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Abstract

This dissertation contributes to the literature on financial intermediation by examining the importance of banks as liquidity providers for corporate borrowers and the role of liquidity on banks' financial performance, as well as its role in the context of joint determination with bank capital and risk.

It is generally accepted in the banking literature that lending relationships are special and bank loans are an important source of external financing for corporate borrowers. Although tight lending relationships have benefits for borrowers, they can also pose a threat when relationship banks experience liquidity problems. Chapter 1 provides evidence about the transmission of banking sector problems to corporate borrowers, and examines the impact of bank credit supply frictions on firm performance. I exploit differences in the composition of banks' liabilities structure during the financial crisis of 2007-2009 as a source of exogenous variation in the availability of bank credit to nonfinancial firms, in order to identify the causal relationship between bank credit supply and firm performance. My results indicate that banking relationships are important for firms. Firms whose banks relied more on core deposit financing had a lower decline in bank credit during the crisis than those whose banks were mainly financed by noncore sources of funding. I find that a decline in bank credit supply is associated with stock valuation losses and sales cuts for nonfinancial firms. However, firms that had lending relationships with healthier banks had a lower decline in bank credit, and thereby lower reductions in their stock returns and sales during the crisis.

The financial crisis of 2007-2009, also known as the Great Recession, revealed problems in banks' funding and liquidity management, and highlighted the importance of bank liquidity buffers. The severity of the Great Recession revitalized a need for the revision of banking regulations, especially in the context of bank liquidity. The Basel Committee on Banking Supervision (BCBS) introduced a new Basel III international framework, which, in addition to enhanced capital requirements also includes two standards for liquidity risk management: the liquidity coverage ratio and the net stable funding ratio.[1] These new liquidity standards are aimed at addressing maturity mismatches of bank assets and liabilities more comprehensively in both the short and long term. However, whether this new regulation will strengthen the banking sector and restore stability is uncertain. Therefore, it is essential to better understand how the new regulations will impact banks. In particular, it is important to examine the relationship between new liquidity standards, bank profitability, bank capital and risk.

Chapter 2 examines whether and how the new liquidity risk measures introduced in the Basel III Accord affect bank profitability. In contrast to previous empirical studies, I analyze how the combination of capital and liquidity ratios affects bank profitability. I conduct a comprehensive analysis to calculate the Basel III liquidity risk measures: the liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR), using historical data for U.S. bank holding companies over 2001-2013. This is the first study to examine the impact of Basel III liquidity risk measures

[1]See Basel Committee on Banking Supervision (2010) for the details.

on bank profitability in the U.S. by employing the GMM estimator technique. The estimates show that increased Basel III liquidity ratios decrease the profitability of small banks. The LCR adversely impacts profitability at large banks, while the NSFR has a significant positive impact on large banks' ROA and ROE. My findings also show that banks that maintain low liquidity ratios are more profitable, and that departures of liquidity ratios from a regulatory level of 1 adversely impact bank profitability. In these cases, the LCR affects profitability of large banks only, while the NSFR affects only small banks. Both liquidity risk measures and capital ratios are important determinants of bank profitability at large and small banks. Moreover, my findings show that two the liquidity risk measures affect bank profitability both pre- and post-crisis. Overall, the results of this chapter show that, in general, there is a tradeoff between bank profitability and stability of the banking system. The findings of this study have implications for bank regulators.

Chapter 3, co-authored with Dorota Kowalczyk, investigates capital, risk and liquidity decisions of U.S. bank holding companies from 2001 till 2007. We extend the simultaneous equation model with partial adjustment introduced by Shrieves and Dahl (1992) to model liquidity adjustments, and examine the relationship between new Basel III liquidity measures, bank capital and risk adjustments. Our findings show that banks targeted capital, risk and new liquidity measures in the pre-Basel III sample period. Moreover, we document that banks simultaneously coordinated short-term adjustments in capital and risk. Incorporation of bank liquidity enables us to establish the presence of the coordination of risk and liquidity decisions. Short-term adjustments in new liquidity rules inversely impact changes in bank capital, while capital adjustments only have a significant adverse effect on changes in the liquidity coverage ratio. Our results emphasize that it is critical to incorporate liquidity ratios, in addition to capital requirements, into the banking regulations. Finally, our research partially verifies the theoretical predictions of Repullo (2005).

Abstrakt

Disertační práce přispívá k tématu finančního zprostředkování. V práci zkoumám význam bank jakožto poskytovatelů likvidity korporátním vypůjčovatelům, vliv likvidity na finanční výkonnost bank a roli likvidity v kontextu společné determinace bankovního kapitálu a rizika.

V literatuře věnované bankovnictví je přijímán názor, že věřitelské vztahy mají speciální charakter a bankovní půjčky jsou důležitým zdrojem externího financování pro korporátní vypůjčovatele. Ačkoliv jsou pevné věřitelské vztahy prospěšné pro dlužníky, mohou zároveň představovat hrozbu, pokud zainteresovaná banky čelí problémům s likviditou. První kapitola dokládá důkazy transmise problémů bankovního sektoru na korporátní vypůjčovatele a zkoumá dopad nabídkové frikce bankovních úvěrů na výkonnost firem. Využívám změn ve struktuře bankovních závazků během finanční krize v letech 2007-2009 jako zdroj exogenní variace v dostupnosti bankovních úvěrů nefinančním firmám s cílem identifikovat kauzální vztah mezi nabídkou bankovních úvěrů a výkonností firem. Mé výsledky naznačují, že vztahy s bankami jsou důležité pro firmy. Firmy, jejichž banky více spoléhají na standardní vklady jako zdroj financování, zažily menší propad objemu bankovních půjček během krize, nežli ty firmy, jejichž banky využívaly financování především z nestandardních zdrojů. Zjišťuji, že pokles nabídky bankovních úvěrů je spojen se ztrátami hodnoty akcií a poklesem prodejů u nefinančních firem. Nicméně, firmy, které měly věřitelské vztahy se zdravějšími bankami, zažily nižší pokles objemu bankovních půjček, a proto i nižší propad akciových výnosů a prodejů.

Finanční krize 2007-2009, která je také označována jako Velká recese, odhalila problémy s financováním a řízením likvidity bank a upozornila na nezbytnost rezerv pro zajištění likvidity. Závažnost Velké recese posílila potřebu bankovních regulací, zejména v kontextu bankovní likvidity. Basilejský výbor pro bankovní dohled (BCBS) vydal nový mezinárodní regulatorní framework Basel III, který kromě posílení kapitálových požadavků také zavedl dva poměrové ukazatele likvidního rizika: poměr krytí likviditou a poměr čistého stabilního financování (BCBS, 2010). Nové ukazatele jsou zaměřeny na posouzení nesouladu splatností bankovních aktiv a pasiv v krátkém i dlouhém horizontu. Není zřejmé, zda nová regulace posílí bankovní sektor a obnoví stabilitu. Proto je nutné lépe pochopit, jakým způsobem nová regulace ovlivní banky. Konkrétně je důležité prozkoumat vztah mezi novými ukazateli likvidity, výdělečností bank, bankovním kapitálem a rizikem.

Druhá kapitola zkoumá, zda a jakým způsobem nové míry rizika zavedené Basel III ovlivňují ziskovost bank. Na rozdíl od předchozích empirických studií analyzuji, jak různé kombinace poměrů kapitálu a likvidity ovlivňují ziskovost bank. Provádím vyčerpávající analýzu k výpočtu Basel III ukazatelů likvidního rizika: poměr krytí likviditou (LCR) a poměr čistého stabilního financování (NSFR). Využívám historická data bankovních holdingů v USA v období 2001-2013. Toto je první studie, která zkoumá dopad Basel III měr rizika a likvidity na výnosnost bank v USA, k čemuž využívám GMM. Odhady ukazují, že zvýšení Basel III ukazatelů likvidity snižuje ziskovost malých bank. LCR negativně ovlivňuje ziskovost velkých bank, zatímco NSFR má významný pozitivní vliv na ROA a ROE velkých bank. Mé výsledky také ukazují, že banky udržující nízké hodnoty ukazatelů likvidity vykazují vyšší zisky a odklon hodnot ukazatelů likvidity od hodnot regulatorní

úrovně 1 nepříznivě ovlivňují zisky bank. LCR v uvedených případech ovlivňuje ziskovost pouze velkých bank, zatímco NSFR ovlivňuje pouze malé banky. Míry likvidního rizika a kapitálové poměrové ukazatele jsou důležité determinanty ziskovosti malých a velkých bank. Mé výsledky navíc ukazují, že obě míry rizika likvidity ovlivňují ziskovost bank v předkrizovém i pokrizovém období. Celkové výsledky této kapitoly ukazují, že v obecnosti je nutné činit kompromis mezi ziskovostí bank a stabilitou bankovního systému. Má zjištění mají důležité implikace pro tvorbu bankovní regulace.

Třetí kapitola je napsána společně se spoluautorkou Dorotou Kowalczyk. V kapitole jsou zkoumány rozhodnutí bankovních holdingů v USA v období od roku 2001 do roku 2007. Rozšiřujeme model simultánních rovnic zavedením částečného přizpůsobení publikovaného Shrievesem a Dahlem (1992) s cílem modelovat přizpůsobení likvidity a prozkoumat vztah mezi novými mírami likvidity Basel III, bankovním kapitálem a přizpůsobením se riziku. Naše výsledky ukazují, že banky v období před přijetím Basel III cílily na kapitálové, rizikové a nové míry likvidity. Navíc zjišťujeme, že banky souběžně koordinují krátkodobé přizpůsobení kapitálu a rizika. Zahrnutí likvidity bank nám umožňuje určit přítomnost koordinace rozhodnutí týkajících se rizika a likvidity. Krátkodobé přizpůsobení při nových pravidlech pro likviditu nepříznivě ovlivňuje změny v kapitálu bank, zatímco přizpůsobení kapitálu má pouze významný nepříznivý vliv na změny v poměru krytí likviditou. Naše výsledky zdůrazňují nezbytnost zahrnutí poměrů likvidity společně s kapitálovými požadavky do bankovních regulací. Závěrem náš výzkum částečně ověřuje teoretické předpovědi, které publikoval Repullo (2005).

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Chapter 1

Bank Credit, Liquidity Shocks and Firm Performance: Evidence from the Financial Crisis of 2007-2009

Bank Credit, Liquidity Shocks and Firm Performance: Evidence from the Financial Crisis of 2007-2009[1]

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Abstract

This paper provides evidence about the transmission of banking sector problems to corporate borrowers, and examines the impact of bank credit supply frictions on firm performance. I exploit differences in the composition of banks' liabilities structure during the financial crisis of 2007-2009 as a source of exogenous variation in the availability of bank credit to nonfinancial firms, in order to identify the causal relationship between bank credit supply and firm performance. My results indicate that banking relationships are important for firms. Firms whose banks relied more on core deposit financing had a lower decline in bank credit during the crisis than those whose banks were mainly financed by noncore sources of funding. I find that a decline in bank credit supply is associated with stock valuation losses and sales cuts for nonfinancial firms. However, firms that had lending relationships with healthier banks had a lower decline in bank credit and thereby lower reductions in their stock returns and sales during the crisis.

Key words: Bank credit, bank liquidity shock, financial crisis, relationship lending, firm financial constraints, firm performance

JEL Classification: E44, G21, G32, L25

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1.1 Introduction

According to Modigliani and Miller (1958), the value of a firm is not affected by its choice of sources of funding, as long as the capital market is efficient and there are no financial frictions. In such a world, if a firm faces difficulties in obtaining funding from a particular source, it can costlessly switch to another source of funding. But in the real world, we have transactional costs, agency costs and costs associated with asymmetric information (Holmstrom and Tirole, 1997). These direct and indirect costs make the actual switch costly and difficult for firms, especially at short notice, causing disruptions in financing, which may lead to investment opportunities being abandoned and to lower performance.

How valuable are banking relationships for corporate borrowers? Bank credit is an important source of external funding for corporate borrowers, especially for small firms that would likely have difficulties obtaining liquidity from nonbank sources of financing. Forming strong long-term lending relationships with banks is essential for firms, as by gathering proprietary information about the firm over the years a bank becomes better informed and can reduce the cost of borrowing for the firm. But this information is not transferable to other lenders (Diamond, 1984; Petersen and Rajan, 1994). The uninformed banks therefore may offer higher interest rates to new borrowers. Thereby higher funding costs at new banks may tie a firm to its current lenders, causing a hold-up problem.

While firm-bank ties are important, there is another hidden, but relevant aspect to note: problems with the financial health of banks trigger contraction of credit supply, which may lead to poorer stock market performance of borrowers and a subsequent slowdown of economic activity.[4] Although there has been a lot of research that examines the real effects of credit supply shocks,[5] their impact on the stock market performance of firms and the sensitivity of firm stock price changes to changes in bank credit remain largely unexplored empirically.[6] This paper examines the relationship between disruptions in bank credit supply and firm performance in terms of stock price change and sales growth.

The examination of consequences of credit supply shocks is challenging, because it requires the clean isolation of supply driven changes in bank credit from firm-specific changes in credit demand. The financial crisis of 2007-2009 provides a unique setting to identify the credit supply shock, because the liquidity shock to the banking system did not originate due to deterioration of firm-specific demand for credit, implying that differences in banks' willingness to grant credit during the crisis were unrelated to the pre-crisis characteristics of banks' corporate borrowers. The crisis of 2007-2009 originated in the sub-prime mortgage market, resulting in an adverse liquidity

[4]The importance of proper financial intermediation for business activity has been documented in empirical studies for instance by Rousseau and Wachtel (1998), Dell'Arricia, Detragiache and Rajan (2008) or Bena and Jurajda (2011).

[5]Recent works include Amiti and Weinstein (2013), Chodorow-Reich (2014), Bottero et al. (2016), Cingano et al. (2016), Bentolila et al. (2017) among others.

[6]Gokcen (2010), Fernando, May and Megginson (2012), Norden et al. (2013), and Carvalho et al. (2015) analyze how firms' stock returns react to bank-specific shocks, but they do not examine how contraction in bank credit affect firms' valuation.

shock to banks' short-term wholesale funding, which triggered severe liquidity problems for banks and contraction in their lending.[7] Those banks that financed their assets mainly with short-term wholesale or noncore funding were highly exposed to the liquidity shock. In contrast, banks that mainly relied on retail or core deposits, which proved to be a more stable source of funding during the recent financial crisis, experienced lower liquidity shock (Cornett, McNutt, Strahan, and Tehranian, 2011; Ivashina and Scharfstein, 2010). I employ heterogeneity in banks' liability structure and explore their reliance on core deposits during the crisis to measure their exposure to the liquidity shock, to study whether firms that had lending relationships with more exposed banks had a relatively higher decline in bank credit, and if the credit crunch during the crisis also incurred any changes in firm stock price performance and sales growth.

In order to establish the impact of contraction in bank credit on firm performance, I assume that there is relationship lending, meaning that bank-borrower ties are strong and valuable. Because switching banks is costly, this implies that firms with outstanding loans from banks that sustained a higher decline in lending during the crisis become more constrained in terms of obtaining bank credit than borrowers from healthier banks. In this study, I show that lending relationships matter in the loan syndication market. In the process of loan syndication, the originating bank (or "lead" bank) prepares the loan contract with the borrowing firm, retains the larger share of the loan and finds other lenders (or "participant" banks) willing to grant the rest of the loan amount. In my sample, there is a 63% higher likelihood for the lead bank of the firm's previous syndicated loan to become lead lender again, if the borrowing firm accesses the loan syndication market for new credit.

In this chapter, I first analyze whether U.S. banks reduced lending to nonfinancial U.S. firms in response to adverse liquidity shock. One of the most harmful consequences of the financial crisis of 2007-2009 was the contraction in bank lending. New loans to businesses fell substantially from the third quarter of 2007. Ivashina and Scharfstein (2010) document a 79% drop in new loan originations to large businesses in the U.S. in the fourth quarter of 2008, relative to the second quarter of 2007. My findings tend to confirm that banks decrease lending due to negative funding shocks. I document a positive correlation between bank credit supply and reliance on core deposit financing during the crisis. My results show that banks that relied more on core deposit financing than wholesale funding reduced lending to a smaller extent.

I next turn to the examination of how bank credit shocks affect outstanding bank credit at the firm level and whether changes in bank credit affect firm stock return performance and sales growth. I document that the positive correlation between banks' reliance on core deposit financing and changes in bank credit during the crisis is also present in a cross-section of firms. Firms whose banks relied more on core deposits had a lower decline in bank credit during the crisis, while switching to healthier banks during the crisis was very difficult. My results for the cross-section of firms provide evidence that bank credit matters for firms. There is a statistically significant

[7] See the discusion of the crisis events in Acharya and Richardson (2009), Adrian and Shin (2010), Brunnermeier (2009), Diamond and Rajan (2009), and Gorton (2009).

positive relationship between bank credit growth and a firm's total return, and between bank credit and sales growth during the crisis: a one standard deviation decline in bank credit to a firm causes a stock return reduction of 3.5 percentage points and a sales cut of 7.9 percentage points. Stock returns of financially constrained firms and firms with weaker financial positions were affected disproportionally more by the credit supply shock during the recent crisis. All in all, my findings are robust to different model specifications and fluctuations in aggregate demand.

The results of this study are important for policy implications in two ways. First, my findings emphasize the need to carefully assess risk and liquidity of banks' funding sources. My results show that banks' higher reliance on core deposits helped them to sustain a lower reduction in lending during the crisis, with the latter adversely impacting business activity. Therefore risk and liquidity of funding sources should be taken into account in regulatory policies, thereby supporting the implementation of liquidity and stable funding ratios within the Basel III frameworks. Second, my research suggests the favorability of government policies aimed at providing liquidity support to banks and restoring the stability of the banking sector during the crisis, because due to the stickiness of bank-firm relationships, this leads to higher stock returns and sales for firms, thereby promoting a boost in the real sector.

1.2 Literature Review

1.2.1 Bank Liquidity, Monetary Shocks and Financial Crisis

My study is related to the large strand of literature examining the consequences for corporate borrowers of shocks to the financial position of banks. This literature started with papers examining the impact of monetary policy driven liquidity shocks on bank lending and economic activity (Bernanke, 1983; Bernanke and Blinder, 1992; Kashyap and Stein, 1995; Gambacorta, 2005; Altunbas et al., 2009)[8].

Apart from the monetary policy induced shocks to banks' health, there is a stream of work that examines causes and consequences of the financial crises that occurred around the world over the last two decades. Peek and Rosengren (2000) and Gan (2007) study the collapse of the Japanese

[8]Bernanke (1983) first showed that shocks to banks' financial health can have a significant effect on the magnitude of an economic recession. Bernanke and Blinder (1992) documented that capital shocks, induced by monetary policy proxied by changes in the Federal funds rate correlate with aggregate macroeconomic variables, such as aggregate bank loan supply, bank deposits and aggregate output. The authors find that monetary policy tightening induces a decline in aggregate lending and output. However, these two studies do not account for a decline in loan demand in times of economic slowdown, which might cause a decline in loan supply as well as monetary tightening. In an attempt to resolve this identification problem, Kashyap and Stein (1995) use disaggregated data on bank balance sheets and repeat the analysis of Bernanke and Blinder (1992). Using cross-sectional differences in banks' responses to monetary tightening, Kashyap and Stein find that the decline in lending is more pronounced for small banks. Despite the authors advocating that there was a decline in lending due to monetary tightening, they do not analyze the effect of credit reduction on real activity. There are also other more recent studies that focus their analysis only on the effect of a deterioration in banks' health on lending. Gambacorta (2005) and Altunbas et al. (2009) study consequences of liquidity shocks induced by monetary policy contractions. The authors find that an increase in the interest rate causes a decrease in bank lending. However, the effect of monetary policy is different across banks. For instance, it is higher for small, less liquid and poorly capitalized banks.

real estate market in the early 1990s. Peek and Rosengren (2000) find that an adverse shock to parent banks in Japan was transmitted to their subsidiaries in the U.S., because these subsidiaries reduced lending in the U.S. Moreover, it had an adverse impact on construction activity in the U.S. states that have higher penetration rates by Japanese banks. Gan (2007), using loan level data of matched pairs of firms and banks in Japan, is able to control for changes in firms' loan demand and risk. She finds that the same firm, with two lending relationships, obtains less funding from a bank that was ex ante more exposed to the real estate market. Gan also documents that reduction of bank lending, proxied by the top lender's exposure to the real estate market, causes a decline in a firm's investment and stock returns. Khwaja and Mian (2008) exploit unexpected nuclear tests in Pakistan as the exogenous shock which resulted in massive withdrawals of dollar denominated deposits in the country. Similarly to Gan (2007), Khwaja and Mian (2008) use loan level data and document that firms' loans from a bank that had a 1% larger decline in liquidity drop by 0.6%. In contrast to other studies, they examine the effect of a decline in bank financing among firms. They find that while the adverse effect of the liquidity shock on lending is large for all firms, its effect on firms' borrowing is large only for small firms. Large firms can completely compensate for a drop in bank lending through public credit markets, while small firms cannot do so. Therefore, small firms face large declines in their total borrowing and experience significant losses. Chava and Purnanandam (2009) use the Russian default of 1998 as an exogenous shock to the U.S. financial system to examine whether adverse shocks to banks' financial health affected stock returns of bank-dependent firms in the U.S. They find that U.S. firms with access to the public debt market (rated firms) performed better than bank-dependent firms after the Russian default, i.e., rated firms reduced capital expenditure less than bank-dependent firms, and their operating profit decreased less than the profit of bank-dependent firms. Moreover, in the post crisis period banks with high exposure to the Russian crisis decreased the number of loans and increased their interest rates significantly more than banks with little exposure.

The financial crisis of 2007-2009 reopened the question of whether bank performance can have a significant impact on business activity. Several papers examine the banks' behavior during the turmoil (Iyer, Lopes, Peydro, and Schoar, 2014; Ivashina and Scharfstein, 2010; Gozzi and Goetz, 2010; Cornett, McNutt, Strahan, and Tehranian, 2011; Wardlaw, 2010; Chodorow-Reich, 2014). Using loan level data for Portugal, Iyer et al. (2014) show that adverse liquidity shocks measured by banks' ex ante reliance on interbank loans triggered a decline in bank lending. Employing the within-firm estimator of Khwaja and Mian (2008), they document that, for the same firm, its borrowing from banks with a higher ratio of interbank loans to total assets declines more. They also show that this effect differs among firms. It is absent for large firms but more pronounced for small firms. Moreover, small firms cannot compensate for the credit drop from more affected banks by obtaining credit from other less affected banks or from nonbank sources of funding. However, the authors do not examine the effect of a drop in credit supply on firm performance.

Ivashina and Scharfstein (2010) use data on syndicated lending in the U.S. and show that provision of new credit to large businesses dropped during the crisis. However, this decline in lending was diverse among banks. Banks funded with deposits managed to have a lower decline in lending, while those that were more exposed to unused credit lines experienced a greater decline in provision of new credit. Cornett, McNutt, Strahan, and Tehranian (2011) extend the work of Ivashina and Scharfstein (2010). They study how commercial banks in the U.S. adjust their holdings of liquid and illiquid assets during a period of macroeconomic illiquidity, and they also show that it is retail or core deposits rather than total deposits that acted as a stable source of funding during the financial crisis of 2007 - 2009. Cornett et al. (2011) find that banks with higher holdings of illiquid assets and a lower share of core deposits accumulated liquid assets on their books during the turmoil, while at the same time they decreased provision of new credit. While Ivashina and Scharfstein (2010) and Cornett et al. (2011) document that banks reduce lending in response to adverse liquidity shocks, they do not analyze whether these shocks affected business activity during the crisis. Research conducted by Gozzi and Goetz (2010) made an attempt to fill this gap. They exploit data on U.S. commercial banks and find that banks that relied heavily on wholesale funding suffered a greater decline in lending than those that used core deposits to finance their assets. Moreover, they documented that the liquidity shock had an adverse effect on economic activity, because employment declined more in metropolitan areas, where banks had higher shares of wholesale funding to total assets. My research contributes to this literature by analyzing how the financial crisis of 2007-2009 affected business activity on the firm level rather than on the level of metropolitan areas.

More recent empirical studies use cross-sectional differences in bank health at the onset of the financial crisis of 2007-2009 to study how credit supply shocks impacted firms' outcomes: mainly investment and employment. Wardlaw (2010) and Chodorow-Reich (2014) examine the consequences of deterioration of bank financial health on investment and employment of U.S. firms, respectively, by using syndicated loan data. Both studies find that bank health matters, though in the case of Chodorow-Reich (2014) it matters only for small and medium firms. Chodorow-Reich (2014) proxies the relative health of firm's lenders using the quantity of lending to other firms during the crisis by the firm's last pre-crisis syndicate. However, this proxy relies on the strong identification assumption that the cross-sectional variation in bank health is not correlated with unobserved characteristics. Therefore, Chodorow-Reich (2014) uses different instruments for bank lending that partially relax this assumption. Greenstone et al. (2014) do not have access to loan-level data, and thereby they have no information about lending relationships at the firm level, so they use an indirect measure - a county-level credit supply shock. Employing microdata from the Bureau of Labor Statistics Longitudinal Database (LBD), they find that credit supply shocks have significant negative effects on county-level small business lending and employment. However, the economic effect on the employment is small.

Cingano et al. (2016) use rich data from Italy's credit register. The authors show that the 2007 liquidity shortage in the interbank market negatively affected credit growth at banks. They also show that firms who borrowed from banks that were more exposed to the liquidity drop in the interbank market experienced higher decline in the 2007-2010 investment rate. Cingano et al. (2016) examine the sensitivity of firms' investment to bank credit, and use the firm's exposure to liquidity shortage in the interbank market as an instrument for bank credit. Their results document a positive response of firms' investment rate to bank credit growth. The authors' findings are consistent with the work of Amiti and Weinstein (2013), who also show that bank supply-side shocks significantly impact investment, using Japanese loan-level data for listed firms.

Other studies that use credit register data also document that bank balance sheet shocks have adverse effects on bank credit supply and the real economy. Bentolila et al. (2017) use data from the credit register of Spain to analyze consequences of the Great Recession for banks and firms. The authors employ procedure of Khwaja and Mian (2008) to isolate the effect of credit supply shock from credit demand and analyze changes in bank credit at firm-bank pair. Their results show that, for the same firm, bank credit from weak banks drops more than from healthy banks. Moreover, this effect was transmitted to the firm level, because affected firms were not able to compensate for the contraction in bank credit. These firm-level credit shocks caused substantial losses of employment in 2006 - 2010, for firms attached to weak banks. The main challenge in the analysis of employment growth at the firm level is to control for selection effects. The authors use data for the cross-section of firms and thus cannot introduce firm fixed effects. Therefore, to deal with the potential issue of selection on firm unobservable characteristics, Bentolila et al. (2017) employ industry-municipality fixed effects and additionally perform several checks using matching techniques and a panel fixed-effects model with 2007 - 2010 annual employment data. They also examine the pass-through effect from bank credit to employment and show that credit growth positively affect employment.

Bottero et al. (2016) as well as Cingano et al. (2016) also use data from the Italian Credit Register, but Bottero et al. (2016) examine consequences of the sovereign debt crisis for bank lending and the real activity in Italy. They show that the 2010 Greek bailout triggered contraction in bank lending for all firms, while it caused investment and employment downfalls only for small firms. Acharya et al. (2016) also examine consequences of the sovereign debt crisis, but they use data for syndicated loans from several European countries. The authors show that pre-crisis borrowers of banks from distressed countries became financially constrained and experienced a higher reduction in employment, investment and sales growth during the European debt crisis. Furthermore, they examine channels through which the crisis might have affected bank lending.

However, none of these recent studies examine the consequences of credit supply contraction for firms' stock market valuation during the crisis. They all consider the impact only on firms' balance-sheet characteristics, which can be measured with a time delay, or cannot be immediately and costlessly adjusted in response to shocks. In this chapter, I examine the impact of bank financial health on firm performance measured by stock returns, which should more accurately measure firms' responses to a changing banking environment. In this respect, my research is primarily related to studies examining firms' stock price reaction to credit supply shocks (Slovin, Sushka and Polonchek, 1993; Ongena, Smith and Michalsen, 2003; Gokcen, 2010; Fernando, May and Megginson, 2012; Norden et al., 2013; Carvalho et al., 2015). Slovin, Sushka and Polonchek

(1993) analyze how the failure of the Continental Illinois Bank and its subsequent bailout by the FDIC impacted bank's borrowers. They show that the near failure of the bank impaired borrowers' stock valuations, while the subsequent rescue of the bank by the FDIC positively impacted borrowers' stock prices. Gokcen (2010) also examines how good and bad announcements in the banking sector affect firms' market values. The author focuses on two events during the recent financial crisis: the Lehman Brothers failure and the first round of the TARP, to show that a firm's credit rating and the lenders' financial health have a significant effect on firms' valuations. However, the author examines the cross-section of firms' stock returns on the event date and therefore cannot properly absorb demand effects. Fernando, May and Megginson (2012) also focus their analysis on the collapse of Lehman Brothers, and show that it triggered stock valuation losses for companies that had security underwriting relationships with the failed bank. However, these papers, by using an event-study approach examine only short-term consequences of bank shocks, while in this study I examine the reaction of firms' stock prices over a longer time horizon. In particular, I analyze whether and how firms' stock prices reacted to contraction in bank credit during the whole crisis period of 2007-2009. Therefore, the analysis shall capture variation in stock prices, not only due to the expected impacts of institutions' failures and government intervention during the crisis, but also due to the actual changes in bank credit.

Norden, Roosenboo, and Wang (2013) and Carvalho, Ferreira and Matos (2015) in addition to a short-term event study approach also examine firms' stock price reaction to the crisis events over the long-term horizon. Norden et al. (2013) analyze the impact of government interventions in the U.S. and show that capital injections in banks during the financial crisis of 2007-2009 triggered significant positive responses of borrowers' stock returns. Carvalho et al. (2015) examine stock returns of firms from 34 countries, including the U.S. They show that decreases in lenders' market capitalization cause stock market losses to borrower firms. However, none of these papers examine the effects of bank-specific shocks in the loan market and show how it transmitted into valuation effects for borrowers. My research fills this gap. To the best of my knowledge, this is the first study that directly examines the impact of bank loan supply on firms' stock returns during the financial crisis of 2007-2009.

1.2.2 Relationship Lending

In this chapter I examine whether credit supply frictions affect firm performance. Here I assume that lending relationships are valuable and important for firms, in order to obtain access to bank credit. Otherwise, firms can almost costlessly switch to new banks to compensate for a shortfall in credit supply from their troubled banks during the crisis. In such a situation, I would not find any differential effect among clients of different banks, and any effect of credit supply frictions on firm performance. Below I provide a brief overview of the existing literature that advocates that lending relationships matter for borrowers.

The large strand of literature on financial intermediation emphasizes the importance of banks and the significant role of strong lending relationships in mitigating information frictions (Diamond, 1984; Ramakrishnan and Thakor, 1984; Boot, 2000). Strong lending relationships are beneficial for borrowers because, as has been shown in prior studies, closer ties to banks increase the availability of credit (Petersen and Rajan, 1994; Cole, 1998), reduce cost of funds (Berlin and Mester, 1998; Bharath et al., 2011) and help to relax collateral requirements (Berger and Udell, 1995). However, there are also costs of strong lending relationships, due to a lender's ability to exercise monopoly power over private borrower-specific information acquired, thereby making it costly for a borrower to switch to another lender who is less informed (Sharpe, 1990; Rajan, 1992). Nevertheless there is evidence that borrowers switch to new lenders if their relationship lenders cannot satisfy their growing credit needs (Gopalan et al, 2011). Gopalan et al (2011) examined why borrowers switch lenders in the context of the U.S. loan syndication market.

In this paper, I use the loan syndication market to link borrowers and lenders. This market expanded tremendously over the last 30 years, starting from around \$137 million in the late 1980s to \$940 billion in 2014 (Sufi, 2007; Adler, 2015). Syndicated lending became one of the most important ways for U.S. corporate borrowers to receive funding from banks and institutional investors, accounting for almost half of the commercial and industrial loans originated, according to the Federal Reserve Survey of Terms of Business Lending.

Syndicated loans are originated by two or more lenders that jointly grant funds to a single borrower. The originating bank (or "lead bank") conducts due diligence, negotiates the preliminary terms of the loan contract with the borrower and then arranges commitments from other participant lenders willing to finance part of the loan. The originating banks retain a larger portion of the loan on their balance sheets than participant banks. They play the most significant role in the syndicate, as they directly communicate with the borrower about preliminary terms of the loan. Later they service the loan and govern its terms, and monitor the borrower. Thereby the lead bank forms a lending relationship with the borrower, while participant banks maintain an arm's-length relationship with the borrower through the lead lender.

The determinants of loan syndicate structure have mainly been examined in the empirical literature, to study the impact of information frictions among multiple lenders. Sufi (2007) tests the model built by Holmstrom and Tirole (1997), which shows that in the case of multiple lenders, one monitoring lender faces a moral hazard problem. He shows that in the loan syndication market, syndicates are established in such a way as to mitigate the moral hazard problem. For less transparent borrowers, lead banks keep a larger loan share in the syndicate, to guarantee their willingness to conduct the optimal level of monitoring. They also establish small and more concentrated syndicates, and turn to participant banks that have stronger lending relationships with borrowers in the case of opaque borrowers. Dennis and Mullineaux (2000) also document the availability of public information about the borrowers as an important factor that influences the decision to syndicate loans and determines the syndicate structure. In addition, Bharath et al. (2011) show that repeated borrowing helps borrowers to get lower loan spreads and that lending relationships are more valuable for less transparent borrowers.

1.3 Liquidity and the Financial Crisis of 2007-2009

The turmoil in financial markets in 2007-2009 has become the most dramatic event since the Great Depression. During the years before the financial crisis, banks had been gradually stepping out from the traditional sources of funding to newly formed practices in which they could finance new credit provision by selling and securitizing preexisting loans, or by using short-term wholesale funding[9] (Acharya and Richardson, 2009; Brunnermeier, 2009; Diamond and Rajan, 2009; Gorton, 2009). The use of wholesale funding became very popular among financial institutions because of decreased regulation, innovation and rivalry from nonbank financial institutions. Reliance on the wholesale funding helped banks to increase their liabilities, which were previously restricted to the local depositors' base. However, when the market for these funds dried up during the crisis, banks faced severe liquidity problems in rolling over their debt, and according to Shin (2009) and Raddatz (2010), dependence on wholesale funding was one of the main causes of the collapse of some financial institutions, as well as of a dramatically expanded depth and transmission of the crisis.

The financial crisis started in mid 2007, with increased delinquencies and foreclosures on sub-prime mortgages, which created panic in the secondary market for securitized assets (Brunnermeier, 2009). All types of securitized assets fell in value and became very difficult to price and to borrow against. These tensions mounted into the meltdown of the market for asset-backed commercial paper in August 2007, as a result of increased uncertainty about banks' exposure to securitized assets and the inability of some lenders to provide funding to their off-balance sheets structured investment vehicles. The collapse of the market for asset-backed commercial paper increased uncertainty about the value of banks' own books, and concerns about off-balance sheet liquidity exposures of banks to their conduits structures brought into question banks' liquidity and solvency. These concerns prevented banks from lending to each other, resulting in the collapse of the interbank market and a huge rise in borrowing interest rates. The costs of borrowed funds are well described by the Treasury-Eurodollar (TED)[10] spread or by the LIBOR-OIS[11] spread[12], which spiked more than twice in their value in August 2007 and remained highly volatile for over a year.

In early 2008 the financial situation improved after the bailout of Bear Stearns and the Federal Reserve's actions to provide liquidity support to the banking sector. However, the situation worsened sharply on September 15, 2008 when the investment bank Lehman Brothers filed for

[9] Wholesale funds include commercial paper, repurchase agreements, interbank loans and wholesale deposits.

[10] The TED spread is the difference between the risky 3-month LIBOR rate and the risk-free 3-month Treasury Bill rate. The LIBOR rate is the interest rate at which banks lend to each other in the interbank market and the T-bill rate is the rate on riskless U.S. government debt.

[11] The LIBOR-OIS spread is the difference between the LIBOR rate and a corresponding overnight indexed swap rate. The OIS rate is considered less risky than the LIBOR and is used as a proxy for a risk-free rate.

[12] The TED spread and the LIBOR-OIS spread measure perceived credit risk in the banking sector and reflect the strain in the interbank market. The narrowing of spreads represents confidence in the interbank market as the risk of default on interbank loans is decreasing, while the widening of spreads reflects liquidity problems in the interbank market.

bankruptcy after unsuccessful attempts to find liquidity support. The collapse of Lehman Brothers immediately provoked a dramatic shock in the financial markets, because of the undermined confidence and increased uncertainty among financial institutions. The panic led to funds drying up in the market for commercial paper and in the interbank market, with the borrowing interest rates rising to beat the historic records of summer 2007. The subsequent events were marked by the federal government's efforts to calm down the situation by pumping liquidity into financial markets and institutions through different programs, and bailouts of the Federal National Mortgage Association (Fannie Mae), Federal Home Loan Mortgage Corporation (Freddie Mac) and the insurer American International Group (AIG). These measures helped to mitigate the panic, but the situation eased only in the midle of 2009 and the costs of interbank lending returned to their pre-crisis levels later in the second half of 2009. By the end of 2009, the Federal Reserve closed many of their liquidity provision programs as conditions in the interbank and credits markets have improved.

According to this overview and to the works of Acharya and Merrouche (2013), and Brunetti et al. (2011), one of the main features of the financial crisis of 2007-2009 was the dramatic collapse of liquidity provision in the short-term wholesale markets. Brunnermeier (2009) even refers to the recent financial crisis as a "liquidity crunch". So the crisis was not triggered by the deterioration of the financial stand of banks' clients. Problems in the banking sector are attributed to the adverse shocks to their short-term funding and are orthogonal to their clients' financial position, which provides a good setting to analyze the impact of bank credit on firms' perfomance. The meltdown of the commercial paper market and freeze of the interbank market was an exogenous and unexpected shock for banks, which provoked severe liquidity problems. Those banks that financed their assets mostly with short-term wholesale or noncore funding such as commercial paper, interbank loans, repurchase agreements and large denomination deposits were highly exposed to the liquidity shock (Shin, 2009; Gozzi and Goetz, 2010; Raddatz, 2010). In contrast, as Cornett et al. (2011) and Ivashina and Scharfstein (2010) show, banks that mostly relied on retail or core deposits, which proved to be a more stable source of funding during the recent financial crisis, experienced lower liquidity shock.

