Market liquidity, funding liquidity and bank quality

A comparison of banks in the USA

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Abstract

The seminal paper of Brunnermeier & Pedersen (2009) distinguishes two channels for banks to obtain liquid assets, namely a market liquidity channel and a funding liquidity channel. This thesis adds to the existing literature by examining whether the use of market liquidity and funding liquidity channels depends on bank quality. The data covers quarterly data from 2001 until 2014 of banks in the USA. I find that high-quality banks make less use of the market liquidity channel compared to low-quality banks. The use of the funding liquidity channel could not be associated with bank quality.

1 Introduction

Since the financial crisis of 2007, the banking industry is a much debated topic around the world. Whether it is about the bonus structure of banks, their capital ratios, equity or the banking union- the public debate mainly between people from the banking industry versus people outside the banking industry- still receives a great deal of attention nowadays.

In recent years, global banks have become increasingly integrated in capital and securities markets. While in the traditional view, banks and capital markets serve as intermediation substitutes for investors, banks and securities markets have become increasingly intertwined in the last decade. This is particularly noticeable from the fact that the securitization market has grown rapidly; banks have shifted their business to secured lending transactions which in turn result in the broadening of collateral to encompass complex products with shifting levels of market liquidity. Furthermore there is a rise in committed creditor liquidity lines to sponsored special purpose vehicles (SPV's) and corporates (Preat & Herzberg, 2008). These trends ensure that banks are intertwined in financial markets, where they depend on and are exposed to liquidity.

The importance of well-functioning liquid markets was reflected in the event of the 2007-2009 financial crises. The 2007-2009 financial crisis has shown that the absence of liquidity can affect banks through two different channels, with both different consequences for the banking system. First, during a (banking) crisis it is common that investors are reluctant to acquire distressed assets. If investors do not even want to take on position in distressed assets, poisoned assets like for instance Mortgage Backed Securities (MBS) are certainly hard to sell. When banks need to restructure their balance sheet, or cannot obtain liquid funds from the interbank market and short-term money market, selling assets is one of the fewest options left. When this happens on a big scale, this can result in fire-sales where assets prices fall below their fundamentals. The event of fire sales lowers market liquidity, which implies that those assets are less easy to sell. According to Brunnermeier & Pedersen (2009), leveraged investors who face a decline in the value of their assets need to sell their assets when the price is low.

The sales of these assets reduces the price even further, inducing more fire-sales. This limits the amount that they can borrow and is known as the loss spiral.
Second, if (wholesale) funding suddenly dries up, banks face funding liquidity problems which result in shocks in for instance bank lending and therefore shocks to the real economy. This channel, where liquidity is linked to the liability side of the bank (in accounting terms), refers to funding liquidity as stated by Brunnermeier and Pederson (2009). If wholesale funding dries up, funding liquidity becomes tight which can result in a margin spiral mentioned by Brunnermeier and Pederson (2009). When margins (haircuts) rise, investors become unwilling to take on "capital intensive" positions in (high-margin) securities. This results in a lower demand for (high margin) securities, which will potentially reduce the price of these assets and thus reduces market liquidity even further. In this way the margin spiral reinforces the loss spiral.

According to Brunnermeier (2008), the full-blown liquidity crisis is the extent of securitization which led to an opaque web of interconnected obligations. The rise of the securization market and this opaque web of interconnected obligations were possible because until the financial meltdown in 2007 regulatory policies only aimed at the financing (debt & equity) side of the bank. Basel II aimed to build on a solid foundation of prudent capital regulation, supervision, and market discipline to enhance further risk management and financial stability (BIS, 2012). In the Basel II accord there was thus less attention to the asset side of the bank balance sheet. This changed after the financial meltdown of 2007, which was, mainly caused by financial products as mortgage backed securities (MBS), credit default swaps (CDS) and similar derivatives, that were all part of the asset side of the bank balance sheet. The Basel Committee on Banking Supervision (BCBS) proposed the Basel III accord which contains reform measures in the field of capital and liquidity. The introduction of liquidity requirements in Basel III is a new measure which was not present in previous Basel accords.

Because of the fact that liquidity played a central role in the 2007-2009 crisis, the new rules proposed by Basel III concerning liquidity and the fact that interbank funding becomes increasingly dependent on market liquidity (Praet and Herzberg, 2008), it is interesting and academically relevant to (empirically) investigate liquidity in the

banking industry. Because liquidity is a broad concept, a distinction has been made in this research between market liquidity and funding liquidity which represent to the two different channels in which banks were hit during the crisis with respect to liquidity. Furthermore, from an academic perspective it is interesting to consider how "high" quality banks made use of their market liquidity and funding liquidity positions with respect to "low" quality banks. To make a distinction between "high" and "low" quality banks, the credit ratings of the bonds of these banks will be considered. To get deeper insight in the way how "high" quality made use of their market liquidity or funding liquidity position with respect to "low" quality banks both pre- and post crisis periods are considered. This research adds to the existing literature, where only the link between credit ratings, liquidity and other financial variables have been considered (see section 2.3), in the way that a distinction between two types of banks in making use of their market- and funding liquidity in pre-crisis, crisis, and post crisis periods is made, which is to my best knowledge, new to the literature of liquidity and banking. The main focus of this research will be on (commercial)banks in the USA, in the period 2001 until 2014. The main research question of this paper is as follows: Do high quality banks use more funding liquidity and less market liquidity in comparison to low quality banks?

The structure of this research is conducted as follows: in section two there will be a broad review of the existing literature. In section three the data used in the empirical research will be explained. Section four provides the methodology used in this research. Section five will describe the results of the empirical research. Section six will consider the robustness of the obtained results and section 7 concludes.

2 Literature Review

2.1 Banks and their role in the financial system

The financial crisis of 2007-2008 made one thing clear; the importance of banks in the financial system and the world as a whole. After the financial crisis, the role of banks has largely been criticized. But what is precisely the role of a bank from an academic point of view?

As Allen and Carletti (2008) pointed out, banks have four main roles within the financial system. First, they mitigate information problems between investors and borrowers. Banks are specialized institutes in judging the creditworthiness of borrowers and monitoring the borrowers to meet their obligations. On the other hand their obligation is to ensure a proper use of the invested funds of their borrowers. Second, banks play an intermediation role in transferring risk. This is called the maturity transformation, as banks transform liquid deposits into illiquid assets like mortgage loans and loans to businesses. Third, banks can encourage economic growth. While there has been a lot of discussion between economists if the banking system does encourage economic growth, recent papers suggest that banks do play a role in encouraging economic growth [1]. Fourth, banks play an important role in corporate governance. Besides the fact that banks play a role as intermediate between borrowers and investors, banks also play a role in overcoming the agency problem of the manager and the firm, by holding both debt and equity by the bank and supporting the client in times of financial stress.

