UNIVERSITY OF SOUTHAMPTON

FACULTY OF BUSINESS, LAW AND ART

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LIQUIDITY, LIQUIDITY RISK AND LIQUIDITY REGULATION IN BANKING

By

Hana Saeed Bawazir

Thesis for the degree of PhD of Philosophy

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"The difference between stumbling blocks and stepping stones is how you use them."-
Unknown

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

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MANAGEMENT

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This thesis focuses on the importance of bank liquidity in the overall banking system during various liquidity shocks. To this end, three different empirical research are conducted in this thesis. We start with an investigation of the impact of bank market power on liquidity creation during the global financial crisis (GFC) in European banking. Second, we extend our analysis and examine how the liquidity ratio requirements under Basel III affects their risk and return. Following this, we consider the banking system in the Gulf Cooperation Council (GCC) and investigate whether the effect of the oil price shock that began in June 2014 on bank lending differs depending upon the level of bank liquidity.

Using different causal effect econometric analysis, we present robust evidence for the following findings. First, we find that banks with greater market power significantly increase liquidity creation in the economy. Second, we present strong evidence for a positive link between bank liquidity and their ability to mitigate a negative shock. Focusing on the GFC, we find that the combined effect of high market power and government intervention through guarantees reduces liquidity creation as the level of bank liquidity increases to ensure financial stability. In addition, we find that adherence to the liquidity requirements under Basel III causes financial stability of European banks to increase. Also, we find evidence of a trade-off between liquidity and bank profitability. The subsequent analysis of bank lending in the GCC countries during the oil price shock suggests that credit growth generally declines as a result of lower oil prices. However, banks with a high level of liquidity buffers mitigate the impact of the oil price shock. This offers greater support for the view that higher liquidity buffers are a source of reducing potential bank distress and promote financial stability during crises years.

Our empirical results give rise to numerous important policy implications. The finding that higher market power induces banks to take on more liquidity risk highlights that the structure of the banking sector deserves greater regulatory scrutiny. In addition, even though we find a robustly positive association of bank liquidity requirements and overall financial stability, it still represents a cost opportunity. As a consequence, there is compelling reason to curtail bank liquidity to achieve or sustain efficiency and stability in the financial system. Finally, the results regarding the impact of oil price shock on bank lending in the GCC indicate that higher liquidity ratios are beneficial in terms of absorbing shocks to bank liquidity supply. Therefore, regulatory authorities could aim to review a more comprehensive set of liquidity risk management indicators similar to the Basel Committee work on liquidity management.

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DECLARATION OF AUTHORSHIP

I, ***Hana Saeed Bawazir*** declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

Liquidity, Liquidity Risk and Liquidity Regulation in Banking

I confirm that:

This work was done wholly or mainly while in candidature for a research degree at this University;
Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
Where I have consulted the published work of others, this is always clearly attributed;
Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
I have acknowledged all main sources of help;
Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
None of this work has been published before submission

Signed: ....

Date: ....

Acknowledgments

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Southampton, 11th January 2018

Hana Saeed Bawazir

Chapter 1: Introduction

1. Introduction

1.1 Aims

This thesis aims to offer new insights into banking liquidity. To this end, this research provides two distinctive analyses of the relationship between bank market power among financial institutions, and bank liquidity creation. A subsequent and unique analysis of the nexus between liquidity shocks, bank performance and credit growth concludes this work.

1.2 Overview

Liquidity shocks appear to be primarily responsible for the 2007-08 financial turmoil. It is not clear whether liquidity tensions are the main source and cause of the difficulties or a sign of deeper structural changes in the financial system. To try investigating this, it is worth looking back at the transformation of financial markets over the last decade and their impact on liquidity. The banking system underwent an important transformation from a traditional banking model, in which issuing banks hold loans on their balance sheets until they are fully repaid, into an "originate and distribute" banking model, in which banks repackage loans and pass them on to various other financial investors via securitization (Gorton and Souleles, 2007). Brunnermeier (2009) argues that what contributed to the liquidity squeeze during the financial crisis are the two banking industrial trends: banks increasingly financed their assets holdings with shorter maturity instruments, such as asset-backed commercial paper (ABCP) and the reliance on short-term funding from institutional investors through repurchase agreements (repo financing). Hence, the severe loss of liquidity in asset-backed securities markets and its repercussions on global interbank markets during 2007 provide a clear example of the channels that link market liquidity to banks' funding and asset liquidity. Through the interaction between market liquidity and funding liquidity, a relatively small shock can cause liquidity to dry up suddenly and carry the potential for a financial crisis.

There were many factors that led to the onset of the global financial crisis and financial experts differ on the weight given to each aspect. There is, however, a general agreement that liquidity risks and weaknesses in liquidity risk management were key factors leading to this crisis and especially its rapid expansion. Therefore, the global financial crisis of 2007-08 has highlighted the importance to regulate banks' liquidity. Until recently, managing and measuring liquidity risk was not seen as a high priority by most banks and financial institutions. Furthermore, no agreement existed in the international financial organizations and in the available literature on the accurate measurement of liquidity. There was neither an integrated measurement able to cover all the dimensions of liquidity risk nor one commonly adopted by the majority of institutions. The main ambition of liquidity supervision and regulation is to minimize the frequency and severity of banks' liquidity droughts, in order to lower their potential impact on the economy.

In light of the above, the proposal of the Basel Committee on Banking Supervision (BCBS) –which is hotly debated- to strengthen the liquidity requirements, in order to minimize risk taking, can be considered as a first step in the right direction.

Motivated by this increased public policy interest in overall financial stability, this PhD thesis highlights the most significant features to take into consideration in order to implement an effective liquidity risk management, uncover the linkages between bank market structure, individual bank behaviour and ultimately, achieving a more integrated supervisory framework for the banking system.

In order to achieve this ambitious goal, my empirical research focuses on four different phenomena. First, using various liquidity shocks, this work contributes to the enhanced and deeper understanding of the macro- and the microeconomics of bank soundness employing a broad variety of econometric methods and a number of different samples. In fact, liquidity regulations can be justified by micro- and macro-prudential motivations: as they are a complement to the lender of last resort (LLR) facility, since they limit the need for emergency liquidity assistance when a bank is in trouble. In addition, they are useful during banking crises or in case of macroeconomic shocks, since they limit the need for a generalized bailout. Therefore, one of their main objectives is to be used as protection for financial stability. Second, we start with an overview that considers how liquidity created by banks can be measured, and also extend this analysis by adding a whole new dimension to this literature by modelling the relationship between bank market power and liquidity creation, thereby also providing new and interesting insights for bank regulation and supervision. Third, using an innovative econometric technique, this thesis investigates whether banks that meet liquidity regulations as described in Basel III exhibit systematic differences from banks that fail to meet liquidity regulations. Fourth, this research presents an alternative way of testing bank liquidity, thus assessing the role of liquidity in the ability of banks to offer lending during the oil price shock that began in June 2014 in the GCC countries. In doing so, this work not only offers insight for public policy debates for reforming liquidity regulations but also suggests a further critical assessment of the new Basel liquidity requirements, especially with respect to Pillar I.

1.3 Structure of this Thesis

This thesis is structured around bank liquidity management frameworks from three distinctive perspectives. As a consequence, one chapter is devoted to each of the three lines of research. What is common between these three distinct lines of research is their ultimate focus on how to make sure banks hold sufficient buffers to face liquidity shocks.

Chapter 2 contains the starting point for the analysis of the relationship between bank market power and liquidity creation using data for 22 European countries. Chapter 3 aims to analyse the impact of a Net Stable Funding Ratio (NSFR) under Basel III on risk and return for banks in 28 European countries. Chapter 4 takes a different approach to analysing the effect of the oil price shock on bank lending using a sample of GCC conventional and Islamic banks to examine whether the effect of the oil price shock on lending differs depending upon the level of banks' liquidity position. Chapter 5 provides an overall summary to this thesis and highlights the important policy implications generated from it.

1.3.1 Chapter 2: Bank Market Power and Liquidity Creation

This chapter presents an empirical analysis of the relationship between bank market power and liquidity creation. While previous research in this area relies heavily on Berger and Bouwman (2009) liquidity creation measures, this chapter also considers an indicator related to the new liquidity requirements established under Basel III (the inverse of NSFR). Hence, our study provides comprehensive measures of liquidity creation compared to the previous literature. Using the efficiency adjusted Lerner and traditional Lerner indices as measures of bank market power; Chapter 2 presents the first empirical analysis of the relationship between bank market power and liquidity creation using non-structural measures of market power in banking systems on a cross-country level. Using an instrumental variables technique, this chapter presents robust evidence that higher market power enhances bank liquidity creation. This finding is robust to various robustness checks using different business models and samples. In addition, this result is confirmed when additional macroeconomic variables are controlled for. Furthermore, we find that market power affects liquidity creation on the asset-side and the liability-side of the balance sheet, but it does not affect liquidity creation off the balance sheet. Several extensions to the baseline are conducted by examining the interaction effect of market power and regulatory interventions during the global financial crisis as well as bank profitability to shed further light on the market power and liquidity creation nexus. In terms of policy implications, our findings highlight the conflicting objectives between sustainable economic growth through liquidity creation and effectiveness of liquidity regulations under Basel III policy.

1.3.2 Chapter 3: The Impact of Liquidity Ratio Requirements on Bank Risk and Return

Chapter 3 makes further important contributions to the literature on bank performance. It examines the impact of the liquidity ratio requirements on bank risk and return. Therefore, the main objective of this chapter is to analyse whether and to what extent adhering to the net stable funding ratio effectively enhances bank stability as well as assessing its impact on bank profitability. To accomplish this goal, we use a Regression Discontinuity Design (RDD) analysis that focuses on the NSFR rule, which allows us to generate quasi-experimental estimates of the impact of a "randomized" change in bank liquidity levels, which pass or fail the rule by a narrow margin, on bank risk and return. Chapter 3 finds robust evidence that adherence to the NSFR requirements causes financial stability of European banks to increase. However, an increase in liquidity of banks assets, increases banks' incentives to take on an amount of new risk that more than offsets the positive direct effect on stability. This is because even though higher asset liquidity directly benefits stability by encouraging banks to reduce the risks on their balance sheets and facilitating the liquidation of assets in a crisis, it also makes crises less costly for banks. As a result, banks have an incentive to take on an amount of new risk that more than offsets the positive direct impact on stability. In addition, our findings highlight a trade-off between liquidity and profitability. Lastly, our results demonstrate the differences between small and large banks. We find that for small banks, our results provide support for the Basel Committee that implementing liquidity regulations will reduce potential distress and promote financial stability. Whereas for large banks, liquidity becomes a less effective tool for ensuring stability. These results show that the implementation of the new liquidity requirements may also require amendments to Pillar 2 of Basel III (risk management and supervision) regarding internal governance as well as risk management tools to effectively manage non-performing loans.

1.3.3 Chapter 4: The Impact of Oil Price Shocks on GCC Banking: Does Liquidity Matter?

Chapter 4 adds a whole new dimension to the analysis of the nexus between liquidity shocks and bank supply of credit. To the best of our knowledge, this is the first study that investigate the impact of the recent collapse in oil prices and revenues on bank lending in the GCC economies and test the hypothesis that higher levels of liquidity mitigate the impact of the oil price shock. In this chapter, we use the difference-in-difference econometric technique as it suits our investigation perfectly, as the oil price shock affects the banking sector as a whole whereas the level of bank liquidity differs, and this enables us to clearly identify the role of bank liquidity. Using a sample of annual observations of GCC conventional and Islamic banks, the results of this chapter show that bank credit growth declines significantly following the oil price shock. However, consistent with a causal effect of a supply shock, we find that banks holding a higher liquidity level mitigate the impact of the oil price shock on credit growth. Furthermore, this chapter examines how the various financial elements within the banking system may affect the transmission mechanism of the oil price shock, taking into account those elements as relevant components in influencing bank loan supply. We find that short-term funding has a significantly negative effect on post-shock changes in lending, whereas long-term funding, non-interest income and bank net worth do not. The policy implication is that regulatory authorities could aim to review a more comprehensive set of liquidity risk management indicators in the spirit of the Basel Committee work on liquidity management.

1.3.4 Chapter 5: Summary, Conclusion and Future Research

A global summary and the concluding remarks of this thesis is provided in this final chapter. In addition, this chapter acknowledges the limitations of this work as well as outlining a number of appealing avenues for future research.

Chapter 2: Bank Market Power and Liquidity Creation

Bank Market Power and Liquidity Creation

Abstract

We empirically investigate how bank market power affects liquidity creation for a large sample of banks in the euro area countries from 2006-2015. Using the instrumental variables approach to deal with possible endogeneity concerns, we find market power as measured by Lerner indices increases liquidity creation significantly. We shed further light on the market power and liquidity creation nexus by examining the interaction effect of market power and regulatory intervention during the global financial crisis. We find that government intervention only affects banks with low market power. Additional results include the effects of market power on various components of liquidity creation as well as bank profitability. Our main results remain robust to several robustness checks.

JEL classification: G21, G28, L16

Keywords: Liquidity creation, Basel III, Bank market power

2. Bank Market Power and Liquidity Creation

2.1 Introduction

Liquidity shocks that lead to the recent global financial crisis (GFC) highlighted deeper structural changes and pressures in the financial system. The significant transformations that take place in financial markets have changed how banks create liquidity. Nowadays, a significant part of bank liquidity creation lies outside the banking system. Besides the traditional bank liquidity creation, a second and growing component, which depends on the amount of credit that banks are willing to extend to each other. Still market liquidity affects the asset side of banks' balance sheets to the extent they want to actively manage their portfolios. Consequently, liquidity shocks have a bigger impact on market and funding liquidity, which is expected to have potential implications on the level of bank competition among market participants. Also, banking competition affects the availability of credit, access to finance, and ultimately, economic growth (Claessens and Laeven (2004), (2005)). Therefore, understanding how market power affects credit supply is essential for the formulation of appropriate regulatory policies.

The goal of this chapter is to empirically examine the effect of bank market power on liquidity creation. Liquidity creation is an essential service that banks provide to the economy. Given the importance of liquidity creation, it is surprising that there is relatively little empirical work on understanding the mechanisms of liquidity creation. It is only recently that Berger and Bouwman (2009) created measures of liquidity creation and thereafter a growing empirical literature has been directed towards understanding the mechanisms of liquidity creation based on the measures offered by Berger and Bouwman (2009). However, little is known about how bank market power after the GFC affect banks' ability to create liquidity for their customers.

As liquidity creation becoming a relatively new research topic, most recent papers investigate the relationship between bank regulatory capital (Horváth *et al.* (2014), Fu *et al.* (2016), Casu *et al.* (2016) and Fungáčová *et al.* (2017)).The macroeconomy following financial crisis (Berger and Bouwman (2015), (2017), and Berger and Sedunov (2017)). Or the effects of regulatory interventions and capital support on liquidity creation (Berger *et al.*, 2010; Berger *et al.*, 2016). Whereas studies that investigate market power have mainly investigate its impact on bank net interest margin (Corvoisier and Gropp, 2002; Amidu and Wolfe, 2013b), financial stability (Berger *et al.*, 2009; Amidu and Wolfe, 2013a), efficiency (Ariss, 2010), and more recently how government interventions affect bank competition (Calderon and Schaeck, 2016).

This chapter adds to the competition and liquidity creation literature and offers several contributions. First, to the best of our knowledge, we are the first study that provide an in-depth analysis on how and to what extent liquidity creation is affected by market power in 22 EU countries. So far, no studies have explored the relationship between market power and liquidity creation in EU countries, our study covers this gap in the literature. While previous research in this area relies heavily on Berger and Bouwman (2009) liquidity creation measures, this chapter also considers an indicator related to the new liquidity requirements established under Basel III (the inverse of NSFR). Hence, our study provides comprehensive measures of liquidity creation compared to the previous studies. Furthermore, using the efficiency adjusted Lerner and traditional Lerner indices as measures of bank market power, this chapter presents the first empirical analysis of the relationship between bank market power and liquidity creation using non-structural measures of market power in banking systems on across-country level. In addition, this chapter presents a methodological advancement in the literature on liquidity creation in that we apply an instrumental variable technique not the widely accepted General Methods of Moments (GMM), to investigate the effect of bank market power on liquidity creation. Our identification strategy exploits plausibly exogenous variation in bank market power, which is instrumented using three instruments: financial freedom, banking activity restrictions and entry restrictions instead of using the lagged variables in the GMM approach. Finally, we are the first to examine the interaction effect of bank market power and government intervention on liquidity creation during the GFC.

In this chapter, we combine bank-specific data for 2,492 banks from 22 EU countries (15,761 country-year observations) with regulatory and macroeconomic variables over the period 2006 to 2015. We attempt to extend the previous empirical literature and analyse the impact of bank market power on liquidity creation. Due to the conflicting opinions on measuring the degree of market power expressed in the economic literature, it has become an important scope for investigating the competitive features of a banking industry. As a result, we apply a more recent measure of market power that allows for the possibility that firms do not choose the prices and input levels in a profit-maximizing way (Koetter *et al.*, 2012).

Our results indicate that banks with greater market power significantly increase their liquidity creation. Specifically, a greater market power increases liquidity creation by 59 and 7.8 percentage points for I.NSFR and TLC, respectively. This is large relative to the means of 127% and 21%. We find that market power only increases liquidity creation on the asset side by 12-percentage points for the adjusted Lerner and it reduces liability-side liquidity creation by 3.06 percentage points. Thus these effects when combined, explains why we find the overall effect of bank market power on total liquidity creation (TLC).

We further extend our analysis to demonstrate whether bank market power enhances overall bank profitability. In fact, we are interested to investigate the functionality of banks and to what extent they will be able to optimise their performance when faced by high-risk exposure in terms of liquidity creation. Our results show that higher market power increases bank profitability by 26-percentage points measured by return on assets, 4% as measured by return on equity and 73-percentage points by net interest margin. All these results are statistically significant at the 1% confidence level. This analysis highlights the importance of adjusting market power for profit inefficiency. Calculating market power using the traditional Lerner index overestimate bank profitability by more than 50%.

Our findings about the combined effect of high market power and government intervention on bank liquidity creation during the GFC reveal a negative relationship between banks with low market power and guarantees suggesting that during the GFC, government intervention through guarantees reduces liquidity creation. In contrast, we find the combined effect of recapitalisation with low market power is positive but only significant at the 10% confidence level for the TLC. This suggests that government intervention through recapitalisation should be targeted at banks with less market power.

We perform a number of robustness checks. First, we investigate how bank specialization affects liquidity creation. Second, we split our sample into under-capitalized and well-capitalized banks to examine whether liquidity creation responds differently at banks with relatively high capital ratios. Third, we re-run our model focusing only on small banks in order to find a link between bank size and liquidity creation. Fourth, we include macroeconomic control variables to investigate their potential influence on our findings. Fifth, we correct standard errors for clustering at the bank and year level to account for the structure of serial correlation within each bank in our tests. Finally, we construct an alternative liquidity creation measure *(I.NSFR)* by applying the October 2014 Basel III factors (BCBS, 2014). Our main findings remain robust to all these tests.

The remainder of this chapter is structured as follows: section 2.2 reviews the related literature and provides the theoretical arguments linking liquidity creation with bank market power and the explicit channels that can influence this relation. Section 2.3 describes the econometric framework. Section 2.4 describes the data and the calculation of the market power measures as well as the liquidity creation measures. Section 2.5 provides the results obtained from examining the impact of bank market power on liquidity creation. Section 2.6 presents various robustness checks. Finally, section 2.7 concludes.

2.2 Literature Review

Following the global financial crisis, Basel III and other strengthening policy responses are expected to affect financial institutions with implications for industry structure and competitive conduct over longer periods of time (Acharya and Mora, 2012). In turn, such actions might reduce banks' ability to provide lending or create liquidity in the economy. The theoretical literature regarding the impact of bank market power on liquidity creation suggests two opposing hypotheses. The "fragility channel" view by Petersen and Rajan (1995), who argue that increased competition reduces credit supply, as banks are less likely to grant credit to clients. The idea is that decreased market power reduces incentives for banks to establish long-term relationships with new borrowers, or relationships that could create future surpluses to be shared. Banks' propensity to lend and invest in information production may be more limited in competitive environments because competition reduces the possibility that banks can recoup the costs involved in building and nurturing long-term relationships with borrowers.

The second hypothesis, the "price channel" view by Boot and Thakor (2000), suggests that increased competition influences bank pricing policies, leading to diminished loan rates and increased deposit rates. As a consequence, demand for both loans and deposits rise. The more dominant view suggests that competition tends to be associated with lower loan rates, which makes credit more affordable and increases lending and access to finance. More broadly, this view argues that competition promotes credit availability. Several studies provide empirical support for a link between competition and low lending rates (Calderon and Schaeck, 2012; Love and Pería, 2015). Liquidity creation follows what financial intermediation assumes: that banks traditional and core business is to "borrow short and lend long", so they gather deposits and then lend these out.

Which of these two views best describes the nature of the relationship between bank market power and liquidity creation is ultimately an empirical issue. As we noted in the introduction, the empirical literature on this relationship is scarce. There is, however, empirical work on the relationship between banks market power and lending (one element of liquidity creation). The empirical results provided are mixed for example, Besanko and Thakor (1992) and Guzman (2000) find that market power is detrimental in banking as more competition leads to lower costs and better access to finance. Similarly, studies reveal that in a market where banks are concentrated, lending reduces as a result of high lending rates but deposit rates decline where banks have excessive market power in a deposit market (Berlin and Mester, 1999; Black and Strahan, 2002; Kahn *et al.*, 2005). Moreover, Cestone and White (2003) suggest that banks exhibit a reduced willingness to lend to new borrowers in uncompetitive markets because their existing lending relationships are highly valuable. Canales and Nanda (2012) and Cetorelli and Strahan (2006) find that reduced competition decreases bank lending.

Our chapter is also related to several other strands in the literature. It builds on previous studies and control for the complex relationship between liquidity creation and capital. Berger and Bouwman (2009) report two opposing hypotheses on the link between capital and liquidity creation. "The financial fragility-crowding out" theory states that higher capital reduces liquidity creation. Contrary, the "risk absorption" theories state that higher capital increases liquidity creation. For instance, Casu *et al.* (2016) find that higher capital requirements may result in reduced liquidity creation in the Eurozone. Similarly, Horváth *et al.* (2014) find Czech banks have a negative and significant relationship between liquidity creation and capital. Furthermore, Fu *et al.* (2016) and Distinguin *et al.* (2013) find similar results when analysing commercial banks in 14 Asia-Pacific economies and a sample containing European and US banks, respectively.

Generally, prior empirical research on bank market power focuses on the relationship between different aspects of bank regulations, supervisory practices, bank performance or financial stability (Beck *et al.*, 2006; Delis, 2012; Tabak *et al.*, 2012; Amidu and Wolfe, 2013a; Beck *et al.*, 2013; Cubillas and Suárez, 2013; Soedarmono *et al.*, 2013; Fiordelisi *et al.*, 2015). However, after the recent global financial crisis, the impact of the rescue operations such as capital injections, state-aid, and bank bailouts on banking competition have been the object of an increasing number of investigation (Beck *et al.*, 2010; Andresen, 2011; Calderon and Schaeck, 2012; Fiordelisi *et al.*, 2015). The financial crisis led to large losses, failure, and closure of many banks, and forced the intervention of both central banks and governments. Our study considers the interaction between market power and government intervention and examines how this might affect liquidity creation during the GFC. Molyneux (2014) states that the on-going reform in the European banking sector since the 2008-10 crisis will lead to a more conservative and less competitive system. In this regards, Ivashina and Scharfstein (2010) find that banks in the U.S. reduced their lending to customers significantly during the crisis period although banks have raised deposit rates to substitute wholesale funding constraints (Acharya and Mora, 2015). Similarly, (Cornett *et al.*, 2011) find that U.S. banks with more illiquid asset portfolios cut back on lending during crisis periods.

In sum, studies on liquidity creation have mainly focused on the complex relationship between liquidity creation and capital or government intervention. However, there has been no studies devoted to the issue of how liquidity creation measured as the new liquidity requirement in Basel III affects market power in the European banking industry. This chapter covers this gap and contributes to this relatively unexplored avenue of research by providing new insights on the relationship between liquidity creation and bank market power.

2.3 Econometric Framework

2.3.1 Identification Strategy

In this chapter, we investigate the contribution of Liquidity creation in explaining bank market power beyond the determinants considered in the existing literature. We define market power as the extent to which banks fix prices above marginal costs. To capture market power, we apply the traditional Lerner index as well as an adjusted Lerner index that allows for the possibility that banks do not choose the prices and input levels in a profit-maximizing way, i.e., avoiding the implicit assumptions of full efficiency in the estimation of traditional Lerner index (Koetter *et al.*, 2012). Ignoring profit inefficiency would lead to a large bias in price-cost margin, as well as in consumer and producer welfare losses. Previous studies show that bank market power is an important determinant of bank liquidity creation (Berger and Bouwman, 2009; Distinguin *et al.*, 2013; Fu *et al.*, 2016). Thus, to mitigate simultaneity concerns, we employ a two-stage least squares technique (2SLS/IV) and estimate Equations (1) and (2) as follows:

$$Lerner_{it} = a_0 + b_1 IV_{it} + b_2 X_{i,t-1} + \gamma_t + \gamma_c + \varepsilon_{it}, \qquad (1)$$

$$\Delta Y_{it} = c_0 + d_1 \widehat{Lerner}_{it} + d_2 X_{i,t-1} + \gamma_t + \gamma_c + \varepsilon_{it}, \quad (2)$$

Where ΔY_{it} is the change in liquidity creation (or one of its components: asset-side, liability-side, and off-balance sheet liquidity creation or one of the profitability measures: ROA, ROE and NIM) scaled by total assets at bank i from year $t-1$ to year t, $Lerner_{i,t}$ is either the adjusted or unadjusted Lerner index. It denotes bank market power indicators for bank i at time t. $X_{i,t-1}$ is a vector of control variables, defined in detail below. $IV_{i,t}$ are instrumental variables used to predict Lerner indices, γ_t and γ_c are year and country dummies, respectively. The term $\varepsilon_{i,t}$ is the error term. We estimate the first-stage regression between instrumental variables and market power in the EU banking using OLS method. All regressions are based on annual data. In the second stage, we regress liquidity creation on the predicted values of the potentially endogenous explanatory variables, control variables, year and country dummies. Standard errors are clustered at the bank level to control for serial correlation within each bank. We use Wooldridge (1995) overidentification and exogeneity tests as well as the explanatory power of the first-stage regression to select suited instruments.

2.3.2 Instruments

Establishing causality requires variables that explain market power but are neither correlated with bank liquidity creation nor a second-stage error term (Elyasiani and Jia, 2008; Danisewicz *et al.*, 2016). Consistent with the banking literature (Schaeck and Cihak, 2012; Amidu and Wolfe, 2013a), we instrument market power using three instruments: banking activity restrictions, entry restrictions and banking freedom. We argue that these instruments are suitable to instrument Lerner indices because they provide information concerning how independent a banking system is from government control as well as legal requirements and state interference in various banking activities. Hence, less government state ownership and interference directly affect bank market power. Firstly, we use bank activity regulatory variable to measure the degree to which national regulatory authorities allow banks to engage in the following three fee-based rather than the more traditional interest-spread-based activities: Securities activities, insurance activities and real estate activities. Following Barth *et al.* (2001), this instrument is proxied by an index taking on values between (1) and (4) for categories that capture information on whether banks can engage in securities, insurance, and real estate activities, and if they can hold stakes in non-banks. The activities are classified as unrestricted (1), permitted (2), restricted (3), or prohibited (4). Higher values indicated greater restrictions. Secondly, bank entry requirements (competition regulatory variable) are used to measure the specific legal requirements for obtaining a license to operate as a bank. This variable takes on values between (1) and (8), where higher values indicate lower entry restrictions. Finally, we use banking freedom as an indicator for the openness of a banking system. The index offers data on whether foreign banks are allowed to operate freely, on difficulties faced when establishing banks, and on government influence over credit allocation. The index ranges from 0 to 100 percent, where higher values indicate fewer restrictions.

2.3.3 The influence of government interventions

Furthermore, we extend our analysis and focus only on the crisis period (2008-2011) by considering whether banks with the highest market power have benefited more from government intervention in terms of creating more liquidity. We sort our sample into four quartiles; quartile four represents banks with the highest adjusted Lerner index and quartile one the lowest. Our pooled-OLS model specification is as follows:

$$\Delta Y_{it} = \alpha + \beta_1 Adjusted\ Lernerq1_{i,t-1} + \beta_2 Adjusted\ Lernerq2_{i,t-1} + \beta_3 Adjusted\ Lernerq4_{i,t-1} + \left[\sum_{j=1}^{2}(\lambda_j + \xi_j Adjusted\ Lernerq_{i,t-1}) * GovInt_{c,t-1}^{j}\right] + \delta X_{i,t-1} + \gamma_c + \gamma_t + \varepsilon_{it}, \quad (3)$$

Where $Adjusted\ Lernerq4_{i,t-1}$ is a variable that represents banks with the highest market power, $GovInt_{c,t-1}^{j}$ are two forms of government intervention; guarantees and liquidity measure as well as recapitalisation and asset relief. The coefficient ξ_j represents the interaction between adjusted Lerner index at various quartiles with the government intervention.

2.4 Data and Summary Statistics

2.4.1 Data Sources

The data used in this study are taken from several sources. We collect annual income statements and balance sheet data from the Fitch-IBCA BankScope (BSC) database. For our analysis, we distinguish between commercial, savings and cooperative banks from 28 EU countries. Income statements and balance sheets are taken in US dollar terms, using the market rate at the closing dates of the bank-specific accounting exercises. While in many cases BankScope reports both consolidated and unconsolidated financial statements, we use consolidated figures to the extent possible, to reflect the overall liquidity positions of the individual banking group.

For the main regressions we focus on the period from 2006-2015. Country-level data is obtained from the World Development Indicators of the World Bank. In addition, we retrieve the regulatory and institutional setting from Barth *et al.* (2001), Barth *et al.* (2004) and the Heritage Foundation. Variable definitions are provided in *Appendix 2.A*, in the top panel, variables employed to estimate cost and profit functions using both OLS and SFA (see section 2.4.3). We apply the following selection criteria: we drop banks with missing or negative total assets, have no loans outstanding loans, zero deposits, or with missing or negative data for three factor prices, tow outputs, cost, profit and equity. We deflate all monetary volumes to 2015 prices using the consumer price index (Koetter *et al.*, 2012; Delis *et al.*, 2016). All balance sheet items and factor prices are then truncated at the 1st and 99th percentile, respectively, to control for outliers. This reduces our final sample to 2,492 banks with 15,761 observations from 22 EU countries.[1] Table 2-1 provides the composition of the sample by country and bank type.

[1] Six countries are removed from our sample as banks in these countries fail to meet our selection criteria. These countries include Estonia, Finland, Lithuania, Poland, Romania and Slovenia.

Table 2-1 Composition of sample observations by country and bank type

Country	Total	Commercial Banks	Savings Banks	Cooperative Banks
Total number of banks	15,761	2,078	3,994	9,689
percent of sample	100%	14%	25%	61%
of which		Observations by category		
1 Austria (AT)	709	113	379	217
2 Belgium (BE)	72	66	3	3
3 Bulgaria (BG)	10	10	0	0
4 Cyprus (CY)	6	6	0	0
5 Czech Republic (CZ)	89	70	0	19
6 Germany (DE)	9,449	317	3,109	6,023
7 Denmark (DK)	242	143	80	90
8 Spain (ES)	38	22	11	5
9 France (FR)	1,065	406	137	522
10 United Kingdom (UK)	222	221	0	1
11 Greece (GR)	1	1	0	0
12 Croatia (HR)	7	7	0	0
13 Hungary (HU)	2	2	0	0
14 Ireland (IE)	1	1	0	0
15 Italy (IT)	3,444	384	207	2,853
16 Luxembourg (LU)	124	111	3	10
17 Latvia (LV)	47	47	0	0
18 Malta (MT)	17	17	0	0
19 Netherlands (NL)	88	88	0	0
20 Portugal (PT)	88	35	46	7
21 Sweden (SE)	33	15	18	0
22 Slovakia (SK)	7	6	1	0

Notes: This table presents a description of all observations included in the sample by country and bank type. Source: BankScope & authors' calculations.

2.4.2 Dependent Variables: Liquidity Creation Measures

Our first liquidity creation proxy is based on the regulatory standards proposed by the Basel Committee on Banking Supervision (BCBS, 2010b). Following the global financial crisis and in recognition of the need for banks to improve their liquidity management, the Basel Committee on Banking Supervision developed an international framework for liquidity assessment in banking. Among the several guidelines, the Basel III accords include the implementation of a net stable funding ratio (NSFR). This ratio aims to promote resiliency over long-term time horizons by creating additional incentives for banks to fund their activities with more stable sources of funding. This liquidity measure is the ratio of the available amount of stable funding to the required amount of stable funding.

We are among the first studies that use the inverse net stable funding ratio (I.NSFR) as a proxy of liquidity creation (Distinguin *et al.*, 2013; Casu *et al.*, 2016). Hence, we calculate our liquidity creation indicator as the amount of required stable funding (RSF) relative to the amount of available stable funding (ASF) (BCBS, 2010b).

$$I.NSFR_{it} = \frac{Required\ Stable\ Funding_{it}}{Available\ Stable\ Funding_{it}} \quad (4)$$

Required Stable Funding (RSF) is a weighted sum of the uses of funding sources (assets and off-balance sheet) according to their liquidity. While Available Stable Funding (ASF) is a weighted sum of funding sources according to their stability features. *Appendix 2.B* shows the breakdown of a bank balance sheet as provided by BankScope and its weighting with respect to the Basel III framework to calculate the inverse of the net stable funding ratio. We follow the same assumptions made by Distinguin *et al.* (2013) and (Gobat *et al.*, 2014) to compute NSFR.

In addition, we calculate four measures of liquidity creations following Berger and Bouwman (2009) and Berger *et al.* (2016) using a three-step procedure. In step 1, we classify all bank balance sheet and off-balance sheet activities using information on the category and maturity of banks' assets and liabilities as liquid, semi-liquid, or illiquid. This is done based on the ease, cost, and time it takes customers to obtain liquid funds from the bank (liability-side of a balance sheet), and based on the ease, cost and time with which banks can dispose their obligations in the case of asset items (asset-side of a balance sheet). In step 2, we assign weights of either +1/2, 0, or -1/2 to the activities classified in step 1. The weights correspond to liquidity creation theory. According to this theory, banks create liquidity by converting illiquid assets into liquid liabilities. In contrast, banks destroy liquidity by transforming liquid assets into illiquid liabilities or equity (see Berger and Bouwman, 2009). In step 3, we combine the activities as classified in step 1 and as weighted in step 2 in different ways to construct our liquidity creation measures. Total liquidity creation *(TLC)* for each bank considers both on- and off- balance sheet activities. Instead of using TLC, we also use an *(off-balance sheet)* measure where we only include off-balance sheet activities. Similarly, we decompose the TLC measure and construct two proxies (*asset-side and liability-side*) that focuses on on-balance sheet activities. *Appendix 2.C* provides a classification of bank activities and construction of four liquidity creation measures.

Higher values of all measures will indicate higher illiquidity. Higher levels of liquidity creation mean that banks invest more liquid liabilities in illiquid assets. In this context, a bank faces risk if some liquid liabilities invested in illiquid assets are claimed on demand. We run the regressions in changes rather than levels because this allows us to observe how changes in our explanatory variables lead to changes in liquidity creation at one particular bank in the following year and avoids our results being driven by cross-sectional variation in the data (see Berger *et al.* (2010) and Berger *et al.* (2016)).