1.4 Methodology

1.4.1 Banks' Financial Health and Lending

When banks' financial health deteriorates due to adverse liquidity shock, it is hard for them to raise funding to compensate for the liquidity shortage in periods of macroeconomic illiquidity. Therefore, banks become liquidity constrained. I examine whether banks that are less exposed to the liquidity shortfall in the wholesale market are less liquidity constrained and thereby reduced lending to a lesser extent during the crisis.

To identify how a change in banks' financial health affects lending, an exogenous measure of their financial health is needed that would be different across banks and would not reflect differences in their performance. The financial crisis of 2007-2009 triggered a substantial liquidity shortfall in markets for wholesale funds, which in turn created huge financing problems for banks. This liquidity shock was unexpected, and it was unrelated to the performance of banks' clients. Banks that relied more on short-term wholesale funds were more exposed to the liquidity shock. These sources of funding are short-term and are less informationally insensitive than retail deposits (Gorton, 2009). In contrast, reliance on retail or core deposits cushions banks from the liquidity dry up in wholesale funds. When the wholesale deposits experienced a decline in autumn 2008, retail deposits continued to rise (Cornett et al., 2011). This is not a new phenomenon; empirical works by Gatev, Schuermann, and Strahan (2006) and Gatev and Strahan (2006) document that banks experience an increase in deposit inflows during periods of tight liquidity. This happens because, during the time of market turbulence, investors transfer their funds from markets to banks, which they consider a safer place for holding their money.

The availability of deposit financing during turbulent times increases the capacity of banks to provide credit. Ivashina and Scharfstein (2010) and Cornett et al. (2011) show that deposits proved to be a more stable source of funding during the recent financial crisis and banks that relied more on deposit financing cut their lending to a lesser extent. This study explores banks' reliance on core deposits during the crisis, as a measure of their exposure to the liquidity shock.

To examine whether banks cut back on lending when they face adverse liquidity shocks, I estimate the following model of credit growth for bank-firm pairs during the quarter:

$$\begin{aligned} \triangle log\, Bank\, Credit_{imt} = \alpha + \beta_1 Bank\, Liquidity\, Exposure_{it-1} + \\ +\beta_2 Bank\, Liquidity\, Exposure_{it-1} * Crisis + \\ +\gamma Bank\, Controls_{it-1} + \mu_{im} + \varphi_t + \mathrm{u}_{imt}. \end{aligned} \tag{1.1}$$

This is a bank-firm level regression, where $\triangle log\, Bank\, Credit$ is the change in the logarithm of the number of outstanding term loans and credit lines[13] made by bank i to non-financial firm cluster m during the quarter t.

$Bank\, Liquidity\, Exposure$ is exposure to the liquidity shock measured by the lagged share of core deposits to the bank's total assets. $Crisis$ is a dummy variable that equals one for the period from 2007 Q3 till 2009 Q4. The main coefficient of interest is β_2. The higher the level of core deposits maintained by a bank, the greater its liquidity buffer, and the lesser its liquidity exposure. Therefore, β_2 measures to which extent banks that relied more on stable short-term core deposit financing changed their provision of credit to firm cluster during the crisis. β_2 is expected to be positive.

$Bank\, Controls$ include bank size, liquid assets, total capital ratio, non-performing loans and return on assets[14]. μ_{im} and φ_t are bank-firm fixed effects and quarterly dummies, respectively.

[13] I use the number of loans instead of the dollar amount, as due to the fact that lender shares in the loan syndicate are usually not available in the Dealscan database, using the dollar amount might lead to a measurement error.

[14] See variable definitions in Table 1.

Bank-firm fixed effects absorb all time-invariant heteregeneity in the supply and demand for bank credit. As a result, this estimation compares variation in bank credit within the same firm cluster and bank over time. Quarterly dummies absorb all other macroeconomic shocks, such as massive liquidity provision by the Federal Reserve during the crisis. Total liquidity supply by the Federal Reserve was exogenous for banks, while internal allocation of liquidity across banks was maintained by their demand for liquidity.

This approach is based on the works of Gan (2007) and Khwaja and Mian (2008), who used a within-firm estimator to account for change in firms' demand for credit.[15] However, due to data limitations I cannot use the original Khwaja and Mian (2008) estimator: in my sample there is not much time variation in bank-firm credit relationships, because the Dealscan database provides information only for the time of loan origination and doesn't document any changes in the loan status over time. Also, loans in the sample are primarily syndicated, and thus have relatively long maturities. So, I follow the work of Acharya et al. (2016) and employ a modified version of Khwaja and Mian's (2008) within firm estimator. I aggregate data for firm clusters to generate enough variation in bank-firm cluster credit relationships.

In line with Acharya et al. (2016), I form firm clusters based on a firm's state of incorporation, industry and credit rating. However, the information on firms' ratings is missing for a large fraction of firms in my sample. I assign ratings to firms based on their three-year median interest coverage ratio, where the median is calculated for the pre-crisis period. I use rating categories from Standard & Poor (2006).

1.4.2 Existence of Relationship Lending

My analysis of the impact of credit supply frictions on firm performance relies on the assumption that firms form relationships with banks that help them to obtain bank credit in the future. To examine the existence of relationship lending in the loan syndication market, I use the following econometric model, which tests the likelihood of the borrower to access the same lender it has borrowed from in the past for a new syndicated loan, depending on the lender's role in the syndicate (Chodorow-Reich, 2014):

$$Lead_{bi} = \alpha + \beta_1 Previous\, lead_{bi} + \beta_2 Previous\, participant_{bi} + \theta_b + \epsilon_{bi}, \tag{1.2}$$

$$Participant_{bi} = \alpha + \beta_1 Previous\, lead_{bi} + \beta_2 Previous\, participant_{bi} + \theta_b + \nu_{bi}. \tag{1.3}$$

The sample covers borrowers that used the loan syndication market from 2003 to 2013, and existing and potential lenders active in that market during the year. The dependent variable *Lead* (or *Participant*) is an indicator variable that equals 1 if bank b served as lead (or participant) lender for borrower i and equals 0 otherwise, as well as if borrower i has no loans from bank b in

[15] Other recent studies as Paravisini (2008), Schnabl (2012), Iyer et al. (2014), Paravisini et al. (2015), and Bentolila et al. (2017) also use within firm estimation to isolate changes in credit supply from changes in the demand for credit.

the current year. The independent variables $Previous\,lead$ and $Previous\,participant$ are indicator variables that equal 1 if bank b served as lead or participant lender for a borrower's previous loan and account for the existence of repeated borrowing from the same bank. θ_b denotes bank fixed effects.

1.4.3 Firm-Level Outcomes

In this subsection I examine the causal effect of bank credit on firm performance. A decline in bank credit can result in the abandoning of profitable investment projects and in poor performance, but only if it poses financial constraints on firms. At the firm level it is important to examine whether a drop in bank credit by a particular bank can impose financial constraints on firms, because firms can compensate this fall in financing by borrowing from other less-troubled banks. Therefore, I need to test whether bank liquidity shocks affect firms' total credit received from banks.

Another concern is that the examination of the causal effect of the bank credit on firm performance is challenging because the amount of credit received by the firm is the equilibrium outcome, determined by the amount of credit supplied by banks and by the firm's demand for bank credit. The latter is driven by a firm's observable and unobservable characteristics, which at the same time may affect firm performance. To address this identification problem, I instrument for the bank credit, using liquidity shocks to the financial position of banks that provide credit to the firm. But this strategy generates unbiased estimates only if the matching of banks and firms is random. To account for potential non-random matching, I control for all unobservables by introducing firm fixed effects to account for unobservable time-invariant firm characteristics, and industry-time fixed effects to account for time-varying shocks to the industry.

Formally, the following two-stage econometric model is used to estimate the effect of changes in banks' credit on firms' performance:

$$\begin{aligned} \triangle log\,Bank\,Credit_{jt} = \alpha + \beta_1 Banks'Liquidity\,Exposure_{jt-1} + \beta_2 Banks'Liquidity\,Exposure_{jt-1} * \\ * Crisis + \gamma Firm\,Controls_{jt-1} + \theta_j + \varphi_t + \epsilon_{jt}, \end{aligned} \tag{1.4}$$

$$\begin{aligned} r_{jt} = \alpha + \beta_1 \triangle log\,Ban\hat{k}\,Credit_{jt} + \beta_2 \triangle log\,Ban\hat{k}\,Credit_{jt} * Crisis + \\ + \gamma Firm\,Controls_{jt-1} + \theta_j + \varphi_t + \nu_{jt}. \end{aligned} \tag{1.5}$$

First, I measure the firm's access to bank credit or its financial constraints by the average exposure of all the firm's lenders, and examine its impact on the changes in the firm's total borrowing from banks. $\Delta log\,Bank\,Credit$ is the change in the logarithm of a firm's total borrowing from banks, measured by the number of outstanding loans.

$Banks'Liquidity\,Exposure$ of a firm j in a quarter t is calculated as follows:

$$\begin{matrix} Banks'Liquidity \\ Exposure \end{matrix}_{jt} = \sum_i \frac{Loan\,Amount_{ijt}}{Total\,Loan\,Amount_{jt}} * \begin{matrix} Bank\,Liquidity \\ Exposure \end{matrix}_{it} \tag{1.6}$$

It is the weighted average of liquidity exposures of banks that have outstanding loans with the firm j in a quarter t. Weights correspond to the size of loan from each bank. Banks' exposure to the financial crisis is measured by the ratio of core deposits to total assets. This measure takes into account all banks from which a firm has outstanding loans. The next measure takes into account only banks that act as lead lenders in the loan syndicate, i.e., it excludes participant lenders.

$$\begin{matrix} Banks' Liquidity \\ Exposure\, Lead \end{matrix}_{jt} = \sum_i \frac{Lead\, Loan\, Amount_{ijt}}{Total\, Loan\, Amount_{jt}} * \begin{matrix} Lead\, Bank \\ Liquidity\, Exposure \end{matrix}_{it} \tag{1.7}$$

Crisis is a dummy variable that equals one for the period from 2007 Q3 till 2009 Q4.

Second, I examine the impact of changes in a firm's total bank credit on changes in its valuation, where the liquidity exposure is used as an exogenous source of variation in bank credit. r_{jt} measures changes in the firm's stock market valuation, such as stock returns[16]. I also examine real effects of changes in firm's total bank credit, where I estimate specification (5) for firm's sales growth.

Firm controls include profitability, Tobin's Q, Z-score, cash holdings, cash flow, tangible assets, leverage, and firm's size[17]. θ_j and φ_t are firm fixed effects and quarterly dummies, respectively. Firm fixed effects absorb all time invariant firm heterogeneity. Quarterly dummies absorb all other macroeconomic shocks that had an impact on all firms during the sample period.

To control for endogeneity of a firm's total bank credit, I estimate this model using an instrumental variables' (IV) estimation technique, where *Liquidity Exposure* is used as an instrument for changes in a firm's total bank credit. The IV estimation provides consistent results only if the chosen instruments are relevant and valid. Instruments are assumed to be relevant if they are correlated with an endogenous regressor, such as a change in a firm's total bank credit, while the instruments' validity assumes that chosen instruments are not correlated with the error term from the second stage regression (Wooldridge, 2010).

The identification assumption of this model is that, conditional on the observable characteristics of firms, and firm and time dummies, instrumental variables are not correlated with unobserved components of the stock return equation, meaning that banks' liquidity exposure influences a firm's stock returns only through changes in its total bank credit. I employ two tests to examine the validity and relevance of instruments: a weak identification test and an overidentification test. The weak identification test (the Cragg-Donald test) examines instruments' relevance. Its null hypothesis is that instruments are weak. If instruments are weak then the IV estimator becomes less efficient, because it generates larger standard errors than those generated by the OLS estimator. To test the null hypothesis, I use F statistics from the Cragg-Donald Wald test, which I compare with the weak ID test critical values provided by Stock and Yogo (2005). Rejection of the null implies that the instruments are relevant. The validity of the instruments is tested by an

[16]I focus here on the firm's stock return rather than an other firm's balance-sheet characteristics because a firm's balance-sheet characteristic may react slowly to bank liquidity shocks. Moreover, there might be a delay in measurement of the balance-sheet characteristics at a firm, and it might be costly for a firm to quickly adjust its books in response to the shock, while stock prices react immediately to shocks and are measured more frequently than balance-sheet characteristics.

[17]See variable definitions in Table 1.

overidentifying restrictions test, a Hansen-J test. This is a joint test of the null hypothesis that the model is correctly specified and the orthogonality conditions are met (correlations between the instruments and the error term is zero). Rejection of the null implies that both of these assumptions are questionable.

1.5 Data

I use data on outstanding bank loans made to U.S. firms by U.S. banks from 2006 to the end of 2013, along with balance sheet information on firms and banks. Loan data comes from the Thomson Reuters Dealscan database, which provides detailed information on loan transactions. The Dealscan database reports flow data on new loan originations and covers a large share of commercial lending to medium and large borrowers in the U.S. (Ivashina and Scharfstein, 2010). It contains information on the identity of lenders and borrowers, lender type (bank vs. nonbank), lender role in the syndicate (lead[18] vs. participant), some borrower characteristics such as sales, industry, credit rating if applicable, firm type (private vs. public), contract terms such as maturity, amount and interest rate, loan type and purpose. Most of these loan transactions are syndicated. Syndicated loans are originated jointly by several banks that later service and monitor the loan. The originating banks retain a significant portion of the loan on their balance sheets, while selling the remaining shares to participant banks. The originating banks play the most significant role in the syndicate and are referred to as lead banks. In this study, I focus on all lenders (lead and participant), and additionally check the results for lead lenders only. I split each loan between these banks according to bank shares in the syndicate. However, the data on the lender shares in the syndicate is missing for 75% of observations. If there is no information about lender shares, then I split the loan amount equally between banks.

Dealscan does not provide balance sheet information[19] for companies that are engaged in loan contracts. To obtain more detailed information about banks, I manually match lender companies from Dealscan,[20] based on the lender's ultimate parent information, with the data on U.S. bank holding companies and individual commercial banks. Financial data on the bank holding companies is taken from the Federal Reserve FR Y-9C Consolidated Financial Statements for Bank Holding Companies. Financial data on individual banks is taken from Reports of Condition and Income (Call Reports) provided by the Federal Deposit Insurance Corporation (FDIC).[21] Firm-level data is obtained from Compustat North America[22] which provides detailed information on balance sheet, cash flow and income statements of public firms in the U.S. on a monthly, quarterly and annual basis. I use quarterly data, and my sample contains only nonfinancial U.S. firms. I exclude from

[18]Lead banks are defined as agents and arrangers but not participants in the Dealscan database.

[19]Dealscan provides data on sales, which is missing for many companies.

[20]I manually matched banks using the following identifiers: lender name and name of parent bank, state and city. I referred to the FFIEC's National Information Center to identify financial institutions.

[21]FR Y-9C and Call Reports are publicly available from the website of Federal Reserve Bank of Chicago.

[22]Dealscan companies are matched to companies from Compustat using the link provided by Michael Roberts. See Chava and Roberts (2008) for details on the link construction.

the analysis financial firms according to the industry code (SIC 6000 - 6999). See Table 1.1 for details on construction of variables. Table 1.2, Panel A reports firms' descriptive statistics. Table 1.2, Panel B reports descriptive statistics at the bank-firm level. The average change in bank credit for the whole sample is -0.0003, indicating that on average there was a decline in bank lending during 2006-2013. Over the entire sample, the average bank has a core deposit ratio of 0.196, a total capital ratio of 0.145, a liquid assets ratio of 0.287, a return on assets (ROA) of 0.002 and a non-performing loan ratio (NPL) of 0.017.

Market data is taken from the Center for Research in Security Prices (CRSP). To account for outliers I winsorize all variables at 1% in the 1st and 99th percentiles of the distribution. Table 1.3 reports descriptive statistics for the sample of the stock returns of nonfinancial U.S. firms. I report descriptive statistics of variables for the whole time period of 2006-2013, and for the pre-crisis, crisis and post-crisis periods. For the entire period of 2006-2013 borrowing firms have, on average, total bank credit of -0.003, a total return of 0.012, profitability of 0.035, a market-to-book ratio of 1.32, a Z-score of 0.767, cash holdings of 0.098, a cash flow of 0.022, tangible assets of 0.331, and leverage of 0.285. When comparing the pre-crisis and crisis periods, there was a decline in firms' total bank credit, total return, profitability, market-to-book ratio, Z-score and cash flow, while there was an increase in cash holding and leverage during the crisis.

Table 1.4 shows pre-crisis differences of bank credit, total return and sales growth across firms with low and high exposure. Firms are divided into two groups based on the average liquidity exposure of their lenders during the crisis. Low exposure firms are those whose banks are less exposed to the liquidity shock. They have higher than the average banks' core deposits, while those of high exposure firms are lower than the average during the crisis period. As can be seen from Table 1.4, there is no systematic difference in bank credit, stock price and sales growth between firms with low and high exposure before the financial crisis of 2007-2009. This indicates that the reasons behind the selection of banks and firms in lending relationships do not drive outcomes for firms.

1.6 Results

1.6.1 Banks' Financial Health and Lending

Table 1.5 shows the estimation results for the effect of the liquidity shock on changes in bank credit, where bank credit is measured by the number of outstanding loans made by a bank to firm cluster during the quarter, and liquidity shock is measured by the share of core deposits in total bank assets. The results in columns 1-3 show that there is a positive correlation between changes in credit supply and reliance on core deposit financing during the crisis, controlling for bank - firm and bank - time fixed effects. As banks on average decreased credit supply to firms during the crisis, the coefficient on the interaction variable $Core\,deposits * Crisis$ indicates that banks with a higher reliance on core deposit financing reduce lending to firm cluster per quarter during the crisis to a smaller extent, while banks with a lower share of core deposits reduced lending relatively more during the financial crisis of 2007-2009. More precisely, the estimation in column 1 indicates that a one standard deviation increase in the fraction of a bank's core deposits to total assets increases credit provision to firm cluster by 14.5 pp per quarter during the crisis. Column 1 shows estimation results for the specification with bank - time dummies, while specifications in column 2 and 3 are augmented with bank - firm cluster fixed effects. The point estimates are almost identical, whether I control for bank - firm cluster fixed effects or not, indicating that firm unobservable heterogeneity doesn't influence firms' access to bank credit. In column 3 I add bank-specific characteristics. Comparison of the estimates in columns 2 and 3 shows that the magnitude and statistical significance of the effect of a liquidity shock on bank credit are unchanged by the addition of control variables. Results confirm that banks in my sample operate under funding constraint and negative shocks to banks' liquidity prevent them from lending.

1.6.2 Existence of Relationship Lending

The estimation results in Table 1.6 confirm the existence of repeated borrowing. In column 1, the probability of the lead bank becoming the lead arranger in the new syndicate is 63%. The impact of $Previous\,participant$ in column 1 is also positive and significant, indicating that the participant bank has a higher probability to become the lead bank in the borrower's next attempt to get financing in the loan syndication market. In addition to lender fixed effects, the specification also accounts for borrowers' industry, state, year, public or private status and size in columns 2 and 4. The use of these additional fixed effects doesn't change the estimation results. These results for the existence of repeated borrowing confirm that borrowers form relationships with lenders in the loan syndication market.

1.6.3 Firm-Level Outcomes

1.6.3.1 The Impact of Banks' Financial Health on Firms' Total Bank Credit

I begin the analysis of bank credit dynamics at the firm level with a semi-parametric test. Figure 2.1 shows the growth of bank credit at the firm level, relative to 2006 Q1 (the beginning of the period) for two groups of firms. I divided firms into high and low exposure groups based on their banks' exposure during the crisis (average for the crisis period). High exposure firms have lower than the average banks' core deposits, while those of low exposure firms are higher than average. Figure 2.1 shows that two groups of firms had similar trends in bank credit growth before the crisis, while there was a reversal of the lending trend for the high exposure firms in 2008 Q2. During the crisis, bank credit declined for all firms, but it declined more for high exposure firms. Two groups of firms had differences in availability of credit during the crisis, which also persisted post crisis.

However, the semi-parametric test in this case doesn't account for firm-specific differences. Therefore, I further focus on multivariate evidence based on estimation of panel regressions. Table 1.7 shows the estimation results from the first-stage of the instrumental variable (IV) model specified in equation (1.4). Bank credit is measured by the log difference of the number of outstanding loans from banks to a firm during the quarter. Changes in bank credit provided to the firm are instrumented by the weighted average liquidity exposure of a firm's lenders, measured by the ratio of core deposits to total assets. Columns 1-2 of Table 1.7 show estimation results for banks' liquidity exposure, based on all lenders in the loan syndicate, while columns 3-4 report results for banks' liquidity exposure based only on lead lenders. The estimation results document a positive correlation between core deposits and changes in bank credit during the crisis. As bank credit declined for all firms during the crisis, those whose banks relied more on core deposits had a lower decline in bank credit, controlling for firms' observable characteristics, firm and time fixed effects. The point estimate in column 1 of Table 1.7 implies that a one standard deviation increase in a bank's reliance on core deposits increases bank credit for a firm by 1.6 percentage points. This is two times higher than the magnitude of the average firm-level bank credit growth rate of - 0.7% during the crisis.

Next I examine firms' ability to substitute a bank credit shortfall by borrowing more from existing banks, or by forming lending relationships with new banks during the crisis. The important question here is whether firms had difficulties in establishing new lending relationships in order to obtain credit during the crisis. Column 1 of Table 1.8 shows estimation results for changes in a firm's total borrowing from banks that were already lending to the firm before the crisis. Again, there is a positive and significant relationship between existing banks' reliance on core deposits and changes in bank credit from existing banks, meaning that firms that were already borrowing from banks with a stronger liquidity position had a lower decline in bank credit during the crisis. Meanwhile firms which borrowed more from banks that relied more on non-core financing (wholesale funding) faced a greater reduction in credit during the crisis. The magnitude of this effect is almost the same as for the whole sample of existing and new banks in Column 3, indicating that firms borrowed more from existing banks and not from new banks during the crisis. Column 2 shows the estimation results for changes in a firm's total borrowing from new banks during the crisis, relative to a firm's total borrowing from existing banks. Bank liquidity exposure during the crisis doesn't have a significant effect on changes in a firm's total borrowing from new banks. Estimation results hold both for the whole sample of banks and for lead banks only. These findings again re-establish the importance of bank-firm ties in the loan syndication market, and confirm the stickiness of lending relationships, because it was not easy for firms tied to weaker banks to switch to healthier banks during the crisis.

1.6.3.2 Valuation Effects of Bank Credit Supply Changes

Table 1.9 shows the estimation results from the second-stage of the instrumental variable (IV) model, specified in equation (1.5), for changes in a firm's total bank credit and stock return. Bank credit is measured by the log difference of the number of outstanding loans from banks to a firm during the quarter. Changes in bank credit provided to the firm are instrumented by the weighted average liquidity exposure of a firm's lenders, measured by the ratio of core deposits to a bank's total assets. Columns 1-2 of Table 1.9 shows estimation results for banks' liquidity exposure based on all lenders in the loan syndicate, while columns 3-4 report results for banks' liquidity exposure based only on lead lenders.

Table 1.9 reports the results of the second-stage of the instrumental variable approach. According to the Cragg-Donald Wald test F statistics for the weak identification test and statistically significant estimates of instrumental variables reported in the firt-stage regression in Table 1.7, the instruments are not weak. Hansen J statistics at the bottom of Table 1.9 indicate that we cannot reject the null hypothesis of correct model specification and instruments' validity. The estimation results show that there is a statistically significant positive relationship between a firm's total bank credit growth and total return during the crisis: a one standard deviation decline in bank credit to a firm causes a stock return reduction of 3.5 percentage points, which is almost three times larger than the average firm-level total return during the sample period of 1.2%. The bank credit matters for a firm's valuation, controlling for firm observable characteristics, firm fixed effects and time dummies. The magnitude and statistical significance of the effect are unchanged when I cluster standard errors at firm and state levels[23]. I also add additional instruments in the first-stage regression, which account for a bank's financial health: bank total risk-based capital ratio and bank size. The estimation results reported in columns 2 and 4 show that my main findings are robust to the inclusion of these instruments.

To further mitigate concerns that the results are driven by changes in firms' demand for credit, I control for time-varying industry shocks. Table 1.10 shows the estimation results for the baseline specification augmented with industry-time fixed effects. The main results remain the same: there is a positive and statistically significant relationship between changes in bank credit and stock returns during the crisis. The magnitude of the effect is only slightly lower. All in all, my findings are robust to different model specifications and fluctuations in aggregate demand.

Firm's Financial Constraints

Further, I analyze to what extent the impact of changes in bank credit on firms' stock returns is heterogeneous across firms. I examine whether firms that are financially constrained are more responsive to changes in bank credit. I employ several identification strategies, which have been widely used in prior studies, to sort firms into two groups: financially constrained and financially unconstrained. I divide my sample based on firms' age, size and access to the public debt market.

A firm's age can be associated with its quality. The longer the firm operates, the more established and mature it is. Old, or mature firms are usually considered less dependent on external finance (Mueller, 1972; Oliner and Rudebusch, 1992). Beck et al. (2003) and Hadlock and Pierce (2010) also document firm age as a useful predictor of financing constraints. I assign firms to the financially constrained (unconstrained) category if they are in the bottom (top) median of the quarterly age distribution.

[23]Estimation results are identical to the previous estimates and are not reported.

A firm's size is another commonly used criteria to identify firms that are financially constrained (Oliner and Rudebusch, 1992; Beck et al., 2003; Almeida et al., 2004). Large firms are usually believed to have fewer difficulties in accessing external finance, because they are usually older, better established and well-known companies. Large firms are also more likely to have larger collateral, which helps them to be less sensitive to credit frictions. Gilchrist and Himmelberg (1995), Fama and French (2002) and Frank and Goyal (2003) also advocate that firm size is a good proxy for financing constraints. I rank firms on the basis of their quarterly sales revenue and assign them to the financially constrained (unconstrained) category if they have net sales lower (higher) than $1 billion, referring to those firms as small (large).

A firm's access to the public debt market is a good direct measure of financing constraints because it shows its ability to access external finance. Firms with no access to the public debt market are considered financially constrained (Gilchrist and Himmelberg, 1995; Almeida et al., 2004). I assign firms to the financially unconstrained category if they issued bonds during the quarter.

The estimation results in Table 1.11 indicate that both young and old firms' stock returns are affected by changes in bank credit[24]. However, if I consider small and large firms and firms with and without access to the bond market, the change in bank credit has a significant effect on the stock returns of small firms and those that had no bond issuance, but it has no significant effect on stock returns of large firms and those that issued bonds. This is consistent with the view that large firms and firms with access to the bond market can switch towards external financing when credit supply by banks is limited.

Another approach identifying financially constrained firms is to look at industries with different dependence on external financing.[25] Rajan and Zingales (1998) were the first to notice that some industries need more external financing than the others, because of technological reasons such as differences in the initial project scale, different cash flow gestation and cash harvest periods, and different needs for continuing investment. Therefore, bank credit can play a more important role for firms in industries that depend more on external financing. I follow Duygan-Bump et al. (2015) and define external financial dependence for each industry as the share of investment financed with external funds. It is equal to total capital expenditures minus operating cash flow. The negative values indicate that firms have free cash flow available to distribute, while positive values mean that firms have no cash, and need to raise capital for further investment. I use an indicator variable for a firm's external financing needs that equals one if the firm operates in an industry with positive external financial dependence, and zero if it operates in an industry with negative external financial dependence.[26]

Table 1.12 reports estimation results for the impact of bank credit on firms' stock returns, separately for firms operating in industries with high (EFD = 1) and low (EFD = 0) external

[24]In column 3 the effect is marginally significant with p-value of 0.137.

[25]See, for example, Buca and Vermeulen (2017), Cetorelli and Strahan(2006) and Duygan-Bump et al. (2015).

[26]I use data for industrial sectors' external financial dependence from Duygan-Bump et al. (2015). The authors calculate it using mature firms in Compustat for the period 1980 – 1996.

financial dependence. Results show that credit reduction during the financial crisis of 2007-2009 caused stock returns losses for firms in industries with high external financial dependence, while firms in industries with low financing needs were not affected. The magnitude of the effect for firms operating in industries with high financing needs is two times larger comparative to the baseline results in table 1.9. This is consistent with the view that credit supply shock disproportionally affected more financially constrained firms during the recent crisis.

Firm's Financial Position

Further, I examine whether the effects I analyze are heterogeneous across firms depending on their financial positions before the crisis. If changes in bank credit affect firms through an increase in the cost of debt financing, then firms' financial positions before the crisis should matter. Recent studies show that firms that have been refinancing their debt during the financial crisis of 2007-2008 cut investment more than firms that needed to roll over their debt just after the crisis (Almeida, Campello, Laranjeira, and Weisbenner, 2012; Duchin, Ozbas, and Sensoy, 2010). Almeida et al. (2012) exploit pre-crisis variation in long-term debt maturity structure of firms, while Duchin et al. (2010) use pre-crisis firms' net short-term debt (short-term debt minus cash reserves) to measure firms' need to roll over their debt during the crisis. I follow the approach of Duchin et al. (2010) and use firms' net short-term debt outstanding before the crisis to define firms with high levels of debt maturing during the crisis. The estimation results in Table 1.13 show a significant positive relationship between firms' stock returns and changes in bank credit only for firms with high net short-term debt, indicating that firms whose short-term debt was largely maturing during the crisis were affected the most by the bank credit supply drop during the crisis.

I also examine the impact of a firm's financial position in terms of its debt-to-equity ratio and leverage on my findings. The estimation results in Table 1.13 also indicate that there is no significant effect of bank credit on firms' stock returns for firms with stronger financial positions (low debt-to-equity ratio and leverage), while there is a positive significant effect for those with weaker financial positions (high debt-to-equity ratio and leverage).

Robustness Checks

I conduct several checks to evaluate the robustness of my main findings. First, my main result that firms' stock returns are highly sensitive to changes in bank credit during the crisis relies on the assumption that sorting of firms to banks is as good as random. However, a possible concern is that it is not. This may happen if high-quality firms borrow from financially healthier banks, while low-quality firms deal with financially unhealthy banks because they might have lower chances of borrowing from financially healthier banks. In this case my main finding captures non-random sorting of firms into banks based on their financial health. If sorting was indeed the issue, then the exclusion of low-quality firms from the analysis should significantly change the estimated results.

I measure firm quality by its net worth and assign firms to the low-quality category if they are in the bottom quartile of the quarterly pre-crisis net worth distribution. The results in Table 1.14

show that changes in bank credit have a positive effect on firms' stock returns during the crisis. The estimates in columns 1 and 2 are statistically significant, while the magnitude is slightly lower. I conclude that even after exclusion of low-quality firms, stock returns of medium- and high-quality firms were negatively affected by the bank credit crunch during the crisis.

Second, I examine how robust my findings are with respect to selected samples of firms. Estimation results in Table 1.15 show that excluding firms with negative profitability and cash flow from the analysis doesn't qualitatively change the results.

1.6.3.3 Real Effects of Bank Credit Supply Changes

In this section, I examine whether changes in bank credit affect real outcomes of firms during the crisis. This allows me to acknowledge that valuation losses are also combined with real losses for nonfinancial firms.

Table 1.16 reports the results for the estimation of equation (1.5), where dependent variable is the change in the logarithm of firm's sales. It is the second-stage of the instrumental variable approach. The Cragg-Donald statistic is higher than the critical value reported by Stock and Yogo (2005) for an estimation with two endogenous variables. This implies that our instruments are relevant. Hansen J statistics at the bottom of table 1.16 indicate that we cannot reject the null hypothesis, which implies that our instruments are relevant and valid. The estimation results show that there is a statistically significant positive relationship between a firm's total bank credit and sales growth during the crisis: a one standard deviation decline in bank credit to a firm causes sales cut of 7.9 percentage points, which is almost six times larger than the average sales growth during the sample period of 1.37%. The bank credit matters for a firm's real effects, controlling for firm observable characteristics, firm fixed effects and time dummies. I also add additional instruments in the first-stage regression, which account for a bank's financial health: bank total risk-based capital ratio and bank size. The estimation results reported in columns 2 and 4 show that my main findings are robust to the inclusion of these instruments. Controlling for time-varying industry shocks in columns 3 and 4 also doesn't alter the main findings.

1.7 Conclusions

This chapter provides evidence about the transmission of banking sector problems to corporate borrowers and examines the impact of bank credit supply frictions on firm performance. To address these questions I examine the financial crisis of 2007-2009, which provides a setting where problems in the banking sector can be attributed to adverse shocks to banks' short-term funding, rather than to problems in borrowers' creditworthiness. In particular, I examine whether banks relying more on core deposit financing decrease lending to a lesser extent than those banks financed mainly by unstable sources of funding. My findings tend to confirm that banks decrease lending due to negative funding shocks. I document a positive correlation between bank credit and reliance on core deposit financing during the crisis. My results show that banks that relied more on core deposit financing rather than wholesale funding reduced lending to a smaller extent.

I exploit differences in the composition of banks' liabilities structure during the financial crisis of 2007-2009, as a source of exogenous variation in the availability of bank credit to nonfinancial firms, in order to identify the causal relationship between bank credit supply and firm performance. I first show that the positive correlation between a bank's reliance on core deposit financing, and a change in bank credit during the crisis, is present in a cross-section of firms: firms whose banks relied more on core deposits had a lower decline in bank credit during the crisis, while switching to healthier banks during the crisis was very difficult for firms. Further, I examine whether a decline in bank credit imposes financial constraints on firms and thereby affects their performance, as measured by firms' stock returns and sales growth. My results provide evidence that bank credit matters for a firm's valuation and sales growth. There is a statistically significant positive relationship between bank credit growth and a firm's total return, and between bank credit and sales growth during the crisis: a one standard deviation decline in bank credit to a firm causes a stock return reduction of 3.5 percentage points and a sales cut of 7.9 percentage points. Stock returns of financially constrained firms and firms with weaker financial positions were affected disproportionally more by the credit supply shock during the crisis. All in all, my findings are robust to different model specifications and fluctuations in aggregate demand.

From the policy perspective, the results of this study support the introduction of the stable funding ratio within Basel III, as this research provides evidence of the importance of banks' stable sources of funding, such as core deposits. They also stand in favor of government policies aimed at providing liquidity support to banks and restoring the stability of the banking sector during the crisis, because due to the stickiness of bank-firm relationships, this leads to higher stock returns and sales for firms, thereby propagating a boost in the real sector.

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Table 1.1: Description of Variables

Variable	Description	Source
Bank level		
Core deposits	(Time deposits under \$100,000 + total transaction deposits)/Total assets	FDIC Call Reports
Total Capital Ratio	Total risk-based capital/Risk-weighted assets	FDIC Call Reports
Bank size	Log of total assets	FDIC Call Reports
Liquid Assets	(Cash + Securities + Fed Funds)/Total assets	FDIC Call Reports
ROA	Net Income/Total assets	FDIC Call Reports
NPL	(Loans past due 30 days or more + non-accruing loans)/Total assets	FDIC Call Reports
Firm level		
Total Return	Change of the firm's average stock price	Compustat-CRSP
Sales growth	Change in the logarithm of sales	Compustat
Profitability	(Operating income before depreciation)/Total assets	Compustat
Market-to-Book	Market value of assets/Total assets	Compustat
Z-score	(3.3*EBITDA[27]+ Sales + 1.4*Retained earnings + 1.2*Working capital)/Total assets	Compustat
Cash	Cash and short - term investments/Total assets	Compustat
Cash Flow	Operating income before depreciation/Non-cash total assets	Compustat
Tangibility	Net PPE[28]/Non-cash total assets	Compustat
Leverage	(Debt in current liabilities + long-term debt)/Total assets	Compustat
Size	Log of total assets	Compustat

Table 1.2: Bank-firm and Firm Level Descriptive Statistics

	N	Mean	St. Dev.	Min	p10	p50	p90	Max
Panel A: Firm level								
Total Return	41081	0.0126	0.126	-0.338	-0.133	0.011	0.155	0.417
Δlog Sales	41259	0.0137	0.238	-5.532	-0.162	0.016	0.181	7.069
Δlog Bank Credit	41259	-0.0022	0.170	-0.693	-0.134	0	0	0.693
Banks' Liquidity Exp_{t-1}	41259	0.1075	0.076	0	0.027	0.096	0.200	0.472
Banks' Liquidity Exp_{t-1}*Crisis	41259	0.0336	0.067	0	0	0	0.125	0.472
Banks' Total CAP_{t-1}	41259	0.0907	0.041	0	0.039	0.091	0.145	0.180
Banks' Size_{t-1}	41259	12.7164	5.364	0	6.002	12.926	19.844	21.485
Lead Banks' Liquidity Exp_{t-1}	41259	0.0937	0.078	0	0.016	0.079	0.186	0.497
Lead Banks' Liquidity Exp_{t-1}*Crisis	41259	0.0299	0.065	0	0	0	0.109	0.497
Lead Banks' Total CAP_{t-1}	41259	0.0869	0.044	0	0.029	0.087	0.147	0.176
Lead Banks' Size_{t-1}	41259	12.4949	6.011	0	4.238	12.789	20.671	21.537
$\text{Profitability}_{t-1}$	41259	0.0343	0.027	-0.066	0.008	0.033	0.065	0.120
$\text{Market-to-Book}_{t-1}$	36086	1.3717	0.895	0.281	0.604	1.111	2.419	5.616
Z-score_{t-1}	38406	0.7645	0.967	-4.240	-0.172	0.891	1.719	2.500
Cash_{t-1}	41259	0.1074	0.118	0	0.008	0.065	0.264	0.595
Cash Flow_{t-1}	41259	0.0217	0.032	-0.167	-0.001	0.023	0.050	0.112
Tangibility_{t-1}	41259	0.3314	0.255	0.016	0.058	0.255	0.762	0.932
Leverage_{t-1}	41259	0.2665	0.210	0	0.009	0.238	0.540	1.242
Size_{t-1}	41259	7.2543	1.621	2.928	5.241	7.222	9.402	11.220
Total Assets (USD mln)	41259	6717	27563	2.855	191.7	1396	12280	846988
Panel B: Bank-firm level								
Δlog Bank Credit	168313	-0.0003	0.155	-1.705	0	0	0	1.705
Core Deposits_{t-1}	168313	0.1955	0.168	0.000	0.041	0.149	0.423	0.927
Core Deposits_{t-1}*Crisis	168313	0.0635	0.136	0.000	0.000	0.000	0.199	0.909
Total CAP_{t-1}	168313	0.1448	0.073	-0.027	0.112	0.140	0.170	1.941
Size_{t-1}	168313	19.305	1.878	9.279	17.128	19.243	21.494	21.625
Liquid Assets_{t-1}	168313	0.2874	0.138	0.019	0.147	0.250	0.477	0.944
ROA_{t-1}	168313	0.0018	0.004	-0.119	-0.000	0.002	0.004	0.060
NPL_{t-1}	168313	0.0167	0.019	0.000	0.002	0.013	0.034	0.224

[27]Property, plant and equipment.

