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THE IMPACT OF BANK REGULATORY CAPITAL ON LIQUIDITY CREATION – A CRITICAL ISSUE FOR EURO AREA POLICY MAKERS

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Resumo

Este estudo avalia o impacto dos requisitos de capital regulamentar na criação de liquidez para a economia, com base numa amostra constituída por bancos da zona Euro entre 2006 e 2012. Com o intuito de estabelecer esta relação, são consideradas três diferentes métricas de criação de liquidez: a métrica de Berger e Bowman (2009), o inverso do Rácio de Financiamento Estável Líquido e a rubrica de crédito bruto. Os resultados desta investigação evidenciam que o aumento do capital regulamentar impacta negativamente na criação de liquidez. Esta relação negativa reforça a ideia de que os decisores políticos devem ponderar as consequências para a economia resultantes da introdução de requisitos regulamentares mais exigentes através de Basileia 3/CRD IV. No entanto, não existe evidência de que a relação entre os requisitos de capital e a criação de liquidez seja diferente em função da dimensão do banco ou durante períodos de crise. Ainda assim, os resultados deste estudo sugerem que, para benefício do crescimento económico, as entidades reguladoras podem estabelecer requisitos de capital e liquidez menos exigentes a bancos de reduzida dimensão, caso estes bancos, de uma forma agregada e a um nível local, não representem uma ameaça sistémica.

Classificações JEL: G21, G28

Palavras-chave: Intermediação Financeira, Regulação Bancária, Requisitos de Fundos Próprios, Criação de Liquidez

Abstract

This study examines the impact of bank regulatory capital on liquidity creation for the economy based on a sample of Euro area banks over the period of 2006-2012. In order to assess this relationship, three different liquidity creation measures are considered: the Berger and Bowman (2009) measure, the inverse of the Net Stable Funding Ratio and the gross loans item. The results of this investigation show that higher regulatory capital negatively impacts liquidity creation. This negative relationship enhances the need for Euro area policy makers to be concerned about the consequences to the economy resulting from more demanding regulatory requirements introduced by the Basel III/CRD IV. However, no evidence is found that the relationship between regulatory capital and liquidity creation differs neither according to bank size nor during a crisis period. Nevertheless, the results of this study suggest that, for the benefit of economic growth, regulatory authorities can at some extent relax on capital and liquidity requirements to small banks as long as these banks, at the aggregate level and on a local basis, do not represent any systemic threat.

JEL Classification: G21, G28

Key Words: Financial Intermediation, Bank Regulation, Bank Regulatory Capital, Liquidity Creation

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Acronyms

ASF – Available Stable Funding

AB – Arellano-Bond

AR - Autoregressive

BB – Berger and Bowman

BCBS – Basel Committee on Banking Supervision

BoE – Bank of England

C&I – Commercial and Industrial

CAGR – Compounded Annual Growth Rate

CRD – Capital Requirements Directive

CRE – Commercial Real Estate

CRR – Capital Requirements Regulation

CYP – Cyprus

DPD – Dynamic Panel Data

EBA – European Banking Authority

ECB – European Central Bank

EONIA - Euro OverNight Index Average

EST – Estonia

EU – European Union

EUR – Euro

FX – Foreign Exchange

GDP – Gross Domestic Product

GMM – Generalized Method of Moments

GTA – Gross Total Assets

IFRS - International Financial Reporting Standards

IRB – Internal-Ratings Based

L/T – Long-term

LC – Liquidity Creation

LCR – Liquidity Coverage Ratio

LIBOR – London InterBank Offered Rate

LM – Lagrange Multiplier

LMI – Liquidity Mismatch Index

LN – Natural Logarithm

LT – Liquidity Transformation

LTCM – Long-Term Capital Management

LVA – Latvia

MLT – Malta

MM – Money Market

NSFR – Net Stable Funding Ratio

PCSE – Panel Corrected Standard Errors

PSE – Public Sector Entities

QAT – Qualitative Asset Transformation

ROA – Return on Assets

ROE – Return on Equity

RRE – Residential Real Estate

RSF – Required Stable Funding

RWA – Risk-Weighted Assets

S/T – Short-term

SIFI – Systemically Important Financial Institution

SME – Small and Medium Enterprises

SNL – SNL Financial Database

SVK – Slovakia

SVN – Slovenia

USD – US Dollars

VIF – Variance Inflation Factor

1. Introduction

One of the main reasons why banks are useful to any economy is because they create liquidity by holding illiquid long-term assets that are funded by liquid short-term liabilities. The determinants of this liquidity creation represent a central topic in banking research and an important source of concern for policy makers. In this regard, bank regulatory capital assumes superior importance, especially during times of increased capital requirements as those we have experienced with the introduction of the Basel II/CRD III framework and most recently with Basel III/CRD IV.

The existing theoretical literature is unanimous when claiming a relationship between bank capital and liquidity creation. However, there is still no consensus on whether this relationship is positive or negative. On the one hand, some authors claim that bank capital "crowds-out" deposits (e.g., Gorton and Winton, 2000) and restricts financial fragility that is needed for liquidity creation (e.g., Diamond and Rajan, 2000). This stream of literature is usually known as the "financial fragility-crowding out" hypothesis. On the other hand, the "risk absorption" hypothesis is supported by a few authors who argue that higher capital enhances the banks' ability to create liquidity as it allows absorbing greater risk (e.g., Allen and Gale, 2003; and Coval and Thakor, 2005).

Although a few existing studies shed light on the determinants of liquidity creation and specifically on its relation with bank capital, this investigation tries to give deeper empirical insights on the impact of regulatory capital on liquidity creation in the Euro area. Focus is also given to the undesirable effect that increased bank capital and liquidity requirements may have in the economy. To address these issues, three hypotheses are formulated: (i) Do higher capital requirements impact liquidity creation in the Euro area? (ii) Does the relationship between capital requirements and liquidity creation differ by size? and (iii) Does the relationship between capital requirements and liquidity creation differ during crises?

To measure liquidity creation, three different measures are considered here. First, we construct a proxy for the BB-measure developed by Berger and Bowman (2009). To build this proxy, bank assets, liabilities, equity and off-balance sheet items are classified by category as liquid, semiliquid and illiquid. Second, we construct a proxy for the Net Stable Funding Ratio, a long-term liquidity requirement introduced by Basel III, and its inverse is assumed to represent liquidity creation. Third, for the sake of parsimony and in order to account explicitly to the impact of regulatory capital on credit availability, we consider gross loans as a simple measure of liquidity creation.

A first general conclusion to be drawn from our study is that banks have in fact increased their regulatory capital during the period of 2006-2012, in accordance with the tightening of capital requirements.

Although statistically significance is not obtained for all measures of liquidity creation, the main results show that banks create less liquidity when regulatory capital increases. Therefore, there is empirical evidence that higher capital requirements negatively impact liquidity creation, which is in line with the "financial fragility-crowding out" hypothesis. Based on the BB-measure, the results show that an increase of 1% in the regulatory capital ratio yields a reduction on liquidity creation which represents 0.2% of the bank's gross total assets.

As stressed by Horváth, Seidler and Weill (2012), there is in fact a trade-off between the benefits of financial stability arising from higher capital requirements and the costs of hampered liquidity creation to the economy. Therefore, the results of our study contribute to the debate on the interaction between capital requirements, liquidity requirements and liquidity creation. In fact, sufficient reasons are given to believe that policy makers need to carefully counterbalance regulatory measures in order to avoid contributing to a deeper deterioration of the macroeconomic environment.

Unlike other authors that suggest a different behavior for large and small banks, we find empirical evidence that for both subgroups the relationship between regulatory capital and liquidity creation is negative and significant. In addition, no evidence is found that this relationship is different during turmoil periods. Therefore, no support is given to the idea that Euro area policy makers should put in place different regulatory capital measures neither according to bank size nor during a crisis period.

However, the negative and significant coefficient that is found for both large and small banks is sufficient to draw some conclusions. If for large banks tight capital and liquidity requirements are crucial to ensure financial stability and avoid systemic events, for small banks, an approach where less demanding buffers are required can be valid. In fact, to support an alternative approach for small banks, it is worth noting that for these banks the coefficient of lagged regulatory capital is highly significant when compared to large banks. Therefore, our findings may suggest that, for the benefit of economic growth, regulatory authorities can at some extent relax on capital and liquidity requirements as long as these small banks, at the aggregate level and on a local basis, do not represent any systemic threat.

The answer to the questions raised in this investigation requires an overview on the existing literature related to the *raison d'être* of banks and to financial stability concerns that lead regulatory authorities to regulate bank capital and impose minimum capital levels. According to Bryant (1980) and Diamond and Dybvig (1983), banks are useful as liquidity providers since they provide depositors with liquidity insurance against idiosyncratic shocks that affect their consumption needs. In turn, Diamond (1984) suggests that banks provide monitoring services and help decreasing asymmetric information between investors and firms. Banks also provide maturity transformation, a process whereby longer-term assets are financed by shorter-term liabilities and hence liquidity creation is facilitated (Bhattacharya and Thakor, 1993). The existing literature advocate that the agency problems (Jeckson and Meckling, 1976) and the risk of a systemic crisis (Santos, 2001) are the main reasons why banks need to comply with minimum capital requirements.

Aiming at providing the necessary insights regarding the variables under analysis, this study also includes an overview on the evolution of bank capital and liquidity regulation, where focus is primarily given upon the Basel III/CRD IV rules which are at present mandatory for Euro area banks. In this respect, besides the enhancement of minimum capital requirements to at least 10.5% of risk-weighted assets, it is worth highlighting the introduction of new liquidity standards: the Liquidity Coverage Ratio and the Net Stable Funding Ratio.

The consideration of regulatory capital measured according to the capital standards applicable during the period analyzed is also a contribution to the existing investigation, since most of the empirical studies in this field simplify the analysis with equity ratio.

This study requires market data to select a set of control variables and a detailed breakdown of accounting data which are core instruments to build the liquidity creation measures. The Bankscope database is the main source used, especially due to its micro-level information of banks. Our sample includes the 2006-2012 period and considers Euro area banks that create liquidity. The recent global financial crisis period is intentionally included in order to test whether a structural break changes the relationship between regulatory capital and liquidity creation.

In order to assess the causal relationship advocated by the aforementioned hypotheses formulated in this study, a Panel Corrected Standard Errors regression that controls for both time and bank fixed effects is conducted. The robustness of the results are confirmed through a dynamic panel model regression that strongly controls for potential endogeneity issues.

This Dissertation is structured as follows. Section 2 reviews existing literature on financial intermediation, bank capital regulation, liquidity regulation and the relationship between bank capital and liquidity creation. Section 3 formulates the hypotheses under analysis. Section 4 describes the data and the measures of liquidity creation, while Section 5 explains the regression framework. Results and robustness checks are presented in Section 6 and 7. Finally, Section 8 concludes.

2. Capital and Liquidity Creation: an important relation for policy makers

2.1. The theory of financial intermediation and the *raison d'être* of banks

In traditional models of financial equilibrium, based in the classical concept of perfect market introduced by Marshall (1961) and Walras (1954), financial intermediaries are useless as long as the market is frictionless, i.e. without imperfections. In such scenario, savers and investors can find each other directly at optimal prices and without information, transaction and bankruptcy costs. This concept leads us to an Arrow-Debreu (1954) world, where markets are perfect and complete, which means that in order to trade against readily available financial instruments, savers and investors find each other directly due to the mutual knowledge about each other preferences.[1] The Arrow-Debreu world is based on an equilibrium model where markets are cleared by price adjustment, through arbitrage, at each moment in time.[2] According to Allen and Gale (2004), in this world, "there is a complete set of Arrow securities, one for each aggregate state", and contracts can be complete (incentive-efficient, where complete contingent contracts are issued) or incomplete (constrained-efficient, where incomplete contracts, like deposits, are issued). Therefore, most of the literature on financial intermediation argues that financial intermediaries may become valuable only in the presence of frictions such as transaction costs and asymmetric information, which may prevent firms from issuing claims up to the full value of their expected returns and force them to hold liquid reserves to meet future financing needs.

According to Gurley and Shaw (1960), authors that contributed for earlier banking theories, banks are valuable because they provide services of divisibility and risk transformation, when converting securities issued by firms into deposits at lower costs than investors would achieve by their own, hence reducing transaction costs.

In turn, Santomero (1984), in his review of the earlier theories of financial intermediation, identifies three streams of literature that answer the question "*Why do banks exist?*".

[1] The concept of a complete market implies that each possible future state of the world is fully covered by a state contingent claim, usually named as "Arrow-Debreu security".

[2] According to Scholtens and Wensveen (2003), optimality, arbitrage and equilibrium are the three pillars that are at the basis of the modern theory of finance. Also based in this perfect and complete world, Freixas and Rochet (1997) argue that borrowers and lenders interact directly through the market and banks have no role in such a world.

First, regarding the function of banks as asset transformers, Klein (1973), Benston and Smith (1976) argue that financial intermediaries are able to transform large-denomination financial assets into smaller units, providing therefore divisibility services and a minimization of transaction costs.[3] Previously, Gurley and Shaw (1960) had already argued that banks are important because they benefit from economies of scale and then reduce the costs *vis-à-vis* a direct trading between lenders and borrowers. In fact, the absence of banks would create a very inefficient market, since the number of contracts in the economy would rather need to be equal to the number of lenders multiplied by the number of borrowers. Also regarding the function of banks as asset transformers, Leland and Pyle (1977) suggested that financial intermediaries can be viewed as a natural response to information asymmetries that exist between lenders and borrowers when financing an investment. Since moral hazard precludes the direct transfer of information between counterparties, lenders are not able to extract, by themselves and at a feasible cost, the true characteristics of borrowers. In a similar fashion as Leland and Pyle (1977), Campbell and Kracaw (1980) argue that, by holding assets of a specific firm about which they have special knowledge, financial intermediaries signal the value of the underlying assets and provide a useful service in the economy.

Second, regarding the role of the bank's liabilities, Santomero (1984) identifies a stream of literature that enhances the central role played by the banks' demand deposits as a medium of exchange. In this field, Fama (1980) had already mentioned, as an example, the ease of money transfer between accounts as an important factor for the evolution of the banking system's monopoly position.

Third, regarding the two-sided nature of banks, Santomero (1984) cites Pyle (1971) as the most quoted reference with its diversification argument, where banks are encouraged to transform deposits into loans. This theory defines banks as investors who hold a long position in securities that yield a positive expected excess return and a short position in securities that yield a negative expected return under the assumption that both returns are positively correlated. According to Sealey (1980), the possibility of engaging in risky arbitrage across markets that have different interest rates allows banks to achieve a positive expected spread across markets, therefore encouraging

[3] Transaction costs encompass exchange or monetary transaction costs (Tobin, 1963; Towey, 1974; Fischer, 1983), search costs, monitoring costs and auditing costs (Benston and Smith, 1976).

intermediation activity. Later, Hellwig (1991) also emphasize the role of financial intermediaries as providers of diversification opportunities.

Somehow grounded in the early theory of financial intermediation, Scholtens and Wensveen (2003) highlight three lines of reasoning under modern theories of intermediation: information asymmetry problems, transaction costs and regulatory factors.

The idea behind the first line of reasoning does not differ considerably from what was mentioned earlier: informational asymmetries generate market imperfections, which are usually followed by specific forms of transaction costs, and financial intermediaries appear to overcome, at least partially, these transaction costs.

The transaction costs approach, emphasized, for example, by Benston and Smith (1976), Campbell and Kracaw (1980) and Fama (1980), does not contradict the assumption of complete markets and sets the existence of financial intermediaries as exogenous. Additionally, this approach is based on nonconvexities in transaction technologies which arise in the presence of fixed costs, and allows financial intermediaries to act as coalitions of individual lenders or borrowers who exploit economies of scale or scope.

The third argument highlighted by Scholtens and Wensveen (2003) is based on the theories of Guttentag and Linsay (1968), Fama (1980), Mankiw (1986) and Merton (1995), where banks are valuable due to their importance for the regulation of money production and for financing the economy.

Modern theories of intermediation introduce new arguments that aim at explaining the existence of financial intermediaries, from which emerge the provision of liquidity services, the provision of monitoring services and the production of information for resale.

As shown in Table 1, Bhattacharya and Thakor (1993) separate the role of banks into two main categories: brokerage services and qualitative asset transformation (QAT).[4]

[4] Scholtens and Wensveen (2003) define QAT as the transformation of deposits into loans, a service that allows banks to provide liquidity and diversification opportunities.

Table 1 - Roles of banks according to Bhattacharya and Thakor (1993)

Brokerage Services	
	Transaction Services (e.g., check-writing, buying/selling securities and safekeeping
	Financial Advice (e.g., advice on where to invest, portfolio management)
	Screening Certification (e.g., bond ratings)
	Origination (e.g., lending operations to borrowers)
	Issuance (e.g., taking a security offering to market)
	Miscellaneous (e.g., trust activities)

Qualitative Asset Transformation (QAT)	
	Term to Maturity (e.g., banks financing assets with longer maturity than liabilities)
	Divisibility (e.g., mutual fund holding assets with larger unit size than its liabilities
	Liquidity (e.g., bank funding illiquid loans with liquid liabilities)
	Credit Risk (e.g., bank monitoring a borrower to reduce default risk)

Source: Bhattacharya and Thakor (1993)

Given its importance for this study, the role of banks as providers of liquidity requires further considerations.

According to Bryant (1980) and Diamond and Dybvig (1983), in the liability side of the balance sheet, banks are useful as liquidity providers because they provide depositors with liquidity insurance against idiosyncratic shocks that affect their consumption needs. Banks are allowed to provide a better risk sharing among people with a different pattern of consumption needs by issuing claims that are riskless and demandable (liquid deposits that can be redeemed for a fixed value at any time) and by underwriting credit (illiquid assets) based on costly information about opaque borrowers. The role of banks as liquidity providers arises from the market friction of information asymmetry, since the idiosyncratic shock that affects an agent's consumption needs is not publicly observable.[5]

Accordingly, Holmstrom and Tirole (1998) and Kashyap, Rajan and Stein (2002) suggest that banks also create off-balance sheet liquidity by underwriting loan commitments and similar claims to liquid funds, contingent securities which are able to fund future liquidity needs. In their models, intermediaries contribute to an optimal allocation by redistributing excess liquidity to firms with liquidity needs, acting like "liquidity pools" and avoiding unnecessary accumulation of liquidity in firms without liquidity needs during the interim period of the claim.

[5] Although deposit contracts may provide an ex-ante Pareto-superior allocation when preferences for the timing of consumption are subject to random individual shocks, Diamond and Dybvig (1983) argue that it generates "multiple equilibria". In order to provide liquidity services, the liquidation value of banks' assets should be lower than the value of liquid deposits and, additionally, an efficient risk sharing is achieved only if confidence is maintained, that is, if a panic among agents does not occur. Otherwise, agents would withdraw their money precipitating a bank run as one of two possible equilibria.

In turn, the asset side of the balance sheet is explained by Diamond (1984) based on the banks' function as providers of monitoring services. Banks can play an important role in decreasing the asymmetric information between investors and firms due to their comparative advantage in monitoring borrowers, where multiple interactions with the same customer allows them to obtain customer-specific information and provide services of delegated monitoring. This service requires economies of scale in monitoring, small capacity of investors to develop this task and low costs of delegation, where the costs of monitoring the bank should not exceed the surplus gained from exploiting economies of scale in monitoring investment projects.

However, it is important to highlight that the benefits arising from services provided by banks are not originated solely from their assets and liabilities in isolation. The usefulness of both sides of banks' balance sheet is achieved through maturity transformation, a process whereby longer-term assets are financed by shorter-term liabilities. In fact, even though it involves bearing interest rate risk, maturity transformation facilitates liquidity creation. According to Calomiris, Kahn, and Krasa (1991), if deposits have a lower duration than loans, their availability and pricing are contingent on the banks' evaluation of their loan portfolio quality, enhancing screening and monitoring incentives. Therefore, maturity mismatching enforces a market discipline on the bank.

Kashyap et al. (2002) refute the so-called "narrow banking" theory by concluding that, as long as liquidity demands from borrowers is not highly correlated with liquidity demands from depositors, synergies between loan commitments and deposits more than offset the costs inherent to commercial banks.[6] This finding is extended by Gatev, Schuermann and Strahan (2006), which provide empirical evidence that, during crisis or liquidity shocks, banks have a comparative advantage in hedging liquidity risk. Actually, although during crisis banks act as "liquidity providers of last resort" leading to an increase of the systematic demand for funds, investors, concurrently, tend to move funds from the capital market towards the bank, implying a negative correlation between liquidity demands from borrowers and from depositors.