2.2 What is liquidity?

Liquidity is a broad and exclusive concept. In general it denotes the ability to trade large quantities quickly, at low cost, and without moving the price (Pastor & Stambaugh, 2001). Liquidity plays a central role in the banking industry, because one of the main features of banks is transforming liquid liabilities into illiquid assets, pointed out in the previous subsection and discussed in the seminal paper of Diamond and

[1] see for instance Tadassee (2002), who finds a difference between bank-based and market-based financial systems regarding economic growth

Dybvig (1983). Furthermore, the existence of banks generates liquidity in the financial market as pointed out by Diamond (1997), because banks are a pool of individuals that possibly need to liquidate on a particular date. The bank as a coalition can manage the maturity of their assets better than an individual on his own and is offering the option to his clients to withdrawal on a short notice while avoiding the need to trade (Diamond, 1997). Banks and financial markets are competing entities which provide investors with liquidity by providing access to their capital or to act as an intermediary when investors are facing excess liquidity (and would like to invest). Besides, avoiding the need to use markets, the asset management of banks, diverts some demand for liquidity away from markets, which in turn can improve the performance of markets (Diamond, 1997).

2.2.1 Market liquidity and funding liquidity

The literature provides two basic concepts of liquidity, namely; market liquidity and funding liquidity. Market liquidity can be characterized as the ease in which assets can be sold and funding liquidity can be characterized as the ease in which banks can obtain secured funding, as stated by Brunnermeier & Pedersen (2009). Another interpretation of funding liquidity provided in the literature is the ability of banks to settle obligations immediately when due, as pointed out by Drehmann and Nikolaou (2009).

Market- and funding liquidity can also be considered from an accounting point of view. When considering the simplified balance sheet of a commercial bank (see Appendix), the execution of market liquidity (selling assets to obtain cash) has no impact on the total amount of the balance sheet total. While, funding liquidity (use assets as collateral to obtain cash) increases the amount of the balance sheet total.

Furthermore, market liquidity and funding liquidity are not two separate financial concepts. To understand the way in which these two concepts are related, one can think from a trader's perspective: when a trader buys a security, he can use this security as collateral and borrow against it. But, trading requires capital because the trader cannot borrow the entire price of the security. The difference between the value of the

collateral and the price of the security is defined as the margin or haircut and must be financed by the trader himself. The way in which shocks in market or funding liquidity affect traders is pointed out by Brunnermeier & Pedersen (2009) who use two concepts to get a deeper insight in the way that market- and funding liquidity interact (see figure 1). The first concept pointed out is a loss spiral: when a trader faces an initial loss, due to for example a fall in assets prices, his net worth falls because of his leveraged position. When the trader's net worth falls, but margins stay the same, the trader has to sell assets in order to meet the margin requirement. When many traders face the same problem as highlighted above, i.e. many traders have to sell assets due to initial losses and reduced wealth, assets prices will fall and move away from their fundamental price (problems in market liquidity) inducing more assets sales and so on. This is known as the loss spiral.

The second concept is the margin spiral (see figure 1). When markets are illiquid and volatile (i.e. when market liquidity is low) traders face an higher margin or haircut, because the collateral pledged by the trader, in case he wants to borrow against a security, is not as valuable as compared when markets were liquid. Thus, this increases the risk of financing a trade, which results in increased margins. Because of the higher levels of margins and haircuts, there are mainly two effects. First, the trader is becoming reluctant to take on new positions due to these higher margins. Second, the trader has to sell assets because he needs to reduce his leverage ratio (due to the higher margins). These two effects lower market liquidity (so asset prices) even further. This deterioration in market liquidity leads again to the need to sell assets, lower prices and higher margins and haircuts which tightens the traders funding constraint even further (problems in funding liquidity). In this way "the margin- and loss spiral reinforce each other, which imply a larger total effect than the sum of their separate effects" according to Brunnermeier & Pedersen (2009).

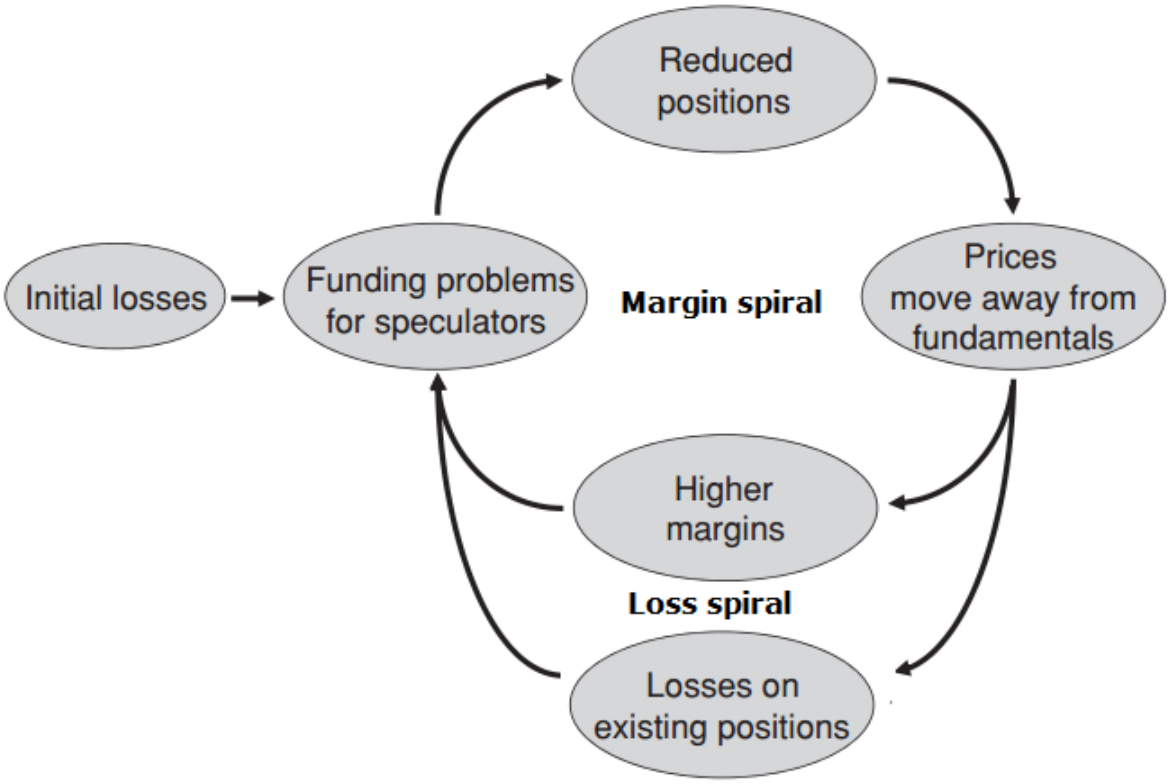

Figure 1: The margin spiral and loss spiral
Source: Brunnenmeier and Pederson (2007) and own modification

In addition to the above specified concepts Brunnermeier & Pedersen (2009)) provide a set of stylized facts concerning liquidity:

1. Liquidity can suddenly dry up. This can be the case when small changes in fundamentals lead to large jumps in illiquidity (fragility). This fragility is due to destabilizing margins, which escalates when financiers are imperfectly informed and the fundamental volatility varies.