[28]Earnings before interest, taxes, depreciation, and amortization.

Table 1.3: Descriptive Statistics

	N	Mean	St. Dev.	Min	p10	p50	p90	Max
Full Sample:								
Δlog Bank Credit	118338	-0.0028	0.169	-0.693	-0.154	0.000	0.061	0.693
Banks' Liquidity Exp_{t-1}	118388	0.1062	0.073	0.000	0.028	0.094	0.198	0.472
Banks' Liquidity Exp_{t-1}*Crisis	118388	0.0331	0.065	0.000	0.000	0.000	0.124	0.472
Banks' Total CAP_{t-1}	118338	0.0894	0.039	0.000	0.041	0.089	0.142	0.180
Banks' Size_{t-1}	118338	12.5339	5.157	0.000	6.217	12.635	19.478	21.485
Lead Banks' Liquidity Exp_{t-1}	118388	0.0921	0.075	0.000	0.017	0.077	0.182	0.497
Lead Banks' Liquidity Exp_{t-1}*Crisis	118388	0.0292	0.063	0.000	0.000	0.000	0.107	0.497
Lead Banks' Total CAP_{t-1}	118338	0.0856	0.043	0.000	0.031	0.085	0.145	0.176
Lead Banks' Size_{t-1}	118338	12.3327	5.836	0.000	4.524	12.505	20.450	21.537
Total Return	118372	0.0116	0.124	-0.338	-0.132	0.011	0.151	0.417
$\text{Profitability}_{t-1}$	116594	0.0348	0.025	-0.066	0.010	0.033	0.063	0.120
$\text{Market-to-Book}_{t-1}$	101915	1.3215	0.829	0.281	0.600	1.088	2.298	5.616
Z-score_{t-1}	108131	0.7667	0.907	-4.240	-0.121	0.878	1.679	2.500
Cash_{t-1}	119054	0.0981	0.110	0.000	0.007	0.060	0.237	0.595
Cash Flow_{t-1}	115932	0.0220	0.030	-0.167	0.001	0.023	0.048	0.112
Tangibility_{t-1}	118727	0.3311	0.255	0.016	0.058	0.254	0.761	0.932
Leverage_{t-1}	117667	0.2851	0.203	0.000	0.052	0.255	0.550	1.242
Size_{t-1}	118388	7.4040	1.572	2.928	5.445	7.361	9.514	11.220
Pre-Crisis Period:								
Δlog Bank Credit	20111	0.0036	0.169	-0.693	-0.134	0.000	0.182	0.693
Banks' Liquidity Exp_{t-1}	20132	0.0953	0.073	0.000	0.021	0.082	0.183	0.472
Banks' Total CAP_{t-1}	20111	0.0736	0.034	0.000	0.030	0.074	0.117	0.180
Banks' Size_{t-1}	20111	11.8719	5.388	0.000	5.103	11.951	19.138	21.427
Lead Banks' Liquidity Exp_{t-1}	20132	0.0818	0.075	0.000	0.012	0.064	0.159	0.497
Lead Banks' Total CAP_{t-1}	20111	0.0696	0.036	0.000	0.023	0.069	0.117	0.176
Lead Banks' Size_{t-1}	20111	11.4667	5.768	0.000	3.847	11.369	19.704	21.427
Total Return	20081	0.0183	0.093	-0.338	-0.086	0.015	0.125	0.417
$\text{Profitability}_{t-1}$	19566	0.0380	0.025	-0.066	0.014	0.036	0.068	0.120
$\text{Market-to-Book}_{t-1}$	17399	1.5397	0.877	0.281	0.734	1.306	2.577	5.616
Z-score_{t-1}	18056	0.8483	0.825	-4.240	0.062	0.947	1.715	2.500
Cash_{t-1}	20298	0.0912	0.111	0.000	0.007	0.048	0.233	0.595
Cash Flow_{t-1}	19410	0.0264	0.027	-0.167	0.006	0.026	0.052	0.112
Tangibility_{t-1}	20217	0.3278	0.245	0.016	0.066	0.259	0.730	0.932
Leverage_{t-1}	20018	0.2639	0.196	0.000	0.044	0.232	0.524	1.242
Size_{t-1}	20132	7.2045	1.629	2.928	5.116	7.165	9.419	11.220
Crisis Period:								
Δlog Bank Credit	37173	-0.0071	0.144	-0.693	-0.105	0.000	0.000	0.693
Banks' Liquidity Exp_{t-1}	37189	0.1055	0.075	0.000	0.026	0.093	0.200	0.472
Banks' Total CAP_{t-1}	37173	0.0806	0.037	0.000	0.035	0.080	0.126	0.180
Banks' Size_{t-1}	37173	12.2637	5.267	0.000	5.844	12.377	19.352	21.485
Lead Banks' Liquidity Exp_{t-1}	37189	0.0930	0.081	0.000	0.015	0.074	0.185	0.497
Lead Banks' Total CAP_{t-1}	37173	0.0782	0.040	0.000	0.028	0.077	0.127	0.176
Lead Banks' Size_{t-1}	37173	12.1984	5.833	0.000	4.551	12.325	20.227	21.537
Total Return	37256	-0.0013	0.155	-0.338	-0.197	-0.003	0.185	0.417
$\text{Profitability}_{t-1}$	36566	0.0328	0.027	-0.066	0.006	0.032	0.063	0.120
$\text{Market-to-Book}_{t-1}$	32082	1.2543	0.797	0.281	0.551	1.027	2.234	5.616
Z-score_{t-1}	33871	0.7587	0.919	-4.240	-0.123	0.873	1.665	2.500
Cash_{t-1}	37471	0.0921	0.108	0.000	0.007	0.052	0.231	0.595
Cash Flow_{t-1}	36275	0.0177	0.037	-0.167	-0.008	0.022	0.047	0.112
Tangibility_{t-1}	37360	0.3303	0.251	0.016	0.059	0.257	0.749	0.932
Leverage_{t-1}	36982	0.2876	0.207	0.000	0.047	0.260	0.557	1.242
Size_{t-1}	37189	7.3086	1.578	2.928	5.370	7.259	9.419	11.220
Post - Crisis Period:								
Δlog Bank Credit	61054	-0.0023	0.183	-0.693	-0.182	0.000	0.154	0.693
Banks' Liquidity Exp_{t-1}	61067	0.1103	0.072	0.000	0.034	0.099	0.201	0.472
Banks' Total CAP_{t-1}	61054	0.0999	0.039	0.000	0.053	0.100	0.150	0.180
Banks' Size_{t-1}	61054	12.9165	4.977	0.000	6.831	13.009	19.647	21.485
Lead Banks' Liquidity Exp_{t-1}	61067	0.0949	0.071	0.000	0.020	0.084	0.185	0.497
Lead Banks' Total CAP_{t-1}	61054	0.0954	0.044	0.000	0.036	0.097	0.152	0.176
Lead Banks' Size_{t-1}	61054	12.6998	5.826	0.000	4.867	12.923	20.850	21.537
Total Return	61035	0.0173	0.110	-0.338	-0.109	0.016	0.142	0.417
$\text{Profitability}_{t-1}$	60462	0.0349	0.024	-0.066	0.011	0.033	0.062	0.120
$\text{Market-to-Book}_{t-1}$	52434	1.2902	0.820	0.281	0.604	1.053	2.231	5.616
Z-score_{t-1}	56204	0.7452	0.924	-4.240	-0.177	0.861	1.676	2.500
Cash_{t-1}	61285	0.1041	0.110	0.000	0.008	0.069	0.242	0.595
Cash Flow_{t-1}	60247	0.0232	0.027	-0.167	0.003	0.023	0.048	0.112
Tangibility_{t-1}	61150	0.3326	0.261	0.016	0.055	0.250	0.776	0.932
Leverage_{t-1}	60667	0.2906	0.203	0.000	0.058	0.259	0.553	1.242
Size_{t-1}	61067	7.5279	1.538	2.928	5.594	7.469	9.594	11.220

Table 1.4: Pre-Crisis Characteristics of Low and High Exposure Firms

This table compares average characteristics of low and high exposure firms in the pre-crisis period. The pre-crisis period is from 2006 Q1 through 2007 Q2. High exposure firms have banks' core deposits lower than the average during the crisis, while low exposure firms have banks' core deposits higher than the average. The test for differences in an average characteristic across two groups of firms is conducted by calculating a t-statistic. ***, ** and * are signicance levels at 1%, 5%, and 10%, respectively.

	Low	High	Difference	t-stat.
Δlog Bank Credit	-0.0010	0.0012	-0.0023	-0.82
Total Return	0.0186	0.0194	-0.0008	-0.52
Δlog Sales	0.0326	0.0285	0.0041	1.17

Figure 1.1: Firms' Bank Credit

This figure illustrates growth of bank credit at the firm level relative to 2006 Q1 for two groups of firms. High exposure firms have banks' core deposits lower than the average during the crisis, while low exposure firms have banks' core deposits higher than the average.

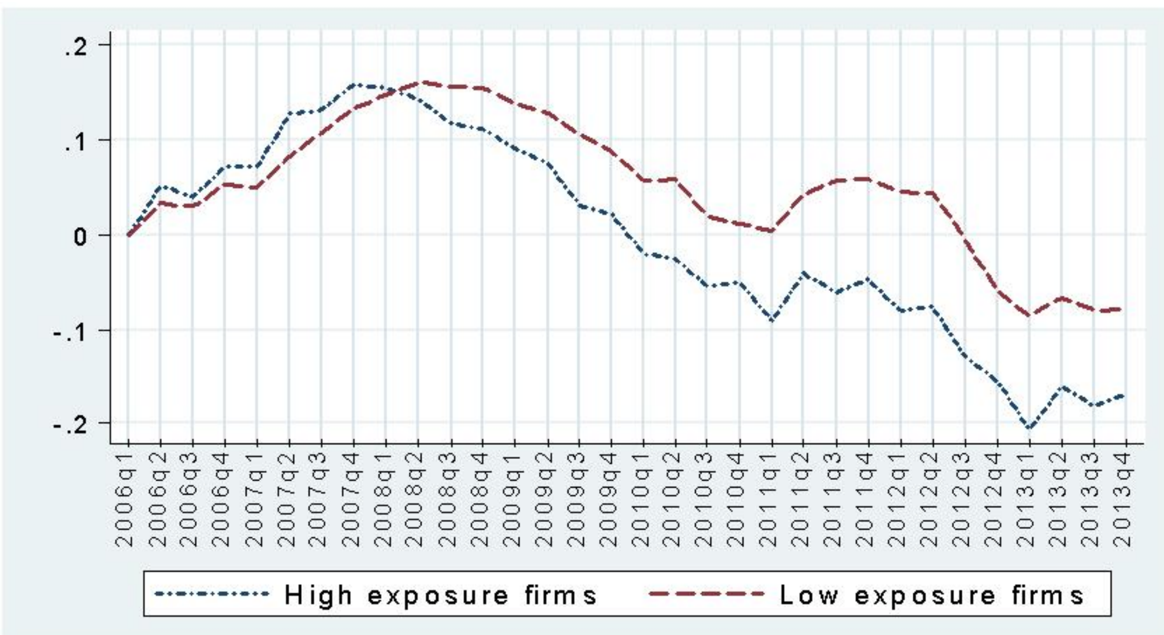

Table 1.5: Bank Liquidity Exposure and Lending

This table reports regression results for the sample of bank-firm cluster pairs over time. The dependent variable $\Delta log\,Bank\,Credit$ is the change in the logarithm of the number of outstanding loans made by a bank to firms' cluster during the quarter. Firm clusters are formed by a firm's state of incorporation, industry and credit rating. The crisis period is from 2007 Q3 through 2009 Q4. See Table 1.1 for variables definitions. Standard errors in parentheses are heteroskedasticity robust and clustered at the bank-firm cluster level. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)
	Δlog Bank Credit	Δlog Bank Credit	Δlog Bank Credit
Core Deposits$_{t-1}$	-0.922***	-1.010***	-0.655**
	(0.256)	(0.270)	(0.268)
Core Deposits$_{t-1}$* Crisis	1.068***	1.124***	1.267***
	(0.297)	(0.321)	(0.355)
Total CAP$_{t-1}$			-0.109
			(0.239)
Size$_{t-1}$			-0.251***
			(0.070)
Liquid Assets$_{t-1}$			-0.543**
			(0.262)
ROA$_{t-1}$			-1.426
			(1.696)
NPL$_{t-1}$			1.906
			(1.394)
_cons	1.310***	0.208***	5.165***
	(0.171)	(0.058)	(1.326)
Bank-firm fixed effects	No	Yes	Yes
Bank-time fixed effects	Yes	Yes	Yes
N	168313	168313	168313
N of bank-firm pairs	11420	11420	11420
R^2	0.026	0.068	0.069

Table 1.6: Relationship Lending

This table reports regression results for the sample of bank-borrower pairs. The dependent variable is the indicator corresponding to a bank participating in the loan syndicate in the indicated role. The bank can serve as a lead lender or participant lender in the loan syndicate. The sample period covers borrowers and lenders accessing the loan syndication market from 2003 to 2013 and, for each borrower, also includes all potential lenders that are active in loan syndication during the year. The independent variables $Previous\,lead$ and $Previous\,participant$ are indicator variables that equal 1 if a bank assumed a lead or participant role in the borrower's previous syndicated loan. Borrower controls include an indicator whether the borrower has public or private status and borrower's sales. All regressions include bank fixed effects. Standard errors in parentheses are heteroskedasticity robust and clustered at the borrower level. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)
	Bank chosen as Lead lender		Bank chosen as Participant lender	
Previous Lead	0.629***	0.628***	0.057***	0.056***
	(0.005)	(0.005)	(0.003)	(0.003)
Previous Participant	0.091***	0.091***	0.404***	0.403***
	(0.003)	(0.003)	(0.006)	(0.006)
Bank FE	Yes	Yes	Yes	Yes
2-digit SIC	No	Yes	No	Yes
State and Year FE	No	Yes	No	Yes
Borrower Controls	No	Yes	No	Yes
N	1165662	1165662	1165662	1165662
N of borrowers	3547	3547	3547	3547
R^2	0.587	0.587	0.246	0.247

Table 1.7: Change in Firms' Total Bank Credit and Banks' Financial Health

This table reports estimation results for the determinants of firm borrowing from banks for the sample of firm-quarter pairs. This is the first-stage regression from the specification (1.4) of the instrumental variable approach. $\Delta log\, Bank\, Credit$ is the change in the logarithm of firm's total borrowing from banks, measured by the number of outstanding loans. Banks' liquidity exposure is the liquidity shock experienced by a firm, measured as the weighted average of liquidity exposures of banks that have outstanding loans with the firm. Banks' exposure to the liquidity shock is proxied by banks' ratio of core deposits. For each firm, all other bank-level measures are also calculated as the weighted averages between all banks that have outstanding loans with the firm. The crisis period is from 2007 Q3 through 2009 Q4. See Table 1.1 for variables definitions. All regressions include firm and time fixed effects. Standard errors in parentheses are clustered at the firm level. ***, ** and * have significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)
	Δlog Bank Credit			
	All Banks		Lead Banks	
Banks' Liquidity Exp_{t-1}	-0.832***	-0.517***	-0.746***	-0.502***
	(0.072)	(0.084)	(0.063)	(0.075)
Banks' Liquidity Exp_{t-1}* Crisis	0.212***	0.200***	0.181***	0.150**
	(0.078)	(0.076)	(0.069)	(0.069)
Banks' $TCAP_{t-1}$		-0.104		-0.195
		(0.123)		(0.151)
Banks' $Size_{t-1}$		-0.002**		-0.001
		(0.001)		(0.001)
Firm Controls:				
$Profitability_{t-1}$	0.083	0.075	0.075	0.074
	(0.077)	(0.078)	(0.077)	(0.078)
$Market\text{-}to\text{-}Book_{t-1}$	0.000	0.000	0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.003)
$Z\text{-}score_{t-1}$	0.007*	0.008*	0.008*	0.008*
	(0.004)	(0.004)	(0.004)	(0.004)
$Cash_{t-1}$	-0.005	-0.010	-0.006	-0.011
	(0.021)	(0.021)	(0.021)	(0.021)
Cash $Flow_{t-1}$	-0.040	-0.039	-0.036	-0.036
	(0.046)	(0.045)	(0.046)	(0.046)
$Tangibility_{t-1}$	0.006	0.006	0.006	0.008
	(0.022)	(0.022)	(0.021)	(0.022)
$Leverage_{t-1}$	-0.053***	-0.052***	-0.052***	-0.051***
	(0.013)	(0.014)	(0.013)	(0.014)
$Size_{t-1}$	-0.010**	-0.012***	-0.011***	-0.011***
	(0.004)	(0.004)	(0.004)	(0.004)
N	92316	92316	92316	92316
N of firms	1495	1495	1495	1495
R^2	0.016	0.017	0.016	0.017

Table 1.8: Bank Credit: Existing and New Lending Relationships during the Crisis

This table reports estimation results for the decomposition of firm borrowing from existing and new banks during the crisis. I split firm's total borrowing during the crisis between banks the firm was borrowing from before the crisis and banks the firm started to borrow from only with the start of the crisis. $\Delta log\, Bank\, Credit$ is the change in the logarithm of a firm's total borrowing from banks, measured by the number of outstanding loans. Banks' liquidity exposure is the liquidity shock experienced by a firm, measured as the weighted average of liquidity exposures of banks that have outstanding loans with the firm. Banks' exposure to the liquidity shock is proxied by banks' ratio of core deposits. For each firm, all other bank-level measures are also calculated as the weighted averages between all banks that have outstanding loans with the firm. The crisis period is from 2007 Q3 through 2009 Q4. Firm controls include profitability, market-to-book, Z-score, cash holdings, cash flow, tangible assets, leverage, and size. See Table 1.1 for variables definitions. All regressions include firm and time fixed effects. Standard errors in parentheses are clustered at the firm level. ***, ** and * have significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Δlog Bank Credit			Δlog Bank Credit		
	Existing Banks	New Banks	Existing and New Banks	Existing Banks	New Banks	Existing and New Banks
	All Banks			Lead Banks		
Banks' Liquidity Exp_{t-1}	-0.625***	-2.354***	-0.517***	-0.601***	-1.908***	-0.502***
	(0.095)	(0.356)	(0.084)	(0.086)	(0.341)	(0.075)
Banks' Liquidity Exp_{t-1}* Crisis	0.281***	0.388	0.200***	0.209**	0.017	0.150**
	(0.095)	(0.258)	(0.076)	(0.083)	(0.239)	(0.069)
Banks' $TCAP_{t-1}$	-0.143	0.006	-0.104	-0.262	0.453	-0.195
	(0.135)	(0.436)	(0.123)	(0.165)	(0.495)	(0.151)
Banks' $Size_{t-1}$	-0.003***	-0.018***	-0.002**	-0.001	-0.018***	-0.001
	(0.001)	(0.004)	(0.001)	(0.001)	(0.004)	(0.001)
Firm Controls:	Yes	Yes	Yes	Yes	Yes	Yes
N	92316	92245	92316	92316	92245	92316
N of firms	1495	1495	1495	1495	1495	1495
R^2	0.019	0.139	0.017	0.017	0.131	0.016

Table 1.9: Bank Credit and Firm Performance

This table reports estimation results of the impact of changes in bank credit on firms' stock returns. The reported results are for the second stage of the instrumental variable approach. Results for the first-stage are shown in Table 1.7. The IV dependent variable is a firm's total return. $\Delta log\, Bank\, Credit$ is the change in the logarithm of a firm's total borrowing from banks, measured by the number of outstanding loans. $\Delta log\, \widehat{Bank}\, Credit$ is the predicted value of $\Delta log\, Bank\, Credit$ computed in the first-stage. Banks' liquidity exposure is the instrument. The set of instruments also includes squared banks' liquidity exposure, its interaction with the crisis dummy (not reported in the estimation results in Table 1.7). Banks' total capital and banks' size are used as additional instruments in columns 2 and 4. The crisis period is from 2007 Q3 through 2009 Q4. See Table 1.1 for variables' definitions. All regressions include firm and time fixed effects. Standard errors in parentheses are clustered at the firm level. ***, ** and * have significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)
	Total Return			
	All Banks		Lead Banks	
Instrumented variables:				
$\Delta log\, \widehat{Bank}\, Credit$	-0.067*	-0.067*	-0.052	-0.047
	(0.039)	(0.040)	(0.036)	(0.036)
$\Delta log\, \widehat{Bank}\, Credit$* Crisis	0.271**	0.321**	0.201*	0.227**
	(0.138)	(0.136)	(0.109)	(0.105)
Firm Controls:				
$\text{Profitability}_{t-1}$	0.351***	0.352***	0.347***	0.348***
	(0.043)	(0.043)	(0.042)	(0.042)
$\text{Market-to-Book}_{t-1}$	-0.031***	-0.031***	-0.031***	-0.031***
	(0.002)	(0.002)	(0.002)	(0.002)
Z-score_{t-1}	-0.006**	-0.006**	-0.006***	-0.006***
	(0.002)	(0.003)	(0.002)	(0.002)
Cash_{t-1}	0.035***	0.035***	0.035***	0.035***
	(0.010)	(0.010)	(0.010)	(0.010)
Cash Flow_{t-1}	0.122***	0.124***	0.121***	0.122***
	(0.026)	(0.026)	(0.025)	(0.026)
Tangibility_{t-1}	0.005	0.006	0.005	0.005
	(0.011)	(0.012)	(0.011)	(0.011)
Leverage_{t-1}	0.030***	0.031***	0.029***	0.030***
	(0.006)	(0.006)	(0.006)	(0.006)
Size_{t-1}	-0.036***	-0.035***	-0.036***	-0.036***
	(0.002)	(0.002)	(0.002)	(0.002)
Firm & time FE	Yes	Yes	Yes	Yes
Additional instruments	No	Yes	No	Yes
N	92316	92316	92316	92316
N of firms	1495	1495	1495	1495
R^2	0.100	0.091	0.110	0.107
Weak identification test:				
Cragg–Donald Wald F	43.668	30.434	59.590	41.321
Stock–Yogo critical value at 5%	11.04	15.72	11.04	15.72
Overidentification test:				
Hansen J-test	0.719	3.542	1.099	3.816
p-value	0.698	0.472	0.577	0.431

Table 1.10: Bank Credit and Firm Performance: Time-Varying Industry Shocks

This table reports estimation results of the impact of changes in bank credit on firms' stock returns. The reported results are for the second stage of the instrumental variable approach, results for the first-stage are not reported. The IV dependent variable is a firm's total return. $\Delta log\, Bank\, Credit$ is the change in the logarithm of a firm's total borrowing from banks, measured by the number of outstanding loans. $\Delta log\, \widehat{Bank}\, Credit$ is the predicted value of $\Delta log\, Bank\, Credit$ computed in the first-stage. Banks' liquidity exposure is the instrument. The set of instruments also includes squared banks' liquidity exposure and its interaction with the crisis dummy. Banks' total capital and banks' size are used as additional instruments in columns 2 and 4. The crisis period is from 2007 Q3 through 2009 Q4. See Table 1.1 for variables' definitions. All regressions include firm and time fixed effects. Standard errors in parentheses are clustered at the firm level. ***, ** and * have significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)
	Total Return			
	All Banks		Lead Banks	
Instrumented variables:				
$\Delta log\, \widehat{Bank}\, Credit$	-0.009	-0.015	-0.010	-0.009
	(0.031)	(0.033)	(0.032)	(0.031)
$\Delta log\, \widehat{Bank}\, Credit$* Crisis	0.168*	0.206*	0.170*	0.168*
	(0.091)	(0.107)	(0.096)	(0.091)
Firm Controls:				
$\text{Profitability}_{t-1}$	0.412***	0.414***	0.412***	0.412***
	(0.041)	(0.042)	(0.041)	(0.041)
$\text{Market-to-Book}_{t-1}$	-0.032***	-0.032***	-0.032***	-0.032***
	(0.002)	(0.002)	(0.002)	(0.002)
Z-score_{t-1}	-0.008***	-0.008***	-0.008***	-0.008***
	(0.002)	(0.002)	(0.002)	(0.002)
Cash_{t-1}	0.040***	0.040***	0.040***	0.040***
	(0.009)	(0.009)	(0.009)	(0.009)
Cash Flow_{t-1}	0.114***	0.115***	0.114***	0.114***
	(0.025)	(0.026)	(0.025)	(0.025)
Tangibility_{t-1}	0.014	0.014	0.014	0.014
	(0.011)	(0.011)	(0.011)	(0.011)
Leverage_{t-1}	0.028***	0.029***	0.028***	0.028***
	(0.006)	(0.006)	(0.006)	(0.006)
Size_{t-1}	-0.032***	-0.032***	-0.032***	-0.032***
	(0.002)	(0.002)	(0.002)	(0.002)
Firm FE	Yes	Yes	Yes	Yes
Industry-time dummies	Yes	Yes	Yes	Yes
Additional instruments	No	Yes	No	Yes
N	92316	92316	92316	92316
N of firms	1495	1495	1495	1495
R^2	0.003	-0.002	0.003	0.003
Weak identification test:				
Cragg–Donald Wald F	58.84	40.93	73.26	50.54
Stock–Yogo critical value at 5%	11.04	15.72	11.04	15.72
Overidentification test:				
Hansen J-test	1.160	3.194	0.947	1.160
p-value	0.885	0.526	0.623	0.885

Table 1.11: Bank Credit, Firm Performance and Firm Financial Constraints

This table reports estimation results of the impact of changes in bank credit on firms' stock returns. It is the second-stage of the instrumental variable approach. The IV dependent variable is firm's total return. $\Delta log\, Bank\, Credit$ is the change in the logarithm of a firm's total borrowing from banks, measured by the number of outstanding loans. $\Delta log\, \widehat{Bank}\, Credit$ is the predicted value of $\Delta log\, Bank\, Credit$ computed in the first-stage. Bank liquidity exposure is the instrument. The set of instruments also includes squared banks' liquidity exposure and its interaction with the crisis dummy, banks' total capital and banks' size. The crisis period is from 2007 Q3 through 2009 Q4. Firm controls include profitability, market-to-book, Z-score, cash holdings, cash flow, tangible assets, leverage, and size. See Table 1.1 for variables definitions. All regressions include firm and time fixed effects. Standard errors in parentheses are clustered at the firm level. ***, ** and * have significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Total Return					
	Young	Old	Small	Large	No Bond Issue	Bond Issue
Panel A: All Banks						
Instrumented variables:						
$\Delta log\, \widehat{Bank}\, Credit$	-0.023	-0.093***	-0.029	-0.107	-0.055	0.016
	(0.064)	(0.030)	(0.037)	(0.086)	(0.041)	(0.068)
$\Delta log\, \widehat{Bank}\, Credit$*Crisis	0.275*	0.273*	0.192*	-0.247	0.277**	0.520
	(0.157)	(0.153)	(0.109)	(0.243)	(0.128)	(0.483)
N	45079	47237	70682	21634	77719	14597
N of firms	882	851	1264	400	1331	254
R^2	0.097	0.099	0.111	0.030	0.098	0.007
Weak identification test:						
Cragg–Donald Wald F	17.249	20.991	43.801	7.011	32.693	3.496
Stock–Yogo critical value at 5%	15.72	15.72	15.72	15.72	15.72	15.72
Overidentification test:						
Hansen J-test	3.760	1.541	4.617	0.753	4.466	1.434
p-value	0.439	0.819	0.329	0.945	0.347	0.838
Panel B: Lead Banks						
Instrumented variables:						
$\Delta log\, \widehat{Bank}\, Credit$	-0.016	-0.072**	-0.025	-0.080	-0.063	0.027
	(0.063)	(0.033)	(0.034)	(0.082)	(0.039)	(0.076)
$\Delta log\, \widehat{Bank}\, Credit$*Crisis	0.248	0.171*	0.157*	-0.456	0.238**	0.446
	(0.167)	(0.093)	(0.092)	(0.546)	(0.108)	(0.338)
N	45079	47237	70682	21634	77719	14597
N of firms	882	851	1264	400	1331	254
R^2	0.101	0.113	0.115	-0.052	0.104	0.034
Weak identification test:						
Cragg–Donald Wald F	20.785	32.209	53.586	3.242	38.412	6.759
Stock–Yogo critical value at 5%	15.72	15.72	15.72	15.72	15.72	15.72
Overidentification test:						
Hansen J-test	2.627	3.361	4.767	0.732	4.061	3.581
p-value	0.622	0.499	0.312	0.947	0.398	0.466

Table 1.12: Bank Credit, Firm Performance and External Financial Dependence

This table reports estimation results of the impact of changes in bank credit on firms' stock returns, separately for firms operating in industries with high (EFD = 1) and low (EFD = 0) external financial dependence. It is the second-stage of the instrumental variable approach. The IV dependent variable is a firm's total return. $\Delta log\, Bank\, Credit$ is the change in the logarithm of a firm's total borrowing from banks, measured by the number of outstanding loans. $\Delta log\, \widehat{Bank}\, Credit$ is the predicted value of $\Delta log\, Bank\, Credit$ computed in the first-stage. Bank liquidity exposure is the instrument. Banks' total capital and banks' size are used as additional instruments in columns 2 and 4. The crisis period is from 2007 Q3 through 2009 Q4. All regressions include firm controls: profitability, market-to-book, Z-score, cash holdings, cash flow, tangible assets, leverage, and size. See Table 1.1 for variables' definitions. All regressions include firm and time fixed effects. Standard errors in parentheses are clustered at the firm level. ***, ** and * have significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)
	Total Return			
	EFD = 1		EFD = 0	
Panel A: All Banks				
Instrumented variables:				
$\Delta log\, \widehat{Bank}\, Credit$	-0.106*	-0.110*	-0.037	-0.030
	(0.062)	(0.062)	(0.066)	(0.063)
$\Delta log\, \widehat{Bank}\, Credit$*Crisis	0.614**	0.601**	-0.053	0.080
	(0.278)	(0.262)	(0.194)	(0.173)
Additional instruments	No	Yes	No	Yes
N	53957	53957	34440	34440
N of firms	859	859	573	573
R^2	0.010	0.016	0.110	0.114
Weak identification test:				
Cragg–Donald Wald F	32.22	22.28	16.91	12.38
Stock–Yogo critical value at 5%	11.04	15.72	11.04	15.72
Overidentification test:				
Hansen J-test	0.196	0.735	2.681	8.007
p-value	0.907	0.947	0.262	0.091
Panel B: Lead Banks				
Instrumented variables:				
$\Delta log\, \widehat{Bank}\, Credit$	-0.055	-0.054	-0.045	-0.028
	(0.045)	(0.044)	(0.063)	(0.062)
$\Delta log\, \widehat{Bank}\, Credit$*Crisis	0.391**	0.363**	-0.045	0.051
	(0.166)	(0.152)	(0.176)	(0.164)
Additional instruments	No	Yes	No	Yes
N	53957	53957	34440	34440
N of firms	859	859	573	573
R^2	0.078	0.085	0.109	0.115
Weak identification test:				
Cragg–Donald Wald F	43.51	31.02	19.90	13.45
Stock–Yogo critical value at 5%	11.04	15.72	11.04	15.72
Overidentification test:				
Hansen J-test	0.195	0.689	2.527	10.061
p-value	0.907	0.953	0.283	0.039

Table 1.13: Bank Credit and Firm Performance: Financial Position

This table reports estimation results of the impact of changes in bank credit on firms' stock returns, separately for firms with low and high net short-term debt, debt-to-equity ratio and leverage. Firms with a low net short-term debt have net short-term debt below median for the pre-crisis period. Firms with a low debt-to-equity ratio (or leverage) have a debt-to-equity ratio (or leverage) below the mean for the pre-crisis period. The reported results are for the second stage of the instrumental variable approach, results for the first-stage are not reported. The IV dependent variable is a firm's total return. $\Delta log\, Bank\, Credit$ is the change in the logarithm of a firm's total borrowing from banks, measured by the number of outstanding loans. $\Delta log\, \widehat{Bank}\, Credit$ is the predicted value of $\Delta log\, Bank\, Credit$ computed in the first-stage. Banks' liquidity exposure is the instrument. The set of instruments also includes squared banks' liquidity exposure, its interaction with the crisis dummy, banks' total capital and banks' size. The crisis period is from 2007 Q3 through 2009 Q4. All regressions include firms controls: profitability, market-to-book, Z-score, cash holdings, cash flow, tangible assets, leverage, and size. See Table 1.1 for variables' definitions. All regressions include firm and time fixed effects. Standard errors in parentheses are clustered at the firm level. ***, ** and * have significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
			Total Return			
	Low Net short-term debt	High Net short-term debt	Low Debt/Equity	High Debt/Equity	Low Leverage	High Leverage
Panel A: All Banks						
Instrumented variables:						
$\Delta log\, \widehat{Bank}\, Credit$	0.026	-0.097**	0.023	-0.090	0.004	-0.115
	(0.045)	(0.045)	(0.032)	(0.063)	(0.034)	(0.079)
$\Delta log\, \widehat{Bank}\, Credit$*Crisis	0.080	0.349**	-0.020	0.528*	0.024	0.591*
	(0.157)	(0.178)	(0.070)	(0.316)	(0.076)	(0.348)
Additional instruments	Yes	Yes	Yes	Yes	Yes	Yes
N	40339	51951	31295	61020	38495	53821
N of firms	1106	1275	987	1238	1032	1150
R^2	0.109	0.088	0.106	0.049	0.114	0.037
Weak identification test:						
Cragg–Donald Wald F	32.14	20.44	44.96	6.67	41.35	5.22
Stock–Yogo critical value at 5%	15.72	15.72	15.72	15.72	15.72	15.72
Stock–Yogo critical value at 30%				4.78		4.78
Overidentification test:						
Hansen J-test	1.396	5.093	5.517	4.127	4.586	2.370
p-value	0.845	0.278	0.238	0.389	0.332	0.668
Panel B: Lead Banks						
Instrumented variables:						
$\Delta log\, \widehat{Bank}\, Credit$	0.009	-0.072**	0.043	-0.124***	0.010	-0.117**
	(0.046)	(0.033)	(0.028)	(0.042)	(0.027)	(0.054)
$\Delta log\, \widehat{Bank}\, Credit$*Crisis	0.138	0.237**	-0.051	0.632***	0.037	0.567**
	(0.149)	(0.115)	(0.065)	(0.244)	(0.064)	(0.278)
Additional instruments	Yes	Yes	Yes	Yes	Yes	Yes
N	40339	51951	31295	61020	38495	53821
N of firms	1106	1275	987	1238	1032	1150
R^2	0.106	0.109	0.104	0.016	0.113	0.044
Weak identification test:						
Cragg–Donald Wald F	35.09	14.68	48.02	9.30	43.93	6.88
Stock–Yogo critical value at 5%	15.72	15.72	15.72	15.72	15.72	15.72
Stock–Yogo critical value at 10%		9.48		9.48		9.48
Stock–Yogo critical value at 20%				6.08		6.08
Overidentification test:						
Hansen J-test	2.798	1.618	2.069	3.465	1.996	1.985
p-value	0.592	0.806	0.723	0.483	0.737	0.739

Table 1.14: Bank Credit and Firm Performance: Firm Quality before the Crisis

This table reports estimation results of the impact of changes in bank credit on firms' stock returns, excluding firms with low net worth. It is the second-stage of the instrumental variable approach. Firms with low net worth are in the bottom quartile of the quarterly pre-crisis net worth distribution. The IV dependent variable is a firm's total return. $\Delta log\, Bank\, Credit$ is the change in the logarithm of a firm's total borrowing from banks, measured by the number of outstanding loans. $\Delta log\, \widehat{Bank}\, Credit$ is the predicted value of $\Delta log\, Bank\, Credit$ computed in the first-stage. Bank liquidity exposure is the instrument. The set of instruments also includes squared banks' liquidity exposure and its interaction with the crisis dummy, banks' total capital and banks' size. The crisis period is from 2007 Q3 through 2009 Q4. See Table 1.1 for variables' definitions. All regressions include firm and time fixed effects. Standard errors in parentheses are clustered at the firm level. ***, ** and * have significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)
	Total Return	
	Excluding Firms with Low Net Worth	
	All Banks	Lead Banks
Instrumented variables:		
$\Delta log\, \widehat{Bank}\, Credit$	-0.056**	-0.048*
	(0.029)	(0.026)
$\Delta log\, \widehat{Bank}\, Credit$* Crisis	0.219*	0.158*
	(0.116)	(0.085)
Firm Controls:		
Profitability$_{t-1}$	0.354***	0.350***
	(0.056)	(0.058)
Market-to-Book$_{t-1}$	-0.034***	-0.034***
	(0.002)	(0.002)
Z-score$_{t-1}$	-0.010***	-0.009***
	(0.003)	(0.003)
Cash$_{t-1}$	0.039***	0.040***
	(0.012)	(0.012)
Cash Flow$_{t-1}$	0.153***	0.152***
	(0.044)	(0.044)
Tangibility$_{t-1}$	-0.005	-0.006
	(0.015)	(0.015)
Leverage$_{t-1}$	0.040***	0.038***
	(0.007)	(0.007)
Size$_{t-1}$	-0.040***	-0.040***
	(0.003)	(0.003)
N	63120	63120
N of firms	1271	1271
R^2	0.104	0.111
Weak identification test:		
Cragg–Donald Wald F	36.452	43.819
Stock–Yogo critical value at 5%	15.72	15.72
Overidentification test:		
Hansen J-test	3.935	3.865
p-value	0.415	0.425