[6] The "narrow banking" is a theory which suggests that economic efficiency can be obtained through a system that separates the functions of deposit-taking and lending. Kashyap et al. (2002) identify the burden-sharing of holding reserves of liquid assets on the balance sheet as a possible synergy between loan commitments and deposits, whereas agency problems, regulation, supervision, capital requirements and reserve requirements are described as costs inherent to commercial banks.

Nevertheless, Allen and Santomero (1998) suggest that the literature has given too much emphasis on the role of financial intermediaries as reducers of market imperfections. Such perspective is supported on the reduction of transaction costs and asymmetric information driven either by the increase in competition and by the technological revolution. In their view, intermediaries play today an important role as facilitators of risk transfer and in dealing with the increasing complexity in financial markets and instruments traded. The sharp growth of financial markets and the increase of financial innovation are linked to a greater use of these instruments by banks both as intermediaries and as proprietary traders.[7]

Even though the reasons advanced by earlier and modern theories of financial intermediaries for the existence of banks are different, two conclusions are virtually consensual: banks are indeed useful and play a critical role in the economy as creators of liquidity by underwriting loans and issuing deposits. Considering that this function leaves banks vulnerable to runs, the response given by regulators to avoid crises is an important topic to discuss. As explored in Section 2.2., there is still no consensus in the literature on whether bank capital need to be regulated.

2.2. The need for bank capital regulation

Santos (2001) summarizes the need for banks to be regulated into two mains arguments: the risk of a systemic crisis and the inability of depositors to monitor banks.

According to Bhattacharya and Thakor (1993), a systemic crisis is an externality resulting from the possibility that the release of information regarding the failure of some banks may create a destructive "panic run" on solvent (but illiquid) banks, triggered by uninsured creditors which are not sure whether the shock, idiosyncratic or more widespread, may affect their banks. In fact, the foundations of this systemic risk are based on the role of banks as liquidity providers, since, as mentioned earlier, demandable debt (deposits) allows intermediaries to provide liquidity insurance against idiosyncratic shocks.

[7] The authors give the following examples of financial innovation: securitization (such as mortgage-backed securities) and derivatives (such as swaps and complex options).

In fact, a bank run can occur even without the release of adverse information about the bank's assets. Diamond and Rajan (2000) highlight that a sound bank can be forced into bankruptcy due to the sequential servicing constraint (also known as "first come, first served" rule) implicit in demand deposits, where each depositor can anticipate the withdrawal only by seizing cash and forcing disintermediation.

Given the asymmetric information regarding bank's assets, the aggregate uncertainty avoids the interbank market to provide depositors with fully liquidity insurance, which, according to Jacklin and Bhattacharya (1988), exposes banks to an additional source of runs. Nevertheless, a full insurance of a bank run is impossible to achieve, given that it would require banks to keep all deposits as cash in vault (100% reserve banking), which would not permit them to proceed with their valuable role as liquidity creators. Bearing this in mind, and given that social costs associated with a systemic crisis are high, bank regulators have been interfering in the free functioning of markets with the introduction of mechanisms, such as deposit insurance, in order to insure banks against liquidity shocks.

The second argument suggested by Santos (2001) is built on the inability of depositors to monitor banks and is based on the contributions of Dewatripont and Tirole (1993a, 1993b). Considering that banks are subject to moral hazard and to adverse selection problems, investors should monitor banks' activities. However, since depositors are usually unsophisticated and have no access to information needed to employ efficient monitoring, regulators intervene in this domain as representatives of depositors.

In order to reduce the distortions caused by the "bad equilibrium" of deposit contracts, Bhattacharya and Thakor (1993) suggest both the introduction of a lender of last resort facility, where governmental authorities commit themselves to intervene in case of distress, and a deposit insurance scheme, where the provider of deposit insurance offer a guarantee that depositors are not subject to loss.[8]

Another stream of literature has found agency problems as one of the main reasons why banks need to be regulated. Jensen and Meckling (1976) introduced the concept of

[8] The introduction of a deposit insurance scheme was first introduced by Diamond and Dybvig (1983) and aims at avoiding panic runs, albeit it does not insure banks against day-to-day routine deposit withdrawals. Unfairly priced deposit insurance gives banks an incentive to increase risk, which, given the risk of contagion to other players in the financial system, has been one of the main reasons why bank capital needs to be regulated. See Santos (2001) for further details.

agency problems between shareholders and managers, where private control benefits may distort managers' decisions, and between shareholders and bondholders, where managers acting on behalf of shareholders have an incentive to make risky investment decisions, especially when capital is low. In order to control for an excessive risk taking triggered by this moral hazard problem and by the appetite for large return, bank regulators use mainly two mechanisms: capital requirements and regulatory monitoring.

As suggested by Berger, Herring and Szego (1995), regulators require capital for protecting themselves against the costs associated with financial distress, agency problems and decreased market discipline inherent to safety net mechanisms, reasons which are very similar to those of uninsured creditors when requiring economic capital. According to Furlong and Keeley (1989) and Repullo (2004), the requirement of higher capital levels imply higher losses for the bank's shareholders in case of default, and hence reduce incentives to adopt a risky behavior.

Nonetheless, some authors argue that higher capital requirements may also encourage risk taking given the reduction of the present value of future earnings. For example, Koehn and Santomero (1980) conclude that, under the assumption that bankers are risk-averse (as a proxy for the incompleteness of markets), the introduction of a flat capital requirement enables to restrict the risk-return frontier of banks, forcing them to deleverage and change their portfolio composition. However, this flat capital requirement may have an adverse effect, since it may lead banks to move towards a riskier portfolio in order to compensate the loss in utility from the deleveraging. Following the same reasoning, Rochet (1992) suggests that, even with a risk-based capital requirement, risk aversion may be dominated by the convexity of preferences due to limited liability and undercapitalized banks will still adopt a risky profile.

However, as argued by Diamond and Rajan (2000), optimality can be achieved if a bank issues a softer and long-term claim (capital) that has not embedded the "first-come-first-served" rule and can be renegotiated in bad times, hence creating a buffer against shocks to asset values. In fact, given that the bank cannot write state contingent deposit contracts (idiosyncratic shocks cannot be written into contracts), the issuance of capital works as an indirect hedge against uncertainty. These authors identify three effects of bank capital: first, on bank safety; second, on the bank's ability to refinance at low cost; and third, on the bank's ability to extract repayment from borrowers.

Indeed, mainly due to the recent turmoil, the standard regulatory response has been to tighten capital requirements, since higher capital implies higher losses for the banks' shareholders in case of default, and hence lower incentives to take on excessive risk. Therefore, the main reason why banks hold capital is to absorb risk, of which we highlight credit risk, the risk of liquidity crunches and the risk of suffering a bank run.

Although the reasons set out above lead us to connect the need for banks to hold capital with their role as risk transformers, recent theories suggest that capital may also influence bank's capability to engage in liquidity creation. In fact, Riccetti, Russo and Mauro (2013) show that a too tight regulation may harm the economy because it leads to a reduction in credit availability, albeit their simulation results support the introduction of a capital conservation buffer. This link between bank capital and liquidity creation will be discussed in more detail in Section 2.5.

2.3. Evolution of bank capital requirements

Given the importance of regulating bank capital, international authorities have seen a need to develop rules that ensure the preservation of sufficient levels of capital. Along with this, during the 1980s, following an increased unfair competition, international efforts have been employed in order to achieve a harmonization of capital standards and a strengthening of the soundness and stability of the banking system. The international convergence of bank capital regulation was achieved through the adoption of the Basel Capital Accord (known as Basel I), a framework on capital adequacy signed by G-10 countries in 1988 following the publication of the Basel Committee on Banking Supervision's proposal of 1987.[9]

The agreed framework included a set of principles for the measurement and assessment of capital in relation to credit risk, providing the establishment of minimum levels of risk-based capital for internationally active banks. The target standard ratio of capital to risk-weighted assets was initially settled at 8%, of which core capital instruments (Tier 1 capital) should be at least 4%. The main advantage of this framework was the

[9] The Basel Committee on Banking Supervision provides a forum for regular cooperation on banking supervisory matters and its objective is to enhance understanding of key supervisory issues and improve the quality of banking supervision worldwide.

weighting of assets according to their risk, thereby accounting for their likelihood to cause unexpected losses. In 1996, the Basel Capital Accord was amended in order to account explicitly for market risks.

Although Basel I framework was in fact a major step forward in capital regulation, it has revealed some shortcomings when applied to large entities. Additionally, the environment has changed significantly with the introduction of new risk management techniques resulting from financial innovation, and with the increasingly concentrated banking system following market pressures. Actually, financial innovation was increasingly being used for regulatory capital arbitrage purposes with the creation of mechanisms, usually denominated as "cosmetic" adjustments, which decreased capital requirements to levels that no longer reflected banks' risk-taking profile, as stressed by Jones (2000).[10] In this domain, Esho, Lam and Sharpe (2001) and Greenbaum and Thakor (1987) emphasize that advances in information technology encouraged the removal of assets from financial institutions' books through asset securitization, thereby reducing dramatically their incentives to monitor entrepreneurs. Furthermore, Basel I was not sufficiently risk-sensitive to account for the shifting of portfolio's composition from high quality towards lower quality credits, a practice that is usually termed as "cherry picking". According to an extensive set of available empirical studies provided by Jackson et al. (1999), the volume of regulatory capital arbitrage was large and growing rapidly, especially among the largest banks.

As a consequence, the Basel Committee proposed in June 1999 a revised framework, moving from a "one-size-fits-all" approach embodied in the previous Accord towards a more risk-sensitive approach, applicable on a fully consolidated basis.[11]

The main change in relation to the previous Accord was the introduction of a new capital adequacy based in the following three pillars: (i) Pillar 1: minimum regulatory capital requirements, (ii) Pillar 2: supervisory review of an institution's capital adequacy; and (iii) Pillar 3: internal assessment process and market discipline.

The final version of the revised framework, usually denominated as Basel II, was published in June 2004.[12]

[10] Regulatory capital arbitrage involves mechanisms that reduce risk-weighted assets without actually lowering risk. Jones (2000) identifies practices of "cosmetic" adjustments both in the numerator and in the denominator of capital ratios, mainly through under-provisioning and securitizations.

[11] See BCBS (1999).

[12] See BCBS (2004).

Although the general requirement for banks to hold a regulatory capital ratio of 8% and the definition of regulatory eligible capital has been maintained unchanged, a strengthening in capital requirements was expected through the introduction of structural changes in the calculation of risk weighted assets. First, operational risk was introduced as a new risk category subject to capital charges. Second, banks had available a broader range of more risk-sensitive options to determine regulatory capital requirements for credit risk. Regarding credit risk, in addition to the standardized approach, banks became allowed to calculate capital requirements through internal-ratings based (IRB) models, which implied an internal estimation of certain risk factors.[13] With the incorporation of the bank's internal estimates in the capital calculation, regulators intended to create a regulatory structure where banks are incentivized to reveal private information about their portfolio risk and asset choices.

Besides minimum capital requirements, denominated as Pillar 1 requirements, Basel II also introduced a supervisory review of banks' internal assessment of capital and risk (Pillar 2) and a market disclosure requirement (Pillar 3). Pillar 2 gave regulators an important source of discretion, since it allows them to impose higher capital requirements to absorb risks that are not covered in Pillar I.

In 2009, as a response to lessons learned from the global financial crisis, the Basel Committee on Banking Supervision published a proposal for enhancing the Basel II framework, especially in what concerns the treatment of certain securitizations in Pillar 1 and their market discipline requirements. In most jurisdictions, minimum capital ratios were also enhanced, such as in Portugal, where the minimum Core Tier 1 capital requirements increased to 10%.

Despite this enhancement, the global financial crisis triggered a set of criticisms to the Basel II framework. First, questions were raised about the potential conflict of interests between rated parties and rating agencies, with a large impact on the standardized approach of the framework since these ratings are used in the assignment of risk weights. Second, the potential complexity of IRB banks' internal methodologies created difficulties on supervisors to apply the necessary degree of expertise and evaluate accurately the model's robustness, creating therefore a scenario where banks regulate

[13] Two approaches are available: IRB Foundation (own estimates of probability of default) and IRB Advanced (own estimates of probability of default, loss given default, credit conversion factor and effective maturity).

themselves. Third, as predicted by Kashyap and Stein (2004) and also mentioned by Repullo and Suarez (2008), Basel II and its IRB approaches tend to promote prociclicality, inducing banks to hold lower capital levels during good economic times, being therefore more exposed to shortfalls in cases of a subsequent economic downturn.[14] As the recent global financial crisis has shown, during an economic downturn, the access to financial equity markets becomes limited and the replacement of comfortable capital levels may be extremely difficult. Therefore, in order to comply with minimum capital requirements, banks may be forced to reduce lending and originate a credit crunch phenomenon, hence contributing to the worsening of the economic situation.

As mentioned by Stefan Waters, General Secretary of the Basel Committee on Banking Supervision, "the vulnerability of the banking sector to the build-up of risk in the system was primarily due to excess leverage, too little capital (of insufficient quality), and inadequate liquidity buffers". In fact, the built-up of excessive on- and off-balance sheet leverage accompanied by the erosion of the level and quality of banks' capital led markets to lose confidence in the banking sector. Hand in hand with the recent financial turmoil, this loss of confidence and the massive reduction on global liquidity creation were addressed by international regulators with the introduction of a new Basel framework (Basel III), where capital requirements are significantly tightened in order to improve the resiliency of the banking industry.[15]

The importance of improving capital requirements was emphasized in 2010 by Timothy Geithner, former United States Secretary of Treasury:

"*We don't know where the next crisis is going to come from. We won't be able to foresee it. We're not going to pre-empt all future bubbles. So we want to build a much bigger cushion into the system against those basic human limitations. I don't want a system that depends on clairvoyance or bravery. The top three things to get done are capital, capital and capital."*

(New York Times Magazine, March 2010, page MM36)

[14] Proclicality is also an issue under the standardized approach, since the rating agencies also tend to act prociclically. For further details on this issue, see Amato and Furfine (2004) and Ferri, Liu and Stiglitz (1999).

[15] See BCBS (2011).

Therefore, the Basel III framework is an attempt to re-regulate the financial sector through a mechanism that limits highly leveraged financial institutions, aimed at reducing the damages of a next crisis and preventing situations where taxpayer-financed bailouts might be required.

Based on the three pillars of the Basel II framework, this new reform intended to increase the resilience of the banking sector against financial crises and the following objectives were outlined: (i) raising the quality, consistency and transparency of the capital base; (ii) enhancing risk coverage; (iii) supplementing the risk-based capital requirement with a leverage ratio; (iv) reducing procyclicality and promoting countercyclical buffers; and (v) addressing systemic risk and interconnectedness. Additionally, Basel III enhanced monitoring tools and introduced a global liquidity standard based on two new liquidity ratios (Liquidity Coverage Ratio and Net Stable Funding Ratio), which will be discussed in more detail in Section 2.4.

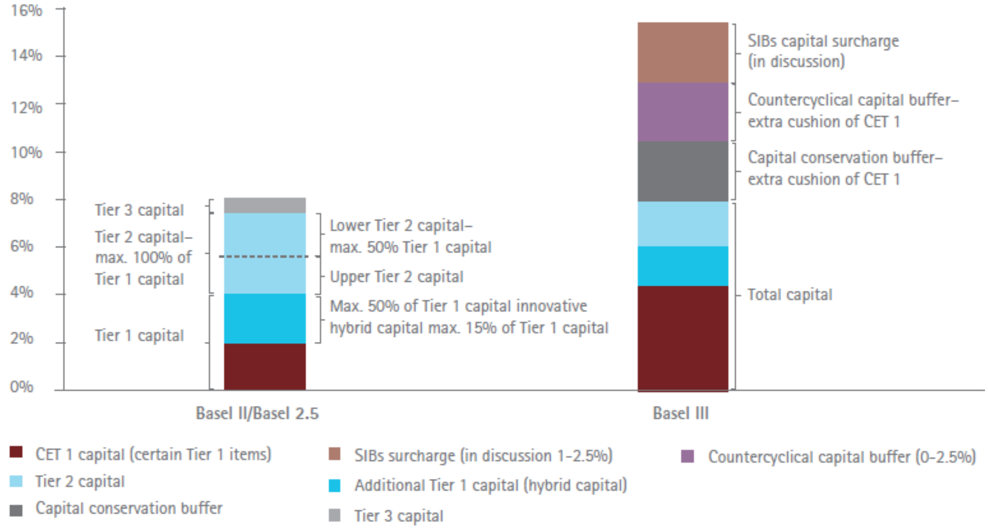
The transposition of Basel III to the European Union entered into force in 2013 *via* a Directive (2013/36/EU), usually known as CRD IV, and a Regulation (575/2013), usually known as CRR.[16]

Relevant for the scope of this study, it is important to highlight the significant increase of the level of own funds through a new and more strict set of criteria for the eligibility of regulatory capital and new capital ratios focusing on the core elements of own funds available to absorb losses as they arise.

As can be observed in Figure 1, the minimum level of Total Capital is settled at 10.5%, of which 4.5% has to be eligible to Common Equity Tier 1 (composed by high-quality own funds) and 6% to Tier 1 capital. This new framework also introduces a Capital Conservation Buffer (eligible to Common Equity Tier 1 capital) of 2.5%, and envisages a Counter-Cyclical Buffer that ranges from 0% to 2.5%.

[16] CRD stands for Capital Requirements Regulation, whereas CRR denotes the Capital Requirements Regulation. For further insights regarding the transposition of the Basel III framework to the European Union, see Dierick, Pires, Scheicher and Spitzer (2005).

Figure 1 - Regulatory Capital ratios according to Basel II and Basel III



Source: Accenture – Basel III handbook

With the introduction of this new framework, authorities are not only focused on the importance of banks' solvency, but also on their capacity to perform their role as liquidity creators, thereby contributing to finance the economy and facilitate transactions between economic agents. Hence, also relevant for this study is the introduction of structural changes regarding the treatment of banks' liquidity, as stressed in the next section.

2.4. Recent developments on liquidity regulation

According to Gatev et al. (2006), liquidity risk arises from the possibility of banks holding insufficient cash to meet random demands from their depositors or borrowers.
According to Bowman (2013), the role of banks as liquidity providers exposes them to risks, including liquidity risk. This risk can be mitigated in three ways: hold liquid assets (e.g., cash), fully dispose of an interbank liquid market and benefit from a regulatory safety net.[17] As mentioned before, although a comfortable pool of liquid assets reduces liquidity risk, banks would not be able to create liquidity if they were fully provisioned against the possibility of a bank run. In fact, absent panic runs and financial crises, shortages of liquidity can be successfully dealt though interbank

[17] Citing Berger et al. (1995), "safety net" refers to "government actions designed to enhance the safety and soundness of the banking system other than regulation and enforcement of capital requirements".

liquidity transfers, hence taking advantage from the non-perfectly correlated level of withdrawals across banks and gaining from diversification.[18] The most widely used regulatory safety net instrument is the aforementioned deposit insurance, a form of government subsidy which reduces the probability of a bank run based on unfounded rumors about bank's assets value. In addition to the interbank market, banks are able to meet their short-term liquidity needs through the access to a discount window provided usually by the central bank, an instrument which gained superior importance after the lack of confidence between financial institutions during the recent financial crisis.[19] Bearing in mind that the access to a discount window is usually a sign of weakness and that funding both from the interbank market and from the discount window requires pledging eligible collateral, the regulation of liquidity assumes a greater importance.

In this regard, Bowman (2013) argues that, even though regulatory safety net mechanisms may trigger events of moral hazard, the social costs associated with the removal of those mechanisms are high (especially disruptive banking panics) and policymakers would rather impose a minimum cash-asset reserve.[20]

In order to address the weaknesses in terms of liquidity evidenced by banks during the recent financial crisis, Basel III introduced new liquidity standards in the form of two liquidity ratios.[21] The first is the Liquidity Coverage Ratio (LCR), developed to "ensure that institutions maintain levels of liquidity buffers which are adequate to face any possible imbalance between liquidity inflows and outflows under gravely stressed conditions over a period of thirty days". The second is the Net Stable Funding Ratio (NSFR), conceived to "ensure that long term obligations are adequately met with a diversity of stable funding instruments under both normal and stressed conditions". [22]

Although, at this time, CRR does not oblige banks to comply with minimum liquidity standards (only requires the reporting of relevant items to calculate liquidity risk),

[18] In Europe, this interbank market for trading cash reserves gives rise to the EONIA (Euro OverNight Index Average), the average rate at which banks borrow and lend on an overnight basis.