2. Fragility and market liquidity are correlated across assets because shocks in funding liquidity affect speculator's market liquidity provision of all assets.

3. Market liquidity is correlated with volatility, because trading more volatile assets requires higher margins payments. Speculators provide market liquidity across assets so that illiquidity per dollar margin is constant.

4. When speculators cut back on market liquidity provision, because funding liquid-

ity worsened there will be a flight to quality with respect to investing in assets.

5. Since funding condition move with the market, market liquidity will move with the market as well.

2.2.2 Why do banks hold liquid assets?

Holding liquid assets brings a certain opportunity cost for banks. Namely, investing in liquid assets gives rise to lower levels of return with respect to investing in more illiquid and thus often more riskier assets (which generally give a higher rate of return). So, from a bankers point of view, there have to be a couple of reasons to invest in liquid assets, which offsets the disadvantage of a relatively lower return. In the extensive literature on banking, there have been different scientific arguments provided from different points of views to answer the question why banks hold liquid assets. The first argument is based on the portfolio management theory developed in 1950. According to Pyle (1971) and Hart and Jaffee (1974) all assets and liabilities of a bank can be viewed as securities. Based on this assumption, Freixas and Rochet (1997) provided a simple mathematical model (based on a risk averse banker) to illustrate that volatility in interest rates should lead to decreased amounts of loans held by the banker and an increase in liquid assets held. Furthermore, if equity and deposits (liabilities of the bank) are viewed as securities, the size of the bank is not relevant in determining the proportion of liquid assets to total assets. Hence, larger (smaller) banks do not hold proportionally less (more) liquid assets with respect to smaller (larger) banks, according to the portfolio management theory point of view. However, the main assumption made by the portfolio management theory is a risk averse banker. As Alger & Alger (1999) pointed out, banks shareholders have a well-diversified stock portfolio, thus risk neutrality seems to be a more appropriate assumption. But, even when bankers are risk neutral, they invest in liquid assets which gives rise to a certain opportunity costs. According to Alger & Alger (1999), the models of Stiglitz & Weiss (1981) and Bester & Hellwig (1987) can be used to partially explain why bank hold liquid assets. Stiglitz & Weiss (1981) and Bester & Hellwig (1987) provide a model to explain why credit rationing can occur. The authors claim that credit rationing can occur when

asymmetric information is present. Moral hazard and adverse selection will lead to an interest rate for which the competitive market does not clear. If the market does not clear, demand is not equal to supply by definition and credit is rationed. If banks ration credit supply for a given amount of funding (ceteris paribus), the investment in liquid assets will increase. Furthermore, note that in line with this theory, increased amounts of liquid assets in period of stress (recession) can be explained. If the population of borrowers becomes more risky, credit supply is rationed and hence investing in liquid assets should rise.

The third argument why banks hold liquid assets incorporates the uncertainty which is present when using deposits as a way of funding. This uncertainty arises because the unpredictability of deposits withdraws by customers. Porter (1961) and Kane & Malkiel (1965) initiated this line of research where they point out the precautionary savings motive for holding liquid assets; banks hold deposits of customers who can liquidate their deposits at any time. Banks need to account for this, by holding a buffer against possible liquidations of deposits, in the form of holding liquid assets. It is catastrophic for banks when they cannot provide liquidity to their customers in case they are liquidating their deposits, because rumor and negative news about a bank can ultimately lead to bank runs which in turn can lead to default of the bank. In times of financial stress, when people are more vulnerable to rumor and are more inclined to liquidate their deposits, banks will react by holding more liquid assets.

Models and arguments discussed above have one thing in common: they do not account the liability side of the bank balance sheet as a source of liquidity. Holmstrom & Tirole (1998) incorporate the fact that liquidity needs can be fulfilled by raising external finance. However, due to moral hazard, a bank cannot pledge the full value of their project/investment as collateral. Furthermore, in an interim stage of the project/investment a liquidity shock can occur which requires extra funds. Although, even when a small liquidity shock makes further investments in this project economically feasible, outside investors can be unwilling to provide extra funds, because they cannot recover the full value of the project. This mechanism leads to inefficiency which can be avoided by investing in liquid assets before performing (risky) projects. In this

way the need to raise external financing when facing a liquidity shock is removed.

Lucas & McDonald (1992) have a different scope to take into account the liability side of a bank in fulfilling liquidity needs. By building on the insights of Myers and Majluf (1984) who state that private information about a bank's asset quality influence the ability to raise external finance. Lucas & McDonald (1992) consider a bank that faces a liquidity shock (deposit shortcoming) and need external finance to cover that shock. As external finance is uninsured, in contrast to deposits, the quality of the bank, which is reflected by their asset quality, is of important matter. Because asset quality of banks is considered as private information, good and bad banks would pay the same rate for external finance if they could not signal their (asset) quality. In this pooling equilibrium good banks pay a rate which is too high considering the asset quality they have, with respect to the situation that banks can signal their quality (separating equilibrium). In this way good banks have an incentive to signal themselves as good banks and use their level of liquid assets as a signaling device. The way good banks can distinguish themselves from bad banks by using their level of liquid assets is as follows: note that the benefits for good and bad banks as being perceived as a good bank are the same, namely, lower funding cost when raising external finance. However, the costs to be perceived as a good bank, by investing in liquid assets, differ between good and bad banks. Namely, the cost of investing in liquid assets is higher for bad banks with respect to good banks. This follows from the fact that in general bad banks only survive when they are generating high returns on future loans (conditional upon surviving). This is not the case for good banks as they will survive even when returns on future loans are low. Thus, the average return is higher for bad banks with respect to good banks. Due to the fact that the average return is higher for bad banks, their opportunity costs to invest in liquid and lower yielding assets are higher with respect to the opportunity cost for good banks. In this way good banks can signal themselves as good banks, while facing lower opportunity cost as bad banks. In this separating equilibrium, it is profitable for good banks to invest in liquid assets and not profitable for bad banks to mimic a good bank. In this way, according to Lucas & McDonald (1992), good banks should invest more in liquid assets than bad banks.