Table 1.15: Bank Credit and Firm Performance: Selected Samples of Firms

This table reports estimation results of the impact of changes in bank credit on firms' stock returns, excluding firms with negative profitability and cash flow. It is the second-stage of the instrumental variable approach. The IV dependent variable is a firm's total return. $\Delta log\, Bank\, Credit$ is the change in the logarithm of a firm's total borrowing from banks, measured by the number of outstanding loans. $\Delta log\, \widehat{Bank}\, Credit$ is the predicted value of $\Delta log\, Bank\, Credit$ computed in the first-stage. Bank liquidity exposure is the instrument. The set of instruments also includes squared banks' liquidity exposure and its interaction with the crisis dummy. Banks' total capital and banks' size are used as additional instruments. The crisis period is from 2007 Q3 through 2009 Q4. All regressions include firm controls, and firm and time fixed effects. Firms controls: profitability, market-to-book, Z-score, cash holdings, cash flow, tangible assets, leverage, and size. See Table 1.1 for variables' definitions. Standard errors in parentheses are clustered at the firm level. ***, ** and * have significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Total Return					
	Excluding Firms with Negative Profitability		*Excluding Firms with Negative Cash Flow*		*Excluding Firms with Negative Profitability and Cash Flow*	
Panel A: All Banks						
Instrumented variables:						
$\Delta log\, \widehat{Bank}\, Credit$	-0.082**	-0.077*	-0.089**	-0.082**	-0.085**	-0.078**
	(0.040)	(0.041)	(0.038)	(0.038)	(0.038)	(0.038)
$\Delta log\, \widehat{Bank}\, Credit$* Crisis	0.324**	0.359**	0.347**	0.365***	0.351**	0.370**
	(0.150)	(0.150)	(0.136)	(0.134)	(0.145)	(0.145)
N	87780	87780	83668	83668	83002	83002
N of firms	1471	1471	1469	1469	1465	1465
R^2	0.090	0.083	0.083	0.079	0.082	0.078
Weak identification test:						
Cragg–Donald Wald F	36.827	26.078	45.509	31.254	40.969	28.165
Stock–Yogo critical value at 5%	11.04	15.72	11.04	15.72	11.04	15.72
Overidentification test:						
Hansen J-test	0.781	2.083	1.089	1.987	1.177	2.245
p-value	0.677	0.720	0.580	0.738	0.555	0.691
Panel B: Lead Banks						
Instrumented variables:						
$\Delta log\, \widehat{Bank}\, Credit$	-0.060*	-0.059*	-0.062*	-0.059*	-0.058*	-0.054
	(0.035)	(0.035)	(0.034)	(0.034)	(0.034)	(0.034)
$\Delta log\, \widehat{Bank}\, Credit$* Crisis	0.207*	0.239**	0.182*	0.208**	0.186*	0.212**
	(0.112)	(0.110)	(0.105)	(0.102)	(0.108)	(0.106)
N	87780	87780	83668	83668	83002	83002
N of firms	1471	1471	1469	1469	1465	1465
R^2	0.110	0.106	0.111	0.109	0.111	0.108
Weak identification test:						
Cragg–Donald Wald F	53.684	37.396	57.624	39.589	55.194	37.904
Stock–Yogo critical value at 5%	11.04	15.72	11.04	15.72	11.04	15.72
Overidentification test:						
Hansen J-test	1.419	2.667	2.412	3.958	2.506	4.071
p-value	0.492	0.615	0.299	0.412	0.286	0.396
Firm and time FE	Yes	Yes	Yes	Yes	Yes	Yes
Additional instruments	No	Yes	No	Yes	No	Yes

Table 1.16: Bank Credit and Firm Performance: Real Effects

This table reports estimation results of the impact of changes in bank credit on firms' sales growth. The reported results are for the second stage of the instrumental variable approach, results for the first-stage are not reported. The IV dependent variable is a firm's sales growth. $\Delta log\, Bank\, Credit$ is the change in the logarithm of a firm's total borrowing from banks, measured by the number of outstanding loans. $\Delta log\, \widehat{Bank\, Credit}$ is the predicted value of $\Delta log\, Bank\, Credit$ computed in the first-stage. Banks' liquidity exposure is the instrument. The set of instruments also includes squared banks' liquidity exposure, its interaction with the crisis dummy (not reported in the estimation results in Table 1.7). Banks' total capital and banks' size are used as additional instruments in columns 2 and 4. The crisis period is from 2007 Q3 through 2009 Q4. See Table 1.1 for variables' definitions. All regressions include firm and time fixed effects. Standard errors in parentheses are clustered at the firm level. ***, ** and * have significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)
	Δlog Sales			
Instrumented variables:				
$\Delta log\, \widehat{Bank\, Credit}$	-0.109	-0.130	-0.140	-0.154*
	(0.102)	(0.102)	(0.092)	(0.092)
$\Delta log\, \widehat{Bank\, Credit}$* Crisis	0.576*	0.552*	0.510*	0.485*
	(0.309)	(0.296)	(0.281)	(0.268)
Firm Controls:				
$\text{Profitability}_{t-1}$	-4.994***	-4.990***	-5.050***	-5.048***
	(0.304)	(0.304)	(0.301)	(0.300)
Cash_{t-1}	-0.068**	-0.068**	-0.025	-0.025
	(0.032)	(0.032)	(0.029)	(0.028)
Cash Flow_{t-1}	0.423***	0.421***	0.401***	0.400***
	(0.100)	(0.101)	(0.090)	(0.090)
Tangibility_{t-1}	-0.096**	-0.096**	-0.053	-0.052
	(0.040)	(0.040)	(0.039)	(0.039)
Leverage_{t-1}	-0.019	-0.021	-0.026	-0.027
	(0.020)	(0.020)	(0.019)	(0.019)
Size_{t-1}	-0.056***	-0.056***	-0.050***	-0.050***
	(0.007)	(0.007)	(0.007)	(0.007)
Firm FE	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	No	No
Industry-time dummies	No	No	Yes	Yes
Additional instruments	No	Yes	No	Yes
N	41246	41246	41246	41246
N of firms	1681	1681	1681	1681
R^2	0.128	0.131	0.106	0.107
Weak identification test:				
Cragg–Donald Wald F	28.41	19.34	29.75	20.52
Stock–Yogo critical value at 5%	11.04	15.72	11.04	15.72
Overidentification test:				
Hansen J-test	3.369	4.839	2.163	3.040
p-value	0.186	0.304	0.339	0.551

Chapter 2

Basel III Requirements and Bank Profitability

Basel III Requirements and Bank Profitability

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Abstract

This chapter examines whether and how new liquidity risk measures introduced in the Basel III Accord affect bank profitability. In contrast to previous empirical studies, I analyze how the combination of capital and liquidity ratios affects bank profitability. I conduct a comprehensive analysis to calculate the Basel III liquidity risk measures: the liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR), using historical data for U.S. bank holding companies over 2001-2013. This is the first study that employs the GMM estimator technique to examine the impact of Basel III liquidity risk measures on bank profitability in the U.S. The estimates show that increased Basel III liquidity ratios decrease the profitability of small banks. The LCR adversely impacts profitability at large banks, while the NSFR has a significant positive impact on large banks' ROA and ROE. My findings also show that banks that maintain low liquidity ratios are more profitable, and that departures of liquidity ratios from a regulatory level of 1 adversely impact bank profitability. In these cases, the LCR affects profitability of large banks only, while the NSFR affects only small banks. Both liquidity risk measures and capital ratios are important determinants of bank profitability at large and small banks. Moreover, my findings show that the two liquidity risk measures affect bank profitability both pre- and post-crisis. Overall, the results show that in general there is a tradeoff between bank profitability and stability of the banking system. The findings of this study have implications for bank regulators.

Key words: Bank profitability, bank regulatory capital, liquidity coverage ratio, net stable funding ratio, liquidity risk, bank regulation, Basel III

JEL Classification: G21, G28

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2.1 Introduction

Severe liquidity shortages faced by banks in many countries during the financial crisis of 2007-2009 revealed problems in banks' funding and liquidity management. To address these problems and to strengthen the stability of the banking sector, the Basel Committee on Banking Supervision (BCBS) introduced a new Basel III international framework that, in addition to enhanced capital requirements, also includes two standards for liquidity risk management (BCBS, 2010). These new liquidity standards are aimed at more comprehensively addressing maturity mismatches of bank assets and liabilities, in both the short and long-term. The first liquidity standard is the liquidity coverage ratio (LCR), which identifies the amount of high-quality liquid assets a bank must hold to be able to offset the net cash outflows under a significant short-term stress scenario specified by regulators. The second liquidity standard is the net stable funding ratio (NSFR) which establishes a minimum amount of stable funding, based on the liquidity of bank's assets and off-balance sheet activities, that will be available over a one year period. It is designed to encourage banks to use longer-term, stable funding of their assets, thereby reducing transformation risk. Together these two liquidity standards are aimed at increasing liquidity buffers and the use of stable funding at banks.

New liquidity standards and enhanced capital requirements are intended to significantly affect banks' behavior. Their implementation is aimed at promoting higher liquidity and capital buffers at banks, and reducing bank funding risks. New liquidity rules require banks to hold more high-quality liquid assets in both the short and long-term. In addition the NSFR requires banks to increase the amount of their stable long-term funding, thereby limiting maturity transformation at banks. While all these measures should increase banks' resistance to stressful periods, they will also negatively affect banks' profitability, as the net interest income will likely decline. With these new liquidity requirements banks will hold fewer illiquid loans, which translates into lower interest income. However, the interest expense will increase, as banks are required to finance their assets with more expensive, longer-term debt. The resulting decline in the net interest income at banks creates a trade-off between liquidity regulation and bank profitability.

In this study, I examine how the profitability of U.S. banks is affected by the Basel III liquidity and capital requirements. Focusing on a large sample of U.S. bank holding companies over 2001-2013, I investigate the following questions: (a) do higher liquidity ratios decrease bank profitability? (b) Do both liquidity and capital ratios significantly affect bank profitability? (c) Is the relationship between liquidity and capital ratios, and bank profitability different for large and small banks?

This work extends the existing literature in several ways. It is the first study that analyzes the impact of both the LCR and NSFR on the performance of U.S. bank holding companies[3]. Moreover, the analysis covers a large sample of banks rather than considering several very big

[3]Dietrich et al. (2014) examine the impact of the NSFR on bank performance in Western Europe, but they do not conduct the analysis for the LCR. Khan et al. (2016) analyze how the LCR and NSFR influence financial performance and funding costs of U.S. commercial banks, but they do not study the simultaneous effect of LCR and NSFR on bank performance.

banks, as in the study by Otker-Robe and Pazarbasioglu (2010), or a set of 15 "representative" banks from 15 countries as in King (2013). In contrast to previous empirical studies, I analyze how the combination of capital and liquidity ratios affects bank profitability. I conduct a comprehensive analysis to calculate the Basel III liquidity measures: the liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR), using historical data for U.S. bank holding companies over the period of 2001-2013. This allows me to some extent to check the effectiveness of the Basel III liquidity and capital standards before their actual implementation and to contribute to the debate on the ongoing global banking reform process.[4]

It is logical to expect that new liquidity standards will have a significant effect on banks, as they should force them to search for alternative funding sources and alter their traditional business models. I find that estimation results from a dynamic panel data model do indeed document that two liquidity standards have a significant adverse effect on the profitability of small banks, and the LCR adversely impacts the profitability of large banks. This is consistent with the conclusion of existing literature that higher liquidity standards reduce the financial performance of banks (King, 2013; Khan et al., 2016). Perhaps surprisingly, my findings also show that an increased NSFR positively impacts profitability at large banks. My results indicate that there are differences in small and large bank liquidity management: small banks maintain higher NSFRs and by increasing NSFRs they reduce their profitability, while large banks maintain lower NSFRs and can gain higher profitability by increasing their funding stability. The estimation results are confirmed by a set of regressions including separately or together two liquidity risk measures, and using different measures of banks capital. Overall, I find that both Basel III liquidity risk measures and capital ratios are significant determinants of profitability at large and small banks. However, the effect of bank capital on return on equity is limited to total capital ratio at small banks only.

I continue the analysis by examining how having liquidity ratios below the regulatory standard of 1 impacts bank profitability. In general, my results state that banks maintaining low liquidity ratios are more profitable. But in particular, the results indicate that a LCR below 1 has a positive impact only on large banks, while a NSFR below 1 positively impacts only small banks. Similarly, I show that departures of liquidity ratios from a regulatory level of 1 adversely impact bank profitability. Once again, the changes in the LCR have a significant impact on the profitability of large banks, while changes in the NSFR have a significant impact on small banks' profitability. The results for the impact of the LCR on large banks are consistent with recommendations of regulators to impose LCR regulations only on large banks (Federal Reserve Bank Press Release, October 24, 2013).

Further, I show that my baseline results hold both if I separate the effect of new liquidity rules on banks' profitability before the financial crisis of 2007 - 2009 and after it. The results show that two liquidity standards are important determinants of bank profitability both pre- and post-crisis. Higher LCRs decrease bank profitability before and after the crisis (except for small banks' ROE).

[4] Although this historical analysis is useful, it provides a limited insight into what would have happened if new liquidity risk standards had been in place, because when regulatory environments change, banks may adopt new business strategies inconsistent with their past behavior (Lucas, 1976).

Higher NSFRs increase profitability at large banks before the crisis, while the NSFR adversely affects small banks' pre-crisis profitability and has a significant positive effect on small banks' post-crisis ROA and ROE, due to changing behavior of small banks' NSFRs and the earnings dynamics after the crisis. Taking all this together, the results of this study indicate that in general the implementation of binding liquidity standards will be likely done at the cost of a profitability drop at banks.

2.2 Background on Basel III Capital and Liquidity Requirements

After the financial crisis of 2007-2009 the Basel Committee on Banking Supervision (BCBS) proposed enhanced capital requirements and introduced new liquidity standards to promote stability and soundness of the banking sector. Under the Basel III framework banks are required to have higher capital buffers composed of higher-quality capital than under the previous Basel II regulations. While the methodology for calculation of the risk-weighted assets was mostly left unchanged, new requirements include countercyclical capital measures, a non-risk-weighted leverage ratio and two measures for liquidity risk management (BCBS, 2010).

The two newly introduced measures for liquidity risk management are the liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR). The LCR measures banks' ability to withstand significant liquidity stress during one month. It is calculated as the ratio of high-quality liquid assets to total net cash outflow over the next month. The NSFR measures banks' ability to fund their assets with stable sources of funding under an extended stress period. It is calculated as a ratio of the available stable funding to the required stable funding. The LCR focuses on banks' short-term asset liquidity while the NSFR reflects banks' funding liquidity risk. Both ratios are required to be above 100% which, in turn, increases banks' liquidity buffers and promotes the stability of their funding structures (BCBS, 2013, 2014).

Calculating the LCR

The LCR measures a bank's ability to meet its short-term obligations. It is calculated as high-quality liquid assets divided by the total net cash outflow over the next 30 days. Table A.1 in the Appendix summarizes banks' liquid assets, cash outflows and inflows used to calculate the LCR, together with weights applied. However, there is a gap between historical data available in FR Y-9C forms and information required for calculating the LCR under Basel III. To make an approximate calculation of the LCR, I have to impose several assumptions. These assumptions were previously used in Hong et al. (2014)[5].

Banks can maintain different levels of LCR, depending on the composition of their deposit and loan portfolios, and the amount of liquid assets. Banks are permitted to hold a certain portion of their deposits in the form of cash and highly liquid assets as the liquidity reserve with the central

[5]See Table A.2 in the Appendix for the major assumptions used for calculation of the LCR.

bank. As investing in liquid securities is less profitable than investing in illiquid loans, banks typically maintain excess reserves and their liquid assets at the minimum level. For certain banks funding loans with inexpensive, although less stable, wholesale deposits is more preferable than issuing stable core deposits, because they cannot attract new depositors or want to economize on payment services and maturity premiums that accompany the issuance of core deposits.

Calculating the NSFR

The NSFR is calculated as the available amount of stable funding (ASF) divided by the required amount of stable funding (RSF). The ASF is the weighted sum of the bank's liabilities and capital with more weight given to more stable funding sources that are more likely to be available during an extended liquidity shortfall, such as equity, subordinated debt and longer-term liabilities, followed by core deposits. The RSF is the weighted sum of the bank's assets with more weight given to less liquid, more volatile and longer-term assets. It includes trading assets, corporate and retail loans, followed by government debt. Cash, interbank loans and short-term marketable assets have 0% weight. The weights in the ASF and RSF range from 0% to 100%. To achieve the required NSFR of 100% or higher, banks must have an ASF greater than or equal to the RSF. Table A.3 in the Appendix summarizes banks' assets, liabilities and capital together with applied weights, as defined in the BCBS guidelines (BCBS, 2010, 2014).

Banks have incentives to operate with a low NSFR. On the one hand, they tend to invest more into illiquid loans than in liquid securities because of the higher returns on loans. On the other hand, funding loans with repurchase agreements, interbank loans, wholesale deposits and commercial paper, instead of relatively more expensive core deposits has become very popular among banks in recent years. Therefore, banks with lower reliance on core deposit financing and larger loan portfolios will tend to have lower NSFRs. However, driving NSFR too low exposes a bank not just to liquidity risk but also to interest rate risk and even to some extent to credit risk. The interest rate risk arises because of the maturity mismatch between long-term loans financed with short-term wholesale funds. Credit risk may arise if a bank reaches a low level of NSFR by granting loans to relatively low-quality borrowers. Therefore, a well-managed bank also will be hesitant to drive its NSFR too low.

2.3 Literature Review

Analysis of liquidity risks in the banking sector has a long history. However, the financial crisis of the 2007-2009 has revealed a not easily observed side of liquidity risks in bank funding structures. Banks, as the liquidity providers for the economy, have traditionally funded long-term loans with relatively short-term deposits (Kashyap et al., 2002). Banks create liquidity by investing into illiquid loans which are financed with liquid deposits (Diamond and Dybvig, 1983). This structure of bank capital is fragile because it exposes banks to sudden episodes of deposit outflows. Diamond and Rajan (2001) argue, however, that this fragility also serves as a commitment tool for banks to monitor loans.

Due to developments in the banking sector and financial markets, in modern banking liquidity risk arises from the loss of short-term wholesale funding rather than massive withdrawal of demand deposits (Strahan, 2010; Cornett et al., 2011). It is hard for banks to hedge against distortion in the market for wholesale funds or a drop in aggregate market liquidity. Therefore, bank regulators, with the introduction of the Basel III Accord, made an effort to make banks hold significant liquidity and capital buffers to withstand sudden funding crises.

The literature on the effects of the recently introduced Basel III liquidity standards is relatively scarce compared to that studying implications of bank capital requirements.[6] Several empirical studies make attempts to approximately calculate the NSFR (Yan et al., 2012; King, 2013; Dietrich et al., 2014; DeYoung and Jang, 2016; Khan et al., 2016; Roulet, 2017). Yan et al. (2012) provide a cost-benefit analysis for the UK banking industry when banks meet liquidity and capital requirements. DeYoung and Jang (2016) show that U.S. banks of all sizes are involved in active liquidity management. King (2013) and Dietrich et al. (2014) examine how the NSFR affects bank net interest margins and bank performance in the broad sense. King (2013) shows that even the most cost efficient bank strategies to meet 100% NSFR will potentially reduce bank interest margins while Dietrich et al. (2014) do not find any significant effect of the NSFR on bank profitability. These conflicting results highlight the need for further investigation. Moreover, all these studies examine the effects of the NSFR and do not consider the simultaneous effects of the LCR.

Empirical studies by Hong et al. (2014) and Chiaramonte and Casu (2017) calculate both of the liquidity ratios and analyze their impact on bank failures. The only study that examines the impact of both liquidity standards for U.S. banks is by Khan et al. (2016). The authors use a 3SLS simultaneous regression framework to analyze how new liquidity standards impact financial performance and funding costs of U.S. commercial banks. Their results show that higher asset liquidity and funding stability decrease banks' performance and increase banks' funding costs. However, they study only the separate effect of the LCR or NSFR on bank performance and do not examine how these two liquidity risk measures simultaneously impact bank performance. Moreover, their results should be interpreted with caution, as the investigation is done on the bank subsidiary level. Many U.S. commercial banks are owned by the same bank holding company (BHC), enabling them to share liquidity and capital with the parent BHC[7]. IIt has been considered in the literature that the analysis should be done on the highest level of banking organization, because liquidity and capital decisions are made by the bank's senior management. (Cornett et al., 2011; Beatty and Gron, 2001; DeYoung and Jang, 2016). In this study, I examine the effects of the LCR and NSFR on bank profitability using data for U.S. bank holding companies, both separately and taken together.

This study also adds to the larger strand of empirical literature on the determinants of bank performance (Bourke, 1989; Molyneux and Thornton, 1992; Demirgüç-Kunt and Huizinga, 1999;

[6] Santos (2001) and VanHoose (2007) present an insightful overview of theoretical literature on capital regulations.
[7] Houston et al. (1997) show that BHCs act as internal capital market for subsidiary banks.

Barth et al., 2003; Demirgüç-Kunt et al., 2003; Pasiouras and Kosmidou, 2007; Athanasoglou et al., 2008; Naceur and Kandil, 2009; Chen et al., 2018). Chen et al. (2018) analyze the impact of bank liquidity risk on performance and show that it endogenously determines bank performance. Other studies use liquidity ratios to measure bank liquidity and consider it as an exogenous determinant of bank performance. They provide mixed evidence of the effect of bank liquidity on performance: Molyneux and Thornton (1992) and Barth et al. (2003) document a positive effect, while Bourke (1989), Demirgüç-Kunt and Huizinga (1999) and Chen et al. (2018) document a negative effect.

2.4 Methodology

2.4.1 Variables Selection

2.4.1.1 Bank Profitability

In this study I use return on assets and return on equity to evaluate bank profitability. The ROA shows how effectively banks' management uses banks' assets to generate profits. The ROE indicates how effectively banks' management uses shareholders' money to generate profits. It shows to shareholders how profitable their investment is. The ROA and the ROE are considered comprehensive measures of bank profitability because they take into account a bank's operational efficiency and provisions for loan losses.

2.4.1.2 Determinants of Bank Profitability

I use bank-specific and macroeconomic factors that determine bank profitability. Bank-specific determinants include bank capital, bank size, loan loss provisions to loans ratio, overhead costs and non-interest income share.

The bank capital ratio shows to which extent creditors are covered in case of loss or liquidation. Banks with lower capital ratios are considered relatively more risky compared to those with higher capital ratios. Therefore, according to the conventional risk-return hypothesis riskier banks should be more profitable, so there is a negative relationship between bank capital and profitability. But at the same time, riskier banks have low creditworthiness and as a result incur high financing costs. Besides paying higher rates, riskier banks may need more external financing than safer banks because they hold less capital. Therefore, riskier banks may be less profitable, so there is a positive relationship between bank capital and profitability. Demirguc-Kunt and Huizinga (1999), Goddard et al. (2004) and Pasiouras and Kosmidou (2007) document a positive relationship between bank capital and performance.

Bank size is considered an important determinant of bank profitability, but its effect is rather ambiguous. On the one hand, larger banks can have access to more diversified investment opportunities and can reduce operating and funding costs by achieving economies of scale. Therefore, larger banks can generate higher profits. But on the other hand, if a bank becomes too large, it can suffer from diseconomies of scale by having problems with coordination and management.

Goddard et al. (2004) and García-Herrero and Vázquez (2007) document significant economies of scale for large banks while Pasiouras and Kosmidou (2007) document a negative relationship between bank size and profitability. I proxy bank size by the natural logarithm of total assets, which is widely used in the recent literature for measuring bank size (Dietrich et al., 2014; DeYoung and Jang, 2016; Hong et al., 2014).

Loan loss provisions over total loans is used as a proxy for bank credit risk. This ratio measures the quality of a banks' loan portfolio and is an expense that banks set aside to cover potential loan losses. Higher numbers indicate a lower loan quality, higher associated costs and therefore lower profitability. Thus, I expect a negative relationship between loan loss provisions over total loans and bank profitability.

Overhead costs measure a bank's operating expenses relative to its total assets. These are an important determinant of profitability, inversely related to bank profits, because by lowering operational expenses bank management can generate higher profits. The non-interest income share measures the share of banks' income derived from collecting fees and trading operations in the total income. Banks with a higher non-interest share are often more profitable, because profit margins in non-interest operations are often higher than in traditional banking activities (Dietrich and Wanzenried, 2011). Therefore, I expect that overhead costs will negatively affect banks' profits while the non-interest share will have a positive effect on profits.

Finally the macroeconomic environment is likely to affect bank profitability. I use the growth rate of real GDP as an external macroeconomic determinant of profitability that measures economic growth within a country. Bourke (1989), Molyneux and Thornton (1992), Demirgüç-Kunt and Huizinga (1999), Pasiouras and Kosmidou (2007) and Athanasoglou et al. (2008) show that economic growth positively impacts banks' performance. Economic slowdown usually decreases demand for bank credit, while the credit risk rises due to increased uncertainty. Banks generate lower profits during turbulent times as asset quality deteriorates and they incur higher losses.

2.4.2 Model Specification

To examine the implications of new liquidity measures on bank profitability, I use an empirical specification similar to Athanasoglou et al. (2008), Garcia-Herrero et al. (2009), and Dietrich et al. (2014), who analyze bank performance in the context of the dynamic linear model:

$$PROF_{it} = c + \alpha PROF_{i,t-1} + \beta LIQ_{it} + \gamma CAP_{it} + \sum_{j=1}^{J} \theta_j X_{it}^{j} + \sum_{m=1}^{M} \theta_m X_{it}^{m} + v_i + u_{it}, \tag{2.1}$$

with $|\alpha| < 1$.

$PROF_{it}$ is the profitability of bank i at time t. I focus on bank profitability, measured by return on assets (ROA) and return on equity (ROE). LIQ_{it} is bank liquidity, proxied by two new liquidity measures under the Basel III regulatory framework: the LCR and the NSFR. CAP_{it} is bank capital, proxied by equity capital to total assets (CAR), equity capital to risk-weighted assets (RB CAP) and the total risk-based capital ratio (TCR). X_{it}^{j} are observable bank-specific characteristics such as bank size (SIZE), quality of loan portfolio (LLOSS), the overhead costs (OVC), and non-interest share as a proxy for the bank business model (NINT). X_{it}^{m} are macroeconomic characteristics. v_i are unobservable bank-specific effects and u_{it} is the idiosyncratic error. $v_i \sim IIN(0, \sigma_v^2)$ is independent of $u_i \sim IIN(0, \sigma_u^2)$.

I expect that bank profits will show a relative persistence due to existing market competition, informational opacity and high sensitivity to macroeconomic fluctuations (Berger et al., 2000). To address this issue, I employ a dynamic model by adding a lagged dependent variable to the list of regressors. $PROF_{i,t-1}$ is a one-period lagged bank profitability and α is the speed of adjustment to the equilibrium level. A value of α close to 0 implies that bank profitability has a high speed of adjustment, while a value close to 1 implies that the adjustment is very slow. Values between 0 and 1 mean that bank profitability persists, but will converge to its normal (equilibrium) level.

I include bank fixed effects, because bank profitability might be influenced by individual banks' characteristics such as available lending opportunities, clients' base and managerial skills. Bank fixed effects absorb all time invariant bank heterogeneity. Given the sample period is relatively short, I assume that banks haven't much changed their client base and managerial skills, and therefore I assume that banks' heterogeneity is fixed over time.

The presence of fixed effects in the model makes the lagged dependent variable endogenous, thereby making OLS estimates biased and inconsistent (Baltagi, 2008). I follow the works of Athanasoglou et al. (2008), Garcia-Herrero et al. (2009), and Dietrich et al. (2014), who use a dynamic panel data technique to control for bank-specific heterogeneity. I employ the Generalized Method of Moments (GMM) method introduced by Arellano and Bond (1991), and extended by Arellano and Bover (1995), Blundell and Bond (1998), and Blundell, Bond, and Windmeijer (2000), also known as the Blundell-Bond system GMM estimator.[8] This estimator produces efficient and consistent estimates as long as the model doesn't have $n+1$ order serial correlation and we use valid instruments. Another challenge for the estimation of bank profitability is the potential endogeneity of the bank's observable characteristics. The Blundell-Bond procedure accounts for the endogeneity of the lagged dependent variable, as well as other regressors by using deeper lags of endogenous variables as instruments in levels and in differences.

The GMM procedure requires application of only exogenous instruments. This condition can be verified by testing for the presence of autocorrelation in first - differenced residuals, where we expect to find the first - order autocorrelation[9]. The presence of higher-order autocorrelation in first-differenced residuals indicates that some lags of the variable, which are used as instruments,

[8]The Arellano-Bond procedure estimates the equation in first differences, thereby removing all unobserved time invariant individual-level effects. However, the differenced lagged dependent variable is still correlated with lagged error in the differenced error term. To account for endogeneity of the lagged dependent variable, the Arellano-Bond difference GMM estimator uses available lags of a dependent variable in levels as instruments for the first-differenced equation. Blundell and Bond (1998) show that the instruments in the Arellano-Bond estimator become weak if the autoregressive parameters are too large. Blundell and Bond (1998), building on the work of Arellano and Bond (1991) and Arellano and Bover (1995), proposed a modified GMM estimator. The Blundell-Bond procedure estimates the system of two equations: the equation in first differences and the equation in levels using lagged variables as instruments for the equation in first differences and lagged first differences of the variables for the equation in levels.

[9]The first-order autocorrelation is expected because test is done on differenced residuals which in period t and t-1 share the same term.

are endogenous. Therefore, if autocorrelation of order n is detected, only deeper lags (e.g., $n+1$) of the variable can be used as instruments (Roodman, 2009). The validity of instruments as a group and correctness of model specification are checked by the Hansen J-test of overidentifying restrictions. I employ the two-step GMM estimator instead of the one-step, due to the two-step estimator's higher efficiency. However, the two-step procedure might produce downward biased standard errors. To correct for that I use the finite-sample "Windmeijer correction" for the two-step covariance matrix (Windmeijer, 2005; Baltagi, 2008).

2.5 Data

I use financial data for U.S. bank holding companies (BHCs) from 2001 Q1 to 2013 Q4. Balance sheet and income statement data is taken from the Federal Reserve FR Y-9C Consolidated Financial Statements for bank holding companies. Many U.S. commercial banks are owned by the same bank holding company. I use data for BHCs because liquidity and capital management is performed at the parent company level.[10] The parent company can inject liquidity and capital into its subsidiary banks, as well as transfer it among its subsidiaries. I remove bank-quarter observations with missing data for bank total assets and capital. To ensure that the results are not driven by outliers I exclude banks in quarters when they had total assets in the 1st and 99th percentiles of the asset size distribution. Moreover, I winsorize all variables except macroeconomic factors at 1% in the 1st and 99th percentiles of the distribution which has become a common practice in the literature.[11] I separate banks into two size categories depending on the amount of their total assets at the beginning of the quarter: large banks have total assets in the top decile of the quarterly total assets distribution and small banks have total assets in the 90th percentile of the quarterly total assets distribution.

Table 2.2 reports bank descriptive statistics for large and small banks. Large banks have, on average, return on assets (ROA) of 0.23% and return on equity (ROE) of 2.34%. Large banks' capital ratios vary from 9.8 percent for the equity capital ratio, to 14.15 percent for the risk-based capital ratio, and 13.7 percent for the total capital ratio. On average, large banks maintain a net stable funding ratio (NSFR) of 98.5%. The minimum value of the NSFR is 55.7% and the maximum is 165.5%. Almost 75% of bank-quarter observations have a NSFR below 100%, thereby not complying with new Basel III liquidity rules. While large banks have, on average, a 206% liquidity coverage ratio (LCR), only less than 50% of bank-quarter observations have a LCR below the 100% threshold.

Small banks have, on average, return on assets (ROA) of 0.2% and return on equity (ROE) of 2.2%. Small banks' capital ratios vary from 9 percent for the equity capital ratio to 14.61 percent for the total capital ratio, and 13.2 percent for the risk-based capital ratio. On average,

[10] Beatty and Gron (2001) and DeYoung and Jang (2016) also perform their analysis at the BHC level to examine bank capital and liquidity decisions respectively.

[11] This correction for outliers is done in the empirical works of Cornett et al. (2011), Chiaramonte and Casu (2017) and DeYoung and Jang (2016) to name a few.

small banks maintain a net stable funding ratio (NSFR) of 104.6%. The minimum value of the NSFR is 55.9% and the maximum is 165.5%. Almost 50% of bank-quarter observations have a NSFR below 100%, thereby not complying with new Basel III liquidity rules. While small banks have, on average, a 338.3% liquidity coverage ratio (LCR), only fewer than 25% of bank-quarter observations have a LCR below the 100% threshold.

When comparing large and small banks, large banks have, on average, higher ROA, ROE, equity and risk-based capital ratios. This is because large banks have higher net income and lower risk-weighted assets. However, large banks maintain lower total capital ratios and liquidity risk measures (LCR and NSFR). This shows that large banks are more exposed to liquidity risk than small banks, but at the same time large banks have more resources to absorb liquidity risk.

Table 2.3 tests whether banks with a LCR below 100% are systematically different when looking at average bank characteristics. It shows that banks with a LCR below 100% perform better in terms of ROA and ROE (only ROA in the case of large banks) compared to banks with a LCR above 100%. Low LCR banks are larger in size, have a higher share of non-interest income in total income (NINT), and maintain lower capital ratios (except for the equity capital of large banks) and NSFR. Moreover, banks with a low LCR have higher loan loss provisions relative to total loans (LLOSS) and overhead costs (only in the case of large banks).

Table 2.4 shows t-tests applied for differences in means for banks with a NSFR below and above 100%. Low NSFR banks are less profitable in terms of ROA and ROE (only ROA in case of large banks). These banks are larger in size, have a higher share of non-interest income in total income (NINT), and maintain lower capital ratios and LCR. Moreover, banks with a low NSFR have higher loan loss provisions relative to total loans (LLOSS) and overhead costs (only higher LLOSS in case of large banks).

Figs. 2.1 and 2.2 show the average LCR and NSFR values for different bank size categories over time. These figures show that large banks maintain lower values of LCR and NSFR. If we look at Fig. 2.1, there is not much variation in the LCR of large banks during the sample period with a slight increase in 2002-2003 and a slight decline from mid 2011. The time dynamics of the LCR of small banks is more pronounced. There was a substantial decline in the LCRs of small banks preceding the financial crisis of 2007-2009, followed by a gradual increase from the third quarter of 2008. Fig. 2.2 shows that there was a decline in the NSFRs of large and small banks preceding the crisis; during the crisis the liquidity ratio stayed low and they started to grow from 2009. While large banks maintain lower NSFRs than small banks, the gap has shrunk in recent years.

The average values of LCR and NSFR for large and small banks during sub-periods of pre-crisis, crisis and post-crisis, reported in Table 2.5, also document the above mentioned dynamics in LCR and NSFR of large and small banks; namely that the LCR of large banks declined during the crisis and decreased even further during the post-crisis period, while the NSFR increased during the crisis and post-crisis periods. Large banks were building up their stable funding sources during the crisis and after it. The LCR and NSFR of small banks decreased during the crisis and slowly increased in the post-crisis period.

Table 2.6 shows the correlations for all variables used in the empirical analysis. The correlation coefficients generally indicate that there is no multicollinearity between our explanatory variables.

2.6 Results

I divide the estimation analysis into several steps. In the first step, I use continuous variables of LCR and NSFR in regressions, thereby testing the hypothesis whether banks with lower or higher LCR (NSFR) are more profitable. In the second step, I use indicator variables of LCR and NSFR, indicating whether banks maintain a LCR (NSFR) below the 100% requirement. Therefore, in the second step, I test the hypothesis whether banks with LCR (NSFR) below 100% are more profitable. Third, I use changes in LCR and NSFR from the minimum liquidity level of 1 set by regulators, thereby testing the hypothesis whether banks that have a lower or higher change of LCR (NSFR) from the regulatory target of 1 are more profitable.

I measure bank profitability by the return on assets (ROA) and the return on equity (ROE), and I use three different proxies for bank capital: equity capital to total assets (CAR), equity capital to risk-weighted assets (RB CAP), and the total risk-based capital ratio (TCR). The estimation results are presented separately for large and small banks. Specifications (1) – (6) use a single liquidity risk measure, while specifications (7) – (9) add together two liquidity risk measures to the model. The model in equation (2.1) is a dynamic panel data model, which is estimated using the two-step Blundell-Bond (1998) system GMM technique. The Hansen J-test indicates that, in most cases, I cannot reject the null hypothesis of correct model specification and valid overidentifying restrictions. In all models I have consistent estimates as the Arellano-Bond test shows that I do not have second-order correlation in residuals.[12] Lagged measures of bank profitability (ROA and ROE) are all highly significant, have the expected positive signs and lie within a unit interval. This shows that bank profitability is persistent thereby advocating the use of a dynamic panel data model.

2.6.1 The Baseline Model

In the baseline model I examine whether and how new liquidity rules affect bank profitability, using continuous variables of the LCR and NSFR in regressions. The estimation results for the ROA are presented separately for large and small banks in Tables 2.7 and 2.8. Tables 2.9 and 2.10 show estimation results for the ROE of large and small banks. The estimation results shows that there is negative and significant correlation between bank profitability and the LCR, indicating that low

[12] Although I have first-order autocorrelation, this is expected because the test is performed on differenced residuals, which in period t and t-1 share the same term. The test for AR(2) in first-differences is more important because it checks for the presence of AR(1) in levels. Finding AR(2) indicates that the instruments we use are endogenous, which leads to inconsistent estimates.

LCR banks have higher ROA and ROE. A higher LCR is aimed at increasing banks' liquidity buffers, thereby increasing short-term investments at banks. By investing short-term banks obtain less interest income, which leads to lower profitability. The estimation results for ROA hold both for large and small banks, while the results for ROE hold only for large banks. The effect of the LCR on small banks' ROE is not significant.

The NSFR aims to encourage banks to use a longer-term stable funding, thereby reducing the maturity mismatch of assets and liabilities at banks. As borrowing long-term is more expensive, we would expect a NSFR to negatively affect banks' profitability. My estimation results in Tables 2.8 and 2.10 document that the NSFR has a statistically significant adverse impact on the ROA and ROE of small banks. Tables 2.8 and 2.10 report estimation results using three different proxies for bank capital. The results in Table 2.8 show that there is a negative and significant correlation between bank ROA and NSFR when bank capital is proxied by equity capital, risk-based capital and total capital ratios. The pattern holds if two liquidity risk measures are included in regressions. The model is correctly specified and has valid instruments in all specifications, except for specification (6), when total risk-based capital ratio is used to proxy bank capital. The NSFR has a statistically significant adverse impact on the ROE of small banks in all specifications reported in Table 2.10. Moreover, all coefficients are stable, because the model is not overidentified, according to the Hansen J-test.