[19] In the Euro area, the discount window is known as "Standing Facilities".

[20] Since deposit insurance entails confidence on the relationship with deposit customers and a discount window is always available, banks may have the incentive to hold low levels of liquid assets in order to invest it at a higher rate than the cost associated with the deposit insurance premium and with the funding from the discount window, which is an example of moral hazard.

[21] See BCBS (2010).

[22] See Articles 412 and 413 of CRR.

regulation on this matter is being finalized and it is worth exhibiting the standards developed by the Basel Committee.[23] The calculation of LCR is as follows:

$$\boldsymbol{LCR} = \frac{\boldsymbol{High\ quality\ liquid\ assets}}{\boldsymbol{Total\ net\ liquidity\ outflows\ over\ 30 - day\ time\ period}} \geq \mathbf{100\%} \qquad (1)$$

According to the Basel Committee understanding, "high quality liquid assets" comprise "level 1 assets" (cash, transferable assets of extremely high liquidity and credit quality) and "level 2 assets" (transferable assets of high liquidity and credit quality). "Level 1 assets" account for more than 60% of the ratio's numerator and should not be subject to any haircut. "Level 2 assets" account for less than 40% of the ratio's numerator and should be subject to a haircut of at least 15%. In turn, the "total net liquidity outflows" is the difference between liquidity outflows and liquidity inflows in a stressed scenario.[24]

Regarding NSFR, the ratio is computed as follows:

$$\boldsymbol{NSFR} = \frac{\boldsymbol{Available\ Amount\ of\ Stable\ Funding}}{\boldsymbol{Required\ Amount\ of\ Stable\ Funding}} \qquad (2)$$

Considering that a proxy for the Inverse of NSFR is used in our study, further details are included in Section 4.2.2.

2.5. The link between bank capital requirements and liquidity creation

According to Santomero and Watson (1977), the requirement of higher capital levels may reduce the value of banks and increase their weighted average cost of funding, hence imposing non-negligible social costs. Therefore, the trade-off between the marginal social benefit of preventing negative externalities from a systemic failure and the marginal social cost of diminishing intermediation needs to be balanced.

Some of the unintended outcomes of changes in regulatory capital requirements are mentioned by Berger et al. (1995), where the possibility of a credit crunch being triggered is highlighted. The authors give the example of the contraction in bank

[23] Regarding the NSFR, the article 510 of CRR states that a binding minimum standard for net stable funding shall only be implemented after EBA analyzes and reports, by December 2015, an appropriate uniform definition for calculating such a requirement.

[24] For more details on this metric, see BCBS (2010).

lending in the U.S. in the early 1990s as a consequence of the introduction of risk-based requirements and leverage requirements. In fact, these measures created an incentive for banks to substitute loans, especially to corporates (weighted at 100%), by government debt (weighted at 0%), which reduced the incentives for banks to proceed with their useful service of liquidity creation.

Bearing in mind that regulators have responded to the 2007-2008 financial crisis with higher capital requirements and with more strict criteria for liquidity buffers, the causal relation between bank capital and liquidity creation raises concerns. Although providing opposing views, theoretical literature suggests that bank capital structure may affect bank's ability to create liquidity, as evidenced both by the "financial fragility-crowding out" and "risk absorption" hypotheses explained below.

2.5.1. "Financial fragility-crowding out" hypothesis

One stream of the literature, usually known as "financial fragility-crowding out" hypothesis, envisages that higher capital reduces liquidity creation.

Although stressing the importance of bank capital to absorb risks and to maintain a safe and sound banking system, the model created by Diamond and Rajan (2000), built on Calomiris and Kahn's (1991) argument, explains why capital requirements can be costly due to its negative impact on liquidity creation and on the flow of credit. In their model, three agents are considered: entrepreneurs (borrowers) with projects in need of funding, investors (depositors) with excess liquidity and a relationship lender (bank) that issues fixed claims with a sequential service constraint (demand deposits) from depositors in order to finance entrepreneurs' projects. Both the entrepreneur and the bank may withhold effort, which reduces the amount of funding and the bank's ability to raise funds from investors. In such a world, liquidity creation is maximized by deposit contracts due to its role in mitigating the bank's holdup problem, since these contracts, unlike bank capital, allow depositors to withdraw their money whenever the bank threatens to withhold his collection skills, which would drive bank manager's rents to zero. By contrast, equity holders cannot run on the bank and provide discipline, which increases the bank manager's rents and reduces the amount of liquidity created to outsiders by preventing the funding of entrepreneurs with high payoff projects.

Flannery (1994) provides a related argument regarding the importance of maturity mismatching through a fragile capital structure, also based on the disciplining effect of deposits. The ability of depositors to withdraw funds on demand through short-term deposits allows a barely continuous renegotiation of contract terms to reflect the bank's current risk profile, thus preventing the banks from expropriating depositor wealth by changing upwards the assets' risk. Likewise, Flannery (1994) also emphasizes the social and private costs inherent in maturity mismatching arising from the erroneous estimation of asset value from outsiders and consequent risk of a bank run.

The "financial fragility-crowding out" hypothesis is also strongly influenced by the contribution of Gorton and Winton (2000), who argue that in general equilibrium a high capital requirement crowds out deposits, thus impacting negatively liquidity creation. It is worth noting that the model developed by Gorton and Winton (2000) is built upon the assumption of a single, unsegmented, capital market, where more bank capital certainly means less bank deposits, which is the case only in smaller markets. By contrast, in larger capital markets, usually quite segmented, the response to more demanding capital requirements could actually be a shift out of other equity securities, rather than a shift out of bank deposits, implying a lower likelihood of a "crowding out" effect.

According to Gorton and Winton (2000), an increase of bank capital requires the rebalance of some agents' portfolios, either by acquiring new bank capital with the proceeds from the selling of some of their assets or by crowding-out deposit holdings in favor of capital. The role of demand deposits as a provider of a desirable and efficient medium of exchange, allowing for a more effective hedge against liquidity shocks, is the reason why bank capital is uniquely costly. Therefore, although higher capital requirements may induce general equilibrium, it may be achieved at the expense of bank deposits, which contributes to reduce the overall liquidity creation.

Even though the theoretical literature underlying the "financial fragility-crowding out" hypothesis applies to all banks, the effect can be different according to the size of the bank. As suggested by Berger, Miller, Petersen, Rajan and Stein (2005), small banks conduct more incisive monitoring activities in line with a relationship-specific lending, which reduce the need to hold high capital buffers and may enhance liquidity creation. In fact, Berger and Bowman (2009), based on a sample of virtually all commercial banks in the U.S. in business between 1993 and 2003, conclude that the relationship between capital and liquidity creation differs for large, medium and small banks, and only the latter is consistent with the "financial fragility-crowding out" hypothesis.

In accordance with this theory, Horváth et al. (2012), based on an extensive dataset of Czech banks over the 2000-2013 period, find empirical evidence that capital negatively Granger-causes liquidity creation.[25] Also Fungácová, Weill and Zhou (2010) and Distinguin, Roulet and Tarazi (2013) find empirical evidence that the relationship between bank capital and liquidity creation is negative and significant.

2.5.2. "Risk absorption" hypothesis

Another stream of the literature, usually known as "risk absorption" hypothesis, which is directly connected with the role of banks as risk transformers, argues that higher capital enhances banks' ability to create liquidity.

On the one hand, according to Allen and Gale (2003), the creation of liquidity exposes banks to risk, since correlated liquidity shocks give rise to aggregate fluctuations in the demand for liquidity that cannot be fully insured. In fact, since liquidity creation requires the disposal of illiquid assets to meet the liquidity demand of deposit customers, the more liquidity is created the more the financial intermediary is exposed to losses.

On the other hand, bank capital allows financial institutions to absorb greater risk. In the model developed by Coval and Thakor (2005), three agents are analyzed: a rational, an optimistic and a pessimistic. The first type are intermediaries, agents that are able to credibly pre-commit to screen and differentiate bad projects from good projects, the second type are the entrepreneurs and, finally, the pessimistic agents are considered to be investors that hold riskless debt claims issued by intermediaries. When pessimism increases among investors, the beliefs gap between the rational intermediaries and the pessimistic investors is more likely to be fulfilled by capital. Besides this, a minimum level of capital may be vital for the solvency of intermediaries, thereby acting as deterrent against the intermediary's willing to take excessive risk and allowing them to provide services of liquidity transformation.

[25] As will be discussed in Section 5, Horváth et al. (2012) suggest that a reverse causality between bank capital and liquidity creation exists.

The importance of having well-capitalized intermediaries is also emphasized by Coval and Thakor (2005), which claim that “If intermediaries themselves are insufficiently capitalized, entrepreneurs will face the specter of rationing, which will depress funding demand and counteract measures to increase the demand through greater entrepreneurial optimism”.

A similar reasoning is provided by Repullo (2004), whereby the only effect of a higher capital requirement is to increase the loss of banks’ shareholders, since in equilibrium the intermediation margins and the banks’ franchise value do not change.

Berger and Bowman (2009) suggest that the “risk absorption” hypothesis is more likely to hold in large banks than in small banks. First, a greater scrutiny conducted by regulators to large banks enhances the need to hold equity capital. Second, a greater market discipline conducted by uninsured providers of funds entails large banks to hold more equity capital and hence reducing the cost of these funds while increasing their availability. Finally, the possibilities to engage in new and riskier activities are higher for large banks and equity capital may be raised in anticipation to prevent future losses arising from these activities.

In accordance with this theory, Peek and Rosengren (1995) and Hancock and Wilcox (1998) find empirical evidence that declines in bank capital drives declines in lending.

3. Formulation of Hypotheses

Bearing in mind the abovementioned ambiguous results obtained by empirical studies regarding the relationship between capital requirements and liquidity creation, the first hypothesis under study is directly linked with the impact of higher capital requirements over the creation of liquidity in the Euro area. It also contributes to assess whether policy makers of the Euro area should be concerned about the consequences of a more demanding regulatory framework.

Hypothesis #1 – Do higher capital requirements impact liquidity creation in the Euro area?

Berger and Bowman (2009) found different empirical results for the relationship between capital requirements and liquidity creation depending on the size of banks. Considering that the Euro area bank regulation is moving towards the harmonization of capital and liquidity requirements across banks, this matter compounds an important concern for policy makers. In fact, this hypothesis calls into question whether policy makers of the Euro area should put in place different regulatory measures according to banks' size.

Hypothesis #2 – Does the relationship between capital requirements and liquidity creation differ by size in the Euro area?

An additional feature of this study is the explicit test of whether financial crises influence the relationship between capital requirements and liquidity creation. The test of the validity of this hypothesis takes advantage of the interesting insights for empirical analysis provided by the recent global financial crisis. This hypothesis implies a study on whether policy makers of the Euro area should put in place different regulatory measures during crises in order to avoid contributing to the worsening of economic conditions.

Hypothesis #3 – Does the relationship between capital requirements and liquidity creation differ during crises in the Euro area?

4. Data and Measures

4.1. Sample description

In order to construct the measures of liquidity creation and to test the hypotheses formulated, annual bank balance sheet and general macroeconomic data is used for virtually all Euro area active banks between 2006 and 2012. The balance sheet data and all bank-specific information are collected from Bankscope database, whereas macroeconomic indicators are collected from SNL database, ECB Statistics and local Central Banks' websites.[26] The first criteria consisted on including all banks that engage on liquidity creation activities from the 18 Euro area member countries as of 2014, corresponding to 3.436 banks.[27]

To ensure that the sample only contains banks that engage on liquidity creation activities, the exclusions described in Table 2 were applied, most of them in line with the Berger and Bowman (2009) methodology.

Table 2 - General criterion for sample selection

Criteria	Banks considered	# Observations
Initial sample	3436	24052
Zero deposits	2343	16401
Low relative amount of deposits (< 1% of total assets)	2309	16163
Zero or negative equity capital in the current year	2301	16107
Zero or negative equity capital in the lagged year	2299	16093
Average current and lagged gross loans below 5 million EUR	2293	16051
Recent Euro area members (CYP, EST, LVA, MLT, SVK, SVN)	2258	15806
Sample after general criterion	**2258**	**15806**

Given the econometric advantages of working with a balanced panel and considering the specificities of each liquidity creation measures (described in Section 4.2.), additional exclusions were applied. Data quality check procedures allow the exclusion of banks with negative values for the items that compose liquidity measures. In order to disregard banks whose activity diverges substantially from traditional commercial banks, outliers that regarding the NSFR measure are ranked in percentiles 0.5% (NSFR

[26] The sources used to retrieve data for each variable is described in Appendix IV.

[27] The first criteria includes institutions with the following specializations: commercial banks, savings banks, cooperative banks, real estate and mortgage banks, specialized governmental credit institutions, bank holdings and holding companies, multi-lateral government banks and micro-financing institutions. In order to ensure consistency, banks from the 6 countries that were not members of the Euro area as of 2006 are excluded afterwards.

of 0.5984) and 99.5% (NSFR of 4.2791) were excluded from the sample. In line with the findings outlined by Gobat, Yanase and Maloney (2014), which verified that the largest banks tend to have a lower NSFR, these percentiles result from a sub-sample of banks which were ranked up to 250th in terms of total assets. The exclusion of banks with gross loans lower than 5% of total assets is an additional procedure to ensure that only banks that grant credit are considered. The other exclusions were conducted in order to obtain a balanced panel. For the few cases where RWA and regulatory own funds were not available, these items were forced to vary over time in line with the variation of total assets and total equity, respectively.

As a consequence from these procedures, the sample size reduces significantly as can be observed in Table 3. The final sample consists of 599 banks and represents, in terms of total assets, 52% of the initial sample. Although Italy is the country with more banks in the sample (336 banks), France and Germany are the most representative countries in terms of total assets (34% and 23%, respectively), whereas the Portuguese banks represent 2% of total assets.

Table 3 - Specific criterion for sample selection

Criteria	Banks considered	# Observations
- Apply data-quality checks - Exclude outliers - Exclude banks with gross loans < 5% of total assets - Exclude banks with unavailable items for: (i) gross loans; (ii) profitability; (iii) solvency; (iv) bank characteristics; and (v) impairments. - Exclude banks with unavailable items needed to build the Inverse NSFR and the Berger and Bownan (2009) measures		
Final Sample	**599**	**4193**

A full description of the representativeness of the final sample in terms of the number of banks and gross total assets, by country, is available in Appendix I.

All variables expressed in absolute monetary amounts are adjusted for inflation, in order to express constant 2006 prices.

The dataset is a short panel, which means that it includes data on many cross section observations (in this case, many banks) spanning a relatively short time period (7 years of annual observations). Therefore, it is assumed that the time series dimension is held fixed and the cross section dimension is allowed to grow.

To conclude about whether policy makers should make use of different regulatory measures to different banks in terms of size, the final sample is split into large banks, medium banks and small banks. In fact, Berger and Bownan (2009), supported on Berger et. al (2005) and Kashyap et al. (2002), besides enhancing that liquidity creation varies significantly with bank size, also find empirical evidence that the relationship between capital and liquidity creation statistically differs with size. The split employed in this study is based on the same thresholds used by Berger and Bowman (2009), but converted from USD to EUR at the average exchange rate along the period of 2006-2012.[28] Table 4 exhibits the representativeness of each sub-sample.

Table 4 - Sub-samples selection – Breakdown by bank size

Sub-sample	Threshold (in million EUR)	# Banks	# Observations
Large Banks	> 2,223	156	1092
Medium Banks	< 2,223 and > 741	85	595
Small Banks	< 741	358	2506
Final Sample		**599**	**4193**

For the purpose of testing the hypothesis #3, a crisis period was selected. In fact, the existing literature is not consensual on the selection of the period that represents the global financial crisis. For example, Horváth et al. (2012) consider a crisis period from 2008 onwards, whereas Lin, Hwang, Wang and Xie (2013) suggest that crisis only started in 2009. Bearing in mind that the annual growth of the Euro area's GDP was negative only in 2009, the crisis period considered in our study was selected to start in 2009 and extended until the end of the sample period (2012).

4.2. Measures of liquidity creation

Considering the typical difficulties when measuring liquidity creation, three different indicators are considered here. First, the Berger and Bowman (2009) measure (BB-measure, hereinafter) seems to be consensual across researchers as it has been used in several studies.[29] Second, the Inverse Net Stable Funding Ratio (Inverse NSFR, hereinafter) includes explicitly a proxy to the new long-term liquidity requirement

[28] The average exchange rate USD-EUR is 0.7408 and was retrieved from the SNL Database.
[29] For example, the following authors use the BB-measure in their studies: Horváth et al. (2012), Berger, Bowman, Kick and Schaeck (2012), Fungácová et al. (2010) and Hackethal, Rauch, Steffen, and Tyrell (2010).

introduced in Basel III, which permits an analysis to the conflict that may exist between regulatory capital requirements and liquidity requirements imposed by the new regulatory framework. Finally, a simple measure that consists only in gross loans allows the use of a parsimony indicator when testing the impact of capital in bank lending behavior.

Although other measures of liquidity creation are used in the literature, the application of those measures is out of the scope of this study.[30]

4.2.1. Berger and Bowman (BB) measure

The impact of bank capital on liquidity creation is empirically studied by Berger and Bowman (2009), based on a sample of nearly all U.S. commercial banks in business between 1993 and 2003. In their study, the authors provide four liquidity measures based on U.S. bank financial statement data in order to quantify more accurately the creation of liquidity.[31] The authors' preferred measure is the "cat fat" measure, which includes off-balance sheet items and classifies the items by category (in terms of their ease, cost and time to be liquidated) rather than by maturity. Therefore, a proxy to the "cat fat" measure is used in our study to calculate the liquidity creation and hence to make use of it as the dependent variable.

The construction of this measure is done through a three-step procedure. In step 1, assets are classified as liquid, semiliquid or illiquid according to the ease, cost and time for banks to obtain liquid funds from the assets' liquidation and meet customers' demand for funds. Accordingly, all liabilities and equity instruments are classified as liquid, semiliquid or illiquid according to the ease, cost and time for customers to obtain liquid funds from the bank. In step 2, weights are assigned to all the items classified in step 1 according to the liquidity creation theory, which state that banks create liquidity because they hold illiquid items and give the public liquid items. Therefore, a negative

[30] Interested readers are referred to Deep and Schaefer (2004) and to Brunnermeier, Gorton and Krishnamurthy (2011, 2012), authors that developed the measures of liquidity creation "Liquidity Transformation (LT) Gap" and "Liquidity Mismatch Index (LMI)", respectively. For more details on the calculation of LMI, see also Bai, Krishnamurthy and Weymuller (2013).

[31] The four measures are: "cat fat" (loans classified by category and off-balance sheet items are included), "mat fat" (loans classified by maturity and off-balance sheet items are included), "cat nonfat" (loans classified by category and off-balance sheet items are not included) and "mat nonfat" (loans classified by maturity and off-balance sheet items are not included). Interested readers are referred to Berger and Bowman (2009) for more details on these measures.

weight of –½ is assigned to liquid assets, illiquid liabilities, equity, liquid guarantees and liquid derivatives, a positive weight of ½ is assigned to illiquid assets, liquid liabilities and illiquid guarantees and, finally, a weight of 0 is assigned to all semiliquid items. Berger and Bowman (2009) give the following example: when liquid liabilities (such as transaction deposits) are used to finance illiquid assets (such as business loans), liquidity is created. The choice of ½ and –½ weights rather than some other weights is not relevant, since what matters is that a perfect symmetry exists between items that create liquidity and those that "destroy" liquidity. In step 3, activities classified in step 1 are combined with the weights attributed in step 2. This combination consists in multiplying the currency unit amounts of the corresponding bank activities by the weights assigned and adding the weighted currency unit amounts to get the total currency unit value of liquidity created by a specific bank. The formula underlying the "cat fat" measure for bank *i* is presented below:[32]

$$\begin{aligned} \boldsymbol{Liquidity\ created_i} &= \left[\frac{1}{2} * \boldsymbol{illiquid\ assets}_{\,i}\right] + [\boldsymbol{0} * \boldsymbol{semiliquid\ assets}_{\,i}] + \left[-\frac{1}{2} * \boldsymbol{liquid\ assets_i}\right] \\ &+ \left[\frac{1}{2} * \boldsymbol{liquid\ liabilities_i}\right] + [\boldsymbol{0} * \boldsymbol{semiliquid\ liabilities_i}] \\ &+ \left[-\frac{1}{2} * \boldsymbol{illiquid\ liabilities_i}\right] + \left[\frac{1}{2} * \boldsymbol{illiquid\ guarantees_i}\right] \\ &+ [\boldsymbol{0} * \boldsymbol{semiliquid\ guarantees_i}] + \left[-\frac{1}{2} * \boldsymbol{liquid\ guarantees_i}\right] \\ &+ \left[-\frac{1}{2} * \boldsymbol{liquid\ derivatives_i}\right] \end{aligned} \tag{3}$$

In order to make the measure comparable across banks, the output from equation (3) is normalized by gross total assets.