The last motive why banks hold liquid assets is from a strategic point of view as explained by Acharya (2009). In times of financial stress, where funding liquidity is tight, banks can conduct fire-sales to obtain liquidity. ''Healthy" banks, that are most likely to survive in times of financial stress, can exploit the need of liquidity of other banks by holding enough liquidity to make windfall profits by purchasing assets at fire-sale prices. This gives bank the incentive to hold liquid assets, so in case they survive, they have acquired assets at fire sales prices (that is most likely to be under its fundamental price).

In the theoretical paper of Myers and Rajan (1995), the negative side of liquidity is pointed out. They argue that holding more liquid assets, gives rise to the opportunity to raise cash on a short notice, but on the other hand reduces the managements ability to credibly commit to an investment strategy that protects investors. As a result, better asset liquidity can reduce the firm's capacity to rise external funding. Moreover, banks may have a natural response to changes in the liquidity of the banks' core business, by moving into illiquid business. The examined forces should thus lower the liquidity premium, according to Myers and Rajan (1995). Furthermore, Jensen (1986) argues that firms with large free cash flows are more likely to incur agency costs and takeovers. From the two academic views presented above, it can be hypothesized that higher liquidity ratios can lower the market-to-book ratio due to the reduction in managerial ability to commit to strategies that protect investors.

2.2.3 Liquidity as central role in the 2007-2008 financial crisis

The 2007-2009 financial crisis pointed out the importance of well-functioning liquid markets. In recent years, global banks have become increasingly integrated in capital markets and have shifed their business to secured lending transactions which in turn resulted in the growth of the securitization market, the broadening of collateral to encompass complex products with shifting levels of market liquidity and the rise in committed creditor liquidity lines to sponsored special purpose vehicles (SPV's) and corporates (Preat & Herzberg, 2008). There are a number of factors responsible for this shift in the banking industry, but one of the main reasons for explaining the rise

of the securitization market, pointed out by Bernanke (2007), is the search for yield triggered by the low level of interest rates at the beginning of the 21th century.

The growth of the securitization market creates a certain liquidity risk at the asset side as well the liability side of the banks' balance sheet. On the assets side of the bank, securitization of corporate loans and mortgages provide a source of cash for banks through the sales of these assets to SPV's. However, when the market liquidity of these structured assets changes, there is a great balance sheet exposure for the valuation of these assets and warehoused assets. Furthermore, the value of these assets held by a bank to form a buffer against unexpected liquidity shocks, are also conditional on market liquidity. The liquidity of these structured assets can also change over time, while for some assets there is no secondary market to trade. For instance collateralized debt obligations (CDO's) were liquid instruments in the primary market, but were not traded in large quantities on the secondary market.

Because of the high level of collateralized borrowing (also in the interbank market) of most banks, there is a certain vulnerability of banks towards changes in market liquidity of the underlying asset. This gives rise to certain risks at the liability side of the bank balance sheet. Moreover, the widening range of acceptable collateral in secured borrowing, especially when considering less liquid and complex assets, gives also rises to more vulnerability in market liquidity shocks. When counterparties are allowed to increase haircuts or if margins have fallen below a certain threshold, margin and collateral requirement may change which gives rise to certain risks, especially in periods of stress in the financial system. In addition, valuation difficulties, disputes, lags in transferability of collateral and suitability of the collateral can occur, when liquidity in the market of the collateral assets suddenly dries up. This can result in undermining borrowing flows.

The story outlined above was reflected in the 2007-2008 financial crisis. As in June 2007, two highly leveraged hedge funds sponsored by Bear Stearns experienced extensive losses on their USD 20 billion portfolio of Asset Backed Securities (ABS's), which were related, via CDO's, to subprime residential mortgage backed securities (RMBSS's). Fire sales of these ABS's, trigged by margin calls, drove down prices of

these assets and undermined confidence in the market of these assets. Furthermore, as was pointed out earlier, CDO's were not easy to liquidate because of the absence of a secondary market for these financial products. When some large brokers refuse to sell a considerable amount of ABS's, market liquidity was further undermined, because of the negative signal sent by these brokers to hold ABS's in their stock.

This market disturbance rolled over to the money market in the summer of 2007. The interbank market, money market, commercial paper (CP) and asset backed commercial paper (ABCP) markets faced risings spreads, rollover problems and failing maturities which further increased banks' liquidity risk. Because of these spillover effects between banks and markets, idiosyncratic liquidity shocks generated considerable aggregate liquidity shortages in August and September 2007, triggering large scale interventions by central banks worldwide (Preat and Herzberg, 2008).

2.3 Basel III accord

Due to the turmoil in the financial sector described in the previous subsection, the Basel Committee on Banking Supervision (BCBS) introduced the third Basel accord (Basel III) that was agreed upon 2010-2011, and was initially planned to be introduced from 2013 until 2015. However, changes in this accord in 2013 lead to an extension of the implementation of these Basel rules to March 2019 (Basel Committee, 2010).

The third Basel Accord was developed because of the deficiencies in financial regulation, exposed by the 2007-2008 financial crises. The aim of Basel III is to strengthen capital requirements of banks, by decreasing leverage and increasing liquidity of banks. According to the website of the Bank of International Settlements (BIS), "Basel III is a comprehensive set of reform measures, developed by the Basel Committee on Banking Supervision, to strengthen the regulation, supervision and risk management of the banking sector". These measures aim to:

- improve the banking sector's ability to absorb shocks arising from financial and economic stress, whatever the source
- improve governance and risk management

- strengthen banks' disclosures and transparency.

The key principles in Basel III are focused on three main categories, namely: capital requirements, leverage ratio and liquidity requirements. The capital requirements set by Basel III require banks to hold 4,5% of common equity and 6% of tier I capital of risk weighted assets. Furthermore, there are also two additional capital buffers, namely the "mandatory capital conservation buffer" of 2.5% and a "discretionary counter-cyclical buffer" to grant national regulators to require up to an additional 2.5% of capital during periods of high credit growth (Basel Committee, 2010). In the case of the leverage ratio, banks are expected to maintain a leverage ratio in excess of 3%. The liquidity requirements, in this paper the most important to consider, set by Basel III consist of two important standards to achieve some financial objectives. First, the Basel Committee developed the Liquidity Coverage Ratio (LCR), to ''promote short-term resilience of a bank's liquidity risk profile"(Basel Committee, 2010). This is achieved by ensuring that a bank has a capable stock of unencumbered high quality liquid assets (HQLA), which consists of "cash or assets that can be converted into cash at little or no loss of value in private markets to meet its liquidity needs for a 30 calendar day liquidity stress scenario" (Ugeux, 2014).

