other asset-backed securities	Loans and leases, net of unearned income	Other trading assets	All other assets
2008Q2	0.03	37.44	2.64	27.32	10.58	21.98
2008Q4	11.45	26.16	3.82	30.23	12.02	16.37
2009Q2	7.28	35.47	3.50	28.38	9.01	16.34
2010Q4	18.24	30.91	2.13	24.90	7.35	16.51
2011Q2	31.07	21.53	1.93	22.94	6.29	16.24
Change 2008Q2 to 2008Q4	11.42	-11.28	1.18	2.91	1.44	-5.61
Change 2008Q4 to 2009Q2	-4.17	9.31	-0.32	-1.85	-3.01	-0.03
Change 2009Q2 to 2010Q4	10.96	-4.56	-1.37	-3.48	-1.66	0.17
Change 2010Q4 to 2011Q2	12.83	-9.38	-0.20	-1.96	-1.06	-0.37

Table 1 summarizes the transformation in foreign institutions’ balance sheets. The Table contains information on selected asset categories as a percent of assets for the periods 2008q2, 2008q4, 2009q2, 2010q4 and 2011q2. The first of these periods is immediately prior to the large increase in reserves, and 2011q2 is the last period covered by our data. We chose the three intermediate periods because they demarcate distinct phases in the transformation of foreign institutions’ balance sheets. The asset categories in the table, in addition to reserves, are the categories that bore the brunt of the increase in reserves. In the first subperiod, reserves increased by more than eleven percent of assets, and there was almost a perfect offset in the foreign institutions’ deposits at other related institutions (“Net due from related depository institutions”). In the second subperiod, reserves fell by more than four percent of assets, and there was a more than offsetting

¹⁷This can be seen as the distance between the dashed and dotted lines in Figure 5.

increase in deposits at related institutions. In the third subperiod, reserves rose by eleven percent of assets, with the offsetting reductions coming primarily from deposits at related institutions (4.56%) and loans (3.48%), and to a lesser extent from trading assets other than Treasuries and Agencies, and non-mortgage ABS. Finally, in the most recent subperiod, which corresponds to the Fed’s asset purchase program, reserves increased by 12 percent of assets, and the offset came overwhelmingly from deposits at related institutions and from loans.

The balance sheet changes displayed in Table 1 can help explain why foreign institutions might have increased their reserves so much. In late 2008, many foreign institutions with large dollar assets experienced difficulty in rolling over short-term dollar funding (Goldberg et al. 2010 and Fleming and Klagge, 2010). It seems plausible that one way these institutions would have responded was to draw down their U.S. affiliates’ deposits in the home office, purchase dollars and build up reserve accounts with the Fed, creating a pool of precautionary dollar balances. The increase in reserves from mid-2009 to late 2010 does not obviously lend itself to such a clean story. One element in explaining the increase must be the decline in market interest rates that occurred over this period: with the Fed holding fixed the interest rate on reserves, it made sense for foreign (and domestic) institutions to hold a larger share of their assets in reserves than in securities bearing lower market interest rates. In mid-2011, dollar funding concerns may have again become relevant.

It may be tempting to associate the behavior of foreign institutions’ reserve holdings in the first two subperiods with swap lines the Fed provided to foreign central banks; drawdowns of those lines rose from \$62 million on September 17, 2008 to more than \$582 billion on December 24, 2008, before gradually declining to pre-Lehman levels over the course of 2009 (see Figure A1 in the appendix). It is indeed the case that the swap lines were used to fund lending to foreign banks (with the lending decisions made by foreign central banks). However, it was not necessarily the case that this lending generated reserves at the foreign institutions being discussed here.

The mechanism behind the swap drawdowns was that when a foreign central bank made a dollar loan to a bank in the foreign country, the reserves would initially appear on the books of a bank with a reserve account in the U.S. Certainly, if the borrowing foreign institution itself had a reserve account with the Fed, and hence was part of our dataset, then the swap line drawdowns would tend to be associated with increases in their reserve holdings.¹⁸ In other cases, a correspondent bank would be involved. Some of the foreign institutions in our data could have acted as correspondents, which would also be consistent with a link between their reserve balances and the swap line drawdowns. But it is also possible that U.S. money center banks played this correspondent role, in which case the link would be weakened.

At its peak in January 2009, outstanding dollar lending originated in swap lines was close to \$500 billion, but reserves held by foreign institutions with Fed accounts were only around \$200 billion. This disparity makes clear that a significant portion of the reserves that originated in swap lines ended up on the balance sheets of US institutions. Either the U.S. institutions were correspondents of foreign banks or they conducted transactions with foreign institutions which resulted in a transfer of reserves to the US banks.

It should be stressed here that reserves at foreign institutions are by no means “stuck” there. Just as the foreign institutions rapidly increased their reserve holdings from 2008 to 2010, they are capable (in principle) of rapidly decreasing their balances. These institutions hold significant quantities of both loans and securities, and presumably they are sensitive to economic conditions and market interest rates in choosing their reserve positions.¹⁹

¹⁸If the institution had collateral pledged to the Fed, it would also have been eligible to borrow directly from the Fed, for example using the Term Auction Facility. For this reason, among others, changes in reserve balances of these institutions do not rely on the existence of the swap lines.

¹⁹Sometimes a banking corporation has both U.S. insured affiliates and uninsured affiliates. An example of this is Deutsche Bank, which has both insured U.S. banks and uninsured U.S. affiliates. Our data does not allow us to incorporate foreign affiliates when we aggregate U.S. insured banks at the holding company level, as we do below. In principle, however, reserves in foreign affiliates could be transferred to a related U.S. bank relatively quickly if the parent company decides to do so. In 2010q4, Deutsche’s domestic insured institutions reported reserves of about \$15 billion, and its uninsured affiliate reported reserves of about \$25 billion.

4.2 Reserves in the cross section

For most of our analysis below we will restrict attention to insured banks and we will aggregate banks up to the bank holding company level; decisions about reserve holdings presumably are made in the interest of the owners of the holding company.²⁰ The holding of reserves across institutions is likely to be associated with the size of the institution. Figure 6 plots the percentage of total reserves of U.S. insured banks held by the top ten and top 75 banks by assets (at each point in time). We can see that the percentage of reserves held by the top ten banks increased significantly at the end of 2008 when the level of reserves was increasing rapidly. This is also true for the top 75 banks. Initially (in 2008q3) the top 10 banks are the main drivers of the increase in the proportion of reserves held by the top 75 banks. From 2008q4 to 2010q4, however, the banks in the top 75 group which were not in the top 10 group increase their reserve holdings more markedly (as shown by the increasing distance between the solid and the dashed lines in Figure 6). Starting in 2010q4, it appears that the top 10 banks are again increasing their reserve holdings faster than the rest of the large banks in the system. Note that the periods when aggregate reserves are growing rapidly coincide with the periods when the top 10 banks increase their holdings of reserves faster than the rest.

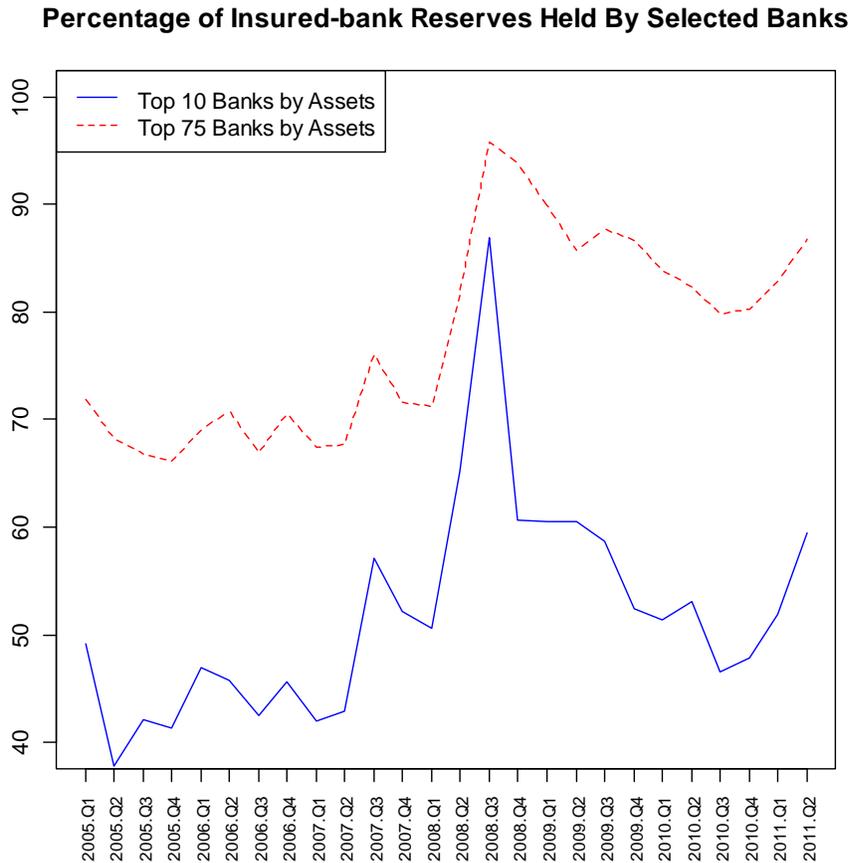


Figure 6

According to Figure 6, large institutions hold a large portion of total reserves. But, are reserve holdings across institutions proportional to assets? The first panel of Figure 7 displays the histogram of the ratio of

²⁰For brevity, we will often use the term “banks” when we mean “banks aggregated to the holding company level.”

reserves to assets for 2011q2 and shows that there is in fact a wide variation in this ratio across institutions. As shown in the second panel of Figure 7, significant variation is also present within the largest 75 holding companies, which account for approximately 80 percent of assets. This pattern suggests that it is generally inappropriate to use a representative bank (normalized by assets) as an abstract representation of the U.S. banking system.

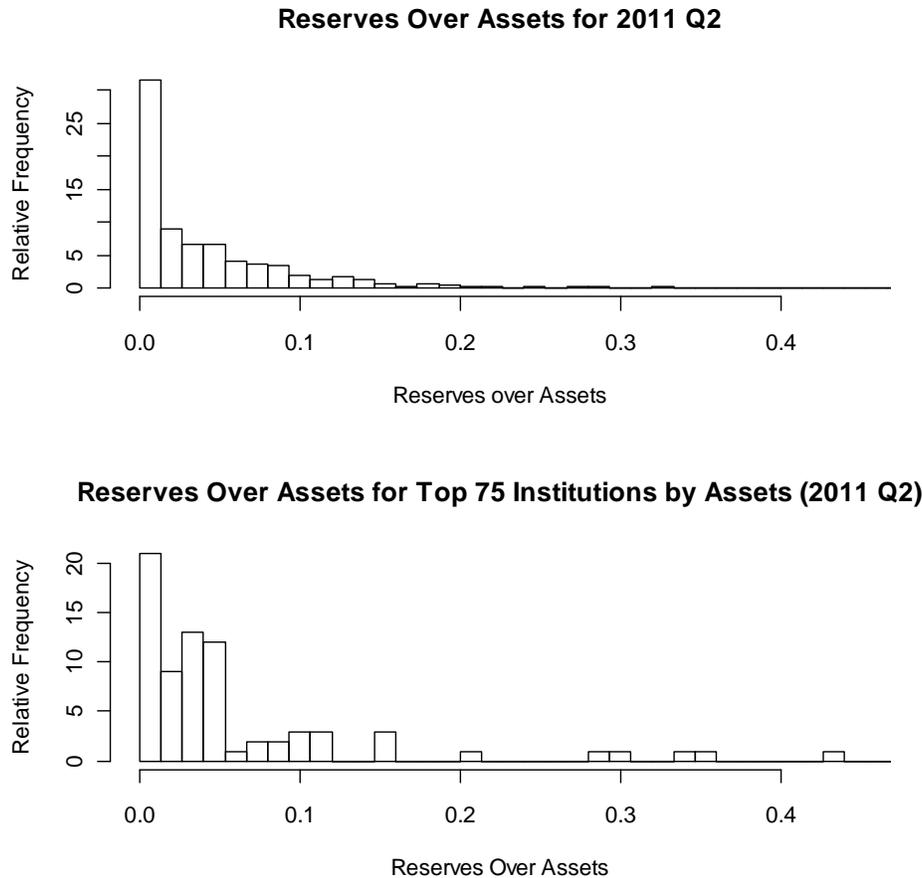


Figure 7

Figure 8 presents the evolution of reserve holdings as a percentage of total assets for the largest seven banks in the system as of December 2007.²¹ For some time after the initial increase in aggregate reserves in 2008q3, there appeared to be two distinct strategies followed by these banks. While Citi, Bank of America, and HSBC held more than 6 percent of assets in reserves for a long period, the rest of the banks stayed at lower levels, at around 2 percent of assets. However, more recently, the “low-reserve” banks have tended to increase their holdings (with HSBC consistently showing higher volatility than the rest).

²¹ Wachovia was the fourth largest institution but was acquired by Wells Fargo in the third quarter of 2008, before the large system-wide increase in reserves. For this reason, we do not include it in the figure.

Reserves over Assets for Top Banks by Assets in 2007q4

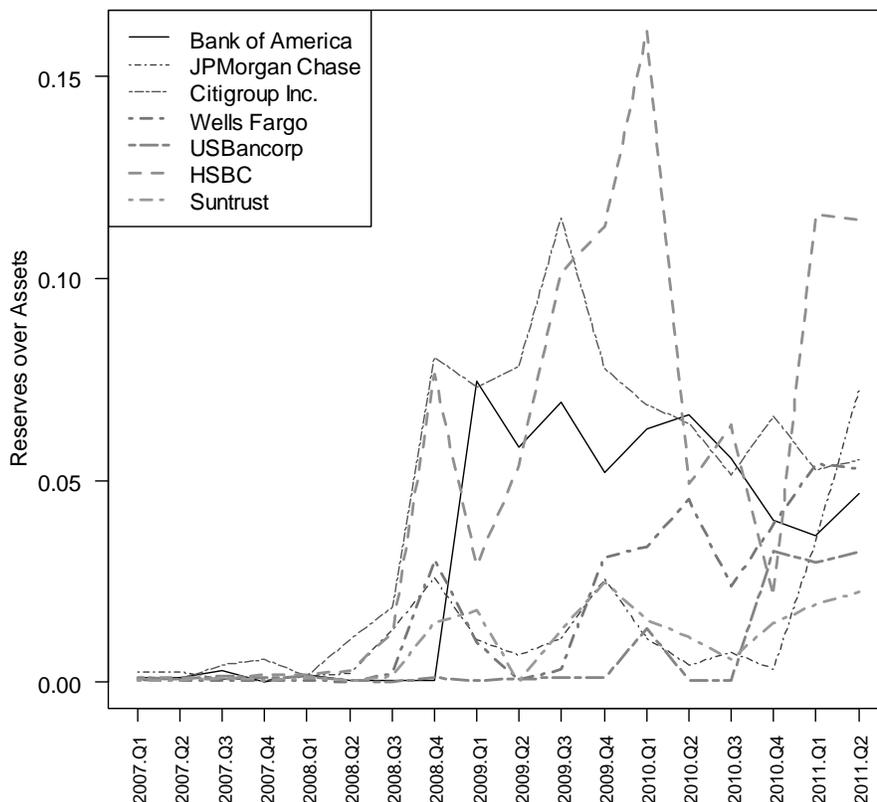


Figure 8

Figures 9, 10, and 11 provide information about how the distribution of reserves across banks of different sizes has evolved over time. The figures show how the large increase in reserves was initially distributed across banks and how the distribution subsequently evolved. Figure 9 covers 2008q3 and 2008q4, the two quarters in which the initial increase in reserves occurred, and the only quarters in which Fed lending was neither a minor factor nor rapidly declining. Figure 10 covers the last two quarters before the new large increase in reserves happened; i.e., 2010q3 and 2010q4. Finally, Figure 11 covers the two most recent quarters, 2011q1 and 2011q2. Each line in these figures represents something *similar* to a Lorenz curve for reserves. Instead of ranking banks by reserves on the horizontal axis, they are ranked by assets, and the horizontal axis measure fraction of assets, not fraction of banks.²²

²²Note that because the horizontal axis measures fraction of assets, the curves can lie above the 45 degree line.