In light of the limited granularity of data available for banks operating in the Euro area, for the purpose of our study, a proxy to the measure developed by Berger and Bowman (2009) is constructed with a few underlying assumptions. Although more details regarding the mapping between the original measure and the proxy can be found in Appendix II, the items considered in each category are exhibited in Table 5 and the main methodological discrepancies and respective reasoning are outlined below.

[32] See Berger and Bowman (2009) for further details regarding the items considered in the original measure for each category and the main methodological options adopted by the authors.

Table 5 - BB-measure proxy items and weights

Category	BB Measure Proxy Items	Proxy Weights
Illiquid Assets	Loans to customers (except mortgage and consumer loans)	1/2
	Loans and advances to banks	1/2
	Other assets	1/2
Semiliquid Assets	Mortgage and consumer loans to customers	1/4
Liquid Assets	Cash and due from banks	- 1/2
	Total securities	- 1/2
Illiquid Liabilities	Subordinated debt	- 1/2
	Total equity	- 1/2
	Other liabilities	- 1/2
Semiliquid Liabilities	Other borrowed money	0
	Current deposits	0
Liquid Liabilities	Term and savings deposits	1/2
	Trading liabilities	1/2
Illiquid Guarantees	Guarantees and commited credit lines	1/2

Berger and Bowman (2009) classify residential mortgages and consumer loans as semiliquid and assign a weight of zero due to the intrinsic characteristics of these loans that allow them to be easily converted into cash through securitization. However, according to a discussion paper published in May 2014 by the ECB and the Bank of England, the amount of asset securitizations dropped dramatically over the past years and the ease, cost and time to convert mortgage and consumer loans into liquidity is to some extent compromised. Hence, an average weight between 1/2 and 0 is assigned to these loans in our proxy.

Considering the lack of information for all the banks in sample regarding both mortgage and consumer loans and trading liabilities, whenever these items are not available, the average proportions extrapolated from a sample consisting of banks with these items available are assumed.

All the assets that are not likely to be sold to quickly meet liquidity needs without incurring a major loss are classified as illiquid. In terms of liabilities, it is worth noting that time deposits are not differentiated according to the maturity, since they can be borrowed without a penalty independently on its maturity. Capital is classified as illiquid, because even when it is publicly traded, investors are only able to liquidate it in the secondary market and capital will always be held by some investor.

4.2.2. Inverse of Net Stable Funding Ratio (NSFR) measure

Distinguin et. al (2013), in their study on the relationship between bank regulatory capital and liquidity, introduce a proxy for liquidity based on the long-term regulatory standards proposed by the Basel Committee on Banking Regulation and Supervision.[33] A proxy to this measure is also used in our study as the dependent variable due to its valuable connection with the long-term liquidity requirements introduced by Basel III. Bearing in mind that the authors intended to use a measure consistent with the BB-measure, the proxy calculated is the inverse of the NSFR, as shown by the formula below for entity *i*:

$$Inverse\_NSFR_i = \frac{Required\ Amount\ of\ Stable\ Funding\ (RSF)_i}{Available\ Amount\ of\ Stable\ Funding\ (ASF)_i} \quad (4)$$

A high value for the ratio of NSFR means high bank liquidity, and hence its inverse is a proxy for liquidity creation as banks that hold liquidity in their balance-sheet do not provide liquidity to the economy. Although more details of the mapping between the NSFR and the proxy constructed can be found in Appendix III, the items considered in each category are exhibited in Table 6 and the main methodological discrepancies and respective reasoning are outlined below.

Table 6 - Inverse NSFR proxy items and weights

Category	Inverse NSFR Proxy Items	Proxy Weights
Available Stable Funding	Total equity	100%
	Total L/T funding	100%
	Term and savings deposits	95%
	Current deposits	90%
	Money market and S/T funding	50%
	Other liabilities	0%
Required Stable Funding	Cash and due from banks	0%
	Loans and advances to banks	5%
	Government bonds	5%
	Other securities	33%
	Gross loans	75%
	Other assets	100%

In view of the lack of available observations for the item "Regulatory capital", whenever this item is unavailable it is replaced by the sum of total equity and long-term funding, under the assumption that long-term funding includes mostly subordinated debt

[33] See BCBS (2010).

with strong loss absorption characteristics eligible as own funds under the Basel III framework.

Other assumptions undertaken are aligned with Gobat et al. (2014), namely the consideration of term and savings deposits as “stable” demand deposits and current deposits as less “stable” demand deposits. However, some refinements to the authors’ methodology are carried out. For example, although Gobat, Yanase and Maloney (2014) assume a 0% weight to assign to loans and advances to banks, the lack of information regarding (i) loans to banks subject to prudential supervision, and (ii) maturity of loans to banks, lead us to assign a 5% weight to this category.[34] Also, even though Gobat et al. (2014) assume a 85% weight to assign to loans, the lack of information regarding (i) the volume of mortgage loans, (ii) loans unencumbered or pledged as collateral, (iii) the risk-weight assigned to each loan, and (iv) performing and non-performing loans, lead us to assign a 75% weight to gross loans, which corresponds to the average between the weights of 65% and 85% considered under the Basel III framework.

Given the lack of information regarding Level 2A and 2B securities, a weight of 33% is assigned to the item “other securities”, which corresponds to the average between 15% and 50% considered in the Basel III framework.[35]

4.2.3. Gross Loans measure

A simple measure that considers only gross loans is also used here as the dependent variable, in line with the empirical studies developed by Hancock and Wilcox (1998), Berger and Udell (1994) and Gambacorta and Mistrulli (2004), who analyze the impact of capital on bank lending. In order to make it comparable across banks, the measure is normalized by gross total assets.

[34] Altough under the Basel III framework a 0% weight is assigned to unencumbered loans to banks subject to prudential supervision with residual maturities of less than six months, the lack of information requires the adoption of a more conservative weight of 5%.

[35] Further details on Basel III categories that compose regulatory capital can be found in BCBS (2011).

4.3. Explanatory variables[36]

The main explanatory variable is the total regulatory capital ratio, following the definition of Basel II that measures the ratio of eligible own funds to risk-weighted assets.[37] Basel III requirements are not considered because, during the period analyzed, Euro area banks still had to comply with the Basel II requirements. Although Berger and Bowman (2009) use a simplified ratio of total equity to gross total assets, we contribute to the investigation in this subject with the use of regulatory capital, since this work aims at measuring the impact on liquidity creation that arises from more demanding capital requirements introduced by Basel II. Distinguin et al. (2013) also take into consideration the regulatory capital ratio.

The control variables are divided into seven different sets of influence factors: market economic conditions, local market competition, monetary policy, bank size, bank market power, bank performance and bank risk.

The macroeconomic factor used to measure market economic conditions by country is the real GDP growth rate. Economic output is expected to positively affect liquidity creation as an indicator of increased demand for funds during economic booms and of reduced bank credit supply during economic downturns.

The Herfindahl Index calculated by country is the indicator of local market competition. The study developed by Fungácova et al. (2010) find a positive coefficient for this variable.

The impact of the interest rate environment (monetary policy) is measured by the spread between short- and long-term interest rates. The long-term interest rate corresponds to each country's secondary market yields of government bonds with a remaining maturity close to ten years, whereas the short-term interest rate is the 3-month EURIBOR. Bearing in mind that the short-term interest rate is the same for all countries, this measure allows controlling for country risk implicit in the yield that investors demand to hold long-term government bonds. Hackethal et al. (2010) argue that a larger yield curve spread allows banks to increase their interest income, and hence a positive relationship between the yield curve spread and liquidity creation is expected.

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[36] A full description of each variable, including the calculation formula and the source, can be found in Appendix IV.

[37] Basel II is transposed for the European banks by the Directives 2006/48/EC and 2006/49/EC.

Bank size is considered in order to control for data distortions due to size heterogeneity and is measured by the natural logarithm of gross total assets (GTA).[38] According to Distinguin et al. (2013), authors that include this measure in their robustness check, the easier access of large banks to the mechanisms of safety net as "too big to fail" institutions may induce a positive relationship between bank size and liquidity creation. However, as stressed by Angora and Roulet (2011), the expected sign for the coefficient of this variable is ambiguous.

Considering that the sample includes a large number of small and medium banks that develop their activity locally, the market power of each bank is the share of total bank's assets divided by the bank's country total assets. In line with Distinguin et al. (2013), a positive sign is expected for the coefficient of the market power in the determination of liquidity creation.

Bank performance is measured by the Return on Equity (ROE). According to Angora and Roulet (2011), higher profitability enhances bank's ability to take risk and hence a positive coefficient for this variable is expected. However, the sign of this relationship is not clearly straightforward, since net income is eligible to regulatory capital (if not distributed as dividends) and the causality of regulatory capital on liquidity creation is actually the subject under analysis.

Finally, bank risk is controlled by z-score. Bearing in mind that the main reason why banks hold capital is to absorb risk, Berger and Bowman (2009) highlight the importance to appropriately control for bank risk.[39] The higher the z-score, the less risky a bank is. Therefore, in the same fashion as ROE, the sign of the respective coefficient is ambiguous in light of the existing theory regarding the benefits and harms of a fragile balance sheet structure for liquidity creation.

[38] The natural logarithm is applied to avoid overweighting large banks.

[39] The authors also suggest that the inclusion of variables that measure bank risk permits to isolate the role of capital in supporting liquidity creation from its role in supporting risk transformation.

5. Regression Framework

Considering that this research is studying the behavior of different banks across time, we use panel data, i.e., the data set combines time series and cross sections. According to Green (2012), the analyses of panel data allows the model builder to make statistical inference about economic issues while accounting for both heterogeneity across individuals (in our case, across banks) and for dynamic effects that are not visible in cross sections. In fact, with panel data, variation comes in two ways: interbank variation, which is variation in the average quantity from one bank to the next; and intrabank variation, which is variation within each bank over time.

As stressed by Stock and Watson (2007), it is worth noting that when bank specific characteristics are unobserved or unmeasured, thus not captured in regressors but contained in the error term, heterogeneity bias can be found if these regressors are correlated with some explanatory variables.[40] Thus, noise is introduced into the analysis and it may induce results towards erroneous effects. Therefore, we need to control for individual or/and time heterogeneity. In this study, a possible example of an omitted regressor is management skills that may allow each bank to behave differently in what concerns liquidity creation. This factor is not easily measurable and hence is not included in the regression, but we are tempted to believe that, although it may help explaining the dependent variable, it is probably correlated with other regressors.

Even though pooled ordinary least squares (OLS) regression can be used to deal with panel data, it does not provide consistent and efficient estimates in presence of individual-specific effects, time effects or both, since it may not comply with the assumptions of exogeneity, homoskedasticity and non-autocorrelation (Wooldridge, 2002). Since these effects can be fixed or random, appropriate formal tests are conducted based on the methodology followed by Park (2011). This procedure starts with the estimation of two fixed effects models, one with bank fixed effects and another with time fixed effects. These two regressions include respectively a bank-specific and a year-specific time-invariant component which is allowed to be correlated with other regressors and hence a limited form of endogeneity is permitted. By applying the "within" estimation, differences to the intra-class mean are considered and the fixed effect term is then dropped. Although first-differences could also be applied,

[40] Heterogeneity bias is also known as omitted variables bias.

Wooldridge (2002) suggest that for a large cross-section with small time periods, when the disturbance are serially uncorrelated and homoskedastic, "within" estimation produces more efficient estimates and the standard errors reported are valid. In order to test the null hypothesis that all dummy variables except for one (the reference group) are jointly zero, an F-test is conducted separately for bank and time fixed effects, as can be observed in Appendix VIII. Since the null hypothesis is rejected in both regressions, then a two-way fixed effects (with both bank and time fixed effects) model increases the goodness-of-fit and is better than the Pooled OLS. A similar procedure is conducted for testing random effects, but since this model includes the bank/year-specific time-invariant components in the composite error term, they are not allowed to be correlated with other regressors. To test for the presence of random effects, the Breusch and Pagan's (1980) Lagrange multiplier (LM) is selected. As shown in Appendix IX, this test rejects the null hypothesis that bank and time specific variance components are zero, and then the random effects model is better than the Pooled OLS in dealing with heterogeneity.[41]

In line with Cameron and Trivedi (2009), we choose between a fixed effects model and a random effects model by using the Hausman (1978) specification test, under the null hypothesis that random effects model provides consistent estimates and hence individual effects are random.[42] The output of this test is available in Appendix X and shows a strong rejection of the null hypothesis. This means that the fixed effects model is more appropriate, since the individual effects are significantly correlated with at least one of the regressors.

Even though the introduction of fixed effects controls for a limited form of endogeneity, strict exogeneity is still not certain. In fact, as suggested in the empirical studies developed by Horváth et al. (2012) and Distinguin et al. (2013), a reverse causality may exist between bank capital and liquidity creation and then we need to deal with the simultaneity issue.[43] To reduce potential endogeneity problems, all regressors are one-

[41] These regressions are computed with cluster-robust standard errors, clustered by bank, and are robust for autocorrelation and heteroskedasticity.

[42] The Hausman (1978) specification test was conducted using the Stata option "sigmamore" which specifies that the covariance matrix is based on the estimated disturbance variance from the efficient estimator.

[43] Horváth et al. (2012) found evidence that capital negatively Granger-causes liquidity creation, in line with the "financial fragility" hypothesis, and that liquidity creation Granger-causes a reduction in capital, which is consistent with a crowding out effect where increased liquidity creation is linked to a shift from

year lagged values, in line with the methodology followed by Berger and Bowman (2009).

Thus, the following equation is estimated to test the hypothesis #1 that regulatory capital impacts liquidity creation:

$$\boldsymbol{Y_{i,t}} = \boldsymbol{\alpha_i} + \sum_{k=1}^{K} \boldsymbol{\beta_k} \mathbf{X_{i,t-1}} + \mathbf{d_t} + \boldsymbol{\varepsilon_{i,t}} \quad (5)$$

where the subscript t denotes the time dimension, i denotes the cross-sectional dimension across banks, k denotes the number of control variables, X represents the control variables, Y represents the dependent variable, α_i and d_t represent the bank and time fixed effects, respectively, and $\varepsilon_{i,t}$ is the error term.

Given that this study considers three different measures of liquidity, three regressions are estimated, where only the left-hand side is changed accordingly.

In order to ensure that statistical inference is based on robust model estimation, other critical assumptions are tested as follows.

The extent to which the variance of the coefficient estimate is being inflated by multicollinearity is tested by the Variance Inflation Factor (VIF), based on a rule of thumbs of 10, which is set, for example, by Neter, Wasserman and Kutner (1989) and Kennedy (1992). As exhibited in Appendix XI, the VIF of all regressors is always lower than 2, and hence there is no evidence of any issue of multicollinearity.

To test the normality assumption, the skewness and kurtosis (D'Agostino, Belanger, and D'Agostino Jr., 1990) and the Cameron and Trivedi (2009) tests are conducted.[44] The Appendix XII exhibits the outputs of these tests. Although normality is rejected in both tests for the three regressions, according to Cameron and Trivedi (2009), the condition of normality is not necessary for consistency of the estimator.[45] Additionally, asymptotic properties of this study's large sample allow relaxing on this assumption without further transformations.

As shown in Appendix XIII, when conducting a Modified Wald Test for groupwise heteroskedasticity in the residuals of a fixed effects regression model, the null

capital towards deposits. Distinguin et al. (2013), test the reverse causality through the creation of both a regulatory capital equation and a liquidity equation. The results of these regressions show that banks do not increase their capital ratios when they face higher illiquidity and that higher regulatory capital ratios drive lower liquidity creation and illiquidity.

[44] The skewness and kurtosis test is similar to the Jarque-Bera test, but adjusts for sample size.

[45] Actually, in Finance, rare are the cases where variables are normally distributed.

hypothesis of homoskedasticity is rejected in all regressions. Therefore, a correction to the standard errors of the estimates is needed.[46] This correction will be further discussed.

The panel data statistical inference can also be biased when the residuals are correlated across banks, that is, when cross-section dependence, also known as contemporaneous correlation, is present. The Pesaran's (2004) test of cross-sectional independence, exhibited in Appendix XIV, shows that, except for the regression that includes gross loans as the dependent variable, the models have cross-sectional dependence at the 5% significance level and further adjustments are necessary.

To deal with both heteroskedasticity and cross-sectional dependence so that consistency and unbiasedness is obtained, a regression with Panel Corrected Standard Errors (PCSE) is employed, in line with Greene (2012). Considering that the Wooldridge (2002) test for autocorrelation, present in Appendix XV, rejects the null hypothesis of no autocorrelation of first-order for all regressions, the linear panel data model is estimated by a Prais-Winsten regression with first-order autocorrelation.[47] Autocorrelation with more lags is not considered, because autocorrelation reduces gradually and considerably, as shown in Appendix XVI. Since autocorrelation is specified in the PCSE regression, the estimates of the parameters are conditional on the estimates of the autocorrelation parameter. Therefore, in line with Hoechle (2007), we obtain standard error estimates that are robust to disturbances being heteroskedastic, contemporaneously cross-sectionally correlated and autocorrelated of type AR(1). In order to continue to account for the bank and time fixed effects, a dummy variable for each bank and for each year is introduced in these regressions.[48]

To test the hypothesis #3, of a structural break during the crisis that affects the relationship between regulatory capital requirements and liquidity creation, we create a dummy variable which equals one for the period of 2009-2012 and zero outside of such period. To the right-hand side of the regression, we add the dummy variable to account

[46] The Modified Wald Test for groupwise heteroskedasticity was developed by Greene (2000). This test is appropriate for panel data and is robust even when the normality assumption is violated.

[47] Drukker (2003) provide simulation evidence that the Wooldridge (2002) test has good size and power properties in reasonable sample sizes.

[48] To ensure that endogeneity is correctly controlled for, a dynamic panel data (DPD) model is estimated as a robustness check. This dynamic model uses Arellano and Bond (1991) estimation, which considers lagged liquidity creation as a regressor and lags of regressors as instruments. See Section 7 and Appendix XX for further details.

for deviations of the crisis intercept relative to the baseline intercept and use the same variables multiplied by the dummy variable to account for deviations of the crisis coefficients from the baseline slopes. This procedure is similar to the one developed by Chow (1960). However, since the non-crisis period only includes three time periods and lagged regressors are considered, it is not possible to run a separate regression for this sub-sample and the alternative is to introduce dummies in the original regression.

6. Results

6.1. Descriptive statistics

As displayed in Figure 2, a different evolution is found among the three measures of liquidity creation. Gross loans and the proxy for the inverse NSFR have increased significantly over the observed period of 2006-2012 in contrast to the small increase of liquidity measured by the proxy for the BB-measure. However, when the liquidity measure is divided by gross total assets, a negative trend can be observed, especially in the last year of observation, as exhibited in Figure 3. The full descriptive statistics are available in Appendix V and descriptive statistics related only to the dependent and the main explanatory variables are available in Appendix VI.

Figure 2 - Evolution of liquidity in absolute values

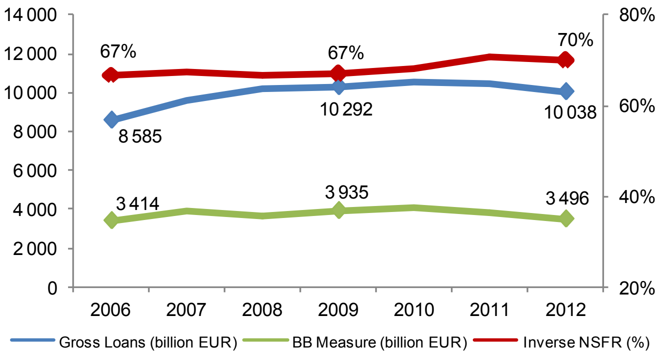
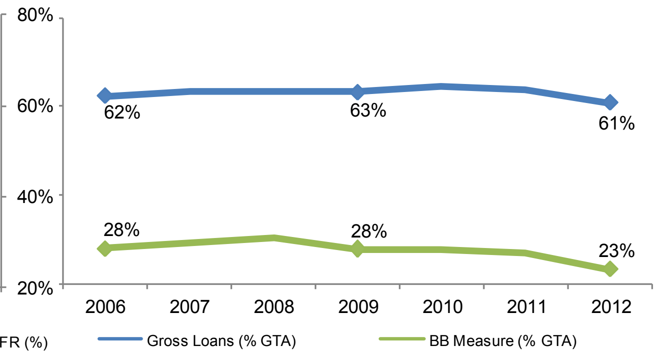


Figure 3 - Evolution of liquidity as a % of GTA



It is worth noting that at the end of the sample period, although large banks only represent 26% of the observations in sample, their gross loans account for 98% of aggregate gross loans and their BB-measure liquidity created accounts for 98% of aggregate liquidity creation.