In order to promote resilience over a longer time horizon. Basel III introduced the Net Stable Funding Ratio (NSFR). The NSFR aims to create additional incentives for banks to fund their activities with more stable sources of funding on a permanent basis. It has been developed to provide a sustainable maturity structure of assets and liabilities (Basel Committee, 2010). In essence, the NSFR is developed to promote structural changes in liquidity risk profiles of institutions away from short-term funding mismatches and toward more stable, longer-term funding of assets and business activities. The ratio of NSFR is defined as the available Amount of Stable Funding (ASF) over the Required Amount of Stable Funding (RSF). This ratio needs to exceed 100%.

2.4 Credit rating agencies

In recent years financial complexity, which is for instance reflected in the growth of the securitization market, and borrower diversity have grown (Cantor & Parker, 1994). Therefore, credit agencies become more important as investors and regulators have increased their dependence on the opinions of the credit rating industry. The credit rating industry is a highly concentrated industry, where three companies are leading the market. S&P and Fitch are controlling 80% of the market share, while S&P, Fitch and Moody's controlling 95% of the market (Alessi et al., 2013). In this paper, the ratings of S&P will be considered, as their main focus is the United States, while they operate all around the world.

The objective of a credit rating agency is to rate a debtor's ability to pay back a certain debt and the likelihood that the debtor will default. However, a credit rating agency may rate the creditworthiness of issuers of debt obligations, of debt instruments, and in some cases, of the services of the underlying debt, but not of individual consumers. The rating grades generated by the rating agencies consist of alphanumeric values, where A is considered as better than B and B better than C and so on. The use of numerical values or a plus or minus is merely to fine tune the ratings.

It should be noted that a rating grade of AAA does not mean that the obligator cannot default. According to S&P, ''ratings express relative opinions about the creditworthiness of an issuer or credit quality of an individual debt issue, from strongest to weakest, within a universe of credit risk. The likelihood of default is the single most important factor in our assessment of creditworthiness" (S&P website, 2015). An overview of ratings published by S&P can be found in the Appendix.

2.5 Recent changes in the banking industry and banking activity

In the paper of Praet and Herzberg (2008) the linkages and vulnerabilities between market liquidity and banking liquidity are broadly described. The rising interdependence of banks and capital markets is one of the main reasons why the vulnerability

of the banking sector has risen in recent times. However, the activities of banks have also changed, which also contributes to this vulnerability of the banking sector. There are mainly three important changes in the banking industry and banking activity in recent years that can be noticed:

- There has been a growing reliance on secured operations in the banking industry. This means that banks have a growing factor of their portfolio pledged as collateral. Moreover, secured funds that are borrowed by banks are used to lend secured to other market participants (Praet and Herzberg 2008). However, the collateral used in these transactions are not necessarily of the same liquidity and nature; banks are using corporate and government bond portfolios to finance less liquid, but higher yielding forms of assets which also can be used as collateral.

- Banks are increasingly supplying the market with new securitised financial products. In an article from "The Economist Magazine" (2008) it is stated that in the US, around 56% of outstanding residential mortgages have been repacked and sold as RMBS's to investors. For subprime mortgages this is 60%. On the other hand, securitization provides banks with a new form of funding, as securitized products can be transformed into cash quickly with low cost. Therefore, securitized products and liquid assets can be seen as substitutes for banks. This process of securitization by banks is assisted by the creation of off-balance sheet entities such as SPV's. These kind of off-balance sheet entities are off-loading risks for banks and leads to access of broad funding markets.

- In addition to traditional retail and corporate lending, banks are increasingly (collateralized) lending to highly levered institutions or specialized investors such as hedge funds. However, in some cases not only lending to these entities take place, but also financing. This protects the conduits for certain liquidity risk, but is a risk for banks because it will increase the demand for their short term provision of liquidity which mostly will happen in periods of market turbulence.

2.6 Determinants of bank's credit ratings

Banks bond credit ratings serve as a proxy for bank quality in this paper. Subsequently, the distinction between bank quality with respect to the use of market- and funding liquidity is of primary interest. The main variable of interest in the empirical part of this paper (see section 3) represents a variable which is constructed by the bond credit ratings of banks in the USA. Because this variable of interest is particularly important in answering the research question, an overview of determinants of banks (bond) credit ratings has been given below.

Poon et al. (1999) use a logistic regression model to explain and predict Bank Financial Strength Ratings (BFSRs), assigned by Moody's, of 130 banks spread over more than 30 countries, by using bank-specific financial and accounting data. The purpose of their research is to identify whether the BFSRs provide different information than that contained in traditional debt ratings (Poon et al., 1999).

To identify the independent variables in their logistic regression, the authors performed a varimax rotation factor analysis to reduce the number of independent variables that explain BFSRs. The main factors that explain the variability in BFSRs are the dimension of risk, loan provision ratios and profitability. In addition to these variables, Poon et al. (1999) adds the long-term debt ratings (LTDRs), short-term debt ratings (STDRs) and country risk for each bank. The results indicate that traditional debt ratings are strongly related with BFSRs, and where risk, loan provision ratios and profitability are significant related to BFSRs.

The same type of research is performed by Mostafa et al.(2011), where the authors try to identify the effect of bank capital structure and financial indicators on financials strength ratings (FSR) of 200 commercial banks in the Middle East. The main objective of their research is to examine the relationship between the FSR of banks and the performance of their financial indicators and how financial indicators and capital structure of banks can distinguish highly rated banks from low rated banks.

According to Mostafa et al. (2001), a bank's asset quality, profitability, interest rate risk, capital adequacy, liquidity and credit risk all have an effect on the FSR of a

bank. These indicators are therefore used as independent variables in their research. Control variables used contain: country specific factors, the size effect (natural logarithm of assets) and a time effect. The estimation method used is the multinomial logit technique. The main concluding remark made by the authors is that bank who's objective is to increase their credit rating should focus on improving their asset quality, profitability, liquidity and capital adequacy and reducing credit and interest rate risk.

Poon and Firth (2005) investigated if unsolicited credit ratings are lower than solicited credit ratings. Normally banks pay a credit rating agency to obtain a credit rating, but in recent years rating agencies have started rating firms that have not asked to obtain a rating. These latter ratings are called unsolicited credit ratings. To examine the possibility of unsolicited ratings to be lower than solicited rating, Poon and Firth use a two-step treatment effect model similar to that of Heckman (1979) to rule out the possible effect of sample-selection bias. The dependent variable used in their main econometric model is Fitch's Financial Bank Rating (FBR) of 1060 banks in 82 countries. Control variables used are variables representing profitability, capital adequacy, liquidity, asset quality and size of the bank. Furthermore, the sovereign credit rating and a dummy variable are used as control variables, to distinguish between solicited banks and unsolicited banks.