Lorenz-type Curve of Concentration of Reserves

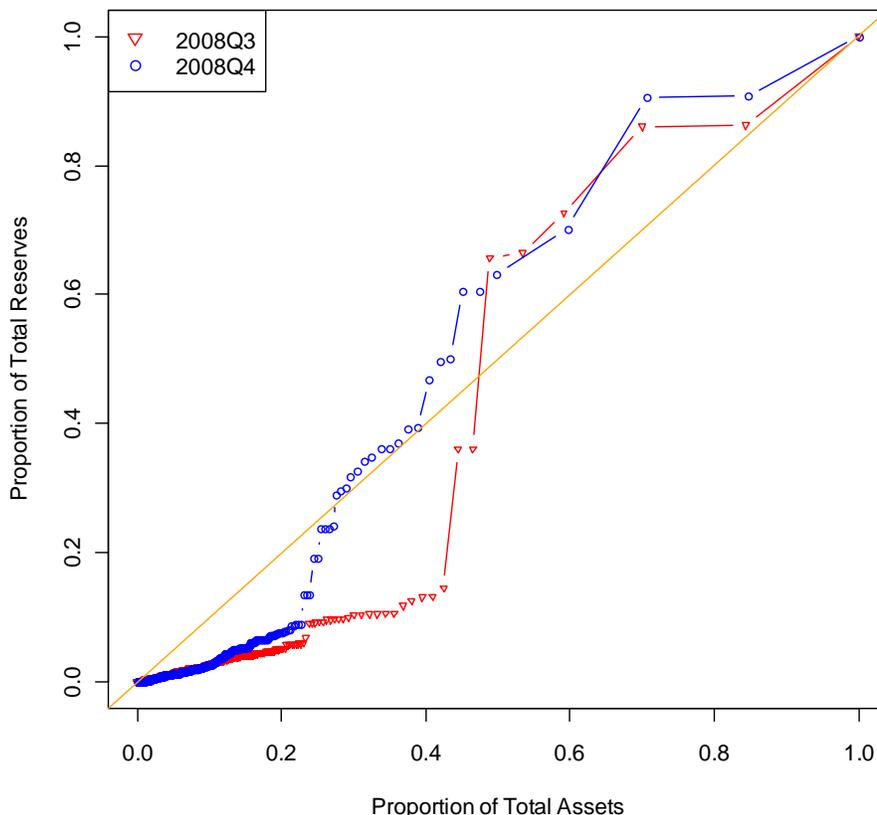


Figure 9

Comparing Figures 9, 10, and 11, we see that the concentration of reserves has changed significantly between these different periods. As was suggested by Figure 6, the largest banks held a disproportionately high amount of reserves at the peak of the crisis. The figures also show that the four largest banks account for roughly 50 percent of assets and that some large changes in their reserve positions had significant effects on the distribution of reserves relative to assets. Consistent with the broad picture of changes in concentration, note that at the end of 2008 banks holding the bottom 20 percent of assets held less than ten percent of reserves, whereas by late 2010 this same group of banks held approximately 25 percent of reserves. In the most recent quarter, as shown in Figure 11, the distribution of reserves over assets has shifted somewhat away from banks representing the bottom 25 percent of assets, although reserves overall are now more evenly distributed (with respect to assets) than in any other quarter shown in these figures.

It is interesting to note that prior to the large increase in reserves (not in the figures), small banks held a disproportionately large share of reserves, because reserve holdings were driven by required reserves, and small banks on average hold relatively large demand deposits. In this sense, although the level of reserves is much higher, the distribution of reserves among small banks as of late 2010 had moved back close to its pre-crisis state.

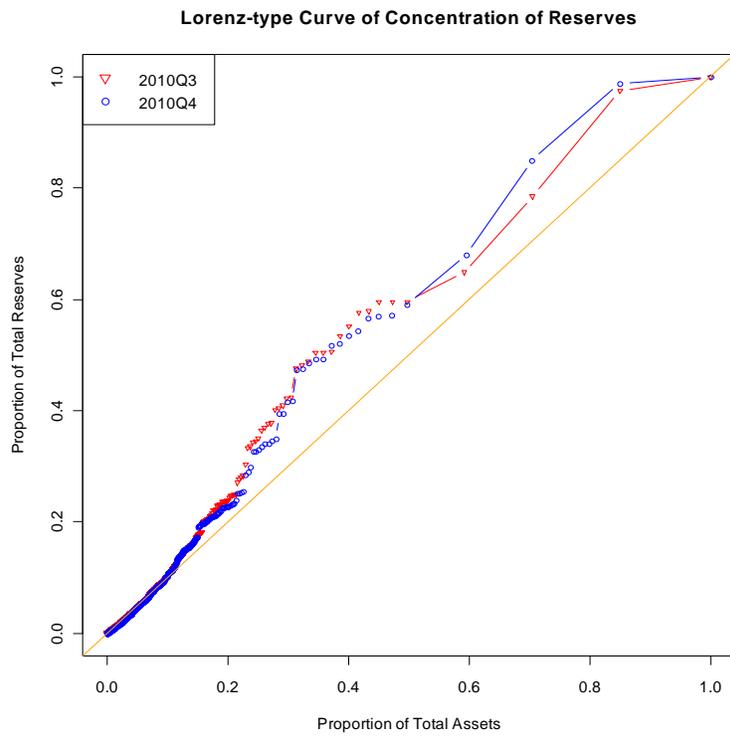


Figure 10

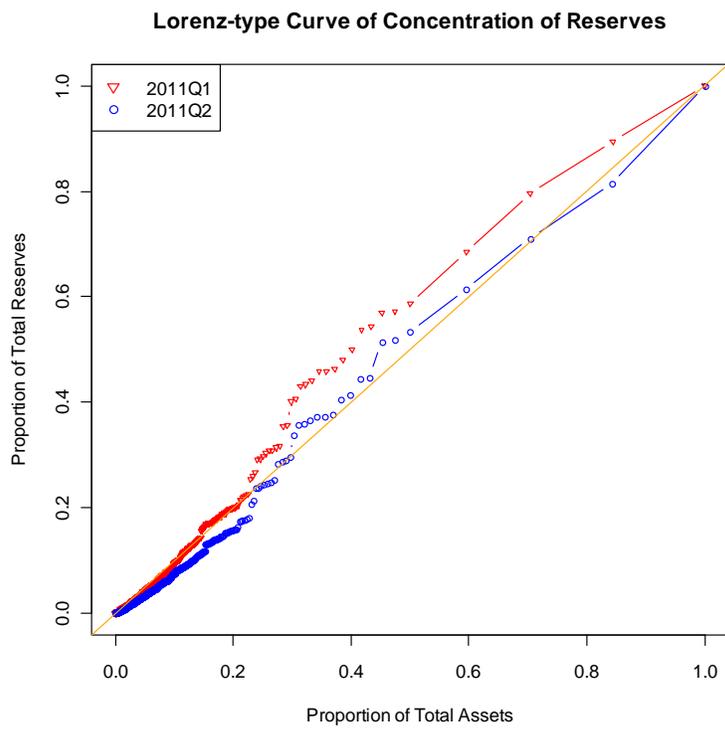


Figure 11

The differences between the Lorenz-type curves in Figure 9, 10, and 11 are likely to be associated with two factors. First, in the last two quarters of 2008 large quantities of reserves were just being introduced into the system. Potentially, the banks that initially received the new reserves did not immediately get rid of them, leading to the more “unbalanced” distribution displayed in Figure 9. Second, the state of the economy was very different in the three periods plotted in the figures. During the peak of the crisis (corresponding to Figure 9) some banks may have had greater incentives to accumulate reserves than others. Both these factors likely contributed to the more unbalanced distribution of actual and desired reserve holdings in the second half of 2008.

The first factor mentioned above is based on the idea that: (1) only a subset of banks played a major role as Fed counterparties during the crisis and (2) banks’ balance sheet adjustments occur only gradually. The fact that the interbank market was severely strained during the crisis probably contributed to making the adjustment more gradual. The way that the reserves are introduced would also play a role in this interpretation. As pointed out in the discussion of Figure 2, the large increases in reserves at the end of 2008 came about through Fed lending programs and liquidity swap lines. In principle, this way of introducing reserves tends to create a more dispersed initial distribution of reserves than when the Fed conducts asset purchases with a limited set of primary dealers. Notwithstanding this force for a more dispersed distribution, Figure 9 suggests some noticeable concentration of reserves at the top (i.e., in large banks). Figure 11 also corresponds to a period where that quantity of aggregate reserves was increasing significantly. While the extremely unbalanced distribution of late 2008 is no longer present in 2011, relative to the 2010 distributions displayed in Figure 10, smaller banks hold proportionately less reserves to assets in 2011. The normalization in the functioning of the financial system is likely to play a role in explaining the difference between 2008 and 2011.

Table 2. Correlation of reserves/assets across periods:
level (top right) and change (bottom left)

	08q4	09q1	09q2	09q3	09q4	10q1	10q2	10q3	10q4	11q1	11q2
08q3	0.33	0.28	0.27	0.28	0.27	0.26	0.23	0.25	0.21	0.22	0.20
08q4	1	0.74	0.58	0.53	0.50	0.47	0.41	0.40	0.44	0.41	0.44
09q1	-0.34	1	0.76	0.68	0.59	0.58	0.54	0.52	0.50	0.46	0.47
09q2	-0.27	-0.19	1	0.84	0.74	0.72	0.67	0.64	0.59	0.56	0.54
09q3	0.03	0.01	-0.13	1	0.83	0.79	0.73	0.70	0.64	0.60	0.58
09q4	0.02	-0.11	0.02	-0.23	1	0.85	0.79	0.74	0.72	0.67	0.63
10q1	0.03	0.07	-0.01	0.00	-0.32	1	0.90	0.83	0.78	0.76	0.73
10q2	-0.11	0.04	0.02	-0.05	-0.02	-0.20	1	0.90	0.83	0.78	0.75
10q3	0.01	0.02	-0.03	0.02	-0.05	-0.03	-0.15	1	0.88	0.82	0.75
10q4	0.11	-0.15	-0.09	-0.07	0.12	-0.12	-0.08	-0.27	1	0.87	0.80
11q1	-0.06	-0.03	0.04	-0.03	-0.05	0.10	-0.13	-0.05	-0.28	1	0.87
11q2	0.12	-0.06	-0.08	0.01	-0.04	0.03	0.01	-0.15	-0.01	-0.21	1

While Figures 9-11 provide some information about how the distribution of reserves evolved over time relative to the distribution of assets, those figures can only hint at how reserves evolved at the level of individual institutions. Table 2 displays correlations between one period and the next for the ratio of reserves to assets at each bank. The entries on the top right are correlations of levels, and the entries on the bottom left are correlations of growth rates. From Figures 9-11 we learned that reserves became more evenly distributed across banks in the later periods. Table 2 shows that the later periods have also been characterized by greater stability of reserves at particular institutions. However, as we will see below, there are in fact significant flows of reserves across institutions. The growth-rate correlations, shown below the diagonal in Table 2, are generally either zero or negative. While hardly conclusive, this evidence does not seem to support the view that banks gradually adjust their reserves to a target level.

4.3 Changes in reserves and the balance sheet

Understanding how the introduction of reserves was accommodated by individual banks is complicated. The impact of the increase in reserves on the size of a bank’s balance sheet and its components potentially depends on how the reserves are initially introduced, as we discussed before. The bank may be a direct counterparty of the Fed (by taking a loan or selling securities) or it may just be the provider of banking services to a non-bank counterparty of the Fed. Each case results in different implications for the bank’s balance sheet.

When a bank takes a loan from the Fed, initially this results in an increase in reserves on the asset side of the balance sheet and an increase in OSTB on the liability side. If these changes were the only ones associated with the central bank loan, then the size of the bank’s balance sheet would increase. However, if the bank accessed Fed credit to be able to fund a pre-existing position, then reserves would be used immediately and the balance sheet of the bank would remain the same, with Fed lending replacing some other liability used for funding the pre-existing asset position.²³ Of course, the reserves will be deposited in some other bank account and hence would result in an increase in deposits and reserve holdings for that other bank.

When the Fed buys securities from the private sector, it may or may not absorb assets previously held by the banking system. If the securities were held by banks, then the Fed is swapping one banking asset for another and the size of the banking system’s balance sheet would stay unchanged. Alternatively, if the Fed buys securities from non-bank investors, then the trade tends to induce an increase in banks’ balance sheets, since the Fed is swapping an asset that can be held by anyone for an asset (reserves) that can only be held by banks. In principle, this trade would create an increase in bank deposits and bank assets in the form of reserves.

To get a better sense for how the introduction of reserves was accommodated by banks, we go back to the data presented in Figure 8 and identify the four largest quarter-to-quarter increases in reserves (not divided by assets) among the top banks in the system. The first four rows of Table 3 deal with these changes. Two of the changes happened during the period where the main source of reserves was central bank lending (as identified in Figure 2) and two of the changes happened in the period where asset purchases were the main driver of the increasing level of reserves. We can see that, in general, the change in reserves was not offset by changes in other liquidity, and assets for the bank did not increase as much as reserves, nor did other short term borrowings (which include loans from the Fed). The bottom rows represent two other prominent changes in reserve positions by two of the top banks, as suggested by Figure 8.²⁴ Again, we see that increases in assets do not account for the increases in reserves, nor do other liquidity changes offset the reserve increases. Notably, OSTB did change significantly for JPMC during the third quarter of 2009, but this is probably not associated with borrowing from the Fed since the lending programs were actually winding down by that time.²⁵

²³Note that “Other short-term borrowings” may or may not increase, since borrowing from the Fed may be substituting for other short-term borrowings or for liabilities other than OSTB.

²⁴There were two other large changes not included in the Table, for Wells Fargo and JPMC, both in the last quarter of 2008, around the time when these two banks acquired large troubled banking organizations (Wachovia and WaMu, respectively). We did not include them in the table as the main changes in their balance sheet were driven by other factors. Bank of New York Mellon also had a large increase in its reserves position during the third quarter of 2008 but, being mainly a clearing bank, we decided to leave it out of the table.

²⁵More detailed data on the recipients of Fed lending during the period (through the Term Auction Facility and the Discount Window) is now publicly available and could be used to analyze how the main users of Fed lending facilities accommodated the new loans in their balance sheet. We leave this analysis for future research.

Table 3. Large changes in individual bank reserves

	Change in Reserves	Change in Assets	Change in Liquidity	Change in Other ST Borrowings
BofA 2008q4 to 2009q1	127.73	16.92	114.24	17.69
Citi 2008q3 to q4	82.38	28.90	61.70	32.18
Citi 2009q2 to q3	48.94	23.78	40.88	-19.76
Wells 2009q3 to q4	33.24	89.20	33.98	1.08
JPMC 2009q3 to q4	24.36	-39.73	13.01	16.98
HSBC 2008q3 to q4	11.73	-0.39	11.19	0.88

More generally, we can ask whether banks of all sizes were expanding or adjusting the composition of their balance sheets as they increased their reserve holdings. In Figures 12 through 15, we address this question for the initial large change in reserves, in Q3 and Q4 of 2008. We then consider the periods corresponding to later increases in reserves, associated with the Fed's two asset purchase programs.

From Figure 4, we know that the initial increase in reserves did not correspond to an aggregate increase in bank assets. Figure 12 expands on this finding, as it shows that there was not a clear relationship in the cross-section between banks' reserve growth and asset growth. To construct the figure we form four groups of banks, according to the value of their change in reserves divided by assets from Q3 to Q4 of 2008. Each group contains 20% of the banks. The first group includes all banks with a change in reserves relative to assets between the first and the third decile of the distribution. The second group includes all banks between the third and the fifth deciles, and so on for the other two groups so that in total we include all banks between the 10th and 90th percentiles when ranked by their change in reserves relative to assets. We then compute the percentage change in assets for each bank and summarize the distributions that condition on each of the four quantiles. In the figure, the horizontal axis measures the change in reserves as a percentage of assets. The four vertical lines correspond to the 20th, 40th, 60th and 80th percentiles of the change in reserves as a percentage of assets – the midpoints of each bin. The points plotted on the vertical lines represent quintiles and the median for the percent change in assets within each group. The distribution of changes in reserves over assets is right-skewed – the 70-90 quantile is far removed from the 10-70 quantiles. However, even for groups of banks with very different changes in reserves (relative to assets) the distribution of the percent change in assets is similar. In other words, Figure 12 suggests that those banks that increased their reserves the most during the fourth quarter of 2008 did not systematically increase their assets the most.