2.4.3 Explanatory Variables: Market Power Measures

We examine the impact of market structure in banking on liquidity creation using two Lerner indices as indicators of the degree of market power and clarify which one is our preferred measure. First, the traditional Lerner index that assumes fully efficient banks represents the mark-up of price over marginal costs. Following the banking literature (Amidu and Wolfe (2013a), Fungáčová *et al.* (2014) and Berger and Roman (2015)), the traditional Lerner index is calculated at the bank level as:

$$Lerner_{jt} = \frac{P_{jt}-MC_{jt}}{P_{jt}} \quad (5)$$

Where P_{jt} is the price of bank output which is calculated as the ratio of total income over total assets for bank j at time t, and MC_{jt} is the marginal cost of the production of that output for bank j at time t. When the marginal cost is not available as in most empirical data sets, it can be estimated using econometric methods. We use a popular approach through estimating a translog cost function and take its derivative to obtain the marginal cost. We follow Koetter *et al.* (2012) and employ the following translog cost function as:

$$log\ Cost_{jt} = \alpha + \sum_{i=1}^{3} B_i \log w_{ijt} + \sum_{p=1}^{2} \gamma_p \log y_{pjt} + \sum_{i=1}^{3} (\varsigma_i/2) (\log w_{ijt})^2 + \sum_{i<k} \sum \eta_{ik} \log w_{ijt} \log w_{kjt} + \sum_{p=1}^{2} (\theta_p/2) (\log y_{pjt})^2 + (\kappa_{12}/2) \log y_{1jt} \log y_{2jt} + \sum_{i=1}^{3} \sum_{p=1}^{2} \lambda_{pi} \log w_{ijt} \log y_{pjt} + \sum_{k=1}^{2} v_k trend^k + \sum_{i=1}^{3} \xi_i \log w_{ijt} trend + \sum_{p=1}^{2} \omega_p \log y_{pjt} trend + \delta log(z_{jt}) + \varepsilon_{jt}, \quad (6)$$

Where *Cost* represents total costs including financial and operating costs, w_{ijt} input factors $i = 1,2,3$ of bank j at time t, y_{1jt} is total securities of bank j at time t. Following Koetter *et al.* (2012) Securities include securities held to maturity, securities available for sale and all other stocks, bonds and securities. y_{2jt} is total loans for bank j at time t, z_{jt} is total equity of bank j at time t, and $trend$ is a time trend to capture technical change.

Once the cost function is estimated, marginal cost is evaluated by taking the first derivative with respect to total securities (y_{1jt}) and total loans (y_{2jt}), which yields

$$MC_{jt} = \frac{Cost_{jt}}{y_{1jt}} [\gamma_1 + \theta_1 \log y_{1jt} + (\kappa_{12}/ 2) \log y_{2jt} + \sum_{i=1}^{3} \lambda_{1i} \log w_{ijt} + \omega_1 trend] + \frac{Cost_{jt}}{y_{2jt}} [\gamma_2 + \theta_2 \log y_{2jt} + (\kappa_{12}/2) \log y_{1jt} + \sum_{i=1}^{3} \lambda_{2i} \log w_{ijt} + \omega_2 trend]. \quad (7)$$

We estimate equation (5) using an OLS approach imposing the restrictions of homogeneity in inputs prices and symmetry in cross-price effects as in Lang and Welzel (1996). We impose homogeneity of degree 1 on input prices and *Cost* by the price of borrowed funds (w_3). Country and time fixed effects are also introduced to control for all unobservable time-variant country-specific factors. We cluster heteroscedasticity-adjusted standard errors at the bank level to account for serial correlation within each bank. The Lerner index ranges between zero and one, and interpreted as follows: zero corresponds to perfect competition and larger values reflect more market power and less competition.

Our second indicator of market power is the adjusted Lerner index estimated using the exact same procedure as Koetter *et al.* (2012). This index allows for the possibility that firms do not choose the prices and input levels in a profit-maximizing way, i.e., avoiding the implicit assumptions of full efficiency in the estimation of the traditional Lerner index. To approximate average revenues, Humphrey and Pulley (1997) propose an alternative profit efficiency model as a more adequate framework when the standard assumptions of a perfectly competitive market do not hold. This model measures to what extent a bank generates maximum profits given its output levels. To measure efficiency, we use profit before taxes (PBT) as the dependent variable in the translog equation (6). We deal with the problem of losses in translog profit models by applying the solution proposed by Bos and Koetter (2011), we specify an additional independent variable, the Negative Profit Indicator (NPI). We define NPI to be equal to one for observations where PBT is positive and equal to the absolute value of PBT for a loss-incurring bank.

We follow the new literature and use stochastic frontier analysis (SFA) to estimate marginal cost and average revenues based on standard assumptions in (Kumbhakar and Lovell, 2000). SFA posits a composed error model ($\varepsilon_j = v_j + \mu_j$), where inefficiencies (μ_j) are assumed to follow an asymmetric distribution, usually the half-normal with a variance σ_μ^2 independent of the $v_j's$, while random errors (v_j) follow a symmetric distribution, normal distribution with mean zero and variance σ_v^2 . The logic is that the inefficiencies must have a truncated distribution because inefficiencies cannot be negative.

An efficiency-adjusted Lerner index is then calculated using predicted total costs *(Cost),* corresponding marginal costs *(MC)*, and predicted profits *(PBT)* relative to total output (*TO* = total loans + total securities) as:

$$Adjusted\ Lerner_{jt} = \frac{\frac{PBT}{TO}+\frac{Cost}{TO}-MC}{\frac{PBT}{TO}+\frac{Cost}{TO}} = \frac{PBT+Cost-MC*TO}{PBT+Cost} \quad (8)$$

Assessing market power using the adjusted Lerner index is our preferred measure. This is because Koetter *et al.* (2012) state that firms with market power prefer to operate inefficiently rather than reap all potential rents. Profit inefficiency arises when firms do not fully exploit their pricing opportunity set. Therefore, ignoring both cost and profit inefficiencies would lead to an even larger bias in price-cost margin, as well as in consumer and producer welfare losses.

2.4.4 Control Variables

Our regressions contain several control variables, which are lagged by one year. We include the following: the natural logarithmic of total assets is included to account for bank size. We control for bank capitalization, using the equity ratio (equity capital to total assets) because Berger and Bouwman (2009) have shown that bank capital is a key determinant for liquidity creation. Furthermore, we follow Berger *et al.* (2010) and Casu *et al.* (2016) and include the return on equity *(ROE)* to control for bank profitability. It is calculated as the ratio of net income to average equity. Finally, we add Loan Loss Provisions *(LLP)* to control for credit risk (Altunbas *et al.*, 2007). According to Berger and Bouwman (2009), it is important to control for risk because adding risk to the regression helps to isolate the role of capial in suppporting bank liquidity creation from the role of capital in supporting banks' function as risk transformers. In addition, we include a dummy variable for commercial banks (Commercial), a dummy variable for savings banks (Savings) and a dummy variable for Cooperative banks (Cooperative) that we drop in the regression to avoid perfect collinerity.

2.4.5 Summary Statistics and Statistical Analysis of Lerner Indices

Table 2-2 presents the descriptive statistics for the variables included in our model. As to our dependent variables, the average inverse net stable funding ratio *(I.NSFR)* is 127%. This result is similar to those reported in US and European banks (90.2% by Distinguin *et al.* (2013)). Total liquidity creation *(TLC)* equals 21% of industry total assets. This result is similar to those reported in Germany (22% by Berger *et al.* (2016)). Banks in our sample create almost all their liquidity on the balance sheet and only 2% liquidity is created off-balance sheet. Distinguin *et al.* (2013) state that the main difference between the liquidity creation indicators based on Berger and Bouwman (2009) and the liquidity indicator as defined in the Basel III accords stems from the liability side of the balance sheet. The liquidity creation indicator *(TLC)* considers some liabilities as liquid because they can be quickly withdrawn without penalty. However, a large share of these liquid liabilities is considered as stable in the Basel III liquidity indicator because they are expected to "stay" within the institution. Furthermore, higher levels of liquidity creation *(TLC)* mean that banks invest more liquid liabilities in illiquid assets. Whereas, higher *(I.NSFR)* implies that the amount of assets that cannot be monetized is deviating from the available amount of stable funding. The mean value of the traditional Lerner index is 5%. While the adjusted Lerner index shows a higher value of 9% consistent with Koetter *et al.* (2012), who find that adjusted Lerner indices are larger than conventional Lerner indices.

Table 2-2 Summary Statistics

	N	Mean	SD	Min	Max
Dependent Variables					
INSFR	15,761	1.27	0 .84	0 .001	32.79
TLC	15,761	0.21	0.21	-0.98	6.64
LC off-balance sheet	15,761	0.02	0.09	-0.009	6.63
LC asset-side	15,761	0.04	0 .21	- 0.78	0.53
LC liability-side	15,761	0.18	0.16	-0.91	0.59
Main Explanatory Variables					
Traditional Lerner index	15,761	0.05	0.34	-6.62	0.92
Adjusted Lerner index	15,761	0.09	0.47	-12.93	0.91
Variables used in the derivation of market power					
Interest income *	15,761	86.16	1315.74	0.01	124074.6
Non-interest income *	15,761	47.75	627.28	0.001	51261.18
Securities*	15,761	1967.31	27163.79	0.001	1534152
Loans*	15,761	3068.88	36556.21	0.15	2974721
Price of physical capital	15,761	1.31	2.65	0.22	26.41
Price of labour	15,761	0.01	0.003	0.002	0.02
Price of borrowed funds	15,761	0.02	0.01	0.002	0.07
Marginal cost (OLS)	15,761	0.02	0.008	0.0007	0.19
Marginal cost (SFA)	15,761	0.03	.0084	0.0007	0.19
Instruments					
Financial freedom	15,761	61.91	8.21	50	90
Banking activities	15,761	1.61	0.49	1.3	2.5
Entry restrictions	15,761	6.65	0.93	1	8
Control Variables					
Total Assets*	15,761	6063.024	72551.92	0.35	5240319
Capital	15,761	2.04	3.07	0.0004	83.64
ROE	15,761	4.87	5.50	-193.54	89.12
LLP	13,636	5.16	0.94	-11.85	-1.38
NII	15,542	1.14	0.95	-6.16	6.03
Commercial	15,761	0.13	0.33	0	1
Savings	15,761	0 .25	0.43	0	1
Crisis dummy	15,761	0.21	0.41	0	1

Notes: This table reports summary statistics on selected variables used throughout the paper from 2006-2015. It contains the means, standard deviations, minimum and maximum values for each variable. * All values are in millions of dollars. Source: BankScope database and the Heritage Foundation.

Consistent with Koetter *et al.* (2012), mean Lerner indices per year in Table 2-3 demonstrate that failure to adjust for inefficiency leads to underestimation of market power. For the period from 2006 to 2010, adjusted Lerner indices are on average about one-third larger compared to unadjusted indices. However, beyond 2010, adjusted Lerner reflect an increase in the level of competition among banks as the adjusted Lerner declined. This could be due to the regulatory reforms after the global financial crisis.

Furthermore, Table 2-4 shows the correlation matrix for the sample. It can be seen that no high correlation between the independent variables is present and hence there are no multicollinearity problems.

Table 2-3 Adjusted and Unadjusted Lerner Indices: EU Banks in the period 2006-2015

	Lerner Index		Spearman's Rank Correlation			Liquidity Creation	
Year	Unadjusted	Adjusted	N	r	p-value	INSFR	TLC
2006	0.005	0.286	1,594	0.813	0.000	1.556	0.254
2007	-0.162	0.140	1,719	0.772	0.000	1.521	0.246
2008	-0.253	0.034	1,659	0.736	0.000	1.083	0.153
2009	-0.025	0.096	1,746	0.708	0.000	1.123	0.158
2010	0.109	0.109	1,796	0.657	0.000	1.130	0.179
2011	0.118	0.075	1,863	0.680	0.000	1.224	0.207
2012	0.136	0.051	1,461	0.692	0.000	1.278	0.202
2013	0.191	0.043	1,339	0.679	0.000	1.316	0.229
2014	0.255	0.057	1,413	0.620	0.000	1.254	0.222
2015	0.280	0.007	1,171	0.599	0.000	1.279	0.243
Total	0.052	0.094	15,761			1.273	0.207

Notes: This table presents the difference between unadjusted and adjusted Lerner indices as well as the mean per year of our liquidity creation measures indicated by INSFR and TLC.

Table 2-4 Correlation Matrix for all Independent variables

	Size	Capital	ROE	LLP	Commercial	Savings	Crisis dummy
Size	1						
Capital	0.4015*	1					
ROE	0.0925*	-0.0302*	1				
LLP	-0.1095*	0.0260*	-0.1488*	1			
Commercial	0.3222*	0.0450*	0.3779*	-0.0575*	1		
Savings	0.2689*	0.1103*	-0.2408*	-0.0154	-0.2270*	1	
Crisis dummy	-0.1478*	-0.2414*	0.0159*	0.0434*	-0.0382*	-0.0028	1

Notes: This table presents the correlation matrix for our independent variables. * Implies significance at 5% or more. Source: BankScope database.

2.5 Empirical Results

2.5.1 First-Stage Results: Instruments

Table 2-5 (column 1 and column 2) analyse the determinants of market power proxied by the adjusted Lerner index and traditional Lerner index. The three instruments are financial freedom, bank activities and entry restrictions. In addition, we use set of control variables as identified in the literature (Claessens and Laeven, 2004; Demirgüç-Kunt and Martínez Pería, 2010).

First, we use financial freedom as an indicator for the openness of a banking system. The index offers data on whether foreign banks are allowed to operate freely, on difficulties faced when establishing banks, and on government influence over credit allocation. The findings suggest that with the higher financial freedom, banking markets appear to be less competitive. Second, we find that higher financial freedom is associated with weaker bank entry restrictions. This lead to new investment opportunities which lead to higher sophistication in banking products that may in turn affect the degree of bank competition.

Finally, we find a significant and positive impact of bank activities for the adjusted Lerner index only. This indicates that banks with higher market power benefit more when national authorities allow them to engage in fee-based non-traditional activities. Regarding the control variables, most of the control variables have the expected sign and are significant.

2.5.2 Second-Stage Results: Market Power

Table 2-5 *Panel A* (columns 3-6). Our key variables of interest are the adjusted Lerner index and the traditional Lerner index. We present our estimations based on two definitions of liquidity creation: the inverse of net stable funding ratio *(I.NSFR)* under Basel III regulatory requirements and total liquidity creation *(TLC)* based on Berger and Bouwman (2009).

We find that banks with greater market power significantly increase their liquidity creation. Our results show that market power has a positive and significant coefficient whether measured by adjusted Lerner or traditional Lerner index. We obtain this result with both measures of liquidity creation. Specifically, a greater market power increases liquidity creation by 59 and 7.8 percentage points for INSFR and TLC, respectively. This is large relative to the means of 127% and 21%. This result supports the hypothesis that market power can affect the availability of funds Petersen and Rajan (1995) and the distributions of the loan portfolio (Berger *et al.*, 2005). In contrast to Cestone and White (2003), Cetorelli and Strahan (2006), and Canales and Nanda (2012), who find that banks reduce their willingness to lend in uncompetitive markets because their existing lending relationships are highly valuable.

Regarding the control variables, our coefficients are in line with those obtained in previous studies (Distinguin *et al.*, 2013; Berger *et al.*, 2016; Casu *et al.*, 2016) we find that size has a positive and significant impact on liquidity creation. This can be justified by the ability of larger banks to access external funding as they might benefit from a reputational advantage, possibly providing them a broader access to financial markets. Furthermore, for bank capital, profitability and credit risk, we find a negative relationship between these coefficients and liquidity creation. Consistent with the "financial fragility structure" (Diamond and Rajan, 2000; Diamond and Rajan, 2001) and the "crowding-out of deposits" (Gorton and Winton, 2017) theories, higher regulatory capital ratios are associated with lower liquidity creation and illiquidity. Finally, we find the coefficient for Commercial is positive while negative for Savings, indicating that commercial banks create more liquidity than savings banks.

Table 2-5 *Panel B* shows several diagnostic tests that we perform on a 2SLS model. Wooldridge (1995) is reported to examine overidentification restrictions as well as exogeneity tests. The results suggest overidentification can be rejected, the null hypothesis that Lerner indices are exogenous can be rejected and explanatory power as indicated by R^2 and F-tests support the choice of instruments. In sum, the results suggest that the three instruments are correctly excluded from the second-stage equation.

Table 2-5 IV Regression Results of the Impact of Bank Market Power on Liquidity Creation

Panel A: IV Regression Model Results

VARIABLES	(1) Adjusted Lerner	(2) Traditional Lerner	(3) ΔINSFR	(4) ΔTLC	(5) ΔINSFR	(6) ΔTLC
Financial freedom	0.0103***	0.00397**				
	[0.0014]	[0.0014]				
Bank activities	0.234**	0.0642				
	[0.082]	[0.047]				
Entry restrictions	-0.136***	-0.0641***				
	[0.0099]	[0.0051]				
Adjusted Lerner			0.5881***	0.0786***		
			[0.099]	[0.021]		
Lerner					1.5460***	0.2067***
					[0.472]	[0.076]
Size $_{(t-1)}$	-0.0917***	-0.0530***	0.0555***	0.0098***	0.0836***	0.0135***
	[0.0081]	[0.0041]	[0.009]	[0.002]	[0.026]	[0.004]
Capital $_{(t-1)}$	0.103***	0.0426***	-0.0565***	-0.0094***	-0.0619***	-0.0101***
	[0.0078]	[0.0041]	[0.011]	[0.002]	[0.021]	[0.003]
ROE $_{(t-1)}$	0.00305	0.0101***	-0.0009	-0.0004	-0.0146***	-0.0022***
	[0.0036]	[0.0013]	[0.001]	[0.000]	[0.005]	[0.001]
LLP $_{(t-1)}$	0.0363***	0.0436***	-0.0316***	-0.0057***	-0.0775***	-0.0119***
	[0.0087]	[0.0053]	[0.004]	[0.001]	[0.019]	[0.003]
Commercial	-0.0902*	-0.00666	0.0440**	0.0077**	0.0013	0.0020
	[0.046]	[0.024]	[0.019]	[0.004]	[0.022]	[0.004]
Savings	0.0111	0.00539	-0.0311***	0.0031*	-0.0329***	0.0028
	[0.020]	[0.010]	[0.007]	[0.002]	[0.010]	[0.002]
Crisis	-0.333***	-0.279***	0.1091***	0.0141***	0.0269	0.0031
	[0.018]	[0.015]	[0.020]	[0.005]	[0.017]	[0.003]
Constant	0.756***	0.469***	-0.3550***	-0.0599***	-0.4356***	-0.0707***
	[0.18]	[0.12]	[0.062]	[0.013]	[0.130]	[0.021]

Panel B: Specification tests for IV regression models on the adequacy of instruments

	(1)	(2)	(3)	(4)	(5)	(6)
Observations	15,761	15,761	15,761	15,761	15,761	15,761
Wooldrige (1995) overidentification						
Chi square			0.000	0.000	0.000	0.000
p-value			0.980	0.9997	0.981	0.985
Wooldrige (1995) exogeneity test						
score			71.30	16.50	75.90	18.47
p-value			0.000	0.000	0.000	0.000
Robust F statistic			69.72	16.40	74.15	18.34
p-value			0.000	0.000	0.000	0.000
First-stage diagnostics						
R^2 value			0.2529	0.2529	0.4381	0.4381
Robust F-Statistic			64.8617	64.8617	12.7686	12.7686
P-value			0.000	0.000	0.0004	0.0004

Notes: Panel A: reports the first stage regressions in columns 1 and 2 as well as the results from instrumental variable regressions. The dependent variables are measures of liquidity creation. Inverse net stable funding ratio (ΔI.NSFR) in columns 3 and 5, total liquidity creation (ΔTLC) in columns 4 and 6. Robust standard errors are reported in parentheses. Country and time-specific effects included but not reported. Panel B: reports specification tests for validity of instruments. The null hypothesis of the robust Wooldrige overidentification score test is that instruments are valid. The null hypothesis for the exogeneity test is that the instrument variable is not endogenous. F statistic report the explanatory power of the regressions. Significance at *10%, **5%, ***1%. Data source: BankScope database. Coverage: 2006-2015.

2.5.3 Liquidity Creation Components

In this section, we examine whether the impact of market power on liquidity creation comes only from on-balance sheet items: if it is on the asset side or the liability side, or it is also goes through off-balance-sheet items. To examine this issue, we perform estimations by measuring the components of liquidity creation focusing on the measures calculated based on Berger and Bouwman (2009). Table 2-6 shows the results for both Lerner indices. We find that market power only increase liquidity creation on the asset side by 12-percentage point for the adjusted Lerner and 32-percentage point for the traditional Lerner.

This analysis also shows that higher market power reduces liability-side liquidity creation by 3.06 percentage points measured by adjusted Lerner and 8.02 percentage points measured by traditional Lerner index. Both results are statistically significant at 1% and 5%, respectively. These effects thus when combined, explain why we find the overall effect of bank market power on total liquidity creation (TLC). We find no significant measured effect of market power on off-balance sheet liquidity creation. Regarding the control variables, we observe that they maintain their signs but are only significant in the asset-side estimation.

Table 2-6 IV Regression Results of the Impact of Bank Market Power on Components of Liquidity Creation

Panel A: IV Regression Model Results						
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	ΔLC asset-side	ΔLC liability-side	ΔLC off-balance sheet	ΔLC asset-side	ΔLC liability-side	ΔLC off-balance sheet
Adjusted Lerner	0.1249***	-0.0306***	-0.0023			
	[0.020]	[0.012]	[0.003]			
Lerner				0.3282***	-0.0802**	-0.0059
				[0.097]	[0.036]	[0.009]
Size $_{(t-1)}$	0.0123***	-0.0013	0.0000	0.0183***	-0.0028	-0.0001
	[0.002]	[0.001]	[0.000]	[0.005]	[0.002]	[0.000]
Capital $_{(t-1)}$	-0.0118***	0.0014	0.0001	-0.0130***	0.0017	0.0001
	[0.002]	[0.001]	[0.000]	[0.004]	[0.002]	[0.000]
ROE $_{(t-1)}$	0.0006**	-0.0009***	-0.0000	-0.0023**	-0.0002	0.0000
	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]
LLP $_{(t-1)}$	-0.0073***	0.0016***	-0.0002*	-0.0170***	0.0040***	-0.0000
	[0.001]	[0.001]	[0.000]	[0.004]	[0.001]	[0.000]
Commercial	0.0106***	-0.0010	0.0008	0.0015	0.0012	0.0010**
	[0.004]	[0.002]	[0.001]	[0.004]	[0.002]	[0.000]
Savings	0.0042***	-0.0013	0.0004*	0.0038*	-0.0012	0.0004*
	[0.002]	[0.001]	[0.000]	[0.002]	[0.001]	[0.000]
Crisis	-0.0151***	0.0343***	-0.0015**	-0.0325***	0.0385***	-0.0012***
	[0.004]	[0.003]	[0.001]	[0.004]	[0.002]	[0.000]
Constant	-0.0836***	0.0169**	-0.0017	-0.1007***	0.0210**	-0.0014
	[0.012]	[0.007]	[0.002]	[0.026]	[0.010]	[0.002]
Panel B: Specification tests for IV regression models on the adequacy of instruments						
Observations	15,761	15,761	15,761	15,761	15,761	15,761
Wooldrige (1995) overidentification						
Chi square	0.000	0.000	0.000	0.000647	0.000	0.001
p-value	1.00	1.00	1.00	0.980	1.00	0
Wooldrige (1995) exogeneity test	84.96	7.024	0.587	92.39	6.723	0.350
score	0.000	0.00804	0.444	0.000	0.00952	0.554
p-value						
Robust F statistic	83.39	7.002	0.585	90.50	6.704	0.349
p-value	0.000	0.00815	0.445	0.000	0.00963	0.555
First-stage diagnostics						
R^2 value	0.2529	0.2529	0.2529	0.4381	0.4381	0.4381
Robust F-Statistic	64.8617	64.8617	64.8617	12.7686	12.7686	12.7686
P-value	0.000	0.000	0.000	0.0004	0.0004	0.0004

Notes: Panel A: reports the results from instrumental variable regressions. The dependent variables are measures of components of liquidity creation. Asset-side liquidity creation (ΔLC asset-side) in columns 1 and 4, liability-side liquidity creation (ΔLC liability-side) in columns 2 and 5, and off-balance sheet liquidity creation (ΔLC off-balance sheet) in columns 3 and 6. Robust standard errors are reported in parentheses. Country and time-specific effects included but not reported. Panel B: reports specification tests for validity of instruments. The instruments used are 1) financial freedom provides overall measures of the openness of the banking sector. 2) Bank activity restrictions and 3) Entry restrictions. The null hypothesis of the robust Wooldrige overidentification score test is that instruments are valid. The null hypothesis for the exogeneity test is that the instrument variable is not endogenous. F statistic report the explanatory power of the regressions. Significance at *10%, **5%, ***1%. Data source: BankScope database. Coverage: 2006-2015.

2.5.4 Extensions: Bank Market Power, Profitability and Government Intervention

We further examine whether bank market power enhances overall bank profitability, one of the main objectives of bank when increasing its illiquidity. We measure profitability by ΔROA, ΔROE and ΔNIM. Table 2-7 presents our results. Our results show that higher market power increases bank profitability by 27-percentage points measured by return on assets, 4% as measured by return on equity and 73-percentage points by net interest margin. The results are statistically significant at the 1% confidence level and consistent with (Schaeck and Čihák (2008) Mirzaei *et al.* (2013) and Amidu and Wolfe (2013b)).

This analysis highlights the importance of adjusting market power for profit inefficiency. Calculating market power using the traditional Lerner index overestimate bank profitability by more than 50%.

Table 2-7 IV Regression Results of the Impact of Bank Market Power on Bank Profitability

Panel A: IV Regression Model Results

VARIABLES	(1) ΔROA	(2) ΔROE	(3) ΔNIM	(4) ΔROA	(5) ΔROE	(6) ΔNIM
Adjusted Lerner	0.2690***	4.2812***	0.7338***			
	[0.084]	[1.129]	[0.120]			
Lerner				0.6447***	10.2614***	1.7589***
				[0.244]	[3.517]	[0.497]
Size $_{(t-1)}$	0.0240***	0.3316***	0.0747***	0.0330**	0.4748**	0.0992***
	[0.008]	[0.107]	[0.011]	[0.013]	[0.189]	[0.027]
Capital $_{(t-1)}$	-0.0181**	-0.2778**	-0.0632***	-0.0190*	-0.2922*	-0.0657***
	[0.009]	[0.121]	[0.013]	[0.011]	[0.162]	[0.023]
NII $_{(t-1)}$	0.0698***	0.9737***	0.0363***	0.0681***	0.9457***	0.0315***
	[0.003]	[0.045]	[0.005]	[0.004]	[0.057]	[0.008]
LLP $_{(t-1)}$	-0.0133***	-0.1885***	-0.0604***	-0.0280***	-0.4224***	-0.1005***
	[0.003]	[0.046]	[0.006]	[0.008]	[0.119]	[0.017]
Commercial	0.0034	0.0660	0.0610***	-0.0297**	-0.4607**	-0.0292
	[0.013]	[0.181]	[0.022]	[0.013]	[0.196]	[0.026]
Savings	-0.0300***	-0.3756***	-0.0220***	-0.0211***	-0.2340***	0.0023
	[0.005]	[0.064]	[0.008]	[0.006]	[0.080]	[0.011]
Crisis	-0.0375**	0.2921	0.1427***	-0.0646***	-0.1400	0.0686***
	[0.018]	[0.245]	[0.026]	[0.014]	[0.191]	[0.025]
Constant	-0.2242***	-3.5654***	-0.7568***	-0.2630***	-4.1830***	-0.8627***
	[0.052]	[0.699]	[0.073]	[0.075]	[1.069]	[0.149]

Panel B: Specification tests for IV regression models on the adequacy of instruments

Observations	15,558	15,558	15,558	15,558	15,558	15,558
Wooldrige (1995) overidentification						
Chi square	0.000	0.000	0.000	0.000647	0.000	0.001
p-value	0.999	0.999	1.00	0.999	0.999	0.999
Wooldrige (1995) exogeneity test	10.78	16.73	71.74	10.11	15.97	72.48
score	0.00103	0.000	0.000	0.00148	0.000	0
p-value						
Robust F statistic	10.88	17.01	72.65	10.21	16.24	73.69
p-value	0.000976	0.000	0.000	0.00140	0.000	0
First-stage diagnostics						
R^2 value	0.2544	0.2544	0.2544	0.4345	0.4345	0.4345
Robust F-Statistic	59.8415	59.8415	59.8415	13.4493	13.4493	13.4493
P-value	0.000	0.000	0.000	0.0002	0.0002	0.0002

Notes: Panel A: reports the results from instrumental variable regressions. The dependent variables are measures of bank profitability. Return on assets (ΔROA) in columns 1 and 4, return on equity (ΔROE) in columns 2 and 5, and net interest margin (ΔNIM) in columns 3 and 6. Robust standard errors are reported in parentheses. Country and time-specific effects included but not reported. Panel B: reports specification tests for validity of instruments. The instruments used are 1) financial freedom provides overall measures of the openness of the banking sector. 2) Bank activity restrictions and 3) Entry restrictions. The null hypothesis of the robust Wooldrige overidentification score test is that instruments are valid. The null hypothesis for the exogeneity test is that the instrument variable is not endogenous. F statistic report the explanatory power of the regressions. Significance at *10%, **5%, ***1%. Data source: BankScope database. Coverage: 2006-2015.

We next examine the combined effect of high market power and government intervention on bank liquidity creation during the Global Financial Crisis (GFC). We sort banks based on their adjusted Lerner index into four quartiles. The combined effects are explored through the interaction between the government intervention and the adjuster Lerner index. Using equation (3), the results are reported in Table 2-8. We find banks in the fourth quartile (*Adjusted Lerner q4)* increase their liquidity creation as measured by *(ΔTLC).* Across both estimations, we find the coefficient of recapitalisation *(Recapitalization)* is positive and statistical significance at the 1% confidence level to bank liquidity creation. Nevertheless, for our key variables of interest, when we consider the combined effect of government intervention with market power. We find the effect is negative for the combined effect of Guarantees with low market power *(Adjusted Lerner q1*Guarantees)* and *(Adjusted Lerner q2*Guarantees)* suggesting that during the GFC, government intervention through guarantees reduces liquidity creation for banks with less market power. The average bank liquidity creation is lowered by 1.28 percentage points and 1.11 percentage points as measured by *(I.NSFR),* respectively. In contrast, we find the combined effect of recapitalisation with low market power *(Adjusted Lerner q1*Recapitalization)* and *(Adjusted Lerner q2*Recapitalization)* is positive and significant at the 10% confidence level for the TLC. This suggests that government intervention through recapitalisation should be targeted at banks with less market power.

Table 2-8 Pooled ordinary least squares regression during crisis period: from 2008-2011

	(1) ΔTLC	(2) ΔINSFR
Adjusted Lerner q1$_{(t-1)}$	0.0128	0.0153
	(0.0076)	(0.027)
Adjusted Lerner q2$_{(t-1)}$	0.00767	0.00251
	(0.0068)	(0.032)
Adjusted Lerner q4$_{(t-1)}$	0.0191***	0.00387
	(0.0054)	(0.021)
Guarantees $_{(t-1)}$	-0.00707	0.0828
	(0.089)	(0.26)
Recapitalization $_{(t-1)}$	2.786***	16.30***
	(0.63)	(2.94)
Adjusted Lerner q1*Guarantees $_{(t-1)}$	-0.250	-1.284*
	(0.13)	(0.54)
Adjusted Lerner q2*Guarantees $_{(t-1)}$	-0.216	-1.110*
	(0.13)	(0.53)
Adjusted Lerner q4*Guarantees $_{(t-1)}$	0.183	-0.268
	(0.097)	(0.77)
Adjusted Lerner q1* Recapitalization $_{(t-1)}$	1.165*	2.297
	(0.50)	(2.11)
Adjusted Lerner q2* Recapitalization $_{(t-1)}$	1.230*	2.508
	(0.49)	(2.05)
Adjusted Lerner q4* Recapitalization $_{(t-1)}$	0.701	1.517
	(0.43)	(1.95)
Constant	-0.0336**	0.121*
	(0.012)	(0.048)
Country Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Bank Controls	Yes	Yes
Observations	4628	4628
R-squared	0.0737	0.140
Number of Banks	1903	1903

Notes: This table reports the results of a pooled ordinary least squares regression with robust standard errors clustered at the bank level. We control for country and year fixed effect. Bank controls include size, capital, ROE, LLP, Commercial, Savings and crisis dummy. Notice that the total number of observations (4628) reflects the unbalanced nature of the dataset. Significance at *10%, **5%, ***1%. Data source: BankScope database. Coverage: 2008-2011.

2.6 Interaction Effects & Robustness Checks

2.6.1 Market Power and Bank Specialization

In this analysis, we turn to bank specialization and investigate how different business models affects liquidity creation (Table 2-9 column 1 and column 2). We consider liquidity creation as measured by (TLC) based on Berger and Bouwman (2009). We first run our estimation considering only cooperative banks as they represent 61% of our sample. The results provide interesting evidence. First, we find the interaction effect between market power and cooperative banks negative and strongly significant, suggesting that cooperative banks create less liquidity compared to commercial and savings banks. This could be explained by the difference between cooperative banks and savings or commercial banks in terms of legal ownership, governance and capital structures and business model. Cooperative banks tend to be lower risk institutions. There are several reasons why cooperative banks tend to have less incentive to take excess risk. First, they are not under pressure to maximise profits. Second, cooperative banks are under less short-term pressure and more inclined to adopt a longer-term horizon in their business decisions and lending policies. Finally, it is less easy for some cooperative banks to raise external capital, i.e. independent of their members.

Second, we rerun our estimations with only commercial and savings banks and find supporting evidence. The coefficients of the interaction term between market power and bank specialization in column 2 are positive and statistically significant at 1% confidence level. In both cases, the adjusted Lerner index remains positive and strongly significant, indicating that higher market enhances liquidity creation.

2.6.2 Market Power and Bank Capital

In this test, we rerun our main analysis but now splitting the sample at the median equity ratio into under-capitalized and well-capitalized banks to examine whether liquidity creation responds differently at banks with relatively high capital ratios (Table 2-9 column 3 and column 4). We construct an interaction variable between bank market power and well-capitalized banks (Adjusted Lerner* Well-Capitalized). Consistent with our main results, we find an inverse relationship between capital ratio and our liquidity creation proxies. Therefore, banks may reduce liquidity creation as capital increases, as suggested by the "financial-fragility-crowding out" hypothesis. This result is consistent with the findings of (Distinguin *et al.*, 2013; Horváth *et al.*, 2014; Fu *et al.*, 2016). Berger and Bouwman (2009) conclude that the effect of capital on liquidity creation is negative only for small banks. Therefore, we run our next test to investigate whether the interaction between bank size and bank market power impacts liquidity creation.

2.6.3 Market Power and Bank Size

Both the "fragility channel" and the "price channel" effects on liquidity creation might differ considerably among banks of different size. We address this by testing whether the net effect of liquidity creation on bank market power is negative or positive for different bank sizes as a further robustness check. We re-run our model focusing only on small banks in order to find a link between bank size and liquidity creation (Table 2-9 column 5 and column 6).[2] We split our sample at the median of total assets into large and small banks. We expect that the financial fragility channel effect is likely to be relatively strong for small banks. One reason is that small banks deal more with entrepreneurial-type small business, where the close monitoring highlighted in Diamond and Rajan (2000) is important. In contrast, the price channel effect is likely to be stronger for large banks because substantial portions of their liquidity off the balance sheet is higher compared with small banks (Berger and Bouwman, 2009).

We construct an interaction variable between bank market power and small banks (Adjusted Lerner*Small). Consistent with Berger and Bouwman (2009), small banks create less liquidity compared to large banks.

2.6.4 Including Macroeconomic Variables

Next, we include macroeconomic contorl variables *GDP* and *Inflation* to investigate their potential influence on the findings (Table 2-9 column 7 and column 8). We find that banks operating in countries with an expected economic boom as measured by *(GDP)* have significant impact on liquidity creation. Similarly, we find the inflation rate has a positive and significant impact on liquidity creation. Our main variable of interest *(Adjusted Lerner)* remains positive and statistically significant at the 1% confidence level.