The estimation results in Tables 2.7 and 2.9 show that there is a positive correlation between the NSFR and bank profitability at large banks. These estimates suggest that by increasing NSFR large banks have a higher ROA and ROE. The pattern holds for all three measures of bank capital (except for risk-based capital in Table 2.9). Overall, such findings for the impact of the NSFR on large banks show that there are differences in small and large bank liquidity management: small banks maintain higher NSFRs, and by increasing them reduce their profitability, while large banks maintain lower NSFRs and can gain higher profitability by increasing their funding stability. As most large banks have NSFRs below 1, becoming compliant with NSFR standards will likely lead to a sizeable increase in their stable funding sources and substantial change in their liquidity risk management regimes, which in turn may break the significant positive relationship between NSFR and profitability that I document in the past. DeYoung and Jang (2016) also report differences in small and large banks' methods of liquidity management. Consistent with their findings, I conclude that implementation of the Basel III NSFR standards will most likely alter large banks liquidity management regimes, while liquidity management of small banks will stay largely unchanged.

The main findings of my research are that two liquidity risk measures, LCR and NSFR, are important determinants of bank profitability, whether I consider their impact separately or together on bank ROA and ROE.

Bank capital has a significant effect on the profitability of U.S. bank holding companies. It positively impacts the ROA of large and small banks. Increased capital requirements improve banks' returns on assets. This result is consistent with the studies of Demirguc-Kunt and Huizinga (1999), Pasiouras and Kosmidou (2007), and Dietrich et al. (2014). Banks with lower capital ratios are risky and therefore they face higher funding costs, which negatively relates to their profitability. Moreover, while banks with significant capital buffers do not need external financing, low-capitalized banks may need substantial external financing which again negatively relates to their profitability. So, low capitalized banks are less profitable. However, bank capital have significant negative impact on return on equity of small banks. This is consistent with conventional risk-return hypothesis which states that riskier banks should be more profitable. Therefore, liquidity risk measures together with capital ratios are significant determinants of bank profitability.

The other important determinants of bank profitability according to the estimation results are loan loss provisions, overhead costs, non-interest income share and banks' size. As expected loan loss provisions and overhead costs are negatively related to bank profitability. In order to increase profits banks improve screening and monitoring of credit risk as well as better manage their operational expenses. Non-interest income share has significant positive effect on bank profitability indicating that income diversification help banks achieve increased profits. The effect of bank size is negative, which is consistent with the studies advocating diseconomies of scale for larger banks (e.g. Pasiouras and Kosmidou, 2007).

2.6.2 Indicator Variables of LCR and NSFR

Now I analyze how new liquidity rules affect bank profitability, using indicator variables of the LCR and NSFR in regressions. Here I test the hypothesis whether banks with a LCR (NSFR) below 100% are more profitable. The estimation results for ROA are presented separately for large and small banks in Tables 2.11 and 2.12. Tables 2.13 and 2.14 show estimation results for ROE of large and small banks. The results show that a LCR below 100% has a significant positive effect on the profitability of large banks, while a NSFR below 100% has a significant positive effect on the profitability of small banks. A LCR (NSFR) below 100% doesn't significantly impact the profitability of small (large) banks. These results hold both for specifications that consider a single liquidity risk measure and the two liquidity risk measures together, indicating that large (small) banks are more profitable when they maintain a LCR (NSFR) below the regulatory target of 100%. Capital ratios only have a significant positive impact on ROA.

2.6.3 Changes of LCR and NSFR

Next I analyze how new liquidity rules affect bank profitability, using deviations of the LCR and NSFR from the regulatory target of 1 in regressions. Here I test the hypothesis whether banks with a lower or higher change from 1 in LCR (NSFR) are more profitable. The estimation results for ROA are presented separately for large and small banks in Tables 2.15 and 2.16. Tables 2.17 and 2.18 show the estimation results for ROE of large and small banks. The results show that ΔLCR has a significant adverse effect on the profitability of large banks, while ΔNSFR has a significant adverse effect on the profitability of small banks. ΔLCR (ΔNSFR) doesn't significantly impact the profitability of small (large) banks. The results indicate that driving the LCR (NSFR) away from the regulatory level of 1 adversely impacts profitability at large (small) banks. These results hold both for specifications that consider a single liquidity risk measure and the two liquidity risk measures together. Capital ratios have a significant positive impact only on ROA.

2.7 Banks' Behavior before and after the Financial Crisis of 2007-2009

To provide a better identification of the effects of Basel III liquidity regulations on bank profitability, I additionally analyze the period before the financial crisis of 2007-2009 and the post-crisis period of 2010-2013. The financial crisis of 2007-2009 was marked by the dramatic collapse of the short-term wholesale markets and the Federal Reserve Bank's attempts to ease crisis tensions by injecting liquidity into the banking system. However, banks accumulated liquidity provisions made by the Federal Reserve and didn't increase lending. Moreover, during the crisis investors were reluctant to invest in risky assets; instead depositing their money at banks. Therefore, deposits at banks, especially core deposits increased during the crisis (Cornett et al., 2011; Acharya and Mora, 2015). In light of the above, many banks had to rethink their liquidity management regimes. Moreover, in response to the financial crisis, international regulators already in early 2009 outlined their plan to impose binding liquidity and funding levels on banks, and in December 2010 introduced new liquidity regulations that banks would have to comply with in the future. Next, I examine whether my baseline results in Section 2.6 hold both pre- and post-crisis.

The estimation results in Table 2.19 show that the LCR has a significant negative effect on large banks' profitability both pre- and post-crisis. Table 2.20 shows estimation results for small banks. It indicates that the LCR adversely affects the ROA only in crisis and post-crisis periods, while small banks' ROE is negatively correlated with the LCR only during the crisis. Overall, these results are consistent with my baseline findings in Section 2.6 and they indicate that higher LCRs decrease bank profitability both pre- and post-crisis (except for small banks' ROE).

NSFR is positively correlated with large banks' profitability only during the pre-crisis period. Large banks with lower stable funding sources were less profitable before the crisis. The results for small banks document a significant negative relationship between NSFR and profitability pre-crisis, and a significant positive relationship post-crisis. Higher NSFR decreases small banks' profitability during the pre-crisis period, which is consistent with my baseline findings in Section 2.6. The change in sign of the relationship between small banks' profitability and NSFR is reflected in the changing behavior of small banks' NSFRs. It declines dynamically during the pre-crisis period, but after the crisis small banks started to build up their stable funding sources, which lead to an increase in NSFRs. Moreover, banks' profitability dramatically declined during the financial crisis of 2007-2009. After the crisis banks managed to recover and had a significant increase in their ROA and ROE, but still levels of average post-crisis ROA and ROE were two times lower pre-crisis averages. So there was room for small banks to raise their NSFRs and at the same time have an increase in profitability post-crisis. My findings for NSFR reveal that it is an important determinant of bank profitability both pre- and post-crisis.

2.8 Conclusion

In this chapter, I examined whether and how new liquidity standards together with enhanced capital requirements introduced in the Basel III Accord affected profitability of U.S. banks over 2001-2013. This period is of particular interest because it preceded the actual implementation of the Basel III liquidity risk measures. Following recent empirical studies on bank performance (Athanasoglou et al., 2008; Garcia-Herrero et al., 2009; Dietrich et al., 2014), I used a dynamic panel data technique by employing the GMM estimator that accounts for unobserved bank-specific effects. I also showed how to calculate the Basel III liquidity measures: the LCR and NSFR using a large sample of U.S. bank holding companies. The results of this study are of particular importance for both academics and bank regulators as it checks the effectiveness of the Basel III liquidity and capital standards and contribute to the ongoing global banking reform process.

My results show that increased LCR decreased the profitability of U.S. bank holding companies. Increased NSFR decreased the profitability of small banks, while it had a positive impact on the profitability of large banks. These findings show that there are differences in small and large bank liquidity management: small banks maintain higher NSFRs and by increasing NSFRs they reduce their profitability, while large banks maintain lower NSFRs and they can obtain higher profitability by increasing their funding stability. Overall, the results state that the two liquidity risk measures, together with capital ratios, are important determinants of bank profitability.

Further, I examined how having liquidity ratios below the regulatory standard of 1 impacts bank profitability. In general, my results state that banks maintaining low liquidity ratios are more profitable. However, the results indicate that a LCR below 1 has a positive impact only on large banks, while a NSFR below 1 positively impacts only small banks. Similarly, I show that departures of liquidity ratios from a regulatory level of 1 adversely impact bank profitability. Once again, the changes in the LCR have a significant impact on the profitability of large banks, while changes in the NSFR have a significant impact on small banks' profitability. The results for the impact of the LCR on large banks are consistent with recommendations of regulators to impose LCR regulations only to large banks (Federal Reserve Bank Press Release, October 24, 2013).

I show that my baseline results hold both if I separate the effect of new liquidity rules on banks' profitability before the financial crisis of 2007 - 2009 and after it. The results show that the two liquidity standards are important determinants of bank profitability both pre- and post-crisis. Higher LCRs decrease bank profitability before and after the crisis (except for small banks' ROE). Higher NSFRs increase profitability at large banks before the crisis, while the NSFR adversely affects small banks' pre-crisis profitability and has a significant positive effect on small banks' post-crisis ROA and ROE, due to changing behavior of small banks' NSFRs and the earnings dynamics after the crisis. Taking all this together, the results of this study show that in general adjusting balance-sheets to comply with binding liquidity standards will be costly for many banks.

I would like to close this chapter with some caveats. First, as my results show that in general if large and small banks increase their balance-sheet liquidity to comply with binding LCR and NSFR standards, it will inversely affect their profitability. Therefore, banks will search for ways to compensate these losses. Banks might take excessive risk in other areas, or they might try to circumvent new liquidity rules in a similar way to how banks relaxed existing risk-based capital requirements by moving illiquid assets off balance-sheet to reduce their riskiness. Second, while my results in general document a significant negative relationship between new liquidity rules and bank profitability in the past, when all banks adopt a new regulation the existing relationship might change in the future. Although this historical analysis provides important new insights, the implications of the Basel III liquidity and capital requirements obviously need further examination.

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Figure 2.1: Liquidity Coverage Ratio (LCR) by Bank Size

Quarterly means for different asset size categories of U.S. bank holding companies, 2001 - 2013.

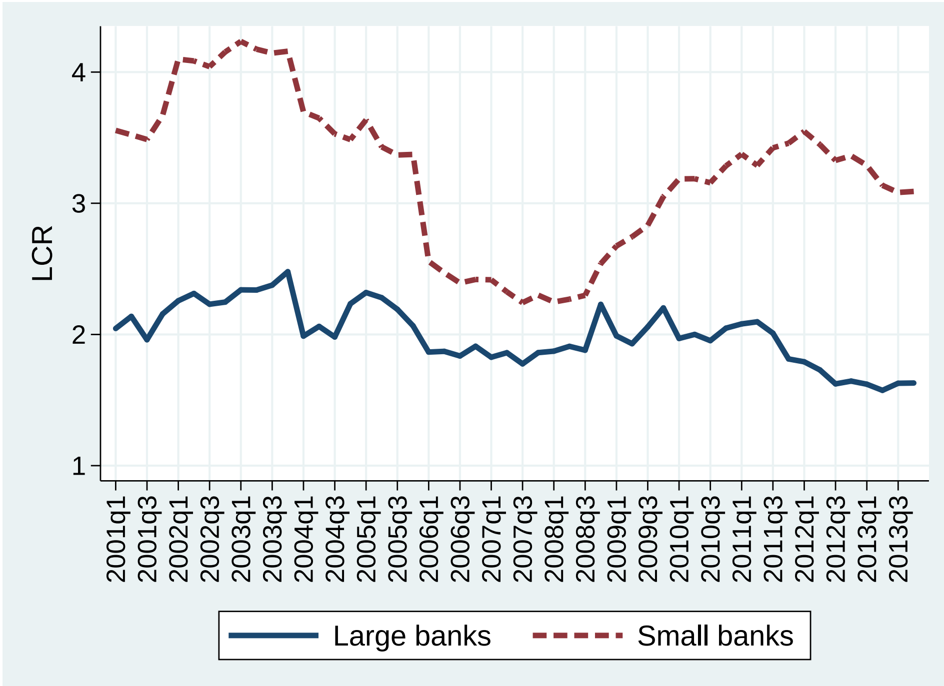

Figure 2.2: Net Stable Funding Ratio (NSFR) by Bank Size

Quarterly means for different asset size categories of U.S. bank holding companies, 2001 - 2013.

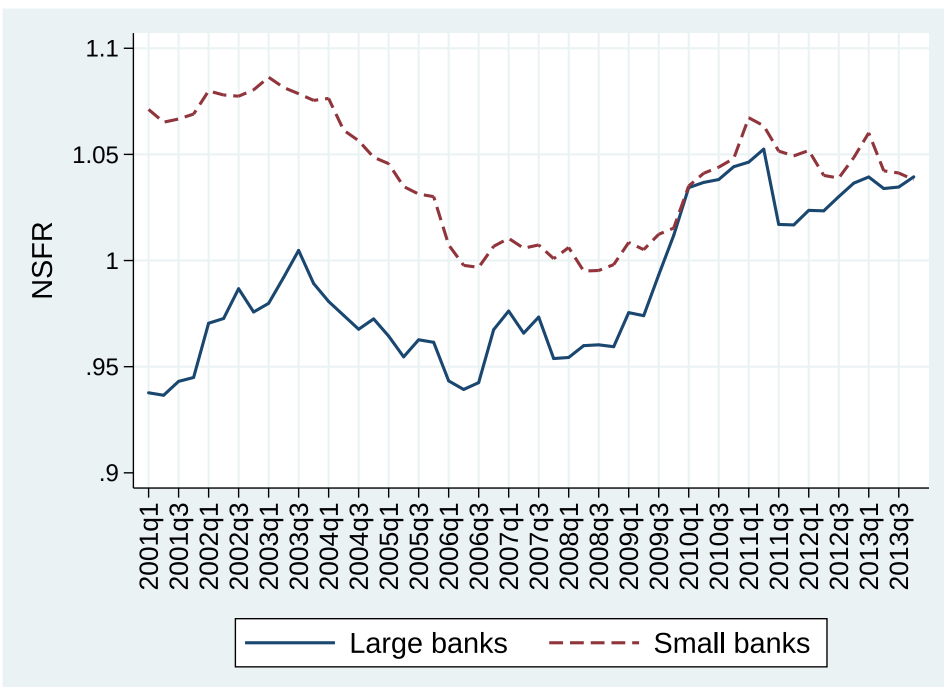

Table 2.1: Varibles Description

Variable	Description
ROA	Return on assets = Net income/Total assets
ROE	Return on equity = Net income/Total equity
LCR/100	Liquidity coverage ratio = (High-quality liquid assets/Total net cash outflow over the next 30 days)/100
LCR	The baseline LCR is calculated based on the baseline assumptions[13]
NSFR	Net stable funding ratio = Available stable funding/Required stable funding
LCR_blw1	Indicator variable that equals 1 if LCR is below 1
NSFR_blw1	Indicator variable that equals 1 if NSFR is below 1
△LCR	Change of LCR from the regulatory level of 1 during the quarter
△NSFR	Change of NSFRR from the regulatory level of 1 during the quarter
CAR	Total equity capital/Total assets
RB CAP	Total equity capital/Risk-weighted assets
TCR	Total risk-based capital/Risk-weighted assets
SIZE	Natural logarithm of total assets
LLOSS	The provision for loan and lease losses/Total loans and leases
OVC	Overhead costs= Noninterest expense/Average total assets
NINT	Non interest share = Noninterest income/Total income
RGDP	Annual growth rate of real GDP

[13] See Table A.2 in the Appendix for the major assumptions used for calculation of the LCR.

Table 2.2: Descriptive Statistics

This table presents descriptive statistics for bank-quarters for the full sample period separately for large and small banks. Large banks are defined as those that have total assets in the top decile of the quarterly total assets distribution. Small banks are defined as those that have total assets in the 90th percentile of the quarterly total assets distribution. The data is taken from the Federal Reserve FR Y-9C Consolidated Financial Statements for Bank Holding Companies for the period from 2001 Q1 through 2013 Q4. All variables except RGDP are winsorized at 1% in the 1st and 99th percentiles of the distribution. See Table 3.1 for variables definitions.

	N	Mean	St. Dev.	Min	p25	p50	p75	Max
Large banks								
ROA	6150	0.0023	0.003	-0.012	0.002	0.003	0.003	0.008
ROE	6150	0.0234	0.034	-0.199	0.016	0.028	0.039	0.099
CAR	6150	0.0981	0.032	0.022	0.078	0.093	0.111	0.222
RB_CAP	5935	0.1415	0.058	0.032	0.108	0.127	0.161	0.389
TCR	6150	0.1371	0.048	0.027	0.116	0.131	0.151	0.383
SIZE	6150	16.4586	1.137	14.632	15.65	16.245	17.271	19.058
LLOSS	6150	0.0019	0.003	-0.001	0	0.001	0.002	0.017
OVC	6150	0.0084	0.004	0	0.006	0.008	0.009	0.028
NINT	6150	0.2511	0.158	-0.03	0.152	0.218	0.31	0.741
RGDP	6150	2.0826	2.389	-8.2	1.2	2.3	3.5	6.9
NSFR	6150	0.9852	0.177	0.559	0.889	0.976	1.071	1.655
LCR/100	6150	0.0206	0.025	0.001	0.008	0.013	0.023	0.183
LCR	6150	2.0574	2.502	0.136	0.813	1.309	2.289	18.345
NSFR_blw1	6150	0.5763	0.494	0	0	1	1	1
LCR_blw1	6150	0.3472	0.476	0	0	0	1	1
△NSFR	6150	-0.0148	0.177	-0.441	-0.111	-0.024	0.071	0.655
△LCR	6150	1.0574	2.502	-0.864	-0.187	0.309	1.289	17.345
Small banks								
ROA	63477	0.002	0.003	-0.012	0.001	0.002	0.003	0.008
ROE	63477	0.022	0.037	-0.199	0.016	0.026	0.036	0.099
CAR	63477	0.0905	0.03	0.022	0.072	0.087	0.104	0.222
RB_CAP	63477	0.1318	0.057	0.032	0.096	0.121	0.153	0.389
TCR	63477	0.1461	0.05	0.027	0.116	0.135	0.162	0.383
SIZE	63477	13.2614	0.831	11.936	12.566	13.239	13.776	15.901
LLOSS	63477	0.0015	0.003	-0.001	0	0.001	0.001	0.017
OVC	63477	0.008	0.003	0	0.006	0.008	0.009	0.028
NINT	63477	0.1536	0.105	-0.03	0.091	0.135	0.192	0.741
RGDP	63477	2.1179	2.344	-8.2	1.2	2.3	3.5	6.9
NSFR	63477	1.0467	0.167	0.559	0.941	1.032	1.135	1.655
LCR/100	63477	0.0338	0.032	0.001	0.014	0.024	0.041	0.183
LCR	63477	3.3837	3.221	0.136	1.405	2.371	4.07	18.345
NSFR_blw1	63477	0.4096	0.492	0	0	0	1	1
LCR_blw1	63477	0.1333	0.34	0	0	0	0	1
△NSFR	63477	0.0467	0.167	-0.441	-0.059	0.032	0.135	0.655
△LCR	63477	2.3837	3.221	-0.864	0.405	1.371	3.07	17.345

Table 2.3: Average Sample Characteristics for Banks with a LCR < 100% and Banks with a LCR >= 100%

This table compares average sample characteristics for banks with a LCR < 100% and banks with a LCR >= 100% for the full sample period separately for large and small banks. Large banks are defined as those that have total assets in the top decile of the quarterly total assets distribution. Small banks are defined as those that have total assets in the 90th percentile of the quarterly total assets distribution. The test for differences in means across two groups of banks is conducted by calculating a t-statistic. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	LCR < 100%	LCR >= 100%	Difference	Std. Error	Obs.
Large banks					
ROA	0.0024	0.0022	-0.0002***	0.0001	6150
ROE	0.024	0.0231	-0.0009	0.0009	6150
CAR	0.1028	0.0956	-0.0071***	0.0009	6150
RB_CAP	0.1285	0.1478	0.0193***	0.0016	5935
TCR	0.1221	0.1451	0.0229***	0.0012	6150
SIZE	17.0745	16.1312	-0.9433***	0.028	6150
LLOSS	0.0023	0.0017	-0.0006***	0.0001	6150
OVC	0.0099	0.0076	-0.0022***	0.0001	6150
NINT	0.3107	0.2195	-0.0912***	0.0041	6150
RGDP	1.9592	2.1482	0.1890***	0.0639	6150
NSFR	0.9368	1.0109	0.0741***	0.0046	6150
LCR	0.6272	2.818	2.1908***	0.0609	6150
Small banks					
ROA	0.0022	0.002	-0.0003***	0	63477
ROE	0.026	0.0214	-0.0046***	0.0004	63477
CAR	0.0888	0.0907	0.0019***	0.0004	63477
RB_CAP	0.1078	0.1354	0.0276***	0.0007	63477
TCR	0.1272	0.1491	0.0219***	0.0006	63477
SIZE	13.5064	13.2237	-0.2827***	0.0096	63477
LLOSS	0.0015	0.0015	0.0001*	0	63477
OVC	0.0085	0.0079	-0.0005***	0	63477
NINT	0.1574	0.153	-0.0043***	0.0012	63477
RGDP	1.7906	2.1683	0.3777***	0.0273	63477
NSFR	0.9331	1.0642	0.1311***	0.0019	63477
LCR	0.6857	3.7988	3.1131***	0.0355	63477

Table 2.4: Average Sample Characteristics for Banks with a NSFR < 100% and Banks with a NSFR >= 100%

This table compares average sample characteristics for banks with a NSFR < 100% and banks with a NSFR >= 100% for the full sample period separately for large and small banks. Large banks are defined as those that have total assets in the top decile of the quarterly total assets distribution. Small banks are defined as those that have total assets in the 90th percentile of the quarterly total assets distribution. The test for differences means across two groups of banks is conducted by calculating a t-statistic. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	LCR < 100%	LCR >= 100%	Difference	Std. Error	Obs.
Large banks					
ROA	0.0022	0.0024	0.0002***	0.0001	6150
ROE	0.023	0.024	0.0011	0.0009	6150
CAR	0.096	0.101	0.0049***	0.0008	6150
RB_CAP	0.1323	0.1542	0.0219***	0.0015	5935
TCR	0.1308	0.1457	0.0149***	0.0012	6150
SIZE	16.573	16.3031	-0.2699***	0.0291	6150
LLOSS	0.002	0.0018	-0.0002**	0.0001	6150
OVC	0.0084	0.0085	0.0001	0.0001	6150
NINT	0.2554	0.2454	-0.0100**	0.0041	6150
RGDP	2.0093	2.1823	0.1730***	0.0616	6150
NSFR	0.874	1.1364	0.2624***	0.0031	6150
LCR	1.9602	2.1897	0.2296***	0.0645	6150
Small banks					
ROA	0.0016	0.0023	0.0007***	0	63477
ROE	0.0187	0.0243	0.0055***	0.0003	63477
CAR	0.0831	0.0956	0.0125***	0.0002	63477
RB_CAP	0.1099	0.1469	0.0371***	0.0004	63477
TCR	0.1304	0.1571	0.0267***	0.0004	63477
SIZE	13.3498	13.2001	-0.1498***	0.0067	63477
LLOSS	0.002	0.0012	-0.0008***	0	63477
OVC	0.0086	0.0076	-0.0009***	0	63477
NINT	0.1556	0.1523	-0.0033***	0.0008	63477
RGDP	1.9995	2.2001	0.2007***	0.0189	63477
NSFR	0.9004	1.1482	0.2477***	0.0009	63477
LCR	2.3787	4.081	1.7024***	0.0251	63477

Table 2.5: Descriptive Statistics for Sub-periods

This table presents descriptive statistics for bank-quarters for the full sample period separately for large and small banks during pre-crisis, crisis and post-crisis periods. Large banks are defined as those that have total assets in the top decile of the quarterly total assets distribution. Small banks are defined as those that have total assets in the 90th percentile of the quarterly total assets distribution. The data is taken from the Federal Reserve FR Y-9C Consolidated Financial Statements for Bank Holding Companies for the period from 2001 Q1 through 2013 Q4. The crisis period is from 2007 Q3 through 2009 Q4. The post crisis period is from 2010 Q1 through 2013 Q4. All variables except RGDP are winsorized at 1% in the 1st and 99th percentiles of the distribution. See Table 3.1 for variables definitions.

	N	Mean	St. Dev.	Min	p25	p50	p75	Max
Large banks: pre-crisis								
ROA	3853	0.0030	0.002	-0.012	0.002	0.003	0.004	0.008
ROE	3853	0.0331	0.022	-0.199	0.026	0.034	0.043	0.099
NSFR	3853	0.9702	0.172	0.559	0.882	0.969	1.054	1.655
LCR/100	3853	0.0216	0.027	0.001	0.008	0.014	0.024	0.183
Large banks: crisis								
ROA	886	0.0000	0.004	-0.012	-0.001	0.001	0.002	0.008
ROE	886	-0.0040	0.057	-0.199	-0.010	0.011	0.025	0.099
NSFR	886	0.9718	0.168	0.559	0.876	0.948	1.041	1.655
LCR/100	886	0.0197	0.025	0.002	0.008	0.012	0.021	0.183
Large banks: post-crisis								
ROA	1411	0.0017	0.003	-0.012	0.001	0.002	0.003	0.008
ROE	1411	0.0141	0.032	-0.199	0.011	0.018	0.024	0.099
NSFR	1411	1.0344	0.186	0.559	0.918	1.019	1.123	1.655
LCR/100	1411	0.0183	0.018	0.001	0.009	0.013	0.022	0.183
Small banks: pre-crisis								
ROA	40288	0.0027	0.002	-0.012	0.002	0.003	0.003	0.008
ROE	40288	0.0307	0.022	-0.199	0.022	0.030	0.039	0.099
NSFR	40288	1.0556	0.171	0.559	0.947	1.040	1.147	1.655
LCR/100	40288	0.0360	0.035	0.001	0.014	0.025	0.044	0.183
Small banks: crisis								
ROA	8704	0.0002	0.004	-0.012	-0.000	0.001	0.002	0.008
ROE	8704	-0.0006	0.059	-0.199	-0.001	0.016	0.028	0.099
NSFR	8704	1.0047	0.142	0.559	0.918	0.996	1.082	1.655
LCR/100	8704	0.0252	0.024	0.001	0.011	0.018	0.030	0.183
Small banks: post-crisis								
ROA	14485	0.0012	0.003	-0.012	0.001	0.002	0.003	0.008
ROE	14485	0.0114	0.046	-0.199	0.008	0.019	0.028	0.099
NSFR	14485	1.0472	0.167	0.559	0.943	1.035	1.133	1.655
LCR/100	14485	0.0329	0.028	0.001	0.015	0.025	0.040	0.183

Table 2.6: Correlation Matrix for Large and Small Banks

This table shows the correlation matrix for bank profitability measures and explanatory variables for U.S. bank holding companies from 2001 Q1 to 2013 Q4 separately for large and small banks. Large banks are defined as those that have total assets in the top decile of the quarterly total assets distribution. Small banks are defined as those that have total assets in the 90th percentile of the quarterly total assets distribution. See Table 3.1 for definitions of variables.

Large banks

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 ROA	1												
2 ROE	0.907	1											
3 CAR	0.146	-0.033	1										
4 RB_CAP	0.137	-0.004	0.796	1									
5 TCR	0.127	0.028	0.4	0.715	1								
6 SIZE	-0.083	-0.105	0.168	0.077	-0.045	1							
7 LLOSS	-0.485	-0.508	0.081	-0.043	-0.04	0.181	1						
8 OVC	0.069	-0.064	0.281	0.203	0.215	0.118	0.215	1					
9 NINT	0.241	0.154	0.235	0.237	0.239	0.375	0.048	0.681	1				
10 RGDP	0.24	0.233	-0.041	-0.004	0.017	-0.14	-0.256	-0.019	0.039	1			
11 NSFR	0.045	0.011	0.157	0.233	0.179	-0.105	-0.053	0.056	-0.027	0.031	1		
12 LCR	-0.068	-0.039	-0.158	0.182	0.305	-0.249	-0.045	-0.271	-0.261	0.022	-0.016	1	
13 NSFR_blw1	-0.036	-0.015	-0.076	-0.187	-0.153	0.117	0.033	-0.015	0.031	-0.036	-0.733	-0.045	1
14 LCR_blw1	0.034	0.013	0.106	-0.157	-0.228	0.395	0.091	0.243	0.275	-0.038	-0.2	-0.417	0.201

Small banks

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 ROA	1												
2 ROE	0.855	1											
3 CAR	0.294	0.082	1										
4 RB_CAP	0.251	0.067	0.883	1									
5 TCR	0.234	0.063	0.76	0.9	1								
6 SIZE	-0.155	-0.137	-0.002	-0.05	-0.078	1							
7 LLOSS	-0.652	-0.598	-0.104	-0.11	-0.093	0.164	1						
8 OVC	-0.15	-0.146	0.014	0.002	0.02	0.005	0.169	1					
9 NINT	0.154	0.115	0.109	0.144	0.152	0.159	0.02	0.633	1				
10 RGDP	0.168	0.154	0.025	0.051	0.068	-0.209	-0.155	-0.014	0.024	1			
11 NSFR	0.147	0.071	0.255	0.446	0.399	-0.107	-0.155	-0.198	-0.041	0.058	1		
12 LCR	-0.024	-0.049	0.113	0.387	0.4	-0.215	-0.004	-0.102	-0.045	0.073	0.393	1	
13 NSFR_blw1	-0.132	-0.073	-0.204	-0.319	-0.264	0.089	0.143	0.15	0.016	-0.042	-0.728	-0.26	1
14 LCR_blw1	0.035	0.042	-0.022	-0.164	-0.15	0.116	-0.007	0.057	0.014	-0.055	-0.266	-0.329	0.257

Table 2.7: Bank ROA and Liquidity Rules in Large Banks: Continuous Variables of the LCR and NSFR

This table reports estimation results using the Blundell-Bond Two-Step GMM procedure. The dependent variable is bank profitability, which is measured by return on assets (ROA). Bank capital CAP is measured by equity capital to total assets (CAR), equity capital to risk-weighted assets (RB CAP), and the total risk-based capital ratio (TCR). Large banks are defined as those that have total assets in the top decile of the quarterly total assets distribution. GMM-type instruments for CAP, LCR and NSFR are used to account for the endogeneity of bank capital and liquidity. All regressions include bank fixed effects and time dummies. Robust standard errors in parentheses are calculated using the finite-sample "Windmeijer correction" for the two-step covariance matrix. A Hansen J-test reports a p-value for the Hansen test of overidentifying restrictions. AR(n) tests present p-values for the Arellano-Bond test of no n-order autocorrelation in residuals. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					ROA				
	CAR	RB CAP	TCR	CAR	RB CAP	TCR	CAR	RB CAP	TCR
Large banks									
L.ROA	0.0814***	0.1956***	0.0849***	0.0701***	0.0759***	0.0710***	0.0791***	0.0841***	0.0801***
	(0.0252)	(0.0626)	(0.0249)	(0.0228)	(3.23)	(0.0233)	(0.0218)	(0.0242)	(0.0242)
LCR/100	**-0.0085**	**-0.0070**	**-0.0095**				**-0.0104***	**-0.0133****	**-0.0160****
	(0.0067)	**(0.0078)**	**(0.0073)**				**(0.0061)**	**(0.0067)**	**(0.0070)**
NSFR				**0.0034****	**0.0038****	**0.0047****	**0.0032***	**0.0035****	**0.0043****
				(0.0017)	**(2.01)**	**(0.0020)**	**(0.0016)**	**(0.0018)**	**(0.0019)**
CAP	**0.0138**	**-0.0003**	**0.0128***	**0.0147***	**0.0082**	**0.0067**	**0.0165***	**0.0093***	**0.0103**
	(0.0099)	**(0.0055)**	**(0.0071)**	**(0.0089)**	**(1.24)**	**(0.0088)**	**(0.0089)**	**(0.0056)**	**(0.0065)**
SIZE	-0.0005**	-0.0006***	-0.0006*	-0.0005	-0.0006*	-0.0005	-0.0004	-0.0005	-0.0005*
	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(-1.73)	(0.0004)	(0.0003)	(0.0003)	(0.0003)
LLOSS	-0.4496***	-0.3978***	-0.4346***	-0.4516***	-0.4384***	-0.4604***	-0.4480***	-0.4328***	-0.4604***
	(0.0865)	(0.0709)	(0.0829)	(0.0900)	(-4.83)	(0.0920)	(0.0755)	(0.0778)	(0.0838)
OVC	-0.6259***	-0.6206***	-0.6378***	-0.5682***	-0.5783***	-0.6252***	-0.5564***	-0.5803***	-0.6189***
	(0.1009)	(0.0997)	(0.1142)	(0.0889)	(-5.99)	(0.1164)	(0.0830)	(0.0827)	(0.0969)
NINT	0.0132***	0.0133***	0.0146***	0.0154***	0.0158***	0.0179***	0.0129***	0.0130***	0.0149***
	(0.0039)	(0.0042)	(0.0039)	(0.0047)	(3.03)	(0.0050)	(0.0037)	(0.0039)	(0.0037)
RGDP_GR	0.0001**	0.0001**	0.0001**	0.0001***	0.0001**	0.0001*	0.0001***	0.0001***	0.0001**
	(0.0001)	(0.0000)	(0.0001)	(0.0000)	(2.26)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
_cons	0.0117***	0.0147***	0.0120***	0.0066	0.0083	0.0073	0.0066	0.0074	0.0077*
	(0.0032)	(0.0037)	(0.0046)	(0.0049)	(1.46)	(0.0058)	(0.0047)	(0.0047)	(0.0043)
N	6150	5935	6150	6164	5949	6164	6150	5935	6150
N of banks	280	259	280	280	259	280	280	259	280
χ^2	1398	1190	1179	1232	1190	1446	1310	1426	1548
Hansen J-test	0.1052	0.3009	0.1891	0.3817	0.3111	0.3924	0.8415	0.8458	0.7924
AR(1) test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AR(2) test	0.4777	0.2216	0.4910	0.5545	0.5386	0.6042	0.4774	0.4735	0.5148

Table 2.8: Bank ROA and Liquidity Rules in Small Banks: Continuous Variables of the LCR and NSFR

This table reports estimation results using the Blundell-Bond Two-Step GMM procedure. The dependent variable is bank profitability, which is measured by return on assets (ROA). Bank capital CAP is measured by equity capital to total assets (CAR), equity capital to risk-weighted assets (RB CAP), and the total risk-based capital ratio (TCR). Small banks are defined as those that have total assets in the 90th percentile of the quarterly total assets distribution. GMM-type instruments for CAP, LCR and NSFR are used to account for the endogeneity of bank capital and liquidity. All regressions include bank fixed effects and time dummies. Robust standard errors in parentheses are calculated using the finite-sample "Windmeijer correction" for the two-step covariance matrix. A Hansen J-test reports a p-value for the Hansen test of overidentifying restrictions. AR(n) tests present p-values for the Arellano-Bond test of no n-order autocorrelation in residuals. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					ROA				
	CAR	RB CAP	TCR	CAR	RB CAP	TCR	CAR	RB CAP	TCR
Small banks									
L.ROA	0.1587***	0.1851***	0.1962***	0.1337***	0.1630***	0.1487***	0.0368***	0.0399***	0.1710***
	(0.0336)	(0.0341)	(0.0332)	(0.0302)	(0.0291)	(0.0291)	(0.0084)	(0.0086)	(0.0293)
LCR/100	-0.0022	-0.0038	-0.0009				-0.0006	-0.0038*	-0.0008
	(0.0028)	(0.0029)	(0.0029)				(0.0021)	(0.0023)	(0.0006)
NSFR				-0.0004	-0.0011*	-0.0010*	-0.0008*	-0.0018***	-0.0020
				(0.0006)	(0.0006)	(0.0006)	(0.0004)	(0.0005)	(0.0028)
CAP	0.0142***	0.0072***	0.0102***	0.0164***	0.0081***	0.0088***	0.0225***	0.0134***	0.0094***
	(0.0034)	(0.0023)	(0.0027)	(0.0034)	(0.0021)	(0.0024)	(0.0027)	(0.0020)	(0.0025)
SIZE	-0.0002**	-0.0003***	-0.0002*	-0.0002*	-0.0002**	-0.0002*	-0.0002**	-0.0002**	-0.0002**
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
LLOSS	-0.7229***	-0.7119***	-0.7381***	-0.7914***	-0.7679***	-0.7796***	-0.8097***	-0.8078***	-0.7615***
	(0.0406)	(0.0411)	(0.0407)	(0.0400)	(0.0396)	(0.0384)	(0.0351)	(0.0376)	(0.0359)
OVC	-0.6643***	-0.7369***	-0.6529***	-0.5512***	-0.6193***	-0.5983***	-0.5764***	-0.6469***	-0.6262***
	(0.0920)	(0.0930)	(0.0966)	(0.0870)	(0.0908)	(0.0876)	(0.0810)	(0.0808)	(0.0824)
NINT	0.0141***	0.0154***	0.0148***	0.0086***	0.0106***	0.0125***	0.0104***	0.0115***	0.0128***
	(0.0019)	(0.0019)	(0.0021)	(0.0025)	(0.0025)	(0.0026)	(0.0020)	(0.0020)	(0.0020)
RGDP_GR	-0.00002	-0.00002*	-0.00002**	-0.00003**	-0.00003**	-0.00003**	-0.00002	-0.00002	-0.00003**
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
_cons	0.0077***	0.0089***	0.0070***	0.0071***	0.0087***	0.0079***	0.0078***	0.0097***	0.0082***
	(0.0017)	(0.0018)	(0.0019)	(0.0016)	(0.0017)	(0.0018)	(0.0015)	(0.0015)	(0.0017)
N	63477	63477	63477	63477	63477	63477	63477	63477	63477
N of banks	2674	2674	2674	2674	2674	2674	2674	2674	2674
χ^2	7999	7556	6896	7339	6771	6741	6600	6183	6803
Hansen J-test	0.1238	0.1993	0.1926	0.1388	0.1467	0.0505	0.1026	0.1507	0.1147
AR(1) test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AR(2) test	0.8316	0.9175	0.6445	0.7774	0.6679	0.9024	0.1952	0.1730	0.7246

Table 2.9: Bank ROE and Liquidity Rules in Large Banks: Continuous Variables of the LCR and NSFR