Changes in Assets & Reserves Across Banks

Quarter 3 to Quarter 4, 2008

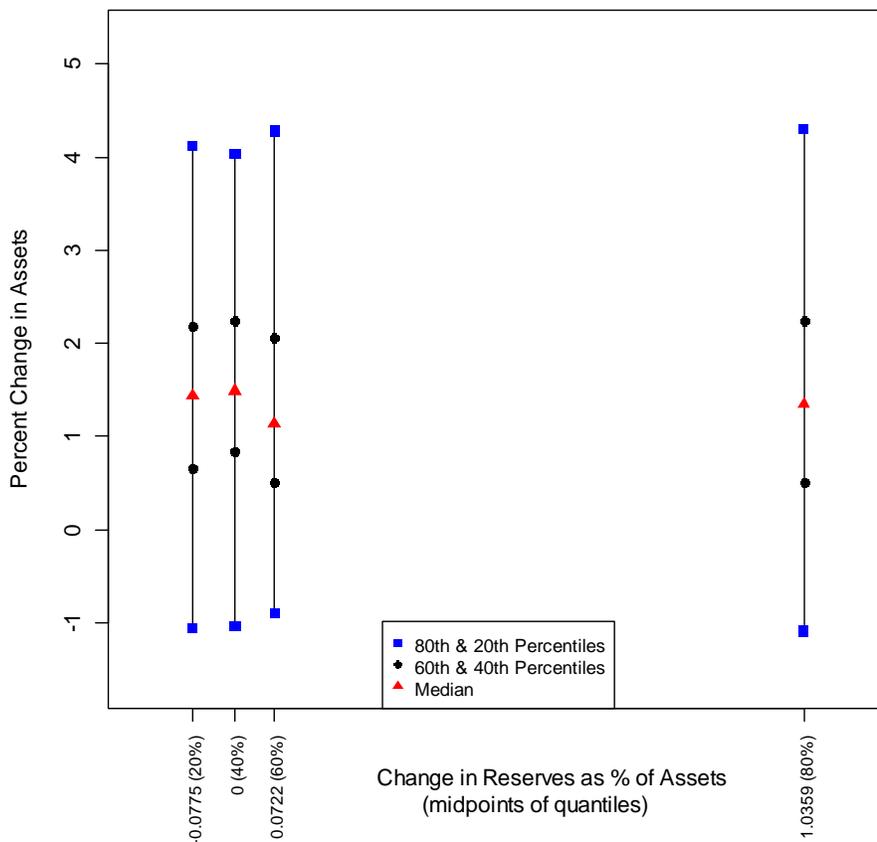


Figure 12

Similarly, we can ask whether those banks that increased their reserve holdings at the end of 2008 also increased their level of total deposits. This would be the case, for example, if banks were using Fed loans to substitute for other sources of funding, in which case the bank holding the reserves would be the one holding the account of the borrowing bank's previous creditor. Figure 13 displays some evidence of a positive relationship between changes in reserves and changes in deposits during that period: banks with a relatively large increase in reserves as a percentage of assets (the 70-90 quantile) had a distribution of deposit changes higher than other banks.

Changes in Deposits & Reserves Across Banks
 Quarter 3 to Quarter 4, 2008

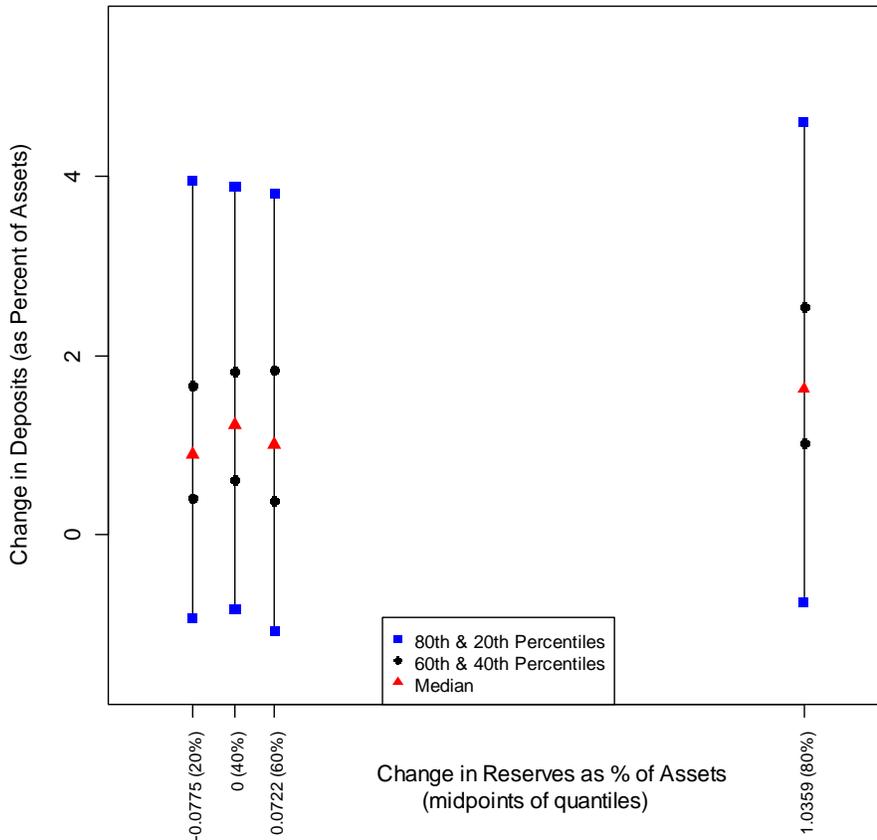


Figure 13

One limitation of Figure 13, and other similar figures, is that they weight all banks equally. Figure 14 restricts attention to the 100 banks that had the largest increases in reserves in 2008q4.²⁶ The figure plots the cumulative change in deposits against the cumulative change in reserves for 2008q3 to q4, with institutions ranked in descending order by their change in reserves. The total increase in *both* deposits and reserves for these institutions was close to \$300 billion. However, among the 15 banks with the very biggest increases in reserves the relationship between deposit changes and reserve changes is weaker.

²⁶We exclude Wells Fargo because its balance sheet approximately doubled with the purchase of Wachovia.

Changes in Deposits & Reserves Across Banks 2008 Q3 to Q4

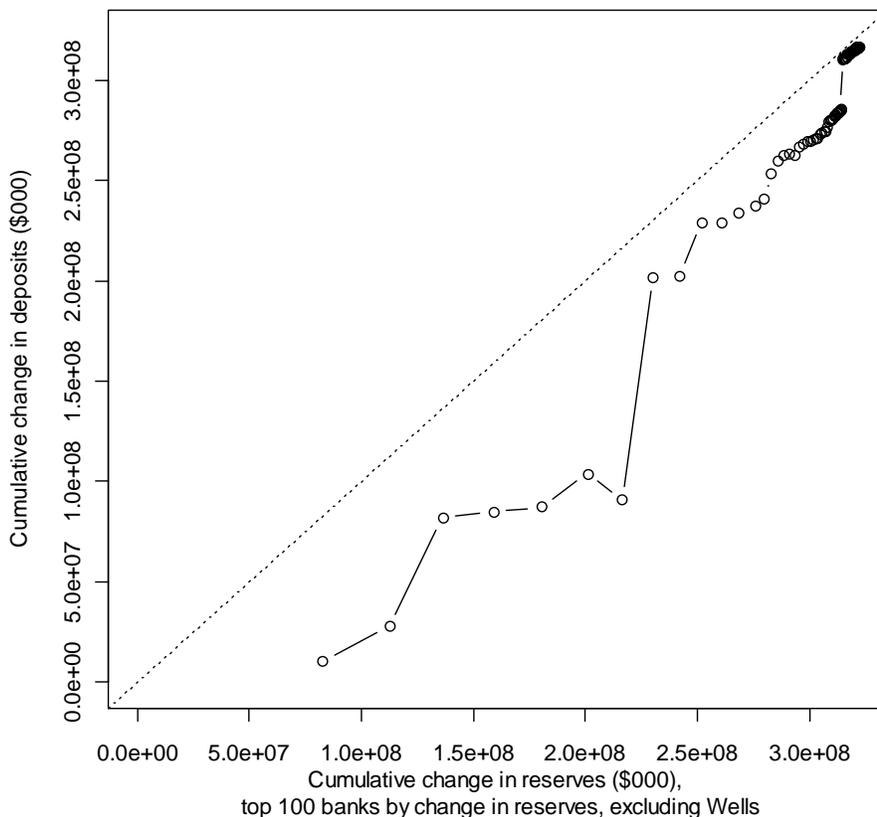


Figure 14

Given that changes in assets are not tightly linked with the changes in reserves, for some institutions the change in reserves may have been offset by a change in securities, leaving total assets unchanged. This fact would suggest for a negative correlation between changes in reserve holdings and changes in securities holdings. Figure 15 shows that there is no strong evidence for such a pattern in the data, but again this figure treats all banks the same, regardless of size. With Figure 14 showing that reserves and deposits moved together in aggregate for the 100 banks that increased reserves the most, it seems unlikely that reserves primarily substituted for securities at those institutions. Figure 16 confirms that substantial substitution only occurred at a small number of institutions.

Changes in Securities & Reserves Across Banks Quarter 3 to Quarter 4, 2008

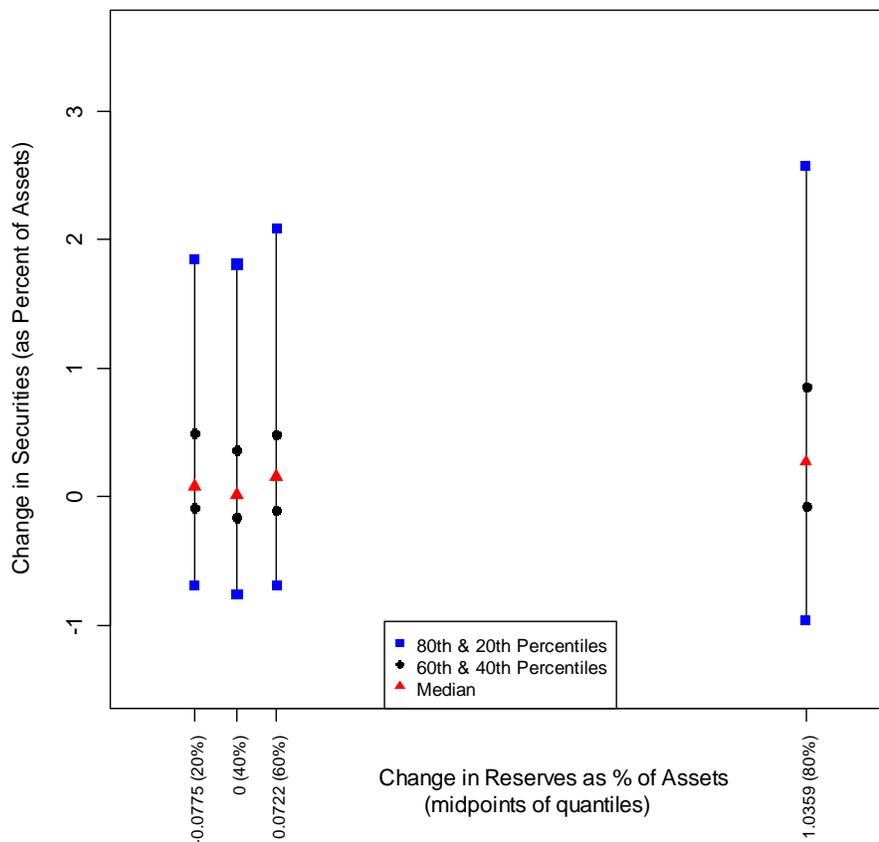


Figure 15

The picture painted by these figures is not easy to interpret. Banks that had a significant increase in their reserves position (relative to assets) did not increase their total assets more than other banks. This would suggest that some other component of the asset side of the balance sheet must have decreased. However, according to Figures 15 and 16, it is not the case that securities play that compensating role. At the same time, there is some evidence that banks that increased their reserves position significantly also increased their deposits. These deposits could reflect the fact that customers of the reserve-holding bank had previously been lenders to other banks. When the borrowing banks switched to Fed facilities for their funding, they paid off private loans, causing an increase in deposits and reserves at their (nonbank) lender's bank.

Changes in Securities & Reserves Across Banks 2008 Q3 to Q4

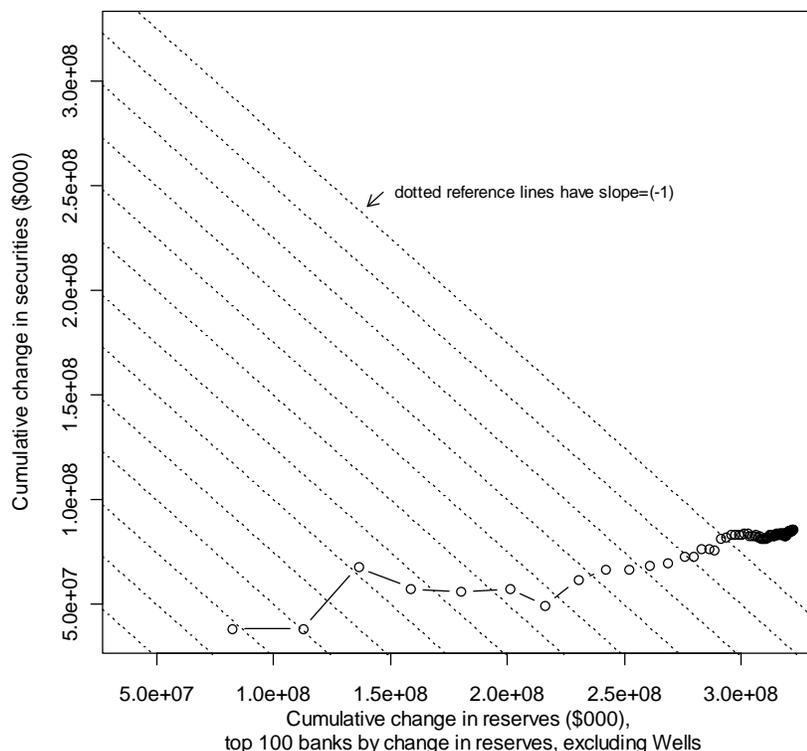


Figure 16

After the late-2008 increases in reserves based on Fed lending, the introduction of reserves has been accomplished mainly through asset purchases.²⁷ As we have explained, if the Fed is purchasing most of the securities from banks, then one would expect to see a negative correlation between reserves and securities holdings across banks during the periods of large increases in reserves. If instead securities are being purchased mainly from nonbanks, then the purchases involve non-banks increasing their holdings of bank deposits: across banks, there would be a positive correlation between reserves and deposits. Total reserves increased significantly during the second and third quarters of 2009, and again in the first and second quarters of 2011, and we study those two episodes in turn.

Figure 17 shows that there is some tenuous evidence of a negative correlation between securities and reserves in the middle periods of 2009 among all banks. However, Figure 18 shows that among those banks experiencing the biggest increases in reserves, very few reduced their securities holdings as much as they increased their reserves. Presumably then, the Fed was absorbing securities not just from the banking system but also from other private holders. Figure 19 hints at a positive relationship between changes in reserve holdings and in deposits. There is indeed a fairly tight relationship between reserve changes and deposit changes for the 12 banks with the largest increases in reserves (see Figure 20). When we consider the top 100 absorbers of reserves the relationship is weaker than in 2008. In sum, the evidence suggests that private holders reduced their securities positions and increased their bank deposits as a result of the Fed's first round of asset purchases.

²⁷Changes in the Treasury's Supplemental Financing Program have also played a role in the behavior of reserves.