2.6.5 Remove the country with the largest number of banks

As a further test, we remove the country with the largest number of banks to observe whether our results are influenced by this concentration. Table 2-1 shows that Germany is by far the most concentrated country with 9,449 total bank observations. We consider liquidity creation as measured by (TLC) based on Berger and Bouwman (2009). We rerun our econometric model excluding Germany from our sample. Table 2-9 column 9 displays this result, in which it can be observed that the coefficient of our main variable of interest *(Adjusted Lerner)* remains positive and statistically significant at the 5% confidence level.

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[2] We re-run the same test for large banks, our results show that large banks create more liquidity, results are available form authors upon request.

Table 2-9 Robustness Checks

Panel A: IV Regression Model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	ΔTLC	ΔTLC	ΔINSFR	ΔTLC	ΔINSFR	ΔTLC	ΔINSFR	ΔTLC	ΔTLC
Adjusted Lerner	0.1411***	0.1040***	0.8223***	0.1096***	0.7353***	0.0859***	0.4896***	0.0743***	0.1372**
	[0.047]	[0.029]	[0.156]	[0.031]	[0.160]	[0.030]	[0.096]	[0.022]	[0.062]
Size $_{(t-1)}$	0.0101***	0.0097***	0.0581***	0.0101***			0.0471***	0.0094***	0.0128**
	[0.002]	[0.002]	[0.011]	[0.002]			[0.009]	[0.002]	[0.005]
Small					-0.0470***	-0.0125***			
					[0.010]	[0.002]			
Capital $_{(t-1)}$	-0.0107***	-0.0094***			-0.0598***	-0.0090***	-0.0450***	-0.0091***	-0.0154***
	[0.003]	[0.002]			[0.014]	[0.003]	[0.010]	[0.002]	[0.005]
Well-Capitalized			0.0079	-0.0009					
			[0.007]	[0.001]					
ROE $_{(t-1)}$	-0.0003	-0.0003	0.0002	-0.0002	0.0015	-0.0000	-0.0003	-0.0004	-0.0020***
	[0.000]	[0.000]	[0.002]	[0.000]	[0.002]	[0.000]	[0.001]	[0.000]	[0.001]
LLP $_{(t-1)}$	-0.0076***	-0.0050***	-0.0275***	-0.0052***	-0.0421***	-0.0067***	-0.0266***	-0.0053***	-0.0106***
	[0.002]	[0.001]	[0.005]	[0.001]	[0.007]	[0.001]	[0.004]	[0.001]	[0.003]
Crisis	0.0111***	0.0166***	0.1262***	0.0164***	0.0285**	0.0012	0.0017	0.0520***	0.0115
	[0.004]	[0.005]	[0.026]	[0.005]	[0.013]	[0.003]	[0.060]	[0.013]	[0.012]
Commercial		-0.0203***	0.0853***	0.0132***	0.1124***	0.0176***	0.0335*	0.0074*	0.0103**
		[0.007]	[0.027]	[0.005]	[0.032]	[0.006]	[0.018]	[0.004]	[0.005]
Savings		-0.0055	-0.0277***	0.0035**	-0.0105	0.0067***	-0.0311***	0.0030*	0.0160***
		[0.004]	[0.008]	[0.002]	[0.008]	[0.002]	[0.007]	[0.002]	[0.006]
Cooperative	0.0016								
	[0.003]								
Adjusted Lerner*Commercial		0.0989***							
		[0.029]							
Adjusted Lerner*Savings		0.0291***							
		[0.010]							

Adjusted Lerner*Cooperative	-0.1123***								
	[0.042]								
Adjusted Lerner* Well-Capitalized			-0.2348***	-0.0310***					
			[0.047]	[0.009]					
Adjusted Lerner*Small					-0.5305***	-0.0533**			
					[0.139]	[0.026]			
GDP							-0.0166**	0.0036**	
							[0.007]	[0.001]	
Inflation							0.0413***	0.0065***	
							[0.009]	[0.002]	
Constant	-0.0503***	-0.0571***	-0.5203***	-0.0818***	-0.0387	-0.0034	-0.3267***	-0.0812***	-0.0861*
	[0.011]	[0.013]	[0.097]	[0.019]	[0.039]	[0.007]	[0.054]	[0.013]	[0.046]
Panel B: Specification tests for IV regression models on the adequacy of instruments									
Observations	15,761	15,761	15,761	15,761	15,761	15,761	15,761	15,761	6,312
Wooldrige (1995) overidentification									
Chi square	0.000	0.000	0.00240	0.000733	0.000	0.000	0.0062	0.0062	0.0592
p-value	1.00	1.00	0.961	0.978	0.710	1.00	0.937	1.00	0.808
Wooldrige (1995) exogeneity test	15.65	16.34	72.223	16.695	61.001	11.55	43.85	13.59	8.615
Score	0.000	0.000	0.000	0.000	0.000	0.0002	0.000	0.0002	0.0033
p-value									
Robust F statistic	15.56	16.24	70.661	16.597	59.809	11.50	43.23	13.59	8.416
p-value	0.000	0.000	0.000	0.000	0.000	0.0002	0.000	0.0002	0.0037
First-stage diagnostics									
R^2 value	0.4883	0.3871	0.3941	0.3941	0.2792	0.2792	0.2542	0.2542	0.2747
Robust F-Statistic	22.1443	50.1485	45.2846	45.2846	27.9362	27.9362	58.721	58.721	6.3677
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0017

Notes: this table presents the results of vaious robustness tests. Columns 1 and 2 present the results for bank market power and bank specialization. Columns 3 and 4 present the results for bank market power and capital. Columns 5 and 6 presnt the result for bank market power and small size banks. Columns 7 and 8 present the results including macroeconomic control variables. Finally, column 9 presents the result after excluding Germany the most concentrated country from the sample. Significance at *10%, **5%, ***1%. Data source: BankScope database. Coverage: 2006-2015.

2.6.6 Standard Errors Corrected for Clustering at the Bank and Year

In this test, we deal with serial correlation in the error term. In the main results we clustered hetroskedasticity-adjusted standard errors on the bank level to account for the structure of the serial correlation within each bank in our tests. As an alternative way, we correct standard errors for clustering at the bank and year (Table 2-10). We find that our results remain robust and do not affect our inferences.

Table 2-10 Robustness Checks- Clustering Standard Errors by Bank and Year

	(1)	(2)
VARIABLES	ΔINSFR	ΔTLC
Adjusted Lerner	0.5881***	0.0786***
	[0.098]	[0.020]
Size $_{(t-1)}$	0.0555***	0.0097 ***
	[0.009]	[0.001]
Capital $_{(t-1)}$	-0.0565***	-0.0093***
	[0.010]	[0.002]
ROE $_{(t-1)}$	-0.0009	-0.0004
	[0.001]	[0.000]
LLP $_{(t-1)}$	-0.0316***	-0.0057***
	[0.004]	[0.001]
Crisis	0.1091***	0.0141***
	[0.020]	[0.004]
Commercial	0.0440**	0.0077**
	[0.019]	[0.003]
Savings	-0.0311***	0.0031*
	[0.007]	[0.001]
Constant	-0.3549***	-0.0599***
	[0.062]	[0.012]
Observations	15,761	15,761
R^2 value	0.2529	0.2529
Robust F-Statistic	64.8617	64.8617
P-value	0.000	0.000

Notes: This table presents the results as we correct standard errors for clustering at the bank and year. We estimate $\Delta Y_{it} = c_0 + d_1 Adjusted\ \widehat{Lerner}_{it} + d_2 X_{i,t-1} + \gamma_t + \gamma_c + \varepsilon_{it}$, where ΔY_{it} denotes the dependent variable of bank i at time t. The dependent variables are measures of liquidity creation. Inverse net stable funding ratio (ΔI.NSFR) in column1 , total liquidity creation (ΔTLC) in column 2. The main explanatory variable is the (*Adjusted Lerner*). Country and time-specific effects included but not reported. Significance at *10%, **5%, ***1%. Data source: BankScope database. Coverage: 2006-2015.

2.6.7 Alternative Liquidity Creation Proxy

As a final robustness check, we construct the *(I.NSFR)* based on Basel III applying the more recent October 2014 factors (BCBS, 2014). The results are shown in Table 2-11 column 5 and column 6. We find that both market power measures *(Adjusted Lerner)* and *(Lerner)* remain positive and statistically significant at the 1% confidence level and do not differ substantially from those obtained in Table 5.

The main differences between calculating INSFR based on previous factors used in the literature and the new factors are as follows: With respect to the assets side; first, NSFR as revised in October 2014 requires a higher weight for loans to financial entities. Hence, we apply a 10% weight instead of 0%. Second, government securities receive a 5% weight. Third, corporate loans receive a weight of 85% instead of 100%. Finally, other securities in available-for-sale or trading portfolios (e.g., equities, commodities, and corporate bonds) receive 50% RSF weight consistent with the revised Basel III NSFR. Similarly, on the liability side, the differences are in the factor given to stable deposits, we increase the weight from 70% to 95% and decrease less stable from 100% to 90%. Whereas unsecured wholesale funding increased form 0% to 50%.

Table 2-11 Robustness Checks- Alternative Liquidity Creation Proxy

VARIABLES	(3) Adjusted Lerner	(4) Traditional Lerner	(5) ΔINSFR	(6) ΔINSFR
Financial freedom	0.0113***	0.00356**		
	[0.0020]	[0.0013]		
Bank activities	0.750***	0.0655		
	[0.089]	[0.095]		
Entry restrictions	-0.0969***	-0.0652***		
	[0.0057]	[0.0093]		
Adjusted Lerner			0.3405***	
			[0.070]	
Lerner				1.0841***
				[0.355]
Size $_{(t-1)}$	-0.0949***	-0.0549***	0.0313***	0.0585***
	[0.0078]	[0.0042]	[0.006]	[0.019]
Capital $_{(t-1)}$	0.0654***	0.0238***	-0.0182***	-0.0217***
	[0.0053]	[0.0032]	[0.004]	[0.008]
ROE $_{(t-1)}$	0.00429	0.0110***	-0.0008	-0.0112***
	[0.0035]	[0.0013]	[0.001]	[0.004]
LLP $_{(t-1)}$	0.0442***	0.0432***	-0.0197***	-0.0515***
	(0.0097)	[0.0049]	[0.003]	[0.014]
Commercial	-0.128**	-0.0151	0.0351***	0.0080
	[0.048]	[0.024]	[0.012]	[0.019]
Savings	0.0163	0.0126	-0.0151***	-0.0232***
	[(0.019]	[0.0099]	[0.004]	[0.007]
Crisis	-0.300***	-0.0552***	0.0635***	0.0213
	(0.026)	[0.016]	[0.014]	[0.013]
Constant	-0.191	0.555**	-0.2833***	-0.4086***
	[0.20]	[0.21]	[0.051]	[0.116]
Observations	17,883	17,883	17,883	17,883
Wooldrige (1995) overidentification				
Chi square			0.00	0.00
p-value			1.00	0.9996
Wooldrige (1995) exogeneity test				
score			63.86	65.97
p-value			0.000	0.000
Robust F statistic			65.96	68.07
p-value			0.000	0.000
First-stage diagnostics				
R^2 value			0.1910	0.3879
Robust F-Statistic			40.6667	11.1933
P-value			0.000	0.000

Notes: this table presents the results of a further robustness check of using alternative measure of liquidity creation applying Basel III more recent October 2014 factors to calculate the INSFR in columns 5 and 6. Robust standard errors are reported in parentheses. Country and time-specific effects included but not reported. Panel B: reports specification tests for validity of instruments. The instruments used are 1) financial freedom provides overall measures of the openness of the banking sector. 2) Bank activity restrictions and 3) Entry restrictions. The null hypothesis of the robust Wooldrige overidentification score test is that instruments are valid. The null hypothesis for the exogeneity test is that the instrument variable is not endogenous. F statistic report the explanatory power of the regressions. Significance at *10%, **5%, ***1%. Data source: BankScope database. Coverage: 2006-2015.

2.7 Conclusion

This chapter examines the impact of bank market power on liquidity creation for a large sample of banks in the euro area countries from 2006 to 2015. Using an instrumental variable approach, we find market power as measured by Lerner indices increases liquidity creation significantly. Further investigation suggests that market power affects liquidity creation on the asset-side and the liability side of the balance sheet, but it does not affect liquidity creation off the balance sheet. We compute adjusted Lerner index where we explicitly compare it with the traditional Lerner index. We find that it is important to adjust for profit inefficiency as calculating market power using traditional Lerner overestimate bank profitability by more than 50%. Overall, our results show that Lerner indices have a positive impact on bank profitability.

As a further step, we investigate how regulatory interventions during the global financial crisis affect liquidity creation. We find a negative relationship between the combined effect of market power and guarantees and liquidity creation, while it is positive for the combined effect of market power and recapitalisation for the (TLC) only. Our main results remain robust to several robustness tests.

The results also suggest several policy implications. First, bank market power matters for macroprudential policies. We find evidence that banks take on more liquidity risk as they achieve greater market power. As market power can have detrimental economic effects through its impact on liquidity creation. The ECB should monitor the structure of the banking sector not only for financial stability reasons, but also to encourage liquidity creation as it may lead to higher levels of economic growth. However, in light of the recent liquidity rules, as banks are required to hold more liquid assets. Thus, policymakers facing conflicting objectives between sustainable economic growth through liquidity creation and effectiveness of Basel III policy.

Second, we find higher required capital ratios may discourage liquidity creation within banks. Hence, the implementation of Basel III may result in reduced liquidity creation by introducing tightened capital requirements, therefore, slowing economic growth through a reduction in the amount available for financing. Therefore, it is necessary to look for a trade-off between benefits for a financial system from stronger capital and liquidity regulations and benefits of greater liquidity creation.

Furthermore, given the differences between liquidity creation measures based on Berger and Bouwman (2009) and Basel III (BCBS, 2010a), using the *(I.NSFR)* measure for liquidity creation may be useful to add to the debate on liquidity assessment in banking. This level of liquidity creation could be considered to appreciate the ability of banks to face transformation risk when they create liquidity. However, given the ambiguity in the definition and measurement of liquidity under a global regulatory framework, it is recommended that regulators further clarify what type of liquid liabilities should be considered stable. By better understanding what factors significantly impact bank exposure to transformation risk, it can help banks to improve their risk management framework.

Chapter 3: The Impact of Liquidity Ratio Requirements on Bank Risk and Return

The Impact of Liquidity Ratio Requirements on Bank Risk and Return

Abstract

This chapter analyses the impact of a Net Stable Funding Ratio (NSFR), as described in Basel III, on risk and return for banks in 28 European countries. Using a regression discontinuity design analysis we assess the impact of NSFR on bank performance. Our results suggest that adherence to the NSFR requirements causes the financial stability of European banks to increase. However, an increase in liquidity of banks assets, increases banks' incentives to take on new risk that more than offsets the positive direct effect on stability. We also show some evidence of a trade-off between liquidity and bank profitability, providing major implications not just for policy development and macroprudential regulation but also for investment decision makers. Finally, our findings have shown that only small banks are significantly positively affected by tightening the liquidity requirements in terms of stability. Our results remain robust to a barrage of robustness tests.

JEL classification: G01, G21, G28

Keywords: Liquidity, banking regulation, Basel III, financial crisis, bank performance

3. The Impact of Liquidity Ratio Requirements on Bank Risk and Return

3.1 Introduction

The liquidity crisis of 2008 revealed weaknesses in bank risk management, as well as substantial deficiencies within the Basel II rule set (Brunnermeier and Pedersen, 2009). In response to this crisis, the Basel Committee on Banking Supervision (BCBS) introduced a more comprehensive set of global standards, the Basel III package in December 2010, to address problems in both short-term and long-term liquidity. The objective of this new rule set is to increase the resilience of banks during periods of recession (BCBS, 2010a).

Under Basel III, the new indicators for liquidity risk management are a Liquidity Coverage Ratio (LCR) and a Net Stable Funding Ratio (NSFR). Both the LCR and NSFR standards aim to increase banks' liquidity buffers and funding stability. In particular, the scope of the LCR is to ensure that banks have enough liquidity to survive short-term (one-month) stress conditions. In comparison, the NSFR aims to ensure that banks have adequate stable funds to survive longer periods of one year, thereby reducing maturity transformation risk. Compared to the LCR, the NSFR is designed to address more structural changes of the liquidity mismatches between assets and liabilities, as banks should finance long-term assets with more stable sources of funding on an ongoing basis to limit any funding risks.

Despite the fact that the new regulation aims at improving the ability of banks to absorb shocks caused by financial and economic stress and to promote resilience in banking systems, the desirability of the Basel III regulations and implementation of the new binding liquidity requirements are hotly debated. One strand of the literature argues that the new requirements reduce the probability of costly financial crisis, lower the risk of bank bankruptcies, and can lead to more capital- and liquidity- efficient business models and products (Harle *et al.*, 2010; Admati *et al.*, 2013). Another strand of the literature, however, points out that implementing a regime with tougher requirements could have significant costs and may reduce GDP (BCBS, 2010a; Angelini *et al.*, 2015) through raising the borrowing costs for households and companies. In particular, the rules relating to NSFR will limit a bank's ability to conduct maturity transformation, one of the core functions of banks. Accordingly, complying with the new standards can also reduce profitability and lead to a squeeze on lending margins (BIS, 2010).

The focus of our study is on the net stable funding ratio (NSFR);[3] a comprehensive empirical analysis is conducted to calculate this ratio for 28 European countries using BankScope financial data over the period 2005-2010. This paper builds on previous quantitative impact studies by analysing the potential effect of introducing the NSFR on bank risk and return. However, the new liquidity standard depends on certain assumptions that have been largely untested (Hong *et al.*, 2014). Therefore, empirical studies of the new liquidity standards using historical data can shed light on these underlying assumptions and have potential and important policy implications. It is therefore the purpose of our research to explore potential impacts of the prescribed funding structures under Basel III on the performance of the banking industry in Europe.

The empirical challenge of our study is to identify the causal effect of imposing high liquidity requirements on bank performance. Identifying the causal effect requires solving the endogeneity problem that arises from a standard ordinary least squares (OLS) approach. Such results could be correlated with bank unobservable characteristics that affect bank performance or the reverse casualty problem that occurs between profitability and instability to influence the level of liquidity. To be able to identify causality, we use a regression discontinuity design (RDD) that relies on "locally" exogenous variation in bank liquidity positions that meet or fail by a small margin the NSFR requirements. It is a powerful and appealing identification strategy because, for these banks close to meeting the NSFR, meeting the rule is very close to an independent random event and therefore is unlikely to be correlated with bank unobservable characteristics (Bradley *et al.*, 2016). Furthermore, we perform various diagnostic tests to ensure that all key identifying assumptions of applying RDD are satisfied.

According to our nonparametric local linear regression estimation, our results show that the new NSFR requirements have advantages in enhancing the financial stability of European banks. We find that meeting the NSFR leads to a 3.45 basis points (bp) increase in financial stability measured by the Z-Score value. In addition, the level of capital increases by 2.38bp, which indicates financial strength. However, the extra liquidity induces a risk-taking behaviour that results in an increase in non-performing loans and loan loss reserves to total loans. This is because even though higher asset liquidity directly benefits stability by encouraging banks to reduce the risks on their balance sheet and

[3] We focus on NSFR because for the LCR, detailed information on the composition and duration of liquid assets and 30-day liabilities are not available from standard financial statements.

facilitating the liquidation of assets in a crisis, it also makes crises less costly for banks. As a result, banks have an incentive to take on an amount of new risk that more than offsets the positive direct impact on stability. In addition, our findings reveal that banks meeting the NSFR requirements suffer from a decline in their profitability compared to those that do not meet the requirements.

We extend our analysis to demonstrate the differences between small and large banks. We find that for large banks only, liquidity becomes a less effective instrument for ensuring stability as these banks aggressively take on more risk as reflected in their NPLs and LLR. Whereas, for small banks, the impact of increased liquidity on stability is strongly and statistically significant at the 1% confidence level. Therefore, for small banks, our results provide support for the Basel Committee that implementing liquidity regulations will reduce potential distress and promote financial stability.

We perform a number of robustness checks. First, we run a RDD analysis focusing on the pre-crisis period only and examine the impact of NSFR requirements on financial stability and bank profitability. Second, we try four alternative minimum liquidity requirements levels for the NSFR using 80%, 90% 110% and 120% cut-off values. Third, we assess the effects of state aid on banking system stability during the GFC. Fourth, we attempt to rule out the possibility of a discontinuity effect, that alternative covariates may drive our results, by using a placebo test. Finally, we use alternative bandwidth choices for our econometric model. Our results are robust to all of these checks.

This chapter contributes to the existing literature in several ways. To the best of our knowledge it is the first study that investigates how and to what extent the new liquidity standard (NSFR) affects the stability and profitability of banks in the EU. It assesses both the cost and benefit of liquidity requirements over an extended period covering the recent global financial crisis (GFC), whereas previous studies (Dietrich *et al.*, 2014; Gobat *et al.*, 2014; Vazquez and Federico, 2015) only focus on one of these two aspects. As a further contribution, unlike previous papers (King, 2013; Dietrich *et al.*, 2014; Gobat *et al.*, 2014; Hong *et al.*, 2014; Vazquez and Federico, 2015) we apply the more recent October 2014 factors to calculate the NSFR (BCBS, 2014). Finally, from a methodological viewpoint, this is the first study that employs a regression discontinuity design (RDD) to evaluate the impact of the new liquidity rules on stability and profitability between two groups: banks that meet the NSFR requirements and banks that fail to meet the NSFR requirements. This will give us an insight into how banks can benefit from adhering to the new regulations beyond 2018 and especially during a crisis period. At present, this subject is of great concern for policy makers and researchers because this regulatory change aims to improve the soundness of the banking system by lowering the probability of bank failures. At the same time, tighter regulations might negatively affect the performance and lending quality of banks in turn harming economic growth.

The remainder of this chapter is organized as follows: Section 3.2 reviews the related literature on liquidity, liquidity risk and the new liquidity regulations. Section 3.3 describes the data and provides background information and calculation of the new NSFR liquidity standard. Section 3.4 describes the econometric framework and regression estimation. Section 3.5 provides the results obtained from examining the links between the new liquidity measure and bank performance. Section 3.6 presents various robustness checks. Finally, section 3.7 concludes.

3.2 Literature Review

The role of liquidity in the GFC has attracted considerable attention from researchers and policy makers. The recent financial crisis has uncovered several systemic weaknesses amongst European banks mainly related to their inability to manage liquidity risk. Previous studies on banking stability have mainly focused on the role of capital in reducing banking fragility during financial crises (e.g. Demirgüç-Kunt and Huizinga, 2010; Berger and Bouwman, 2013; Gorton and Winton, 2014; Thakor, 2014), while less attention has been devoted to the impact of liquidity on the stability and soundness of the banking system during periods of distress.

Before the GFC, studies on liquidity have mainly focused on the determinants of bank liquidity buffers and especially on the role that the required reserves and Lender of Last Resort (LOLR) play in a liquidity crisis (Aspachs *et al.*, 2005; Repullo, 2005; Delechat *et al.*, 2012). Whereas the GFC has generated renewed interest for liquidity management frameworks as well as how to make sure banks hold sufficient buffers to face liquidity shocks. A body of literature has recently evolved focusing on the reasons for bank failures during the recent GFC and explicitly state the majority of commercial bank failures were partly caused by the joint occurrence of liquidity risk and credit risk (Cai and Thakor, 2008; Acharya *et al.*, 2011; Acharya and Viswanathan, 2011). Hence, liquidity risk and credit risks play a tremendous role for banks and their stability.

Following the Basel III liquidity regulations (BCBS, 2010b), the impact of liquidity on banking systems in Europe has been the object of an increasing number of investigation (Cole and White, 2012; DeYoung and Torna, 2013; Acharya and Mora, 2015; Altunbas *et al.*, 2015). As stated in the introduction, the Basel III liquidity regulations (BCBS, 2010b) introduced a more comprehensive global set of standard indicators to address the mismatch in short-term and long-term liquidity and to redress past failures of bank risk management. Despite the fact that the new rules will be implemented from January 2018, some scholars have started to explore the potential impact of new liquidity standards in reducing bank failures. Results of these studies provide mixed evidence in terms of banking stability. Some recent papers show that the new requirements can lead to a considerable reduction in the likelihood of failure and distress (BCBS, 2010a; BIS, 2010; Ötker-Robe *et al.*, 2010; Cosimano and Hakura, 2011; Chiaramonte and Casu, 2016). Similarly, (Vazquez and Federico, 2015) find that banks with lower liquidity and higher leverage in the pre-crisis period were more likely to fail during the GFC. They also state that small banks are more vulnerable to liquidity risk, while larger counterparts are exposed more to solvency risk due to their high leverage exposure. In contrast, Hlatshwayo et al. (2013) and Hong et al. (2014) maintain that the new liquidity requirements, the NSFR and the LCR, do not explain bank failures.

Risky bank assets together with uncertainty about the economy's liquidity needs spark bank runs based on pure panic (Samartín, 2003; Iyer and Puria, 2012; Imbierowicz and Rauch, 2014). Based on these models, liquidity and credit risk should be positively related and contribute to bank instability. By contrast, a very recent and still developing body of literature suggests the possibility that the relationship between liquidity and credit risk in banks might be negative (Cai and Thakor, 2008; Gatev *et al.*, 2009; Acharya *et al.*, 2011; Acharya and Naqvi, 2012).

Given the importance of studying the impact of Basel III NSFR on bank stability and the lack of a reliable relationship between liquidity and credit risk and their role for banks stability, this study is among the first papers that analyse the impact of NSFR on financial stability as well as the riskiness of a bank's loan portfolio.

The literature on the impact of liquidity on bank performance is still scarce and provides mixed results. For example, Ratnovski (2013) suggests that banks can minimize the chances of liquidity shocks by increasing liquidity buffers. In addition, maintaining a higher level of liquidity can be costly for a bank as liquid assets generate low returns compared to illiquid assets. In other words, there is a trade-off between the benefit associated with liquidity buffers in terms of less instability and the costs of holding less profitable assets. Using a sample of 15 worldwide countries, King (2013) shows that the NFSR reduces net interest margins by 70–88 basis points on average, and penalizes especially universal banks with diversified funding sources and high levels of trading assets. Similarly, Harle et al. (2010) show that the new regulations cause bank return on equity (ROE) to decline by an average of 3% in the US and 4% in Europe. In contrast, Bordeleau and Graham (2010) find that banks can improve their profitability by holding liquid assets. While Dietrich *et al.* (2014) find that the NSFR has no significant impact on NIM, ROA and ROE.

So far, no studies have explored the costs and benefits of NSFR requirements during the GFC. Our study covers this gap and contributes to the existing literature by providing new insights on the effectiveness of Basel III liquidity requirements during a crisis period. We specifically explore at the same time whether tightening the Basel III liquidity requirements contribute to enhancing financial stability and profitability during the GFC.

3.3 Data and Descriptive Statistics

3.3.1 Calculating the NSFR

The key variable of interest explored in this study is the Basel III Net Stable Funding Ratio (NSFR), with pre-determined balance sheet categories and parameter weights (factors) for banks (BCBS, 2010b, P. 25-31; BCBS, 2014). This ratio is defined as:

$$NSFR_{it} = \frac{Available\ Stable\ Funding_{it}}{Required\ Stable\ Funding_{it}} \geq 100\% \qquad (1)$$

Available Stable Funding (ASF) is a weighted sum of funding sources according to their stability features. *Stable funding* is defined as the portion of those types and amounts of equity and liability financing expected to be reliable sources of funds over a one-year time horizon under extended stress conditions.

Likewise, the Required Stable Funding (RSF) is a weighted sum of the uses of funding sources (assets and off-balance sheet) according to their liquidity. To calculate the required amount of stable funding, specific RSF factors are applied to the assets and off balance sheet activity (or any potential liquidity exposure). The RSF factor represents the proportion of the exposure that should be backed by stable funding: the more liquid and more readily available is the asset to act as a source of extended liquidity in the stressed environment, the lower the RSF factors (i.e. require less stable funding). In such circumstances, less liquid assets will require more stable funding.

We follow Gobat *et al.* (2014, Annex 3, p.42), to compute the NSFR. *Appendix 3.A* provides a summary of definitions and coefficients defined by the Basel proposal and data obtained from BankScope that is used for calculations of the ASF and RSF factors under both the original NSFR (December 2010) and the proposed revised NSFR standard (January and October 2014). Our calculations are based on three main assumptions on the assets side and three on the liability side of the balance sheet. With respect to the asset side; First, Basel III requires different weights for loans ranging from 0.50 to 1.00. However, the breakdown of loan portfolios by categories, maturity, or currency are not generally available. Therefore, they are treated here conservatively, with all loans assumed to have a maturity of more than one year and hence have a RSF weight of 85%. Second, Basel III also distinguishes between securities based on their liquidity risk. That is the detailed breakdown of high quality liquid assets (HQLAs) into Level 1, and Level 2a and 2b and the type of assets whether they are encumbered or unencumbered consistent with the LCR framework. However, bank financial statements fail to report such detail.[4] Consequently, we give government securities a RSF factor of 5 percent and other securities in available-for-sale or trading portfolios (e.g., equities, commodities, and corporate bonds) a 50 percent RSF weight consistent with the revised Basel III NSFR. Third, fixed assets and non-earning assets (except for cash and due from banks) receive a weight of 1.00 following a conservative approach. Similarly, on the liability side, bank balance sheets do not report the breakdown of customer deposits into stable and less stable components. However, a good estimate of NSFR is to distinguish between current, term and savings deposits. Secondly, hybrid instruments that have debt-like characteristics are treated as long-term funding instruments. Finally, long-term liabilities and equity are considered to be stable at the one-year time horizon.

[4] The NSFR under Basel III treats assets (such as residential mortgages) that are encumbered for one year or more with a 100% RSF weight. Assets encumbered for a period of 6 months or more and less than one year, receive a 50% RSF weight. Encumbered assets include but are not limited to asset backed securities, covered bonds, or repos.

Thus far, only a few research studies have attempted to calculate NSFR, and they limit their calculations to a restricted number of balance sheet categories.[5] In this study, we produce a more comprehensive application of the index by adding all balance sheet items previously ignored in the literature. For the Available Stable Funding (ASF), these balance sheet categories include the following: total amount of any preferred stock, unsecured wholesale funding < 1 year provided by non-financial corporates such as other deposits & short-term borrowings as well as repos and cash collateral. Similarly, for the Required Stable Funding (RSF): all other assets (other earning assets, investment in property, fixed assets, insurance assets, goodwill, other intangibles, deferred tax assets, and other assets) are included. In addition, irrevocable and conditionally revocable credit and liquidity facilities to any client (managed securitized assets reported off-balance sheet, other off-balance sheet exposure to securitizations, guarantees, acceptances & documentary credits reported off-balance sheet, committed credit lines and other contingent liabilities) are added. *Appendix 3.B* provides comparisons between the approaches followed by previous studies in calculating NSFR.

3.3.2 Variable Definitions

3.3.2.1. Measures of Risk and Profitability

We use alternative meaures of risk exposure and performance in our models. In particular, as regards risk, we include a measure for bank stability, level captialization and credit risk. Firstly, following Lepetit and Strobel (2015) and Forssbæck and Shehzad (2015) we measure bankings stability by making use of Z-Score. The higher the value of the Z-Score, the more solvent is the bank and therefore it gives a direct measure of stability. Z-Score is calculated as follows:

$$ZScore = \frac{ETA+ROA}{\sigma ROA} \qquad (2)$$

Where *(ETA)* is the equity-to-total-asset ratio, *(ROA)* is the return on assets and *(σROA)* is the standard deviation of the return on assets calculated over the last two years. To control for a skewed distribution, we follow Danisewicz *et al.* (2015) and use the log transformation of this measure to smooth out higher values of the distribution.

[5] Ötker-Robe *et al.*, 2010; King, 2013; Dietrich *et al.*, 2014; Gobat *et al.*, 2014; Hong *et al.*, 2014; Vazquez and Federico, 2015, simplified their calculation of the ratio.

Next, we select the ratio of equity capital to total assets *(Capital)* to measure bank soundness. A high level of capitalization is associated with a high level of banking stability. Most theories predict that capital enhances a bank's survival probability (Berger *et al.* (2009) and Berger and Bouwman (2013)). Von Thadden (2004) and Repullo (2004) emphizes the role of capital as a buffer to absorb shocks to earnings. Demirgüç-Kunt and Huizinga (1999), Goddard *et al.* (2004) and Demirguc-Kunt *et al.* (2013) indicate that the best performing banks are those, which maintain a high level of equity relative to their assets. Therefore, we expect that a higher ratio indicates higher bank stability (lower bank insolvency risk).

Then, we include two measures that capture the current riskness of a bank's loan portfolio and the accurancy of a bank's risk management to anticipate near-term loan losses in our models. In particular, we consider the volume of nonperforming loans to net loans *(NPLs)* to account for loan portfolio risk. A higher value indicates a riskier loan portfolio (Berger *et al.*, 2009; Delis and Kouretas, 2011). In addition, we use the ratio of loan loss reserve to gross loans *(LLR)*. Banks with riskier portfolios could be less stable, and could find it harder to imporve their profitability (Schaeck and Cihak, 2012).

For performance, we select three measures of bank profitability; we employ net interest margin *(NIM)* defined as net interest income divided by average total assets, the return on assets *(ROA)* defined as the ratio of net income to the average of total assets, as well as the return on equity *(ROE)* calculated as the ratio of net income to average equity also they are all measured using logarithms. We expect that higher liquidity requirments cause bank profitiblity to decline.

3.3.2.2. Control Variables

We include several bank-specific control variables in our models. For our risk models, we account for bank leverage *(Leverage)*. Leverage represents the ability of banks to meet their financial obligations through the total liabilities to total equity ratio. High levels of levearge increase the level of risk as it suggests that banks are aggresivly financiang their growth with debt. Thus, we expect a negative releation with our dependent variables (Saunders *et al.*, 1990). We further control for bank profitably. Profitability is measured as the ratio of net income to the average of total assets *(ROA)*. We expect a positive relationship between profitability and bank risk. Banks with high profitability are likely to invest in riskier assets. Hence, higher risk leads to higher return and lower financial stability. Furthermore, we include the cost-to-income ratio to control for bank efficiency *(Efficiency)*. Since low values of the cost to income ratio indicate better managerial quality, we would expect a positive relationship between the cost to income ratio and risk.

With regard to our profitability models, we include the following control variables. Following Demirgüç-Kunt and Huizinga (2010) and Amidu and Wolfe (2013a) we use deposits to total liability ratio to proxy for bank funding structure and liquidity sources of banks *(Funding Structure)*. We control for funding structure because providers of funding have an incentive to monitor the bank and could withdraw their financing if doubts about bank stability arise, which will have an impact on bank profitability. In another words, if profitability goes down, deposits go down simultaneously. Therefore, we would expect a positive relationship between funding structure and profitability. Following Dietrich *et al.* (2014), we include overhead costs to control for bank profitability *(Overhead)*, the higher the overhead costs in relation to the assets, the lower the profitability. In addition, we include the ratio of non-interest income to net income as the non-interest income measure *(NII)* to capture changes in the business mix. Banks with a higher share of interest income relative to total income are usually less profitable, because profit margins of fee, commission and trading operations are usually higher than profit margins in interest operations (Dietrich and Wanzenried, 2011). Next, we use the ratio of equity capital to total assets as a measure for bank capitalization in line with the Basel III leverage rules *(Capital)*. As to the impact of the capital ratio on bank profitability, empirical evidence (Demirgüç-Kunt and Huizinga, 1999; Goddard *et al.*, 2004; Mercieca *et al.*, 2007; Demirguc-Kunt *et al.*, 2013) indicate that the best performing banks are those, which maintain a high level of equity relative to their assets. However, we expect a negative relationship due to the financial crisis, better capitalized banks should have easier access to markets and thus hold less liquidity which was the case during the GFC.