The overall gross loans, measured at constant 2006 prices, increased 17% during the period of 2006-2012, a growth rate that is also found within large banks. This yields an absolute increase of 2,427 billion EUR on average gross loans. Medium and small banks present higher growth rates, yielding growths of 28% and 26%, respectively. However, when this measure is considered as a fraction of gross total assets, a decrease of 2% in overall gross loans is exhibited, mainly driven by an increase at a faster rate of gross total assets among medium and small banks. It is also worth highlighting that banks that create more liquidity through gross loans are of medium size, since liquidity creation accounts for 66% of their gross total assets, which compares with 59% and 60% from large and small banks.

The proxy for the overall inverse NSFR increased 4%, on average, from 2006 to 2012, an evolution which is barely homogenous within large, medium and small banks. In fact, the positive evolution of 31% in gross loans more than compensates the negative impact of the increase in 40% and 44% in term and savings deposits and in money market and short-term funding, respectively. Considering this measure, large banks create, on average, more liquidity. The breakdown of growth rates and the stand-alone contributions of each item for liquidity creation measured by the proxies for the inverse NSFR and BB-measure can be found in Appendix VII.

In turn, according to the proxy of the BB-measure, as of 2012 at constant 2006 prices, banks created 3,496 billion EUR of liquidity, which represents an overall increase of 2% over the observed period.[49] This amount of liquidity created equals, on average, 23% of gross total assets and represents approximately 3.5 EUR of liquidity created per 1 EUR of regulatory capital. Liquidity creation measured by the BB-measure decreased as a fraction of gross total assets, equity, gross loans and total deposits, which suggests that liquidity creation increased at a lower rate than all these items.

The BB-measure liquidity created as a fraction of gross total assets peaked in 2008 at 31% and then started a downward trend, which coincides with the onset of the global financial crisis that contributed to dampening the growth of liquidity creation, as exhibited in Figure 3.

Throughout the period under analysis, liquidity creation measured by the BB-measure increased 2% among large banks and 4% among medium and small banks. The positive evolution of liquidity created is mainly driven by the increases of 49% and 16%, respectively, in mortgage and consumer loans and in other loans (illiquid assets; 1/4 and 1/2 weights), and 40% in term and savings deposits (liquid liability; 1/2 weight). The positive variation of 30% in off-balance sheet activities (illiquid guarantee; 1/2 weight) also contribute to the favorable evolution in liquidity created. In fact, the evolution of these variables more than compensate the significant negative impact resulting from the increases of 19% in total securities (liquid asset; -1/2 weight) and 262% in cash and due from banks (liquid asset; -1/2 weight).

[49] At current prices, liquidity creation increased 15% and amounted to 3,941 billion EUR in 2012.

The average liquidity created measured by the proxy for the BB-measure amounted to 5.8 billion EUR in 2012. In 2012, when considering liquidity creation as a fraction of gross total assets, large and medium banks create more liquidity than small banks.[50]

Off-balance sheet items assume an important role in financing the economy, especially when liquidity creation is measured by the proxy for the BB-measure. Actually, off-balance sheet account for approximately 61% of total liquidity created over the observed period, which is in line with the findings from Berger and Bowman (2009), where off-balance sheet items contribute for approximately 50% of the overall liquidity created by the US bank. The importance of off-balance sheet activities is especially driven by large banks, which represent 62% of the overall liquidity created by these banks according to the BB-measure. Its importance decreases with the size of the bank, since the percentage drops to 29% and 24% for medium and small banks, respectively. The impact of off-balance sheet activities is not so expressive with the proxy for the inverse NSFR measure, but it still contributes to an increase of one percentage point in the overall liquidity.

It is important to mention that there are some significant differences between the proxies for the BB-measure and the inverse NSFR, especially in what concerns the treatment of securities. In fact, the BB-measure penalizes more the investment in securities by assigning a weight of -1/2, whereas the inverse NSFR considers that 5% of government bonds and 33% of other securities require stable funding and thus securities contribute positively for liquidity creation according to the second measure.

Following the conclusions drawn by Hackethal et al. (2010), the low amounts of liquidity created as a fraction of gross total assets show that rather than providing liquidity to the economy, banks retain a lot of liquidity as a buffer to support sudden liquidity shocks. In fact, this retention of funds may not be due to their willing to avoid a fragile balance sheet structure, but rather to regulatory pressures that oblige them to comply with more demanding liquidity requirements. Additionally, financial crisis may justify an increase in banks' risk-aversion, making them more susceptible to shift their portfolios from loans towards securities and hence reduce liquidity creation.

Even though the results are not totally consistent across the different liquidity measures, the BB-measure show that large banks hold a significant amount of liquidity in their

[50] Large and medium banks create, respectively, 0.245 and 0.242 of liquidity per unit of gross total assets, whereas small banks create 0.226.

balance sheets, which can be a response to their quicker access to safety net mechanisms *vis-à-vis* smaller banks.

Considering the main explanatory variable, regulatory capital ratio, the assumption under hypothesis #1 that more demanding capital requirements are followed by an effective reinforcement of capital buffers is now confirmed. As exhibited in Appendix VI, the average regulatory capital ratio increased in sample from 14.8% in 2006 to 16.5% in 2012. During all the period observed, small banks exhibit consistently higher regulatory capital ratios than large and medium banks.[51]

6.2. Regression results

We now investigate the hypothesized causality relations between regulatory capital and liquidity creation. The regression's outputs from which are based the conclusions that follow are present in Appendix XVII.

In the first specification of the model that makes use of the proxy for the BB-measure as dependent variable, we find that the relationship between regulatory capital and liquidity creation is negative and statistically significant at the 1% level. The magnitude of the coefficient of one-year lagged regulatory capital ratio, -0.200, suggests that an increase of 1% in the regulatory capital ratio yields a reduction on liquidity creation which represents 0.2% of the bank's gross total assets. This result is strongly consistent with the "financial fragility-crowding out" hypothesis, which envisages that higher capital ratios reduces liquidity creation. As discussed in Section 2.5.1., a fragile financial structure favors liquidity creation as banks benefit from their informational advantage to extort rents from depositors and to gain their confidence, thus allowing the collection of more deposits and the grating of more loans. Additionally, higher capital ratios shift investors from liquid deposits towards illiquid capital.

A similar conclusion had already been obtained by Fungácová et al. (2010) in their study based on a sample of Russian banks, where they conclude that high capital

[51] The average regulatory capital ratios of large, medium and small banks are 13.2%, 13.9% and 17%, respectively. As an informative note, it is worth mentioning that the Portuguese banks always report regulatory capital ratios below the average of the Euro area (in 2012, 13.2% versus the Euro area average of 16.5%).

requirements may hamper liquidity creation and hence cause economic harm, especially in emerging countries.

When considering the sub-samples, large banks and small banks also exhibit a negative and significant relationship at least at the 5% level.[52] However, for small banks, the magnitude of the coefficient is lower in comparison with the full sample (-0.172), whereas for large banks is slightly higher (-0.210). For medium banks, the relationship becomes positive, but not significant. These results converge to the conclusions obtained by Berger and Bowman (2009) regarding small and medium banks, but diverges in what concerns large banks. In fact, the empirical results from Berger and Bowman (2009) suggest that, for a large bank, when considering off-balance sheet activities, the relationship between capital and liquidity is positive and significant. The negative relationship among small banks corroborates the results found by Fungácová et al. (2010), although these authors' results show a non-significant coefficient for large banks and a negative relationship for medium banks.

Berger and Bowman (2009) suggest that the negative and significant relationship between capital and liquidity creation among small banks, which is also found in our study, is consistent with the argument of "crowding out" of deposits introduced by Gorton and Winton (2000). This effect has already been suggested by Berger et al. (2005), which provide empirical evidence that small banks engage in more relationship-specific lending than large banks and employ strongly their delegated monitoring skills. Hence, the negative relationship between bank capital and liquidity creation was expected to be more pronounced among small banks, which is not the case in our study. However, it is worth noting that the coefficient for small banks is highly significant when compared to large banks (0.001 versus 0.045).

As shown in Appendix XVIII, when regressing on the components of the BB-measure, we can observe that most of the effect of lagged regulatory capital on liquidity creation is driven by the asset side of the balance-sheet. For the full sample, the coefficient of the lagged regulatory capital when "liquid assets" is introduced as dependent variable is significant at the 1% level and its magnitude of 0.1356 shows that increases in the regulatory capital leads banks to hold more liquid assets that do not contribute to

[52] The breakdown of the sample into large, medium and small banks is defined in Section 4.1, and corresponds to thresholds of 2.223 million Eur and 741 million Eur for large and medium banks, respectively.

liquidity creation. Although not significant, when "illiquid assets" is introduced as dependent variable, the coefficient is negative (-0.1212), suggesting that banks shift their portfolios from illiquid to liquid assets. Similar conclusions are obtained when large and small banks are considered, albeit for small banks the increase of liquid assets as a response to regulatory capital increases is less noticeable.

In the second specification of the model where the proxy for the inverse of NSFR is used as dependent variable, the relationship between regulatory capital and liquidity creation is negative but not significant. Distinguin et al. (2013) have already tested the causality between bank capital and liquidity creation by considering a proxy for the inverse of NSFR as dependent variable. In their study, the relationship is also found to be negative, albeit a significant coefficient is obtained. Considering the sub-samples, we find that only for small banks the relationship is significant at the 10% level and a negative coefficient of -0.118 is found. For large and medium banks, although not statistically significant, the coefficient exhibits the same signs as in the first specification of the model.

In the third specification of the model which introduces gross loans as dependent variable, the coefficient for the regulatory capital variable is also negative but not significant. For large and small banks, similar results as in the first specification are found, since they suggest that regulatory capital impact negatively liquidity creation as coefficients are significant at least at the 10% level. In comparison to the results obtained in the first specification, the magnitude of the coefficient is slightly lower for large banks (-0.198 versus -0.210), whereas for small banks the impact is more noticeable (-0.199 versus -0.172). Moreover, with gross loans as dependent variable, the magnitude of the main explanatory variable is no longer superior for large banks than for small banks (-0.198 and -0.199, respectively). The negative relationship between regulatory capital and liquidity creation is in line with the findings obtained by Gambacorta and Mistrulli (2004), which suggest that lending reduces significantly as a response to regulators' requirement of capital levels above the minimum established. In turn, the negative correlation obtained in our study contrasts the empirical evidence of Peek and Rosengren (1995) and Hancock and Wilcox (1998) that capital crunches contribute to the limitation of credit availability. In a similar fashion, Berger and Udell (1994), based on the study of the significant flow from loans to securities in the early

1990s in the U.S., conclude that regulatory pressures to reduce risk mainly through risk-based capital ratios did not get consistently stronger during the credit crunch since this specific crunch was mainly driven by demand-side factors.

Although not significant for all measures of liquidity creation and different in terms of magnitude, we obtain fairly consistent results that lagged regulatory capital impact negatively liquidity creation. Nevertheless, contrarily to the findings obtained by some other empirical studies, we find no evidence that the sign of the relationship differs for large and small banks.

Regarding the other explanatory variables and for the full sample, in the first specification, the coefficient for lagged GDP growth is positive and significant at the 10% level, whereas the coefficients for lagged ln(GTA) and lagged market share are negative and significant at the 1% level and 5% level, respectively. In sharp contrast, the second specification yields positive coefficients for lagged ln(GTA) and for lagged market share at the 10% level and 1% level, respectively. Finally, in the third specification, the coefficient for lagged spread between short- and long-term interest rates is negative and significant at the 5% level. Also negative and significant are the coefficients for lagged ROE and lagged market share, the latter in line with the results obtained from the first specification. All other explanatory variables are not statistically significant. Although the sign of some coefficients is not coherent with the initial expectations, too much focus should not be given to this fact, since the inclusion of these variables is supported in strong economic reasoning and they only work as control variables.

The effect of pre-crisis bank capital ratios on bank's liquidity creation market shares had already been examined by Berger and Bowman (2008). The main findings regarding the behavior of bank liquidity creation around financial crises suggest that banking crises (the credit crunch of 1990-1992 and the recent subprime lending crisis) were preceded by positive abnormal liquidity creation, whereas market-related (the 1987 stock market crash, the Russian debt crisis plus the Long-Term Capital Management meltdown in 1998 and the bursting of dot.com bubble plus the September 11 terrorist attack of the early 2000s) were preceded by negative abnormal liquidity creation. The response of liquidity creation during crises was not consistent, since it has both decreased (e.g., during the 1990-1992 credit crunch) and increased (e.g., during the

1998 Russian debt crisis/LTCM bailout).[53] These results emphasize that liquidity creation is highly influenced by financial crises, although a different behavior can be found according to the type of financial crisis experienced. However, as shown in Appendix XIX, when we conduct in our study a test of a structural break during the global financial crisis (here represented by the 2009-2012 period), the results suggest that deviations of lagged regulatory capital's coefficient from the baseline period coefficient are not significant for none of the measures of liquidity creation. This means that no evidence is found to support that the relationship between regulatory capital and liquidity creation changes during crisis *vis-à-vis* a period of economic growth. Moreover, if the regression includes only the crisis period, no statistically significance is found for none of the three measures. However, it is worth noting that the sign of the lagged regulatory capital's coefficient remains negative but smaller than the ones provided by the full sample (-0.090, -0.012 and -0.062 for the first, second and third specification models, respectively). This suggests that during crisis an increase of capital buffers may harm liquidity creation to a lower extent.

[53] The authors also argue that, since the subprime lending crisis was preceded by a positive abnormal liquidity creation, while financial fragility may be important to create liquidity, excessive liquidity creation may lead to financial fragility.

7. Robustness Checks

In section 6.2, a negative relationship was found for the relationship between regulatory capital and liquidity creation when considering the full sample, as well as for large and small banks. However, although the problem of endogeneity is mitigated by the consideration of lagged regressors, caution is needed when claiming a causal relationship. Therefore, the robustness of this finding is tested through a dynamic panel data (DPD) model.

Arellano and Bond (1991) propose a generalized method of moments (GMM) – henceforth, the AB estimator – where the regressors need not be strictly exogenous, meaning they are correlated with past and possibly current realizations of the error. According to Roodman (2009), the AB estimator accounts for fixed effects and is appropriate for large panels and small time periods. This estimator consists on moment conditions based on a system of two equations: one differenced and one in levels. The variables in levels are instrumented with their own first differences, hence allowing for a significant increase in efficiency. Dynamics are introduced by the lagged levels of the dependent variable. Fixed effects are eliminated by first-differencing and differenced variables that are not strictly exogenous are instrumented with their own lags.[54]

The regression used in this robustness check includes fixed effects components, contemporaneous and lagged values for the dependent variable and for all explanatory variables, as shown in the equation below:[55]

$$\mathrm{Y_{i,t}} = \alpha_i + \beta_1 Y_{i,t-1} + \sum_{j=0}^{1}\sum_{k=1}^{K} \beta_k \, \mathrm{X_{k,t-j}} + \mathrm{d_t} + \varepsilon_{\mathrm{i,t}} \tag{6}$$

where the subscript t denotes the time dimension, i denotes the cross-sectional dimension across banks, j denotes the number of lags, k denotes the number of control variables, X represents the control variables, Y represents the dependent variable, α_i and d_t represent the bank and time fixed effects, respectively, and $\varepsilon_{i,t}$ is the error term.

[54] Lagged values are expected to be "good" instruments, meaning that they are uncorrelated with the fixed effects and with the idiosyncratic error.

[55] Besides contemporaneous values, also lagged values for explanatory variables are included since the PCSE regression conducted in Section 5 provides evidence that past realizations of some of these variables help explaining liquidity creation.

The one-step robust estimation is selected, where the moment conditions are weighted by a matrix that is independent of the parameters of the model and standard errors are consistent with panel-specific autocorrelation and heteroskedasticity.

Since regulatory capital and lagged liquidity creation are considered to be endogeneous, this AB estimation uses as instruments the second lag of regulatory capital, the second lag of liquidity creation and all lags of the exogenous variables.

According to Cameron and Trivedi (2009), consistent AB estimation requires the error to be serially uncorrelated. Since the lagged dependent variable is included as a regressor, we expect to reject the test of autocorrelation of order 1, but not at higher orders. In fact, as shown in Appendix XX, the null hypothesis of no second order autocorrelation is not rejected in all regressions at the 5% level and hence the assumption of no serial correlation holds. A second specification test is a test of overidentifying restrictions, where the validity of instruments is tested. Except for regressions that consider gross loans as the dependent variable, the Sargan/Hansen tests for overidentifying restrictions do not reject that the instruments, as a group, appear exogenous at least at the 1% level[56]. Therefore, this dynamic panel data regression framework appears to overcome the endogeneity issue.

Based on the outputs present in Appendix XX, when all banks are considered and for the three measures of liquidity creation as dependent variables, the signal of the coefficient of regulatory capital is negative, which is consistent with the evidence found through the PCSE regression that the "financial-fragility crowding-out" hypothesis holds. In comparison to the results obtained by the PCSE regression, this robustness check allows inclusively to gain statistical significance for the regressions that include the inverse NSFR and the gross loans as dependent variables. The magnitude of the coefficient is nevertheless higher than the one resulting from our PCSE regression. For example, when the BB-measure is included as dependent variable, an increase of 1% in the regulatory capital ratio yields a reduction on liquidity creation of 0.8% of the bank's gross total assets, which compares to a decrease of only 0.2% when the PCSE regression is conducted. For large banks, a negative coefficient is also found in all regressions, but statistical significance at the 5% level is only present when the Inverse NSFR is considered as dependent variable. Similarly, for small banks, all regressions

[56] See Roodman (2009) for further details on Sargan and Hansen tests for overidentifying restrictions.

suggest a negative relationship between regulatory capital and liquidity creation, but statistical significance at the 5% level is only found when the BB-measure is considered as dependent variable.

8. Concluding Remarks

This work aims at studying the impact of bank regulatory capital on liquidity creation among Euro area banks, a subject of growing interest in a regulatory environment undergoing deep changes. Building on banking theory that asserts both the importance of banks as liquidity creators and the need for banks to comply with minimum capital requirements, this study contributes for the investigation on the sign and magnitude of the relationship between regulatory capital and liquidity creation.

Such an investigation gains superior interest in times of rising capital requirements as those we have experienced with the introduction of Basel II/CRD III and most recently with Basel III/CRD IV. In fact, a first conclusion that we are able to draw is that, during the 2006-2012 period under analysis, banks have increased their buffers of own funds in accordance with the tightening of capital adequacy requirements.

Prior to the establishment of a causal relationship, this study contributes with the development of three different measures as proxies to liquidity creation. Based on such measures, our calculations suggest that liquidity creation has increased in the 2006-2012 period. However, when liquidity creation is considered as a fraction of gross total assets, a negative trend can be observed, suggesting that the increase of banks' balance-sheets has not been met with a corresponding increase in liquidity creation.

A Panel Corrected Standard Errors regression is used in order to answer three relevant policy questions in the context of the Euro area: (i) Do higher capital requirements impact liquidity creation? (ii) Does the relationship between capital requirements and liquidity creation differ by size? (iii) Does the relationship between capital requirements and liquidity creation differ during crises?

Although statistically significance is not obtained for all measures of liquidity creation, the main results show that banks create less liquidity when regulatory capital increases. Therefore, there is evidence that higher capital requirements impact liquidity creation and that the sign of the relationship is negative, suggesting that the "financial fragility-crowding out" hypothesis holds. Based on the BB-measure, the results show that an increase of 1% in the regulatory capital ratio yields a reduction on liquidity creation which represents 0.2% of the bank's gross total assets. A robustness check that makes use of a dynamic panel model regression validates this relationship.