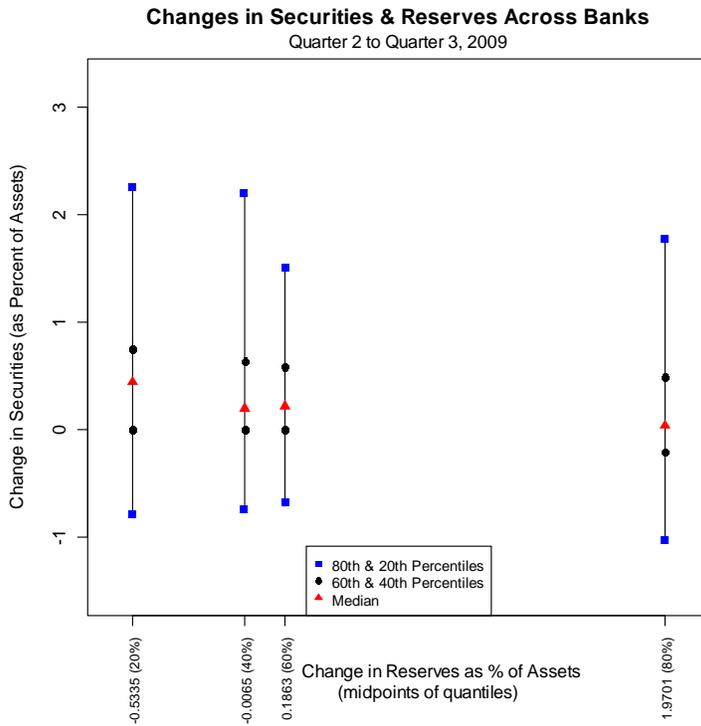


Figure 17

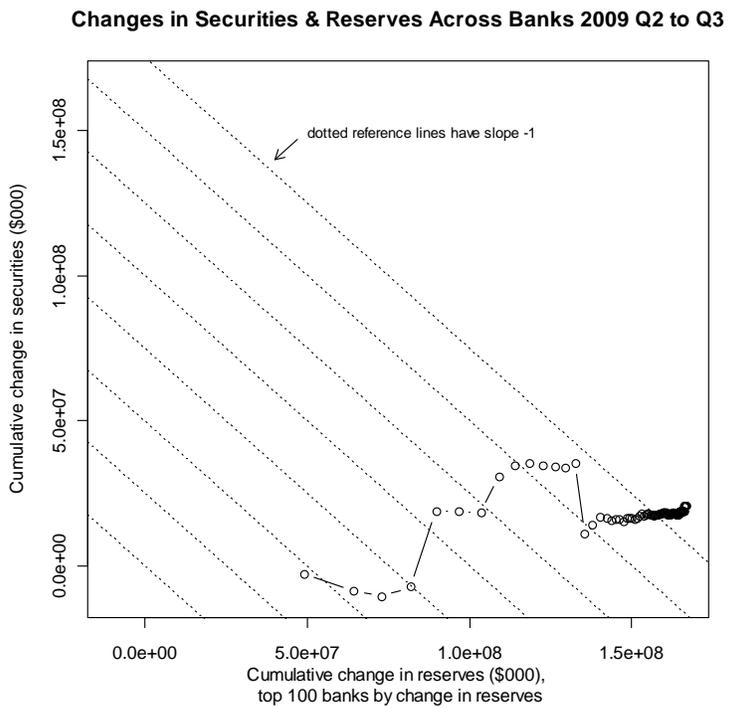


Figure 18

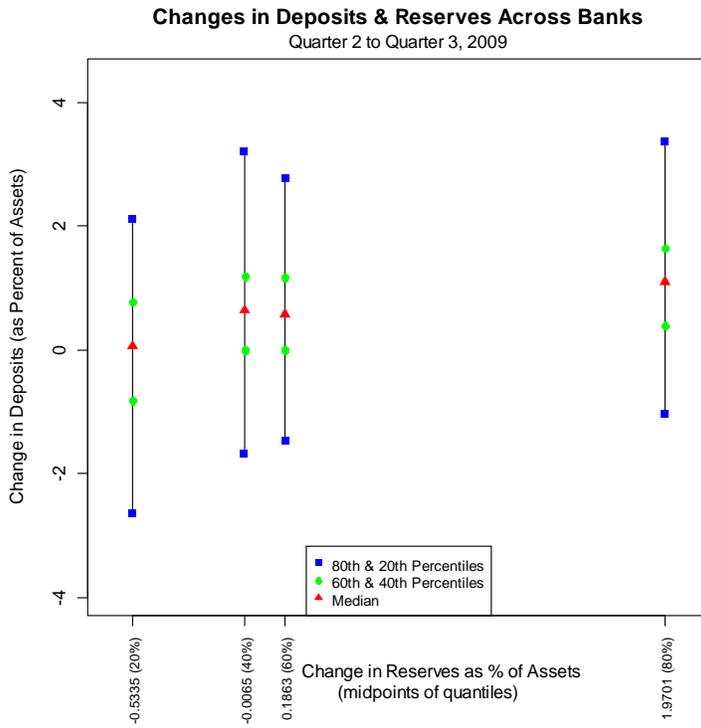


Figure 19

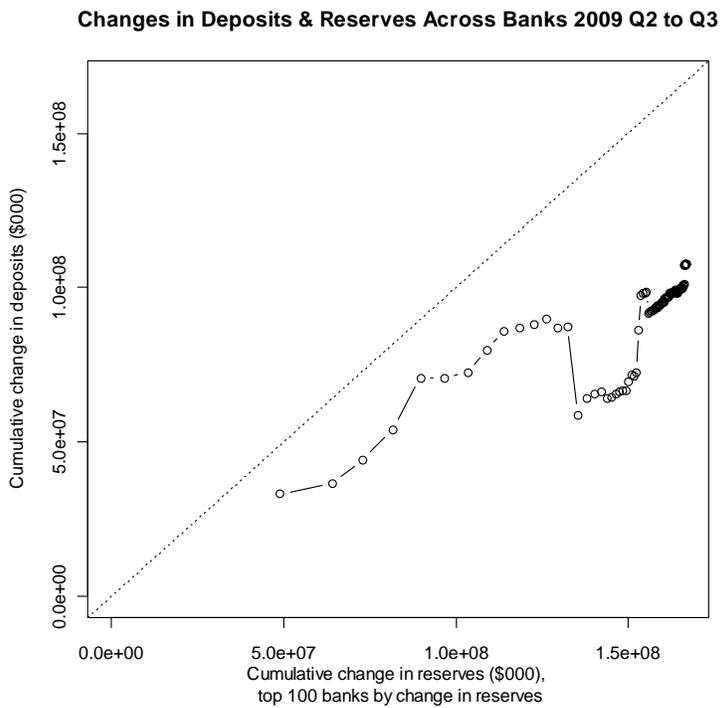


Figure 20

Figures 21 through 24 repeat the previous four figures, for the Fed’s second Large Scale Asset Purchase program— they plot changes from 2010Q4, which was just a few weeks after the program began, to 2011Q2, which was just after the program concluded. Although Figure 21 displays a negative relationship between reserve changes and securities changes, among the 100 banks that increased reserves the most, no such relationship is evident (Figure 22). From those two figures then, it appears that the increase in reserves was accomplished mainly by purchasing securities from nonbanks, which would imply an increase in bank deposits. Figures 23 and 24 are consistent with this view: banks with large increases in reserves also had large increases in deposits (Figure 23), and among the 100 banks that increased reserves the most, there was approximately a one-for-one increase in deposits (Figure 24).

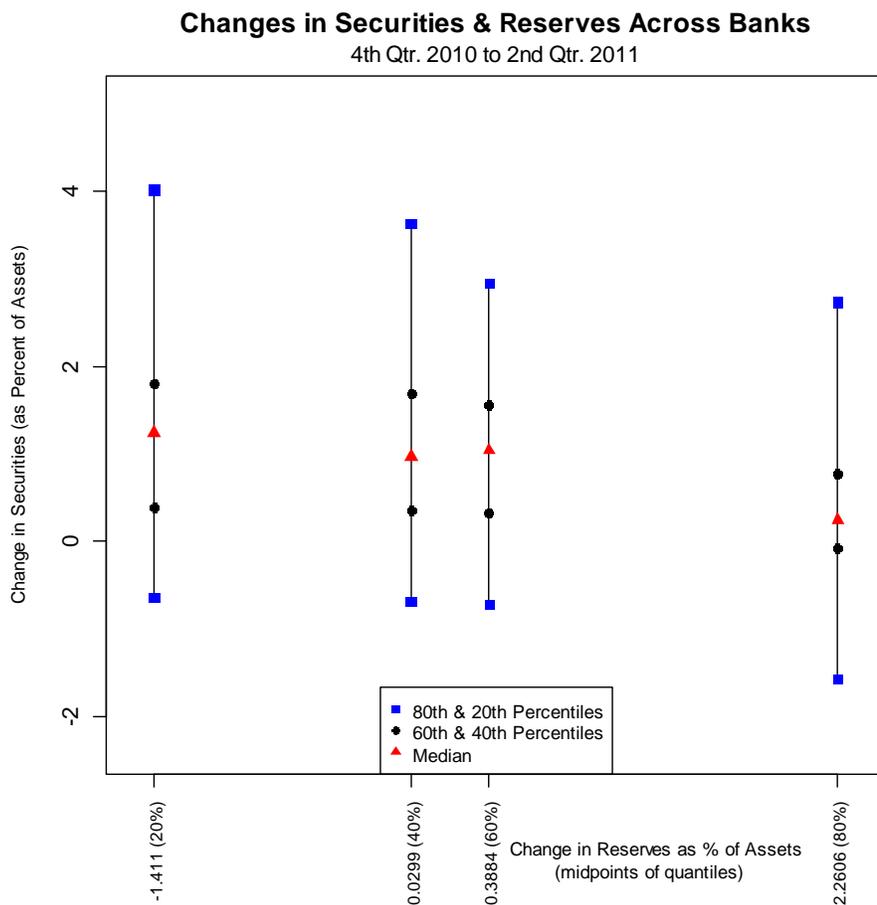


Figure 21

Changes in Securities & Reserves Across Banks 2010 Q4 to 2011 Q2

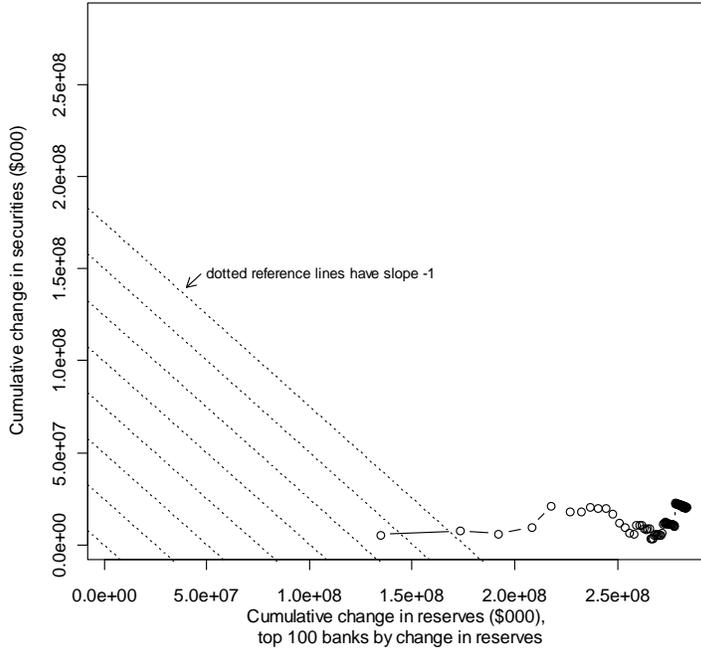


Figure 22

**Changes in Deposits & Reserves Across Banks
4th Qtr. 2010 to 2nd Qtr. 2011**

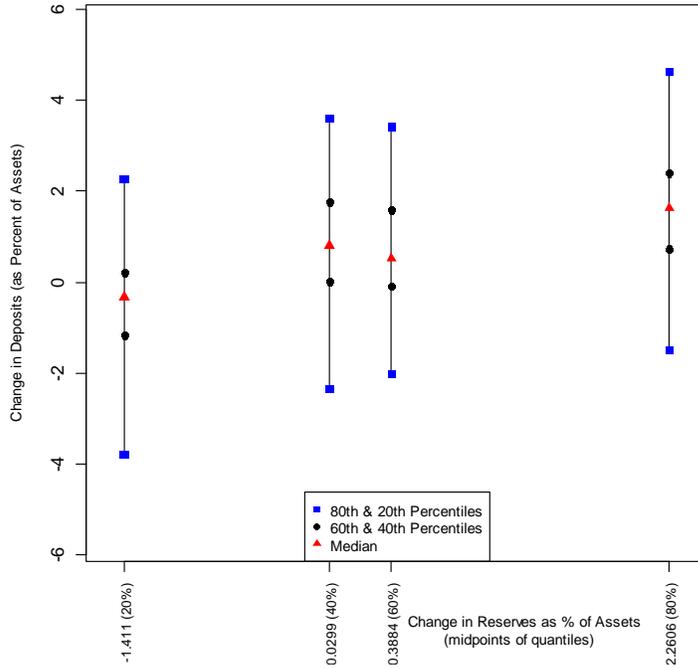


Figure 23

Changes in Deposits & Reserves Across Banks 2010 Q4 to 2011 Q2

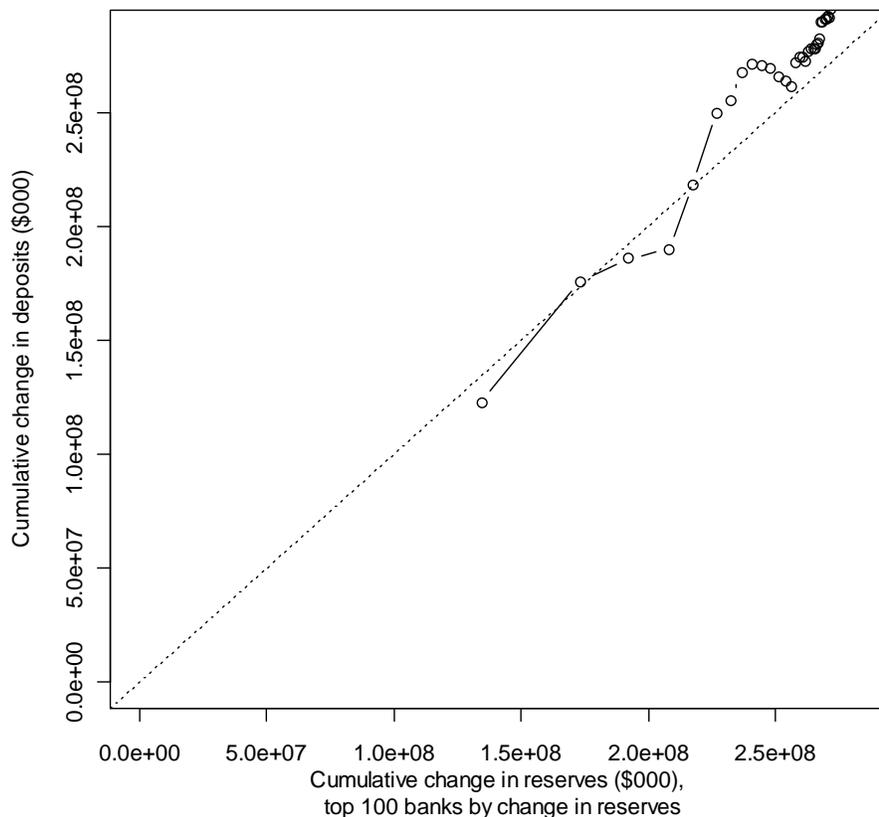


Figure 24

4.4 Gross Flows

Going back to Figure 9, one could alternatively think that the uneven distribution of reserves was the result of a deliberate choice by some banks to accumulate disproportionately large quantities of reserves during the crisis. Under this interpretation, market transactions actually reallocate reserves quite effectively. Figure 25 displays the time series for the change in total reserves, together with the gross flow of reserves, defined as the sum of each institution's absolute change in reserves. If the only changes in bank-level reserve holdings were due to the change in total reserves, then the two lines would be identical. In 2008q4 this was approximately the case: the gross flow of reserves was quite close to the change in total reserves. This pattern does not suggest a significant flow of reserves across institutions during the peak of the crisis.²⁸ Instead, reserves flowed mainly from the Fed to banks. A strained interbank market might have contributed to this situation. Also though, the fact that the lending programs were broadly accessible to banks, and in particular to those banks that wanted to hold reserves, surely implied that reserve flows across banks did not need to be large during this initial period of reserves creation.