Finally, we include the following control variables for both risk and profitability models. We control for the degree of banking system concentration by using the Herfindahl-Hirschman Index *(HHI)*. The HHI is calculated as follows:

$$HHI = \sum_{i=1}^{N} (MS_i)^2 \qquad (3)$$

Where the HHI is defined as the sum of the squared market share value (in terms of total assets) of all banks operating in a country. MS_i is the market share of bank i and

N is the total number of banks in the market.[6] The impact of HHI on stability and profitability is uncertain. Some studies find a negative relationship between market concentration and risk of failure (Allen and Gale, 2000; Allen and Gale, 2004; Carletti, 2008; Beck *et al.*, 2013), while Boyd and De Nicolo (2005), find a positive association between market concentration and bank risk taking. We also consider the ratio of operating income to total assets *(Operating Income to Total Assets)* to proxy for a bank's management quality. We expect a positive relationship between this variable and stability and a negative relationship with our profitability measures. Lastly, we include a crisis dummy *(C)* to control for the crisis years, the crisis dummy is an indicator variable that assumes a value of 1 for the period 2008 to 2010, and zero otherwise. All the control variables (Covariates), $X_{i,c,t-1}$, are lagged by one year to address the pre-determined nature of bank characteristics and to mitigate potentially omitted variable problems.

3.3.2.3. Data Description

We collect annual income statements and balance sheet data from the Fitch-IBCA BankScope (BSC) database for commercial banks in 28 EU countries for the period from 2005-2010. We select annual data frequency because the scope of our main variable of interest *NSFR* requirement is to ensure that banks have adequate stable funding "Available Stable Funding" and expected to be reliable over the time horizon considered by the NSFR, which extends to one year, thereby reducing maturity transformation risk (BCBS, 2014). However, this data frequency poses some limitations to capture the short-term effects of the NSFR on bank stability and return. Also, it is not possible to get monthly or quarterly data on the composition and duration of liquid assets and liabilities from BankScope database.

For our econometric analysis, we drop banks with missing data for total assets and negative common equity values. Hence, our initial sample consists of 729 banks.

Furthermore, we require banks to consistently meet the rule (NSFR≥ 100%) or consistently fail to meet the rule (NSFR<100%) to avoid having treated and untreated observations mixed together in our analysis. Therefore, we exclude banks with mixed results during the period of analysis from our sample. This further reduces our sample to

[6] According to Capraru and Andries, (2015) this index can reach a maximum value of 10,000 which denotes a monopolistic market, while 1/N is the minimum value.

500 banks. Table 3-1 provides the composition of the sample for each country by control and treatment groups.

We set limits for NSFR to be greater than 20% and not exceed 200% in any period. This excludes banks with unusual balance sheet structures and/or banks with potential data quality problems in the BankScope database (missing data). Finally, we apply additional filter criteria to ensure NSFR data and all our variables are available, satisfy minimal data quality standards, and mitigate the impact of outliers. This is done through the Winsorisation technique. Therefore, we remove the lowest and highest 1% of observations and replace them by 1 and 99 percentiles.

Table 3-1 Composition of sample by control and treatment groups and country

Country	Number of banks	Control Group	Treatment Group
Number of banks	500	243	257
Austria (AT)	27	12	15
Belgium (BE)	10	5	5
Bulgaria (BG)	6	3	3
Cyprus (CY)	6	3	3
Czech Republic (CZ)	9	2	7
Germany (DE)	71	24	47
Denmark (DK)	21	7	14
Estonia (EE)	2	1	1
Spain (ES)	17	9	8
Finland (FI)	8	4	4
France (FR)	62	36	26
United Kingdom (GB)	50	29	21
Greece (GR)	5	2	3
Croatia (HR)	19	16	3
Hungary (HU)	12	10	2
Ireland (IE)	4	1	3
Italy (IT)	45	12	33
Lithuania (LT)	8	7	1
Luxembourg (LU)	36	15	21
Latvia (LV)	7	3	4
Malta (MT)	5	4	1
Netherlands (NL)	9	4	5
Poland (PL)	15	10	5
Portugal (PT)	12	8	4
Romania (RO)	10	7	3
Sweden (SE)	12	2	10
Slovenia (SI)	6	5	1
Slovakia (SK)	6	2	4

Notes: This table presents a description of all banks included in the sample by groups. Banks in the treatment group (meet the NSFR requirements); banks with NSFR ≥ 100%. As well as, all banks in the control group (fail to meet the NSFR requirements); banks with NSFR <100%. Source: BankScope & authors' calculations.

Table 3-2 presents the descriptive statistics for the variables included in our models. The average net stable funding ratio (NSFR) is 97%. Note that 51% of all bank-year observations have a NSFR value equal to or more than 100%, and therefore, they fulfil the new Basel III NSFR requirements. As to our outcome variables, Table 3-2 shows that the average bank in our sample has a Z-score (ln) of 3.88, the equity ratio amounts to 10.63%. Overall, the loan portfolio allocation seems to be highly efficient as the stock of non-performing loans account for a mere -3.78% of total loans. This is quite a low amount given the backdrop of an average annual loan growth rate of 58% over the sample period (not reported). Profitability of the sample is about 0.56% of the assets, 6.64% of equity, and a Net Interest Margin (NIM) of 2.7%. The average size of the bank is USD 48,877 million in assets (not reported).

Table 3-2 Summary Statistics

	Obs	mean	SD	min	max
A. Outcome Variables					
Z-Score*	1647.00	207.31	867.80	-1.02	20573.04
Z-Score (ln)	1635.00	3.88	1.59	-3.46	9.93
Capital	2080.00	10.63	10.35	0.11	100
NPLs/Net Loans (ln)	1345.00	-3.78	1.11	-9.51	0.69
LLR/Gross Loans (ln)	1364.00	0.73	1.20	-5.30	4.20
NIM	2066.00	2.70	1.95	-0.89	22.36
ROA	2079.00	0.56	1.81	-38.71	20.25
ROE	2079.00	6.64	16.53	-184.18	98.00
B. Key Explanatory Variables					
Cutoff	2080.00	0.48	0.50	0.00	1.00
NSFR	2080.00	0.97	0.48	0.20	2.00
Δ NSFR	2080.00	-0.03	0.48	-0.80	1.00
ΔNSFR*Cutoff	2080.00	0.20	0.27	0.00	1.00
C. Covariates					
Leverage $_{(t-1)}$	1665.00	2.40	0.83	-0.72	4.32
HHI $_{(t-1)}$	1779.00	0.25	0.11	0.08	0.70
ROA $_{(t-1)}$	1446.00	-0.39	1.00	-6.21	3.01
Capital $_{(t-1)}$	1666.00	2.10	0.71	0.24	4.23
Funding Structure $_{(t-1)}$	1618.00	0.58	0.28	0.00	0.99
Efficiency $_{(t-1)}$	1645.00	64.91	26.47	11.64	189.47
Net Interest Income (NII) $_{(t-1)}$	1426.00	0.56	1.03	-2.42	3.71
Overhead/Total Assets $_{(t-1)}$	1657.00	-3.91	0.84	-6.97	-1.95
Operating Income/ Total Assets $_{(t-1)}$	1600.00	-4.46	0.92	-7.26	-2.08

Notes: This table presents descriptive statistics of our sample. It reports bank performance statistics, liquidity requirements measure as well as our control variables. It contains the means, standard deviations, minimum and maximum values for each variable. NSFR is the level of liquidity requirement for all banks in our sample. Cutoff is an indicator variable that equals to one if a bank liquidity level is above 100% and zero otherwise. *calculated over the last two years. Data source: BankScope database. Coverage: 2005-2010.

Furthermore, Table 3-3 and Table 3-4 show the correlation matrix for the financial risk and profitability models, respectively. It can be seen that no high correlation between the independent variables is present and hence there are no multicollinearity problems.

Table 3-3 Correlation Matrix of Explanatory Variables of Model 1

	NSFR	Cutoff	Leverage	HHI	ROA	Operating Income/ Total Assets	Efficiency	Crisis Dummy
NSFR	1							
Cutoff	0.8700	1						
Leverage	-0.0654	-0.0519	1					
HHI	0.0849	0.1186	-0.0550	1				
ROA	0.0409	0.0165	-0.4358	0.0644	1			
Operating Income/ Total Assets	0.1820	0.1339	-0.3247	-0.0311	0.4031	1		
Efficiency	0.1571	0.1482	0.0687	-0.0019	-0.3747	0.1996	1	
Crisis Dummy	-0.0202	-0.0013	-0.0102	-0.0110	-0.1661	-0.0674	-0.0247	1

Notes: This table presents the correlation matrix of all the independent variables.

Table 3-4 Correlation Matrix of Explanatory Variables of Model 2

	NSFR	Cutoff	HHI	Capital	Operating Income/ Total Assets	NII	Overhead/Total Assets	Funding Structure	Crisis Dummy
NSFR	1								
Cutoff	0.8696	1							
HHI	0.0946	0.1338	1						
Capital	0.0831	0.0558	0.0169	1					
Operating Income/ Total Assets	0.1854	0.1375	-0.0458	0.2669	1				
NII	0.0884	0.0818	-0.0813	-0.0947	0.4028	1			
Overhead/Total Assets	0.1609	0.1529	-0.0079	0.3403	0.5517	0.3356	1		
Funding Structure	0.4317	0.4279	0.0970	0.1220	0.1747	0.0629	0.1894	1	
Crisis Dummy	-0.0195	-0.0028	-0.0668	0.0001	-0.0884	0.1334	-0.0018	0.0186	1

Notes: This table presents the correlation matrix of all the independent variables.

3.4 Econometric Framework

3.4.1 Identification Strategy and Diagnostic Tests for the Validity of Applying RDD

In this chapter, we employ the Regression Discontinuity Design (RDD) methodology to analyse the effect of NSFR requirements on bank performance and stability. The new liquidity requirements provides a clear threshold rule that allows us to focus on a sharp contrast in financial stability and bank profitability between banks that meet and fail to meet the NSFR rule.

In a sharp RDD setting, assignment to treatment and control groups is not random. Instead, RDD takes advantage of a known cutoff determining treatment assignment or the probability of receiving treatment. Hence, banks are assigned to or selected for treatment solely on the basis of a cutoff of an observed variable. The rule under Basel III states that a bank must hold a minimum level of liquidity when its NSFR equals or passes the 100% threshold. Therefore, we assign banks to the treatment group through this known and measured *deterministic* decision rule:

$$d = d(x) = \begin{cases} 1 \; if \; x \geq \bar{x} \\ 0 \; otherwise \end{cases} \qquad (4)$$

Where x is the assignment variable (NSFR) and $\bar{x}$ the cutoff (100%). In other words, assignment to treatment occurs if the value of NSFR of a bank meets or exceeds 100%.

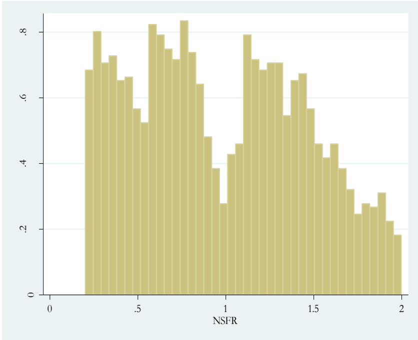
Identifying the effect of liquidity requirements on bank performance and stability requires solving the endogeneity problem. Given the delineation of the data into treatment and control groups by the assignment rule. A simple, naïve approach to estimate the treatment effect using the ordinary least squares (OLS) in a bank-year panel generates biased results due to bank unobservable characteristics related with both NSFR and bank performance (omitted variables), or banks with low profitability or instability may be more likely to influence the level of liquidity (reverse causality). To address the identification concern, we use RDD that requires less strict assumptions regarding the assignment of treatment compared with other non-experimental approaches.

The RDD relies on *"locally"* exogenous variation between banks generated by liquidity levels that pass or fail by a small margin around the 100% threshold. In other words, a comparison of average outcomes just above and just below the threshold identifies the average treatment effect for banks sufficiently close to the threshold. Identification is achieved assuming only smoothness in expected potential outcomes at the discontinuity. Conceptually, this empirical approach compares bank performance subsequent to holding a NSFR ratio that meets the liquidity requirements by a small margin to those banks that fail to meet by a small margin. It is a powerful and appealing identification strategy because, for these close-to liquidity requirements, randomized variation in banks is a consequence of the RDD, which helps identify the effect of liquidity requirements on bank performance.

A key identifying assumption of the RDD is that banks are not able to precisely manipulate the assignment variable (i.e., NSFR) near the known cutoff (Lee and Lemieuxa, 2010). If this identification assumption is satisfied, the variation in banks is as good as that from a randomized experiment. For RDD to be valid, banks should not be able to precisely choose whether they will be above the cutoff or not but rather have imprecise control. The gap between available stable funding and required stable funding in calculating the assignment variable is not likely to be completely manipulated in this study. NSFR is driven by actual values of assets, liabilities, and off-balance sheet activities reported at the end of each year, therefore, banks in our sample have no control in choosing the level of their NSFR. In addition, the fact that the NSFR rule was not legally binding during our sample period gives support that the level of NSFR observed are actual figures and not subject to manipulation. Furthermore, we limit our data sample from 2005-2010 because the announcement of the Basel III rule was in December 2010, so limiting our sample until 2010 excludes the possibility of banks that may have made adjustments to their financial activities as a consequence of Basel III.

We perform two tests to check the validity of the assumption that banks are not able to manipulate the assignment variable (NSFR). First, we examine the assignment variable's distribution to check for violations of the exogenous treatment assignment (Murnane and Willett, 2010). Figure 3-1 shows a histogram of the sample distribution of NSFR in 40 equally spaced NSFR bins (with 0.03 wide intervals "bin width"), and the x axis represents the NSFR requirements. The figure shows that the NSFR distribution is continuous within close proximity of the cutoff, and thus no evidence of precise manipulation is observed at the cutoff point.

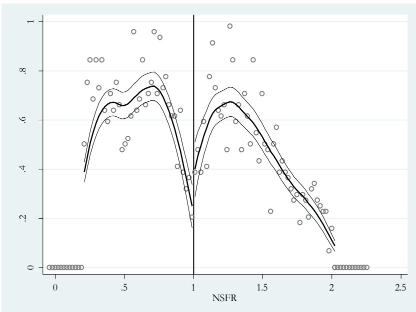
Figure 3-1 Distribution of NSFR



Notes: This figure shows a histogram of the sample distribution of NSFR in 40 equally spaced NSFR bins (with 0.03 wide intervals) to check for violations of the exogenous treatment assignment.

Second, we follow McCrary (2008) and provide a formal test of a discontinuity in the density of NSFR. Using the two-step procedure developed in McCrary (2008), Figure 3-2 plots the density of NSFR. The x axis represents the NSFR. The dots depict the density and the solid line represents the fitted density function of the assignment variable with a 95% confidence interval around the fitted line. The density appears generally smooth and the estimated curve gives little indication of a strong discontinuity near the 100% cutoff. The discontinuity estimate is 0.51 with a standard error of 0.27. Therefore, we cannot reject the null hypothesis that the difference in density at the threshold is zero. Overall, it appears that the validating assumption that there is no precise manipulation by banks at the threshold is not violated. According to McCrary (2008) in case of precise control one would expect surprisingly few observations just below and surprisingly many observations just above the cutoff. Clearly, this is not the case in our sample.

Figure 3-2 McCrary (2008) Density test to check for manipulation of the assignment variable



Notes: This figure plots the density of NSFR to test for a discontinuity in the assignment variable. The dots depict the density and the solid line represents the fitted density function of the assignment variable with a 95% confidence interval around the fitted line.

Another important assumption of the RDD is that there should not be discontinuity in other covariates that are correlated with bank performance at the cutoff point. In other words, banks that meet the NSFR requirements should not be systematically different ex ante from banks that fail to meet the rule. An intuitive way of doing this is to conduct both a graphical as well as a formal estimation analysis to show that other predetermined bank-specific characteristics are smooth around the cutoff. We follow Lee and Lemieuxa (2010) and Bonner and Eijffinger (2016) and perform a local randomization test by running Seemingly Unrelated Regressions (SURs) with each equation representing a different bank-specific variable. As independent variables we include a dummy variable describing whether an institution's NSFR is above the cutoff as well as banks' distance to the cutoff (ΔNSFR). SUR allows us to test whether the coefficients for banks' deviation from the cutoff are jointly insignificant for all lagged bank-specific characteristics. Table 3-5 *Panel A* shows our results with respect to the impact of being above the cutoff on lagged covariates included in our risk models. While *Panel B*, reports the results with respect to covariates included in our profitability models. The coefficients of both the dummy describing whether an institution's NSFR is above the cutoff as well as the distance of an institution's NSFR to the cutoff are insignificant for all covariates.

Table 3-5 SURs of the lagged covariates

Panel A: Covariates included in our risk models

Variables (lags)	(1) Leverage	(2) HHI	(3) ROA	(4) Operating Income/ Total Assets	(5) Efficiency
Cutoff	-0.346	0.0923	0.514	-0.281	-6.699
	(0.34)	(0.047)	(0.45)	(0.34)	(7.67)
Δ NSFR	2.256	-0.3633	-2.790	1.220	79.62
	(2.60)	(0.36)	(3.44)	(2.66)	(59.1)
constant	2.574***	0.200***	-0.718**	-4.315***	63.28***
	(0.20)	(0.028)	(0.27)	(0.21)	(4.60)
Obs	106	106	106	106	106
R-squared	0.009	0.0575	0.0143	0.0094	0.0214

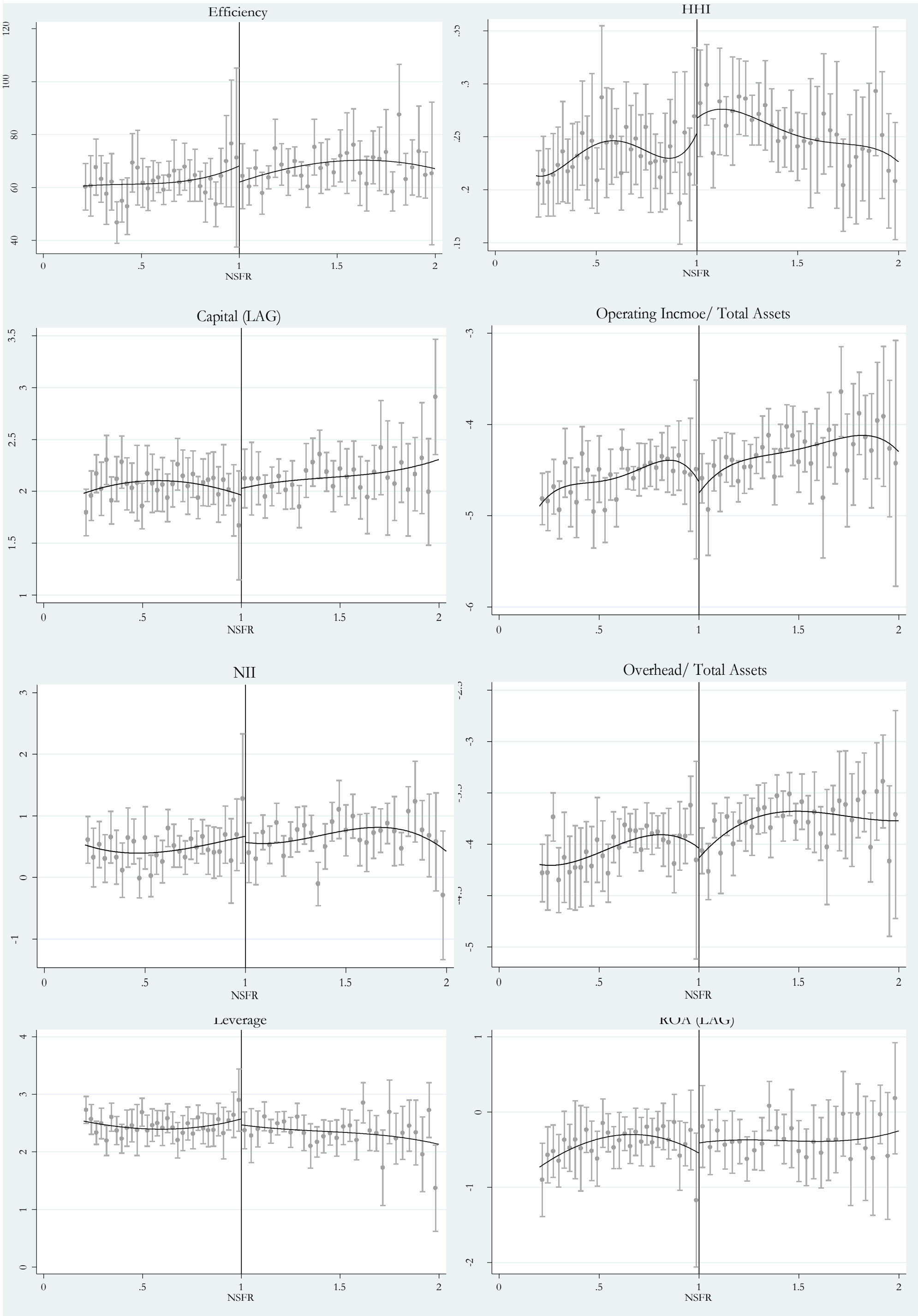
Panel B: Covariates included in our profitability models

Variables (lags)	(1) HHI	(2) Capital	(3) Operating Income/ Total Assets	(4) Overhead	(5) NII	(6) Funding Structure
Cutoff	0.0916	0.312	-0.254	-0.315	-0.668	0.114
	(0.047)	(0.26)	(0.34)	(0.30)	(0.46)	(0.091)
Δ NSFR	-0.369	-2.618	0.595	2.507	2.600	0.659
	(0.37)	(2.02)	(2.64)	(2.32)	(3.56)	(0.71)
constant	0.203***	1.898***	-4.351***	-3.795***	0.974***	0.515***
	(0.028)	(0.16)	(0.20)	(0.18)	(0.27)	(0.055)
Obs	102	102	102	102	102	102
R-squared	0.0572	0.0163	0.0141	0.0118	0.0345	0.1691

Notes: This table shows SURs with the dependent variables being lagged. Cutoff is a dummy variable equals to 1 in case an institution's NSFR, is above the cutoff and 0 otherwise. ΔNSFR is defined as the difference between an institution's NSFR and the cutoff. (NSFR within the interval [90%, 110%]). Statistical significance is indicated by ***p<0.01, **p<0.05, *p<0.1 while bank-clustered robust standard errors are in parentheses. Source: BankScope database. Coverage: 2005-2010.

We complement the formal regressions with a graphical analysis. Figure 3-3 shows graphs of several bank-specific variables on the y-axis and the NSFR on the x-axis. Again, we use the lags of all bank-specific variables. Additionally the graphs show parametric curves predicted with the results from a fourth-order polynomial as well as the 95% confidence interval.

Figure 3-3 Smoothness of lagged covariates around the cutoff management



Notes: The figure presents results of RDD following a pooled non-parametric approach. The dependent variables being lagged are efficiency, HHI, capital, operating income to total assets, NII, overhead to total assets, leverage and ROA. The key explanatory variable is Cutoff (1 in case a bank's NSFR is above 100% and 0 otherwise). The figure shows the bank-specific variables on the y-axis and average of banks' NSFR on the x-axis. We use the lags of all bank-specific variables. Additionally, the graphs show parametric curves fitted as well as the respective 95% confidence interval.

In addition, we follow Lee *et al.* (2004) and Bradley *et al.* (2016) and perform this test by comparing the covariates of banks that fall in a narrow margin around the cutoff. The results are reported in Table 3-6. The results of both tests suggest that the covariates do not show discontinuities around the cutoff. While it is not possible to prove the validity of RDD, the combined evidence discussed above does not give any reason to doubt the validity of RDD in our sample.

Table 3-6 Difference in Observable Characteristics between Banks that Meet and Fail to Meet NSFR

	Control	Treatment	Difference	t-Statistic	p-value
Leverage $_{(t-1)}$	2.47	2.36	0.12	0.71	0.48
HHI $_{(t-1)}$	0.24	0.31	-0.07	-1.41	0.18
ROA$_{(t-1)}$	-0.56	-0.35	-0.20	-0.97	0.33
Operating Income/ Total Assets $_{(t-1)}$	-4.43	-4.61	0.18	1.05	0.30
Efficiency$_{(t-1)}$	70.73	64.32	6.41	1.11	0.27
Capital $_{(t-1)}$	2.03	2.12	-0.09	-0.67	0.50
Overhead $_{(t-1)}$	-3.87	-3.99	0.12	0.89	0.38
NII $_{(t-1)}$	0.72	0.48	0.23	1.01	0.32

Notes: This table shows differences in observable characteristics between banks that meet versus those that fail to meet the NSFR requirements (NSFR within the interval [90%, 110%]). Source: BankScope database. ***p<0.01, **p<0.05, *p<0.1 Coverage: 2005-2010.

3.4.2 Regression Estimation

Identifying the effect of liquidity requirements on bank risk and return using RDD can be estimated through parametric and non-parametric analyses. As emphasized by Roberts and Whited (2012), when deciding between the two methods one faces the usual trade-off between precision and bias. In our analysis, we follow Hahn *et al.* (2001), McCrary and Royer (2011), Bonner and Eijffinger (2016) and Bradley *et al.* (2016) and apply a non-parametric approach. A likely reason for this practice is the increased risk of misspecification in the case of parametric approach. Misspecification is a general problem however; it is particularly severe in RDD.

We use the local-linear-regression technique which estimates the discontinuity non-parametrically, assuming more weight to data points closer to the cutoff value than points further away. Our regression takes the following form:

$$Y_{it} = \alpha + \beta_1 Cutoff_{it} + \beta_2 \Delta NSFR_{it} + \beta_3 (Cutoff_{it} * \Delta NSFR_{it}) + \delta X_{i(t-1)} + \gamma_i + \gamma_t + \gamma_c + \varepsilon_{it}, \quad NSFR \in (100\% - K, 100\% + K) \qquad (5)$$

where the dependent variable ($Y_{i,t}$) denotes risk and bank profitability measures for bank i at time t. The right-hand side is broadly in line with Roberts and Whited (2012), Lee and Lemieuxa (2010) and Bonner and Eijffinger (2016), reflecting common practice when estimating a RDD model with a pooled non-parametric approach. $Cutoff_{it}$ is a binary liquidity indicator which allows us to gain insight into whether a bank below the cutoff behaves differently. The variable equal to 1 for all banks in case their NSFR liquidity ratio is above 100%, 0 otherwise. Our coefficient of interest is β_1 this parameter measures the discontinutiy in the change in bank performance observed at the threshold. Its magnitude identifies the direct impact of liquidity requirements on bank stability and profitability in banks that meets the NSFR requirments. $\Delta NSFR_{it}$ represents the distance between bank $i's$ liquidity ratio and the cutoff. ($Cutoff_{it} * \Delta NSFR_{it}$) is an interaction term between the distance from the cutoff value and a post-cutoff liquidity indicator, the interaction term is only there to allow the slope above and below the cutoff to be different as we are applying a pooled regression. $X_{i(t-1)}$ is a vector of observable characteristics which may be associated with the outcomes of interest. We also consider bank (γ_i), time (γ_t) and country (γ_c) fixed effects. ε is the error term. We cluster by bank to adjust the standard errors for hetroskedasticity to account for serial correlation within each panel. It is important to choose the optimal bandwidth *(K).* While there are various approaches used in the literature, none of them provides a clear answer and the selection of bandwidths remains a subjective decision. According to Roberts and Whited (2012), it is best to choose a bandwidth and experiment with a variety of other bandwidths to illustrate the robustness of results. We use improved MSE-optimal bandwidth for sharp RDD following Imbens and Kalyanaraman (2012), but implemented as discussed in Calonico *et al.* (2016), Calonico *et al.* (2014b) and Calonico *et al.* (2014a).[7] We use a rectangular kernel in our analyses.[8]

3.5 Empirical Results

3.5.1 Graphical Analysis

RDD enables us to start the analysis with plotting the relationship between our variables of interest and the NSFR to identify the presence of discontinuity. Figure 3-4 visually

[7] The CV (cross-validation) bandwidth selection method is not used, as it appears to be considerably less popular in empirical work.

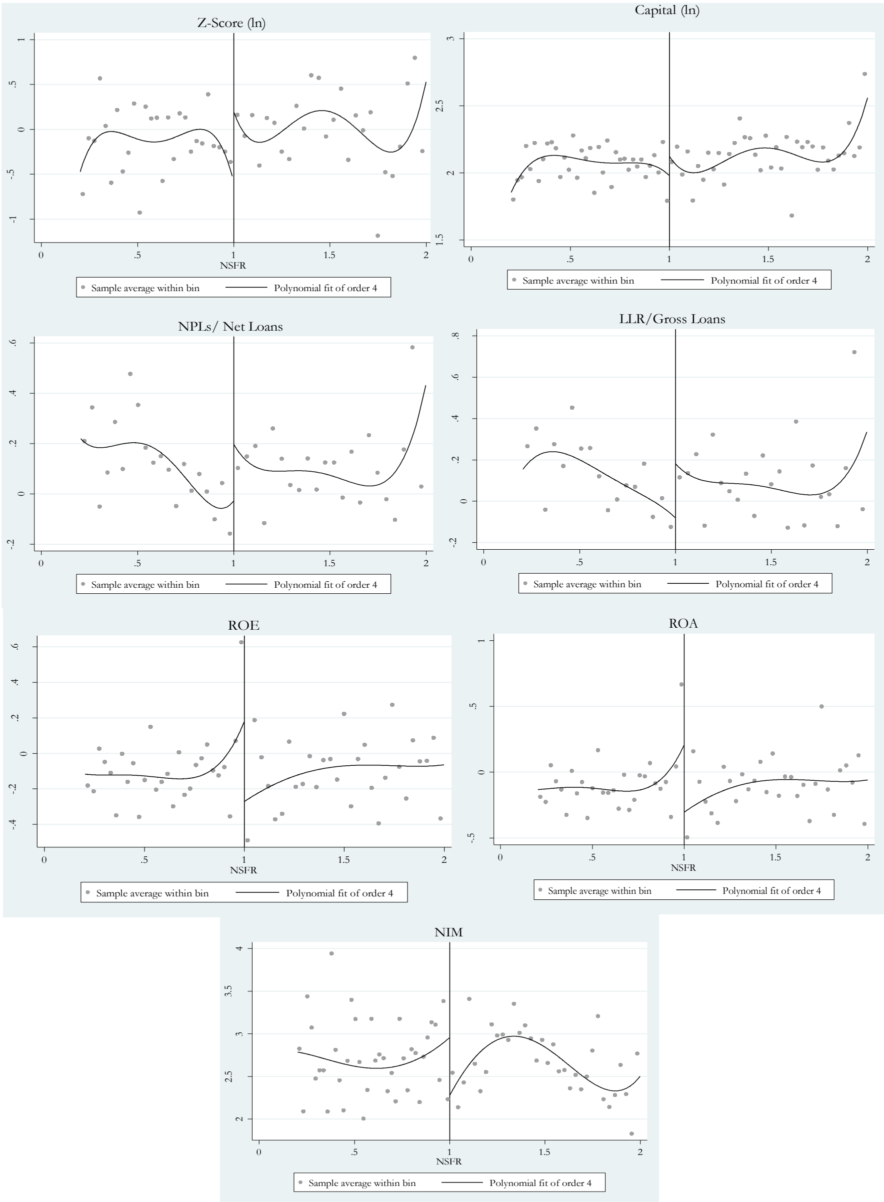
[8] As Imbens and Lemieux (2008) as well as the consensus in the technical literature point out, the choice of kernel typically has little impact on estimation in practice, but the choice of bandwidth is more influential.

checks the relation around the cutoff. The x axis represents the NSFR liquidity requirements. In all plots displayed, banks that failed to meet the NSFR rule are to the left of 100% threshold and banks that successfully meet it are to the right of the threshold. The dots depict the average value of bank risk and profitability in the bins. The solid line represents the fitted regression estimate that includes the fourth-order polynomial.

Figure 3-4 shows a clear discontinuity in risk and profitability at the threshold. Specifically, within close proximity of the threshold, bank stability as measured by the Z-Score and Capital increase significantly once they rise their level of liquidity holdings and crosses the 100% cutoff point. This observation points to a likely positive impact of NSFR liquidity requirements on bank stability. Furthermore, the remaining plots that illustrate the relationship between NSFR liquidity requirements and risk measures show a positive relationship; this indicates that excessive liquidity induces risk-taking behaviour by banks.

In contrast, profitability measures show an opposite direction. Which indicate a negative impact of tightening the liquidity requirements on bank profitability as indicated by the lower profitability for banks that meet the NSFR liquidity requirements.

Figure 3-4 Regression Discontinuity



Notes: This figure presents results of RDD following a pooled non-parametric approach. The dependent variables are financial risk as well as bank profitability measures. The purpose of this figure is to show whether there is discontinuity in banks' behaviour depending on whether they are below or above the Cutoff.

3.5.2 Local-linear Regression

3.5.2.1. Financial Risk

We employ a nonparametric local linear estimation in the neighbourhood around the 100% threshold, using the optimal bandwidth defined by Imbens and Kalyanaraman (2012) that minimizes the mean squared error (MSE) in a sharp regression discontinuity setting. Table 3-7 reports the local linear estimation results using a rectangular kernel that have as the outcome variables: overall bank risk (Z-Score) in columns 1 and 2. Capitalisation ratio in columns 3 and 4, loan portfolio risk with the ratio of nonperforming loans to net loans and LLR to gross loans in columns 5-8. All specifications include bank, time and country fixed effects as illustrated in equation (5).

Table 3-7 presents point estimates of the financial risk discontinuity at the Cutoff liquidity level from a baseline specification in which they are regressed on an indicator of NSFR level above 100% (Cutoff), the distance between a bank's liquidity ratio to the Cutoff (ΔNSFR), their interaction (Cutoff*ΔNSFR) and a constant. The key parameter of interest is the coefficient of the Cutoff that estimates the average treatment effect.

We find a positive and significant discontinuity at the Cutoff for all our risk measures. The estimated effect is statistically significant at 1% confidence levels. As regard to Z-Score (ln) value, we find that banks above the Cutoff hold higher liquidity buffers, which reduce their default risk and improve their ability to survive financial crises by 3.45 basis points (bp). Similarly, institutions above the Cutoff tend to be able to hold higher Capital buffers by 2.38 bp, which lead to a more stable financial system as indicator of effort to control overall bank risk. The combination of high liquidity and capital buffers enhance the stability of the financial system. Our findings are in line with Distinguin *et al.* (2013) who examine the relation between bank liquidity and bank regulatory capital. They argue that banks reduce their regulatory capital when faced with a lower net stable funding ratio. Columns 2 and 4 further control for bank stability measures, the estimated coefficient on the "Cutoff" indicator variable remain economically large and statistically significant at 5% and 1% confidence level, respectively. By contrast, we find that banks meeting the NSFR liquidity requirements increase the riskiness of their loan portfolios as indicated by NPLs and LLR ratio. Our results are in line with Myers and Rajan (1998), Acharya *et al.* (2011) and Acharya and Naqvi (2012), who argue that access to liquidity allow banks to switch to riskier assets, and lower their lending standards. Therefore, excessive bank liquidity triggers overinvestment in risky assets that in turn offset the overall improvement in financial stability. Firstly, the ratio of nonperforming loans to net loans in column 5 shows a positive and significant estimate at the 1% confidence level. However, the discontinuity estimate obtained from an extended specification that controls for additional covariates is lower and statistically significant at the 1% confidence level from 3.17 bp to 2.71 bp as shown in columns 5 and 6, respectively. Secondly, the LLR ratio is also positive and statistically significant at the 1% confidence level. However, when we estimate the results from specifications that include additional covariates, LLR becomes insignificant.

Overall, our results suggest that tougher liquidity requirements should have the largest impact on banks operating close to the regulatory minimum in terms of bank stability. Banks above the rule's threshold witnessed positive and significant Z-score and Capital ratio but this positive impact is offset by the aggressive investment in risky assets indicated by the NPLs and LLR ratio. In the next section below, we investigate further the impact of tougher liquidity requirements on bank profitability.