When analyzing the financial profile of solicited versus unsolicited banks, the authors claim that banks with unsolicited ratings were more liquid than the banks with solicited ratings and that solicited banks have more of their assets tied up in loans than the unsolicited banks. In the end, the authors conclude that unsolicited banks ratings are lower than solicited bank ratings. Furthermore they claim that profitability, capital adequacy, liquidity, asset quality and size of the bank are important factors in explaining the FBR of a bank.

Choy et al. (2006) examine the impact of various financial and industry variables on credit ratings issued by S&P. The data used in their research contains non-bank data, but is interesting to refer to as related literature. This is because Choy et al. (2006) claim that financial variables are more precise in explaining credit ratings when discriminating between lower rating categories than higher categories. This could

be explained by the fact that differences in the higher rating groups are driven by qualitative (non-financial) considerations (Choy et all, 2006). Furthermore, Choy et al. (2006) incorporate a time trend in their econometric model to account for the fact that a stronger set of financial ratios is required over time to maintain the same credit rating.

The econometric model used by the authors is an ordered probit model, because the ordered probit model accounts for the fact that an AA rating is higher than a B rating (not merely different) and that the rating classes are not necessarily evenly spaced, something that is assumed when performing a regression analysis. The dependent variable used is the credit rating of a company i in a particular year t, while the authors use different financial variables; the interest coverage, return on capital, cash flow to total debt, as control variables. These financial ratios used in their econometric model are average values over the past 3 years to account for the business cycle effect.

Choy et al (2006) conclude that interest coverage and leverage ratios have the most noticeable effect on the credit rating of a firm, while profitability and industry concentration measures also have their impact on the credit rating. Furthermore, the standard to require a particular credit rating has increased over time.

In the empirical paper of Horrigan (1966), the usefulness of accounting data in assisting long-term credit-administration decisions is studied. By using financial ratios of American manufacturing corporations and bond ratings of Moody's and S&P, the relation between financial ratios and the assigned bond rating of these firms are considered. The financial ratio, which represents the independent variables in this research, represents ratios of mainly liquidity and profitability. Horrigan (1966) mentioned the fact that financial ratios are correlated over time, which is a problem if the dependent variable moves in an random pattern. However, the credit ratings of bond rating tend not to change over time, so any relationships found have predictive value. The empirical model used by Horrigan (1966) is multiple regression analyses. Horrigan (1966) used along with total assets, the ratios of working capital to sales, net worth to total debt, sales to net worth and net operating profit to sales as the independent variables in the main model for explaining bond credit ratings. All of these ratios have

a significant relation with bond credit ratings and predict over half of samples of bond rating. Horrigan (1966) concludes that financial ratios and accounting data are useful in explaining the determination of corporate bond ratings.

2.7 Determinants of bank liquidity

2.7.1 Theory

Capital adequacy and liquidity Capital adequacy of a bank refers to the proportion of equity over risk weighted assets. Capital adequacy can be measured by the Risk-Adjusted Capital Ratio (RACR) which refers to equity over risk weighted assets. Risk weighted assets are measured by multiplying the value of each asset by a risk weighting. In the theoretical literature on bank liquidity determinants, capital adequacy can either positively or negatively influence bank liquidity. In the first view, capital adequacy hampers liquidity creation due to the financial fragility structure and the crowding-out of deposits hypothesis. This first hypothesis states that bank capital tends to deter liquidity creation because of two specific effects: first, financial fragility, which is characterized by banks which have a lower capital adequacy, tends to favor liquidity creation. This hypothesis is supported by Diamond and Rajan (2001) who conclude that the higher a bank's capital adequacy (capital ratio) the less liquidity it will create, because of the characteristics of capital providers who cannot run on a bank. Second, a higher capital ratio may reduce liquidity because of the crowding out effect of deposits. According to Gorton and Winton (2000) deposits are a more effective liquidity hedge for investors than investments in equity capital. The findings of their study revealed that higher capital ratios of banks shift funds of investors from liquid deposits to illiquid bank capital.

In the second view, capital adequacy improves liquidity creation (which means less liquid assets held on the balance sheet), due to the so called "risk-absorption" hypothesis. This hypothesis argues that creating liquidity increases the exposure of a bank "as its potential losses increase with the level of illiquid assets to satisfy the liquidity demands of customers" (Allen and Gale, 2004). Therefore, if a bank creates

more liquidity, the chance of disposing off these illiquid assets to meet liquidity demands of customers will increase. That is why bank capital allows the bank to absorb greater risk (Repullo, 2004). More liquidity creation due to a higher capital adequacy means that in this view capital adequacy and bank liquidity is negatively related.

Size and liquidity With respect to the influence of bank size on liquidity, there is also no consensus in the theoretical literature. According to Ianotta et al. (2007) large banks can benefit from an implicit guarantee (Lender of Last Resort) which decreases their cost of funding and allows them to invest in riskier assets. This is known as the "too big to fail" argument. As large banks view themselves as "too big to fail" this could lead to excessive risk taking and moral hazard. Subsequently, their motivation to hold liquid assets is limited, because in case of a liquidity shortage they rely on the LOLR. In this view size and bank liquidity are negatively related. On the other hand, Rauch et al (2008) and Berger and Bouwman (2009) argue that small banks are more likely to focus on traditional bank activities as intermediation and transformation. This lowers the amount of liquid assets on their balance sheet. There could therefore also be a positive relationship between size and bank liquidity.

Profitability and liquidity It has already been highlighted that holding liquid assets generates a certain opportunity cost for banks, as those liquid assets could otherwise be invested in for instance high yielding loans. In general there exists a tradeoff for a bank in generating higher returns by transforming liquid deposits into illiquid loans while increasing their liquidity risk. So, according to Hempel et al (1994) a high liquidity ratio indicates a less risky and less profitable bank. Moreover, as already highlighted in section 2.2, Myers and Rajan (1998) argue that more liquid assets reduce management's ability to commit credibly to an investment strategy that protects investor, which in turn can result in a deterioration of the "firm's capacity to raise external finance". Thus, a negative relationship between profitability and liquidity is expected.

Business model of the bank and liquidity The business model of a bank can influence both the portfolio of liquid assets of a bank, as well the sources of funding as described by Oura et al. (2013). The core business of traditional commercial banks is usually making loans to customers. This negatively influences the portfolio of liquid assets of these banks. Furthermore, banks can rely mostly on customer deposits as main source of funding. This bears a risk for these banks, due to the maturity transformation mismatch. This is even more stringent if these banks are making loans as their core business. Holing liquid assets could protect these banks for this risk.