²⁸Note that in Figure 25 there are two consecutive quarters, 2008q3 and 2008q4, in which the gross flows move closely with the change in aggregate reserves. Since the level of reserves in 2008q2 was very low, it is not surprising that the two series move together in 2008q3. However, this pattern persists for 2008q4, which is the more interesting fact.

Gross Flows and Net Change in Reserves

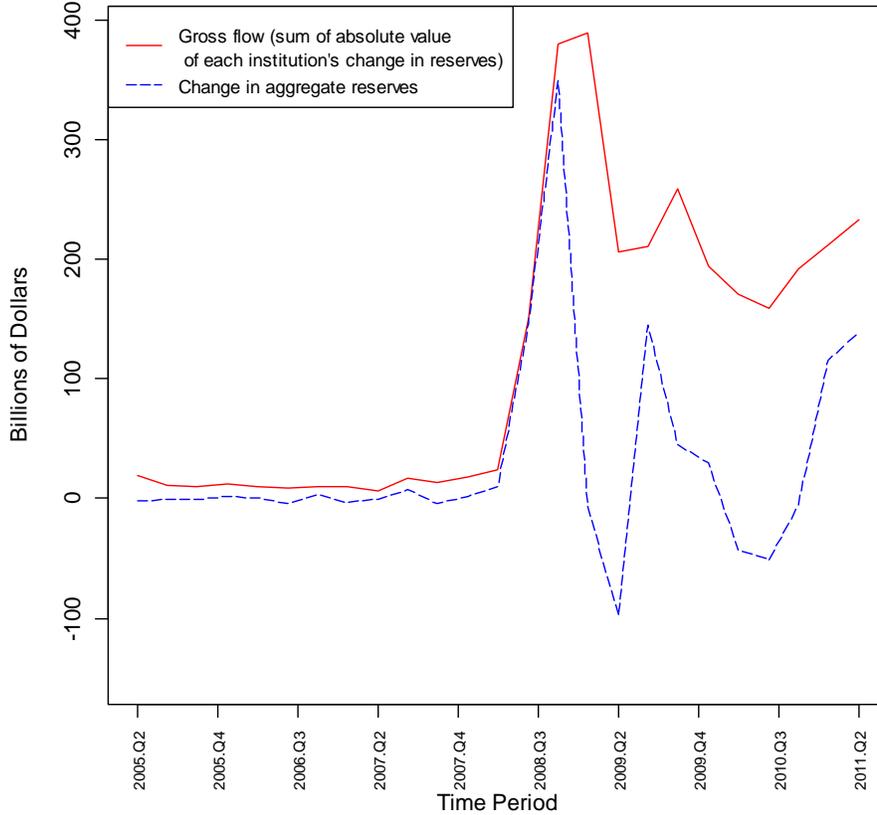


Figure 25

Subsequently, however, the changes in total reserves have generally been small relative to the gross flows. Figure 26 shows that while the gross flows have been large, since the third quarter of 2009 they have not risen relative to the level of reserves; for each period “t,” the figure plots the gross flow from t-1 to t divided by the level of reserves at t. We can see in the figure that gross flows relative to reserves increased significantly in the initial periods of the crisis. In fact, such a change happened even before the large increase in the level of reserves during the third and fourth quarters of 2008. Starting in mid 2007 several Fed programs were implemented that tended to redistribute reserves across the system. Also, the Fed sterilized the effects of those programs on reserves until September or October of 2008. Sterilization meant that the Fed absorbed reserves from some institutions who eventually, then, needed to acquire new reserves to continue acting as agents for counterparties of the Fed’s open market operations. All these reserves-based transactions likely underlie the increase in relative gross flows in the second half of 2007 shown in Figure 26. Furthermore, note that after the first quarter of 2009, gross flows fell dramatically relative to the stock of reserves, and by mid 2011 these relative flows lay well below precrisis levels.

In evaluating the gross flows data, it is important to understand the factors that lead to these flows. We have already discussed Fed behavior: if the Fed is changing the total stock of reserves or is turning over that stock (as, for example, with short-term repo), then gross flows will naturally be created. However, the turnover effect is likely to be reflected mostly in high-frequency data, and not so much in the quarterly numbers studied here. Gross flows also result from interbank payments that are a natural part of the business of banking. These flows are likely to be most relevant at the intraday frequency. Finally, gross flows result

from institutions choosing to rebalance their portfolios. If the Fed keeps the total stock of reserves high and banks begin to increase their lending, then large gross flows would likely ensue.

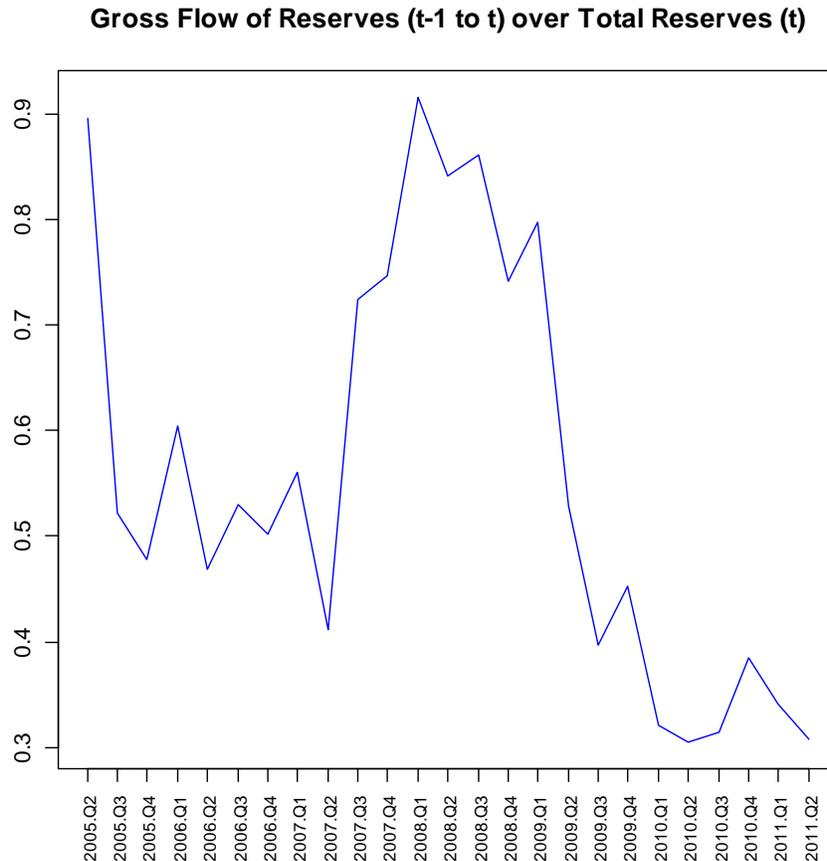


Figure 26

When the banking system functions with low levels of reserves, it is not surprising that reserves move across institutions with high velocity. Reserves are scarce and need to be reallocated to those banks that need them the most. Figure 25 shows that before the crisis roughly half of the reserves changed hands from one quarter to the next. When the system functions with high levels of reserves, presumably this pressure for reserves reallocation is weaker. Yet Figure 26 shows that gross flows in 2011 were still over 30 percent of the level of existing reserves, and gross flows exceeded net flows by about \$100 billion. Contrary to what one might conclude based on the convergence of distributions suggested by Figures 9-11, it is not the case that reserves have reached their final destination after a gradual adjustment period. Keister and McAndrews (2009) emphasize that in the short run banks have no choice but to hold the reserves created by the Fed; Figures 25 and 26 underscore the fact that *an individual bank* can hold whatever level of reserves it wishes, and that, in fact, there are substantial fluctuations in reserve holdings across banks.²⁹

²⁹We discussed in Section 2 the possibility of banks in aggregate attempting to decrease their reserves. In principle they could reduce total deposits, in the process transforming reserves into currency held by the public. Alternatively, banks' attempt to reduce reserve holdings could actually lead to the creation of new deposits and an adjustment of prices or economy-wide rates of return so as to make banks willing to hold the reserves supplied by the Fed.

4.5 Higher frequency reserve changes

The Call Reports, our basic data source, summarize banks' balance sheet positions at the end of the quarter. Given the nontrivial gross flows presented in Figure 25, it is natural to suspect that individual banks' reserve balances also fluctuate within the quarter, and potentially in a significant manner.

In some of the interpretations we provide in this paper, we take the end-of-quarter position to represent a bank's medium-term decision with respect to its asset holdings (not just an end-of-quarter event). To get a sense of how good an approximation this working assumption is, for the top 75 banks by assets we report summary statistics for the difference, as a percentage of assets, between average reserve holdings during a quarter and end-of-quarter holdings in that same quarter (labeled $D(i,t)/A$).³⁰ For 2009q1 and 2010q4, Table 4 displays quintiles based on ascending values of $D(i,t)/A$ for two sub-groups of the top 75 banks by assets: the top 25 and the rest.³¹

Table 4. Percent deviation of average within-quarter reserves from end-of-quarter reserves

2010q4			
Top 25 banks by assets		Top 26-75 banks by assets	
Rank	$D(i,t)/A$	Rank	$D(i,t)/A$
5	-1.69	10	-3.13
10	-0.45	20	-0.82
15	-0.09	30	-0.12
20	0.02	40	0.26
2009q1			
Top 25 banks by assets		Top 26-75 banks by assets	
Rank	$D(i,t)/A$	Rank	$D(i,t)/A$
5	-0.85	10	-0.18
10	-0.02	20	0.00
15	0.60	30	0.13
20	1.30	40	1.38

We can see from the table that for many banks the difference between average reserves within the quarter and reserves at the end of the quarter is not large as a percentage of assets. Aggregate reserves were 4.1% of assets for the top 75 banks in 2010q4, but there was some significant concentration, as illustrated by the second panel of Figure 7. Table 4 tells us that for the top 25 largest banks the reallocation of assets due to changes in reserves positions within a quarter amounts to less than 2% of assets for at least 15 banks, and for the 25th to 75th largest banks the reallocation is less than 3% of assets for at least 30 banks. It is notable that this reallocation was significantly smaller for the second group in 2009q1, as shown in the bottom panel of the table. In the appendix, we provide a similar table for the changes in reserves from one quarter to the next. These numbers are a useful benchmark for interpreting Table 4. The changes from quarter to quarter

³⁰It is the case that some banks have been able to borrow in the overnight repo market at rates lower than IOR, deposit the proceeds at the Fed and thereby obtain an interest differential. This phenomenon was much discussed in the financial press following an April 1, 2011 change in FDIC insurance premiums. When banks borrow in the repo market and increase their balances with the Fed, they fully anticipate that the reserves will be used the next day to cancel the repo transaction. In that sense, those reserves are not available for funding. This kind of repo transaction, however, likely is less prominent on the last day of the quarter, when banks want to control their reported leverage ratios as much as possible. Such repo transactions may drive some of the difference between averages during the quarter and end-of-quarter numbers, but the difference is not necessarily a problem for our purpose to the extent that end-of-quarter numbers are more representative of the actual liquidity available to banks for funding lending or the purchase of new securities. This reasoning, of course, assumes that the reserves unloaded by some banks at the end of the period are more evenly distributed in the system and hence constitute a smaller bias in our data.

³¹The numbers in Table 4 were provided to us exactly as they appear in the Table, by the Statistics Division of the Federal Reserve Bank of Richmond.

in reserves are roughly comparable to those within the quarter. In other words, end-of-quarter adjustments do not appear to undermine the value of our data as being representative of banks' desired reserve position.³²

A recurrent theme throughout this section, and in the rest of the paper, is the speed at which reserves get reallocated in the system. We have seen that gross flows of reserves are nonnegligible and that, while the differences between end-of-quarter and averages are not very large, they are certainly not zero. The speed of reallocation is also an issue when interpreting the Lorenz-type curves in Figures 9-11, since the uneven distribution of reserves during the peak of the crisis (as reflected in Figure 9) may reflect either gradual reallocation of reserves or banks reacting differently to the crisis. In the former case the desired distribution of reserves deviates from the actual distribution, whereas in the latter case the desired distribution itself displays the dispersion seen in the data. Similarly, we have discussed the fact that when reserves are increasing rapidly, the manner in which reserves are introduced may affect the observed end-of-quarter reserve distribution; this relationship depends on banks' (in)ability to quickly reshuffle reserves. We generally take the view that although reallocation of reserves does take place, actual holdings are likely to be influenced by transitional movements and the type of interventions the central bank uses to alter aggregate reserves.

The idea that adjustments to individual banks' balance sheets is likely to take some time is also important for understanding why we believe that a banking system holding a large quantity of reserves will be able to react more rapidly to improvements in general economic conditions. If banks are not holding the necessary liquidity to finance new loans, it may take them a few weeks (or even months) to arrange the appropriate funding sources to back the long-term loans. But when banks hold a large stock of reserves, funding is no longer an issue, and hence loans can be made more promptly.

5 Reserves as a form of liquidity

To the extent that interest-bearing reserves are now a perfect substitute for short-term low-risk securities, we would expect that the increase in aggregate reserves brought about by the Fed was eventually offset by a reduction in banks' holdings of short-term low-risk securities. We say eventually, because in the fall of 2008 there was clearly a shock to the demand for liquid assets. The point here is that if reserves are a perfect substitute for other liquid assets, then it may not be interesting to look at reserves in isolation – doing so would be akin to studying the behavior of \$20 bills instead of total currency outstanding.

Figure 27 displays the time series for a measure of aggregate liquidity (reserves, vault cash, short-term securities, and net repo and fed funds sold to non-banks) held by banks. We view this measure as a reasonable proxy for low-risk assets on a bank's balance sheet.³³ Given the large changes in levels that we are concerned with, alternative measures of liquidity are unlikely to modify the main conclusions. Note that prior to the crisis, this measure of liquid assets in the banking system was negative: banks were borrowing short-term funds from the non-bank sector in excess of the liquid assets they held. The initial increase in liquidity corresponds to a period (fall 2008) where there was presumably a large increase in banks' demand for liquid assets. Thus, not much can be inferred from the initial increase in the quantity. However, in subsequent quarters financial market conditions normalized, and the quantity of liquid assets remained high. We interpret Figure 27 as showing that once financial conditions normalized, banks did not substitute reserves for other forms of liquid assets.³⁴

³²Fedwire data provides information about reserve flows at an even higher frequency. However, this data is dominated by intraday payments and is less informative about the issues we are concerned with here.

³³Note that we have excluded from our measure of liquidity balances due from other depository institutions. These balances represent liquidity to individual institutions but not to the banking system as a whole.

³⁴It is of course true that because reserves have been introduced by purchasing Treasury and mortgage-related securities, the consolidated private sector did substitute reserves for other forms of liquid assets. As discussed in Section 2, the extent to which the increase in reserves matters depends in large part on the extent to which banks matter.