Table 3-7 Regression Discontinuity: Non-parametric Local Linear Regression-Financial Risk

	(1) Z-Score	(2) Z-Score	(3) Capital	(4) Capital	(5) NPLs/Net Loans	(6) NPLs/Net Loans	(7) LLR/Gross Loans	(8) LLR/Gross Loans
Cutoff	3.451***	6.976**	2.382***	2.490***	3.172***	2.708***	3.027***	0.342
	(0.39)	(2.58)	(0.11)	(0.27)	(0.063)	(0.30)	(0.068)	(0.44)
Δ NSFR	-2.055	-1.716	0.135	-0.0610	0.485	0.314	0.451	0.532
	(2.30)	(2.37)	(0.34)	(0.33)	(0.65)	(0.81)	(0.87)	(1.27)
Δ NSFR *Cutoff	5.100	5.194	0.213	0.589	0.422	-0.437	1.241	-0.146
	(3.58)	(3.58)	(0.44)	(0.49)	(1.97)	(1.48)	(2.19)	(1.66)
Leverage $_{(t-1)}$		-0.0387		-0.120		-0.159		0.114
		(0.65)		(0.062)		(0.26)		(0.41)
HHI $_{(t-1)}$		-2.101		-0.585		0.0952		0.648
		(5.33)		(0.75)		(1.10)		(1.53)
ROA $_{(t-1)}$		-0.333		-0.0584*		-0.183*		-0.101
		(0.20)		(0.026)		(0.088)		(0.14)
Operating Income/ Total Assets $_{(t-1)}$		-0.0877		0.0248		-0.0338		0.0704
		(0.35)		(0.030)		(0.080)		(0.16)
Efficiency $_{(t-1)}$		0.0101		-0.00294		-0.0201*		-0.0161
		(0.016)		(0.0016)		(0.0082)		(0.0082)
Crisis Dummy		-0.364		0.0322		0.131		0.322
		(0.42)		(0.045)		(0.12)		(0.22)
Constant	1.575***	3.663	2.373***	3.066***	-7.007***	-6.210***	1.391***	-0.0488
	(0.42)	(2.79)	(0.049)	(0.30)	(0.17)	(1.17)	(0.24)	(1.45)
Observations	399	358	595	403	377	273	347	252
R-squared	0.697	0.664	0.966	0.979	0.916	0.951	0.859	0.855
Adjusted R-Squared	0.428	0.341	0.943	0.962	0.852	0.904	0.745	0.702

Notes: This table presents local linear regression results using the optimal bandwidth following Imbens and Kalyanaraman (2012). Results using rectangular kernels are reported. The financial risk is measured by: Z-Score in columns (1) and (2), Capital in columns(3) and (4), NPLs in columns (5) and (6) and LLR ratio in columns (7) and (8). Our variable of interest is Cutoff. This parameter measures the discontinutiy in the change in bank performance observed at the threshold. Year, bank and country fixed effects are included in all models but not reported. Standard errors are clustered on bank level. ***p<0.01, **p<0.05, *p<0.1. Data source: BankScope database. Coverage: 2005-2010.

3.5.2.2. Bank Profitability

We also investigate the discontinuity in banks' profitability at the cutoff. Table 3-8 presents the nonparametric local linear regression estimate results in the neighbourhood around the 100% threshold, using the optimal bandwidth defined by Imbens and Kalyanaraman (2012) that minimizes the mean squared error (MSE) in a sharp regression discontinuity setting. Our outcome variables are ΔROA in columns 1 and 2, ΔROE in columns 3 and 4 and ΔNIM in columns 5 and 6. We also use a rectangular kernel and include time and bank fixed effects as illustrated in equation (5).

In general, when being above the threshold of 100%, banks make negative profitability. Our results are consistent with Harle *et al.* (2010), who suggest that banks generate low returns associated with holding more liquid assets. All things being equal, an increase in cash and liquidity would reduce interest income. Specifically, institutions above the cutoff lose around 0.70 basis points (bp) more in return on assets, 0.77 bp in return on equity and 0.81 in net interest margin. Our results are statistically significant at the 5% and 1% confidence level, respectively. However, our results become less significant with the inclusion of various covariates. According to Bradley *et al.* (2016) and Lee and Lemieuxa (2010) one of the advantages of the RDD is that we do not have to include observable covariates (X_{t-1}), in the analysis because the inclusion of covariates is unnecessary for identification.

We can conclude that during economic upturns, expected profits from risky assets are high. However, during the GFC, adverse asset-side shocks that followed good times result in deeper fire-sale discounts and lower profitability as bank balance-sheets suffer a squeeze in liquidity. Our results confirm this hypothesis and provide evidence that even for banks meeting the NSFR liquidity requirements; during the GFC, they still suffer a decline in their profitability measures.

Table 3-8 Regression Discontinuity: Non-parametric Local Linear Regression-Financial Performance

	(1)	(2)	(3)	(4)	(5)	(6)
	Δ ROA	Δ ROA	Δ ROE	Δ ROE	Δ NIM	Δ NIM
Cutoff	-0.696**	-3.304*	-0.768***	-0.786	-0.806***	-1.156**
	(0.21)	(1.35)	(0.21)	(1.27)	(0.094)	(0.36)
Δ NSFR	-0.605	-1.453	-0.496	-1.447	0.645	0.455
	(1.21)	(0.98)	(1.06)	(0.88)	(0.49)	(0.39)
NSFR*Cutoff	2.818	2.615	2.773	2.897	-1.627	-0.695
	(3.33)	(2.33)	(2.81)	(2.14)	(1.19)	(0.61)
HHI $_{(t-1)}$		2.560		2.991		-0.255
		(4.19)		(4.09)		(0.59)
Capital $_{(t-1)}$		-0.351		-0.307		-0.0549
		(0.61)		(0.58)		(0.20)
Operating Income/Total Assets $_{(t-1)}$		-0.787*		-0.806**		0.0340
		(0.30)		(0.29)		(0.072)
NII $_{(t-1)}$		0.971***		0.924***		0.0780
		(0.15)		(0.16)		(0.046)
Overhead/Total Assets $_{(t-1)}$		0.542		0.633		-0.191
		(0.59)		(0.57)		(0.14)
Crisis Dummy		-0.384		-0.405*		-0.0392
		(0.22)		(0.17)		(0.060)
Funding Structure $_{(t-1)}$		2.505		2.844		-0.189
		(1.51)		(1.47)		(0.32)
Constant	0.137	-4.292	0.0294	-4.180	0.225***	0.00120
	(0.20)	(2.31)	(0.20)	(2.37)	(0.062)	(0.65)
Observations	391	377	413	396	436	372
R-squared	0.409	0.671	0.405	0.661	0.602	0.695
Adjusted R-Squared	-0.0872	0.373	-0.0666	0.372	0.285	0.419

Notes: This table presents local linear regression results using the optimal bandwidth following Imbens and Kalyanaraman (2012). Results using rectangular kernels are reported. Bank profitability is measured by: Δ ROA in columns (1) and (2), Δ ROE in columns (3) and (4) and Δ NIM in columns (5) and (6). Our variable of interest is Cutoff. This parameter measures the discontinutiy in the change in bank performance observed at the threshold. Year, bank and country fixed effects are included in all models but not reported. Standard errors are clustered on bank level. ***p<0.01, **p<0.05, *p<0.1. Data source: BankScope database. Coverage: 2005-2010.

3.5.2.3. Does the Size of Banks Matter?

Following Schaeck and Cihak (2012) and Mercieca *et al.* (2007), we split our sample into large and small banks sorted by asset size using a cut-off point of 485 million USD.[9] Furthermore, we require including banks that consistently meet the NSFR rule or consistently fail to meet it. For this reason, our sample consists of 150 small banks and 382 large banks from 2005-2010. We then re-estimate the regressions over each subsample separately, using the optimal bandwidth defined by Imbens and Kalyanaraman (2012) that minimizes the mean squared error (MSE) in a sharp regression discontinuity setting. All

[9] In their paper the cut-off point is 450 million EUR, and since our sample is in USD, we convert this amount using an exchange rate of €1=$1.0777 (spot inter-bank market rate) on 20th April 2017.

of our regressions include the full set of control variables and have bank, time and country fixed effects, but are not shown for brevity.

Table 3-9 provides the results for the non-parametric local linear regression for large banks, while small banks are reported in Table 3-10. The results in Table 3-9 suggest that for large banks, institutions above the cutoff tend to be able to hold higher capital buffers by 0.33bp as shown in column 3. While we find no significant impact of holding higher liquidity ratio on bank stability measured by the Z-Score (ln), we find that large banks tend to be engaged in excessive risk-taking activities. This suggest that overinvestment in risky activities continue an important part of the effect of high liquidity levels on bank performance. The magnitude of the coefficient on the NPLs is 1.26bp, suggests that large banks with a 1 percentage point higher NSFR liquidity requirements invest in riskier assets of over 1 percentage point, which appears to be a substantial effect. Including control variables in the estimation as shown in column 6, remain economically large and statistically significant at 1% confidence level.

The results in Table 3-10 suggest that for small banks, the relationship between higher liquidity ratio and financial stability is positive and strongly significant at 1% confidence level. providing sharp contrast to the result found for large banks, yielding a fairly clear result that from a financial stability perspective, regulations on liquidity are likely to play a more critical role for small banks than is the case for large banks. Small banks support Basel III objectives that increasing the NSFR will have a positive outcome on the resilience of banks in future financial crises and limit their investing in risky assets. As we find the relationship between high NSFR liquidity requirements and NPLs and LLR ratio to be weakly significant. As regard to the profitability measures, we find negative and significant discontinuity at the Cutoff for both large and small subsamples.

In sum, we find that for large banks, liquidity and riskiness of loan portfolios are positively correlated, while for small banks, the causal effect of tightening the liquidity ratio has a positive and significant impact on financial stability. Collectively, these results indicate that small banks will perform better when the NSFR requirement is implemented and the enhanced financial stability objective will be achieved during difficult times.

Table 3-9 Regression Discontinuity: Non-parametric Local Linear Regression for estimated effect of Cutoff on bank risk and return for large banks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Z-Score	Z-Score	Capital	Capital	NPLs/Net Loans	NPLs/Net Loans	LLR/Gross Loans	LLR/Gross Loans	Δ ROA	Δ ROA	Δ ROE	Δ ROE	Δ NIM	Δ NIM
Cutoff	0.498	2.589	0.333***	0.890**	1.262**	3.004***	3.035***	0.730	-0.176	-4.188**	-0.289	-6.214***	-0.742***	-0.646
	(1.82)	(4.02)	(0.098)	(0.32)	(0.47)	(0.67)	(0.079)	(1.57)	(0.23)	(1.61)	(0.49)	(1.58)	(0.049)	(0.48)
Δ NSFR	-2.113	3.828	0.208	-0.219	0.277	0.173	2.387	1.674	0.343	-0.174	0.00157	-1.581	0.0665	0.117
	(12.1)	(12.9)	(0.95)	(0.51)	(0.71)	(0.74)	(1.93)	(1.88)	(0.73)	(0.91)	(0.78)	(1.23)	(0.21)	(0.22)
ΔNSFR*Cutoff	4.890	-2.828	-0.281	0.669	0.380	-1.023	-2.103	-2.342	0.720	-0.693	1.554	1.049	0.0422	-0.0960
	(14.0)	(15.9)	(1.31)	(0.75)	(2.07)	(1.62)	(2.63)	(2.18)	(1.54)	(1.67)	(1.67)	(2.62)	(0.33)	(0.33)
Covariates	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Constant	1.630	-2.208	2.361***	2.667***	-3.286***	-1.699	0.653	1.640	0.201	-2.354	-0.203	5.251	0.0447	-0.267
	(2.03)	(9.75)	(0.10)	(0.52)	(0.16)	(0.86)	(0.42)	(1.77)	(0.44)	(1.79)	(0.28)	(4.25)	(0.077)	(0.58)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	183	163	225	224	343	253	354	260	510	417	493	287	651	572
R-squared	0.740	0.734	0.977	0.984	0.917	0.956	0.832	0.841	0.366	0.677	0.385	0.677	0.339	0.395
Adjusted R-Squared	0.377	0.270	0.950	0.964	0.858	0.914	0.716	0.695	-0.0451	0.416	-0.0181	0.358	-0.00117	0.0429

Notes: This table presents local linear regression results using the optimal bandwidth following Imbens and Kalyanaraman (2012). Results using rectangular kernels are reported. We examine the effect of the new liquidity requirements (NSFR) on bank performance for large banks only. Our variable of interest is Cutoff. This parameter measures the discontinutiy in the change in bank performance observed at the threshold. The regressions include year fixed effects, bank-fixed effects and country fixed effect. Standard errors are clustered on bank level. ***p<0.01, **p<0.05, *p<0.1. Data source: BankScope database. Coverage: 2005-2010.

Table 3-10 Regression Discontinuity: Non-parametric Local Linear Regression for estimated effect of Cutoff on bank risk and return for small banks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Z-Score	Z-Score	Capital	Capital	NPLs/Net Loans	NPLs/Net Loans	LLR/Gross Loans	LLR/Gross Loans	Δ ROA	Δ ROA	Δ ROE	Δ ROE	Δ NIM	Δ NIM
Cutoff	3.350***	10.22***	0.785***	0.399*	1.581*	0.262	1.552*	0.194	-2.009***	-4.015*	-0.214	-2.871	-2.230***	-0.687*
	(0.69)	(1.32)	(0.22)	(0.19)	(0.75)	(0.79)	(0.72)	(0.76)	(0.50)	(1.74)	(0.40)	(2.07)	(0.046)	(0.30)
Δ NSFR	0.232	2.946	0.0744	0.227	0.609	0.460	0.617	0.490	2.109	-1.436	1.100	-1.438	-0.00467	-0.102
	(4.74)	(2.21)	(0.96)	(0.57)	(1.29)	(0.75)	(1.24)	(0.72)	(2.09)	(1.89)	(1.16)	(2.06)	(0.26)	(0.29)
ΔNSFR*Cutoff	-0.473	0.657	-0.409	-0.303	0.548	0.405	0.533	0.320	2.784	6.973*	3.016	6.824*	-0.375	0.158
	(5.06)	(3.26)	(1.01)	(0.60)	(1.65)	(1.67)	(1.58)	(1.62)	(2.87)	(2.68)	(2.21)	(2.79)	(0.45)	(0.40)
Covariates	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Constant	-5.205***	-10.23***	1.067***	2.900***	-1.950***	-3.890	2.541***	0.704	1.197**	1.790	-0.857	0.201	1.294***	1.155*
	(1.27)	(2.86)	(0.27)	(0.43)	(0.31)	(2.01)	(0.30)	(1.94)	(0.43)	(4.20)	(0.67)	(5.07)	(0.099)	(0.55)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	134	151	172	107	157	130	158	130	110	101	130	101	149	102
R-squared	0.706	0.671	0.951	0.984	0.902	0.886	0.908	0.888	0.657	0.816	0.560	0.807	0.818	0.848
Adjusted R-Squared	0.415	0.360	0.900	0.963	0.814	0.786	0.823	0.790	0.332	0.581	0.166	0.561	0.660	0.666

Notes: This table presents local linear regression results using the optimal bandwidth following Imbens and Kalyanaraman (2012). Results using rectangular kernels are reported. We examine the effect of the new liquidity requirements (NSFR) on bank performance for small banks only. The financial risk is measured by Z-Score in columns (1) and (2), Capital in columns (3) and (4), NPLs in columns (5) and (6) and LLR ratio in columns (7) and (8). Bank profitability is measured by Δ ROA in columns (9) and (10), Δ ROE in columns (11) and (12) and Δ NIM in columns (13) and (14). Our variable of interest is Cutoff. This parameter measures the discontinutiy in the change in bank performance observed at the threshold. The regressions include year fixed effects, bank-fixed effects and country fixed effect. Standard errors are clustered on bank level. ***p<0.01, **p<0.05, *p<0.1. Data source: BankScope database. Coverage: 2005-2010.

3.6 Robustness Checks

3.6.1 Estimated Effect Prior to GFC

Our first test focuses on the pre-crisis period. We run RDD for this era because the treatment did not exit. In this case, according to Roberts and Whited (2012), we can rerun the RDD for this period in the hopes of showing no estimated treatment effect. For this fasification test, we run the analysis for the period from 2005-2007. Table 3-11 shows the results for both risk and return. We do not obsere positive significant relation between risk measures and the "Cutoff" variable, nor a significant negative realation between profitability measures and the "Cutofff" variable. This reinforce the assertaion that the estimated effect is not due to a coincidental discontinuity or discontinuity in unobservables.

3.6.2 Placebo Tests at Different Cutoff

Roberts and Whited (2012) and Kane (2003) suggest testing whether the actual cutoff fits the data better than other nearby cutoffs. Therefore, we run placebo tests to check if we are still able to observe a discontinuity in bank performance output varaibles at artificially chosen thresholds that are different from the true 100% threshold. We first randomly select an alternative threhold other than 100%. We then assume it is the threshold that determines bank performance outcomes and reestimate the local linear model with a rectangular kernel. We repeat this placebo estimation using four alernative cutoff values (80%, 90% , 110% and 120%) and present the resutls in Table 3-12. The results show that the treatment effect of NSFR liquidity requirments on bank performance is absent at artifically chosen NSFR thresholds. Hence, such false cutoffs alleviate concerns that our RDD estimates are spurious.

3.6.3 State Aid and Government Support

For our next analysis, we examine the effect of NSFR requirements on risk and return for banks that received government support and bailouts during the GFC. While interventions and the availability of government support can have positive effects in helping banks to survive during crisis and enhance stability in the short-run, they can also create moral hazard problems and provide incentives for misleading behaviour among banks (Hakenes and Schnabel, 2010; Black and Hazelwood, 2013; Berger and Roman, 2015; Calabrese *et al.*, 2016; Calderon and Schaeck, 2016). Therefore, banks that were bailed-out can be riskier and less stable than banks that did not receive the same amount of state aids. For this part of our analysis, we use the European Commission website to collect the different government state aid and support measures at the country level.[10] These measures include capital injections, guarantees, asset relief interventions and liquidity measures. To avoid comparison problems, we measure the cost of intervention as a percentage of Gross Domestic Product (GDP).

To conduct this analysis we add two further variables. First, recapitalisation and asset relief and second, guarantees and liquidity measures. Table 3-13 and Table 3-14 presents the results for financial stability and bank profitability, respectively. Our results are robust to this change.

3.6.4 Balanced Covariates

As discussed in the validity of RDD in section 4.1 above, it is sufficient to assume that the potential covariates under treatment and control have equal conditional expectation at the cutoff (i.e. "balanced") or "zero RD treatment effect on covariates". The covariates will not affect the consistency of the RD treatment effect estimator if they are "balanced". Indeed, this is often presented as a falsification or "placebo" test in RDD empirical studies. Based on the empirical results in Table 3-15, we find that all our additional covariates have an RD treatment effect indistinguishable from zero at conventional significance levels. In other words, we cannot reject the null hypothesis of equal conditional expectations at the cutoff.

3.6.5 Alternative Bandwidth Choices

Finally, we examine whether our local linear estimates are robust to alternative bandwidths. The choice of bandwidth reflects a trade-off between precision and bias. Using a wider bandwidth includes more observations and yields more precise estimates. The reverse occurs if we use a narrower bandwidth. Therefore, we perform this robustness test to ensure that our results are not sensitive to alternative bandwidths.

Specifically, we repeat the regression for different bandwidths around the threshold with a rectangular kernel and plot the results in Figure 3-5. For the main results we use the optimal bandwidth as suggested by Calonico *et al.* (2016), as a robustness we follow Lee and Lemieuxa (2010) and Bradley *et al.* (2016) and provide a graphical illustration

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[10] European Commission [Online] Available: http://ec.europa.eu/index_en.htm [Accessed: 25 February 2016].

representing the sensitivity of the results to bandwidths by plotting the local linear discontinuity estimate against a continuum of bandwidths. It can be seen that the results obtain in sections 3.5.2.1 and 3.5.2.2 are robust to changes in the bandwidth. We observe that the RDD for the risk measures are still positive but for the profitability measures variables are always negative and are stable in statistical significance over the range of bandwidth choices, suggesting that the baseline RDD results using local linear regressions are robust to alternative choices of bandwidths.

Table 3-11 Robustness Check 1: Falsification tests for estimated effect of Cutoff on bank risk and return before the GFC

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Z-Score	Z-Score	Capital	Capital	NPLs/Net Loans	NPLs/Net Loans	LLR/Gross Loans	LLR/Gross Loans	Δ ROA	Δ ROA	Δ ROE	Δ ROE	Δ NIM	Δ NIM
Cutoff	-0.645	-13.40	-1.148***	-0.411	0.186	-0.712*	-2.232***	-0.587*	1.329	1.144	1.800	0.417	0.558*	-4.126
	(3.97)	(21.9)	(0.042)	(6.01)	(0.20)	(0.31)	(0.19)	(0.29)	(1.51)	(3.56)	(1.90)	(3.42)	(0.25)	(2.31)
Δ NSFR	15.02	32.35	-0.0584	0.0727	-0.0299	-0.697	0.0459	-0.555	-3.488	3.173	-3.949	2.272	-1.012	-0.230
	(41.6)	(44.8)	(0.26)	(0.53)	(0.57)	(0.85)	(0.57)	(0.89)	(5.90)	(4.25)	(5.24)	(3.61)	(1.52)	(1.32)
NSFR_C	-22.71	-46.04	0.215	0.191	-0.709	-0.0331	-0.0819	0.0871	-5.247	-5.777	-4.688	-5.141	1.409	0.674
	(52.3)	(58.9)	(0.33)	(0.69)	(1.15)	(1.55)	(0.90)	(2.03)	(14.8)	(6.50)	(13.6)	(5.94)	(1.50)	(1.36)
NSFR*Cutoff		5.420		0.0493		0.252		0.0641						
		(6.65)		(0.17)		(0.34)		(0.30)						
HHI		-16.64		-0.336		-1.615		-1.378		6.201		5.597		-0.766
		(58.4)		(0.62)		(3.64)		(3.33)		(20.9)		(19.9)		(1.70)
ROA		-2.386		-0.0279		0.0870		0.0717						
		(3.91)		(0.036)		(0.15)		(0.16)						
Operating Income/ Total Assets		181.9		2.271		8.052		5.169		6.918		-1.066		-1.142
		(383.8)		(5.83)		(15.2)		(14.0)		(81.3)		(72.3)		(13.8)
Efficiency		-0.0628		0.0000598		-0.0115		-0.0110						
		(0.099)		(0.0030)		(0.0084)		(0.0087)						
Capital										0.606		0.922		-0.621
										(1.71)		(1.70)		(0.58)
NII										1.368		1.287		0.0526
										(0.77)		(0.72)		(0.084)
Overhead/Total Assets										-0.601		-0.630		-0.452
										(0.81)		(0.75)		(0.52)
Funding Structure										-1.394		-0.942		0.746
										(4.64)		(4.30)		(1.39)
Constant	5.780*	1.414	2.604***	1.432*	-3.421***	-2.651	3.507***	2.922	-0.0989	-5.777	-0.153	-6.326	-0.728**	0.360
	(2.54)	(19.8)	(0.045)	(0.59)	(0.12)	(1.50)	(0.10)	(2.37)	(0.40)	(12.2)	(0.36)	(11.6)	(0.26)	(3.25)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Z-Score	Z-Score	Capital	Capital	NPLs/Net Loans	NPLs/Net Loans	LLR/Gross Loans	LLR/Gross Loans	Δ ROA	Δ ROA	Δ ROE	Δ ROE	Δ NIM	Δ NIM
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	121	118	401	253	261	174	258	172	147	144	150	147	207	195
R-squared	0.769	0.844	0.990	0.996	0.981	0.993	0.985	0.995	0.723	0.914	0.769	0.929	0.942	0.907
Adjusted R-Squared	-0.319	-0.304	0.978	0.985	0.961	0.975	0.969	0.981	-0.189	0.559	0.0150	0.644	0.782	0.589

Notes: This table presents local linear regression results using the optimal bandwidth following Imbens and Kalyanaraman (2012). Results using rectangular kernels are reported. The financial risk is measured by Z-Score in columns (1) and (2), Capital in columns (3) and (4), NPLs in columns (5) and (6) and LLR ratio in columns (7) and (8). Bank profitability is measured by Δ ROA in columns (9) and (10), Δ ROE in columns (11) and (12) and Δ NIM in columns (13) and (14). Our variable of interest is Cutoff. This parameter measures the discontinutiy in the change in bank performance observed at the threshold. The regressions include year fixed effects, bank-fixed effects and country fixed effects. Standard errors are clustered on bank level. ***p<0.01, **p<0.05, *p<0.1. Data source: BankScope database. Coverage: 2005-2007.

Table 3-12 Robustness Check 2: Falsification tests for estimated effect using alternative Cutoff values

Panel A: Financial Risk

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Z-Score	Z-Score	Capital	Capital	NPLs/ Net Loans	NPLs/Net Loans	LLR/Gross Loans	LLR/Gross Loans
Placebo Cutoff 80%	-12.57*** (2.05)	-9.879* (4.12)	-1.296* (0.53)	2.273 (1.60)	-1.765* (0.77)	-0.189 (2.00)	-0.737 (0.97)	-0.307 (1.96)
Placebo Cutoff 90%	-2.734** (1.02)	2.964 (2.94)	-0.0651 (0.63)	-1.318 (1.29)	0.265 (0.33)	-1.814 (1.11)	-2.106*** (0.37)	-0.119 (0.35)
Placebo Cutoff 110%	-3.925** (1.30)	-4.589 (2.78)	-1.031*** (0.27)	-2.073 (1.10)	-1.841** (0.64)	-1.348 (1.02)	0.419 (1.14)	2.466 (1.69)
Placebo Cutoff 120%	-0.530 (1.81)	4.55 (3.44)	3.559 (2.53)	-0.622*** (0.11)	-2.39*** (0.17)	-3.023*** (0.72)	-0.0762 (0.98)	-0.458 (0.41)
Covariates	No	Yes	No	Yes	No	Yes	No	Yes

Panel B: Bank Profitability

	(1)	(2)	(3)	(4)	(5)	(6)
	Δ ROA	Δ ROA	Δ ROE	Δ ROE	Δ NIM	Δ NIM
Placebo Cutoff 80%	-5.001 (5.66)	-3.601 (3.25)	14.66** (5.54)	17.32* (6.91)	-0.691 (2.13)	0.734 (2.12)
Placebo Cutoff 90%	-0.282 (0.29)	-1.926 (2.34)	-0.288 (1.02)	-0.597 (1.05)	1.004* (0.47)	0.228 (0.59)
Placebo Cutoff 110%	-0.396 (0.49)	-4.870 (3.93)	-1.293 (1.15)	-4.856 (4.25)	0.0863 (0.12)	1.827*** (0.48)
Placebo Cutoff 120%	-1.089 (1.76)	-2.827 (2.01)	-0.823 (3.32)	-4.190 (2.44)	-0.0843 (0.15)	0.871** (0.32)
Covariates	No	Yes	No	Yes	No	Yes

Notes: This table presents local linear regression results using the optimal bandwidth following Imbens and Kalyanaraman (2012). Results using rectangular kernels are reported. We examine the effect of using minimum requirement liquidity level (NSFR≥ 80%, NSFR≥ 90%, NSFR≥ 110% and NSFR≥ 120%) for international banks on bank performance. Panel A: presents risk measures, while Panel B present bank profitability. The regressions include year fixed effects, bank-fixed effects and country fixed effects. Standard errors are clustered on bank level. ***p<0.01, **p<0.05, *p<0.1. Data source: BankScope database. Coverage: 2005-2010.

Table 3-13 Robustness Check 3: Estimated effect of Cutoff on financial risk including state aid and government bailout during the GFC

	(1) Z-Score	(2) Z-Score	(3) Capital	(4) Capital	(5) NPLs/Net Loans	(6) NPLs/Net Loans	(7) LLR/Gross Loans	(8) LLR/Gross Loans
Cutoff	3.451***	6.688*	2.382***	2.272***	3.172***	3.129***	3.027***	0.323
	(0.39)	(3.25)	(0.11)	(0.37)	(0.063)	(0.60)	(0.068)	(0.40)
Δ NSFR	-2.055	-1.598	0.135	-0.0863	0.485	0.315	0.451	0.622
	(2.30)	(2.42)	(0.34)	(0.34)	(0.65)	(0.84)	(0.87)	(1.34)
NSFR_C	5.100	4.637	0.213	0.605	0.422	-0.262	1.241	0.106
	(3.58)	(3.55)	(0.44)	(0.50)	(1.97)	(1.45)	(2.19)	(1.57)
ΔNSFR*Cutoff		-0.0977		-0.108		-0.128		0.115
		(0.55)		(0.058)		(0.21)		(0.35)
HHI		-2.415		-0.563		-0.190		0.497
		(5.46)		(0.73)		(1.05)		(1.54)
ROA		-0.339		-0.0576*		-0.182*		-0.0977
		(0.21)		(0.026)		(0.088)		(0.14)
Operating Income/ Total Assets		-0.138		0.0275		-0.0167		0.0842
		(0.35)		(0.030)		(0.073)		(0.15)
Efficiency		0.0102		-0.00309		-0.0191*		-0.0150
		(0.015)		(0.0016)		(0.0075)		(0.0079)
Crisis Dummy		-0.467		0.000188		0.179		0.380
		(0.44)		(0.029)		(0.12)		(0.22)
Recapitalisation		19.10		-1.669		-4.893		0.0995
		(19.5)		(2.08)		(8.40)		(12.1)
Guarantees and LM		1.166		0.133		-0.952**		-1.151**
		(2.82)		(0.17)		(0.31)		(0.40)
Constant	1.575***	3.914	2.373***	3.044***	-7.007***	-6.624***	1.391***	0.0212
	(0.42)	(2.83)	(0.049)	(0.31)	(0.17)	(0.82)	(0.24)	(1.30)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	399	358	595	403	377	273	347	252
R-squared	0.697	0.668	0.966	0.980	0.916	0.953	0.859	0.858
Adjusted R-Squared	0.428	0.342	0.943	0.962	0.852	0.907	0.745	0.702

Notes: This table presents local linear regression results for banks that receive support from government using the optimal bandwidth following Imbens and Kalyanaraman (2012). Results using rectangular kernels are reported. The financial risk is measured by Z-Score in columns (1) and (2), Capital in columns (3) and (4), NPLs in columns (5) and (6) and LLR ratio in columns (7) and (8). Our variable of interest is Cutoff. This parameter measures the discontinutiy in the change in bank performance observed at the threshold. The regressions include year fixed effects, bank-fixed effects and country fixed effects. Standard errors are clustered on bank level. ***p<0.01, **p<0.05, *p<0.1. Data source: BankScope database. Coverage: 2005-2010.

Table 3-14 Robustness Check 3: Estimated effect of Cutoff on bank profitability including state aid and government bailout during the GFC

	(1)	(2)	(3)	(4)	(5)	(6)
	Δ ROA	Δ ROA	Δ ROE	Δ ROE	Δ NIM	Δ NIM
Cutoff	-0.696**	-3.231*	-0.768***	-0.362	-0.806***	-1.198**
	(0.21)	(1.38)	(0.21)	(1.33)	(0.094)	(0.39)
Δ NSFR	-0.605	-1.528	-0.496	-1.472	0.645	0.493
	(1.21)	(1.06)	(1.06)	(0.90)	(0.49)	(0.40)
ΔNSFR*Cutoff	2.818	2.829	2.773	3.065	-1.627	-0.704
	(3.33)	(2.33)	(2.81)	(2.07)	(1.19)	(0.61)
HHI		2.526		3.020		-0.281
		(4.29)		(4.13)		(0.58)
Capital		-0.367		-0.322		-0.0657
		(0.63)		(0.59)		(0.20)
Operating Income/ Total Assets		-0.754*		-0.773**		0.0341
		(0.31)		(0.29)		(0.072)
NII		0.971***		0.924***		0.0773
		(0.16)		(0.16)		(0.044)
Overheads/Total Assets		0.500		0.593		-0.200
		(0.61)		(0.59)		(0.14)
Crisis Dummy		-0.305		-0.318		-0.0420
		(0.23)		(0.22)		(0.062)
Funding Structure		2.496		2.826*		-0.172
		(1.42)		(1.39)		(0.31)
Recapitalisation		-8.401		-7.537		1.624
		(17.5)		(15.0)		(3.03)
Guarantees and LM		-0.707		-0.823		-0.206
		(1.52)		(1.47)		(0.17)
Constant	0.137	-4.277	0.0294	-4.173	0.225***	0.0236
	(0.20)	(2.28)	(0.20)	(2.35)	(0.062)	(0.62)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	391	377	413	396	436	372
R-squared	0.409	0.675	0.405	0.665	0.602	0.697
Adjusted R-Squared	-0.0872	0.374	-0.0666	0.374	0.285	0.417

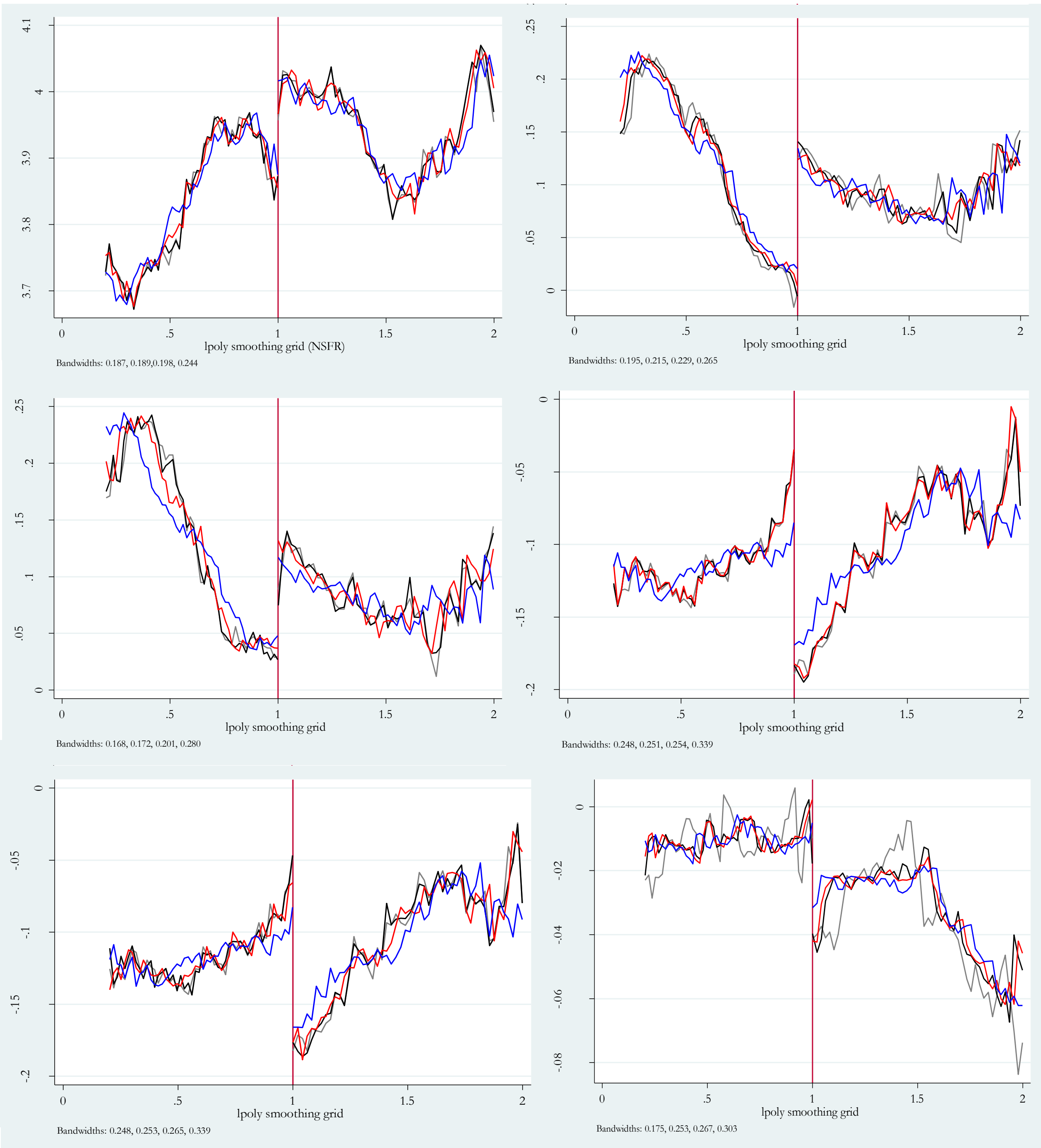
Notes: This table presents local linear regression results for banks that receive support from government using the optimal bandwidth following Imbens and Kalyanaraman (2012). Results using rectangular kernels are reported. Bank profitability is measured by Δ ROA in columns (1) and (2), Δ ROE in columns (3) and (4) and Δ NIM in columns (5) and (6). Our variable of interest is Cutoff. This parameter measures the discontinutiy in the change in bank performance observed at the threshold. The regressions include year fixed effects, bank-fixed effects and country fixed effects. Standard errors are clustered on bank level. ***p<0.01, **p<0.05, *p<0.1. Data source: BankScope database. Coverage: 2005-2010.