Bearing in mind that regulatory requirements for banks to hold more liquid assets means lower liquidity creation, this finding enhances the need for policy makers to carefully counterbalance capital requirements, liquidity requirements and liquidity creation to the economy. This means that the introduction of Basel III/CRD IV, where both liquidity and capital requirements are increased for financial stability purposes, may severely contribute to the worsening of the economic environment.

When the sample is split by bank size, for most of the liquidity creation measures we find empirical evidence that among large and small banks the relationship between regulatory capital and liquidity creation is negative and significant. For medium banks, the relationship is positive but not significant. Therefore, there is no evidence that Euro area policy makers should put in place different regulatory measures dependent on the bank size. However, the negative and significant coefficient among large and small banks is sufficient to draw some conclusions. If for large banks tight capital and liquidity requirements are crucial to ensure financial stability and avoid systemic events, for small banks, an approach where less demanding buffers are required can be valid. In fact, to support an alternative approach for smaller banks, it is worth noting that for these banks the coefficient of lagged regulatory capital is highly significant when compared to large banks. Therefore, our findings may suggest that, for the benefit of economic growth, regulatory authorities can at some extent relax on capital and liquidity requirements as long as these small banks, at the aggregate level and on a local basis, do not represent any systemic threat. Although regulatory capital requirements usually enhance credit risk management and hence contribute to an efficient allocation of liquidity on projects that add value to the economy, for small banks the same could be achieved with the tightening of governance practices rather than the requirement of high levels of capital.

When we test for the presence of a structural break during the recent global financial crisis, no evidence is found that the relationship between regulatory capital and liquidity creation is different during turmoil periods. Therefore, no support is given to the idea that Euro area policy makers should put in place different regulatory capital measures during crises in order to avoid contributing to the worsening of the economic environment. However, the lack of non-crisis time periods in our sample is a limitation that should not be neglected. In this sense, the test for a structural break should be conducted in further researches that benefit from a longer time period with economic growth.

Overall, our conclusions are of interest to the regulatory authorities, especially in what concerns the negative impact that higher regulatory capital requirements tends to have on liquidity creation and consequently on economic growth. This fact can eventually trigger an increase of the “shadow banking” activities, where other sources of funding such as pension funds and investment banking may benefit from less strict capital adequacy rules. If, on the one hand, regulatory authorities should promote consistency of requirements across the financial system in order to ensure a level playing field, on the other hand, these alternative sources of funding can be a good solution for economic agents looking for funding at competitive prices.

Beyond the scope of this study, there are other relevant issues that require further research. For example, the study on whether banks comply with capital requirements and the consequences for liquidity creation generated by those that do not comply is an interesting subject to be listed on the research agenda. Likewise, the impact of liquidity creation in economic growth also compounds concern and should be explicitly studied. Finally, further research should consider as large banks those that are deemed as too-big-to-fail, a task that will get easier when policy makers formally clarify which banks are considered Systemically Important Financial Institutions (SIFI).

9. References

Accenture. 2012. Basel III handbook, 14:18.

Allen, F. and Gale, D. 2003. Financial fragility, liquidity and asset prices. Working Paper 01-37-B, Wharton Financial Institutions Center.

Allen, F. and Gale, D. 2004. Financial intermediaries and markets. Econometrica, 72: 1023-1061.

Allen, F. and Santomero, A. 1998. The theory of financial intermediation. Journal of Banking and Finance, 21: 1461-85.

Amato, J. and Furfine, C. 2004. Are credit ratings procyclical? Journal of Banking and Finance, 28: 2641-2677.

Angora, A. and Roulet, C. 2011. Transformation risk and its determinants: A new approach based on the Basel III liquidity management framework, Working Paper, Université de Limoges.

Arellano, M. and S. Bond. 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. The Review of Economic Studies, 58: 277-97.

Arrow K. J. and Debreu, G., 1954. The Existence of an Equilibrium for a Competitive Economy. Econometrica, 22:3, 265–290.

Bai, J., Krishnamurthy, A. and Weymuller, C.-H. 2013. Measuring liquidity mismatch in the banking sector. Working Paper.

Basel Committee on Banking Supervision. 1999. A new capital adequacy framework.

Basel Committee on Banking Supervision. 2004. International convergence of capital measurement and capital standards: a revised framework.

Basel Committee on Banking Supervision. 2010. Basel III: International Framework for liquidity risk measurement, standards and monitoring.

Basel Committee on Banking Supervision. 2011. Basel III: A global regulatory Framework for more resilient banks and banking system.

Basel Committee on Banking Supervision. 2014. Basel III: The Net Stable Funding Ratio. Consultative Document.

Benston, G. and Smith, C. 1976. A transaction cost approach to the theory of financial intermediation. Journal of Finance, 31: 215-231.

Berger, A. and Bowman, C. 2008. Financial crises and bank liquidity creation. Working Paper, University of South Carolina and Case Western Reserve University.

Berger, A. and Bowman, C. 2009. Bank Liquidity Creation. Review of Financial Studies, 22 (9): 3779-3837.

Berger, A., Bowman, C., Kick, T. and Schaeck, K. 2012. Bank risk taking and liquidity creation following regulatory interventions and capital support. CentER Discussion Paper, Tilburg, 2011-088.

Berger, A., Herring, R. and Szego, G. 1995. The role of capital in financial institutions. Journal of Banking and Finance, 19: 393-430.

Berger, A., Miller, N., Petersen, M., Rajan, R. and Stein, J. 2005. Does function follow organizational form? Evidence from the lending practices of large and small banks. Journal of financial Economics, 76: 237-69.

Berger, A. and Udell, G. 1994. Did risk-based capital allocate bank credit and cause a “credit crunch” in the United Stated?. Journal of Money, Credit and Banking, 26: 585-628.

Bhattacharya, S. and Thakor, A. 1993. Contemporary banking theory. Journal of Financial Intermediation, 3: 2-50.

Bowman, C. 2013. Liquidity; how banks create it and how it should be regulated. The Oxford Handbook of Banking, 2nd edition, forthcoming.

Breusch, T. and Pagan, A. 1980. The Lagrange Multiplier test and its applications to model specification in econometrics. Review of Economic Studies. 47(1): 239-253.

Brunnermeier, M., Gorton, G. and Krishnamurthy, A. 2011. Risk topography. NBER Macroeconomics Annual.

Brunnermeier, M., Gorton, G. and Krishnamurthy, A. 2012. Liquidity mismatch measurement, in Systemic Risk and Macro Modeling, ed. M. Brunnermeier and A. Krishnamurthy, NBER.

Bryant, J. 1980. A model of reserves, bank runs, and deposit insurance. Journal of Banking and Finance, 4: 335-344.

Calomiris, C. and Kahn, C. 1991. The role of demandable debt in structuring optimal banking arrangements. American Economic Review, 81: 497-513.

Calomiris, C., Kahn, W. and Krasa, S. 1991. Optimal contingent bank liquidation under moral hazard. Issues in Financial Regulation, Federal Reserve Bank of Chicago, Working Paper, Series no. 1991-13.

Cameron A. and Trivedi, P. 2009. Microeconometrics using Stata. College Station, TX: Stata Press.

Campbell, T. and Kracaw, W. 1980. Information production, market signaling, and the theory of financial intermediation. Journal of Finance, 35: 863-882.

Chow, G. 1960. Test of equality between sets of coefficients in two linear regressions. Econometrica, 28: 591-603.

Coval, J. and Thakor, A. 2005. Financial intermediation as a beliefs-bridge between optimists and pessimists. Journal of Financial Economics, 75: 535-69.

D'Agostino, R., Belanger, A. and D'Agostino Jr., R. 1990. A suggestion for using powerful and informative tests of normality. American Statistician, 44: 316-321.

Deep, A. and Schaefer, G. 2004. Are banks liquidity transformers?. Working Paper Series rwp04-022, Harvard University, John F. Kennedy School of Government.

Dewatripont, M. and Tirole, J. 1993a. The Prudential Regulation of Banks. Cambridge, MA, MIT Press.

Dewatripont, M. and Tirole, J. 1993b. Efficient Governance Structure: Implications for Banking Regulation. Capital Markets and Financial Intermediation, C. Mayer and X. Vives ed. Cambridge University Press, Cambridge, 12–35.

Diamond, D. 1984. Financial intermediation and delegated monitoring. Review of Financial Studies, 51: 393-414.

Diamond, D. and Dybvig, P. 1983. Bank runs, deposit insurance and liquidity. Journal of Political Economy, 91: 401-419.

Diamond, D. and Rajan, R. 2000. A theory of bank capital. Journal of Finance, 55: 2431-65.

Dierick, F., Pires, F., Scheicher, M., Spitzer, K. G. 2005. The new Basel capital framework and its implementation in the European Union. European Central Bank, Working Paper, No. 42.

Distinguin, I., Roulet, C. and Tarazi, A. 2013. Bank regulatory capital and liquidity: evidence from US and European Publicly Traded Banks. Journal of Banking and Finance, Elsevier, 37 (9): 3295-3317.

Drukker, D. 2003. Testing for serial correlation in linear panel-data models. Stata Journal (3)2: 168-177.

European Central Bank. 2005. The new Basel capital framework and its implementation in the European Union. Occasional Paper Series, 42.

European Central Bank and Bank of England. 2014. The case for a better functioning securitization market in the European Union. Discussion Paper.

European Parliament and Council of the European Union. 2006. Directive 2006/48/EU - the taking up and pursuit of the business of credit institutions. Official Journal of the European Union.

European Parliament and Council of the European Union. 2006. Directive 2006/49/EU - capital adequacy of investment firms and credit institutions. Official Journal of the European Union.

European Parliament and Council of the European Union. 2013. Capital Requirements Directive 2013/36/EU - access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms. Official Journal of the European Union.

European Parliament and Council of the European Union. 2013. Capital Requirements Regulation (575/2013) - prudential requirements for credit institutions and investment firms. Official Journal of the European Union.

Esho, N., Lam, Y. and Sharpe, I. 2001. Are maturity and debt type decisions interrelated? Evidence from international capital markets. Journal of Financial Intermediation, 10: 3-4.

Fama, E. 1980. Banking in the theory of finance. Journal of Monetary Economics, 6(1): 39-57.

Ferri, G., Liu, L. and J. Stiglitz. 1999. The procyclical role of rating agencies: evidence from the East Asian crisis. Economic Notes, 28: 335-356.

Fischer, S. 1983. A framework for monetary and banking analysis. Economic Journal, 93: 1-16.

Flannery, M. 1994. Debt maturity and the deadweight cost of leverage: optimally financing banking firms. American Economic Review, 84: 320-321.

Freixas, F. and Rochet, J. 1997. Microeconomics of banking. MIT Press, Cambridge, MA.

Fungácová, Z., Weill, L. and Zhou, M. 2010. Bank capital, liquidity creation and deposit insurance. BOFIT Discussion Papers 17/2010, Bank of Finland, Institute for Economies in Transition.

Furlong, F. and Keeley, M. 1989. Capital regulation and bank risk-taking: a note. Journal of Banking and Finance, 13 (6): 883-91.

Gambacorta, L. and Mistrulli, P. 2004. Does banks capital affect lending behavior?. Journal of Financial Intermediation, Elsevier, 13: 436-457.

Gatev, E., Schuermann, T. and Strahan, P. 2006. How do banks manage liquidity risk? Evidence from the equity and deposit markets in the fall of 1998. Risks of Financial institutions, (eds.) M. Carey and R. Stulz, University of Chicago Press, 105-27.

Gobat, J., Yanase, M. and Maloney, J. 2014. The Net Stable Funding Ratio: impact and issues for consideration. IMF Working Paper, 14/106.

Gorton, G. and Winton, A. 2000. Liquidity provision, bank capital, and the macroeconomy. Working Paper, University of Minnesota.

Greenbaum, S. and Thakor, A. 1987. Bank funding modes: securitization versus deposits. Journal of Banking and Finance, 11: 379-401.

Greene, W. 2000. Econometric analysis. 4th ed., New York, Prentice-Hall.

Greene, W. 2012. Econometric analysis. 7th ed., Boston, Prentice-Hall.

Gurley, J., Shaw, E. 1960. Money in a theory of finance. Washington, DC: Brookings Institute Press.

Guttentag, J. and Lindsay, R. 1968. The uniqueness of commercial banks. Journal of Political Economy, 71: 991-1014.

Hackethal, A., Rauch, C., Steffen, S. and Tyrell, M. 2010. Determinants of bank liquidity creation. Working Paper, European School of Management and Technology.

Hancock, D. and Wilcox, J. 1998. The "credit crunch" and the availability of credit to small business. Journal of Banking and Finance, Elsevier, 22: 983-1014.

Hausman, J. 1978. Specification tests in Econometrics. Econometrica, 46(6): 1251-1271.

Hellwig, M. 1991. Banking, financial intermediation and corporate finance. A. Giovannini and C. Mayer (eds.), European Financial Integration, Cambridge University Press.

Hoechle, D. 2007. Robust standard errors for panel regressions with cross-sectional dependence. Stata Journal 7(3): 281-312.

Holmstrom, B. and Tirole, J. 1998. Public and private supply of liquidity. Journal of Political Economy, 106: 1-40.

Horváth, R., Seidler, J. and Weill, L. 2012. Bank capital and liquidity creation: Granger-causality evidence. Working Paper Series 1497, European Central Bank.

Jacklin, C. and Bhattacharya, S. 1988. Distinguishing panics and information-based bank runs: welfare and policy implications. Journal of Political Economy, 96: 568-592.

Jackson, P., Furfine, C., Groeneveld, D., Hancock, D., Jones, D., Perraudin, W., Redecki, L., Yoneyama, M. 1999. Capital requirements and bank behavior: the impact of the Basle Accord. Basel Committee on Banking Supervision, Working Paper, No. 1.

Jensen, M. and Meckling, W. 1976. Theory of the firm: managerial behavior, agency costs and ownership structure. Journal of Financial Economics, 4: 305-360.

Jones, D. 2000. Emerging problems with the Basel Capital Accord: Regulatory capital arbitrage and related issues. Journal of Banking and Finance, 12: 35-38.

Kashyap, A., Rajan, R. and Stein, J. 2002. Banks as liquidity providers: an explanation for the coexistence of lending and deposit-taking. Journal of Finance, 57: 33-73.

Kashyap, A., Stein, J. 2004. Cyclical implications of the Basel II capital standards. Federal Reserve Bank of Chicago, Working Paper.

Kennedy, P. 1992. A guide to econometrics. Oxford: Blackwell, p.p. 183.

Klein, M. 1973. The economics of security divisibility and financial intermediation. The Journal of Finance, 28: 923-931.

Koehn, M. and Santomero, A. 1980. Regulation of bank capital and portfolio risk. Journal of Finance, 35: 1235-1244.

Leland, M., Pyle, D. 1977. Informational asymmetries, financial structure and financial intermediation. Journal of Finance, 32: 371-387.

Lin, S., Hwang, D., Wang, K. and Xie, Z. 2013. Banking capital and risk-taking adjustment under capital regulation: the role of financial freedom, concentration and governance control. International Journal of Management, Economics and Social Sciences, 2(2): 99-128.

Mankiw, N. 1986. The allocation of credit and financial collapse. Quarterly Journal of Economics, 101: 455-470.

Marshall, A. 1961. Principles of economics. Ninth (Valorium) Edition, Vol. I. Text, Macmillan and Co., London.

Merton, R. 1995. Financial innovation and the management and regulation of financial institutions. Journal of Banking and Finance, 19: 461-481.

Neter, J., Wasserman, W and Kutner, M. 1989. Applied linear regression models. Homewood, IL: Irwin, p.p. 409.

Park, H. 2011. Practical guides to panel data modeling: a step-by-step analysis using Stata. Tutorial Working Paper. Graduate School of International Relations, International University of Japan.

Peek, J. and Rosengren, E. 1995. The capital crunch: neither a borrower nor a lender be. Journal of Money, Credit and Banking, 27: 625-38.

Pesaran, M. 2004. General diagnostic tests for cross section dependence in panels. Cambridge Working Papers in Economics, 0435, University of Cambridge.

Pyle, D. 1971. On the theory of financial intermediation. Journal of Finance, 26: 737-747.

Repullo, R. 2004. Capital requirements, market power, and risk-taking in banking. Journal of Financial Intermediation, 13: 156-182.

Repullo, R. and Suarez, J. 2008. The procyclical effects of Basel II. CEMFI, Paper No. 0809.

Riccetti, L., Russo, A. and Mauro, G. 2013. Financial regulation in an agent-based macroeconomic model. MPRA Paper No. 51013.

Rochet, J. 1992. Capital requirements and the behavior of commercial banks. European Economic Review, 36: 1137-1178.

Roodman, D. 2009. How to do xtabond2: an introduction to "Difference" and "System" GMM in Stata. Stata Journal, 9(1): 86-136.

Santomero, A. and Watson, R. 1977. Determining an optimal capital standard for the banking industry. Journal of Finance, 32(4): 1267-1282.

Santomero, A. M. 1984. Modeling the banking firm: a survey. Journal of Money, Credit and Banking, 16: 576-602.

Santos, J. 2001. Bank capital regulation in contemporary banking theory: a review of the literature. Financial Markets, Institutions, and Instruments, 10: 41-84.

Scholtens, B. and Wensveen, D. 2003. The theory of financial intermediation: an essay on what it does (not) explain. The European Money and Finance Forum.

Sealey, C. 1980. Deposit rate setting, risk aversion, and the theory of production and cost at depository financial intermediaries. Journal of finance, 35, 5: 1139-54.

Stock, J. and Watson, M. 2007. Introduction to econometrics. 2nd ed., Boston: Pearson/Addison.

Tobin, J. 1963. Commercial banks as creators of “money”. W. L. Smith and R. L. Teigen (eds.), Readings in Money, National Income, and Stabilization Policy, Homewood III, Richard D. Irwin.

Towey, R. 1974. Money creation and the theory of the banking firm. Journal of Finance, 29: 57-72.

Walras, L. 1954. Elements of pure economics. Translated by William Jaffé from the 5th ed., Irwin, Homewood, III.

Wooldridge, J. 2002. Econometric analysis of cross section and panel data. Cambridge, MA: MIT Press.

Appendixes

I. Sample representativeness by country

Country	Country Code	Banks available in Bankscope	Banks in sample	Total Assets in sample / Total assets Bankscope (by country)
Austria	AT	310	23	81%
Belgium	BE	54	7	67%
Germany	DE	1726	181	42%
Spain	ES	148	10	69%
Finland	FI	20	5	90%
France	FR	275	13	54%
Greece	GR	14	1	0%
Ireland	IE	24	2	37%
Italy	IT	598	336	61%
Luxembourg	LU	84	3	25%
Netherlands	NL	58	10	41%
Portugal	PT	40	8	85%
New Euro area members		85	0	0%
Total		**3436**	**599**	**52%**

II. Mapping between the Berger and Bowman (2009) original measure and the proxy for the BB-measure

BB-measure Items	BB Measure Weights	Proxy Items	Proxy Weights	Calculation (if applicable)	Assumptions
A. Illiquid Assets					
A1. Commercial real estate (CRE) loans	1/2	**Loans to customers (except mortgage and consumer loans)**	1/2	[Loans to customers = Total Gross loans - Mortgage and consumer loans]	These categories of loans are assumed to be included in the proxy item of loans to customers after the exclusion of mortgage and consumer loans.
A2. Loans to agricultural production	1/2		1/2		
A3. Commercial and industrial (C&I) loans	1/2		1/2		
A4. Other loans and lease financing receivables	1/2		1/2		
A5. Other real estate owned (OREO)	1/2		1/2		
A6. Customers' liabilities on bankers acceptances	1/2	**Other assets**	1/2		These categories of Illiquid assets are included in the residual proxy item of other assets and a weight of 1/2 is assigned in accordance.
A7. Investment in unconsolidated subsidiaries	1/2		1/2		
A8. Intangible assets	1/2		1/2		
A9. Premises	1/2		1/2		
A10. Other assets	1/2		1/2		
B. Semiliquid Assets					
B1. Loans to depository institutions	0	**Loans and advances to banks**	0		A direct mapping is possible for this item.
B2. Loans to state and local governments	0	**Loans to customers (except mortgage and consumer loans)**	1/2		Since the breakdown of loans available does not identify loans to government, and securitization of these assets is not common, the weight assigned is 1/2 such as the weight attributed to loans to customers (except mortgage and consumer loans).
B3. Loans to foreign governments	0		1/2		
B4. Residential real estate (RRE) loans	0	**Mortgage and consumer loans to customers**	1/4	If available: item Mortgage and consumer loans if not available: extrapolation of the proportion of Mortgage and consumer loans on Total Gross loans, for each year, over a sample of 6983 observations (average ratio of 47.7%)	Berger and Bowman (2009) assign a weight of 0 to mortgage and consumer loans due to the ease, cost and time with which the bank can securitize these loans. However, considering the significant reduction of these portfolios' securitization (as stated in the Discussion Paper from ECB and BoE in 2014), the weight assigned is the average between 0 and 1/2.
B5. Consumer loans	0		1/4		
C. Liquid Assets					
C1. Cash and due from other institutions	- 1/2	**Cash and due from banks**	- 1/2		A direct mapping is possible for this item.
C2. All securities (regardless of maturity)	- 1/2	**Total securities**	- 1/2		Trading assets are assumed to be included in the broad concept of total securities from the European accounting standards.
C3. Trading assets	- 1/2		- 1/2		
C4. Fed funds sold	- 1/2	**Cash and due from banks**	- 1/2		The European accounting standards do not include an item explicitly for the recording of ECB funding and it is assumed to be included in the proxy item of cash and due from banks.