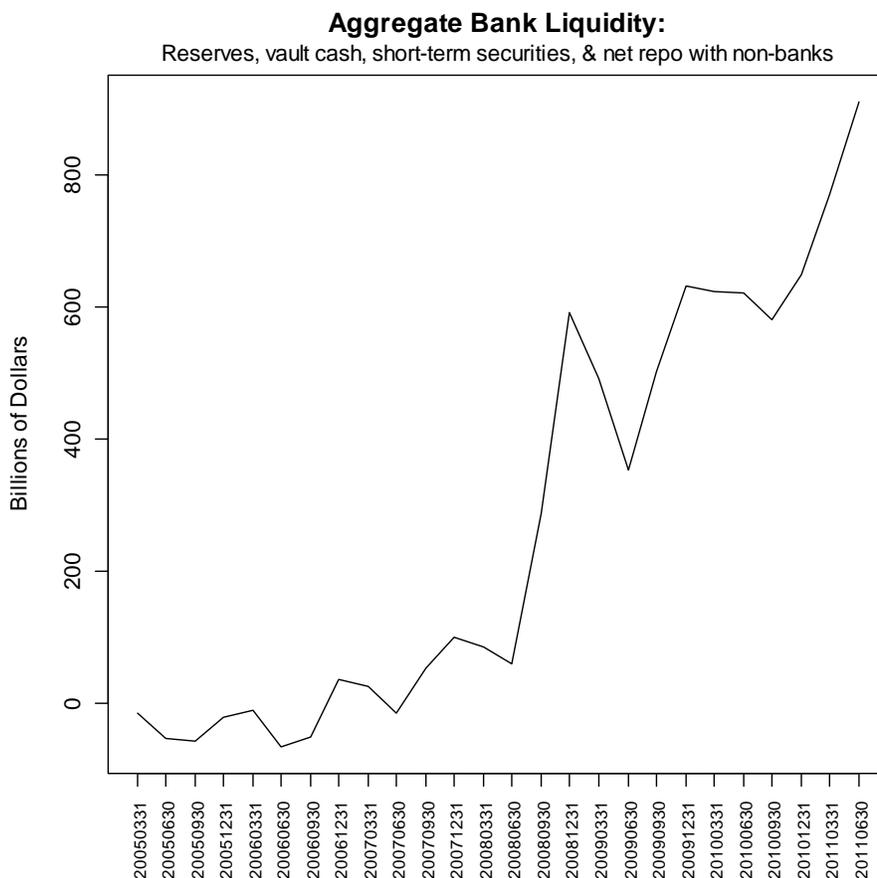


Figure 27

At the level of individual banks, we again do not find that there was meaningful substitution of reserves for other liquid assets. There is a strong positive correlation across banks between changes in reserves and changes in the liquid asset measure used in Figure 27 – this holds for all periods in the sample. It is clear then that banks increased their overall level of liquidity, and did not simply substitute reserves for other liquid assets. Even with historically normal levels of reserves, the high level of liquidity would represent an increased ability to quickly react to changes in economic activity. And reserves represent the most liquid of assets, amplifying this ability to react.

6 Reserves and capital across banks

We have established that banks did not simply use reserves to substitute for other liquid assets on their balance sheets. In other words, banks are currently holding high levels of liquidity. Our working hypothesis is that banks holding liquidity are in a better position to fund new loans or securities purchases when profitable opportunities arise. While attracting new depositors may take time and resources, liquidity that is already on the balance sheet can immediately be used for funding higher-return assets. From this perspective, it is also natural to expect that reserves will be the “first out the door” source of funding; in the ranking of liquid assets, reserves are effectively at the top.

In principle, then, holding high levels of reserves provides flexibility to a bank that is looking to expand its loan portfolio. However, loans (and risky securities) are associated with higher capital requirements than

reserves. A bank that is holding reserves but is facing a binding capital constraint is thus unlikely to engage in a sudden expansion of lending. As with deposits, raising capital is costly and can take time. For this reason, even a bank that holds a high level of excess reserves may not be able to take advantage of new lending (or investment) opportunities if its level of capital is not sufficiently high (see, for example, Van den Heuvel, 2002, and Carlson, Shan and Warusawitharana, 2011).

In light of these considerations, it is important to assess the extent to which banks hold capital that would allow them to “convert” excess reserves into loans or other risky assets. It is a well-known empirical regularity that smaller U.S. banks tend to hold higher capital ratios. As a first pass at the data, we therefore look at only the 75 largest banks by assets. Within this group there is no systematic, long standing relationship between size and capital. Figure 28 plots the risk-based capital ratio on the horizontal axis and the ratio of reserves to assets on the vertical axis for this sub-sample of large banks in the second quarter of 2011. The figure shows that not all banks holding high reserves tend to be poorly capitalized, and that in fact there are many large banks with both high levels of reserves and high capital ratios.³⁵

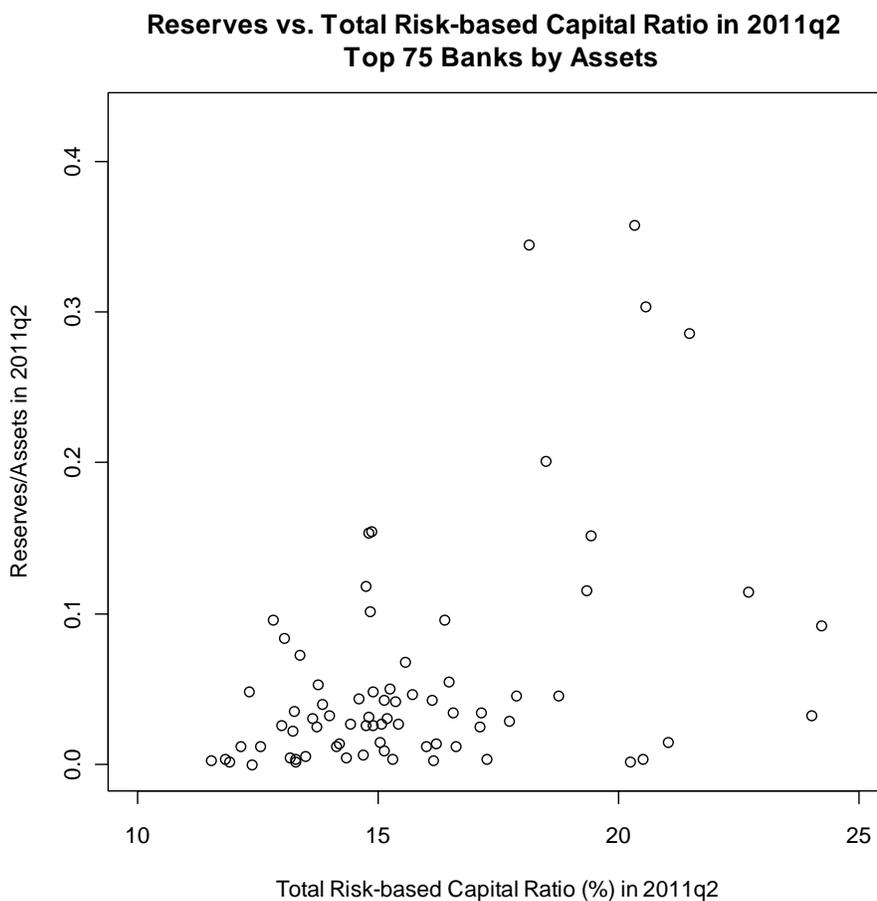


Figure 28

Based on the figure alone, it is difficult to quantify banks’ immediate ability to expand lending, as implied by their reserve holdings and capital ratios. While binding capital requirements are likely to limit the ability of certain banks to transform reserves into loans, Figure 28 suggests that several banks can indeed lend out their reserves without facing a capital constraint. To get a sense of how prevalent this situation is, we

³⁵To be considered well-capitalized, a bank must have a total capital ratio of at least ten percent.

compute below an aggregate measure of loanable reserves that adjusts for the fact that each bank's new lending has to be consistent with satisfying its capital requirement.

6.1 Total loanable reserves

Capital requirements in the US mandate that banks satisfy several minimum ratios of capital to assets, based on different measures of capital and of assets. The leverage ratio, for example, is a simple ratio of capital to assets (without any significant adjustments). Since transforming reserves into loans on the asset side of the balance sheet does not change this ratio in any material way, the leverage ratio is not a relevant limiting factor in the ability of banks to lend out reserves.

The tier 1 capital ratio is the ratio of tier 1 capital to risk-adjusted assets.³⁶ The risk charge for reserves is lower than the risk charge for loans. Hence, transforming reserves into loans results in an increase in risk-adjusted assets and, given tier 1 capital, a decrease in the tier 1 capital ratio. A bank with a low tier 1 capital ratio will then be less able to increase lending (or investment), even if it is holding sufficient excess reserves to fund the loans.

The total capital ratio is the ratio of the sum of tier 1 and tier 2 capital to risk-adjusted assets.³⁷ As with tier 1 capital, a bank with a relatively low total capital ratio (such that approaching the regulatory minimum becomes a concern), will tend to limit its expansion of credit, even when funding could be readily provided with the holdings of excess reserves.

In summary, some of the potential lending capacity associated with holding excess reserves should be "discounted" to the extent that those reserves are being held by banks with (effectively) binding capital constraints.³⁸ It is impossible to determine precise levels of capital ratios at which the requirements become effectively binding. Some banks may be willing to make certain loans even if their capital requirement is relatively low. Others may take a more conservative approach to capital management and lending. To obtain a simple estimate, we take the view that each bank's lending capacity is given by the amount of new loans that could be funded by excess reserves while keeping the bank "well-capitalized" for regulatory purposes. Currently, a "well-capitalized" bank must have a tier 1 capital ratio higher than 6% and a total capital ratio higher than 10%. Using this criterion, we compute for each quarter in our data set the following measure of lending capacity for all insured banks in the sample:

$$LC(t) = \sum_i \min \left\{ \frac{[K_i^{T1}(t) - K_{iR}^{T1}(t)]^+}{0.06}, \frac{[K_i^T(t) - K_{iR}^T(t)]^+}{0.1}, [R_i(t) - R_{iR}(t)]^+ \right\},$$

where K_i^{T1} is the dollar amount of tier 1 capital held by bank i and K_{iR}^{T1} is the amount of tier 1 capital that would allow the bank to have a ratio equal to 6%. Similarly, K_i^T is the dollar amount of total capital held by bank i and K_{iR}^T is the amount of total capital that would allow the bank to have a ratio equal 10%. Finally, R_i is the level of reserves held by bank i and R_{iR} is the required reserves (net of vault cash) given its average level of transaction accounts liabilities in the quarter. The superscript sign $+$ means that we are only considering non-negative values of these terms.

It is clear now that capital ratios are going to increase in the near future, especially for large banks. For this reason, we also compute a more conservative measure of lending capacity for the last quarter in our dataset, 2011q2. To compute this alternative measure, we based our estimates on the Basel III proposal and fix the required tier 1 capital ratio to 8.5% and the required total capital ratio at 10.5%. We use these ratios for all but the top 25 banks. For the larger banks (the top 25 by assets) we increase the tier 1 capital ratio to 10.5% and the total capital ratio to 12.5%. There is still significant uncertainty with respect to the capital requirements that will be imposed on large banks in the U.S. We use these ratios as a way to obtain a relatively conservative measure of lending capacity.

³⁶Tier 1 capital consists of common equity and some types of preferred stock.

³⁷Tier 2 capital consists of allowance for loan losses, subordinated debt, and other convertible debt securities.

³⁸Bliss and Kaufman (2003) argue that the effects of reserve injections by the Fed will depend on whether or not capital requirements are binding.

Figure 29 plots our measure of loanable reserves $LC(t)$ together with total (excess) reserves $ER(t)$ across time, where:

$$ER(t) = \sum_i [R_i(t) - R_{iR}(t)]^+.$$

The figure shows that in the second quarter of 2011 about 96% of reserves could be converted into loans without pulling banks into poorly-capitalized territory.

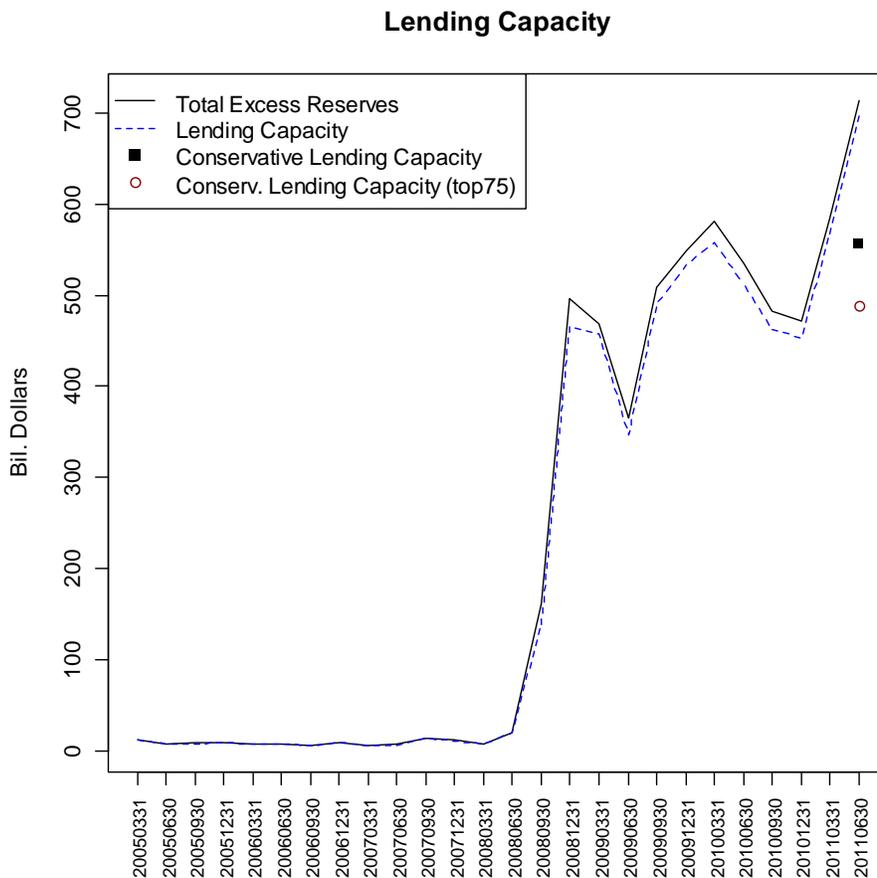


Figure 29

We also indicate with an (isolated) black square in Figure 29 the value of our more conservative measure of loanable reserves for the fourth quarter of 2010. Even when we use extremely high capital requirements (by historical standards) the total amount of loanable reserves is still around \$400 billion, more than 80% of the total excess reserves available in insured banks.

Figure 30 plots the conservative measure of loanable reserves for the top 75 banks by asset size in the second quarter of 2011 (large open circles) and the actual excess reserves held by each of those banks (small solid circles). We can see from the figure that several banks are capital constrained but the majority of them are not. Furthermore, it is clear from the figure that capital constraints do not reduce the loanable reserves of the top 75 banks to levels that would preclude a large (and potentially sudden) increase in bank credit. Finally, the isolated (open) circle in Figure 29 aggregates the lending capacity of these 75 largest banks and it accounts for about 70% of the total excess reserves held by insured banks.

Lending Capacity and Reserve Lending Capacity for Top 75 Banks by Assets

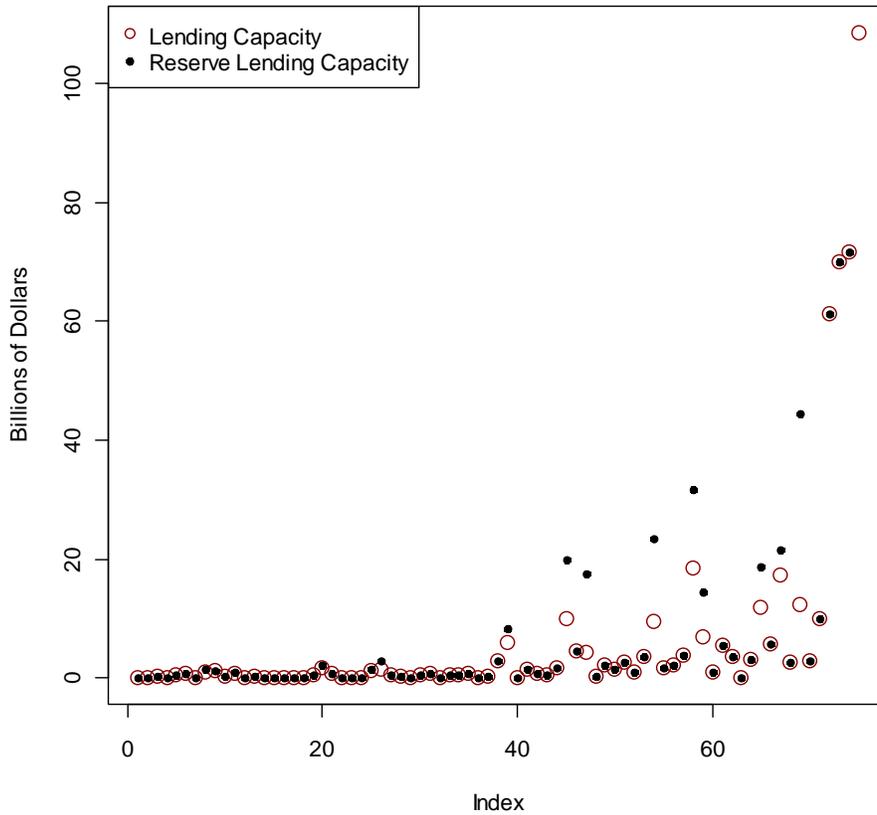


Figure 30

Of course, the kind of massive aggregate shifts we are considering here could not occur without triggering some major price and interest rate adjustment. The point of the figure is to show that there is a large amount of reserves that could potentially be used to fund new bank credit. Understanding what factors could induce banks to attempt such a transformation is clearly important for monetary policy considerations. Below we investigate the characteristics of banks holding reserves as a first step in gaining such an understanding.