This table reports estimation results using the Blundell-Bond Two-Step GMM procedure. The dependent variable is bank profitability which is measured by return on equity (ROE). Bank capital CAP is measured by equity capital to total assets (CAR), equity capital to risk-weighted assets (RB CAP), and the total risk-based capital ratio (TCR). Large banks are defined as those that have total assets in the top decile of the quarterly total assets distribution. GMM-type instruments for CAP, LCR and NSFR are used to account for endogeneity of bank capital and liquidity. All regressions include bank fixed effects and time dummies. Robust standard errors in parentheses are calculated using the finite-sample "Windmeijer correction" for the two-step covariance matrix. A Hansen J-test reports a p-value for the Hansen test of overidentifying restrictions. AR(n) tests present p-values for the Arellano-Bond test of no n-order autocorrelation in residuals. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					ROE				
	CAR	RB CAP	TCR	CAR	RB CAP	TCR	CAR	RB CAP	TCR
Large banks									
L.ROE	0.1013***	0.1104***	0.1025***	0.0892***	0.1091***	0.0985***	0.1034***	0.1193***	0.1092***
	(0.0296)	(0.0298)	(0.0302)	(0.0301)	(3.39)	(0.0351)	(0.0316)	(0.0345)	(0.0319)
LCR/100	**-0.1763***	**-0.2179***	**-0.1922**				**-0.2283****	**-0.2504****	**-0.2598****
	(0.1053)	**(0.1202)**	**(0.1199)**				**(0.1108)**	**(0.1148)**	**(0.1172)**
NSFR				**0.0524****	**0.0514***	**0.0689*****	**0.0501****	**0.0426**	**0.0568****
				(0.0243)	**(1.81)**	**(0.0250)**	**(0.0245)**	**(0.0309)**	**(0.0283)**
CAP	**0.0442**	**0.1020**	**0.1900**	**0.0497**	**0.0693**	**0.1040**	**0.0671**	**0.0810**	**0.1599**
	(0.1621)	**(0.1107)**	**(0.1225)**	**(0.1396)**	**(0.64)**	**(0.1140)**	**(0.1514)**	**(0.0881)**	**(0.1107)**
SIZE	-0.0085***	-0.0082**	-0.0074	-0.0103**	-0.0085	-0.0077	-0.0089**	-0.0070**	-0.0079*
	(0.0030)	(0.0035)	(0.0048)	(0.0041)	(-1.62)	(0.0057)	(0.0038)	(0.0031)	(0.0047)
LLOSS	-5.8088***	-5.9076***	-5.9104***	-5.8076***	-5.6565***	-5.6292***	-5.8678***	-5.8843***	-5.9430***
	(1.2655)	(1.2603)	(1.2803)	(1.1776)	(-4.32)	(1.4577)	(1.1727)	(1.2544)	(1.2689)
OVC	-9.3117***	-9.8537***	-10.0829***	-7.7683***	-8.3762***	-9.1910***	-8.0515***	-8.5547***	-9.2141***
	(1.3619)	(1.3187)	(1.7022)	(1.1133)	(-6.99)	(1.5959)	(1.1513)	(1.2151)	(1.4679)
NINT	0.2039***	0.1834***	0.2092***	0.2581***	0.2063***	0.2340***	0.2021***	0.1665***	0.1999***
	(0.0466)	(0.0501)	(0.0487)	(0.0488)	(2.96)	(0.0723)	(0.0458)	(0.0500)	(0.0527)
RGDP_GR	0.0010	0.0010	0.0008	0.0009	0.0010	0.0008	0.0010*	0.0010	0.0009
	(0.0007)	(0.0007)	(0.0007)	(0.0006)	(1.48)	(0.0007)	(0.0006)	(0.0006)	(0.0006)
_cons	0.1985***	0.1958***	0.1659**	0.1520**	0.1332	0.0978	0.1461**	0.1295**	0.1201
	(0.0478)	(0.0571)	(0.0801)	(0.0658)	(1.59)	(0.0890)	(0.0670)	(0.0559)	(0.0826)
N	6150	5935	6150	6164	5949	6164	6150	5935	6150
N of banks	280	259	280	280	259	280	280	259	280
χ^2	1057	1068	810	1068	1345	1169	1272	1165	975
Hansen J-test	0.2189	0.2382	0.1515	0.5800	0.4613	0.2884	0.8947	0.7535	0.5833
AR(1) test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AR(2) test	0.7233	0.8225	0.7838	0.6826	0.7829	0.7321	0.8059	0.8912	0.8460

Table 2.10: Bank ROE and Liquidity Rules in Small Banks: Continuous Variables of the LCR and NSFR

This table reports estimation results using the Blundell-Bond Two-Step GMM procedure. The dependent variable is bank profitability, which is measured by return on equity (ROE). Bank capital CAP is measured by equity capital to total assets (CAR), equity capital to risk-weighted assets (RB CAP), and the total risk-based capital ratio (TCR). Small banks are defined as those that have total assets in the 90th percentile of the quarterly total assets distribution. GMM-type instruments for CAP, LCR and NSFR are used to account for the endogeneity of bank capital and liquidity. All regressions include bank fixed effects and time dummies. Robust standard errors in parentheses are calculated using the finite-sample "Windmeijer correction" for the two-step covariance matrix. A Hansen J-test reports a p-value for the Hansen test of overidentifying restrictions. AR(n) tests present p-values for the Arellano-Bond test of no n-order autocorrelation in residuals. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					ROE				
	CAR	RB CAP	TCR	CAR	RB CAP	TCR	CAR	RB CAP	TCR
Small banks									
L.ROE	0.0602***	0.0609***	0.0593***	0.0618***	0.0622***	0.0655***	0.0647***	0.0635***	0.0699***
	(0.0166)	(0.0167)	(0.0158)	(0.0164)	(0.0168)	(0.0164)	(0.0157)	(0.0161)	(0.0156)
LCR/100	**0.0195**	**0.0192**	**0.0256**				**0.0328**	**0.0334**	**0.0340**
	(0.0524)	**(0.0515)**	**(0.0503)**				**(0.0470)**	**(0.0465)**	**(0.0464)**
NSFR				**-0.0291*** **	**-0.0314*** **	**-0.0231** **	**-0.0297*** **	**-0.0302*** **	**-0.0218** **
				(0.0099)	**(0.0098)**	**(0.0094)**	**(0.0090)**	**(0.0092)**	**(0.0087)**
CAP	**-0.0398**	**-0.0213**	**-0.0863**	**-0.0731**	**-0.0001**	**-0.0816***	**-0.0208**	**0.0069**	**-0.0752***
	(0.0768)	**(0.0453)**	**(0.0526)**	**(0.0701)**	**(0.0405)**	**(0.0451)**	**(0.0645)**	**(0.0390)**	**(0.0454)**
SIZE	-0.0028	-0.0029	-0.0047**	-0.0018	-0.0016	-0.0022	-0.0017	-0.0019	-0.0025
	(0.0017)	(0.0017)	(0.0019)	(0.0017)	(0.0017)	(0.0017)	(0.0015)	(0.0016)	(0.0016)
LLOSS	-14.2262***	-13.8691***	-13.3671***	-14.3087***	-14.7080***	-13.6179***	-13.4185***	-13.6167***	-12.7825***
	(1.0375)	(0.9799)	(0.9274)	(0.9974)	(1.0030)	(0.9864)	(0.9243)	(0.9288)	(0.8637)
OVC	-3.6299*	-3.8477*	-4.0345*	-2.0429	-1.7781	-2.2313	-2.7515	-2.5840	-3.0529*
	(2.0614)	(2.0436)	(2.0923)	(1.9317)	(1.7988)	(1.9305)	(1.7864)	(1.7576)	(1.8500)
NINT	0.1014**	0.1093**	0.1352***	0.0776	0.0666	0.1052**	0.1057**	0.1071**	0.1399***
	(0.0494)	(0.0503)	(0.0518)	(0.0633)	(0.0543)	(0.0515)	(0.0473)	(0.0449)	(0.0425)
RGDP_GR	-0.0010***	-0.0010***	-0.0008***	-0.0010***	-0.0011***	-0.0007**	-0.0007**	-0.0008***	-0.0005*
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
_cons	0.0983***	0.0979***	0.1282***	0.1078***	0.1015***	0.1078***	0.1017***	0.1010***	0.1083***
	(0.0298)	(0.0305)	(0.0338)	(0.0299)	(0.0291)	(0.0288)	(0.0278)	(0.0279)	(0.0290)
N	63477	63477	63477	63477	63477	63477	63477	63477	63477
N of banks	2674	2674	2674	2674	2674	2674	2674	2674	2674
χ^2	2188	2252	2257	2209	2238	2335	2297	2172	2227
Hansen J-test	0.5471	0.3130	0.2450	0.5752	0.3735	0.2097	0.5443	0.3756	0.1746
AR(1) test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AR(2) test	0.9616	0.9985	0.9421	0.9942	0.9556	0.8456	0.8783	0.9054	0.6941

Table 2.11: Bank ROA and Liquidity Rules in Large Banks: Indicator Variables of the LCR and NSFR

This table reports estimation results using the Blundell-Bond Two-Step GMM procedure. The dependent variable is bank profitability, which is measured by return on assets (ROA). Bank capital CAP is measured by equity capital to total assets (CAR), equity capital to risk-weighted assets (RB CAP), and the total risk-based capital ratio (TCR). Large banks are defined as those that have total assets in the top decile of the quarterly total assets distribution. GMM-type instruments for CAP, LCR and NSFR are used to account for the endogeneity of bank capital and liquidity. All regressions include bank fixed effects and time dummies. Robust standard errors in parentheses are calculated using the finite-sample "Windmeijer correction" for the two-step covariance matrix. A Hansen J-test reports a p-value for the Hansen test of overidentifying restrictions. AR(n) tests present p-values for the Arellano-Bond test of no n-order autocorrelation in residuals. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					ROA				
	CAR	RB CAP	TCR	CAR	RB CAP	TCR	CAR	RB CAP	TCR
Large banks									
L.ROA	0.0770***	0.0836***	0.0753***	0.0870***	0.0861***	0.0767***	0.0928***	0.0944***	0.0921***
	(0.0255)	(0.0265)	(0.0237)	(0.0275)	(0.0266)	(0.0248)	(0.0254)	(0.0262)	(0.0283)
LCR below1	**0.0005***	**0.0008*****	**0.0008****				**0.0006****	**0.0008****	**0.0008****
	(0.0003)	**(0.0003)**	**(0.0003)**				**(0.0003)**	**(0.0003)**	**(0.0003)**
NSFR below1				**0.00004**	**0.0002**	**0.0001**	**0.0001**	**0.0002**	**0.0002**
				(0.00023)	**(0.0002)**	**(0.0003)**	**(0.0002)**	**(0.0003)**	**(0.0003)**
CAP	**0.0096**	**0.0093**	**0.0138***	**0.0110**	**0.0073**	**0.0104**	**0.0125**	**0.0096**	**0.0126***
	(0.0096)	**(0.0061)**	**(0.0078)**	**(0.0092)**	**(0.0064)**	**(0.0081)**	**(0.0096)**	**(0.0062)**	**(0.0069)**
SIZE	-0.0005*	-0.0006**	-0.0006**	-0.0004*	-0.0005**	-0.0005**	-0.0005**	-0.0005**	-0.0005
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0002)	(0.0002)	(0.0003)
LLOSS	-0.4549***	-0.4458***	-0.4449***	-0.4594***	-0.4622***	-0.4460***	-0.4325***	-0.4518***	-0.4355***
	(0.0949)	(0.0912)	(0.1018)	(0.0829)	(0.0699)	(0.0743)	(0.0710)	(0.0720)	(0.0732)
OVC	-0.6257***	-0.6481***	-0.5990***	-0.5607***	-0.5839***	-0.5516***	-0.5483***	-0.5677***	-0.5337***
	(0.1056)	(0.1050)	(0.1053)	(0.0809)	(0.0765)	(0.0912)	(0.0631)	(0.0688)	(0.0690)
NINT	0.0141***	0.0134***	0.0145***	0.0137***	0.0150***	0.0164***	0.0113***	0.0110***	0.0122***
	(0.0037)	(0.0042)	(0.0037)	(0.0041)	(0.0042)	(0.0034)	(0.0029)	(0.0031)	(0.0030)
RGDP_GR	0.0001**	0.0001**	0.0001**	0.0001**	0.0001**	0.0001**	0.0001**	0.0001**	0.0001**
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
_cons	0.0117***	0.0125***	0.0122**	0.0100**	0.0116***	0.0106**	0.0107***	0.0113***	0.0099*
	(0.0045)	(0.0038)	(0.0051)	(0.0039)	(0.0038)	(0.0045)	(0.0033)	(0.0035)	(0.0051)
N	6164	5949	6164	6164	5949	6164	6164	5949	6164
N of banks	280	259	280	280	259	280	280	259	280
χ^2	1640	1291	1665	1249	1197	1306	1231	1341	1380
Hansen J-test	0.2958	0.3514	0.4973	0.2399	0.3751	0.2892	0.6592	0.8661	0.7500
AR(1) test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AR(2) test	0.5753	0.5564	0.6067	0.4501	0.4407	0.4951	0.4753	0.4673	0.5011

Table 2.12: Bank ROA and Liquidity Rules in Small Banks: Indicator Variables of the LCR and NSFR

This table reports estimation results using the Blundell-Bond Two-Step GMM procedure. The dependent variable is bank profitability, which is measured by return on assets (ROA). Bank capital CAP is measured by equity capital to total assets (CAR), equity capital to risk-weighted assets (RB CAP), and the total risk-based capital ratio (TCR). Small banks are defined as those that have total assets in the 90th percentile of the quarterly total assets distribution. GMM-type instruments for CAP, LCR and NSFR are used to account for the endogeneity of bank capital and liquidity. All regressions include bank fixed effects and time dummies. Robust standard errors in parentheses are calculated using the finite-sample "Windmeijer correction" for the two-step covariance matrix. A Hansen J-test reports a p-value for the Hansen test of overidentifying restrictions. AR(n) tests present p-values for the Arellano-Bond test of no n-order autocorrelation in residuals. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					ROA				
	CAR	RB CAP	TCR	CAR	RB CAP	TCR	CAR	RB CAP	TCR
Small banks									
L.ROA	0.0293***	0.0296***	0.0308***	0.0312***	0.0327***	0.0340***	0.0313***	0.0320***	0.0332***
	(0.0083)	(0.0086)	(0.0085)	(0.0086)	(0.0089)	(0.0088)	(0.0081)	(0.0084)	(0.0084)
LCR	**-0.0001**	**0.0001**	**0.0001**				**-0.00002**	**0.0001**	**0.0001**
below1	**(0.0001)**	**(0.0001)**	**(0.0001)**				**(0.00012)**	**(0.0001)**	**(0.0001)**
NSFR				**0.0002***	**0.0003****	**0.0003*****	**0.0002***	**0.0003*****	**0.0003*****
below1				**(0.0001)**	**(0.0001)**	**(0.0001)**	**(0.0001)**	**(0.0001)**	**(0.0001)**
CAP	**0.0215*****	**0.0129*****	**0.0129*****	**0.0213*****	**0.0119*****	**0.0121*****	**0.0217*****	**0.0127*****	**0.0127*****
	(0.0028)	**(0.0021)**	**(0.0022)**	**(0.0028)**	**(0.0021)**	**(0.0021)**	**(0.0027)**	**(0.0019)**	**(0.0020)**
SIZE	-0.0002**	-0.0001	-0.0001	-0.0002**	-0.0002	-0.0001	-0.0002**	-0.0002*	-0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
LLOSS	-0.8143***	-0.8410***	-0.8387***	-0.8234***	-0.8477***	-0.8428***	-0.8023***	-0.8296***	-0.8228***
	(0.0384)	(0.0388)	(0.0384)	(0.0383)	(0.0387)	(0.0376)	(0.0343)	(0.0345)	(0.0342)
OVC	-0.5641***	-0.5499***	-0.5429***	-0.6452***	-0.6442***	-0.6216***	-0.6707***	-0.6604***	-0.6377***
	(0.0849)	(0.0943)	(0.0936)	(0.0778)	(0.0848)	(0.0869)	(0.0692)	(0.0750)	(0.0773)
NINT	0.0146***	0.0138***	0.0148***	0.0134***	0.0135***	0.0131***	0.0147***	0.0144***	0.0145***
	(0.0022)	(0.0022)	(0.0022)	(0.0023)	(0.0022)	(0.0023)	(0.0019)	(0.0019)	(0.0019)
RGDP_GR	-0.00002	-0.00002*	-0.00003**	-0.00002*	-0.00003**	-0.00003**	-0.00002	-0.00003**	-0.00003**
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
_cons	0.0065***	0.0059***	0.0050***	0.0071***	0.0068***	0.0058***	0.0072***	0.0069***	0.0060***
	(0.0014)	(0.0017)	(0.0017)	(0.0015)	(0.0017)	(0.0018)	(0.0014)	(0.0016)	(0.0017)
N	63477	63477	63477	63477	63477	63477	63477	63477	63477
N of banks	2674	2674	2674	2674	2674	2674	2674	2674	2674
χ^2	7096	6728	6789	6619	6206	6294	6967	6607	6719
Hansen J-test	0.1944	0.1198	0.1732	0.0582	0.0520	0.0548	0.3081	0.2623	0.2148
AR(1) test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AR(2) test	0.1650	0.1627	0.1714	0.1627	0.1596	0.1680	0.1447	0.1398	0.1453

Table 2.13: Bank ROE and Liquidity Rules in Large Banks: Indicator Variables of the LCR and NSFR

This table reports estimation results using the Blundell-Bond Two-Step GMM procedure. The dependent variable is bank profitability, which is measured by return on equity (ROE). Bank capital CAP is measured by equity capital to total assets (CAR), equity capital to risk-weighted assets (RB CAP), and the total risk-based capital ratio (TCR). Large banks are defined as those that have total assets in the top decile of the quarterly total assets distribution. GMM-type instruments for CAP, LCR and NSFR are used to account for the endogeneity of bank capital and liquidity. All regressions include bank fixed effects and time dummies. Robust standard errors in parentheses are calculated using the finite-sample "Windmeijer correction" for the two-step covariance matrix. A Hansen J-test reports a p-value for the Hansen test of overidentifying restrictions. AR(n) tests present p-values for the Arellano-Bond test of no n-order autocorrelation in residuals. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					ROE				
	CAR	RB CAP	TCR	CAR	RB CAP	TCR	CAR	RB CAP	TCR
Large banks									
L.ROE	0.0946***	0.1089***	0.1046***	0.0996***	0.1169***	0.1077***	0.1104***	0.1205***	0.1156***
	(0.0294)	(0.0329)	(0.0337)	(0.0315)	(0.0328)	(0.0284)	(0.0285)	(0.0313)	(0.0303)
LCR	**0.0057**	**0.0085****	**0.0075***				**0.0045**	**0.0065**	**0.0070***
below1	**(0.0036)**	**(0.0041)**	**(0.0044)**				**(0.0038)**	**(0.0044)**	**(0.0042)**
NSFR				**-0.0006**	**0.0019**	**-0.0001**	**0.0002**	**0.0027**	**0.0023**
below1				**(0.0039)**	**(0.0041)**	**(0.0042)**	**(0.0034)**	**(0.0034)**	**(0.0035)**
CAP	**0.0402**	**0.0777**	**0.1714**	**0.0557**	**0.0547**	**0.0787**	**0.0604**	**0.0739**	**0.1483**
	(0.1470)	**(0.0913)**	**(0.1093)**	**(0.1072)**	**(0.0882)**	**(0.0883)**	**(0.1280)**	**(0.0939)**	**(0.1051)**
SIZE	-0.0091***	-0.0076**	-0.0083**	-0.0096***	-0.0084**	-0.0091***	-0.0075***	-0.0072**	-0.0068**
	(0.0032)	(0.0032)	(0.0033)	(0.0029)	(0.0038)	(0.0033)	(0.0024)	(0.0030)	(0.0031)
LLOSS	-5.7597***	-6.3269***	-5.9589***	-6.2730***	-6.3334***	-6.0039***	-6.1262***	-6.3186***	-6.0744***
	(1.2408)	(1.2299)	(1.4280)	(1.0839)	(1.0706)	(1.1711)	(0.9605)	(0.9872)	(1.0831)
OVC	-8.8240***	-9.1218***	-8.7489***	-7.7139***	-8.5290***	-8.0628***	-7.7389***	-8.0999***	-7.8906***
	(1.1306)	(1.5187)	(1.5005)	(1.0716)	(1.2195)	(1.1044)	(0.8833)	(0.9318)	(0.9727)
NINT	0.2142***	0.1780***	0.2037***	0.2416***	0.2105***	0.2343***	0.1901***	0.1637***	0.1835***
	(0.0507)	(0.0545)	(0.0562)	(0.0475)	(0.0501)	(0.0493)	(0.0390)	(0.0431)	(0.0414)
RGDP_GR	0.0009	0.0008	0.0008	0.0008	0.0008	0.0009	0.0010*	0.0010*	0.0010
	(0.0006)	(0.0007)	(0.0007)	(0.0006)	(0.0006)	(0.0006)	(0.0005)	(0.0006)	(0.0006)
_cons	0.1978***	0.1765***	0.1663***	0.1939***	0.1829***	0.1822***	0.1663***	0.1635***	0.1394**
	(0.0507)	(0.0473)	(0.0549)	(0.0458)	(0.0596)	(0.0567)	(0.0389)	(0.0465)	(0.0551)
N	6164	5949	6164	6164	5949	6164	6164	5949	6164
N of banks	280	259	280	280	259	280	280	259	280
χ^2	1523	1302	1225	1179	1062	1196	1608	1571	1367
Hansen J-test	0.6040	0.5648	0.5686	0.4180	0.2956	0.5657	0.9513	0.8841	0.9438
AR(1) test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AR(2) test	0.6218	0.7078	0.6977	0.7113	0.8017	0.7536	0.7179	0.7731	0.7529

Table 2.14: Bank ROE and Liquidity Rules in Small Banks: Indicator Variables of the LCR and NSFR

This table reports estimation results using the Blundell-Bond Two-Step GMM procedure. The dependent variable is bank profitability, which is measured by return on equity (ROE). Bank capital CAP is measured by equity capital to total assets (CAR), equity capital to risk-weighted assets (RB CAP), and the total risk-based capital ratio (TCR). Small banks are defined as those that have total assets in the 90th percentile of the quarterly total assets distribution. GMM-type instruments for CAP, LCR and NSFR are used to account for the endogeneity of bank capital and liquidity. All regressions include bank fixed effects and time dummies. Robust standard errors in parentheses are calculated using the finite-sample "Windmeijer correction" for the two-step covariance matrix. A Hansen J-test reports a p-value for the Hansen test of overidentifying restrictions. AR(n) tests present p-values for the Arellano-Bond test of no n-order autocorrelation in residuals. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					ROE				
	CAR	RB CAP	TCR	CAR	RB CAP	TCR	CAR	RB CAP	TCR
Small banks									
L.ROE	0.0586***	0.0621***	0.0580***	0.0692***	0.0730***	0.0682***	0.0714***	0.0748***	0.0708***
	(0.0167)	(0.0166)	(0.0159)	(0.0166)	(0.0165)	(0.0160)	(0.0153)	(0.0152)	(0.0148)
LCR	**-0.0041**	**-0.0038**	**-0.0045**				**-0.0040**	**-0.0040**	**-0.0040**
below1	**(0.0030)**	**(0.0029)**	**(0.0028)**				**(0.0027)**	**(0.0027)**	**(0.0026)**
NSFR				**0.0037***	**0.0034**	**0.0024**	**0.0038***	**0.0034***	**0.0023**
below1				**(0.0021)**	**(0.0021)**	**(0.0021)**	**(0.0020)**	**(0.0020)**	**(0.0020)**
CAP	**-0.0710**	**-0.0243**	**-0.0874***	**-0.0277**	**0.0038**	**-0.0572**	**-0.0417**	**-0.0064**	**-0.0637**
	(0.0727)	**(0.0416)**	**(0.0489)**	**(0.0671)**	**(0.0381)**	**(0.0465)**	**(0.0636)**	**(0.0368)**	**(0.0457)**
SIZE	-0.0029*	-0.0025	-0.0043**	-0.0028*	-0.0028*	-0.0048***	-0.0034**	-0.0033**	-0.0051***
	(0.0017)	(0.0017)	(0.0018)	(0.0016)	(0.0016)	(0.0017)	(0.0015)	(0.0015)	(0.0016)
LLOSS	-14.5372***	-14.1493***	-13.7863***	-13.6687***	-13.5349***	-13.1294***	-13.5487***	-13.3928***	-13.0750***
	(0.9930)	(0.9306)	(0.9000)	(0.9884)	(0.9522)	(0.9311)	(0.8385)	(0.8060)	(0.7761)
OVC	-3.6702*	-3.8657**	-4.1352**	-4.5494**	-4.4321**	-5.0380**	-5.2405***	-5.1448***	-5.7393***
	(1.8867)	(1.8894)	(1.9380)	(1.9516)	(1.9971)	(2.1677)	(1.7672)	(1.7747)	(1.8451)
NINT	0.0985*	0.0935*	0.1167**	0.0755	0.0788	0.0984*	0.0984**	0.0979**	0.1176***
	(0.0535)	(0.0522)	(0.0557)	(0.0505)	(0.0487)	(0.0544)	(0.0442)	(0.0429)	(0.0454)
RGDP_GR	-0.0012***	-0.0011***	-0.0010***	-0.0010***	-0.0010***	-0.0008***	-0.0010***	-0.0010***	-0.0009***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0002)
_cons	0.1046***	0.0973***	0.1294***	0.1048***	0.1004***	0.1377***	0.1173***	0.1114***	0.1464***
	(0.0272)	(0.0273)	(0.0304)	(0.0267)	(0.0274)	(0.0314)	(0.0244)	(0.0244)	(0.0274)
N	63477	63477	63477	63477	63477	63477	63477	63477	63477
N of banks	2674	2674	2674	2674	2674	2674	2674	2674	2674
χ^2	2367	2500	2499	2570	2686	2607	2605	2700	2658
Hansen J-test	0.8813	0.6371	0.5312	0.5643	0.4191	0.2491	0.6452	0.4625	0.3162
AR(1) test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AR(2) test	0.9357	0.9869	0.9978	0.9621	0.9042	0.8972	0.9195	0.8674	0.8697

Table 2.15: Bank ROA and Liquidity Rules in Large Banks: Changes of the LCR and NSFR

This table reports estimation results using the Blundell-Bond Two-Step GMM procedure. The dependent variable is bank profitability, which is measured by return on assets (ROA). Bank capital CAP is measured by equity capital to total assets (CAR), equity capital to risk-weighted assets (RB CAP), and the total risk-based capital ratio (TCR). Large banks are defined as those that have total assets in the top decile of the quarterly total assets distribution. GMM-type instruments for CAP, LCR and NSFR are used to account for the endogeneity of bank capital and liquidity. All regressions include bank fixed effects and time dummies. Robust standard errors in parentheses are calculated using the finite-sample "Windmeijer correction" for the two-step covariance matrix. A Hansen J-test reports a p-value for the Hansen test of overidentifying restrictions. AR(n) tests present p-values for the Arellano-Bond test of no n-order autocorrelation in residuals. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					ROA				
	CAR	RB CAP	TCR	CAR	RB CAP	TCR	CAR	RB CAP	TCR
Large banks									
L.ROA	0.1817***	0.1958***	0.0874***	0.0777***	0.0789***	0.0736***	0.0852***	0.0833***	0.0823***
	(0.0650)	(0.0623)	(0.0250)	(0.0231)	(0.0240)	(0.0224)	(0.0224)	(0.0223)	(0.0215)
△LCR	**-0.0001**	**-0.0001**	**-0.0001**				**-0.0001**	**-0.0001***	**-0.0001***
	(0.0001)	**(0.0001)**	**(0.0001)**				**(0.0001)**	**(0.0001)**	**(0.0001)**
△NSFR				**0.0021**	**0.0018**	**0.0023**	**0.0017**	**0.0017**	**0.0019**
				(0.0015)	**(0.0015)**	**(0.0015)**	**(0.0013)**	**(0.0013)**	**(0.0014)**
CAP	**-0.00002**	**-0.0003**	**0.0130***	**0.0127**	**0.0040**	**0.0065**	**0.0156***	**0.0077**	**0.0089**
	(0.01049)	**(0.0056)**	**(0.0067)**	**(0.0085)**	**(0.0060)**	**(0.0077)**	**(0.0092)**	**(0.0054)**	**(0.0065)**
SIZE	-0.0005**	-0.0006***	-0.0005*	-0.0005**	-0.0008**	-0.0007***	-0.0004*	-0.0006***	-0.0006**
	(0.0002)	(0.0002)	(0.0003)	(0.0002)	(0.0003)	(0.0003)	(0.0002)	(0.0002)	(0.0003)
LLOSS	-0.4397***	-0.4109***	-0.4492***	-0.4121***	-0.4311***	-0.4074***	-0.4055***	-0.4189***	-0.3997***
	(0.0726)	(0.0709)	(0.0850)	(0.0825)	(0.0749)	(0.0767)	(0.0728)	(0.0729)	(0.0671)
OVC	-0.6025***	-0.6098***	-0.6291***	-0.5720***	-0.5872***	-0.5605***	-0.5428***	-0.5687***	-0.5545***
	(0.1012)	(0.0968)	(0.1122)	(0.0968)	(0.0893)	(0.1079)	(0.0778)	(0.0803)	(0.0830)
NINT	0.0135***	0.0128***	0.0140***	0.0162***	0.0186***	0.0195***	0.0135***	0.0145***	0.0157***
	(0.0039)	(0.0041)	(0.0039)	(0.0034)	(0.0042)	(0.0032)	(0.0031)	(0.0034)	(0.0031)
RGDP_GR	0.0001**	0.0001**	0.0001**	0.0001***	0.0001**	0.0001***	0.0001***	0.0001***	0.0001***
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
_cons	0.0122***	0.0145***	0.0113**	0.0110***	0.0155***	0.0136***	0.0095**	0.0134***	0.0117***
	(0.0033)	(0.0038)	(0.0047)	(0.0036)	(0.0047)	(0.0044)	(0.0040)	(0.0034)	(0.0044)
N	6150	5935	6150	6164	5949	6164	6150	5935	6150
N of banks	280	259	280	280	259	280	280	259	280
χ^2	1368	1265	1190	1079	1040	1116	1107	1181	1090
Hansen J-test	0.3019	0.3409	0.1847	0.2026	0.2419	0.3684	0.6624	0.7423	0.6630
AR(1) test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AR(2) test	0.2318	0.2136	0.4715	0.5138	0.5089	0.5465	0.4411	0.4543	0.4766

Table 2.16: Bank ROA and Liquidity Rules in Small Banks: Changes of the LCR and NSFR

This table reports estimation results using the Blundell-Bond Two-Step GMM procedure. The dependent variable is bank profitability, which is measured by return on assets (ROA). Bank capital CAP is measured by equity capital to total assets (CAR), equity capital to risk-weighted assets (RB CAP), and the total risk-based capital ratio (TCR). Small banks are defined as those that have total assets in the 90th percentile of the quarterly total assets distribution. GMM-type instruments for CAP, LCR and NSFR are used to account for the endogeneity of bank capital and liquidity. All regressions include bank fixed effects and time dummies. Robust standard errors in parentheses are calculated using the finite-sample "Windmeijer correction" for the two-step covariance matrix. A Hansen J-test reports a p-value for the Hansen test of overidentifying restrictions. AR(n) tests present p-values for the Arellano-Bond test of no n-order autocorrelation in residuals. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					ROA				
	CAR	RB CAP	TCR	CAR	RB CAP	TCR	CAR	RB CAP	TCR
Small banks									
L.ROA	0.1489***	0.1800***	0.1871***	0.1447***	0.1679***	0.1586***	0.1476***	0.1728***	0.1711***
	(0.0331)	(0.0339)	(0.0326)	(0.0318)	(0.0328)	(0.0318)	(0.0318)	(0.0327)	(0.0317)
△LCR	**0.00002**	**0.00001**	**0.00001**				**0.00004**	**0.00002**	**0.00002**
	(0.00003)	**(0.00003)**	**(0.00003)**				**(0.00003)**	**(0.00003)**	**(0.00003)**
△NSFR				**-0.0005**	**-0.0013*** **	**-0.0011*** *	**-0.0010*** *	**-0.0015*** **	**-0.0013*** **
				(0.0005)	**(0.0005)**	**(0.0005)**	**(0.0004)**	**(0.0005)**	**(0.0005)**
CAP	**0.0183*** **	**0.0090*** **	**0.0097*** **	**0.0186*** **	**0.0109*** **	**0.0110*** **	**0.0185*** **	**0.0104*** **	**0.0103*** **
	(0.0031)	**(0.0021)**	**(0.0023)**	**(0.0030)**	**(0.0021)**	**(0.0023)**	**(0.0030)**	**(0.0020)**	**(0.0023)**
SIZE	-0.0002*	-0.0002*	-0.0002	-0.0002**	-0.0002*	-0.0001	-0.0002**	-0.0002*	-0.0002*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
LLOSS	-0.7349***	-0.7234***	-0.7246***	-0.7503***	-0.7545***	-0.7639***	-0.7427***	-0.7353***	-0.7434***
	(0.0401)	(0.0402)	(0.0378)	(0.0423)	(0.0436)	(0.0418)	(0.0387)	(0.0393)	(0.0377)
OVC	-0.6251***	-0.6897***	-0.6322***	-0.6151***	-0.6557***	-0.6013***	-0.6250***	-0.6681***	-0.6129***
	(0.0896)	(0.0921)	(0.0930)	(0.0846)	(0.0877)	(0.0859)	(0.0743)	(0.0752)	(0.0764)
NINT	0.0142***	0.0151***	0.0144***	0.0130***	0.0136***	0.0131***	0.0138***	0.0144***	0.0138***
	(0.0019)	(0.0019)	(0.0020)	(0.0019)	(0.0019)	(0.0019)	(0.0015)	(0.0016)	(0.0016)
RGDP_GR	-0.00001	-0.00002*	-0.00002*	-0.00001	-0.00002**	-0.00002**	-0.00002	-0.00002**	-0.00002**
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
_cons	0.0063***	0.0073***	0.0063***	0.0064***	0.0067***	0.0059***	0.0063***	0.0070***	0.0062***
	(0.0016)	(0.0018)	(0.0019)	(0.0015)	(0.0016)	(0.0017)	(0.0015)	(0.0016)	(0.0017)
N	63477	63477	63477	63477	63477	63477	63477	63477	63477
N of banks	2674	2674	2674	2674	2674	2674	2674	2674	2674
χ^2	7774	7368	7479	7525	7134	7021	7907	7552	7518
Hansen J-test	0.1703	0.2374	0.2886	0.1361	0.0940	0.0775	0.2219	0.2726	0.1914
AR(1) test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AR(2) test	0.9098	0.8520	0.4975	0.9136	0.9196	0.7831	0.9490	0.8580	0.6331

Table 2.17: Bank ROE and Liquidity Rules in Large Banks: Changes of the LCR and NSFR

This table reports estimation results using the Blundell-Bond Two-Step GMM procedure. The dependent variable is bank profitability, which is measured by return on equity (ROE). Bank capital CAP is measured by equity capital to total assets (CAR), equity capital to risk-weighted assets (RB CAP), and the total risk-based capital ratio (TCR). Large banks are defined as those that have total assets in the top decile of the quarterly total assets distribution. GMM-type instruments for CAP, LCR and NSFR are used to account for the endogeneity of bank capital and liquidity. All regressions include bank fixed effects and time dummies. Robust standard errors in parentheses are calculated using the finite-sample "Windmeijer correction" for the two-step covariance matrix. A Hansen J-test reports a p-value for the Hansen test of overidentifying restrictions. AR(n) tests present p-values for the Arellano-Bond test of no n-order autocorrelation in residuals. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					ROE				
	CAR	RB CAP	TCR	CAR	RB CAP	TCR	CAR	RB CAP	TCR
Large banks									
L.ROE	0.1011***	0.1097***	0.1020***	0.1050***	0.1089***	0.1111***	0.1106***	0.1162***	0.1085***
	(0.0300)	(0.0301)	(0.0300)	(0.0312)	(0.0336)	(0.0288)	(0.0311)	(0.0325)	(0.0306)
△LCR	**-0.0019***	**-0.0023****	**-0.0022***				**-0.0018***	**-0.0024****	**-0.0022****
	(0.0011)	**(0.0011)**	**(0.0012)**				**(0.0010)**	**(0.0011)**	**(0.0011)**
△NSFR				**0.0297**	**0.0198**	**0.0305**	**0.0239**	**0.0141**	**0.0237**
				(0.0192)	**(0.0200)**	**(0.0204)**	**(0.0203)**	**(0.0206)**	**(0.0220)**
CAP	**0.0439**	**0.1027**	**0.1937**	**0.0809**	**0.0094**	**0.0437**	**0.0599**	**0.0526**	**0.1128**
	(0.1616)	**(0.1099)**	**(0.1187)**	**(0.1298)**	**(0.0846)**	**(0.1062)**	**(0.1386)**	**(0.0823)**	**(0.0930)**
SIZE	-0.0084***	-0.0080**	-0.0070	-0.0091***	-0.0089**	-0.0093**	-0.0070**	-0.0067**	-0.0065*
	(0.0031)	(0.0034)	(0.0046)	(0.0031)	(0.0036)	(0.0036)	(0.0028)	(0.0029)	(0.0033)
LLOSS	-5.9075***	-6.0790***	-6.0361***	-5.5781***	-6.0944***	-5.7939***	-5.6365***	-6.0045***	-5.7775***
	(1.2757)	(1.2654)	(1.2912)	(1.2045)	(1.1541)	(1.0789)	(1.0950)	(1.1031)	(1.0916)
OVC	-9.3412***	-9.8147***	-9.9233***	-8.0368***	-8.3815***	-7.9258***	-7.9222***	-8.5191***	-8.3456***
	(1.3891)	(1.3343)	(1.6649)	(1.1388)	(1.4078)	(1.3225)	(1.1827)	(1.1922)	(1.3227)
NINT	0.2019***	0.1788***	0.2029***	0.2636***	0.2375***	0.2586***	0.2009***	0.1830***	0.2131***
	(0.0482)	(0.0510)	(0.0490)	(0.0485)	(0.0622)	(0.0539)	(0.0407)	(0.0414)	(0.0408)
RGDP_GR	0.0010	0.0009	0.0008	0.0010*	0.0008	0.0009	0.0012**	0.0011*	0.0011*
	(0.0007)	(0.0007)	(0.0007)	(0.0006)	(0.0006)	(0.0005)	(0.0006)	(0.0006)	(0.0006)
_cons	0.1959***	0.1908***	0.1555**	0.1795***	0.1918***	0.1833***	0.1607***	0.1637***	0.1437**
	(0.0492)	(0.0556)	(0.0743)	(0.0480)	(0.0563)	(0.0606)	(0.0450)	(0.0450)	(0.0563)
N	6150	5935	6150	6164	5949	6164	6150	5935	6150
N of banks	280	259	280	280	259	280	280	259	280
χ^2	1040	1082	872	1371	1226	1202	1382	1258	1147
Hansen J-test	0.2151	0.2858	0.1877	0.3699	0.2206	0.4491	0.6960	0.7487	0.7480
AR(1) test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AR(2) test	0.7227	0.8242	0.7868	0.7452	0.7598	0.7772	0.8038	0.8611	0.8241