BB Measure Items	BB Measure Weights	Proxy Items	Proxy Weights	Calculation (if applicable)	Assumptions
D. Illiquid Liabilities plus Equity					
D1. Bank's liability on bankers acceptances	- 1/2	**Other borrowed money**	0	[Other borrowed money = Total L/T funding - Subordinated debt + Money market and S/T funding]	Since information on bank's liabilities on bankers acceptances is not available, other borrowed money is assumed to include these liabilities.
D2. Subordinated debt	- 1/2	**Subordinated debt**	- 1/2		A direct mapping is possible for this item.
D3. Other liabilities	- 1/2	**Other liabilities**	- 1/2	[Other liabilities = Other liabilities NSFR - Trading liabilities]	The residual liabilities are assumed to correspond to the item of other liabilities.
D4. Equity	- 1/2	**Total equity**	- 1/2		A direct mapping is possible for this item.
E. Semiliquid Liabilities					
E1. Time deposits	0	**Current deposits**	0		A direct mapping is possible for this item.
E2. Other borrowed money	0	**Other borrowed money**	0	[Other borrowed money = Total L/T funding - Subordinated debt + Money market and S/T funding]	Total long-term funding after excluding subordinated debt and money market and short-term funding is assumed to correpond to the item of other borrowed money.
F. Liquid Liabilities					
F1. Overnight fed funds purchased	1/2	N/A	1/2		Since information on ECB funds purchased is not available, it is considered to be included in the categories of Deposits.
F2. Transaction deposits F3. Savings deposits	1/2 1/2	**Term and savings deposits**	1/2 1/2		A direct mapping is possible for these items.
F4. Trading liabilities	1/2	**Trading Liabilities**	1/2	If available: item Trading liabilities If not available: extrapolation of the proportion of Trading liabilities on Other liabilites over a sample of 70 observations (average ratio of 23%)	A direct mapping is possible for this item. Due to the lack of available information, the extrapolation described in the column of calculation is conducted.
G. Illiquid Guarantees					
G1. Unused commitments G2. Net standby letters of credit G3. Commercial and similar letters of credit G4. All other off-balance sheet liabilities	1/2 1/2 1/2 1/2	**Guarantees and Commited credit lines**	1/2 1/2 1/2 1/2		A direct mapping is possible for this item.
H. Semiliquid Guarantees					
H1. Net credit derivatives	0	N/A	0		Information not available
H2. Net securities lent	0	N/A	0		Information not available
I. Liquid Guarantees					
I1. Net participations acquired	- 1/2	N/A	0		Information not available
J. Liquid Derivatives					
J1. Interest rate, FX, equity and commodity derivatives	- 1/2	N/A	0		Information not available

Source: Berger and Bowman (2009) and ECB and BoE (2014)

III. Mapping between the regulatory concept of NSFR and the proxy for the Inverse NSFR measure

Basel III Regulation Items	Regulatory Weights	Proxy Items	Proxy Weights	Calculation (if applicable)	Assumptions
A. NSFR: Available Stable Funding (ASF)					
A1. Total regulatory capital	100%	**Total equity**	100%		The item of total equity is used due to the lack of available observations of the item regulatory capital. Since regulatory capital includes total equity and some instruments of L/T funding (subordinated debt with strong loss absorption characteristics), the assignment of the same weight to both regulatory capital and total L/T Funding (100%) is an assumption with a negligible impact.
A2. Other capital instruments and liabilities with effective residual maturity of one year or more	100%	**Total L/T funding**	100%		
A3. "Stable" demand deposits and/or term deposits with residual maturity < 1 year provided by retail and SME customers	95%	**Term and savings deposits**	95%	[Term and savings deposits = Total customer deposits - Current deposits]	The weight assigned follows the assumptions undertaken by Gobat, Yanase and Maloney (2014). The items Term and Savings Deposits are assumed to represent "stable" demand deposits. Although the lack of information regarding the depositors (retail, SME or other) could lead us to assign a lower weight than 95%, the lack of information regarding maturities is the reason why the weight of 95% is assigned to all term and savings deposits (deposits with maturities greater than 1 year would be assigned with a 100% weight).
A4. Less stable demand deposits and/or term deposits with residual maturity < 1 year provided by retail and SME customers	90%	**Current deposits**	90%		The weight assigned follows the assumptions undertaken by Gobat, Yanase and Maloney (2014). Current deposits are assumed to represent less "stable" demand deposits. Although the lack of information regarding the depositors (retail, SME or other) could lead us to assign a lower weight than 90%, the lack of information regarding maturities is the reason why the weight of 90% is assigned to all term and savings deposits (deposits with maturities greater than 1 year would be assigned with a 100% weight).
A5. Funding with residual maturity of less than one year provided by non-financial corporate customers	50%	**Money market and S/T funding**	50%	[MM and S/T funding = Total deposits, MM and S/T funding - Total customer deposits]	The item of money market and S/T funding is assumed to represent all these 4 categories.
A6. Operational deposits	50%		50%		
A7. Funding with residual maturity of less than one year from sovereigns, public sector entities (PSEs), and multilateral and national development banks	50%		50%		
A8. Other funding with residual maturity of not less than six months and less than one year not included in the above categories, including funding provided by central banks and financial institutions	50%		50%		
A9. All other liabilities and equity categories not included in the above categories, including liabilities without a stated maturity	0%	**Other liabilities**	0%	[Other liabilities = Total liabilities - Total L/T funding - Total customer deposits - MM and S/T funding]	The remaning items of total liabilities are assumed to fall under these 2 categories.
A10. Derivatives payable net of derivatives receivable if payables are greater than receivables	0%		0%		

Basel III Regulation Items	Regulatory Weights	Proxy Items	Proxy Weights	Calculation (if applicable)	Assumptions
B. NSFR: Required Stable Funding (RSF)					
B1. Coins and Banknotes	0%	**Cash and due from banks**	0%		The item of cash and due from banks is assumed to represent all these 2 categories.
B2. All central bank reserves	0%		0%		
B3. Unencumbered loans to banks subject to prudential supervision with residual maturities of less than six months	0%	**Loans and advances to banks**	5%		Although Gobat, Yanase and Maloney (2014) assume a 0% weight to assign to loans and advances to banks, the lack of information regarding (i) loans to banks subject to prudential supervision and (ii) maturity of loans to banks, lead us to assign a more conservative weight of 5% to this category.
B4. Unencumbered Level 1 assets, excluding coins, banknotes and central bank reserves	5%	**Government bonds**	5%		Considering the lack of information regarding level 1 assets, all government bonds are assumed to fall under this category and other securities are not considered.
B5. Unencumbered Level 2A assets	15%		33%		
B6. Unencumbered Level 2B assets	50%		33%		
B7. HQLA encumbered for a period of six months or more and less than one year	50%		33%		Considering the lack of information regarding Level 2A and 2B assets, as well as of other categories assigned with a 50% weight, a weight of 33% is assigned to the item of other securities (average between 15% and 50%).
B8. Loans to banks subject to prudential supervision with residual maturities six months or more and less than one year	50%	**Other securities**	33%	[Other securities = Total securities - Government bonds]	
B9. Deposits held at other financial institutions for operational purposes	50%		33%		
B10. All other assets not included in the above categories with residual maturity of less than one year, including loans to non-bank financial institutions, loans to non-financial corporate clients, loans to retail and small business customers, and loans to sovereigns, central banks and PSEs	50%		33%		
B11. Unencumbered residential mortgages with a residual maturity of one year or more and with a risk weight of less than or equal to 35%	65%		75%		
B12. Other unencumbered loans not included in the above categories, excluding loans to financial institutions, with a residual maturity of one year or more and with a risk weight of less than or equal to 35% under the Standardised Approach	65%	**Gross loans**	75%		Although Gobat, Yanase and Maloney (2014) assume a 85% weight to assign to loans, the lack of information regarding (i) the volume of mortgage loans, (ii) loans unemcumbered or pledged as collateral, (iii) the risk-weight assigned to each loan and (iv) performing and non-performing loans, lead us to assign a 75% weight to this category (average between 65% and 85%).
B13. Other unencumbered performing loans with risk weights greater than 35% under the Standardised Approach and residual maturities of one year or more, excluding loans to financial institutions	85%		75%		
B14. Unencumbered securities that are not in default and do not qualify as HQLA including exchange-traded equities	85%		75%		
B15. Physical traded commodities, including gold	85%		100%		
B16. All assets encumbered for a period of one year or more	100%		100%		
B17. Derivatives receivable net of derivatives payable if receivables are greater than payables	100%		100%	[Other assets = Total assets - Cash and due from banks - Loans and advances to banks - Government bonds - Other securities - Net loans]	The remaning items of total assets are assumed to fall under these 4 categories. Due to the lack of information regarding physical traded commodities, it is assumed to be included in the item other assets and a weight of 100% is assigned.
B18. All other assets not included in the above categories, including non-performing loans, loans to financial institutions with a residual maturity of one year or more, non-exchange-traded equities, fixed assets, pension assets, intangibles, deferred tax assets, retained interest, insurance assets, subsidiary interests, and defaulted securities	100%	**Other assets**	100%		
B19. Irrevocable and conditionally revocable credit and liquidity facilities to any client	5%	**Off-balance sheet**	5%		A direct mapping is possible for this item.

Source: BCBS (2014) and Gobat et al. (2014)

IV. Description of the explanatory variables

Variable	Category	Calculation	Source
Regulatory Capital Ratio	Main Explanatory Variable	$\left[\frac{Total\ Regulatory\ Capital}{Total\ RWA}\right]$ Bank-level	Bankscope
Real GDP growth	Market Economic Conditions	Country-level	SNL Database
Herfindahl Index	Local Market Competition	Country-level	ECB statistics
Spread ST LT interest rates	Monetary Policy	$[LT\ interest\ rate - ST\ interest\ rate]$ Country-level **LT interest rate:** secondary market yields of government bonds with a remaining maturity close to ten years. **ST interest rate:** 3-month "European Interbank Offered Rate". **Observations:** annual data are averages of monthly figures. Figures not available in ECB Statistics were retrieved from Eurostat or local central bank websites.	ECB statistics, Eurostat and Local Central Bank websites
Ln (GTA)	Bank Size	$\ln(GTA)$ Bank-level	Bankscope
Market Share	Bank Market Power	$\left[\frac{Total\ Assets_i}{Total\ Assets}\right]$ Bank-level **Total Assets$_i$:** total assets from country i banks included in the initial sample **Total Assets:** total assets from the Euro area banks included in the initial sample	ECB statistics
ROE	Bank Performance	$\left[\frac{Net\ Income}{Equity}\right]$ Bank-level	Bankscope
Z-score	Bank Risk	$\left[\frac{ROA}{\sigma(ROA)} + \frac{Equity}{GTA}\right]$ Bank-level **Observations:** standard deviation of ROA is fixed for each bank and calculated across the entire period of the sample	Bankscope

V. Full descriptive statistics (2006-2012)

		All Banks					Large Banks					Medium Banks					Small Banks				
Variables	Δ [06-12]	Mean	Median	Max	Min	Std. Dev.	Mean	Median	Max	Min	Std. Dev.	Mean	Median	Max	Min	Std. Dev.	Mean	Median	Max	Min	Std. Dev.
Gross Loans (€Mn)	17%	16 625	347	709 943	17	66 738	62 781	18 245	773 128	131	126 933	1 055	995	3 474	27	534	931	182	1 032	17	173
Gross Loans/GTA (%)	-2%	63,1%	65,8%	96,0%	6,5%	16,5%	59,6%	63,2%	93,6%	6,7%	19,9%	71,2%	72,3%	94,6%	6,5%	15,3%	62,5%	65,4%	96,0%	21,4%	14,5%
Inverse NSFR (%)	4%	68,1%	68,4%	170,3%	17,1%	13,6%	75,1%	77,8%	171,0%	23,6%	18,8%	72,0%	71,0%	140,6%	17,1%	13,2%	64,1%	65,5%	115,8%	31,7%	10,4%
BB Measure (€Mn)	2%	6 280	142	363 559	-505 547	30 652	23 686	8 277	378 180	-258 877	81 624	442	374	998	33	169	148	93	424	1	79
BB Measure/GTA (%)	-17%	27,7%	27,3%	136,5%	-33,0%	14,6%	27,8%	33,7%	98,4%	-45,1%	22,8%	28,6%	36,9%	57,0%	4,0%	11,1%	27,5%	41,6%	78,7%	0,2%	13,9%
Regulatory Capital (€Mn)	14%	1 787	52	84 308	3	6 987	6 710	1 863	88 414	93	13 260	138	136	340	16	63	116	30	158	3	24
Regulatory Capital ratio (%)	12%	15,5%	14,1%	53,6%	0,8%	5,8%	13,2%	12,1%	48,5%	0,8%	4,3%	13,9%	13,3%	35,0%	6,8%	3,9%	17,1%	15,3%	53,6%	5,9%	6,2%
GDP growth (%)	-143%	0,3%	0,9%	6,6%	-8,5%	2,9%	0,5%	1,4%	6,6%	-8,5%	2,8%	-0,1%	0,9%	4,1%	-5,5%	2,8%	0,3%	0,9%	5,5%	-7,1%	2,9%
Herfindahl Index (%)	44%	4,0%	3,1%	37,0%	1,8%	3,9%	6,6%	4,1%	37,0%	1,8%	6,7%	4,1%	3,1%	12,1%	1,8%	1,5%	3,1%	3,1%	14,9%	1,8%	0,9%
Spread ST/LT int. rate (%)	313%	1,8%	1,2%	21,9%	-0,6%	1,8%	1,8%	1,6%	10,0%	-0,6%	1,8%	2,2%	1,8%	10,0%	-0,6%	1,8%	1,9%	1,2%	21,9%	-0,6%	1,8%
GTA (€Mn)	11%	37 458	538	2 098 792	34	172 221	142 272	28 262	2 204 361	888	333 708	1 515	1 448	8 280	405	676	2 346	305	1 277	34	227
Ln (GTA)	2%	14	13	21	10	2	17	17	22	14	2	14	14	16	13	0	12	13	14	10	1
Market Share (%)	-1%	1%	0%	61%	0%	4%	4,0%	0,8%	60,8%	0,0%	7,2%	0,1%	0,0%	0,5%	0,0%	0,1%	0,1%	0,0%	0,1%	0,0%	0,0%
ROE (%)	-71%	5%	5%	57%	-97%	8%	5,9%	6,5%	56,6%	-96,6%	13,1%	5,3%	4,8%	33,0%	-35,1%	5,4%	4,6%	4,1%	46,2%	-56,2%	4,6%
Z-score	-36%	2,7	2,0	34,0	-2,4	3,6	1,7	1,2	16,3	-2,4	2,3	2,5	2,2	20,8	-2,4	3,1	3,2	2,2	34,0	-2,4	4,0

VI. Descriptive statistics of the dependent and the main explanatory variables

		2006		2012		Growth rate		CAGR
Dependent variables	# of banks	LC (€Mn / %)	LC / GTA (%)	LC (€Mn / %)	LC / GTA (%)	LC (€Mn / %)	LC / GTA (%)	LC (€Mn / %)
Gross Loans - All banks	599	8 584 554	-	10 038 315	-	17%	-	-
Average	-	14 331	62,4%	16 758	60,9%	17%	-2%	3,2%
Standard deviation	-	56 334	16,3%	66 656	15,4%	18%	-6%	-
Gross Loans - Large banks	156	8 443 599	58,0%	9 859 413	59,3%	17%	2%	3,1%
Gross Loans - Medium banks	85	74 612	68,7%	95 547	66,0%	28%	-4%	5,1%
Gross Loans - Small banks	358	66 343	62,8%	83 355	60,4%	26%	-4%	4,7%
Inverse NSFR - All banks	599	-	-	-	-	-	-	-
Average	-	66,8%	-	69,8%	-	4%	-	0,9%
Standard deviation	-	13,3%	-	13,6%	-	2%	-	-
Inverse NSFR - Large banks	156	73,1%	-	75,5%	-	3%	-	0,7%
Inverse NSFR - Medium banks	85	70,6%	-	72,9%	-	3%	-	0,6%
Inverse NSFR - Small banks	358	63,2%	-	66,6%	-	5%	-	1,0%
BB measure - All banks	599	3 413 789	-	3 496 482	-	2%	-	-
Average	-	5 699	28,0%	5 837	23,3%	2%	-17%	0,5%
Standard deviation	-	27 007	15,2%	29 400	14,6%	9%	-4%	-
BB measure - Large banks	156	3 354 429	27,8%	3 434 697	24,5%	2%	-12%	0,5%
BB measure - Medium banks	85	31 388	30,4%	32 781	24,2%	4%	-21%	0,9%
BB measure - Small banks	358	27 972	27,5%	29 004	22,6%	4%	-18%	0,7%

Main explanatory variable	# of banks	Own Funds / RWA	Own Funds / RWA	Own Funds / RWA	Own Funds / RWA
Reg. Capital ratio - All banks	599	-	-	-	-
Average	-	14,8%	16,5%	11,6%	2,2%
Standard deviation	-	5,6%	5,7%	1,8%	-
Reg. Capital ratio - Large banks	156	12,0%	15,1%	25,8%	4,7%
Reg. Capital ratio - Medium	85	13,2%	15,0%	13,3%	2,5%
Reg. Capital ratio - Small banks	358	16,4%	17,5%	6,7%	1,3%

Observations: the values are inflation adjusted.

VII. Stand-alone contribution of each item to aggregate liquidity creation measured by the Inverse NSFR and the BB-measure

	Growth rate (2012 vs. 2006)				Contribution to LC measure variation			
	All banks	Large banks	Medium banks	Small banks	All banks	Large banks	Medium banks	Small banks
Inverse NSFR (RSF/ASF)	**4,5%**	**3,3%**	**3,2%**	**5,3%**				
Required Stable Funding	**26,6%**	**26,4%**	**41,5%**	**40,2%**				
Gross loans	31,5%	31,8%	33,8%	33,9%	74%	74%	93%	89%
Government bonds	52,9%	41,7%	102,5%	56,6%	1%	1%	3%	3%
Loans and advances to banks	-9,7%	-8,6%	21,0%	19,5%	0%	0%	1%	1%
Other securities	13,8%	6,0%	-6,1%	1,3%	11%	12%	0%	4%
Cash and due from banks	261,6%	85,7%	8,8%	-2,9%	0%	0%	0%	0%
Other assets	25,6%	22,5%	-0,9%	8,3%	13%	13%	3%	3%
Off-balance sheet	44,3%	10,7%	12,8%	18,9%	2%	2%	0%	0%
Available Stable Funding	**21,1%**	**20,9%**	**38,7%**	**34,2%**				
Total equity	40,9%	31,0%	21,7%	23,5%	-12%	-13%	-14%	-17%
Total L/T funding	-16,6%	-11,3%	23,6%	40,9%	23%	25%	14%	13%
Term and savings deposits	39,6%	37,8%	11,6%	3,3%	-45%	-48%	-28%	-18%
Current deposits	25,6%	19,8%	28,8%	31,0%	-26%	-27%	-41%	-51%
Money market and S/T funding	43,9%	34,0%	75,9%	54,7%	-41%	-43%	-61%	-58%
BB measure	**2,4%**	**2,4%**	**4,4%**	**3,7%**				
Mortgage and Consumer loans	49,4%	49,1%	50,4%	41,6%	92%	92%	93%	75%
Other loans	16,3%	19,7%	26,5%	38,0%	72%	71%	109%	146%
Loans and advances to banks	-9,7%	-4,4%	28,5%	29,6%	-22%	-24%	28%	40%
Cash and due from banks	261,6%	166,6%	38,2%	-0,1%	-59%	-60%	-8%	1%
Total securities	18,7%	16,4%	35,8%	30,2%	-138%	-137%	-163%	-180%
Other assets	25,6%	26,7%	9,4%	23,0%	33%	33%	6%	8%
Total equity	40,9%	30,7%	21,5%	26,4%	-33%	-33%	-32%	-42%
Subordinated debt	-11,1%	-2,0%	102,0%	70,2%	3%	3%	-4%	-3%
Current deposits	25,6%	21,8%	25,1%	30,1%	0%	0%	0%	0%
Term and savings deposits	39,6%	38,7%	26,9%	9,7%	130%	132%	71%	48%
Other borrowed money	43,9%	47,6%	189,4%	338,5%	0%	0%	0%	0%
Trading liabilities	-4,3%	-11,1%	-20,3%	5,5%	-6%	-6%	2%	5%
Other liabilities	24,4%	20,1%	-20,7%	-0,2%	-38%	-38%	-3%	-5%
Off-balance sheet	30,3%	24,8%	5,9%	18,9%	65%	66%	2%	7%

Observations: the main stand-alone contributions are highlighted in green.