One caveat to the calculations provided here is that by limiting our analysis to Call Report data we consider capital holdings only at the level of the bank subsidiaries in a bank holding company. We do not include the level of capital at the bank holding company, which of course is a relevant factor for determining the ability of a given bank subsidiary to increase its supply of credit. The parent company can always increase capital in the subsidiary if lending opportunities are attractive enough and if the company has access to liquidity that can be quickly transformed into capital for the subsidiary. Our working hypothesis is that if a bank subsidiary is not well-capitalized then the parent company is unlikely to have ready access to liquidity that could be used to increase capital at the subsidiary when lending opportunities arrive. For this reason, then, we have decided to only consider as loanable reserves those reserves in well-capitalized bank subsidiaries.

6.2 Balance sheet capacity

So far we have considered the extent to which excess reserve holdings by banks truly constitute readily available lending capacity. An alternative perspective on the remarkable increase in the stock of reserves is that those reserves could put pressure on the balance sheet capacity of banks. Reserves must be held by banks. For a given level of bank capital, increases in the outstanding stock of reserves must be met with a decrease in other asset categories or in the banks' leverage ratio. Regulatory requirements may restrict the latter as a mechanism for adjustment. To the extent that the leverage ratios of banks were close to their regulatory minimum, increasing the stock of reserves implies that some other category of assets (for example, loans) must fall, and in that sense increases in reserves might have actually been contractionary.

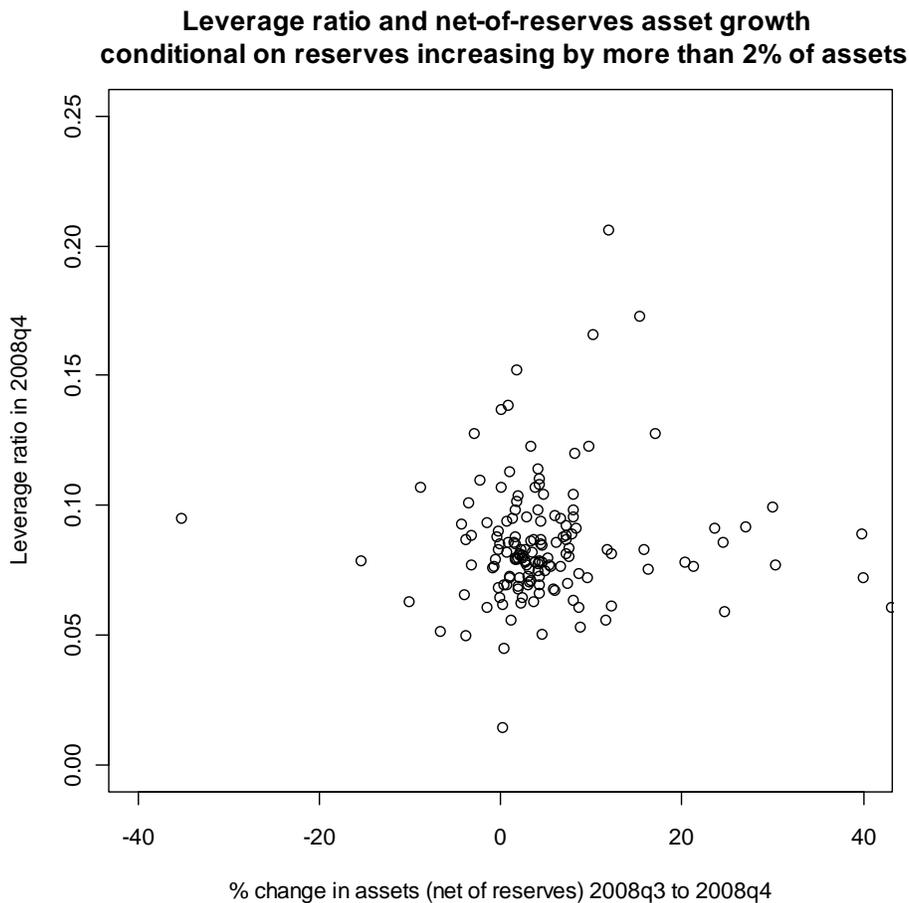


Figure 31

To get a sense of how operative this channel was at the end of 2008, when reserves were increasing rapidly, in Figure 31 we plot the leverage ratio (on the vertical axis) against the changes in assets net of reserves for a subsample of banks. The banks we include in the subsample are those large banks (with more than \$500 million in total assets in 2008q3) that experience a change in reserves between 2008q3 and q4 greater than 2% of assets (that is, banks with significant increases in reserve holdings).³⁹ The idea behind the picture is that if adding reserves was contractionary, then banks that increased their reserve holdings significantly

³⁹To account for outliers, we also eliminate all banks that had an increase in total assets greater than 50% between the third and fourth quarter of 2008.

and had a low leverage ratio would have decreased their assets net of reserves. In other words, the cross section presented in the figure would show a positive relationship. There is in fact little evidence of such a relationship. We conclude that reserves did not systematically absorb scarce balance sheet capacity and, hence, crowd out other kinds of banking assets, such as loans.

7 Reserves and interest income across banks

Over the more than two years that the Fed has been paying interest of 25 basis points (bps) on reserves, the economy has only slowly begun to recover from the great recession, and judging by the quantity of lending, banks on average are not seeing good lending opportunities. In the longer run however, banks will presumably expand their lending as opportunities arise. If the Fed wishes to maintain a large quantity of reserves, then an appropriate interest rate policy will require the Fed to raise the interest rate it pays on reserves. A constant i.o.r. and large reserves in the face of a booming economy would give banks an incentive to replace reserves with higher yielding assets. In this section we investigate the cross-sectional evidence on how banks' reserve holdings relate to their interest income. The cross-sectional relationship may be useful for understanding the aggregate consequences of holding i.o.r. fixed as lending opportunities proliferate.

Prior to autumn of 2008, reserves yielded minimal interest. Thus, banks held reserves only to meet reserve requirements and to be able to satisfy their customers' demands for funds. As has been discussed, reserves also are liquid assets that enable a bank to rapidly change the composition of its balance sheet, minimizing transaction costs that are presumably low but nonzero. Furthermore, reserves are a truly risk-free nominal asset when held overnight, whereas liquid short-term securities, such as Treasury bills (Tbills), contain some price risk unless they mature the next day. The fact that excess reserve holdings were so low prior to autumn 2008 suggests that these benefits of holding reserves were not sufficient to compensate for the unfavorable rate of return differential.

By the end of 2008, when the Fed was paying interest on reserves at 25 bps and had stopped narrowly targeting the Fed Funds Rate, a bank's decision about reserve holdings changed quite dramatically. Since the end of 2008 the 3-month Tbill rate has been below 25 basis points the majority of the time. For a bank choosing how to allocate its liquid assets, there is now good reason to prefer reserves yielding 25bps to a T-bill.

Tbill rates represent one element of the opportunity cost of holding reserves for any bank. However, the rate of return on loans is also an element of that opportunity cost, and banks face heterogeneous rates of return on loans. For a bank attempting to maximize profits, it would not make sense to hold large excess reserves if higher rate-of-return assets were available. In the cross section of banks, this behavior should manifest itself in a negative relationship between excess reserves as a fraction of assets and the marginal rate of return on assets.

To approximate the marginal rate of return on a bank's assets we calculate each institution's ratio of total interest income to assets. This is an imperfect measure, but we will proceed under the assumption that it is informative about marginal returns. Because interest income has a strong seasonal component, when reporting interest income over assets we use a four-quarter moving average.

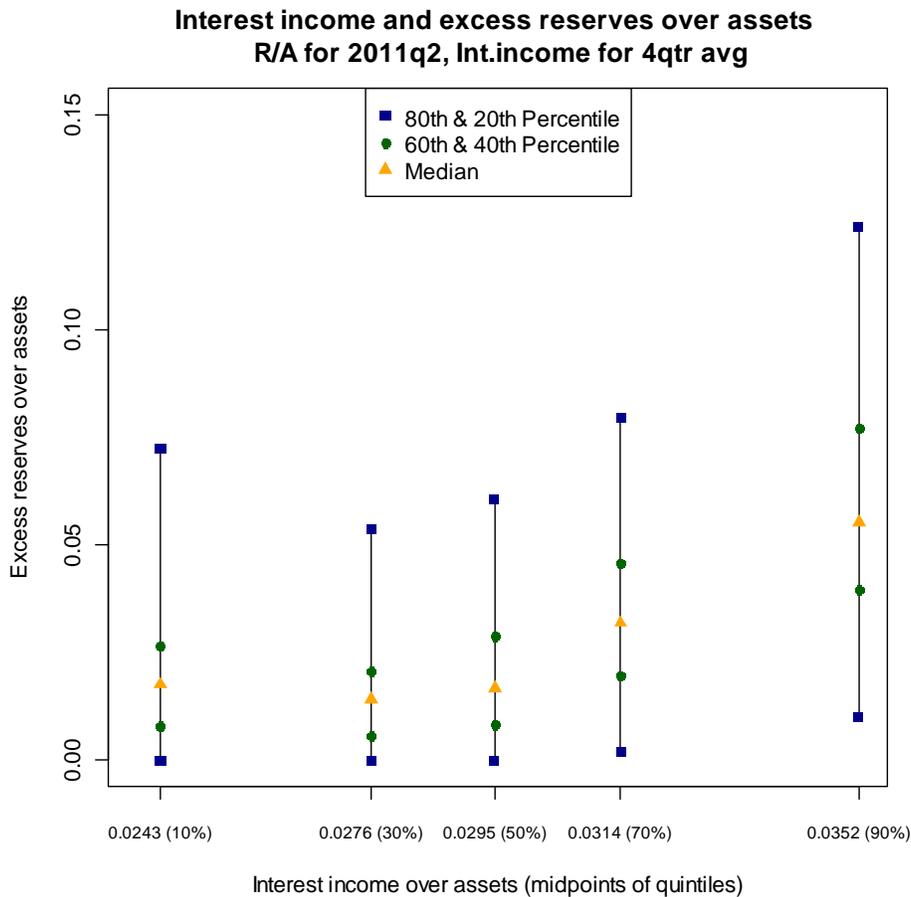


Figure 32

Figure 32 summarizes the conditional distribution of reserves over assets for the quintiles of interest income over assets for 2011q2.⁴⁰ Measured by median reserves over assets, or by the 40th to 60th percentile range, the relationship between reserves and interest income is u-shaped: the lowest interest income quintile has relatively high reserves, but reserves are increasing from the second through the fifth quintiles. While the positive relationship for the top quintiles is, perhaps, surprising, it is important to note that the interest income quintiles do not represent equal shares of assets or reserves. Approximately 75 percent of assets and 70 percent of reserves are held by institutions in the first two quintiles of interest income, and over this range there is evidence of a negative relationship between reserve holdings and interest on assets. Figure 33 presents a scatter plot of the reserves over assets and interest income over assets for the top 75 banks by asset size. There is a fairly strong negative correlation between these two variables, equal to -0.3 (among all institutions the correlation is only -0.09).

⁴⁰Unlike the earlier figures with change in reserves on the horizontal axis, Figure 32 splits the data into standard quintiles (e.g. - 0-20 instead of the earlier figures' 10-30, etc.).

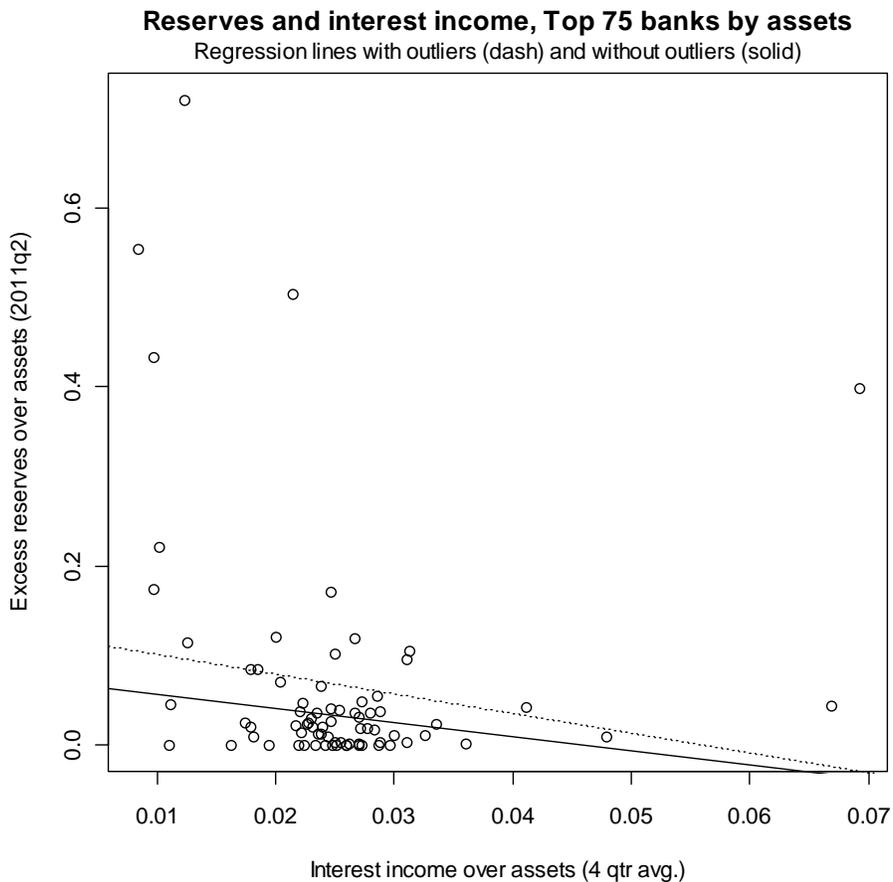


Figure 33

If there is some evidence that reserve holdings are currently concentrated in banks with low returns, have reserves been moving to such banks over time? Figure 34 plots two measures of the aggregate ratio of interest income to assets in our sample of insured institutions. The dashed line is the aggregate ratio of interest income to assets (adjusting for reserves and interest on reserves), or equivalently a weighted average of interest income over assets, where the weights are the institutions' asset shares. The solid line is an alternative weighted average, where the weights are excess reserve shares. If the solid line is below the dashed line – as it is from 2008 onward, then reserves are held disproportionately by institutions with a low ratio of interest income to assets. Additionally, a widening spread over time between the two lines indicates that reserves are being reallocated to institutions with low interest income. From mid-2008 until mid-2009 the spread indeed widened. Late in 2009 the reserve-weighted series was extremely volatile. This seems to be associated with one large institution, Ally Bank, which increased its reserve ratio dramatically in the third quarter of 2009. In the last two quarters reserves have again shifted toward institutions with lower interest income.