Loan growth and liquidity Making loans is the principal business activity for most commercial banks and their loan portfolio is generally their largest asset and the main source of income (Comptroller's Handbook, 1998). As loans are viewed as illiquid assets, an increase in the amount of loans means an increase in the portfolio of illiquid assets for a bank. Pilbeam (2010) argues that the amount of liquidity of a bank is influenced by loan demand. If loan demand is low, banks hold more liquid assets. When demand for loans is high, banks make more loans (as this is more profitable) which deceases their liquid assets holdings. In this way loan growth and liquidity are negatively related.

GDP growth and liquidity According to Pana et al. (2009) and Shen et al. (2010) the macroecnomic environment is likely to affect the activities of a bank in terms of investment decisions as well the portfolio of liquid assets of a bank. In line with the previous highlighted argument of Pilbeam (2010) loan demand is low in times of economic downturn, which implies higher levels of liquid assets. Subsequently, in times of economic expansions which go hand in hand with general confidence in the economy, investments will rise. This will increase the demand for loans and hence decreases the liquid asset portfolio of banks. Subsequently, Painceira (2010) argues that during economic expansions, banks are more willing to take on risky assets with higher rates of return. In this way, banks are more likely to hold less liquid assets and incur short term debt with generally high interest rates. Moreover, there is a liquidity hoarding argument, as Aspachs et al. (2005) argues, that banks hoard liquidity in times

of economic downturn, because of the poor lending opportunities. Subsequently, they run down there liquidity in economic booms when lending opportunities have picked up. In this way crisis periods are positively related to liquidity while economic booms are negatively related to liquidity.

Ted spread and liquidity The TED spread is defined as the difference between the LIBOR rate and the U.S. treasury T-bill rate. The LIBOR rate is the average benchmark rate at which the leading banks in the world economy charge each other in order to obtain unsecured loans. Hence, the LIBOR rate is not risk free. This is in contrast with the U.S. treasury T-bill rate which is perceived to be risk free. In times of economic stress and uncertainty, banks become less willing to make (unsecured) loans to each other which raise the LIBOR rate. Furthermore, as highlighted by Brunnenmeier (2008), banks are willing to obtain U.S. treasury T-bills in times of crisis as this is a prime source of collateral. This increases the price of these bonds which in turns lowers the yield (interest rate). Due to both reasons, the TED spread increases in times of economic stress. The influence of the TED spread on liquidity can be twofold. First, it can be argued that increasing TED spreads mean higher cost for banks to obtain unsecured loans. In this way it is harder for banks to obtain cash. Furthermore, as banks are more willing to obtain US treasury T-bills in times of crisis, they have to exchange these for cash. From this point of view the tedspread and liquidity should be negatively correlated. On the other hand, it can be argued that in times of financial stress banks are protecting themselves against potential bank runs and keep more liquidity (cash) on their balance sheet. Furthermore, as they are less willing to make loans to other banks (which is reflected in the LIBOR rate), they can have higher amounts of cash on their balance sheet [2] . From this point of view the tedspread and liquidity should be positively correlated.

Federal funds rate and liquidity The U.S. federal funds rate is the overnight interest rate at which banks lend reserves to each other to meet the central bank's reserve requirements (Brunnermeier, 2008). As the federal funds rate rises, it becomes

[2]Cornett et al. (2011) argue that banks with high liquidity risk exposure are expected to build

more expensive to obtain cash for banks. On the other hand, it becomes more profitable to make loans to other banks, which decreases the portfolio of liquid assets of a bank. Therefore, the federal funds rate and liquidity are expected to be negatively related.

2.7.2 Empirical literature

The literature has emphasized the importance of liquidity in the financial system. A large and growing body of literature has empirically investigated the determinants of liquidity. Vadova (2011, 2012, 2013) investigated the determinants of commercial banks liquidity in Poland, the Czech Republic and Hungary respectively. Vadova highlighted the importance of her research by referring to the fact that banks became more reliance on repo financing and were densely exposed to maturity mismatch both through off balance sheets vehicles and on balance sheet exposure. By using panel data of the above specified countries for the period of 2001 to 2010 she used four different liquidity ratios in her studies, namely: liquid assets over total assets (L1) to give information about the liquidity shock absorption capacity of a bank, liquid assets over deposits + short term borrowing (L2) to captures the bank vulnerability related to funding sources, loans over total assets (L3) to indicate the percentage of illiquid assets over total assets and loans over deposits + short term funding (L4) to indicate the vulnerability of illiquid assets related to funding resources. For each liquidity ratio, a panel data regression analyses has been specified. Vadova included both bank specific and macroeconomic variables in her analyses. Bank specific variables include: share of capital over total assets, the share of non-performing loans over total loans, the return on equity and the logarithm of total assets of the bank. Macroeconomic variables include: the growth rate of GDP, inflation rate, interest rate on bank transactions, interest rate on loans, the difference between interest rate on loans and interest rate on deposits, monetary policy interest rate, unemployment rate and a dummy variable which specifies the realization of a crisis.

up more cash and liquid assets in times of financial stress (higher ted spread) than banks with less liquidity risk exposure. Banks with less liquidity exposure could even run down their liquid assets in times of financial stress. This also highlights the fact that liquidity and the tedspread could be positvely and negatively related from a theoretic point of view.

Together, these studies indicate on average that bank liquidity is negatively related to profitability, higher interest rate margin and size of the bank (in Poland and Hungary). Furthermore, a financial crisis, GDP growth, increase in unemployment, the monetary policy rate and interest rate on inter-bank transactions are also negatively related to commercial banks liquidity. However, bank liquidity increases with inflation, higher capital adequacy and the share of non-performing loans to total loans.

Similarly, Melese & Laximikantham (2015) found that profitability, size of the bank and GDP growth is significant and negatively related to liquidity of Ethiopian commercial banks. However, Melese & Laximikantham also found that capital adequacy is negatively related to commercial bank liquidity. In their research, the authors explain this by referring to the fragility-crowding out hypothesis supported by Gorton and Winton (2000) and Diamond and Rajan (2001), as explained in the previous subsection. Moreover, the size of the bank is positively and significant related to liquidity. This is in contrast with the results reported by Vadova, which argued that size has either a negative or ambiguous effect on commercial banks liquidity. Other independent, hence insignificant variables of this study included: non-performing loans, measured by impairment loss provision over total loans, loan growth and inflation.

Aspachs et all (2005) analyzed the determinants of UK banks' liquidity holdings with respect to both idiosyncratic and macro- determinants. Special attention has been paid to the way central bank Lender or Last Reosort (LOLR) policy may affect the liquidity buffers of UK banks. Furthermore, the authors analyzed how liquidity buffers of UK banks vary over the economic cycle and whether the presence of countercyclical liquidity buffers might be the consequence of financial constraints of UK banks' lending policy.