Table 3-15 Robustness Check 4: A placebo test- Balanced Covariates

	RD Effect	Robust p-value
HHI	0.03	0.34
ROA	0.51	0.13
Operating Income/ Total Assets	-0.17	0.61
Efficiency	-13.84	0.25
NII	-0.58	0.14
Overhead/Total Assets	-0.24	0.38
Recapitalisation	0.00	0.66
Guarantees and LM	-0.01	0.47

Notes: This table presents the RD treatment effect on covariates. The dependent variables being the lagged HHI, ROA, operating income to total assets, efficiency, NII, overhead to total assets, recapitalisation and guarantees. Data source: BankScope database. Coverage: 2005-2010.

Figure 3-5 Robustness Check 5: Various Bandwidth Choices:



Notes: This figure plots the RDD estimates with alternative bandwidth using local linear regressions with the choice of optimal bandwidth following Imbens and Kalyanaraman (2012) and Calonico *et al.* (2016).

3.7 Conclusion

Considerable progress has been made since the global financial crisis of 2008 in strengthening the resilience of financial systems. The Net Stable Funding Ratio (NSFR) is one of the new indicators for liquidity risk management introduced under Basel III that is designed to enhance funding stability. This chapter makes an important contribution to the empirical literature by estimating the NSFR for banks in 28 European countries and focuses on the role it plays for overall financial system stability and profitability. We employ a RDD that differentiates between banks based on the threshold level (100%) using a large sample of European banks over 2005-2010 to compare behavior of banks that meet the NSFR requirements to a sample of banks failing to meet the requirements close to the cutoff.

We find evidence that the NSFR leads to an increase in the overall financial stability of the banking system. However, the excessive liquidity induces risk-taking behaviour resulting in an increase in non-performing loans and a loan loss reserve ratio that offsets the positive impact on stability. In addition, our findings reveal that banks meeting the NSFR requirements suffer from a decline in their profitability compared to those that did not meet the requirements. As a further step, we extend our analysis and demonstrate the differences across bank size. Our research has shown that only small banks are significantly positively affected by tightening the liquidity requirements in terms of stability. Notably, the coefficients of a bank's riskiness of its loan portfolio are found to be weakly significant. We perform a number of robustness checks, and find that the main results hold.

The results suggest several policy implications. First, the Basel Committee, concerned with tightening levels of liquidity requirements and their ability to control illiquidity shocks, assumes that raising and implementing liquidity regulations will reduce potential bank distress and promote financial stability during crises years. Therefore, by increasing the liquidity requirements, local and international authorities could restore and maintain banking stability without resorting to ad-hoc bailouts and government interventions. However, we find evidence that banks generally tend to invest in highly risky assets as measured by NPLs and LLR ratio, which might point to a gambling for resurrection behavior. Thus, the implementation of the new liquidity requirements may also require more improvement to Pillar 2 of Basel III (risk management and supervision) regarding internal governance as well as risk management tools to effectively manage non-performing loans. Second, even though the increase of liquidity requirements may improve performance during the crises, it still represents a cost opportunity. Reaching a proper equilibrium therefore is a matter of great importance for policymakers aiming at the best possible trade-off between efficiency and stability in the financial system. Furthermore, the fact that the liquidity regulatory requirements have not yet been implemented and the lack of clarity with the definition and measurement of liquidity, regulators could consider for example the need to determine what type of liquid liabilities should be considered stable to avoid any ambiguity in defining core or stable deposits. Our approach in calculating the NSFR index is more complete and useful as a tool for academics considering NSFR for future research.

Chapter 4: The Impact of Oil Price Shocks on GCC Banking: Does Liquidity Matter?

The Impact of oil Price Shocks on GCC Banking: Does Liquidity Matter?

Abstract

In this chapter, we study the effect of the oil price shock that began in June 2014 on bank lending. The sharp decline in oil prices represents an unexplored negative shock to the supply of credit by banks. We use a sample of annual observations of GCC conventional and Islamic banks to examine whether the effect of the oil price shock on lending differs depending upon the level of bank liquidity. Using a difference-in-difference approach, we compare bank lending behaviour before and after the oil price shock. To address concerns about the endogeneity of banks' liquidity to changes in lending channels, we measure the liquidity positions as much as three years prior to the oil price shock. Consistent with a causal effect of a supply shock, the decline is greatest for banks that have a low level of liquidity buffers.

JEL classification: G21, G28, Q43

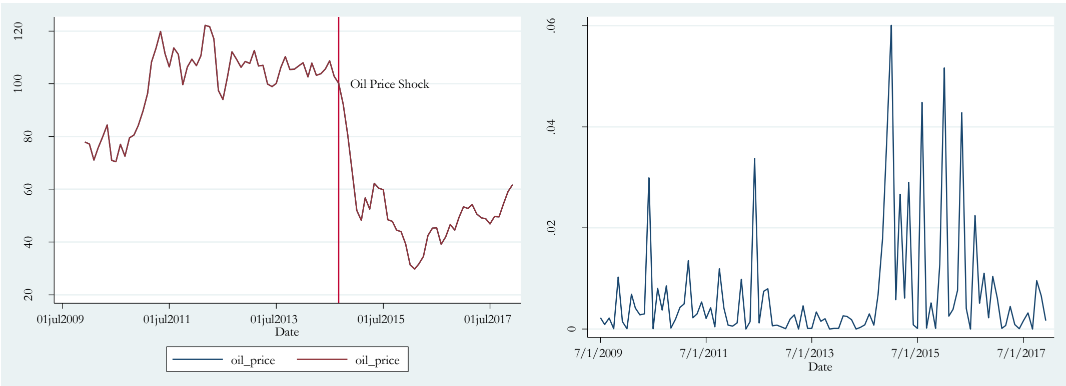
Keywords: Banking system, bank lending, bank liquidity, oil price shocks

4. The Impact of Oil Price Shocks on GCC Banking: Does Liquidity Matter?

4.1 Introduction

Sufficient liquidity is essential for a banking system to function properly and supply credit to the real sector. However, the Gulf Cooperation Council (GCC) banks are facing large shocks to their liquidity supply due to the recent oil price shock that hit the entire banking system in mid-2014. Oil prices have seen a tremendous decline from $110 per barrel to below $50, the trend and volatility of monthly oil prices is shown in Figure 4-1 below. Given the high dependency of GCC economies on oil and energy exports for their incomes and the strong oil-macro-financial linkages, fluctuations in oil prices have a serious impact on funding costs, loan growth and hence, diminishing overall economic activity. The GCC banking and financial sector remains the second major industry after the oil and gas sector, therefore, a strong banking sector soundness provides an important buffer in the GCC to an oil price decline (IMF, 2015; El-Katiri, 2016; Al-Khazali and Mirzaei, 2017).

Figure 4-1 Trend and Volatility of Monthly Oil Prices from July 2009- July 2017



Data Source: Datastream database.

Since the oil price shock, growth in deposits have largely slowed, as governments and government-related entities have withdrawn deposits from the banking system and liquidity conditions are likely to worsen over time. As demand for liquidity has grown faster than supply, central banks in the region have used their available monetary instruments to manage liquidity pressures and prevent a large rise in interest rates, while banks have turned to alternative funding sources. These developments have generated renewed interest for liquidity management frameworks and instruments as well as how to make sure banks hold sufficient buffers to face liquidity shocks. Thus, banks with a lower amount of liquidity during the oil price shock are expected to be affected more heavily. For these reasons, policymakers are keen to design regulations that mitigate vulnerability and increase resilience and reform of the banking sector.

The high dependency of energy-exporting countries to oil income on the one hand and instability of world energy prices on the other hand, make these economies a good laboratory for testing the extent to which oil price shocks influence bank lending. The goal of this chapter is to empirically examine the effect of the oil price shock on bank lending. Specifically, we exploit plausibly exogenous variation in the exposure to the oil price shock across the GCC countries over the period 2011-2016 using a difference-in-difference (DID) estimator to tease out the causal effect of the oil price shock on bank lending. Liquidity buffers that banks held prior to the oil price shock represents a good proxy to measure an individual bank's exposure to the negative oil price shock.

Two empirical challenges arise here. First, the measurement of liquidity buffers (the treatment variable here is liquidity buffers) that proxy for the variation in banks' exposure to the shock needs to be exogenous from the outcome variable. A standard criticism of liquidity buffers as an identification function that are based on bank-level variables, is that they are to some extent endogenous to choices made by the bank, and in particular may be endogenous to unobserved variation in bank performance. Following Duchin *et al.* (2010) we calculate banks' liquidity levels *three years prior* to the shock, at the end of 2011. In this way, we can identify a negative shock that is exogenous to the state of the economy. As a result, we can study the causal effect of this shock on banks' lending supply and examine the transmission of this shock to the real economy.

Second, is an identification problem regarding the separation of loan supply from loan demand, as the bank lending channel concerns only changes in the supply of bank loans. Clearly, unobserved differences across countries that vary over time may result in heterogeneity in our sample that ultimately derive our results. To remove these time-variant demand/country-specific conditions, our approach includes year*county fixed effects that control for the local environment of banks because banks in the same location face the same economic environment, and differences in the amount of loans should then be related to differences between banks. Second, employing a DID methodology helps to control for the systemic shock on loan demand during the oil price shock that affects all banks in my sample and for the possible differences in loan demand between banks with different exposure to the oil price shock independent of the year. As a further check, we compare the lending behaviour between banks and Specialized Credit Institutions (SCIs) in Saudi Arabia to assess how the demand for lending is affected as SCIs lend to some of the same sectors as banks do, which may increase or decrease bank lending (Miyajima, 2017).

The following main results emerge from the empirical section. First, we find that credit growth declines by 34.6% of its unconditional mean following the oil price shock, specifically by 3.218% of assets relative to an unconditional mean of 9.29% of assets per year. Consistent with a causal effect of a supply shock, we find that banks holding a higher liquidity level mitigate the impact of the oil price shock on credit growth. Second and as a further step, we show that the results differ by liquidity level. For highly-liquid banks, we find that the effect of the oil price shock on credit growth becomes significantly positive only after banks retain sufficient liquid assets. Notably, the interaction effect is found to be nonsignificant or negligibly negative for medium- and low- liquid banks. This suggests that the relationship between a high-liquidity level and credit growth is positive and stronger during the oil price shock, but is negative between a low-liquidity level and credit growth.

We present tests that explore the mechanism behind these results. We extend the analysis and examine whether other funding sources explain the possible channels associated with less impact of the oil price shock on bank lending. We find that short-term funding has a significantly negative effect on post-shock changes in lending, whereas banks' net worth, non-interest income and long-term funding do not. Because short-term funding represents a looming reduction in liquidity in times when refinancing is difficult or costly, whereas other longer-term sources do not, these findings reinforce the interpretation of our results as a supply effect. We perform a number of robustness checks and our results hold to these tests.

This chapter contributes to the existing literature in several ways. First, the recent oil price shock has highlighted the crucial role performed by banks in supplying lending to the economy, especially in a situation of serious financial distress. Understanding the lending behaviour of the financial sector, exposure to the oil price shock matters from a macroeconomic perspective in the GCC economies. To the best of our knowledge, this is the first study that investigates the impact of the recent oil price shock on bank lending in the GCC economies. Previous studies (Hesse and Poghosyan, 2016; Al-Khazali and Mirzaei, 2017; Grigoli *et al.*, 2017) focus on the consequences of the oil price shock on bank profitability, NPLs or economic growth and financial development. Second, we are the first to examine the interaction effect of the oil price shock and liquidity on bank lending. Most of the previous studies (Hesse and Poghosyan, 2016; Al-Khazali and Mirzaei, 2017; Khandelwal *et al.*, 2017) make use of a linear panel framework, or adopt dynamic panel methods (system GMM). We are using this approach, as we are mostly interested in studying the role of banks' liquidity buffers in mitigating or worsening the impact of the oil price shock. This approach suits our investigation, as the oil price shock affects the banking sector as a whole whereas the level of bank liquidity differs, and this enables us to clearly identify the role of bank liquidity. Third, this study is important because the findings shed new light on the functioning of the bank-lending channels in the GCC countries, which is a timely and relevant question for macroprudential policy in that region. This chapter helps inform the debate in the policy community. In fact, this research examines the question of whether imposing higher liquidity requirements on the banking system in the GCC will work in practice and contribute to developing an appropriate macroprudential policy response to overcome liquidity shocks. Finally, in this study, we analyse the question of the transmission of oil price shocks in the GCC banking system. In particular, we examine how the various financial elements within the banking system may affect the transmission mechanism of the oil price shock, taking into account those elements as relevant components in influencing bank loan supply. Foremost among these are: other sources of funding such as short-term funding, long term funding, derivatives and trading liabilities as well as non-interest income and capital.

The remainder of the chapter is organized as follows: Section 4.2 presents a review of the literature, and section 4.3 presents the data used and describes the empirical methodology and variables. Section 4.4 discusses the regression results, and section 4.5 addresses identification concerns and robustness checks. Section 4.6 presents the study's conclusions and discusses the policy implications of the results.

4.2 Literature Review

This chapter is related and contributes to three strands in the literature. First, it adds to those empirical studies that investigate the impact of oil price shocks on bank performance. A growing number of papers study the consequences of the recent oil price shock and seek to understand its impact on bank behavior. Al-Khazali and Mirzaei (2017) investigate the relationship between oil price shocks and bank NPLs in oil-exporting countries. They argue that the quality of bank loan portfolios declines following adverse oil price movements, making banks financially instable. Miyajima (2017) focuses on explaining determinants of bank-level credit growth in Saudi Arabia, and find that lending remained robust in 2015 despite oil prices decline, helped by strong bank balance sheets and a reduction in bank holding of "excess liquidity". More specifically, Chen and Wu (2014) confirm the importance of strong balance sheet conditions and banking regulation in supporting robust credit growth.

Hesse and Poghosyan (2016) examine oil prices influence on bank profitability for conventional, investment and Islamic banks. They find that bank profitability is affected by oil prices via macro channels and investment banks have the highest exposure compared to conventional and Islamic banks. Further undesirable consequences that arise from oil price shocks on economic growth and macroeconomic and financial development is documented for the GCC banking system and across oil exporting economies by Khandelwal *et al.* (2017) and Grigoli *et al.* (2017).

Second and in the same vein, our study is also linked to the macroprudential policy in the GCC. The use of macroprudential policy to address structural risks in the GCC financial system is discussed in (Aljabrin *et al.*, 2014; Arvai *et al.*, 2014; Prasad *et al.*, 2015). As mentioned in the introduction, GCC economies are heavily dependent on oil, which makes them especially vulnerable to swings in global oil prices. Therefore, macroprudential policy measures are important to limit systemic risk and in strengthening the stability of their financial systems.

While negative market shocks has sparked an extensive policy debate, as well as a number of research initiatives that discuss instruments to foster financial stability including: capital, leverage, policy rate, FX reserve buffers and taxes, studies on liquidity requirements are still scarce in the literature on macroprudential policy (Blanchard *et al.*, 2010; Caruana, 2010; Lenza *et al.*, 2010; Borio, 2011; Galati and Moessner, 2013). In this regard, BIS (2010) and (BCBS, 2010a) are among the first studies that examine the macroeconomic impact of stronger capital and liquidity requirements proposed under Basel III for a number of countries, they show that stronger requirements can lead to a reduction in the likelihood of bank distress.

Our work adds to this literature by exploring the consequences of an oil price shock on bank lending. To the best of our knowledge, this is the first to examine the interaction effect of oil shock and liquidity on lending in the GCC. In addition, this chapter contributes in quantifying the effect of macroprudential tools measured by liquidity requirements on credit growth. In this context, liquidity buffer is a key. Adequate liquidity buffers would help to smooth the transition to a more resilient banking system, and would prevent liquidity shocks during tough times.

Ultimately, this chapter is also related to a growing body of research on bank funding, as weaknesses on the asset side of banks' balance sheets tend to trigger funding problems (Borio, 2010). Recently, the banking sector has witnessed a steady shift in banks' funding sources away from traditional core deposits and into market funding (Dagher and Kazimov, 2015). Hahm *et al.* (2013) argue that banks' overreliance on specific sources of financing other than deposits and equity has significant power for immediate funding tensions. For example, the large share of short-term debt in banks' liabilities has been identified as a major source of banks' vulnerability (Brunnermeier, 2009; Shin, 2009; Goldsmith-Pinkham and Yorulmazer, 2010; Cornett *et al.*, 2011; Hanson *et al.*, 2011; Huang and Ratnovski, 2011). In contrast, banks that relied more heavily on deposit funding continued to lend during difficult times relative to other banks, showed better overall performance and were less risky (Demirgüç-Kunt and Huizinga, 2010; Ivashina and Scharfstein, 2010; Raddatz, 2010; Vazquez and Federico, 2015). Nevertheless, there exists considerable academic support for the view that bank funding instruments make a positive contribution to economic growth. Hence, it might be a rational strategy for banks to resort to wholesale funding in the face of economic uncertainty and volatile demand for bank loans (Dinger and Craig, 2013).

4.3 Data and Methodology

4.3.1 Sample

The sample in this study consists of annual income statements and balance sheet data from Fitch-Connect database and macroeconomic data collected from the World Economic Outlook database (WEO). For our analysis, we include both conventional banks and Islamic banks from the six GCC countries which are the most representative types of entities from the GCC banking sector between 2011 and 2016. We choose this specific sample horizon to have a balanced window of time before and after the oil price shock.

We also require that all bank-year observations have no missing data for total assets. Furthermore, we only consider banks that have gross loans data both before and after the oil price shock. Finally, all bank-specific variables are winsorized at the 1^{st} and 99^{th} percentiles to remove the influence of outlier values.

The final balanced sample consists of 394 bank-year observations and 67 banks. This sample represents more than 90 percent of the size of the GCC banking system (See Table 4-9, Panel A for the size of GCC financial system). Regarding the composition of the sample, 44 banks are conventional banks representing 66% of the sample while the remaining 23 banks are Islamic banks. Table 4-1 provides the composition of the sample for each country by bank type.

Table 4-1 composition of sample by bank type and GCC country

Country	Number of banks	Conventional Bank	Islamic Bank
Number of banks	67	44	23
Bahrain	14	8	6
Kuwait	8	6	2
Oman	7	7	0
Qatar	8	5	3
Saudi Arabia	12	6	6
United Arab Emirates	18	12	6

Notes: This table presents a description of banks included in the sample by bank type and country. Source: Fitch-Connect database.

4.3.2 Identification Strategy

To analyse the impact of the oil price shock on bank lending, we employ a difference-in-difference approach in which we compare lending behaviour before and after the oil price shock. We therefore make use of this method to identify the causal effect of banks' exposure to shocks on bank lending and assess how and to what extent liquidity levels allow banks to be more resilient after the oil price shock.

In our analysis, we include the level of liquidity as a key explanatory variable to investigate whether this liquidity measure significantly influences bank lending. We are mostly interested in studying the role of banks' liquidity level in mitigating or worsening the impact of the oil price shock on lending. Inferences may be confounded, however, if variation in these liquidity levels as the oil price shock unfolds is endogenous to unobserved variation in lending. Our base specification, as well as the rest of our analysis described fully below, are designed to address this issue. Because changes in a bank's liquidity level as the oil shock unfolds may be related to unobserved changes in lending activities, we purge our specifications of this variation by using (only) the bank liquidity levels measured *three years prior* to the start of the oil price shock, specifically at the end of 2011.

Following Duchin et al. (2010), we study the effect of the negative oil price shock on bank lending and focus on the period from 2011-2016, a balanced window of three years before and after the oil price shock in 2014.[11] To study the effect of the shock, we use a difference-in-difference (DID) estimation method with a continuous treatement variable (Liquidity), and estimate

$$\Delta\ln(y_{i,c,t}) = \alpha_0 + \alpha_1 Post_t + \alpha_2\, Liquidity_i * Post_t + \theta X_i + \gamma_i + \varepsilon_{i,t} \quad (1)$$

Where the dependent varialbe $\Delta\ln(y_{i,c,t})$ denotes growth rate of gross loans for bank i in time period t.[12] $Post_t$ is the post-treatment indicator that is equal to 1 for all banks in countries and years following the oil price shock in 2014 and zero otherwise. Including the level $Post_t$ contols for trends common to all banks independent of their exposure to the oil price shock. For example, if the loan supply of banks is decreasing during the oil price shock due to uncertainity in the markets, α_1 will capture this variation. $(Liquidity_i * Post_t)$ is an interaction of the post-treatment indicator variable with the bank's level of liquidity measured three years prior to the oil price shock. the coefficient of interest is α_2, its magnitude provides information about the effect of oil price shock on banks with high liquidity levels. X_i includes a set of bank characteristics and macroeconomic control variables. γ_i is the bank fixed effects, country fixed effect and the intercept between country and year fixed effects. Of course, the bank fixed effects subsume the level of liquidity (because liquidity is measured only once per bank) and control for all sources, observed or unobserved, of time-variant variation in bank performance across banks. We cluster heteroskedasticity-adjusted standard errors at the bank level to account for serial correlation within each panel (Duflo *et al.*, 2004).

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[11] Fitch-Connect restricts us to an ending period of 2016.

[12] By using a continuous treatment, we study the effect of a change in the exposure to the negative oil price shock instead of defining a binary variable for treated and control groups.

Our second test is to focus our analysis on how the different level of bank liquidity impact lending. To conduct this analysis, we modify my original equation (1) and decompose our main explanatory vaiable into three different variables, which represent the interaction between each liquidity category and the oil price shock. This means that we generate interaction variables for each of the following liquidity levels: low liquidity level, medium liquidity level and high liquidity level. Thus, our regression model is as follow:

$$\Delta \ln(y_{i,c,t}) = \alpha_0 + \alpha_1 Post_t + \alpha_2 \sum_{j-1}^{j=3} Liquidity\ level_j * Post_t + \theta X_i + \gamma_i + \varepsilon_{i,t} \quad (2)$$

The coefficient α_2 captures the difference-in-difference effect of the oil price shock on the dependent variable for each bank in different liquidity categrogy in the sample.

Futhermore, we are interested to analyze the possible channels associated with less impact of the oil price shock to bank lending. Hence, we modify equation (1) to take into account other funding sources. This is done by multiplying the variabel *(Post)* by the variable *(Funding)*. The model is expressed by the following eqation:

$$\Delta \ln(y_{i,c,t}) = \alpha_0 + \alpha_1 Post_t + \alpha_2 Funding_i * Post_t + \theta X_i + \gamma_i + \varepsilon_{i,t} \quad (3)$$

The variable Funding includes: short-term funding, long-term funding, non-interest income and capital. For this equation, α_2 is the variable coefficient of interest, which represents the relevant components in influencing loan supply movement.

Finally, it is argued that Islmaic banks are more liquid than conventional banks. Therefore, we analyze the impact of the oil price shock on Islamic banks. To conduct this part of our analysis, we use the difference-in-difference-in-differences technique (DIDID), by which we estimate the following regression specifications:

$$\Delta \ln(y_{i,c,t}) = \alpha_0 + \alpha_1 Post_t + \alpha_2 Liquidity_i * Post_t * IslamicB + \alpha_3 IslamciB_i * Post_t + \theta X_i + \gamma_i + \varepsilon_{i,t} \quad (4)$$

In which the added (IslamicB) is a dummy variable that takes the value 1 if the entity is an Islamic bank and zero otherwise. Similarly, α_2 is the variable coefficient of interest, which represents the effects of the oil price shock on Islamic banks with a higher level of liquidity.

4.3.3 Variable Definitions

We use the annual growth rate of lending as a measure of my dependent variable. It is calculated as the gross loans divided by total assets. Following the convention adopted by most studies (e.g., Gambacorta and Mistrulli, 2004; Berrospide, 2012; Drehmann and

Gambacorta, 2012; Brei *et al.*, 2013; Kapan and Minoiu, 2013) we use the growth rate of the dependent variable instead of the variable levels to mitigate spurious correlation.

The key variable of our analysis is the liquidity level banks hold prior to the oil price shock. The macroprudential policies offer a variety of liquidity tools to promote a more sound funding profile in banks. GCC countries have considerable experience with the use of macroprudential policies, although these have generally not been employed countercyclically (IMF, 2015). Macroprudential tools include liquidity buffer requirements (e.g. a liquid asset ratio), liquidity coverage ratio (LCR), stable funding requirement ratio (e.g. NSFR, loan-to-deposit ratio (LTD), core funding ratio).

We use both liquid asset ratio and LTD ratio to account for both liquidity buffer requirements and stable funding requirements. We measure liquid asset ratio as liquid assets divided by all short-term funding. We determine liquid assets by summing cash, trading securities and assets specifically designated at fair value through income statement, loans and advances less than three months and loans and advances to banks less than three months. Loan-to-deposit (LTD) ratio can help ensure that banks hold stable liabilities (e.g. deposits) to fund their relatively illiquid assets. This suggests that the loan to deposit ratio is a good proxy of banks' commercial aggressiveness and as such, a good leading indicator of potential liquidity risk. These ratios help contain liquidity risk and the reliance on wholesale funding. We measure liquidity before the oil shock for two reasons. First, because we are interested to know whether banks that have higher liquidity going into the oil price shock benefit from these higher liquidity ratios during a shock. Second, this approach mitigates endogeneity concerns because lagged liquidity and bank lending are less likely to be jointly determined.

In addition, we run further analysis to investigate the possible channels that lead to an impact of the oil shocks on bank lending. We use different measures to represent these channels. First, short-term funding calculated as total deposits and money market short term funding minus total customer deposits divided by total assets.[13] Second, long-term funding calculated as the sum of bonds, long-term senior debt, subordinated debt, other funding, derivatives and trading liabilities divided by total assets. Third, following Gambacorta and Marques-Ibanez (2011), we use non-interest income divided by net

[13] Money market short term funding involves unsecured and secured (or repo) borrowing in money markets and the issuance of other short-term debt such as commercial paper (CP) as well as certificate of deposits (CD).

income, which represents the proportion of fee-based revenues (trading, investment banking and higher brokerage fees and commissions). This variable is also considered a relevant component in influencing loan supply movement. The increase in non-interest income provides banks with additional sources of income. Such diversification can help foster stability in banks' overall revenue. At the same time, non-interest income is usually a more volatile source of revenue than interest-rate income. In periods of financial stress, there could be a decline in the traditional sources of revenue together with an even larger decline in revenues from fees and brokerage services. Under these circumstances, it is highly likely that the change in a business model could have an impact on banks' performance and their ability to supply credit. Finally, stable sources of funding measured by bank net worth or capital. Bank capital (Tier 1 capital) consists of: shareholders' equity and reserves as well as bank retained earnings.

We use several bank-level control variables that affect bank lending in my models. We include the natural logarithm of total assets to control for bank size (size). Several empirical studies have shown that bank size may affect lending (Gambacorta and Marques-Ibanez, 2011; Berger *et al.*, 2016; Chouchène *et al.*, 2017). In any case, the relationship between bank size and lending is uncertain. A positive relationship could be expected between bank size and lending as larger banks could provide more loans than smaller banks because they have easier access to the capital markets. Nonetheless, Horváth *et al.* (2014) and Fu *et al.* (2016) find a significantly negative coefficient of bank size, suggesting that smaller banks create more liquidity than larger ones.

We use equity to assets as a proxy for bank capital (capital). The equity to total assets ratio is the book value of common equity divided by the book value of the total assets of the banking organization. Capital accounts for the extent to which a bank can absorb potential losses and provide lending more vigorously.

Following Lepetit and Strobel (2015) and Forssbæck and Shehzad (2015), we select Z-Scores to measure financial stability and to observe changes in bank behaviour in terms of increased propensity to take risk. The Z-Score offers a measure of bank soundness because it specifies the number of standard deviations by which bank return on assets have to decline in order to consume all the capital of a bank or to trigger insolvency. The higher the value of the Z-Score, the more solvent is the bank and therefore it gives a direct measure of stability. Z-Score is calculated as follows:

$$ZScore = \frac{ETA+ROA}{\sigma ROA} \qquad (5)$$

Where (ETA) is the equity-to-total-asset ratio, (ROA) is the return on assets and (σROA) is the standard deviation of the return on assets calculated over the last two years. To control for a skewed distribution, we follow Danisewicz *et al.* (2015) and use the log transformation of this measure to smooth out higher values of the distribution.

We also include the return on asset (ROA) in our equation as several studies indicate that profitability may positively influence bank lending. We control for loan quality using two measures, the ratio of impaired loans and advances to customers divided by gross loans (NPLs) and the ratio of reserves for impaired loans divided by gross loans (Allowances). The higher the level of the variable is, the worse the portfolio quality is. We also include a dummy variable that controls for bank type as it may affect bank lending. Bank lending also depends on macroeconomic conditions. We include the annual growth rate of the real non-oil gross domestic product of the country (non-oil GDP) and the annual growth rate of oil prices. Table 4-2 provides summary statistics and definitions for all variables used in our econometric analyses.

Table 4-2 Definitions and summary statistics for variables

Variable	Definition	Obs	mean	SD	min	max
Δ Gross Loans	Gross loans divided by total assets	394	9.29	13.02	-50.32	98.77
Liquidity ratio	liquid assets to deposits and short-term funding calculated in 2011	394	1.34	8.02	0.04	65.75
Loans to deposit ratio	Loans to customer deposits calculated in 2011	388	1.40	3.85	0.47	32.06
Post	Dummy variable equals to 1 for the years after the oil price shock and zero otherwise.	394	0.5	0.50	0	1
Liquidity*Post	The interaction between liquidity (measured by the liquidity ratio) and Post	394	0.67	5.71	0	65.75
Liquidity $_{LTD}$*Post	The interaction between liquidity (measured by the loans to deposits) and Post	388	0.70	2.81	0	32.06
Z-Score	Equity to assets plus return on assets divided by standard deviation of ROA	394	245.37	380.30	2.24	3168.14
Z-Score (ln)	The log transformation of Z-Score	394	4.79	1.22	0.81	8.06
Capital	Equity to total assets	394	0.15	0.08	0.07	0.57
Total assets (millions)		394	25188.66	28587.38	469.68	197718.3
Total assets (ln)	natural logarithm of total assets	394	9.48	1.26	6.15	12.19
ROA	Net income divided by total assets	394	0.02	0.01	-0.04	0.07
NPL	Impaired loans and advances to customers divided by gross loans	394	0.05	0.05	0.0004	0.41
Allowances	Reserves for impaired loans divided by gross loans	394	0.04	0.03	0.0007	0.27
Δ non-oil GDP		394	4.91	2.87	-4.67	14.36
Δ Oil prices		394	-89.45	21.35	-107.27	-48.61
STF (ln)	Total deposits and money market short term funding minus total customer deposits divided by total assets calculated in 2011.	388	-2.69	1.39	-9.90	-0.29
LTF (ln)	The sum of bonds, long-term senior debt, subordinated debt, other funding, derivatives and trading liabilities divided by total assets calculated in 2011.	290	-3.43	1.55	-9.49	-0.85
NII (ln)	Non-interest income divided by net income calculated in 2011.	372	-0.22	1.012	-1.93	3.64
Net worth	Common equity to total assets calculated in 2011.	394	0.16	0.08	0.07	0.53

Notes: this table provides definitions as well as descriptive statistics of the sample. It contains the means, standard deviations, minimum and maximum values for each variable. Data source: Fitch-Connect database and World Economic Outlook database (WEO). Coverage: 2011-2016.

4.3.4 Validity of DID Assumptions

In this chapter, we employ the difference-in-difference estimation (DID) technique to identify the casual effect of the oil price shock on bank lending. As Angrist and Krueger (1999) and Lee (2005) note, the DID strategy is well suited for estimating the effect of sharp changes in the economic environment or changes in government policy. We therefore make use of this method to assess how and to what extent banks with higher liquidity buffers are able to absorb a liquidity shock and be more resilient during such periods.

It is common in the literature of program evaluation or estimating the effect of sharp changes in the economic environment to measure the treatment as a binary variable (see for example Blundell and Dias, 2002; Imbens, 2004). However, the oil price shock is a systemic shock that affected all banks at the same in our sample. The lack of a randomized design where the event is widespread in the oil price shock means that selection into treatment is not random and that the extent of treatment among the treated is not uniform.

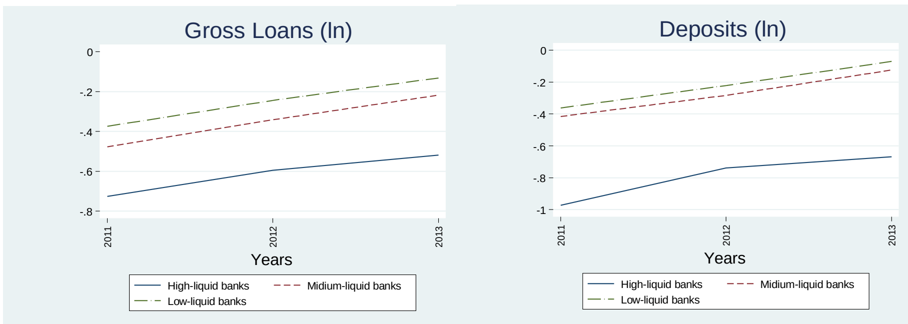
Therefore, we need to identify a variation in the exposure of similar banks to the oil shock. Hence, we evaluate the impact of the oil price shock when the treatment is defined as a continuous variable following Duchin *et al.* (2010) and Dursun-de Neef (2017).[14] We purge our specification of this variation by using (only) the banks' ability to absorb the shock (liquidity levels) measured three years prior to the start of the oil shock, specifically at the end of 2011. Thus, the identification assumption is that three-year-before liquidity levels are not positively correlated with unobserved within-bank changes in lending following the oil price shock. In this way, we can identify a negative shock that is exogenous to the state of the economy. As a result, we can study the causal effect of this shock on banks' lending supply and examine the transmission of this shock to the real economy.

Furthermore, and in line with previous studies (Lemmon and Roberts, 2010; Danisewicz *et al.*, 2015; Park and Horn, 2015; Calderon and Schaeck, 2016), we test for the validity of the "parallel trend" assumption. Parallel trend is a key identifying assumption behind the DID strategy that is, in the absence of a treatment, the observed difference-in-difference estimator must be zero. In other words, changes in the dependent variables are similar for

[14] Alternative approaches for non-binary treatment include Imbens, G.W. (2000) The role of the propensity score in estimating dose-response functions. *Biometrika,* 87 (3), 706-710. for categorical treatments. See also Behrman, J.R., Cheng, Y. and Todd, P.E. (2004) Evaluating preschool programs when length of exposure to the program varies: A nonparametric approach. *The Review of Economics and Statistics,* 86 (1), 108-132.

high-liquid and low-liquid banks during the pre-shock period. We conduct a parallel trend analysis for the dependent variable (growth rate of gross loans) as well as for the deposits between banks based on their liquidity level as of 2011 for the period prior to the oil price shock of 2014.[15] This means that, in the absence of the oil price shock, high-liquid banks would have performed similarly to low-liquid and medium- liquid banks. Figure 4-2, graphically examines the extent to which bank lending evolve over the three years prior to the oil price shock of 2014. The similarity between the movements in various liquidity levels indicate that both low-liquid and high-liquid banks do not behave differently and high-liquid banks do not anticipate any change in their lending levels during the three years prior to the oil price shock.