VIII. F-test for bank and time fixed effects

BB-measure as dependent variable

F-test for bank fixed effects

```
F test that all u_i=0:     F(598, 2982) =    23.95          Prob > F = 0.0000
```

F-test for time fixed effects

```
( 1)  2008.year = 0
( 2)  2009.year = 0
( 3)  2010.year = 0
( 4)  2011.year = 0                F(  5,  2982) =    50.02
( 5)  2012.year = 0                     Prob > F =    0.0000
```

Observations: In order to avoid perfect multicollinearity, the periods of 2006 and 2007 are automatically dropped by the software package Stata.

Inverse NSFR as dependent variable

F-test for bank fixed effects

```
F test that all u_i=0:     F(598, 2982) =    20.54          Prob > F = 0.0000
```

F-test for time fixed effects

```
( 1)  2008.year = 0
( 2)  2009.year = 0
( 3)  2010.year = 0
( 4)  2011.year = 0                F(  5,  2982) =     5.69
( 5)  2012.year = 0                     Prob > F =    0.0000
```

Observations: In order to avoid perfect multicollinearity, the periods of 2006 and 2007 are automatically dropped by the software package Stata.

Gross loans as dependent variable

F-test for bank fixed effects

```
F test that all u_i=0:     F(598, 2982) =    48.81          Prob > F = 0.0000
```

F-test for time fixed effects

```
( 1)  2008.year = 0
( 2)  2009.year = 0
( 3)  2010.year = 0
( 4)  2011.year = 0                F(  5,  2982) =    41.58
( 5)  2012.year = 0                     Prob > F =    0.0000
```

Observations: In order to avoid perfect multicollinearity, the periods of 2006 and 2007 are automatically dropped by the software package Stata.

IX. Breusch and Pagan Lagrange multiplier test for random effects

BB-measure as dependent variable

LM-test for random effects

```
Breusch and Pagan Lagrangian multiplier test for random effects

        bb_measure[rank,t] = Xb + u[rank] + e[rank,t]

        Estimated results:
                         |       Var     sd = sqrt(Var)
                ---------+-----------------------------
                bb_meas~e|   .0209512       .1447453
                        e|   .0033061       .0574989
                        u|   .0115691       .1075596

        Test:   Var(u) = 0
                             chibar2(01) =   4944.15
                          Prob > chibar2 =    0.0000
```

Inverse NSFR as dependent variable

LM-test for random effects

```
Breusch and Pagan Lagrangian multiplier test for random effects

        i_nsfr[rank,t] = Xb + u[rank] + e[rank,t]

        Estimated results:
                         |       Var     sd = sqrt(Var)
                ---------+-----------------------------
                   i_nsfr|   .0185853        .136328
                        e|   .0030249       .0549989
                        u|   .0094537         .09723

        Test:   Var(u) = 0
                             chibar2(01) =   4792.89
                          Prob > chibar2 =    0.0000
```

Gross loans as dependent variable

LM-test for random effects

```
Breusch and Pagan Lagrangian multiplier test for random effects

        grossloans[rank,t] = Xb + u[rank] + e[rank,t]

        Estimated results:
                         |       Var     sd = sqrt(Var)
                ---------+-----------------------------
                grosslo~s|   .0271299       .1647117
                        e|   .0021608       .0464845
                        u|   .0149387       .1222241

        Test:   Var(u) = 0
                             chibar2(01) =   5525.31
                          Prob > chibar2 =    0.0000
```

X. Hausman (1978) specification test for fixed vs. random effects

BB-measure as dependent variable
Hausman (1978) specification test

```
    chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =      189.47
Prob>chi2 =        0.0000
```

Inverse NSFR as dependent variable
Hausman (1978) specification test

```
    chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =      122.50
Prob>chi2 =        0.0000
```

Gross loans as dependent variable
Hausman (1978) specification test

```
    chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =      330.86
Prob>chi2 =        0.0000
```

XI. Variance Inflation Factor (VIF) for multicollinearity testing

Variable	VIF	1/VIF
l1lngta	1.83	0.545438
l1share	1.73	0.579356
l1herfindahl	1.36	0.732956
l1spread_l~t	1.23	0.814344
l1regcap_r~o	1.17	0.856655
l1gdp	1.13	0.881390
l1zscore	1.12	0.895131
l1roe	1.08	0.927022
Mean VIF	1.33	

XII. D'Agostino et al. (1990) and Information Matrix tests for normality

BB-measure as dependent variable

D'Agostino et al. (1990) test for normality

Skewness/Kurtosis tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	joint adj chi2(2)	joint Prob>chi2
uhat	3.6e+03	0.0000	0.0000	.	0.0000

Cameron and Trivedi (2009) test for normality (Information Matrix test)

Cameron & Trivedi's decomposition of IM-test

Source	chi2	df	p
Heteroskedasticity	217.20	44	0.0000
Skewness	18.46	8	0.0180
Kurtosis	6.55	1	0.0105
Total	242.21	53	0.0000

Inverse NSFR as dependent variable

D'Agostino et al. (1990) test for normality

Skewness/Kurtosis tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	joint adj chi2(2)	joint Prob>chi2
uhat3	3.6e+03	0.0000	0.0000	.	0.0000

Cameron and Trivedi (2009) test for normality (Information Matrix test)

Cameron & Trivedi's decomposition of IM-test

Source	chi2	df	p
Heteroskedasticity	397.64	44	0.0000
Skewness	56.12	8	0.0000
Kurtosis	18.18	1	0.0000
Total	471.94	53	0.0000

Gross loans as dependent variable

D'Agostino et al. (1990) test for normality

Skewness/Kurtosis tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	joint adj chi2(2)	joint Prob>chi2
uhat2	3.6e+03	0.0000	0.0000	.	0.0000

Cameron and Trivedi (2009) test for normality (Information Matrix test)

Cameron & Trivedi's decomposition of IM-test

Source	chi2	df	p
Heteroskedasticity	342.46	44	0.0000
Skewness	213.59	8	0.0000
Kurtosis	32.32	1	0.0000
Total	588.37	53	0.0000

XIII. Modified Wald test for groupwise heteroskedasticity

BB-measure as dependent variable
Modified Wald test for groupwise heteroskedasticity

```
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (599)  =    2.0e+05
Prob>chi2 =       0.0000
```

Inverse NSFR as dependent variable
Modified Wald test for groupwise heteroskedasticity

```
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (599)  =    4.2e+05
Prob>chi2 =       0.0000
```

Gross loans as dependent variable
Modified Wald test for groupwise heteroskedasticity

```
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (599)  =    1.3e+05
Prob>chi2 =       0.0000
```

XIV. Pesaran (2004) test for cross-sectional independence

BB-measure as dependent variable
Pesaran (2004) test for cross-sectional independence
Pesaran's test of cross sectional independence = 3.354, Pr = 0.0008
Average absolute value of the off-diagonal elements = 0.461

Inverse NSFR as dependent variable
Pesaran (2004) test for cross-sectional independence
Pesaran's test of cross sectional independence = 2.411, Pr = 0.0159
Average absolute value of the off-diagonal elements = 0.446

Gross loans as dependent variable
Pesaran (2004) test for cross-sectional independence
Pesaran's test of cross sectional independence = -1.116, Pr = 0.2646
Average absolute value of the off-diagonal elements = 0.480

XV. Wooldridge (2002) test for autocorrelation in panel data

BB-measure as dependent variable
Wooldridge (2002) test for autocorrelation
Wooldridge test for autocorrelation in panel data H0: no first-order autocorrelation F(1, 598) = 14.539 Prob > F = 0.0002

Inverse NSFR as dependent variable
Wooldridge (2002) test for autocorrelation
Wooldridge test for autocorrelation in panel data H0: no first-order autocorrelation F(1, 598) = 96.410 Prob > F = 0.0000

Gross loans as dependent variable
Wooldridge (2002) test for autocorrelation
Wooldridge test for autocorrelation in panel data H0: no first-order autocorrelation F(1, 598) = 453.327 Prob > F = 0.0000

XVI. Higher order autocorrelation

BB-measure as dependent variable
Wooldridge (2002) test for autocorrelation
Autocorrelation at lag 1 = 0.844
Autocorrelation at lag 2 = 0.771
Autocorrelation at lag 3 = 0.744
Autocorrelation at lag 4 = 0.668
Autocorrelation at lag 5 = 0.640

Inverse NSFR as dependent variable
Wooldridge (2002) test for autocorrelation
Autocorrelation at lag 1 = 0.218
Autocorrelation at lag 2 = 0.229
Autocorrelation at lag 3 = 0.191
Autocorrelation at lag 4 = 0.139
Autocorrelation at lag 5 = 0.116

Gross loans as dependent variable
Wooldridge (2002) test for autocorrelation
Autocorrelation at lag 1 = 0.308
Autocorrelation at lag 2 = 0.313
Autocorrelation at lag 3 = 0.284
Autocorrelation at lag 4 = 0.247
Autocorrelation at lag 5 = 0.265

XVII. Panel Corrected Standard Errors regression outputs

	All Banks			Large Banks			Medium Banks			Small Banks		
Variables	BB-measure	Inverse NSFR measure	Gross Loans measure	BB-measure	Inverse NSFR measure	Gross Loans measure	BB-measure	Inverse NSFR measure	Gross Loans measure	BB-measure	Inverse NSFR measure	Gross Loans measure
Lagged Regulatory Capital Ratio	-0.200	-0.121	-0.151	-0.210	-0.002	-0.198	0.119	0.115	0.016	-0.172	-0.118	-0.199
	(0.002)***	(0.202)	(0.132)	(0.045)**	(0.991)	(0.092)*	(0.114)	(0.436)	(0.917)	(0.001)***	(0.092)*	(0.014)**
Lagged GDP growth	0.655	0.063	0.351	0.538	-0.307	0.247	0.595	0.190	0.538	1 528	-0.528	1 139
	(0.091)*	(0.839)	(0.315)	(0.085)*	(0.203)	(0.103)	(0.404)	(0.624)	(0.188)	(0.066)*	(0.643)	(0.216)
Lagged Herfindahl Index	-0.381	-0.035	-0.127	-0.742	-0.402	-0.326	0.708	1 656	2 384	2 891	0.838	3 704
	(0.129)	(0.872)	(0.654)	(0.005)***	(0.008)***	(0.013)**	(0.579)	(0.108)	(0.029)**	(0.083)*	(0.743)	(0.090)*
Lagged Spread ST LT interest rates	0.330	0.153	-1 222	-0.558	-0.026	-0.723	-0.578	-0.946	-2 138	2 081	0.391	-1 086
	(0.493)	(0.743)	(0.024)**	(0.142)	(0.923)	(0.000)***	(0.490)	(0.025)**	(0.000)***	(0.012)**	(0.713)	(0.221)
Lagged Ln (Gross Total Assets)	-0.037	0.028	0.003	0.086	0.058	0.020	-0.081	-0.172	-0.203	0.004	0.030	-0.036
	(0.001)***	(0.051)*	(0.834)	(0.000)***	(0.011)**	(0.444)	(0.023)**	(0.000)***	(0.000)***	(0.904)	(0.069)*	(0.341)
Lagged Market Share	-0.421	0.506	-0.305	-0.813	0.354	-0.311	48 780	86 485	131 766	-395 601	-66 560	483 315
	(0.021)**	(0.010)***	(0.014)**	(0.001)***	(0.093)*	(0.093)*	(0.127)	(0.012)**	(0.002)***	(0.114)	(0.622)	(0.201)
Lagged Return on Equity	0.014	-0.035	-0.060	0.012	-0.008	-0.051	0.108	-0.019	0.142	0.058	-0.092	0.010
	(0.378)	(0.238)	(0.014)**	(0.701)	(0.872)	(0.101)	(0.201)	(0.746)	(0.051)*	(0.375)	(0.089)*	(0.852)
Lagged z-score	-0.001	-0.003	0.003	-0.002	-0.004	0.003	-0.006	-0.005	-0.004	-0.001	-0.001	0.001
	(0.375)	(0.138)	(0.158)	(0.636)	(0.360)	(0.464)	(0.247)	(0.131)	(0.223)	(0.433)	(0.489)	(0.656)
Constant	-0.836	0.110	0.155	-1 815	-0.503	-0.184	1 346	3 178	3 344	0.314	0.450	1 174
	(0.000)***	(0.718)	(0.654)	(0.000)***	(0.296)	(0.728)	(0.008)***	(0.000)***	(0.000)***	(0.370)	(0.032)**	(0.008)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample size	3 594	3 594	3 594	936	936	936	510	510	510	2 148	2 148	2 148
R-squared	0.845	0.852	0.921	0.829	0.786	0.916	0.828	0.840	0.916	0.866	0.888	0.930

Estimation method: PCSE (Panel Corrected Standard Errors)

Observations: p-values associated w ith t-statistics are in parentheses. *, ** and *** denote significance at 10%, 5% and 1% levels, respectively.

XVIII. The effect of regulatory capital on the components of liquidity creation

	Assets / GTA			Liabilities / GTA			Equity / GTA	Off-Balance Sheet
Variables	Illiquid	Semiliquid	Liquid	Illiquid	Semiliquid	Liquid	Illiquid	Illiquid
All Banks								
Lagged Regulatory Capital Ratio	-0.1212 (0.247)	0.0063 (0.937)	0.1356 (0.004)***	0.0093 (0.204)	-0.1400 (0.056)*	-0.0097 (0.813)	0.0873 (0.001)***	-0.0489 (0.099)*
Large Banks								
Lagged Regulatory Capital Ratio	-0.1282 (0.310)	-0.0546 (0.548)	0.2106 (0.005)***	0.0102 (0.678)	-0.1833 (0.136)	0.0923 (0.355)	0.0190 (0.415)	-0.0591 (0.386)
Small Banks								
Lagged Regulatory Capital Ratio	-0.1705 (0.044)**	0.0921 (0.161)	0.1004 (0.043)**	0.0242 (0.000)***	0.0674 (0.270)	-0.0157 (0.604)	0.0925 (0.006)***	-0.0405 (0.061)*
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Estimation method: PCSE (Panel Corrected Standard Errors)

Observations: p-values associated w ith t-statistics are in parentheses. *, ** and *** denote significance at 10%, 5% and 1% levels, respectively.

XIX. Test for a structural break during crisis

	All Banks		
Variables	BB-measure	Inverse NSFR measure	Gross Loans measure
Baseline Regression with dummies for the crisis period			
Lagged Regulatory Capital Ratio	-0.154 (0.042)**	-0.097 (0.319)	-0.182 (0.050)**
Lagged Regulatory Capital Ratio * Dummy	-0.055 (0.216)	-0.027 (0.450)	0.044 (0.333)
Baseline Regression			
Lagged Regulatory Capital Ratio	-0.200 (0.002)***	-0.121 (0.202)	-0.151 (0.132)
Regression for the crisis period			
Lagged Regulatory Capital Ratio	-0.090 (0.267)	-0.012 (0.920)	-0.062 (0.609)
Bank Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes

Estimation method: PCSE (Panel Corrected Standard Errors)

Observations: p-values associated w ith t-statistics are in parentheses. *, ** and *** denote significance at 10%, 5% and 1% levels, respectively. The coefficient of the lagged regulatory capital ratio mulitplied by the crisis period dummy gives the deviation of the crisis slope from the baseline slope

XX. Arellano-Bond (1991) regression outputs

Variables	All Banks			Large Banks			Small Banks		
	BB-measure	Inverse NSFR measure	Gross Loans measure	BB-measure	Inverse NSFR measure	Gross Loans measure	BB-measure	Inverse NSFR measure	Gross Loans measure
Lagged Dependent Variable	0.220	0.089	1.430	-0.023	0.213	-1.707	0.151	0.458	0.804
	(0.207)	(0.787)	(0.024)**	(0.963)	(0.444)	(0.168)	(0.252)	(0.164)	(0.391)
Regulatory Capital Ratio	-0.799	-1.552	-0.880	-1.381	-2.052	-1.533	-1.027	-0.370	-1.318
	(0.094)*	(0.009)***	(0.049)**	(0.405)	(0.043)**	(0.330)	(0.029)**	(0.121)	(0.130)
GDP growth	0.115	-1.103	-0.443	0.448	0.210	0.728	0.989	.141	0.635
	(0.772)	(0.712)	(0.207)	(0.453)	(0.673)	(0.283)	(0.487)	(0.754)	(0.783)
Herfindahl Index	-0.860	0.239	0.062	-0.627	0.042	-0.521	-1.637	5.370	4.288
	(0.002)***	(0.359)	(0.805)	(0.127)	(0.893)	(0.338)	(0.785)	(0.000)***	(0.376)
Spread ST LT interest rates	0.576	0.707	-2.763	1.091	-0.135	0.470	0.754	6.584	-0.817
	(0.306)	(0.257)	(0.004)***	(0.414)	(0.857)	(0.697)	(0.786)	(0.005)***	(0.902)
Ln (Gross Total Assets)	-0.081	-0.116	-0.204	-0.106	-0.096	-0.141	-0.125	-0.140	-0.321
	(0.007)***	(0.001)***	(0.000)***	(0.414)	(0.308)	(0.308)	(0.011)**	(0.000)***	(0.000)***
Market Share	0.086	0.960	0.104	0.045	0.556	0.128	338.645	70.274	597.416
	(0.789)	(0.031)**	(0.800)	(0.937)	(0.161)	(0.817)	(0.178)	(0.506)	(0.129)
Return on Equity	-0.245	-0.072	0.074	-0.278	-0.106	-0.860	-0.035	-0.033	0.133
	(0.347)	(0.029)**	(0.106)	(0.455)	(0.016)**	(0.305)	(0.608)	(0.521)	(0.004)***
Z-score	-0.000	0.003	-0.003	0.003	0.007	0.0138	-0.000	-0.001	-0.000
	(0.854)	(0.350)	(0.335)	(0.686)	(0.233)	(0.193)	(0.864)	(0.762)	(0.891)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AB test for AR(1) in first differences	(0.013)**	(0.458)	(0.068)*	(0.568)	(0.174)	(0.136)	(0.104)	(0.044)	(0.374)
AB test for AR(2) in first differences	(0.869)	(0.104)	(0.284)	(0.752)	(0.697)	(0.525)	(0.977)	(0.573)	(0.094)*
Sargan test	(0.324)	(0.541)	(0.021)**	(0.800)	(0.183)	(0.672)	(0.021)**	(0.017)**	(0.283)
Hansen test	(0.397)	(0.630)	(0.335)	(0.758)	(0.392)	(0.621)	(0.083)*	(0.016)**	(0.615)
Sample size	3 594	3 594	3 594	936	936	936	2 148	2 148	2 148

Estimation method: Dynamic Panel Model with Arellano - Bond Difference GMM (Generalized Method of Moments) estimator (includes one lag of the dependent variable as regressor and standard errors are robust)

Instruments: regulatory capital (only the second lag), dependent variable (only the second lag) and exogenous variables (all lags) as their own instruments

Observations: p-values associated with t-statistics are in parentheses. *, ** and *** denote significance at 10%, 5% and 1% levels, respectively.