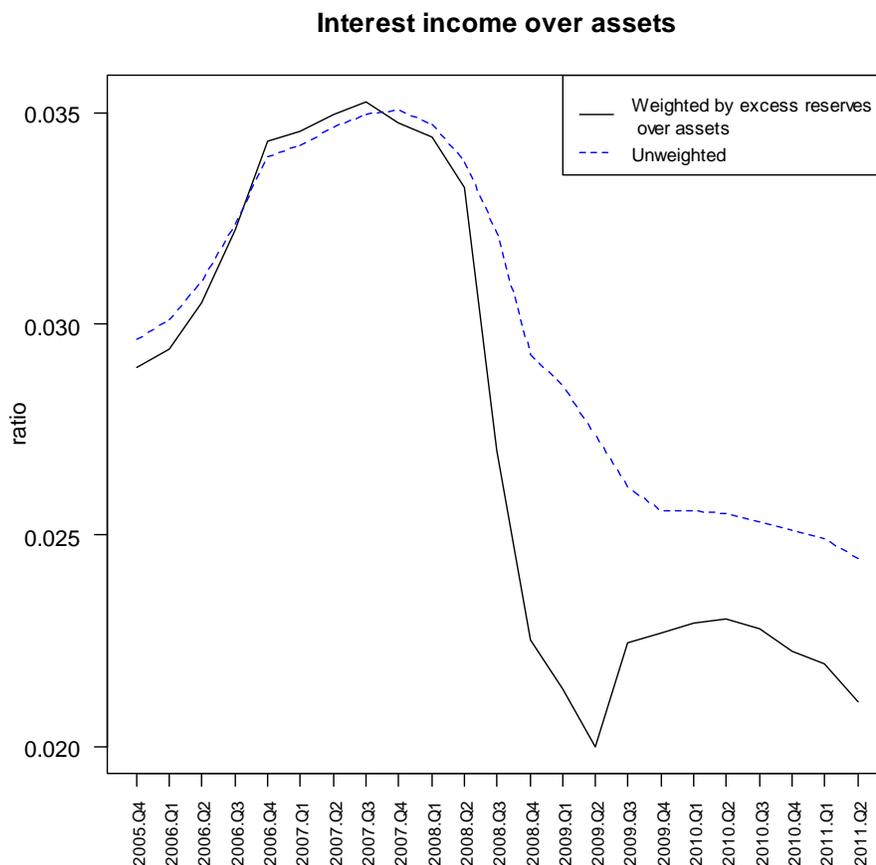


Figure 34

I.o.r. has been fixed for more than two years, and as can be seen from Figure 34, banks' interest income has shown some signs of stabilizing following the steep decline in the great recession. At some point in the future it is likely that rates of return in the economy will rise, and banks' ratio of interest income to assets will also rise toward more "normal" levels. As Figures 32-34 show, reserves display some sensitivity to interest income, which suggests that banks facing higher rates of return will attempt to lower their holding of reserves, all else equal. If reserves were to remain relatively stable and i.o.r. were to remain at 25bps, then banks would make loans or increase security holdings so as to align marginal rates of return with the level of i.o.r..

8 Reserves and other bank characteristics

It is clear that there is significant heterogeneity among banks with regard to their reserve holdings. There is also heterogeneity among banks' observable characteristics though, so it is natural to ask whether those observable characteristics can explain reserve holdings. The bivariate relationships discussed in the previous sections go some way towards addressing that question, but they are limited by their bivariate nature. To the extent that we can explain reserve holdings with a multivariate regression, the nature of that explanation may be a useful element in understanding (a) how a monetary policy scenario of falling behind the curve might play out, and (b) what the potential effects of persistent large increases in the quantity of reserves

would be. By better understanding what it would mean to fall behind the curve, we will be better equipped to avoid it. And by better understanding the effects of persistent large increases in reserves, we will be better able to evaluate that policy option. To that end, we report two regressions of the ratio of reserves to assets in 2010q4 on a number of other Call Report variables. One regression is unweighted, so that the many small banks play a dominant role in the parameter estimates. The other regression uses weighted least squares, with the weights given by bank assets, so that the largest banks play the dominant role. Judgement calls had to be made in choosing explanatory variables, because there are hundreds of variables in the Call Report, and we are not being guided here by a formal theoretical model.

For the most part, the variables included in the regression are variables that have appeared earlier in the paper. Interest income over assets appears because of our conjecture – weakly supported in the bivariate analysis – that banks earning high interest income will choose to hold low reserves.⁴¹ We include loans relative to assets in the regression because this is an important dimension of heterogeneity among banks; our prior is that banks which specialize in making loans will tend to hold a higher level of reserves.⁴² We also expect a positive association between deposits and reserves because servicing deposits requires holding liquidity (Kashyap et. al., 2002). Trading assets are held by a relatively small fraction of institutions; we include them as a way of controlling for different types of institutions. The change in deposits relative to assets over the most recent quarter (variable 7) appears so that we can check the conjecture that if a bank receives a large deposit inflow it simply increases reserve holdings because of the lack of attractive alternatives. Leverage and capital ratios have been discussed above: a low leverage ratio may mean that a bank has little balance sheet capacity to take on reserves, although we did not find evidence that this factor led to banks shedding assets in order to increase reserve holdings. Banks with low tier 1 capital ratios may wish to increase their reserve holdings in order to raise their tier 1 capital ratios. Holding fixed the leverage ratio however, the fact that reserves have zero risk weight induces a positive relationship between reserves and tier 1 capital. Variables 10 and 11 allow for the possibility that the size of an institution has an independent effect on its reserve holdings. $\text{Log}(\text{assets})$ is a pure size effect. The next variable is the tier 1 capital ratio only for those banks with assets greater than \$50 billion.⁴³ This asset-size cutoff is meant to single out institutions that are “systemically important” and may be required to hold higher capital levels once the new regulatory environment has been clarified. Finally, the 2008q2 level of reserves to assets can be thought of as a fixed effect: in 2008q2 the level of reserves was very low, but it may be that banks increased their reserves in proportion to the aggregate increase in reserves.

In discussing the results, which are displayed in Table 5, we begin with the explanatory variables that appear with the same sign coefficients in both the unweighted and weighted regressions. We allowed for a quadratic term in interest income over assets because the bivariate relationship in Figure 32 appeared quadratic. The estimated relationship is convex for both regressions, as was suggested by Figure 32. When we evaluate the marginal effect of interest income on reserves (combining the linear and the quadratic terms) at the mean level of interest income, that effect is negative for the weighted regression and positive for the unweighted regression. As we expected, the ratio of deposits to assets has a positive coefficient, and the coefficient is large and highly significant. Trading assets appear with a large positive coefficient that is highly significant in both regressions. A possible interpretation of the significance of trading assets is that the Fed’s recent asset purchases have put reserves on the balance sheets of custodial banks with significant trading operations. Bank size (assets) appears with a small positive coefficient that is marginally significant; a doubling of assets corresponds to a 0.1% or 0.2% increase in reserves over assets. Finally, the pre-crisis ratio of reserves to assets – from 2008q2 which predates the increase in reserves – has a positive coefficient that is large and highly significant in both regressions. One might think that pre-crisis reserves are simply reflecting pre-crisis demand deposits which are highly correlated with current deposits. The first part of this conjecture is certainly true, as banks generally did not hold excess reserves when i.o.r. was zero. However, the partial correlation between pre-crisis reserves and current demand deposits is low (0.18).

⁴¹As above, interest income over assets is averaged over the four quarters of 2010.

⁴²Note that there is a negative mechanical balance sheet relationship between current loans over assets and current reserves over assets. To mitigate this effect, we measure loans to assets as the four quarter average over the four quarters of 2008.

⁴³We omit this variable from the weighted regression because the regression already overweights those institutions.

Table 5. Regressions of Level of Reserves/Assets in 2011q2

	Coefficient on	unweighted			weighted by assets		
		Estimate	t	sig.	Est.	t	sig.
1	Intercept	0.031	1.004		-0.052	3.239	**
2	Int. Income/Assets	-9.086	-6.740	***	-6.970	-9.734	***
3	(Int.Income/Assets) ²	178.874	8.201	***	99.264	8.960	***
4	Loans/Assets	0.020	1.930	*	-0.068	-6.986	***
5	Deposits/Assets	0.091	5.640	***	0.178	14.315	***
6	Trading Assets/Assets	0.429	3.897	***	0.219	14.585	***
7	(Δ Deposits)/Assets	0.039	-1.866	*	-0.118	-5.544	***
8	Leverage Ratio	-0.204	-3.065	**	0.080	1.339	
9	Tier 1 Capital Ratio	0.142	4.115	***	-0.088	-2.543	*
10	Log(assets)	0.002	1.931	*	0.001	2.399	*
11	(T.I.C.R.) \times I _(Assets>\$50bn)	-0.036	-0.449		-	-	-
12	(Reserves/Assets) _{2008Q2}	0.761	4.698	***	0.797	4.148	***
	Adjusted R ²	0.116			0.444		

As for the variables whose coefficients change signs in the weighted and unweighted regressions, the most notable is perhaps loans, which appear with a modest negative coefficient and highly significant in the weighted regression, but with a small, positive coefficient, and only marginally significant in the unweighted regression. The significance of loans in the weighted regression may simply reflect the mechanical balance sheet relationship (as one asset's share rises another must fall). The coefficient on change in deposits over the most recent quarter also flips its sign from positive to negative across the two regressions, with the coefficient highly significant in the weighted regression and not in the unweighted regression. The result from the weighted regression runs counter to the idea that banks experiencing large deposit inflows are holding high reserves. In fact, one could interpret the large negative coefficient as suggesting that banks experiencing large deposit inflows are healthy banks with better options than holding reserves.

The coefficients on the leverage ratio and capital ratio also flip signs across the two regressions, with higher degrees of significance in the unweighted regression. That the coefficient on tier 1 capital is positive in the unweighted regression may simply reflect the mechanical effect described above – reserves have zero risk weight and thus correspond to a higher tier 1 ratio for given leverage. The negative coefficient on the leverage ratio suggests that in a static sense, banks holding high reserves may be balance-sheet constrained from making loans. On the other hand, given our earlier finding that increases in reserves did not correspond to reductions in other assets, a more reasonable interpretation of the negative coefficient may be that poorly capitalized banks choose to hold high reserves in order to reduce their riskiness as much as possible.

We have compared the regression results to analogous results using 2010q4 data (not shown). The coefficients on deposits, loans, assets and lagged reserves changed little from 2010q4 to 2011q2. However, in the weighted regression, the coefficients on the leverage and tier 1 capital ratios switched signs and lost significance in 2011q2 relative to 2010q4. The sign switch also occurred in the weighted regression for trading assets and the change in deposits, with the latter gaining in significance. In addition, the marginal effect of interest income evaluated at its mean switched from positive to negative. These changes could indicate that some of the estimated coefficients are spurious, or they could reflect changes in the environment and in the factors affecting reserve holding between 2010q4 and 2011q2. Given the large change in reserves that occurred over that period, one should not discount the latter possibility.

9 Conclusion

We started this paper by suggesting two sets of reasons for why the quantity of bank reserves might be relevant for monetary policy, even in a situation with interest-on-reserves or a zero nominal interest rate. First a large quantity of excess reserves may make the economy unusually sensitive to ex-post delays in

adjusting the i.o.r. rate. Second, increases in the quantity of reserves affect bank balance sheets, and we explained how large enough increases in reserves could induce banks to counteract these effects in ways that could be either contractionary or expansionary. These possibilities helped motivate our study of the distribution of bank reserves in the U.S. from 2008 to 2011.

For large reserves to represent a risk to policy, the logic requires that banks holding reserves are able to increase lending or securities purchases relatively fast if economic conditions improve. In particular, banks need to have enough extra capital to continue to comply with requirements after undertaking these actions. Furthermore, the new opportunities should be available to banks with excess lending capacity, which is more likely to happen if that capacity is not all concentrated on the balance sheet of a few institutions. Whether these conditions are present in the current system is an empirical question.

To try to answer this question, we analyze balance sheet data from the Call Report filings that banks submit to regulatory agencies on a quarterly basis. There are thousands of banking institutions in the U.S. and they tend to be very heterogeneous. Not surprisingly, then, broad generalizations are hard to come by. However, we do find that a large proportion of reserves is on the balance sheets of banks with sufficient slack in their capital position to (quickly) generate massive increases in lending. This has been the case, in fact, for most of the period when aggregate reserves have been high. We also find some evidence that large banks with high interest income tend to hold relatively less reserves, which may suggest that if interest income were to improve (as would be expected if economic conditions improve) then banks would try to reduce their reserve holdings.

Aside from these basic findings, we provide an overview of the evolution of banks' balance sheets from a cross sectional perspective, for the period since total reserves increased significantly (i.e., since the peak of the recent financial crisis). It is hard to provide a single explanation for how banks accommodated the increase in reserves, but we identify and explore a few possible alternatives. We also address some views that are often put forth in discussions of how banks behaved in response to the increase in reserves. We show that providing unequivocal evidence for these views is no easy task. In other words, the evidence is at best mixed and sometimes completely absent.

We see the research provided in this paper as an initial empirical inquiry into a situation that is radically new for the U.S. banking system. As we have discussed, the fact that banks are holding large quantities of excess reserves raises new and potentially important questions for policymakers. While we provide a first step in the search for answers to those questions, more research is clearly needed. Following our approach, it would be interesting to investigate other countries' experiences with large increases in reserves, such as the quantitative easing episodes in Japan and the United Kingdom.⁴⁴

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⁴⁴Along these lines, Bowman et al. (2011) study the relationship between bank liquidity and lending in the cross-section of Japanese banks during the QEP.

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10 Appendix: Other tables and figures

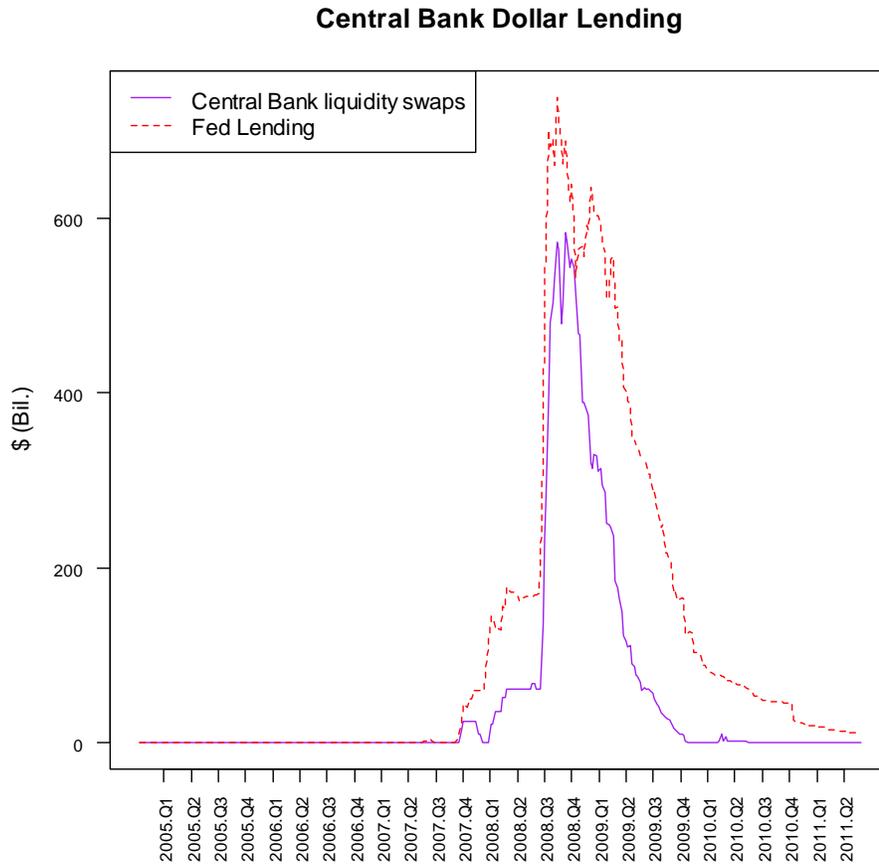


Figure A1

Table A.1. Deviation of 2010q3 reserves from 2010q4 reserves,
as percentage of 2010q4 assets

Top 25 banks by assets		Top 26-75 banks by assets	
Rank	$D(i,t)/A$	Rank	$D(i,t)/A$
5	-1.643	10	-0.67
10	-0.3466	20	-0.0044
15	0.4312	30	0.0323
20	1.8291	40	1.743