Figure 4-2 Parallel trends graphic illustration



Notes: This figure depicts the behavior of the dependent variable (growth rate of gross loans) as well as deposits during the years preceding the oil price shock. High-liquid banks are presented by a continuous line, whereas low-and medium- liquid banks are represented by dashed and dotted lines, respectively. Data source: Fitch-Connect database. Coverage: 2011-2013.

In addition, we run an auxiliary regression that provides insights into the predictors of being classified as high/low liquidity banks other than sorting banks in the sample into terciles based on their liquidity ratios. We apply a Logit for binary response by maximum likelihood approach for this test. The aim of this model is to determine which predictor variables are statistically significant. The variables used to fit a logit model explaining bank liquidity are banks' size, capital and profitability. The variable Liquidity takes on two unique values, 0 and 1. The value 0 denotes a low liquid bank and 1 a high liquid bank. The results of the estimations show that these determinants are statistically significant.

15 We sort banks into terciles based on their liquidity levels into low-liquid banks, medium-liquid banks and high-liquid banks.

Next, we obtain predicted influence statistics for the estimation sample. Table 4-3 below provides summary statistics for predictors of being classified as a high/low liquid bank.

Table 4-3 Summary Statistics for predictors of being classified as a high/low liquidity bank

Variable	Obs	mean	SD	min	max
Liquidity	394	0.492	0.5005	0	1
Probability of a positive outcome	394	0.492	0.150	0.168	0.978
Linear prediction of Liquidity	394	-0.0003	0.737	-1.598	3.788

Notes: This table presents a summary statistics of the calculated predictions after running a logit model for a binary response by maximum likelihood estimations. It models the probability of a positive outcome (high liquid banks) using bank size, capital and ROA as regressors. Liquidity is the dependent variable and it takes on two unique values, 0 and 1. The value 0 denotes a low liquid bank and 1 a high liquid bank.

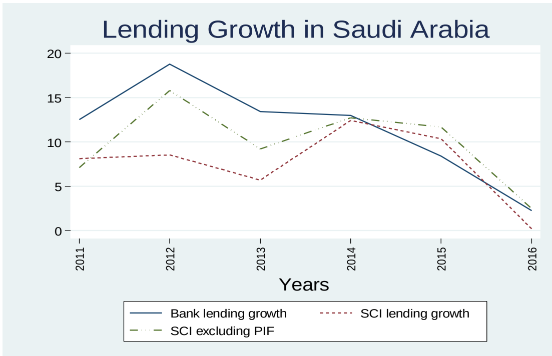
Finally, one of the key issues in determining the effects of a negative shock on banks' loan supply is controlling for changes in the loan demand. The reason behind this concern is that the same economic conditions that lead to negative liquidity shocks can have a direct effect on the demand for loans. To control for this, we employ a difference-in-difference (DID estimation methodology and use year*country fixed effect. First, employing DID controls for trends common to all banks independent of their exposure to the oil price shock. Second, using year*country fixed effects enables us to control for demand/country-specific conditions as they vary over time within a country and differences in the amount of loans should then be related to differences between banks and it accounts for loan demand shifts through time . In addition and as a further check, we collect data on lending by Specialized Credit Institutions (SCIs) in Saudi Arabia as it is considered to account for country-specific characteristics.[16]

SCIs are unlevered non-deposit institutions that rely mainly on budgetary support by the Ministry of Finance. Miyajima (2017) argues that lending by specialized credit institutions may affect bank lending as they lend to some of the same segments as banks do. For instance, outstanding loans of SCIs are classified into five funds that lend to various government and private projects. These funds include: the Saudi Agricultural Development fund, Social Development Fund, Public Investment Fund (PIF), Saudi Industrial Development Fund and the Real Estate Development Fund. Figure 4-3 shows

[16] Data is collected from Saudi Arabian Monetary authority's website (SAMA): http://www.sama.gov.sa/en-US/EconomicReports/Pages/MonthlyStatistics.aspx

trends for the average bank lending growth, SCIs lending growth and SCIs excluding PIF. This figure shows that before the oil price shock of 2014, bank lending is higher than SCIs. However, after the oil price shock, bank lending falls dramatically while on average SCIs remain on the same level in 2015 compared to 2013. This provides further evidence to our hypothesis of a causal supply effect of the oil price shock on bank lending, rather a demand-side effect.

Figure 4-3 Banks vs SCIs lending in Saudi Arabia



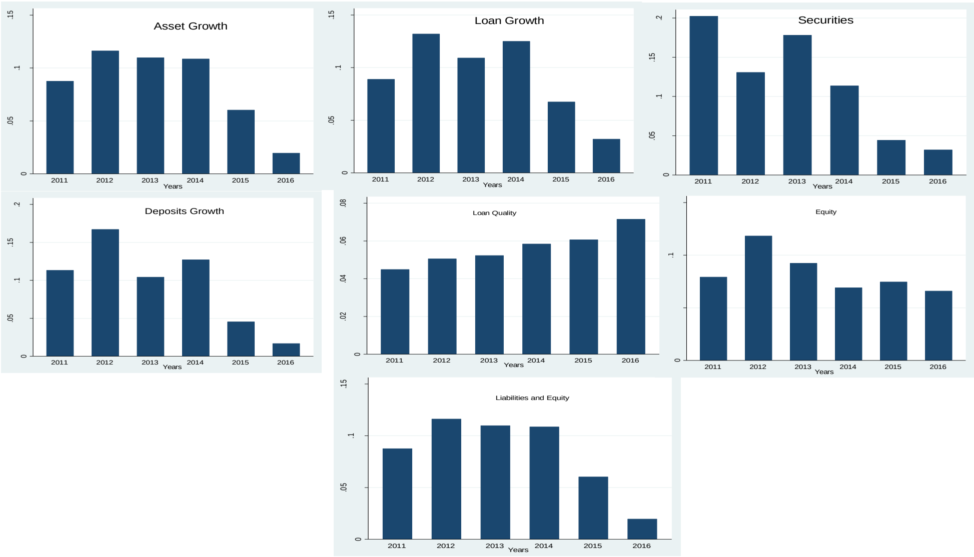
Notes: This figure shows the behavior of bank lending growth presented by a continuous blue line, specialized credit institutions (SCIs) lending growth presented by red dotted line as well as SCIs excluding public investment fund presented by dashed green line. Data source: Fitch-Connect database and Saudi Arabian Monetary Agency (SAMA). Coverage: 2011-2016.

4.4 Results

4.4.1 Stylized Facts

To trace the impact of the oil price shock on GCC banks, we start by analyzing the balance sheet activities before and after the oil price shock. Figure 4-4 presents the behavior of GCC banking sector for the period from 2011 to 2016. Bank-level data shows that the growth in banks' deposits as well as loans slowed down significantly after 2014. The average growth in bank loans declined from 10 percent during 2011-13 to 7.5 percent after 2013. A possible explanation of this deceleration in bank lending may be the tighter bank liquidity conditions brought about by the oil- shock-induced slowdown in domestic deposits, largely as governments and government-related entities have withdrawn deposits from the banking sector. Indeed, during 2014-16, deposits in the sample of banks under consideration grew by less than 6.5 percent on average annually, compared to close to 13 percent in 2011-13. In this environment, bank NPLs are likely to rise as borrowers have increasing difficulties servicing their debts. Loan quality measured as NPLs divided by gross loans supports this argument. Nonetheless, it is important to mention that the GCC banking sector remains healthy and well-capitalized reflected in their equity.

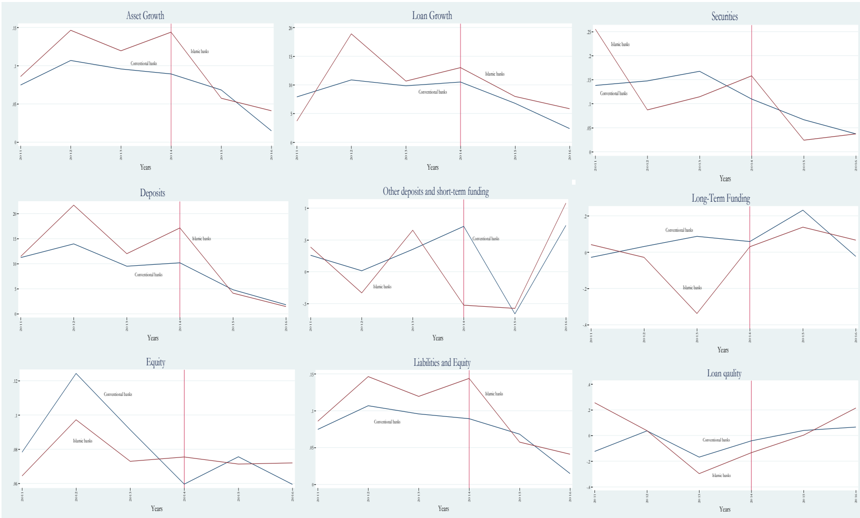
Figure 4-4 Behaviour of GCC Banking Sector



Notes: This graph represents the trend for the dependent variable (growth rate of gross loans) as well as other balance sheet items for conventional and Islamic banks during a six-year window (three years before and three years after the oil price shock. Data source: Fitch-Connect database. Coverage: 2011-2016.

Furthermore, Figure 4-5 segregates our sample and demonstrates the behaviour of conventional and Islamic banks separately. Among the various balance sheet activities, the trends for the averages of total assets, loans and deposits during 2011-2013 of Islamic banks show higher growth compared to conventional banks. However, after the oil price shock of 2014, total assets, loans and deposits of Islamic banks decline dramatically while conventional banks show a steady decline. The recent oil price shock has an adverse impact on bank liquidity. As demand for liquidity has grown faster than supply, banks turned to alternative funding sources. Banks have reacted to lower growth in deposits by shifting to long-term funding (LTF). This increase in the wholesale funding is considered as a means to sustain robust private sector credit growth. However, after 2015, LTF started to decline while short-term funding witnessed a sharp increase for both Islamic and conventional banks.

Figure 4-5 Behaviour of GCC Banking Sector by bank type



Notes: This graph represents the behavior of the balance sheet variables between conventional banks (blue line) and Islamic banks (red line) during a six-year window (three years before and three years after the oil price shock). The vertical line in 2014 represents the oil price shock. The banks included in this time span have growth rate of gross loans data both before and after the oil price shock. Before the oil shock refers to the years from 2011-2013. After the oil shock refers to the years from 2014- 2016. Data source: Fitch-Connect database. Coverage: 2011-2016.

4.4.2 Post-shock Lending and Liquidity: Base Regressions

Table 4-4 presents estimates from the baseline specification described in section 4.3.2 above. Columns 1-3, which do not include controls for credit growth but do include bank fixed effects, country fixed effects and the intercept between year and country fixed effects, establish the basic patterns in the data.

Column 1 shows that annual credit growth as a fraction of assets by the average bank decline by 3.218 percent following the oil price shock, a decline of 34.6 % (3.218 ÷ 9.29) relative to an unconditional mean of 9.29% of assets per year (the mean of Δ Gross Loans). Column 2 of Table 4-4 shows that this decline is substantially greater for banks as the coefficient estimates imply 3.41 percent decline in lending after the oil price shock, and no decline for banks holding 24% of assets in cash and liquid assets indicated by the interaction effects of liquidity and oil price shock on bank lending. In column 3, we measure the treatment variable (Liquidity) using the ratio of loans to deposits (LTD). The results show a decline of lending by 0.21 percentage point. This suggests that banks that fund their illiquid assets with short-term liabilities following the drying-up of market-wide liquidity during the oil price shock were less able to extend credit compared to banks with higher liquidity ratio measured three years prior to oil price shock. In other words, the higher the LTD ratio, the more illiquid a bank is. Therefore, the interaction effect between illiquidity and oil price shock is significantly negative on credit growth.

Columns 4 and 5 of Table 4-4 further control for bank lending using bank-specific characteristics and macroeconomic variables. The estimated coefficients on the "Post" indicator variable as well as the interaction of this variable with liquidity levels remain economically large and statistically significant.

The estimates in column 4 imply that lending declines by 13.16% after the oil price shock. and after interacting this variable with the liquidity ratio, holding 49% of cash and liquid assets eliminates this decline. Additionally, the standard deviation increase in cash and liquid assets mitigates the decline by 1.533 (5.7*0.269) percent, or 11.6% of the decline indicated by the "Post" variable (1.533/13.16). Similarly, column 5 shows that our main explanatory variable remains negative but it becomes significant at 5% confidence level. Compare this with the previous results, the magnitude of this effect increases up to 1.959% (2.81*0.697) from 0.607% (2.81*0.216). These results support the idea that if banks implement higher liquidity buffers, then shocks do not have a negative impact on their loan supply.

Table 4-4 Difference-in-difference regressions: Base Model

	(1) Δ Gross Loans	(2) Δ Gross Loans	(3) Δ Gross Loans	(4) Δ Gross Loans	(5) Δ Gross Loans
Post	-3.218*	-3.412*	-1.668	-13.16**	-12.34**
	(1.23)	(1.24)	(1.10)	(4.50)	(4.55)
Liquidity*Post		0.144***		0.269***	
		(0.020)		(0.076)	
Liquidity $_{LTD}$ *Post			-0.216***		-0.697**
			(0.21)		(0.22)
Size				39.56*	39.95*
				(17.3)	(16.9)
Capital				83.59	76.95
				(66.6)	(70.6)
Z-Score (ln)				-1.313	-1.336
				(0.86)	(0.86)
NPLs				-104.3*	-99.95*
				(43.0)	(38.6)
Allowance				-47.43	-11.02
				(35.5)	(43.4)
ROA				-17.15	0.186
				(172.3)	(164.0)
Bank				-94.66*	118.0**
				(42.9)	(39.6)
Δ Oil Prices				0.423	0.410
				(0.82)	(0.81)
Δ Non-oil GDP				-0.00220	-0.00455
				(0.061)	(0.063)
Constant	6.903***	6.934***	12.01***	-164.4	-379.0*
	(0.61)	(0.61)	(0.54)	(83.2)	(167.0)
Bank FE	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Year*Country	No	No	No	Yes	Yes
Observations	394	394	388	394	388
R-squared	0.292	0.294	0.319	0.542	0.546
Number of Banks	67	67	66	67	66

Notes: This table presents the results of difference-in-difference regressions examining the effect of the oil price shock on bank lending. I estimate $\Delta\ln(y_{i,c,t}) = \alpha_0 + \alpha_1 Post_t + \alpha_2\, Liquidity_i * Post_t + \theta X_i + \gamma_i + \varepsilon_{i,t}$ where the dependent variable $\Delta\ln(y_{i,c,t})$ denotes growth rate of gross loans for bank i in country c at time t. $Post_t$ is a dummy variable equal 1 for all years following the oil price shock, and 0 otherwise. The main explanatory variable is the interaction between $Post_t$ and $Liquidity_i$. The regressions include bank fixed effects, country fixed effects and year*country fixed effect. Standard errors are clustered on bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Data source: Fitch-Connect database and World Economic Outlook database (WEO). Coverage: 2011-2016.

4.4.3 Post-shock Lending and Various Levels of Liquidity

This section focuses on the impact of the oil price shock on three different categories of liquidity. We classify banks into three terciles based on their liquidity levels as of December 2011. Table 4-5 shows that the coefficient on the "Post" indicator variable corresponds to the post-oil shock lending decline in the banking system. For model (2) when controlling for credit growth, the decline becomes statistically significant at 5% confidence. The estimates are comparable in magnitude to those in Table 4-4, ranging from 11% to 13%.

Moreover, it can be observed that the results differ by liquidity level, and our hypothesis- the effect of oil price shock on lending is positively associated with the liquidity level- is confirmed only with high-liquid banks. A standard deviation increase in the interaction between oil shock and high-liquid banks elevate the effect of a 1-percentage point increase in the liquidity ratio by approximately 1.73 percent in a year (9.80*0.177). [17] Furthermore, when we include control variables, the estimate of the interaction of the "Post" indicator variable and high-liquid banks increases to 2.62 percent (9.80*0.267). This finding suggests that the effect of the oil price shock on credit growth is negative for banks, becoming significantly positive only after banks retain sufficient liquid assets. The interaction effect is found to be nonsignificant or negligibly negative for medium- and low-liquidity banks. This indicates that that the relationship between high-liquidity level and credit growth is positive and stronger during the oil price shock, but is negatively affected between low-liquidity level and credit growth. This finding is consistent with those of Cornett *et al.* (2011), Berrospide (2012) and Kim and Sohn (2017).

Overall, Table 4-5, in which we find the strongest effects for high-liquid banks, provides further evidence of a causal effect of the oil shock on bank lending. The results suggest that following external economic shocks, banks with sufficient liquid assets can supply more credit than banks with low-liquidity level or insufficient liquid assets.

[17] The standard deviation of the variable (High Liquidity*Post) is 9.79, which is not reported.

Table 4-5 Difference-in-difference regressions with various levels of liquidity

	(1) Δ Gross Loans	(2) Δ Gross Loans
Post	-3.598	-12.81**
	(4.82)	(4.46)
Low Liquidity*Post	18.92	-8.007
	(12.5)	(15.1)
Medium Liquidity*Post	9.946	2.071
	(7.09)	(9.17)
High Liquidity*Post	0.177***	0.267***
	(0.036)	(0.076)
Size		40.12*
		(17.5)
Capital		83.58
		(65.2)
Z-Score (ln)		-1.330
		(0.88)
NPLs		-108.0*
		(41.4)
Allowance		-42.69
		(33.1)
ROA		-22.30
		(170.8)
Δ Oil Prices		-0.00870
		(0.063)
Δ Non-oil GDP		0.406
		(0.82)
Constant	8.969	-382.4*
	(5.57)	(174.1)
Bank FE	Yes	Yes
Country FE	Yes	Yes
Year*Country	Yes	Yes
Observations	394	394
R-squared	0.404	0.543
Number of Banks	67	67

Notes: This table presents the results of difference-in-difference regressions examining the effect of the oil price shock on bank lending. I estimate $\Delta \ln(y_{i,c,t}) = \alpha_0 + \alpha_1 Post_t + \alpha_2 \sum_{j-1}^{j=3} Liquidity\ level_j * Post_t + \theta X_i + \gamma_i + \varepsilon_{i,t}$ where the dependent variable $\Delta \ln(y_{i,c,t})$ denotes growth rate of gross loans for bank i in country c at time t. $Post_t$ is a dummy variable equal 1 for all years following the oil price shock, and 0 otherwise. $\sum_{j-1}^{j=3} Liquidity\ level_j$ is a continuous treatment variable for each of the following liquidity levels: low liquidity level, medium liquidity level and high liquidity level. The main explanatory variable is the interaction between $Post_t$ and $Liquidity\ level_i$. The regressions include bank fixed effects, country fixed effects and year*country fixed effect. Standard errors are clustered on bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Data source: Fitch-Connect database and World Economic Outlook database (WEO). Coverage: 2011-2016.

4.4.4 Post-shock lending and Banks Response to Various Sources of Funding

In this section, we extend the analysis to explain the possible channels associated with less impact of the oil price shock to bank lending. We are particularly interested in bank net worth, bank funding sources and non-interest income. Outputs in Table 4-6 provide the results of this analysis. Column 1 reports the results of the role of bank capital on supplied lending. As expected well-capitalized banks show positive and higher supply of lending. However, the coefficient for bank capital is insignificant but with the expected positive sign post the oil price shock.

Column 2 shows that the response of bank lending to short-term funding has the expected negative sign and the effect is amplified post the oil price shock. A one-percentage point increase in the short-term funding post the oil price shock causes a 2.07% drop in lending. The result is statistically significant at 5% confidence level and is consistent with the findings of Gambacorta and Marques-Ibanez (2011). Because short-term funding represents a looming reduction in liquidity in times when refinancing is difficult or costly, whereas long-term debt does not, these findings reinforce the interpretation of the main results as a supply effect (Duchin *et al.*, 2010).

In contrast, long-term funding with greater maturity does not have an immediate effect on bank liquidity. Thus to the extent that the oil price shock resulted in a decreased supply or higher costs of debt financing, the result shows post-shock lending declines to be greater for banks with high-short term funding, but no similar affect for long-term funding as expected. Colum 2 and 4 present evidence consistent with these ideas.

Finally in column 3, we have replaced the liquidity ratio with the ratio between non-interest income and net income (NII). The results show that those banks that adopted an unbalanced business model titled towards non-traditional activities were hit most during the oil price shock. However, the results show that the coefficient in fact turns out not to be significant but with the expected sign.

Table 4-6 Difference-in-difference regressions: Banks Response to Various Sources of Funding

	(1) Δ Gross Loans	(2) Δ Gross Loans	(3) Δ Gross Loans	(4) Δ Gross Loans
Post	-10.25**	-17.91***	-12.17*	-12.56
	(3.48)	(4.85)	(5.14)	(7.50)
Funding*Post	4.960	-2.067**	-1.843	-0.167
	(21.0)	(0.68)	(1.44)	(1.11)
Size	27.18*	38.59*	38.59	44.74*
	(12.3)	(17.1)	(23.0)	(19.1)
Capital		82.24	115.4	40.34
		(63.7)	(95.0)	(81.4)
Z-Score (ln)	-1.315	-1.225	-1.258	-1.773
	(0.89)	(0.87)	(0.83)	(1.13)
NPLs	-97.25*	-103.6*	-99.83	-65.10
	(41.2)	(40.2)	(63.7)	(40.1)
Allowance	-49.22	-47.17	-27.94	-66.72
	(38.6)	(38.9)	(46.4)	(73.7)
ROA	13.68	-37.74	191.9	-227.6
	(138.2)	(174.2)	(174.0)	(328.0)
Bank	-65.27*	111.7*	-90.46	-111.0*
	(32.1)	(48.6)	(56.6)	(47.8)
Δ Oil Prices	-0.00366	0.043	0.00607	-0.0294
	(0.062)	(0.065)	(0.067)	(0.072)
Δ Non-oil GDP	0.601	0.508	0.441	0.541
	(0.95)	(0.84)	(0.79)	(0.88)
Constant	-169.9	-258.0	-189.2	-314.4*
	(97.6)	(133.4)	(121.0)	(141.4)
Funding	Capital	STF	NII	LTF
Bank FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Year*Country	Yes	Yes	Yes	Yes
Observations	394	388	372	290
R-squared	0.529	0.549	0.512	0.547
Number of Banks	67	66	63	49

Notes: This This table presents the results of difference-in-difference regressions examining the effect of the oil price shock on bank lending. I estimate $\Delta\ln(y_{i,c,t}) = \alpha_0 + \alpha_1 Post_t + \alpha_2 Funding_i * Post_t + \theta X_i + \gamma_i + \varepsilon_{i,t}$ where the dependent variable $\Delta\ln(y_{i,c,t})$ denotes growth rate of gross loans for bank i in country c at time t. $Post_t$ is a dummy variable equal 1 for all years following the oil price shock, and 0 otherwise. The main explanatory variable is the interaction between $Post_t$ and $Funding_i$. The regressions include bank fixed effects, country fixed effects and year*country fixed effect. Standard errors are clustered on bank level. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Data source: Fitch-Connect database and World Economic Outlook database (WEO). Coverage: 2011-2016.

4.5 Robustness Tests

4.5.1 Regression Analysing Islamic Banks

The first robustness check is focused on the impact of the oil price shock on lending for Islamic banks. we applied model (4), in which we use the difference-in-difference-in-differences technique (DIDID). The results, in Table 4-7 shows that the coefficient for the main interaction variable ($Liquidity_i * Post_t * IslamicB$) is positive and statistically significant at 1% confidence level, respectively. The results give extra support to our hypothesis that more liquid banks (Islamic banks) are able to mitigate the impact of the oil price shock and reinforce the interpretation of our main results as a causal effect.

Table 4-7 Sensitivity tests

	(1) Δ Gross Loans	(2) Δ Gross Loans	(3) Δ Gross Loans
Post	-0.106	-1.377	-15.89**
	(4.62)	(4.90)	(4.82)
Liquidity *Post *IslamicB		0.139***	0.263***
		(0.034)	(0.076)
IslamicB*Post			3.522
			(2.52)
Size			40.74*
			(17.0)
Capital			79.91
			(65.5)
Z-Score			-1.251
			(0.86)
NPLs			-107.3*
			(42.4)
Allowance			-45.11
			(36.0)
ROA			2.251
			(180.8)
Δ Oil Prices			-0.00997
			(0.060)
Δ Non-oil GDP			0.394
			(0.82)
Constant	8.812	8.744	-389.0*
	(5.59)	(5.60)	(169.7)
Bank FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Year*Country	Yes	Yes	Yes
Observations	394	394	394
R-squared	0.399	0.401	0.546
Number of Banks	67	67	67

Notes: This table presents the results of the difference-in-difference-in-differences (DIDID) regressions to examine the effects of the oil price shock for Islamic banks. I estimate $\Delta \ln(y_{i,c,t}) = \alpha_0 + \alpha_1 Post_t + \alpha_2 Liquidity_i * Post_t * IslamicB + \alpha_3 IslamciB_i * Post_t + \theta X_i + \gamma_i + \varepsilon_{i,t}$ where the dependent variable $\Delta \ln(y_{i,c,t})$ denotes growth rate of gross loans for bank i in country c at time t. $Post_t$ is a dummy variable equal 1 for all years following the oil price shock, and 0 otherwise. $IslamicB$ is a dummy variable takes value 1 if the bank is Islamic bank, 0 otherwise. $Liquidity_i$ is a continuous treatment variable measures liquidity levels banks hold three years prior to the shock. The coefficient α_2 represents the DIDID effect of the oil price shock on bank lending for Islamic banks. The regressions include bank fixed effects, country fixed effects and year*country fixed effect. Standard errors are clustered on bank level. $^* p < 0.1$, $^{**} p < 0.05$, $^{***} p < 0.01$. Data source: Fitch-Connect database and World Economic Outlook database (WEO). Coverage: 2011-2016.

4.5.2 Placebo Test

As a second robustness check, we repeat our base specifications for a placebo (i.e., nonexistent) shock occurring in 2011. For this falsification test, we run the analysis for the period from 2008-2013 and measure liquidity ratio in 2008 three years prior to the chosen shock date of 2011. The aim of this analysis is to check whether the oil price shock only affects bank lending. In this way, we expect to obtain non-significant values for our key variable compared to those obtained in the main results. Table 4-8 column 1, shows the outputs for this test. We do not observe a significant negative relation between lending and post-placebo shock, nor a significant positive relation between lending and the interaction between liquidity and post-placebo shock.

4.5.3 Remove the Country Concentration from Our Sample

Next, we remove banks located in a county that is considered in our sample to be with a greater banking system concentration to observe whether our results are bias towards this concentration. Furthermore, there may be some concern that banking system concentration may limit competition and reduce credit growth and that if so, this may confound the interpretation of our results. Table 4-9 panel A shows that among the GCC banking system, Qatar is the most concentrated with a ratio of 77.86 %. Hence, we rerun our econometric model excluding Qatar from our sample. Therefore, we would expect to observe results similar to our main results if we remove the country concentration from our sample. Table 4-8 column 2 displays the outcome of this analysis. The coefficient on the interaction between the "Post" indicator variable and liquidity ratio is still large and highly significant, though slightly smaller in magnitude compared to the main results in Table 4-4.

4.5.4 Remove Saudi Arabia from Our Sample to Check for Loan Demand

In the validity of the DID assumptions discussed above, we provide evidence that the shock is a supply shock by comparing bank lending and lending by SCIs in Saudi Arabia. Given the lack of data on loan demand, and to confirm that my results are robust, we remove banks located in Saudi Arabia to observe whether the results will change. Table 4-8 column 3 displays the outcome of this analysis. The coefficient on the interaction between the "Post" indicator variable and liquidity ratio is still large and highly significant, though slightly smaller in magnitude compared to the main results in Table 4-4.

4.5.5 Other Measures of Liquidity

Furthermore, we investigate the robustness of the results by employing two alternative measures for liquid assets. (1) I determine liquid assets by summing cash and balances due from depository institutions, mandatory reserves, securities and interbank loans and then subtracting pledged securities. (2) liquid assets equalling to cash and balances due from depository institutions, mandatory reserves, government securities, available for sale securities and reverse repurchase agreements (repos). Specifications (4) and (5) in Table 4-8 show the regression results of our main key variable (Liquidity*Post) remain positive and statistically significant at 1% confidence level.

Table 4-8 Sensitivity tests

	(1) (Placebo) Δ Gross Loans	(2) (Excluding Qatar) Δ Gross Loans	(3) (Excluding KSA) Δ Gross Loans	(4) Alternative measures for liquidity Δ Gross Loans	(5) Δ Gross Loans
Post	0.207	-12.71**	-17.40*	-13.25**	-13.25**
	(8.15)	(4.68)	(6.75)	(4.52)	(4.52)
Liquidity*Post	1.648	0.266**	0.259**	0.239***	0.307***
	(2.13)	(0.079)	(0.078)	(0.067)	(0.085)
Size	13.55	38.04*	39.16*	39.60*	39.59*
	(23.3)	(18.4)	(18.8)	(17.3)	(17.3)
Capital	-13.83	84.11	50.55	83.37	83.3
	(90.0)	(69.4)	(67.6)	(66.4)	(66.4)
Z-Score	-2.948**	-1.239	-1.071	-1.296	-1.297
	(1.01)	(1.00)	(0.94)	(0.88)	(0.88)
NPLs	-23.59	-106.1*	-104.6*	-104.8*	-104.6*
	(51.2)	(42.3)	(41.3)	(42.2)	(42.2)
Allowance	-86.41	-45.52	-27.54	-46.52	-46.34
	(70.2)	(36.5)	(34.3)	(36.3)	(36.4)
ROA	414.7***	-28.55	2.493	-17.88	-17.06
	(117.4)	(174.9)	(187.1)	(174.8)	(174.8)
Bank	49.19	70.57	69.85	-107.3**	-107.2**
	(90.8)	(35.5)	(36.6)	(37.5)	(37.5)
Δ Oil-Prices	-0.0692	-0.00734	0.0618	-0.00228	-0.00197
	(0.11)	(0.061)	(0.1)	(0.061)	(0.061)
Δ Non-oil GDP	0.736	0.433	0.531	0.421	0.421
	(0.79)	(0.83)	(0.88)	(0.82)	(0.82)
Constant	-68.88	-432.7	-260.5	-269.4	-269.4
	(195.2)	(218.0)	(144.9)	(135.3)	(135.3)
Bank FE	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Year*Country FE	Yes	Yes	Yes	Yes	Yes
Observations	339	346	323	394	394
R-squared	0.579	0.52	0.532	0.542	0.542
Number of Banks	60	59	55	67	67

Notes: This table presents several specifications for validation purposes. In column 1, Liquidity is measured in 2008 to explain bank-level credit growth for six years [-3, +3] around a placebo shock occurring in 2011. Columns 2 and 3 removes country concentration (Qatar) as well as KSA to check for loan demand, respectively. Finally, columns 4 and 5 presents various measures of liquidity ratio. All regressions include bank fixed effects, country fixed effects and year*country fixed effect. Standard errors are clustered on bank level. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Data source: Fitch-Connect database and World Economic Outlook database (WEO). Coverage: 2008-2013 in model 1 and from 2011-2016 in models 2-5.

Table 4-9 Size of the GCC financial system and sensitivity tests

Panel A: Size of the GCC financial system

Country	TA of the total banking sector $ mil	TA of the three biggest banks in the sample	Concentration for the three biggest banks per country	TA of our sample $ mil	GCC banking sectors' TA	Concentration of our sample
Bahrain	186050.5	84888.8	45.63%	200722	2126322	94.41%
Kuwait	200130.66	150835.02	75.37%			
Oman	77625.8	47606.5	61.33%			
Qatar	349300.11	271952.99	77.86%			
Saudi Arabia	601640.95	270051.11	44.89%			
UAE	711573.94	306877.28	43.13%			

Panel B: High- and low- liquid banks in years prior to the oil price shock in 2014

	High-liquid banks	Low-liquid banks	Difference	t-statistics	P-value
Δ Gross Loans	11.97	8.30	3.68	1.36	0.18

Notes: Panel A of this table shows the concentration of banks in my sample and the concentration of the biggest three banks and the banking sector of the GCC as of December 2016. Data source: Haver and Fitch-Connect database. Whereas Panel B shows differences in credit growth between high-liquid banks and low-liquid banks in years prior to the oil price shock in 2014. Data source: Fitch-Connect database. . $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Coverage: 2011-2013.

4.5.6 Parallel Trends

Finally, as a last robustness check, we re-examine the validity of the parallel trends assumption. A concern about inferences from studies using a treatment-effects framework is whether the data processes generating the high-liquid and low-liquid banks outcomes followed "common or parallel trends" prior to the oil price shock. Differences in the post-treatment period can be ascribed to the treatment when this assumption holds. The outcome variable of our study is the within-bank change in credit supply. Recall, our graphical illustration showed low-liquid and high-liquid banks to have a very similar trend in lending going back three years prior to the shock (See Figure 4-2). In addition to illustrating the evolution of bank behaviour graphically, we conduct t-tests to verify the assumptions of parallel trends. Following Lemmon and Roberts (2010) and (Danisewicz *et al.*, 2015), we examine whether there are significant differences in the yearly growth rate of each variable between the high-liquid and low-liquid banks during each pre-treatment. Table 4-9 Panel B reports the mean yearly change in lending. Note that this assumption does not require identical levels between high-liquid and low-liquid levels, as they are differenced out (Lemmon and Roberts, 2010). The result supports the assumption of parallel trends: the null of equality of means cannot be rejected.

4.6 Conclusion

In this paper, we study the effect of the oil price shock that began in June 2014 on GCC banking. The sharp decline in oil prices represents an unexplored negative shock to the supply of credit by banks. We focus on the period between 2011 and 2016 and examine whether the effect of the oil price shock on lending differs depending upon the liquidity level. This chapter makes an important contribution to the empirical literature by estimating the impact of the recent oil price shock to the GCC countries and focuses on the role of bank liquidity for overall bank credit supply.

We find that bank credit growth declines significantly following the oil price shock, controlling for bank and country fixed effects as well as time-varying measures of credit growth. Using the base specifications, we find that credit growth declines by 34.6% of its unconditional mean following the oil price shock, specifically by 3.218% of assets relative to unconditional mean of 9.29% of assets per year. Consistent with a causal effect of a supply shock, we find that banks holding a higher liquidity level mitigate the impact of the oil price shock on credit growth. This interaction effect is found to be significantly positive for banks in the sample. We estimate that credit growth declines by 13.16% post the oil price shock. A one standard deviation increase in cash and liquid assets mitigates the decline by 1.533% or 11.6% of the decline by banks after the oil price shock.

As a further step, we show that the results differ by liquidity level. Only for high-liquid banks, we find that the effect of oil price shock on credit growth becomes significantly positive after banks retain sufficient liquid assets. Notably, the interaction effect is found to be nonsignificant or negligibly negative for medium- and low-liquid banks. This suggests that the relationship between high-liquidity level and credit growth is positive and stronger during the oil price shock, but is negatively affected between low-liquidity level and credit growth. To address endogeneity concerns, we measure bank liquidity as much as three years prior to the oil price shock and confirm that we do not find similar results following a placebo shock in 2011. We also run several robustness tests and find that the main results hold.