Table 2.18: Bank ROE and Liquidity Rules in Small Banks: Changes of the LCR and NSFR

This table reports estimation results using the Blundell-Bond Two-Step GMM procedure. The dependent variable is bank profitability, which is measured by return on equity (ROE). Bank capital CAP is measured by equity capital to total assets (CAR), equity capital to risk-weighted assets (RB CAP), and the total risk-based capital ratio (TCR). Small banks are defined as those that have total assets in the 90th percentile of the quarterly total assets distribution. GMM-type instruments for CAP, LCR and NSFR are used to account for the endogeneity of bank capital and liquidity. All regressions include bank fixed effects and time dummies. Robust standard errors in parentheses are calculated using the finite-sample "Windmeijer correction" for the two-step covariance matrix. A Hansen J-test reports a p-value for the Hansen test of overidentifying restrictions. AR(n) tests present p-values for the Arellano-Bond test of no n-order autocorrelation in residuals. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					ROE				
	CAR	RB CAP	TCR	CAR	RB CAP	TCR	CAR	RB CAP	TCR
Small banks									
L.ROE	0.0613***	0.0624***	0.0595***	0.0616***	0.0628***	0.0588***	0.0634***	0.0640***	0.0602***
	(0.0167)	(0.0166)	(0.0158)	(0.0157)	(0.0157)	(0.0153)	(0.0149)	(0.0150)	(0.0146)
△LCR	**0.0002**	**0.0002**	**0.0003**				**0.0003**	**0.0003**	**0.0003**
	(0.0005)	**(0.0005)**	**(0.0005)**				**(0.0004)**	**(0.0004)**	**(0.0004)**
△NSFR				**-0.0226*** **	**-0.0240*** **	**-0.0178** **	**-0.0243*** **	**-0.0240*** **	**-0.0163** **
				(0.0078)	**(0.0080)**	**(0.0083)**	**(0.0072)**	**(0.0075)**	**(0.0078)**
CAP	**-0.0331**	**-0.0178**	**-0.0831**	**-0.0417**	**0.0156**	**-0.0352**	**-0.0113**	**0.0170**	**-0.0428**
	(0.0763)	**(0.0450)**	**(0.0526)**	**(0.0662)**	**(0.0399)**	**(0.0476)**	**(0.0645)**	**(0.0399)**	**(0.0480)**
SIZE	-0.0027	-0.0028	-0.0047**	-0.0031**	-0.0027*	-0.0043**	-0.0030**	-0.0027*	-0.0047***
	(0.0017)	(0.0017)	(0.0019)	(0.0016)	(0.0015)	(0.0017)	(0.0015)	(0.0015)	(0.0017)
LLOSS	-14.1749***	-13.8253***	-13.3729***	-14.0339***	-13.6858***	-13.3971***	-13.5593***	-13.2746***	-13.0413***
	(1.0368)	(0.9785)	(0.9332)	(0.9223)	(0.8866)	(0.8816)	(0.8288)	(0.7824)	(0.7530)
OVC	-3.6765*	-3.9506*	-4.2202**	-5.0042***	-5.0235***	-5.1664***	-5.2459***	-5.1315***	-5.3503***
	(2.0776)	(2.0788)	(2.1079)	(1.8847)	(1.8959)	(1.9480)	(1.8603)	(1.8201)	(1.7935)
NINT	0.1045**	0.1118**	0.1360***	0.0906**	0.0908**	0.1072**	0.1081***	0.1113***	0.1325***
	(0.0489)	(0.0490)	(0.0505)	(0.0431)	(0.0425)	(0.0438)	(0.0400)	(0.0397)	(0.0397)
RGDP_GR	-0.0010***	-0.0010***	-0.0008***	-0.0010***	-0.0010***	-0.0008***	-0.0009***	-0.0008***	-0.0008***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0002)
_cons	0.0963***	0.0962***	0.1299***	0.1149***	0.1027***	0.1296***	0.1084***	0.0994***	0.1328***
	(0.0295)	(0.0303)	(0.0338)	(0.0257)	(0.0263)	(0.0298)	(0.0260)	(0.0261)	(0.0297)
N	63477	63477	63477	63477	63477	63477	63477	63477	63477
N of banks	2674	2674	2674	2674	2674	2674	2674	2674	2674
χ^2	2208	2287	2285	2787	2938	2833	2768	2884	2774
Hansen J-test	0.5461	0.3299	0.2790	0.7013	0.4509	0.3717	0.7337	0.5842	0.5643
AR(1) test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AR(2) test	0.9754	0.9841	0.9481	0.9457	0.9834	0.9878	0.9987	0.9654	0.9650

Table 2.19: Profitability and Liquidity Rules: Large Banks' Behavior before and after the Crisis

This table reports estimation results using the Blundell-Bond Two-Step GMM procedure. The dependent variable is bank profitability, which is measured by return on assets (ROA) and return on equity (ROE). Bank capital CAP is measured by equity capital to total assets (CAR), equity capital to risk-weighted assets (RB CAP), and the total risk-based capital ratio (TCR). Large banks are defined as those that have total assets in the top decile of the quarterly total assets distribution. GMM-type instruments for CAP, LCR and NSFR are used to account for the endogeneity of bank capital and liquidity. The crisis period is from 2007 Q3 through 2009 Q4. The post crisis period is from 2010 Q1 through 2013 Q4. All regressions include bank controls, fixed effects and time dummies. Bank controls: bank size, loan loss provisions over total loans, overhead costs and the annual growth rate of real GDP. Robust standard errors in parentheses are calculated using the finite-sample "Windmeijer correction" for the two-step covariance matrix. A Hansen J-test reports a p-value for the Hansen test of overidentifying restrictions. AR(n) tests present p-values for the Arellano-Bond test of no n-order autocorrelation in residuals. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1) CAR	(2) RB CAP	(3) TCR	(4) CAR	(5) RB CAP	(6) TCR	(7) CAR	(8) RB CAP	(9) TCR
Panel A: ROA									
L.ROA	0.0891***	0.0903***	0.0853***	0.1555***	0.0876***	0.1877***	0.0803***	0.0872***	0.0845***
	(0.0244)	(0.0242)	(0.0247)	(0.0597)	(0.0220)	(0.0583)	(0.0216)	(0.0197)	(0.0205)
LCR/100	-0.0107**	-0.0145**	-0.0139**				-0.0144**	-0.0093*	-0.0098*
	(0.0053)	(0.0061)	(0.0060)				(0.0069)	(0.0051)	(0.0057)
LCR*Crisis	-0.0053	-0.0080	-0.0080				0.0112	-0.0064	-0.0079
	(0.0085)	(0.0097)	(0.0101)				(0.0157)	(0.0087)	(0.0094)
LCR*Post	-0.0187*	-0.0253**	-0.0242**				0.0002	-0.0195*	-0.0164*
	(0.0100)	(0.0109)	(0.0101)				(0.0136)	(0.0099)	(0.0096)
NSFR				0.0046*	0.0015	0.0063**	0.0026	0.0006	0.0023
				(0.0026)	(0.0021)	(0.0030)	(0.0019)	(0.0022)	(0.0022)
NSFR*Crisis				0.0004	0.0011	-0.0019	0.0015	0.0010	-0.0003
				(0.0050)	(0.0050)	(0.0047)	(0.0031)	(0.0024)	(0.0025)
NSFR*Post				-0.0012	0.0021	-0.0024	0.0025	0.0017	-0.0001
				(0.0029)	(0.0027)	(0.0031)	(0.0031)	(0.0027)	(0.0025)
CAP	0.0155	0.0127**	0.0157**	0.0123	0.0101*	-0.0003	0.0144	0.0118**	0.0133**
	(0.0097)	(0.0061)	(0.0064)	(0.0088)	(0.0056)	(0.0083)	(0.0104)	(0.0051)	(0.0060)
N	6150	5935	6150	6164	5949	6164	6150	5935	6150
N of banks	280	259	280	280	259	280	280	259	280
χ^2	1145	1149	1165	1574	1430	1663	1469	1401	1370
Hansen J-test	0.7382	0.6759	0.7559	0.9277	0.8719	0.9110	0.8371	0.9999	0.9999
AR(1) test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AR(2) test	0.4241	0.4112	0.4689	0.2622	0.4689	0.1901	0.4798	0.4049	0.4470
Panel B: ROE									
L.ROE	0.1071***	0.1147***	0.1129***	0.0983***	0.1127***	0.1061***	0.1010***	0.1196***	0.1098***
	(0.0281)	(0.0288)	(0.0302)	(0.0293)	(0.0289)	(0.0303)	(0.0277)	(0.0333)	(0.0305)
LCR/100	-0.1436	-0.2150**	-0.1861**				-0.0799	-0.2407*	-0.2269*
	(0.0911)	(0.0938)	(0.0930)				(0.0931)	(0.1425)	(0.1322)
LCR*Crisis	-0.2698	-0.2398	-0.2710				-0.1607	-0.1755	-0.2423
	(0.1866)	(0.1850)	(0.1946)				(0.1704)	(0.3427)	(0.3254)
LCR*Post	-0.6541***	-0.6103***	-0.5963***				-0.3046*	-0.6521***	-0.6438**
	(0.1980)	(0.1907)	(0.1700)				(0.1698)	(0.2317)	(0.2528)
NSFR				0.0546*	0.0532	0.0669*	0.0304	0.0312	0.0471
				(0.0324)	(0.0337)	(0.0357)	(0.0327)	(0.0391)	(0.0383)
NSFR*Crisis				-0.0626	-0.0538	-0.0750	-0.0112	-0.0309	-0.0357
				(0.0627)	(0.0581)	(0.0584)	(0.0295)	(0.0450)	(0.0441)
NSFR*Post				-0.0124	-0.0082	-0.0190	0.0140	0.0150	0.0115
				(0.0358)	(0.0376)	(0.0386)	(0.0304)	(0.0487)	(0.0479)
CAP	0.0605	0.1163	0.1903	0.1021	0.0924	0.1440	0.0649	0.0957	0.1749
	(0.1696)	(0.1076)	(0.1289)	(0.1533)	(0.0944)	(0.1217)	(0.1547)	(0.0950)	(0.1148)
N	6150	5935	6150	6164	5949	6164	6150	5935	6150
N of banks	280	259	280	280	259	280	280	259	280
χ^2	1390	1525	1129	1143	1196	1171	1320	1039	1176
Hansen J-test	0.8936	0.8120	0.6394	0.8912	0.8686	0.8268	0.9999	0.6848	0.7328
AR(1) test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AR(2) test	0.7863	0.8766	0.8392	0.7509	0.8203	0.8108	0.7577	0.9496	0.9018

Table 2.20: Profitability and Liquidity Rules: Small Banks' Behavior before and after the Crisis

This table reports estimation results using the Blundell-Bond Two-Step GMM procedure. The dependent variable is bank profitability, which is measured by return on assets (ROA) and return on equity (ROE). Bank capital CAP is measured by equity capital to total assets (CAR), equity capital to risk-weighted assets (RB CAP), and the total risk-based capital ratio (TCR). Small banks are defined as those that have total assets in the 90th percentile of the quarterly total assets distribution. GMM-type instruments for CAP, LCR and NSFR are used to account for the endogeneity of bank capital and liquidity. The crisis period is from 2007 Q3 through 2009 Q4. The post crisis period is from 2010 Q1 through 2013 Q4. All regressions include bank controls, fixed effects and time dummies. Bank controls: bank size, loan loss provisions over total loans, overhead costs and the annual growth rate of real GDP. Robust standard errors in parentheses are calculated using the finite-sample "Windmeijer correction" for the two-step covariance matrix. A Hansen J-test reports a p-value for the Hansen test of overidentifying restrictions. AR(n) tests present p-values for the Arellano-Bond test of no n-order autocorrelation in residuals. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	CAR	RB CAP	TCR	CAR	RB CAP	TCR	CAR	RB CAP	TCR
Panel A: ROA									
L.ROA	0.1586***	0.1808***	0.1880***	0.0334***	0.0352***	0.0333***	0.0349***	0.0382***	0.0372***
	(0.0331)	(0.0327)	(0.0322)	(0.0084)	(0.0086)	(0.0084)	(0.0084)	(0.0085)	(0.0085)
LCR/100	0.0027	-0.0027	-0.0005				0.0014	-0.0001	-0.0006
	(0.0024)	(0.0027)	(0.0026)				(0.0023)	(0.0024)	(0.0025)
LCR*Crisis	-0.0028	-0.0041	-0.0050*				-0.0095	-0.0089	-0.0073
	(0.0029)	(0.0029)	(0.0028)				(0.0058)	(0.0056)	(0.0057)
LCR*Post	-0.0015	-0.0080**	-0.0094***				-0.0074	-0.0124**	-0.0103*
	(0.0037)	(0.0036)	(0.0035)				(0.0056)	(0.0058)	(0.0059)
NSFR				-0.0013**	-0.0031***	-0.0022***	-0.0027***	-0.0047***	-0.0030***
				(0.0007)	(0.0007)	(0.0007)	(0.0009)	(0.0009)	(0.0009)
NSFR*Crisis				0.0004	0.0004	-0.0007	0.0042**	0.0043**	0.0022
				(0.0015)	(0.0016)	(0.0015)	(0.0019)	(0.0020)	(0.0019)
NSFR*Post				0.0010	0.0025**	0.0012	0.0036**	0.0065***	0.0036*
				(0.0010)	(0.0011)	(0.0010)	(0.0017)	(0.0018)	(0.0019)
CAP	0.0180***	0.0079***	0.0097***	0.0204***	0.0117***	0.0098***	0.0208***	0.0121***	0.0096***
	(0.0029)	(0.0020)	(0.0024)	(0.0027)	(0.0021)	(0.0022)	(0.0029)	(0.0021)	(0.0024)
N	63477	63477	63477	63477	63477	63477	63477	63477	63477
N of banks	2674	2674	2674	2674	2674	2674	2674	2674	2674
χ^2	8270	8564	7421	6733	6249	6191	6913	6610	6470
Hansen J-test	0.0559	0.1257	0.1047	0.0458	0.0865	0.0323	0.0873	0.2606	0.0487
AR(1) test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AR(2) test	0.6919	0.6844	0.5425	0.2180	0.2074	0.2145	0.1796	0.2062	0.2127
Panel B: ROE									
L.ROE	0.0584***	0.0594***	0.0583***	0.0600***	0.0592***	0.0631***	0.0617***	0.0603***	0.0675***
	(0.0161)	(0.0160)	(0.0152)	(0.0164)	(0.0166)	(0.0157)	(0.0153)	(0.0156)	(0.0152)
LCR/100	0.0118	0.0144	0.0316				0.0256	0.0264	0.0309
	(0.0476)	(0.0463)	(0.0449)				(0.0403)	(0.0412)	(0.0406)
LCR*Crisis	-0.1437**	-0.1454**	-0.1561**				-0.1043*	-0.1041*	-0.0976
	(0.0689)	(0.0683)	(0.0653)				(0.0629)	(0.0627)	(0.0605)
LCR*Post	0.0729	0.0802	0.0404				0.0138	0.0284	0.0189
	(0.0666)	(0.0672)	(0.0642)				(0.0699)	(0.0706)	(0.0665)
NSFR				-0.0433***	-0.0472***	-0.0368**	-0.0375***	-0.0387***	-0.0250**
				(0.0152)	(0.0155)	(0.0147)	(0.0121)	(0.0127)	(0.0119)
NSFR*Crisis				-0.0063	-0.0017	0.0028	-0.0059	-0.0091	-0.0120
				(0.0343)	(0.0351)	(0.0328)	(0.0152)	(0.0156)	(0.0146)
NSFR*Post				0.0371*	0.0424**	0.0333*	0.0175	0.0204	0.0071
				(0.0208)	(0.0203)	(0.0201)	(0.0167)	(0.0171)	(0.0166)
CAP	-0.0394	-0.0274	-0.0951**	-0.1056	-0.0172	-0.0985**	-0.0491	-0.0126	-0.0796*
	(0.0696)	(0.0407)	(0.0483)	(0.0661)	(0.0386)	(0.0427)	(0.0591)	(0.0362)	(0.0414)
N	63477	63477	63477	63477	63477	63477	63477	63477	63477
N of banks	2674	2674	2674	2674	2674	2674	2674	2674	2674
χ^2	2471	2567	2546	2161	2155	2305	2428	2279	2428
Hansen J-test	0.7744	0.5927	0.6554	0.9061	0.7697	0.5928	0.8428	0.6735	0.5483
AR(1) test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AR(2) test	0.9620	0.9900	0.9380	0.9865	0.9973	0.8358	0.8746	0.8813	0.7060

Chapter 3

The Relationship Between Capital, Liquidity and Risk in U.S. Banks

The Relationship Between Capital, Liquidity and Risk in U.S. Banks [1]

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Abstract

This paper investigates capital, risk and liquidity decisions of U.S. bank holding companies from 2001 to 2007. We extend the simultaneous equation model with partial adjustment introduced by Shrieves and Dahl (1992) to model liquidity adjustments and examine the relationship between new Basel III liquidity measures, bank capital and risk adjustments. Our findings show that banks targeted capital, risk and new liquidity measures in the pre-Basel III sample period. Moreover, we document that banks simultaneously coordinated short-term adjustments in capital and risk. Incorporation of bank liquidity enables us to establish the presence of the coordination of risk and liquidity decisions. Short-term adjustments in new liquidity rules inversely impact changes in bank capital, while capital adjustments only have a significant adverse effect on changes in the liquidity coverage ratio. Our results emphasize that it is critical to incorporate liquidity ratios, in addition to capital requirements, into the banking regulations. Finally, our research partially verifies the theoretical predictions of Repullo (2005).

Key words: Bank regulation, bank capital, risk-taking, bank liquidity, liquidity coverage ratio, net stable funding ratio, Basel III

JEL Classification: G21, G28

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3.1 Introduction

Financial supervision authorities impose regulations on banks to ensure the safeness and soundness of the banking system. Unregulated banks are believed to maintain too little capital and liquidity to absorb losses. Furthermore, it has been shown[5] that the resilient banking sector facilitates proper financial intermediation and enhances capital allocation in the economy. Therefore, achieving and maintaining financial stability has been one of the main concerns of policymakers and has received much attention from researchers, as did the ongoing reform process of the banking industry launched in response to the recent financial crisis. Until recently the capital requirements have been considered sufficient to curb bank risk appetite and preserve the liquidity and stability of the banking system. Liquidity regulations were absent, mostly due to a commonly shared belief that bank access to funding liquidity vitally depends on the quality of its assets. The recent crisis revealed a collective over-confidence in this respect. Financial innovations, deregulation and competition from non-bank financial intermediaries, which led to the 2007-2009 crisis, have altered traditional roles played by banks and sources of risk to be regulated.

Many banks have changed their traditional "originate and transform" *modus operandi*, where they transformed liquid deposits into illiquid loans and held loans on their books until their maturity, to a model where bank loans are sold in the secondary markets. The new "originate-to-distribute" banking model and banks' greater reliance on wholesale creditors emphasized the importance of liquidity requirements. At the same time, the "originate-to-distribute" model and securitization might have resulted in an increased interdependence of bank capital, liquidity and risk. Should a joint reshuffling of the two financial buffers and risk be confirmed by the banks' behavior, the design of banking regulations would need to account for this coordination effect. Moreover, with the rise of securitization activity there is a need to reexamine sources of banks' credit risk, taking into account their on and off balance sheet activities. Therefore, traditionally accepted determinants of bank capital, risk and liquidity have to be augmented with off balance sheet exposure and, more importantly, with bank involvement in securitization activity.

This study investigates capital, risk and liquidity decisions of the U.S. bank holding companies in the period leading to the recent financial crisis. In particular, we examine the relationship between new Basel III liquidity measures, bank capital and risk adjustments. To analyze how banks might respond to new liquidity rules, we look back and observe how U.S. banks managed their liquidity coverage ratio (LCR) and net stable funding ratio (NSFR), together with capital and risk adjustments in the past. Our estimations show that banks targeted capital, risk and new liquidity measures in the pre-Basel III sample period. We find that banks simultaneously adjust capital and risk, which is consistent with previous empirical studies. This relationship is positive: banks respond to an increase in risk-taking by augmenting their capital ratios, while an increase in bank capital leads to even higher risk-taking. Incorporation of bank liquidity enables us to establish the presence of the coordination of risk and liquidity decisions. We find a negative relation between

[5]The key role of the financial intermediation to performance of the real sector has been empirically documented for instance by Rousseau and Wachtel (1998) or Dell'Ariccia, Detragiache and Rajan (2014).

bank risk and liquidity adjustments, suggesting that banks increase risk by reducing their liquidity position and increase liquidity by lowering risk-taking. Furthermore, short-term adjustments in new liquidity rules inversely impact changes in bank capital, and these changes adversely affect changes in LCR, while we find no significant effect of changes in bank capital on NSFR. Our research contributes to the discussion on monitoring banks' performance and ensuring financial sector stability. Our findings suggest that bank capital and liquidity ought to be regulated jointly. In particular, they emphasize the importance of a liquidity buffer as a regulatory tool, and support the incorporation of liquidity requirements, in addition to capital requirements, into the Basel III Accord.

While investigating U.S. banks' coordination of the quality of assets, capital and liquidity we - to some extent - test the predictions of Repullo (2005). Although Repullo (2005) focuses on the implications of the presence of the lender of last resort for bank liquidity, the paper also establishes that higher capital and liquidity induces lower asset risk, and capital and liquidity are inversely related. Our empirical investigation tests these theoretical relationships for U.S. banks. Repullo's conclusions regarding the reverse relations are more ambiguous. Nevertheless, unlike many previous theoretical studies, the study does not ignore banks' liquidity buffers. Notably, it is the first theoretical paper to jointly model banks liquidity, capital and risk decisions. Our research partially verifies the theoretical predictions of Repullo (2005): we show that higher liquidity does indeed reduce banks' riskiness, and we document a bidirectional adverse relationship between bank capital and LCR.

This study contributes to the debate on the ongoing global banking reform process and the banking literature in several ways. We are the first to jointly examine capital, risk and liquidity decisions of U.S. banks. Moreover, this is the first study that analyzes how banks coordinated the Basel III liquidity ratios with capital and risk adjustments in the past, in order to analyze how banks might respond to new liquidity rules in the future. Our findings regarding a joint allocation of capital, liquidity and risk shed light on how banks had reshuffled them, and in effect relaxed constraints of the banking regulations. The issue of how existing capital requirements proved ineffective is of critical importance to the reform of the banking regulatory framework. In contrast to the previous empirical studies on bank capital and portfolio risk we analyze a larger sample of U.S. bank holding companies rather than focusing on a limited sample of publicly traded banks. This allows us to understand consequences for banking industry more generally.

3.2 Literature Review

Banking theory identifies asset transformation and liquidity creation as essential functions performed by banks. Banks create liquidity and transform assets by investing into illiquid loans which are financed with liquid deposits (Diamond and Dybvig, 1983). This involves risk associated with financing illiquid loans with short-term deposits. This mismatch causes banks' vulnerability to depositors' confidence. After all, banks hold illiquid loans that are hard to sell at short notice without incurring a loss, if there is a large deposit outflow (Diamond and Rajan, 2001). To ensure against liquidity risk arising from massive deposit outflows banks can hold significant liquidity and capital buffers. The academic literature on bank capital and capital regulations in the banking system has by now grown plentiful. Liquidity, on the contrary, as a more complex concept has only recently emerged in banking firm theory. Baltensperger (1980) is the first to draw attention to the bank liquidity buffer. Both Baltensperger (1980) and Santomero (1984) analyze bank liquidity buffers from the perspective of the inventory theory. They argue that it is costly for banks to keep a stock of liquid assets, but banks may also benefit as it reduces the probability of being 'out of stock' in case of deposit withdrawals. Inventory theory predicts that the size of the liquidity buffer should reflect the cost of the forgone return from holding liquid assets rather than loans, and the cost of raising funds at short notice. Prisman, Slovin and Sushka (1986) introduce liquidity risk into the liquidity management model as they allow for random deposit withdrawals. They show that the cost of a bank's resources tends to increase due to the premium for the expected costs of a liquidity shortage arising if the amount of deposit withdrawals is greater than bank reserves.

An insightful overview of the theoretical literature on capital regulations[6] is presented in VanHoose (2007). The paper discusses banking models and examines the efficiency of deposit insurance and solvency ratio as disciplining tools in the frameworks ranging from pure portfolio choice to moral hazard and incentive models. VanHoose concludes that the academic literature on the effects of capital regulations offers divergent predictions regarding bank responses to regulatory constraints. The predictions depend on what aspect of the banking framework is emphasized. The strand of literature that treats banks primarily as portfolio managers (Kahane, 1977; Koehn and Santomero, 1980; Kim and Santomero, 1988; Rochet, 1992), indicates that as long as the risk weights are market-based the imposition of a solvency ratio is likely to yield an efficient and less risky asset allocation. However, if the risk weights are not market-based, the implementation of capital ratios would cause excessive risk-taking. In contrast, the academics who view banks mostly as monitors for moral hazard advocate that capital requirements may increase banks' risk appetites (Calem and Rob, 1999; Milne, 2002; Hellmann, Murdock and Stiglitz, 2000), because it is costly for them to maintain higher capital ratios. Therefore, banks would incur more risk-taking in order to compensate for costs associated with maintaining higher capital ratios. These conflicting conjectures have motivated researchers to empirically examine the relationship between bank capital and portfolio risk.

Several empirical studies examine the relationship between bank capital and risk under capital requirements (Shrieves and Dahl, 1992; Jacquers and Nigro, 1997; Aggarwal and Jacquers, 2001; Heid, Porath and Stolz, 2004; Jokipii and Milne, 2011). Shrieves and Dahl (1992) examine the relationship between changes in bank capital and changes in asset risk allocation for the U.S. commercial banks. They employ a two-stage simultaneous equation model to take into account the simultaneity of banks' capital and risk decisions. The authors document a positive relationship between changes in bank capital and changes in bank risk, which can be explained by regulatory

[6] See Stolz (2002) for the survey of empirical literature on bank capital.

pressure, regulatory or bankruptcy costs avoidance and managerial risk aversion. Their results suggest that banks that have to increase their capital buffer due to capital regulations tend to increase their risk levels as well. An increase in bank risk levels leads to further increases in bank capital ratios. In contrast, Jacquers and Nigro (1997) find that risk-based capital requirements have a positive effect on bank capital and a negative effect on bank portfolio risk. As Shrieves and Dahl (1992) argue, the negative relationship may exist if banks are seeking to exploit the deposit insurance subsidy. Using the same framework, Aggarwal and Jacquers (2001) examine how prompt corrective action imposed by the Federal Deposit Insurance Corporation Improvement Act (FDICIA) affected bank capital and risk. They find that such a regulatory action encouraged both capitalized and undercapitalized U.S. banks to increase their capital ratios and reduce their credit risk.

More recent empirical studies by Heid, Porath and Stolz (2004), and Jokipii and Milne (2011), which build on the Shrieves and Dahl (1992) framework, document a positive two-way relationship between bank capital and risk. Furthermore, they show that the capital and risk adjustments depend on the size of capital buffer, that is the amount of capital in excess of the regulatory minimum. Heid, Porath and Stolz (2004) examine risk and capital decisions of German banks, while Jokipii and Milne (2011) analyze behavior of U.S. banks. Both studies find that when capital increases, well-capitalized banks tend to maintain their capital buffers by increasing their allocation of risky assets. At the same time, low-capitalized banks prefer to rebuild their capital buffers by simultaneously increasing capital and decreasing risk. Jokipii and Milne also control for bank liquidity in the estimation, and find that more liquid banks tend to have smaller capital buffers and are more likely to increase their credit risk. However, their estimates of the liquidity are not statistically significant. Moreover, Jokipii and Milne consider bank liquidity as exogenous, while in this study we endogenize it, because banks can simultaneously determine capital and liquidity, as well as risk and liquidity. Therefore, we account for the simultaneity of bank capital, risk and liquidity decisions in our estimation.

Until Repullo (2005) no theoretical study examined bank liquidity, capital and risk jointly. Repullo (2005) studies a strategic interaction between a bank and a lender of last resort to derive the optimal bank's levels of liquidity, capital and risk with and without capital regulation, and with and without penalty rates and collateral lending. In our research, we focus on the case when a bank chooses liquidity, capital and risk under capital requirements. Under this regime, Repullo (2005) predicts that a higher capital requirement and liquidity buffer imply lower risk, while capital and liquidity are inversely related. The work of Aspachs, Nier and Tiesset (2005) is the first to test the empirical implications of Repullo (2005). Using a sample of UK banks, the authors investigate the determinants of bank liquidity holdings and show that a higher probability of obtaining potential support from the central bank adversely affects banks' liquidity buffers. Their work is, however, solely focused on the bank liquidity buffers, their determinants and the effect of macroeconomic conditions on liquidity holdings. Distinguin, Roulet and Tarazi (2013) analyze how bank capital and liquidity are related, using a simultaneous equation model. They show that banks decrease their capital ratios when there is a decline in liquidity. DeYoung and Jang (2016) examine how U.S. commercial banks managed liquidity in the period from 1992 to 2012. They show that on average, banks actively managed their liquidity by targeting the loans-to-core deposits ratio and net stable funding ratio. However, neither study considers the interrelation between bank capital, liquidity and risk. The only study that jointly analyze the possible coordination of bank's liquidity, capital and risk decisions in line with theoretical work of Repullo (2005) is Kowalczyk (2012). The author documents coordination of risk and liquidity decisions of the European banks between 2001 and 2007, but finds no evidence of the joint coordination of capital and liquidity adjustments. In contrast to Kowalczyk (2012), rather than analyzing how banks adjust their liquid assets, in this study we examine whether U.S. banks coordinated the Basel III liquidity measures together with capital and risk adjustments.

This research contributes to a stream of empirical studies that examine the impact of securitization separately on bank liquidity and bank capital. Loutskina (2011) analyzes the impact of securitization on bank liquidity for the U.S. commercial banks. She finds that a higher involvement in the securitization activity reduces banks' holdings of liquid assets. Dionne and Harchaoui (2008) and Uzun and Webb (2007) document that securitization is negatively related to the banks' capital ratios. Banks that are involved in securitization can hold less capital, as they may transfer assets off balance sheet to reduce capital requirements. Additionally, Dionne and Harchaoui (2008) show that securitization positively affects bank credit risk. This can occur if banks transfer only less risky loans off balance sheet, and thereby keep more risky assets on the balance sheet. To the best of our knowledge, the first study to simultaneously examine the impact of the securitization on bank liquidity, capital and credit risk is by Kowalczyk (2012). It considers the Eurozone banks and finds that higher risk in the previous period implies greater securitization in the next period. At the same time, the study provides no significant evidence of the effect of the securitization on bank liquidity and capital for European banks. In this research we will reinvestigate this relationship using a large sample of the U.S. banks.

Our study is related to the emerging empirical literature on the potential impacts of the Basel III liquidity ratios on European and U.S. banks: a liquidity coverage ratio (LCR) and a net stable funding ratio (NSFR). Several empirical studies make attempts to approximately calculate the NSFR (Yan et al., 2012; King, 2013; Dietrich et al., 2014; DeYoung and Jang, 2016; Khan et al., 2015; Roulet, 2017). Yan et al. (2012) provide a cost-benefit analysis for the UK banking industry when banks meet liquidity and capital requirements. DeYoung and Jang (2016) show that U.S. banks of all sizes are involved in active liquidity management. King (2013) and Dietrich et al. (2014) examine how the NSFR affects bank net interest margins and bank performance in the broad sense. King (2013) shows that even the most cost efficient bank strategies to meet 100% NSFR will potentially reduce bank interest margins, while Dietrich et al. (2014) do not find any significant effect of the NSFR on bank profitability. Empirical studies by Hong et al. (2014) and Chiaramonte and Casu (2017) calculate both LCR and NSFR, and analyze their impact on bank failures. Khan et al. (2015) analyze the impact of both liquidity standards on financial performance and funding costs of U.S. commercial banks. Their results show that higher asset liquidity and funding stability negatively impact banks' performance and positively affect banks' funding costs.

3.3 Methodology

3.3.1 Empirical Model and Variable Measures

This chapter examines the relationship between bank liquidity, capital and risk adjustments by employing the simultaneous equation model with partial adjustment. The simultaneous equation model accounts for a joint coordination of bank capital and risk suggested by financial theory and emphasized in the empirical works of Shrieves and Dahl (1992), Jacquers and Nigro (1997) and Jokipii and Milne (2011), among others. Furthermore, the model allows us to consider the interrelation between bank capital, risk and liquidity as discussed in Repullo (2005). Under this approach, the observed changes in bank capital, risk and liquidity result from banks' discretionary behavior as well as an exogenous random shock. Formally, the model can be expressed as:

$$\triangle CAP_{it} = \triangle CAP_{it}^{bank} + \varepsilon_{it}, \tag{3.1}$$

$$\triangle RISK_{it} = \triangle RISK_{it}^{bank} + \epsilon_{it}, \tag{3.2}$$

$$\triangle LIQ_{it} = \triangle LIQ_{it}^{bank} + \nu_{it}, \tag{3.3}$$

where $\triangle CAP_{it}$, $\triangle RISK_{it}$ and $\triangle LIQ_{it}$ are the observed changes in bank capital, risk and liquidity, respectively, $\triangle CAP_{it}^{bank}$, $\triangle RISK_{it}^{bank}$ and $\triangle LIQ_{it}^{bank}$ are the changes in capital, risk and liquidity managed by banks, while ε_{it}, ϵ_{it} and ν_{it} are exogenous random shocks in capital, risk and liquidity levels for bank i at time t. Therefore, the observed changes in capital, risk and liquidity are modeled as the sum of a discretionary component and a random shock.

Financial theory argues that banks face financial frictions and adjustment costs which make instantaneous adjustments in bank capital, risk and liquidity unattainable. Accordingly, we model a discretionary part of the observed changes in capital, risk and liquidity using a partial adjustment framework. This approach assumes that banks choose optimal levels of capital, risk and liquidity, and then target them over time. More importantly, when actual levels depart from their targets, banks revert to the optimal levels in a gradual manner. The choice of partial adjustments over full adjustments is typically motivated by the fact that the latter are likely to be too costly, or even not feasible. Consequently, the adjustments in bank capital, risk and liquidity are defined as:

$$\triangle CAP_{it}^{bank} = \alpha(CAP_{it}^{*} - CAP_{it-1}), \tag{3.4}$$

$$\triangle RISK_{it}^{bank} = \beta(RISK_{it}^{*} - RISK_{it-1}), \tag{3.5}$$

$$\triangle LIQ_{it}^{bank} = \gamma(LIQ_{it}^{*} - LIQ_{it-1}), \tag{3.6}$$

where α, β, and γ are the speeds of adjustments. CAP_{it}^{*}, $RISK_{it}^{*}$ and LIQ_{it}^{*} are the target levels. CAP_{it-1}, $RISK_{it-1}$ and LIQ_{it-1} are the actual levels in the previous period.

Substituting equations (3.4), (3.5) and (3.6) respectively into equations (3.1), (3.2) and (3.3) yields the following expressions for the observed changes in bank capital, risk and liquidity:

$$\triangle CAP_{it} = \alpha(CAP_{it}^{*} - CAP_{it-1}) + \varepsilon_{it}, \tag{3.7}$$

$$\triangle RISK_{it} = \beta(RISK_{it}^{*} - RISK_{it-1}) + \epsilon_{it}, \tag{3.8}$$

$$\triangle LIQ_{it} = \gamma(LIQ_{it}^{*} - LIQ_{it-1}) + \nu_{it}, \tag{3.9}$$

As shown above, the observed changes in capital, risk and liquidity in period t for bank i depend on deviations of its actual capital, risk and liquidity levels in the previous period $(t-1)$ from their respective targets, as well as on the exogenous shocks. The target levels of capital, liquidity and risk cannot be observed and, hence, need to be proxied for. The discussion of plausible variables that capture unobservable target levels follows the examination of capital, risk and liquidity measures provided below. We complete the model by adding changes of capital, risk and liquidity to each equation, which accounts for the simultaneity of capital, risk and liquidity adjustments.

$$\triangle CAP_{it} = \alpha(CAP_{it}^{*} - CAP_{it-1}) + \varphi_1 \triangle RISK_{it} + \varphi_2 \triangle LIQ_{it} + \varepsilon_{it}, \tag{3.10}$$

$$\triangle RISK_{it} = \beta(RISK_{it}^{*} - RISK_{it-1}) + \phi_1 \triangle CAP_{it} + \phi_2 \triangle LIQ_{it} + \epsilon_{it}, \tag{3.11}$$

$$\triangle LIQ_{it} = \gamma(LIQ_{it}^{*} - LIQ_{it-1}) + \psi_1 \triangle CAP_{it} + \psi_2 \triangle RISK_{it} + \nu_{it}. \tag{3.12}$$

Empirical studies commonly use one of the following measures of bank capital: the leverage ratio or the risk-based capital ratio. The leverage ratio is defined as total equity capital over total assets and the risk-based capital ratio is total capital over risk-weighted assets. Shrieves and Dahl (1992), Heid, Porath, and Stolz (2004) and Kowalczyk (2012) used the leverage ratio to measure bank capital. The risk-based capital ratio has become more popular after the introduction of risk-based regulation.[7] To make our results comparable to Kowalczyk (2012) and to avoid potential correlation with our risk measure, we employ the leverage ratio (CAP) in the investigation. There is no consensus in the literature on the measure which captures bank portfolio risk better. However,

[7] See for example Jacques and Nigro (1997), Aggarwal and Jacques (2001) and Rime (2001).

the ratio of risk-weighted assets to total assets ($RWATA$) is widely used to measure credit risk at banks (Shrieves and Dahl, 1992; Rime, 2001; Heid et al., 2004; Jokipii and Milne, 2011; Stolz and Wedow, 2011; Delis et al., 2014; Khan et al., 2017). Such a wide usage is based on the belief that as it allocates a bank's assets among risk categories it intends to measure the bank's true risk. Moreover, it is used as the key measure of bank's credit risk under the Basel accords. We also use the risk-weighted assets over total assets ($RWATA$) to measure risk.