The results also suggest several policy implications. First, we find that a higher liquidity ratio and lower loans to deposits (LTD) have a beneficial impact during a shock in terms of absorbing the liquidity shock. Central banks of the GCC countries could review a more comprehensive set of liquidity risk management indicators in the spirit of the Basel

Committee work on liquidity management, which includes indicators that capture the maturity structure of liabilities so as to ensure the availability of high liquid assets. First, it could be helpful to ease some of the constraints set by the traditional liquidity ratio such as the LTD. The sole reliance on a traditional liquidity ratio can have undesirable effects through the cycle. For example, the need to restore 100 percent LTD ratio is useful when we have an oil price boom and loans grow more quickly but when banks fall under liquidity stress, this can eliminate the impact of liquidity support operations, and have no impact in terms of asset expansion.

Second, the ratio of liquid assets to short term deposits has a significant effect on credit growth. Typically, banks with substantial liquid assets, which can act as a buffer against sudden withdrawals of deposits, would, *ceteris paribus*, tend to lower their lending rate. However, the estimation results suggest that GCC banks' lending conditions, did not, on average reflect this relationship. The shock's impact was lower in banks with more adequate liquidity buffers, suggesting they contributed to soften the magnitude of the shock's impact.

Furthermore, Islamic banks behave differently from conventional banks. This behavioural difference might support the idea that policy actions and regulations should be applied differently according to bank business models. Looking forwards, policy efforts aimed at building or restoring the conditions that helped dampen the negative effects of the 2014 oil price shock are necessary as strengthening the banking regulation, including macroprudential policies has also made the banking sector more resilient to oil shocks.

Chapter 5: Conclusions

5. Conclusions

5.1 Introduction

This final chapter provides overall concluding remarks for each of the three preceding core chapters. In particular, this conclusion not only highlights the individual contributions to the existing literature of each chapter, it also raises the limitations of the chosen analytical methods. Finally, this chapter emphasises the public policy implications of the thesis and suggest areas for future work.

5.2 Chapter 2: Bank Market Power and Liquidity Creation

Chapter 2 offers the first empirical analysis of the link between bank market power and liquidity creation. While previous studies heavily draw upon measures based on Berger and Bouwman (2009) to proxy for liquidity creation, this chapter also uses an indicator related to the new liquidity requirements established under Basel III (the inverse of NSFR). In addition, this chapter uses two measures of market power; the efficiency adjusted Lerner index and the traditional Lerner index. We find that it is important to adjust for profit inefficiency as calculating market power using traditional Lerner index overestimate bank profitability by more than 50%. This chapter additionally presents a methodological advancement in the literature on liquidity creation in that it does not use the widely accepted General Methods of Moments (GMM) estimations but we employ an instrumental variable technique to investigate the effect of bank market power on liquidity creation. To overcome the fact that market power is endogenously determined, we exploit plausibly exogenous variation in bank market power, which is instrumented using three instruments: financial freedom, banking activity restrictions and entry restrictions instead of using the lagged variables in the GMM approach.

Using a dataset consisting of commercial, savings and cooperative banks from 22 European countries over the sampling period 2006-2015, this chapter presents evidence that higher degrees of market power are associated with greater liquidity creation. This finding is robust using numerous alternative samples, business models and adding macroeconomic control variables. The empirical analysis further suggests that market power affects liquidity creation on the asset-side and the liability-side of the balance sheet, but it does not affect liquidity creation off the balance sheet. The empirical analysis further investigates how regulatory interventions during the global financial crisis affect liquidity creation. The results suggest a negative relationship between the combined effect of market power and guarantees and liquidity creation. To this extent, the results provide support for previous research that suggests a negative relationship between liquidity creation and regulatory intervention.

5.3 Chapter 3: The Impact of Liquidity Ratio Requirements on Bank Risk and Return

Motivated by the recent discussions between the first NSFR proposal in 2010 and it revision in October 2014, chapter 3 focuses on analysing the impact of the NSFR on bank risk and return applying the more recent 2014 factors to calculate the NSFR. Importantly, from a methodological viewpoint, this is the first study that employs a Regression Discontinuity Design (RDD) to evaluate the impact of the new liquidity rules on stability and profitability between two groups: banks that meet the NSFR requirements and banks that fail to meet the NSFR requirements. Hence, this chapter stresses an important question on the effectiveness of the new regulation especially during a crisis period.

Drawing upon a dataset that consists of commercial banks only in 28 European countries during the period 2005-2010, the Regression Discontinuity Design (RDD) suggests that banks subject to a binding liquidity requirement enhance the strength and stability of the banking system. However, the excessive liquidity induces risk-taking behaviour resulting in an increase in non-performing loans and a loan loss reserve ratio that offsets the positive impact on stability. Furthermore, we find that banks with high level of liquidity suffer from a decline in their profitability compared to those that did not meet the NSFR. Additionally, this chapter sheds new light on the association of NSFR with differences across bank size. Our research has shown that only small banks are significantly positively affected by tightening the liquidity requirements in terms of stability. Notably, the coefficients of a bank's riskiness of its loan portfolio are found to be weakly significant. A vast array of robustness checks are presented in this chapter: the main model is re-evaluated using a sample prior to the global financial crisis because the treatment did not exist. Additionally, another placebo test at different cutoffs is presented in order to check whether the actual cutoff fits the data better than other nearby cutoffs. Moreover, core results are corroborated when we examine the effect of NSFR requirements on risk and return for banks that received government support and bailouts during the global financial crisis. Similarly, and as a validity test of RDD, we include additional covariates and assume that the potential covariates under treatment and control have equal conditional expectation at the cutoff (i.e. "balanced"). Lastly, a graphical representation of the RDD show that our local linear estimates are robust to alternative bandwidths. In this last analysis, we observe that the RDD for the risk measures are still positive but for profitability measures variables are always negative over the range of bandwidth choices, suggesting that the baseline RDD results using local linear regressions are robust to alternative choices of bandwidths.

5.4 Chapter 4: The Impact of Oil Price Shocks on GCC Banking: Does Liquidity Matter?

Chapter 4 takes a different view of a liquidity shock and examines the role of bank liquidity positions on mitigating the recent oil price shock to the supply of credit by banks. This is due to the following two reasons: First, liquidity positions directly impact upon the crucial role performed by banks in supplying lending to the economy. Second, imposing higher liquidity requirements to the banking system contribute indirectly to overcome liquidity shocks. To further investigate the question of the transmission of oil price shocks to the banking system, this chapter explores how the various financial elements, as relevant components in influencing bank loan supply, affect this transmission.

Using a sample of both conventional and Islamic banks from the six GCC countries between 2011 and 2016, the proposed DID regression estimator compares lending behaviour before and after the oil price shock. To that extent, the results show bank credit growth declines significantly following the oil price shock. However, we find that banks holding higher liquidity level mitigate the impact of the oil price shock on credit growth. Furthermore, the results differ when banks are classified into three different categories of liquidity. Only for high-liquid banks, the effect of the oil price shock on credit growth becomes significantly positive after banks retain sufficient liquid assets. Notably, the interaction effect is found to be nonsignificant or negligibly negative for medium- and low-liquid banks. This result is aligned with the hypothesis that banks with a lower amount of liquidity during the oil price shock are expected to be affected more heavily. Regarding the analysis of whether other funding sources explain the possible channel associated with less impact of the oil price shock to bank lending, this chapter presents mixed results. Expressed more precisely, short-term funding has a significantly negative effect on post-shock changes in lending, while the results for long-term funding, non-interest income and bank net worth do not. Robustness checks corroborate the core results when the main model is run using a subsample of Islamic banks only. Furthermore, a placebo test is conducted for non-existent shock occurring in 2011 instead of 2014. Hence, the main model is re-evaluated using a sample prior to the oil price shock to observe whether the oil price shock impacts differently bank lending. Additionally, the findings are insensitive to removing country concentration from our sample, using alternative measures of liquidity or re-examine the validity of the parallel trends assumption.

5.5 Summary and Public Policy Implications

This thesis offers several important contributions to the literature on bank liquidity. To this end, several different econometric approaches (instrumental variable estimation for panel data, Pooled-OLS model, regression discontinuity design and difference-in-difference) and a set of different samples (European as well as GCC sample) are employed for the purpose of this thesis.

Chapter 2 examines the impact of bank market power on liquidity creation in the euro area. The results show that market power as measured by Lerner indices increases liquidity creation significantly. In addition, this chapter investigate how regulatory interventions during the global financial crisis affect liquidity creation. The results indicate a negative relationship between the combined effect of market power and guarantees and liquidity creation. Throughout Chapter 3 and Chapter 4, robust empirical evidence is found that higher levels of bank liquidity tend to go hand in hand with increased bank stability and credit growth. Specifically, Chapter 3 focuses on European banks and disentangles banks that meet the NSFR requirements from banks that fail to meet the requirements and compare them in terms of achieving higher stability and profitability, whereas Chapter 4 focuses on the negative oil price shock that hit the GCC banking system in 2014. The results indicate that banks with higher levels of liquidity mitigate the impact of the oil price shock on credit growth.

These results give rise to important public policy considerations: First, it is pertinent to note that a robustly positive association between market power and liquidity creation in Chapter 2 supports the argument in the existing literature that under the pressure of intense competition (low market power), banks with extra liquidity will keep it, in order to secure the benefits of their superior hedging strategies. Whereas banks with liquidity needs would do everything to avoid signalling their fragilities. The results offered in this thesis indicate that banks may have been eager to lend in order to restore their own market power and to lock in a larger number of customers whose future liquidity needs constitute future income. This mechanically reduces the optimal share of liquid assets. Through this negative effect, liquidity creation tends to worsen the risk profile of bank asset portfolios.

This shows that liquidity creation, in some circumstances, participate in creating the preconditions for a liquidity crisis. However, bank market power is known to have powerful benefits in terms of accessing to various capital markets. The extent to which the former effect may significantly mitigate the later in welfare terms remains an open question. Consequently, bank regulations under Basel III policy may need to be re-evaluated given the conflicting objectives between sustainable economic growth through liquidity creation and the effectiveness of Basel III policy. Second, the results presented in Chapter 3 have implications for commercial banks, supervisory agencies and bank regulators. The Basel Committee concerned with tightening levels of liquidity requirements and their ability to control liquidity shocks, a reduction of this uncertainty could be brought about through standardisation of securitized products and improvements in the rating system, in order to eliminate information asymmetries. It remains difficult, however, to find the appropriate balance between various conflicting objectives. Product standardisation may come at the expense of financial innovations. By the same token, too stringent liquidity requirements would reduce the return on financial activities and may be circumvented. It may therefore take some time before all lessons of the GFC can appropriately be drawn. Third, inter-bank and financial markets may be insufficient providers of liquidity to banks in trouble. A liquidity requirement is a way to limit the need to use the lender of last resort (LLR) facility. A cost and benefit analysis of the LLR is thus needed to determine the appropriate extent of liquidity regulations. As we have seen, there are two basic motives for regulating banks' liquidity, one being micro-prudential (i.e. limiting individual bank failures), and the other being macro-prudential (i.e. limiting exposures to macroeconomic shocks by banks, under the expectation of government intervention). A simple liquidity ratio seems to be appropriate to achieve the first objective, with the possible qualification that under-capitalized banks could be subject to more stringent requirements. This would be in the spirit of the "prompt corrective action" approach imposed by the FDIC Improvement Act to US supervisors, i.e. the idea of some progressiveness in the restrictions imposed to trouble banks, forcing supervisors to act before it is too late. However, the macro-prudential objective of liquidity regulation seems harder to attain, given in particular the difficulty to predict precisely the liquidity needs of banks during a crisis. Thus, there seems to be a need for a second type of liquidity requirement, based on some indices of exposure to macroeconomic shocks by an individual bank, and intended to limit the need for an ex-post government intervention and liquidity support. These indices should be designed (and adjusted regularly) by the

Banking Supervisors, possibly after using the internal risk model of each bank and different sorts of stress tests. Finally, Chapter 4 points out the beneficial impact of a higher liquidity ratio during a shock in terms of absorbing the liquidity shock. The extra liquidity being held in normal times is encouraged in order to survive difficult times. However, additional liquidity requirements aimed at mitigating macroeconomic shocks could constitute a "waste" of liquidity, given that they would be used only under exceptional circumstances. Thus, what is surly needed now is a reassessment and comprehensive review of what the principles of bank liquidity management should be.

5.6 Limitations

While this thesis presents very strong results and a range of policy implications for regulatory oversight and industrial organisation of banking systems, a number of limitations for the preceding chapters are mentioned in this section.

The literature on the impact of financial regulation, especially regarding liquidity, on bank behaviour is still fairly new. Under Basel III, the two new liquidity indicators are Liquidity Coverage Ratio (LCR) and Net Stable Funding Ratio (NSFR). Due to data restrictions, we focus on NSFR because for the LCR, detailed information on the composition and duration of liquid assets and 30-day liabilities are not available from standard financial statements from the BankScope database. In any case, focusing on NSFR in this thesis cannot provide a complete picture of an institution's liquidity risk profile. This is confirmed by the BCBS when clearly referencing the Sound Principles BCBS (2008) as an important complement to the LCR and NSFR.

In Chapter 2, the results are drawn upon an array of regulatory and institutional variables that are only available as cross-sectional data. Therefore, a note of caution is appropriate when drawing inferences based on the regressions where these variables enter the econometric analyses.

Regarding Chapter 3, the analysis focuses on the effectiveness of the NSFR requirements. Whether or not the empirical evidence presented using RDD will be helpful for regulators to ensure sufficient implementation of liquidity standards remains to be seen. Advanced stress tests are a useful instrument to analyse and understand institutions' vulnerabilities. However, unlike capital for which harmonized stress tests are widespread, practices regarding liquidity stress testing still differ and often liquidity risk is only a small component of stress tests, which are not covered in this chapter.

Chapter 4 raises a concern about the selection of Islamic and conventional banks in our sample. Especially that many conventional banks in the Gulf region are increasingly becoming interested in entering the market of Islamic financial products and operate with an Islamic window. Hence, the selection between Islamic and conventional banks may cause more than just sample bias. To avoid the selection bias, this thesis considers banks to be Islamic banks only if all their activities are Shariah Compliant.

Moreover, Chapter 4 does not consider the NSFR requirement as a proxy for liquidity for the following two reasons: First, the business model for Islamic banks is somehow different from that of conventional banks in terms of their assets-liability structure and product offering. The Islamic Financial Services Board (IFSB) is the standard setting body for the Islamic banking industry. The IFSB endorsed the Basel III regulatory framework after making some adjustments for the difference in the nature of assets and liabilities of Islamic banks. The IFSB issued Guidance Note No. 12, which provides guidelines for the calculation of the NSFR for Islamic banks. Regulatory requirements under the BCBS's framework are based upon the underlying riskiness of banks and are designed to adequately buffer levels of risk. However, this regulatory framework cannot stay efficient and effective if its implementation does not consider the risk-sharing nature of Islamic banks. Second and most importantly, the main difference between the liquidity measures used in Chapter 4 and the liquidity indicator under Basel III accords stems from the liability side of the balance sheet. The liquidity measures used in Chapter 4 consider some liabilities as liquid because they can be withdrawn without penalty (such as deposits). However, a large share of these liquid liabilities is considered as stable in the Basel III liquidity indicator because they are expected to "stay" within the bank, which was not the case during the oil price shock. For the above reasons and due to data restrictions from FitchConnect database on Islamic products based on underlying Islamic financial contracts as well as its limitation to provide detailed data on interest income or what is or is not included in capital, we do not consider the NSFR requirements in Chapter 4.

5.7 Avenues for Future Research

Any comprehensive research tends to give rise to additional questions. Therefore, this section offers a number of valuable avenues for future research.

First, future work is advisable to investigate in more detail the nature of the relationship between bank market power and liquidity creation. While this thesis answers a number of empirical questions, there is wide scope for future work. This thesis does not aim to understand the transmission mechanism by which increased market power contributes to enhanced liquidity creation. The results presented here may be due to increased efficiency and the presence of economies of scale. Future research therefore could analyse the link between bank efficiency, market power and liquidity creation.

Second, another area for future work is the impact of Basel III Pillar 2 frameworks on bank behaviour. If they have not done so already, most bank regulators around the globe will implement Pillar 2 frameworks in the coming few years. In contrast to Pillar 1, which focuses on "one size fits all" minimum requirements, Pillar 2 guidelines aim at enhancing banks' own risk management frameworks. Although there has been a lot of work on issues around governance and compensation, the introduction of Pillar 2 frameworks offer a number of quasi-experiments that could help us understanding the impact of different risk management incentives on banks' risk taking.

Third, Chapter 3 aims to analyse the impact of liquidity regulation on bank behaviour, future research could investigate the interaction of different regulatory requirements and monetary policy as well as their impact on banks' risk shifting.

Finally, Chapter 4 aims to analyse the impact of the 2014 oil price shock on bank lending in the GCC countries. The presented difference-in-difference (DID) estimation suggests that liquidity requirements cause banks' credit growth to increase during a liquidity shock. While most incentives are substituted by liquidity regulation, a bank's disclosure requirements remain important. These reinforcing effects of disclosure and liquidity requirements provide a strong rationale for considering them jointly in the design of regulation.

Appendices

Appendix 2.A: Variable Definitions and Sources

Name	Description	Data Source
A. Measures of Market Power		
Cost of fixed assets	sum of general administrative expenses, depreciation, amortisation, occupancy costs, software costs, operating lease rentals and other operating expenses, divided by fixed assets	BankScope database
Cost of labour	personnel expenses divided by total assets	BankScope database
Cost of borrowed funds	total interest expenses divided by total deposits, money markets and short-term funding	BankScope database
Total securities	Sum of reverse repos and cash collateral, trading securities and FV through income, derivatives, AFS securities, HTM securities, at-equity investments in associates and other securities.	BankScope database
Total loans	Sum of residential mortgage loans, other mortgage loans, other consumer/retail loans, corporate and commercial loans and other loans.	BankScope database
Equity	total common equity	BankScope database
Operating costs	sum of total interest expenses, loan impairment charge, other operating expenses and personnel expenses	BankScope database
Profit before tax	Pre-tax profit	BankScope database
B. Measures of Liquidity Creation		
I.NSFR	Required Stable Funding divided by Available Stable Funding (Basel III)	BankScope database
TLC/ Total assets	measure of liquidity creation based on Berger et al., 2016	BankScope database
LC off-balance sheet / Total assets	measure of liquidity creation based on Berger et al., 2016	BankScope database
LC asset side/ Total assets	measure of liquidity creation based on Berger et al., 2016	BankScope database
LC liability side/ Total assets	measure of liquidity creation based on Berger et al., 2016	BankScope database
C. Bank characteristics		
Size	Total assets in logarithmic form.	BankScope database
Capital	Total equity to total assets	BankScope database
LLP	Loan loss provisions divided by total loans	BankScope database
ROE	Return on equity (%)	BankScope database
Crisis dummy	Dummy variable. It takes value 1 for the years 2008 and 2009 and 0 otherwise.	BankScope database
Commercial	Dummy variable. It takes value 1 for commercial banks and 0 otherwise.	BankScope database
Savings	Dummy variable. It takes value 1 for savings banks and 0 otherwise.	BankScope database
Cooperatives	Dummy variable. It takes value 1 for Cooperative banks and 0 otherwise.	BankScope database
D. Country- level variables		
GDP Growth	Rate of growth of the Gross Domestic Product (real)	World Bank
Inflation	rate of consumer price index	World Bank
E. Instrumental variables		
Banking activity restrictions	the degree to which national regulatory authorities allow banks to engage in the following three fee-based rather than more traditional interest-spread-based activities: Securities activities, insurance activities and real estate activities	Barth et al. (2001) and Barth et al. (2004)
Entry restrictions	The specific legal requirements for obtaining a license to operate as a bank. This variable takes on values between (1) and (8), where higher values indicate lower entry restrictions.	Barth et al. (2001) and Barth et al. (2004)
Banking freedom	An indicator for the openness of a banking system. The index offers data on whether foreign banks are allowed to operate freely, on difficulties faced when establishing banks, and on government influence over credit allocation. The index ranges from 0 to 100 percent, where higher values indicate fewer restrictions.	Heritage foundation.

Appendix 2.B: Classification of bank activities as documented in the Basel III report and construction of I.NSFR as a liquidity creation measure from BankScope and associated ASF and RSF.

Basel Proposal	BankScope Item Structure (Used in NSFR Calculations)	Factors following Distinguin et al. (2013)
Available Stable Funding (ASF)		
Equity & Liabilities		
Total regulatory Capital	Shareholders' Equity	1.00
Secured and unsecured borrowings and liabilities > 1 year	Total long-term funding	1.00
	Senior debt maturing after 1 year	1.00
	Subordinated borrowing	1.00
	Other funding	1.00
Stable deposits < 1 year	Customer deposits- Savings	0.7
	Customer deposits- Term	1.00
Less stable deposits < 1 year	Customer deposits-Current	0.7
Required Stable Funding (RSF)		
Assets		
cash immediately available to meet obligations	Cash and due from banks	0
loans to financial entities < 1 year	Loans and advances to banks	0
Marketable securities ≥ 1 year representing claims on sovereigns, Central Banks, BIS, IMF, EC, non-central government PSEs	Marketable securities and other short-term investments	0
loans to non-financial corporate clients < 1 year	Corporate and commercial loans	1
loans to retail < 1 year	Other consumer/ Retail loans	1
loans to non-financial corporate clients > 1 year	Corporate and commercial loans	0.65
loans to retail > 1 year	Other consumer/ Retail loans	0.85
Residential mortgages of any maturity	Residential mortgage loans	0.65
	other mortgage loans	0.65

Appendix 2.B (Continued)

Basel Proposal	BankScope Item Structure (Used in NSFR Calculations)	Factor October 2014
Other performing loans with risk weights greater than 35% under the Standardised Approach and residual maturities of one year or more	Other loans	0.85
equity securities not issued by financial institutions		
All other assets not included in the above categories	Other earning assets	1.00
	Total assets - total earning assets	1.00
	Investment in property	1.00
	Fixed assets	1.00
	Insurance assets	1.00
	Other assets	1.00
Off-Balance Sheet Items		
Irrevocable and conditionally revocable credit and liquidity facilities to any client	Managed Securitized assets reported off-balance sheet	0.05
	Other off-balance sheet exposure to securitizations	0.05
	Guarantees	0.05
	Acceptances & documentary credits reported off-balance	0.05
	Committed credit lines	0.05
	Other contingent liabilities	0.05

Notess: Source: Basel III, BankScope and authors' calculation.

Appendix 2.C: Classification of bank activities and construction of five liquidity creation measures

Step 1: Classify all bank activities as liquid, semi-liquid, or illiquid based on product category "Cat" and maturity "Mat"
Step 2: Assign weights to the items classified in Step 1.

ASSETS

Illiquid assets (weight= 1/2)	**Semi-liquid assets (weight=0)**	**Liquid assets (weight= -1/2)**
Corporate and commercial loans	Residential mortgage loans	Cash and due from banks
other loans	Other mortgage loans	Trading securities and at future
Investments in property	Other consumer/retail loans	Derivatives
Insurance assets	Loans and advances to banks	Available for sale securities
Fixed assets		Held to maturity securities
		At-equity investments in associates
		Other securities

LIABILITIES PLUS EQUITY

Liquid liabilities(weight= 1/2)	**Semi-liquid liabilities (weight=0)**	**Illiquid liabilities plus equity (weight= -1/2)**
Customer deposits-Current	Customer deposits-Term	Senior debt maturing after 1 year
Customer deposits-Savings	Deposits from banks	Subordinated borrowing
	Repos and cash collateral	Other funding
	Other deposits and short-term borrowing	Other liabilities
	Fair value portion of debt	Total Equity

OFF-BALANCE-SEET ACTIVITIES

Illiquid OBS(weight= 1/2)	**Semi-liquid OBS (weight=0)**	**Liquid OBS (weight= -1/2)**
Acceptances and documentary credits reported	Managed securitized assets reported OBS	
Committed credit lines	Other OBS exposure to securitizations	
Other contingent liabilities	Guarantees	

Appendix 2.C (Continued)

Step 3: Combine bank activities as classified in Step 1 and as weighted in Step 2 to construct our liquidity creation measures

TLC	+1/2 *illiquid assets + 1/2 * liquid liabilities + 1/2 * illiquid OBS	+ 0 * semi-liquid assets + 0* semi-liquid liabilities+ 0 *semi-liquid OBS	-1/2*liquid assets - 1/2 * illiquid liabilities - 1/2 * equity -1/2 * liquid OBS
LC OBS	+1/2 * illiquid OBS	+ 0 *semi-liquid OBS	-1/2 * liquid OBS
LC asset-side	+1/2 *illiquid assets	+ 0 * semi-liquid assets	-1/2*liquid assets
LC liability side	+ 1/2 * liquid liabilities	+ 0* semi-liquid liabilities	-1/2 illiquid liabilities -1/2 * equity

Notes: We follow Berger and Bouwman (2009), Molyneux et al. (2016) and Berger et al. (2016) to classify the on- and off- balance sheet items. Source: BankScope database.

Appendix 3.A: This table compares balance sheet categories as documented in the Basel III report with that from BankScope used for our calculation and associated ASF and SFR factors as NSFR changes since the original proposal in December 2010. Source: Basel III report, BankScope and authors' calculation.

Basel Proposal	BankScope Item Structure (Used in NSFR Calculations)	Factor December 2010	Factor January 2014	Factor October 2014
Available Stable Funding (ASF) **Equity & Liabilities**				
Total regulatory Capital	Shareholders' Equity	1.00	1.00	1.00
Total amount of any preferred stock	Pref. Shares and Hybrid capital accounted as debt	1.00	1.00	1.00
	Pref. Shares and Hybrid capital accounted as equity	1.00	1.00	1.00
Secured and unsecured borrowings and	Total long-term funding	1.00	1.00	1.00
Stable deposits < 1 year	Customer deposits- Savings	0.90	0.95	0.95
	Customer deposits- Term	0.90	0.95	0.95
Less stable deposits < 1 year	Customer deposits-Current	0.80	0.90	0.90
Unsecured wholesale funding < 1 year	Other deposits & short-term borrowings	0.50	0.50	0.50
	Repos and Cash Collateral			
Funding from financial institutions	Deposits from banks	0.00	0.50	0.50
All other liabilities & equity categories not	Total liabilities- Funding liabilities	0.00	0.00	0.00
Required Stable Funding (RSF) **Assets**				
cash immediately available to meet	Cash and due from banks	0.00	0.00	0.00
loans to financial entities < 1 year	Loans and advances to banks	0.00	0.00	0.10
marketable securities ≥ 1 year representing claims on sovereigns, Central Banks, BIS, IMF , EC, non-central government PSEs	Memo: Government Securities -**Level 1**	0.05	0.05	0.05
loans to non-financial corporate clients < 1	Corporate and commercial loans	0.50	0.50	0.50
loans to retail < 1 year	Other consumer/ Retail loans	0.85	0.50	0.50
loans to non-financial corporate clients > 1	Corporate and commercial loans	0.65	0.65	0.65
loans to retail > 1 year	Other consumer/ Retail loans	0.65	0.65	0.65
Residential mortgages of any maturity	Residential mortgage loans	0.65	0.65	0.65
	other mortgage loans	0.65	0.65	0.65
Other performing loans with risk weights greater than 35% under the Standardised Approach and residual maturities of one year or more	Other loans	0.65	0.85	0.85

Appendix 3.A (Continued)

Basel Proposal	BankScope Item Structure (Used in NSFR Calculations)	Factor December 2010	Factor January 2014	Factor October 2014
equity securities not issued by financial institutions	Total Securities - Memo: Government Securities, **Level 2**	0.50	0.50	0.50
All other assets not included in the above	Other earning assets	1.00	1.00	1.00
	Total assets - total earning assets	1.00	1.00	1.00
	Investment in property	1.00	1.00	1.00
	Fixed assets	1.00	1.00	1.00
	Insurance assets	1.00	1.00	1.00
	Goodwill	1.00	1.00	1.00
	Other intangibles	1.00	1.00	1.00
	Deferred tax assets	1.00	1.00	1.00
	Other assets	1.00	1.00	1.00
Off-Balance Sheet Items				
Irrevocable and conditionally revocable credit and liquidity facilities to any client	Managed Securitized assets reported off-balance sheet	0.05	0.05	0.05
	Other off-balance sheet exposure to securitizations	0.05	0.05	0.05
	Guarantees	0.05	0.05	0.05
	Acceptances & documentary credits reported off-balance	0.05	0.05	0.05
	Committed credit lines	0.05	0.05	0.05
	Other contingent liabilities	0.05	0.05	0.05

Appendix 3.B: Comparison between Prior Research in calculating NSFR.

Basel Proposal	**BankScope Item Structure (Used in our NSFR Calculations)**	**King, M. R. (2013)**	**Dietrich et al., (2014)**	**Gobat et al., (2014)**	**Vazquez et al., (2015)**
Available Stable Funding (ASF) **Equity & Liabilities**					
Total regulatory Capital	Shareholders' Equity	✓	✓	✓	✓
Total amount of any preferred stock	Pref. Shares and Hybrid capital accounted as debt		✓		✓
	Pref. Shares and Hybrid capital accounted as equity		✓		✓
Secured and unsecured borrowings and liabilities > 1 year	Total long-term funding	✓	✓	✓	✓
Stable deposits < 1 year	Customer deposits- Savings	✓	✓	✓	✓
	Customer deposits- Term	✓	✓	✓	✓
Less stable deposits < 1 year	Customer deposits-Current	✓	✓	✓	✓
Unsecured wholesale funding < 1 year provided by non-financial corporates	Other deposits & short-term borrowings		✓	✓	✓
	Repos and Cash Collateral		✓		
Funding from financial institutions	Deposits from banks	✓	✓	✓	✓
All other liabilities & equity categories not included above	Total liabilities- Funding liabilities		✓	✓	✓
Required Stable Funding (RSF) **Assets**					
cash immediately available to meet obligations	Cash and due from banks	✓	✓	✓	✓
loans to financial entities < 1 year	Loans and advances to banks	✓	✓	✓	✓
marketable securities ≥ 1 year representing claims on sovereigns, Central Banks, BIS, IMF , EC, non-central government PSEs	Memo: Government Securities -**Level 1**	✓	✓	✓	✓
loans to non-financial corporate clients < 1 year	Corporate and commercial loans	✓	✓	✓	✓
loans to retail < 1 year	Other consumer/ Retail loans	✓	✓	✓	✓

Appendix 3.B (Continued)

Basel Proposal	BankScope Item Structure (Used in our NSFR Calculations)	King, M. R. (2013)	Dietrich et al., (2014)	Gobat et al., (2014)	Vazquez et al., (2015)
loans to non-financial corporate clients > 1 year	Corporate and commercial loans	✓	✓	✓	✓
loans to retail > 1 year	Other consumer/ Retail loans	✓	✓	✓	✓
Residential mortgages of any maturity	Residential mortgage loans	✓	✓	✓	✓
	other mortgage loans	✓	✓	✓	✓
Other performing loans with risk weights greater than 35% under the Standardised	Other loans		✓	✓	✓
equity securities not issued by financial institutions	Total Securities - Memo: Government Securities, **Level 2**	✓	✓	✓	✓
All other assets not included in the above categories	Other earning assets		✓	✓	✓
	Total assets - total earning assets			✓	
	Investment in property		✓		
	Fixed assets				✓
	Insurance assets		✓		
	Goodwill				✓
	Other intangibles				✓
	Deferred tax assets				
	Other assets	✓	✓		✓
Off-Balance Sheet Items					
Irrevocable and conditionally revocable credit and liquidity facilities to any client	Managed Securitized assets reported off-balance sheet			✓	
	Other off-balance sheet exposure to securitizations			✓	
	Guarantees		✓	✓	
	Acceptances & documentary credits reported off-balance sheet		✓	✓	
	Committed credit lines	✓	✓	✓	
	Other contingent liabilities	✓	✓	✓	

Notes: Our contribution is to include all balance sheet items ignored before and apply the newest factors (October 2014).

Appendix 4.A : GCC Banks included in the Econometric Analyses

Country		Bank	Bank type
Bahrain	1	Ahli United Bank BSC	Commercial Bank
	2	Alubaf Arab International Bank	Commercial Bank
	3	Arab Banking Corporation B.S.C.	Commercial Bank
	4	Bahrain Commercial Facilities Company Bsc	Commercial Bank
	5	BBK B.S.C.	Commercial Bank
	6	Future Bank	Commercial Bank
	7	Gulf International Bank B.S.C.	Commercial Bank
	8	National Bank of Bahrain	Commercial Bank
	9	Bahrain Islamic Bank B.S.C.	Islamic Bank
	10	Al-Khaleeji Commercial Bank	Islamic Bank
	11	Al Baraka Banking Group B.S.C.	Islamic Bank
	12	Al Salam Bank-Bahrain B.S.C.	Islamic Bank
	13	BMI Bank B.S.C.	Islamic Bank
	14	Kuwait Finance House B.S.C.	Islamic Bank
Kuwait	15	Ahli United Bank (Kuwait)	Commercial Bank
	16	Al Ahli Bank of Kuwait	Commercial Bank
	17	Commercial Bank of Kuwait	Commercial Bank
	18	Commercial Facilities Company	Commercial Bank
	19	Gulf Bank K.S.C.P.	Commercial Bank
	20	National Bank of Kuwait	Commercial Bank
	21	Kuwait Finance House (K.S.C.P.)	Islamic Bank
	22	Boubyan Bank K.S.C.	Islamic Bank
Oman	23	Ahli Bank S.A.O.G	Commercial Bank
	24	Bank Dhofar S.A.O.G	Commercial Bank
	25	Bank Muscat SAOG	Commercial Bank
	26	Bank Sohar SAOG	Commercial Bank
	27	HSBC Bank Oman SAOG	Commercial Bank
	28	National Bank of Oman SAOG	Commercial Bank
	29	Oman Arab Bank SAOC	Commercial Bank
Qatar	30	Ahli Bank Q.S.C	Commercial Bank
	31	Al Khalij Commercial Bank (al khaliji) P.Q.S.C.	Commercial Bank
	32	Doha Bank	Commercial Bank
	33	Qatar National Bank	Commercial Bank
	34	The Commercial Bank (Q.S.C.)	Commercial Bank
	35	Masraf Al Rayan (Q.S.C.)	Islamic Bank
	36	Qatar International Islamic Bank	Islamic Bank
	37	Qatar Islamic Bank (Q.P.S.C)	Islamic Bank

Saudi Arabia	38	Arab National Bank	Commercial Bank
	39	Banque Saudi Fransi	Commercial Bank
	40	National Commercial Bank (The)	Commercial Bank
	41	Riyad Bank	Commercial Bank
	42	SAMBA Financial Group	Commercial Bank
	43	Saudi British Bank	Commercial Bank
	44	Al Rajhi Bank	Islamic Bank
	45	Alawwal bank	Islamic Bank
	46	Alinma Bank	Islamic Bank
	47	Bank Albilad	Islamic Bank
	48	Bank Aljazira	Islamic Bank
	49	Saudi Investment Bank	Islamic Bank
United Arab Emirates	50	Abu Dhabi Commercial Bank	Commercial Bank
	51	Bank of Sharjah	Commercial Bank
	52	Commercial Bank of Dubai P.S.C.	Commercial Bank
	53	Emirates NBD PJSC	Commercial Bank
	54	Finance House P.J.S.C.	Commercial Bank
	55	First Abu Dhabi Bank PJSC	Commercial Bank
	56	First Gulf Bank P.J.S.C.	Commercial Bank
	57	HSBC Bank Middle East Limited	Commercial Bank
	58	National Bank Of Fujairah PJSC	Commercial Bank
	59	National Bank of Ras Al-Khaimah	Commercial Bank
	60	National Bank Of Umm Al-Qaiwain	Commercial Bank
	61	Union National Bank	Commercial Bank
	62	Abu Dhabi Islamic Bank PJSC	Islamic Bank
	63	Al Hilal Bank PJSC	Islamic Bank
	64	Dubai Islamic Bank PJSC	Islamic Bank
	65	Mashreq bank PSC	Islamic Bank
	66	Noor Bank	Islamic Bank
	67	Sharjah Islamic Bank	Islamic Bank

Notes: This table presents a description of all banks included in the sample by bank type and country. Source: Fitch-Connect database.

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