Finally, to measure a bank's liquidity we utilize two liquidity ratios introduced in the Basel III Accord: a liquidity coverage ratio (LCR) and a net stable funding ratio ($NSFR$). The LCR measures a bank's ability to meet its short-term obligations. It is calculated as high-quality liquid assets divided by the total net cash outflow over the next 30 days. Table A.1 in the Appendix summarizes a bank's liquid assets, cash outflows and inflows used in calculation of LCR, together with applied weights. However, there is a gap between historical data available in FR Y-9C forms and information required for calculating the LCR under Basel III. To make an approximate calculation of LCR, we have to impose several assumptions. These assumptions were previously used in Hong et al. (2014)[8]. The NSFR is calculated as the available amount of stable funding (ASF) divided by the required amount of stable funding (RSF). The ASF is the weighted sum of the bank's liabilities and capital with more weight given to more stable funding sources that are more likely to be available during an extended liquidity shortfall, such as equity, subordinated debt and longer-term liabilities, followed by core deposits. The RSF is the weighted sum of the bank's assets with more weight given to less liquid, more volatile and longer-term assets. It includes trading assets, corporate and retail loans, followed by government debt. Cash, interbank loans and short-term marketable assets have 0% weight. The weights in the ASF and RSF range from 0% to 100% based on the BCBS guidelines (BCBS, 2010, 2014). To achieve the required NSFR of 100% or higher, banks must have the ASF greater or equal to the RSF. Table A.3 in the Appendix summarizes a bank's assets, liabilities and capital together with applied weights.

As already indicated, the partial adjustment framework relies on the unobserved internal bank's target levels of capital, risk and liquidity. These internal targets need to be proxied by the observed bank specific variables, describing its financial stance and the nature of its business strategy. For the sake of comparability we rely on variables typically chosen in the empirical literature. One commonly employed proxy, which is believed to affect the target capital, risk and liquidity, is the size of the financial institution, measured by a logarithm of its total assets ($SIZE$). Among others, it accounts for the relative access to capital and liquidity, investment opportunities and diversification of business activities. Therefore, we expect a negative impact of size on capital and liquidity. The nature of the size effect on bank risk tends to be less clear. Following Diamond (1984) and Ramakrishnan and Thakor (1984) the literature on intermediation promotes diversification as a way to minimize the risk of failure. While doing so, it uses the argument of uncorrelated returns in line with Markowitz (1952) portfolio theory. Although portfolio diversification is not a strategy that only a big bank may implement, larger banks are likely to enjoy lower diversification costs. In

[8]See Table A.2 in the Appendix for the major assumptions used for calculation of the LCR.

particular, the advantage of considerable size is that larger banks interact with a sizable number of borrowers and have access to an ample number of investment opportunities. A larger number of investments allows a big bank to pool those investments and lower its portfolio risk. In the same spirit, larger banks might have less risky loan portfolios, due to the economies of scale in screening and monitoring borrowers. On the other hand, the corporate finance literature argues that specializing may lead to improvement of a bank's monitoring effectiveness and incentives, and thus is likely to reduce credit risk (Stomper, 2006). Consequently, we expect a significant size effect on the risk and leave its sign undetermined. Loan loss provisions lower a nominal amount of the risk-weighted assets and therefore are expected to negatively affect bank risk. At the same time, banks with higher expected loan losses, in order to meet capital requirements and mitigate solvency risk, will tend to raise more capital. Therefore, we expect that loan loss provisions will positively affect bank capital. We measure the loan loss provisions as a ratio of new loan provisions in the current period to total assets ($LLOSS$). As long as a bank prefers to raise capital through retained earnings rather than through equity issuance, its profitability will positively influence the size of bank capital. Typically, the former way of raising capital is more likely to occur, as it is less costly, does not affect the ownership structure and sends a positive signal to the markets. Hence, a bank's profitability and capital should move in the same direction. We measure a bank's profitability as a ratio of net income to total assets (ROA). We control for bank-specific financial constraints by incorporating the bank's net interest margin (NIM) and loan growth rate ($LOAN$) in the liquidity equation. The net interest margin is defined as the ratio of quarterly annualized net interest income, that is interest income less interest expense, to average earning assets. The net interest margin and loan growth rate are expected to adversely affect the liquidity buffer.

One of the key concerns of our study is the impact of the securitization on bank capital, risk and liquidity adjustments. The immediate effect of the securitization is a reduction in the risk-weighted assets and the untying of regulatory capital due to a removal of the securitized loans from the bank's balance sheet. Whether or not it decreases the overall risk exposure depends on the bank's lending and investment strategies and the competitiveness of the financial sector. Financing new assets with the liquidity released should result in an increased diversification and should lower the bank risk. While Instefjord (2005) recognizes the benefits of risk sharing, the paper additionally shows that securitization encourages more risk-taking. Increased competition in the financial markets strengthens the impact of the latter effect (Instefjord, 2005). Moreover, Greenbaum and Thakor (1987) argue that banks tend to withhold poorer quality assets. So if banks primarily securitize low-risk assets and withhold riskier assets, the on-balance sheet asset risk will increase. Given the benign macroeconomic conditions and the search for yield observed in the period analyzed, we expect a positive dependency between the asset quality, measured by credit risk, and the securitization activity.[9] The predictions about the interaction of the liquidity and securitization, and bank capital and securitization are even less evident. Therefore, we simply

[9] However, the opposite could be the case if banks would securitize high-risk assets, thereby decreasing the on-balance sheet asset risk.

expect to obtain a significant relation. We measure banks' involvement into the securitization activity by the outstanding principal balance of assets sold and securitized with recourse or other seller-provided credit enhancements over total assets (SEC).

Finally, changes in banks' liquidity, capital and risk might be influenced by individual banks' characteristics. We account for bank unobserved heterogeneity by incorporating bank fixed effects, which are designed to absorb all time invariant bank heterogeneity. To control for any regulatory or macroeconomic environment changes we include quarterly dummies. Thus, the estimated system of the equations takes the following form:

$$\begin{aligned} \triangle CAP_{it} = \alpha_0 + \alpha_1 SIZE_{it} + \alpha_2 LLOSS_{it} + \alpha_3 ROA_{it} + \alpha_4 SEC_{it} - \\ -\alpha_5 CAP_{it-1} + \alpha_6 \triangle RISK_{it} + \alpha_7 \triangle LIQ_{it} + \mu_i + \delta_t + \varepsilon_{it}, \end{aligned} \tag{3.13}$$

$$\begin{aligned} \triangle RISK_{it} = \beta_0 + \beta_1 SIZE_{it} + \beta_2 LLOSS_{it} + \beta_3 ROA_{it} + \beta_4 SEC_{it} - \\ -\beta_5 RISK_{it-1} + \beta_6 \triangle CAP_{it} + \beta_7 \triangle LIQ_{it} + \mu_i + \delta_t + \epsilon_{it}, \end{aligned} \tag{3.14}$$

$$\begin{aligned} \triangle LIQ_{it} = \gamma_0 + \gamma_1 SIZE_{it} + \gamma_2 NIM_{it} + \gamma_3 LOAN_{it} + \gamma_4 SEC_{it} - \\ -\gamma_5 LIQ_{it-1} + \gamma_6 \triangle RISK_{it} + \gamma_7 \triangle CAP_{it} + \mu_i + \delta_t + \nu_{it}, \end{aligned} \tag{3.15}$$

where μ_i and δ_t are bank and time components, respectively, and ε_{it}, ϵ_{it}, and ν_{it} are white noise processes.

The coefficients α_6, α_7, β_5, β_6, γ_6 and γ_7 are our main interest. Their sign and significance determine the relationship between short-term adjustments in bank capital, risk and liquidity.

3.3.2 Estimation Strategy

Empirical studies in the field use the three-stage least squares estimation technique to account for simultaneity of capital and risk adjustments.[10] However, the presence of fixed effects in the model make a lagged dependent variable endogenous. We follow Jokipii and Milne (2011) and Stolz and Wedow (2011) and employ a dynamic panel data technique to control for bank-specific heterogeneity, μ_i. In particular, we use the Generalized Method of Moments (GMM) introduced by Arellano and Bond (1991), and put forward by Arellano and Bover (1995), Blundell and Bond (1998), and Blundell, Bond, and Windmeijer (2000), also known as the Blundell-Bond system GMM estimator.[11] This estimator produces efficient and consistent estimates, as long as the

[10] See for example Shrieves and Dahl (1992), Jacques and Nigro (1997), Aggarwal and Jacques (2001) and Shim (2013), while Imbierowicz and Rauch (2014) employ 3SLS technique to examine the relationship between liquidity risk and credit risk.

[11] The Arellano-Bond procedure estimates the equation in first differences, thereby removing all unobserved time invariant individual-level effects. However, the differenced lagged dependent variable is still correlated with lagged error in the differenced error term. To account for the endogeneity of the lagged dependent variable, the Arellano-Bond difference GMM estimator uses available lags of the dependent variable in levels as instruments for the first-differenced equation. Blundell and Bond (1998) show that the instruments in the Arellano-Bond estimator become weak if the autoregressive parameters are too large. Blundell and Bond (1998), building on the work of Arellano and Bond (1991) and Arellano and Bover (1995), proposed a modified GMM estimator. The Blundell-Bond procedure estimates the system of two equations: the equation in first differences and the equation in levels using

model doesn't have an $n + 1$ order serial correlation and we use valid instruments. Another challenge for the estimation of bank capital, risk and liquidity is the potential endogeneity of the bank's observable characteristics. The Blundell-Bond procedure accounts for the endogeneity of the lagged dependent variable, as well as other regressors, by using deeper lags of endogenous variables as instruments in levels and in differences. Given the simultaneous structure of our model, we account for the endogeneity of capital, risk and liquidity adjustments in the estimation procedure, using GMM-type instruments for $\triangle CAP_{it}$, $\triangle RISK_{it}$ and $\triangle LIQ_{it}$. Another concern is the potential endogeneity of securitization, as banks involved in securitization activity plan their securitization schedules and may use it as a tool to manage their liquidity, capital and risk levels. We control for endogeneity of SEC in the Blundell-Bond system GMM estimator by using lagged levels of SEC as instruments for the first differences equation and lagged differences of SEC for the levels equation.

The GMM procedure requires us to apply only exogenous instruments. This condition can be verified by testing for the presence of autocorrelation in first-differenced residuals, where we expect to find the first order autocorrelation. A presence of higher-order autocorrelation in first-differenced residuals indicates that some lags of the variable, which are used as instruments, are endogenous. Therefore, if autocorrelation of order n is detected, only deeper lags (e.g., $n + 1$) of variable can be used as instruments (Roodman, 2009). The validity of instruments as a group and correctness of model specification are checked by the Hansen J-test of overidentifying restrictions. We employ the two-step GMM estimator instead of the one-step due to the two-step estimator's higher efficiency. However, the two-step procedure might produce downward biased standard errors. To correct for that we use the finite-sample "Windmeijer correction" for the two-step covariance matrix (Windmeijer, 2005; Baltagi, 2008).

3.4 Data

In this study we use financial data for U.S. bank holding companies (BHCs). The dataset covers the period from 2001 Q1 to 2007 Q2. Balance sheet and income statement data is taken from the Federal Reserve FR Y-9C Consolidated Financial Statements for bank holding companies. Many U.S. commercial banks are owned by the same bank holding company. We use data for BHCs because liquidity and capital management is performed at the parent company level[12]. The parent company can inject liquidity and capital into its subsidiary banks, as well as transfer it among its subsidiaries. We remove bank-quarter observations with missing data for bank total assets and capital. To ensure that the results are not driven by outliers we exclude banks in quarters when they had total assets in the 1st and 99th percentiles of the asset size distribution in a given

lagged variables as instruments for the equation in first differences and lagged first differences of the variables for the equation in levels.

[12]Beatty and Gron (2001) and DeYoung and Jang (2016) also perform their analysis at the BHC level to examine bank capital and liquidity decisions, respectively.

quarter. Moreover, we winsorize all variables except macroeconomic factors at 1% in the 1st and 99th percentiles of the distribution which has become a common practice in the literature[13].

Table 3.2 reports bank descriptive statistics. Banks on average reduce their capital ratios and liquidity buffers and increase risk-taking during the period from 2001 till 2007. Banks have, on average, an equity capital ratio of 9 percent, $RWATA$ of 0.7, LCR of 3.44, $NSFR$ of 1.04, return on assets of 0.003, SEC of 0.004 and loan growth of 2.7 percent. On average, banks hold 2 372 million dollars in assets.

Table 3.3 shows the correlations for all variables. We can see that changes in bank capital and risk are positively related, while changes in two liquidity ratios are inversely related to changes in risk. Changes in LCR and capital are also inversely related, while changes in NSFR and capital have a positive correlation. The correlation coefficients generally indicate that there is no multicollinearity between our explanatory variables.

3.5 Results

Estimation results for equations (3.13)−(3.15) are reported in Tables 3.4 - 3.6. Figure 3.1 illustrates and summarizes the relationship between short-term adjustments in bank capital, risk and liquidity. The dynamic panel estimations corroborate that U.S. bank holding companies simultaneously coordinate capital, risk and liquidity adjustments. In all equations we have lagged dependent variables, CAP, RISK and LIQ, which are endogenous in the presence of bank fixed effects. We account for that by using GMM-type instruments of CAP, RISK and LIQ. We also account for the simultaneity of capital, risk and liquidity adjustments using GMM-type instruments. For instance, in the capital equation changes in risk and liquidity are predetermined and are instrumented by lagged levels and lagged first-differences of changes in risk and liquidity. The appropriate lags of variables used as instruments are chosen based on the test for autocorrelation. The Hansen J-test in Tables 3.4 - 3.6 indicates that we cannot reject the null hypothesis of correct model specification and valid overidentifying restrictions.

The estimation results in Tables 3.4 and 3.5 show that the impact of capital adjustments on risk adjustments and vice versa are both positive and highly significant. A positive coordination of capital and risk is in accordance with the findings of Shrieves and Dahl (1992), Jokipii and Milne (2011) and Kowalczyk (2012), and indicates that banks increase their capital ratios in response to an increase in riskiness of bank asset portfolio and vice versa, banks reduce their risk-taking when they face a decline in capital. However, these findings are not consistent with the theoretical implications of Repullo (2005), who predicts that higher capital implies a lower risk. The liquidity adjustments have a negative impact on both risk and capital adjustments. The inverse influence of new liquidity rules on banks' riskiness suggests that banks accumulating short-term and long-term stable funding tend to have safer portfolios, which confirms one of the implications of Diamond and

[13]This correction for outliers is made in the empirical works of Cornett et al. (2011), Chiaramonte and Casu (2017) and DeYoung and Jang (2016) to name a few.

Rajan (2006). The estimates in Table 3.6 suggest that this dependency is bidirectional: an increase in bank risk-taking causes a simultaneous decrease in bank liquidity buffers. On the one hand, liquidity adjustments negatively affect capital adjustments, suggesting that banks augment their capital ratios when they experience a liquidity shortage, in terms of lower LCR and NSFR. On the other hand, the estimation results in Table 3.6 show that there is no significant effect of capital adjustments on changes in NSFR. However, if we consider the impact of $\triangle CAP$ on $\triangle LCR$, there is a statistically significant adverse relationship. This indicates that banks increase their short-term liquidity buffers, in terms of LCR, when the capital ratio deteriorates. Consequently, we can only partially support the theoretical predictions of Repullo (2005), who documents a negative relationship between bank capital and liquidity. But as the relationship between NSFR and capital is significant only in one direction, an increase in capital buffers cannot stimulate an increase in banks' funding liquidity. Therefore, our results highlight the importance of simultaneous regulation of both bank capital and liquidity to ensure that banks concurrently maintain appropriate levels of capital and long-term stable funding. As such, this study supports the introduction of the stable funding ratios in the Basel III regulations.

With respect to lagged measures of capital, they are all highly significant, have expected negative signs and lie within a unit interval. This supports the validity of the partial adjustment framework. The coefficient estimates vary from -0.076*** to -0.120*** for two measures of bank liquidity. These estimates suggest that U.S. banks have a relatively low speed of capital adjustment to their target levels. The estimates for the risk equation are presented in Table 3.5. The fitted coefficients on lagged measures of risk have expected negative signs and lie within a unit interval. The coefficient on lagged $RWATA$ varies from -0.064** to - 0.164*** for two liquidity rules. These values imply that the U.S. bank holding companies slowly adjust their risk-weighted ratios to the target levels. Surprisingly, securitization plays no direct significant role in the bank capital- and risk-adjustment process. Nevertheless, capital and risk adjustments are likely to be indirectly influenced by securitization via the impact of securitization on liquidity adjustments and the impact of liquidity adjustments on changes in capital and risk. The effect of $SIZE$ on bank risk is positive, which contradicts the predictions of the literature on intermediation (Diamond, 1984; Ramakrishnan and Thakor, 1984). It does not necessarily undermine the benefits of diversification. As shown by Boyd and Runkle (1993), while being better diversified, larger banks may also use excessive financial leverage. Consequently, the net effect tends to be an increase in risk. Actually, Boyd and Runkle likewise obtain the positive size effect both on risk and on capital. This is consistent with the argument that larger banks, which enjoy an easier access to investment opportunities, capital markets and funding, can maintain higher levels of risk. Providing that a large number of investment opportunities result in diversification, the positive size effect may in fact imply that specializing leads to improvement of the bank's monitoring effectiveness and incentives, and thus reduces credit risk (Stomper, 2006). ROA positively impacts changes in risk indicating that more profitable banks tend to incur more risk. This result is also documented in the work of Khan et al. (2017). With regard to the coordination of risk and liquidity adjustments, we find a negative and highly significant impact of liquidity adjustments on risk. The estimates for liquidity changes in the risk equation vary from -0.003* to -0.194*** (Table 3.5). Moreover, the outcome for the liquidity equation presented in Table 3.6 confirms that this relationship is bidirectional. Such a result indicates that liquidity shortages induce an increase in bank riskiness, and vice versa, banks tend to reduce their liquidity buffers when they face higher risk.

The estimates for the liquidity equation are presented in Table 3.6. As expected, lagged values of liquidity have negative signs and lie within a unit interval. The coefficient estimates on lagged liquidity vary from -0.168*** to -0.300*** for two liquidity measures. SEC adversely impacts changes in LCR and $NSFR$, indicating that banks with higher involvement in securitization activity have lower liquidity buffers and stable funds. This result is in line with the findings of Loutskina (2011) and it shows that, although by securitizing illiquid assets banks can release funds and increase liquidity buffers, they find another use for these funds. The estimate of $LOAN$ has the expected negative sign, showing that banks with higher loan growth maintain lower long-term liquidity buffers.

The estimation results partially confirm the theoretical predictions of Repullo (2005), who shows that higher capital and liquidity imply lower risk, and that capital and liquidity are inversely related. Our findings suggest that higher capital induces higher risk, while higher liquidity indeed yields to lower risk. Consistent with Repullo (2005), we document a negative bidirectional relationship between bank capital and LCR. Moreover, we confirm that the partial adjustment approach to modeling deviations from the internal target levels of risk, capital and liquidity is the appropriate one. The coefficients on the three lagged variables are significant and lie within unit interval in each equation respectively, which suggest that after a shock occurs our model returns to the target equilibrium. All in all, our results indicate that U.S. banks coordinated their capital, risk and liquidity adjustments during the pre-crisis period. This result is worth noting, as it sheds light on how banks could overcome the regulations on capital and emphasizes the critical role of a joint regulation of capital ratios and liquidity ratios in relation to bank risk-taking behavior. We have established that banks with more stable sources of financing maintain lower capital ratios, while they tend to incur less risk. Our result emphasizes a need to regulate both bank capital and liquidity, to ensure that banks simultaneously maintain appropriate capital and liquidity levels. As such, it supports the idea of the stable funding ratios introduced in the new Basel III regulations.

3.6 Conclusions

In this chapter, we examine whether and how the U.S. bank holding companies coordinate capital, risk and liquidity. In particular, we are interested to check whether U.S. banks acted as if they were targeting new liquidity rules, together with capital and risk, during the pre-Basel III time period. We employ a simultaneous equation model with partial adjustment introduced by Shrieves and Dahl (1992) and extend it to model the liquidity buffers. Moreover, instead of a pooled regression approach we use a dynamic panel data technique that accounts for unobserved bank-specific effects.

The results establish that banks simultaneously coordinate capital and liquidity levels, as well as their risk exposure. We document a positive influence of capital adjustments on risk adjustments, and vice versa. A decrease in bank risk causes a simultaneous decrease in bank capital, while banks respond to an increase in capital by increasing their risk-taking. We find a bidirectional negative coordination between bank risk and liquidity, which suggests that banks lower their riskiness by increasing their liquidity position and increase risk-taking by lowering their liquidity buffer. The inverse influence of the banks' liquidity on riskiness suggests that banks accumulating liquid assets tend to have safer portfolios, which confirms one of the implications of Diamond and Rajan (2006). With regard to coordination of bank capital and liquidity, we document a significant impact of changes in new liquidity measures on bank capital, while capital adjusments adversely affect only changes in LCR. This is consistent with Repullo (2005). However, our results also show that an increase in capital buffers cannot stimulate an increase in banks' funding liquidity (NSFR). Our findings partially confirm the theoretical predictions of Repullo (2005) regarding the impact of capital and liquidity on risk. Contrary to Repullo (2005), we document that higher capital induces higher risk, while higher liquidity indeed reduces banks' risk-taking. These results are confirmed by the set of regressions using two measures of bank liquidity.

Finally, this study examines the role securitization played in coordination of capital, risk and liquidity decisions. We find no evidence that securitization directly affected bank capital and risk. The estimation results show that securitization does not weaken banks' capital position. Therefore, banks didn't use securitization to relax constraints of existing capital requirements. However, we show that securitization reduces banks' liquidity. Although an increased loan securitization strengthened banks' capacity to lend, it weakened banks' incentives to maintain adequate short-term and long-term liquidity buffers.

Our research is instructive for the discussion on monitoring banks with instruments such as capital and liquidity ratios. All in all, our results indicate that U.S. banks coordinated their capital, risk and liquidity adjustments during the pre-Basel III sample period. This result is worth noting as it sheds light on how banks could overcome the regulations on capital and emphasizes the critical role of liquidity regulation in relation to bank risk-taking behavior. In particular, our findings indicate that not only do banks coordinate their risk, liquidity and capital levels, but also banks with more stable sources of financing incur less risk. Our estimation results for the coordination of capital and liquidity highlight the need to regulate them together to assure that banks concurrently maintain appropriate capital levels and stable funding sources. These suggest that bank liquidity is an important coordination tool and supports an implementation of the stable funding ratios in the new Basel III regulations in addition to capital requirements. As such, the study contributes to the discussion on the evaluation of Basel III and its implementation.

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Table 3.1: Varibles Description

Variable	Description
EQ CAP	Total equity capital/Total assets
RWATA	Risk-weighted assets/Total assets
LCR	High-quality liquid assets/Total net cash outflow over the next 30 days
NSFR	Available stable funding /Required stable funding
SIZE	Natural logarithm of total assets
ROA	Net income/Total assets
LLOSS	The provision for loan and lease losses/Total loans and leases
NIM	Net interest income/Average total assets
LOAN	The growth rate of total loans and leases
SEC	(Off-balance sheet assets sold and securitized with servicing retained or with recourse or other seller-provided credit enhancements)/Total assets

Figure 3.1: Banks' Coordination of Capital, Risk and Liquidity

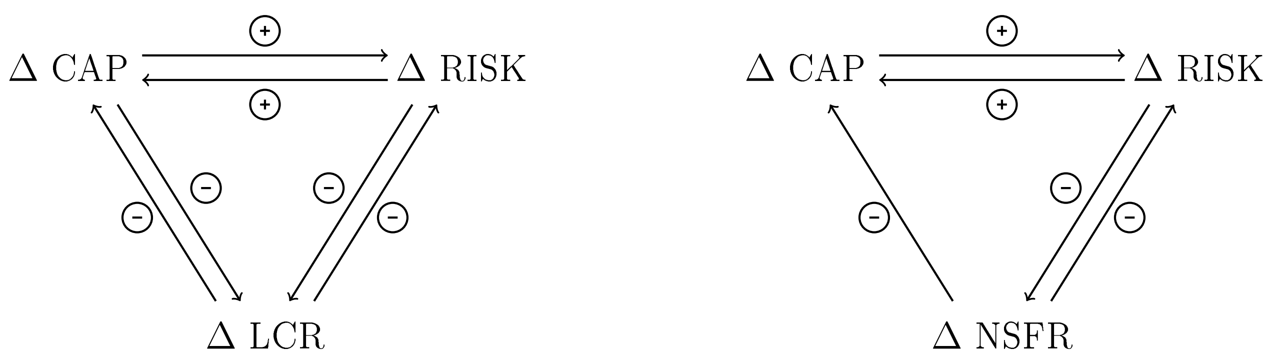

Table 3.2: Bank Descriptive Statistics

This table presents descriptive statistics for bank-quarters for the full sample period. The data is taken from the Federal Reserve FR Y-9C Consolidated Financial Statements for Bank Holding Companies for the period from 2001 Q1 through 2007 Q2. All variables are winsorized at 1% in the 1st and 99th percentiles of the distribution. See Table 3.1 for variables definitions.

	N	Mean	St. Dev.	Min	p25	p50	p75	Max
TA (USD mln)	44611	2372	10262	147	237	399	843	222530
△EQ CAP	44611	-0.00004	0.006	-0.107	-0.002	0.000	0.002	0.145
△RWATA	44611	0.0025	0.034	-0.957	-0.009	0.003	0.014	0.934
△LCR	44611	-0.0230	1.228	-16.235	-0.275	-0.013	0.238	16.452
△NSFR	44611	-0.0015	0.043	-0.498	-0.022	-0.003	0.016	0.791
EQ CAP	44611	0.0906	0.029	0.022	0.072	0.086	0.103	0.222
RWATA	44611	0.7025	0.145	0.000	0.637	0.720	0.793	0.961
LCR	44611	3.4485	3.439	0.136	1.329	2.326	4.177	18.345
NSFR	44611	1.0478	0.173	0.559	0.940	1.033	1.141	1.655
SIZE	44611	13.2331	1.210	11.936	12.377	12.898	13.645	19.058
LLOSS	44611	0.0009	0.002	-0.001	0.000	0.001	0.001	0.017
ROA	44611	0.0027	0.002	-0.012	0.002	0.003	0.004	0.008
NIM	44611	0.0093	0.002	0.000	0.008	0.009	0.010	0.015
LOAN	44610	2.7067	4.773	-9.348	0.115	2.151	4.557	27.368
SEC	44611	0.0037	0.025	0.000	0.000	0.000	0.000	0.226

Table 3.3: Variable Correlation Matrix

This table shows the correlation matrix for bank capital, risk and liquidity adjustments and explanatory variables for U.S. bank holding companies from 2001 Q1 till 2007 Q2. See Table 3.1 for variables definitions.

	△EQ CAP	△RWATA	△LCR	△NSFR	SIZE	LLOSS	ROA	NIM	LOAN	SEC
△EQ CAP	1.000									
△RWATA	0.088	1.000								
△LCR	-0.091	-0.126	1.000							
△NSFR	0.001	-0.196	0.111	1.000						
SIZE	0.030	-0.017	0.003	0.027	1.000					
LLOSS	-0.064	-0.029	0.020	0.017	0.050	1.000				
ROA	0.121	0.008	0.004	0.026	0.047	-0.276	1.000			
NIM	0.007	0.015	0.003	0.002	-0.208	0.130	0.360	1.000		
LOAN	-0.160	0.153	-0.072	-0.240	0.032	-0.034	0.011	0.063	1.000	
SEC	0.013	-0.005	0.003	0.015	0.269	0.129	0.067	-0.057	-0.012	1.000

Table 3.4: Capital Equation: Relationsip Between Changes in Bank Capital, Risk and Liquidity

This table reports estimation results using the Blundell -Bond Two-Step GMM procedure. GMM-type instruments for $\triangle RISK_{it}$ and $\triangle LIQ_{it}$ are used to account for simultaneity of capital, risk and liquidity adjustments. Additionally, we control for endogeneity of SEC by using lagged levels of SEC as instruments for first differences equation and lagged differences of SEC for levels equation. All regressions include bank fixed effects and time dummies. Robust standard errors in parentheses are calculated using the finite-sample "Windmeijer correction" for the two-step covariance matrix. Hansen J-test reports a p-value for the Hansen test of overidentifying restrictions. AR(n) tests present p-values for the test of no n-order autocorrelation in residuals. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)
	△EQ CAP	△EQ CAP	△EQ CAP
EQ CAP$_{t-1}$	-0.1113***	-0.0760**	-0.1204***
	(0.0301)	(0.0324)	(0.0269)
△RWATA	0.0759***	0.0694***	0.0552***
	(0.0177)	(0.0195)	(0.0123)
△LCR	-0.0004***		-0.0004***
	(0.0001)		(0.0001)
△NSFR		-0.0224**	-0.0172**
		(0.0087)	(0.0074)
SIZE	0.0003	0.0003	0.0002
	(0.0003)	(0.0003)	(0.0003)
LLOSS	0.1314	-0.1093	-0.1807
	(0.8691)	(0.8777)	(0.5963)
ROA	0.1816	-0.1713	-0.0371
	(0.8233)	(0.9038)	(0.6069)
SEC	0.0007	0.0055	0.0056
	(0.0094)	(0.0101)	(0.0080)
_cons	0.0064	0.0045	0.0094*
	(0.0054)	(0.0049)	(0.0048)
N	44611	44611	44611
N of banks	2677	2677	2677
N of instruments	100	100	125
χ^2	1279	1161	1373
χ^2 p-value	0.000	0.000	0.000
Hansen J-test	0.129	0.209	0.167
AR(1) test	0.000	0.000	0.000
AR(2) test	0.471	0.294	0.412

Table 3.5: Risk Equation: Relationship Between Changes in Bank Risk, Capital and Liquidity

This table reports estimation results using the Blundell -Bond Two-Step GMM procedure. GMM-type instruments for $\triangle CAP_{it}$ and $\triangle LIQ_{it}$ are used to account for simultaneity of risk, capital and liquidity adjustments. Additionally, we control for endogeneity of SEC by using lagged levels of SEC as instruments for first differences equation and lagged differences of SEC for levels equation. All regressions include bank fixed effects and time dummies. Robust standard errors in parentheses are calculated using the finite-sample "Windmeijer correction" for the two-step covariance matrix. Hansen J-test reports a p-value for the Hansen test of overidentifying restrictions. AR(n) tests present p-values for the test of no n-order autocorrelation in residuals. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)
	△RWATA	△RWATA	△RWATA
RWATA $_{t-1}$	-0.064**	-0.164***	-0.128***
	(0.028)	(0.035)	(0.041)
△EQ CAP	2.047***	1.760***	1.755***
	(0.384)	(0.304)	(0.312)
△LCR	-0.005**		-0.003*
	(0.002)		(0.002)
△NSFR		-0.167***	-0.194***
		(0.032)	(0.041)
SIZE	0.001	0.003**	0.002
	(0.001)	(0.002)	(0.002)
LLOSS	2.936	3.733	2.395
	(3.806)	(3.366)	(3.156)
ROA	2.174	6.506***	3.787
	(2.540)	(2.492)	(2.769)
SEC	0.009	0.001	0.028
	(0.040)	(0.063)	(0.065)
_cons	0.028	0.066**	0.054**
	(0.019)	(0.027)	(0.027)
N	44611	44611	44611
N of banks	2677	2677	2677
N of instruments	114	119	141
χ^2	558	577	699
χ^2 p-value	0.000	0.000	0.000
Hansen J-test	0.192	0.137	0.131
AR(1) test	0.000	0.000	0.000
AR(2) test	0.451	0.457	0.458

Table 3.6: Liquidity Equation: Relationship Between Changes in Bank Liquidity, Capital and Risk

This table reports estimation results using the Blundell -Bond Two-Step GMM procedure. GMM-type instruments for $\triangle RISK_{it}$ and $\triangle CAP_{it}$ are used to account for simultaneity of liquidity, risk and capital adjustments. Additionally, we control for endogeneity of SEC by using lagged levels of SEC as instruments for first differences equation and lagged differences of SEC for levels equation. All regressions include bank fixed effects and time dummies. Robust standard errors in parentheses are calculated using the finite-sample "Windmeijer correction" for the two-step covariance matrix. Hansen J-test reports a p-value for the Hansen test of overidentifying restrictions. AR(n) tests present p-values for the test of no n-order autocorrelation in residuals. ***, ** and * are significance levels at 1%, 5%, and 10%, respectively.

	(1)	(2)
	△LCR	△NSFR
LCR_{t-1}	-0.168***	
	(0.038)	
$NSFR_{t-1}$		-0.300***
		(0.023)
△RWATA	-7.388**	-0.475***
	(3.313)	(0.161)
△EQ CAP	-21.054*	-0.137
	(12.554)	(0.631)
SIZE	-0.046	-0.002
	(0.066)	(0.002)
NIM	39.674	1.266
	(93.192)	(4.406)
LOAN	0.008	-0.003***
	(0.014)	(0.001)
SEC	-1.652**	-0.273***
	(0.833)	(0.089)
_cons	0.710	0.328***
	(1.474)	(0.074)
N	44610	44610
N of banks	2677	2677
N of instruments	115	116
χ^2	577	928
χ^2 p-value	0.000	0.000
Hansen J-test	0.285	0.034
AR(1) test	0.000	0.000
AR(2) test	0.001	0.000
AR(3) test	0.840	0.149

Appendix

Table A.1: Summary of LCR Calculation

This table shows the weights and components for calculating the high-quality liquid assets and the net cash outflows. I divide the high-quality liquid assets by the net cash outflows to compute the liquidity coverage ratio (LCR). The calculation of the LCR is based on the standards revised by the Basel Committee on Banking Supervision (2013). My calculation of the LCR is a close approximation of the LCR calculated by regulators because of the limitations of the historical data in the Y-9C reports.

Weight (%)	**Panel 1: Stock of High Quality liquidity assets**
100	A. Level 1 Assets
	Cash
	Securities in 0% risk weight category
	Reverse repos in 0% risk weight category
85	B. Level 2 Assets
	Securities in 0% risk weight category
	Reverse repos in 20% and 100% risk weight category
	Panel 2: Cash Outflows
3	Stable retail transaction deposits
	Stable small time deposits with a remaining maturity of one month or less
	Stable retail savings deposit
5	Stable foreign deposits with a remaining maturity of one month or less
10	Less stable retail transaction deposits
	Less stable small time deposits with a remaining maturity of one month or less
	Less stable retail savings deposits
25	Less stable foreign deposits with a remaining maturity of one month or less
5	Stable wholesale transaction deposits
25	Less stable wholesale transaction deposits
20	Stable wholesale saving deposits
	Stable large time deposits with a remaining maturity of one month or less
40	Less stable wholesale saving deposits
	Less stable large time deposits with a remaining maturity of one month or less
15	Securities lent in 20% risk weight category
100	Securities lent in 50% and 100% risk weight category
	Other liabilities
	Negative fair value Derivatives
5	Unused commitments of home-equity line of credit
	Unused commitments of credit cards
10	Unused commitments of commercial real estate
	Unused commitments for securities underwriting
	Other unused commitment
5	Letters of credit
	Panel 3: Cash Inflows
100	50% of loans with a remaining maturity less than one month
	Positive fair value of derivatives

Table A.2: Assumptions used for LCR Calculation

This table shows the major assumptions I used for calculating the LCR. These assumptions are taken from Hong et al. (2014).

Description	Parameter
U.S. bank holding companies do not divide uninsured deposits by category of deposits, they only report the total amount of uninsured deposits in the Y-9C reports. I assume that the uninsured deposits in each category of deposits are proportional to the size of that category. Stable deposits are insured deposits and less stable deposits are uninsured deposits.	
I assume banks' assets maturity is evenly distributed so that the share of loans with a remaining maturityof less than one month is one-twelfth of loans with a remaining maturity of one year or less.	
Share of wholesale deposits in saving deposits	50%
Share of wholesale deposits in transaction deposits of individuals, partnerships, and corporations	50%
Share of deposits with a remaining maturity of less than one month in time deposits with a remaining maturity of three months or less	1/3
Share of deposits with a remaining maturity of less than one month in foreign deposits	1/12
Share of other borrowed money with a remaining maturity of less than one month in other borrowed money with a remaining maturity of one year or less	1/12

Table A.3: Summary of NSFR Calculation

This table shows the weights and components for calculating the available stable funding (ASF) and the required stable funding (RSF). I divide the ASF by the RSF to compute the net stable funding ratio (NSFR). The calculation of the NSFR is based on the standards revised by the Basel Committee on Banking Supervision (2014). My calculation of the NSFR is a close approximation of the NSFR calculated by regulators because of the limitations of the historical data in the Y-9C reports.

ASF weight (%)	**Components of Available Stable Funding (Sources)**
100	Total equity capital
	Subordinated notes and debentures
	Other borrowings with remaining maturity more than a year
95	Total transaction deposits
90	Non-transaction savings deposits and MMDAs
	Time deposits of less than $100,000
50	Time deposits of more than or equal to $100,000
	Other borrowed money
0	Other liabilities
	Trading liabilities
	Fed funds purchased in domestic offices
	Securities sold under agreements to repurchase
RSF weight (%)	**Components of Required Stable Funding (Uses)**
100	Loans to depository institutions and acceptances of other banks
	Trading assets
	Premises and fixed assets
	Other real estate owned
	Investments in unconsolidated subsidiaries and associated companies
	Direct and indirect investments in real estate ventures
	Intangible assets
	Nonperforming loans
	Other assets
85	Loans secured by real estate including 1–4 family mortgages
	Agricultural loans
	Commercial and industrial loans
	Loans to individuals
	Lease financing receivables
65	Loans to foreign governments and official institutions
50	Mortgage-backed securities
	Asset-backed securities and structured financial products
	Other debt securities
	Mutual funds and equity shares with readily determinable fair values
	Fed funds sold and securities purchased under agreements to resell in domestic offices
20	U.S. Government agency obligations
	Securities issued by states and political subdivisions in the U.S.
5	U.S. Treasury securities
	Unused loan commitments
	Financial standby letters of credit
	Performance standby letters of credit
	Commercial and similar letters of credit
0	Cash and balances due from depository institutions