Aspach et all (2005) point out that the support of the LOLR gives rise to a moral hazard problem, where incentives of banks to self-insure against liquidity shocks reduce, when LOLR support is present. Therefore, the authors use Fitch support rating of UK banks as one of the determinants of UK banks liquidity holdings, beside the more conventional used determinants as profit, interest margin and size. Moreover, to control for macroeconomic factors and monetary policy, GDP growth and the short

term interest rate are used. Almeida et al. (2004) argues that constrained firms may be controlling their internal source of liquidity more closely than unconstrained firms, in order to set aside funds for investment opportunities in the future. Aspachs et all (2005) account for this by incorporating financial constraints in their list of determinants by making use of a loan growth variable and Tobin's Q which proxies future investment opportunities. As the dependent variable the authors use both liquid assets over total assets and liquid assets over deposits. As the main data set of the authors contains both UK-owned banks and foreign-owned banks which are settled in the UK, a dummy variable has been used to account for this. This dummy has been multiplied by each determinant in order to allow the slope terms to vary across both UK-owned banks and foreign-owned banks. In addition the authors use bank fixed effects in a Gerneral Methods of Moments (GMM) procedure. The results of their study suggest that there is not a difference in the results between each of the different dependent variable used. Furthermore, the amount of liquidity holdings by UK-owned banks depends negatively on the presence of the LOLR. Third, monetary policy appears to negatively influence liquidity holdings of UK-owned banks'. Finally GDP growth and liquidity holdings tend to be negatively correlated, which indicates the fact that UK- banks hoard liquidity in times of economic downturn and hold smaller amounts of liquid assets in times of economic growth. These results differ in some ways for the foreign banks located in the UK. With respect to the presence of the LOLR, foreign banks do not change their holdings of liquid assets. This can be due to the fact that foreign banks depend on their home central banks rather than the UK central bank. The variables that were reported significant for UK-owned banks remain significant for foreign owned banks. However, the magnitude of the results was less strong.

Cornett et al. (2011) examined how the expansion of liquidity by the monetary policy of the FED was distributed across the banking system. The authors analyzed data of all US commercial banks in the period of 2006 until 2009. Their mean goal was to capture within-bank variation in holdings of cash and other liquid assets, to get an understanding of why some banks chose to build up liquidity at a faster rate than others during the crisis. In order to do so, they first argue that banks "rationally protect

themselves by hoarding liquidity to the detriment of their customers and markets" Cornett et al. (2011). On the other hand, banks, that faced stable source of financing, were less constrained by the crisis which resulted in being able to continue lending. In fact, it is well known that banks hold cash and other liquid assets to manage their liquidity risk. In order to test these predictions in an empirical way, the authors conducted three different regression specifications with four key drivers of liquidity risk management for banks, namely:

1. The market liquidity of assets, to capture the structure of the asset portfolio of the bank. Specified by illiquid assets over total assets of the previous period
2. Core deposits over total assets of the previous period
3. Equity capital over total assets of the previous period
4. Funding liquidity exposure due to loan commitments made by the bank. Specified by loan commitments over total assets and loan commitments of the previous period

The main identification strategy used by the authors is based on the fact that tight liquidity conditions during the financial crisis changed their liquidity management due to being exposed to a larger risk. To capture the liquidity environment in the economy, the authors use the TED spread to capture these risk exposures. They test their three main specifications of change in liquidity, loans and credit by the main four key drivers interacted by the TED spread.

Their results indicate that banks which have a more illiquid asset portfolio increased their holdings of liquid assets and decreased lending during times of liquidity expansion by the FED. Moreover, banks that have more stable sources of financing on the liability side of their balance sheet, continued to lend to other banks.

In contrast to Cornett et all (2011), Hackethal et al (2010) did not find any bank specific factors which influence liquidity creation. In their study on liquidity creation of German savings banks over the period of 1997-2006, the authors tried to detect possible factors which influence liquidity creation. They used two different liquidity measures

in order to test their data on German savings banks, namely the BB-Measure and the Liquidity Transformation (LT) Gap. The BB-Measure, developed by Berger and Bouwman (2009) groups balance sheet items of banks into different groups according to their liquidity and the fact if they create or extract liquidity for the economy. The Liquidity Transformation (LT) Gap represents a ratio of illiquid assets to total assets as proposed by Deep and Schaefer (2004). In their multivariate dynamic panel model where a GMM estimator has been used, they incorporate four different sets of factors which could influence liquidity creation. These four sets include:

- Macroeconomic variables
- Bank performance variables
- Bank characteristics
- Bank size

Macroeconomic variables include the savings quota, interest rate spread, yield spread and the unemployment rate. Bank performance and characteristics variables include EBIT and Return on Equity (RoE), the ratio of provision income and interest income and the ratio of outstanding loans to total number of outstanding loans in the whole economy. The two latter variables are used to account for differences in the bank core lending business and operating business. Additionally time fixed effects are used in the model to account for time effects not captured by the independent variables. The results of the research show that German saving banks increased their liquidity creation by 50% over the period 1997 to 2006. The regression results indicated that liquidity creation is positively and significant related to general economic health. Furthermore, liquidity creation is dependent on both the interest environment and monetary policy instruments like the ECB main refinancing rate. However, bank specific variables like size and RoE of the bank did not seem to influence liquidity creation of German banks.

In the same vein, Laurine (2013) investigated the determinants of Zimbabwe commercial banks liquidity risk from 2009 until 2011. Laurine (2013) highlights the fact that according to the literature there is no agreement on which liquidity measure to

use. However, main approaches include cash flow analysis, a stock approach and a hybrid approach. In addition, Laurine (2013) argues that liquidity risk of banks is due to several factors, namely: internal banking factors which are bank specific and external banking factors which emanate from external sources like the macroeconomic and monetary environment. Laurine (2013) employed a fixed effect panel regression in order to test the data. Independent variables used in the regression consist of bank specific, macroeconomic and supervisory variables. In detail, explanatory variables used in the regression are the capital adequacy ratio, size of the bank, the spread between interest rates on loans and deposits, the non-performing loan ratio, inflation rate and the reserve requirement. The dependent variable used in the regression is the financing gap ratio, which is the difference between banks' loans and deposits. The results indicate that, firstly capital adequacy is significant and negatively related to liquidity risk. Secondly, size is positively and significant related to liquidity risk. Thirdly, interest spread is negatively and significant related to liquidity risk. Fourthly, non-performing loans are positive and significant related to liquidity risk. Fifthly, the inflation rate is negative and significant related to liquidity risk. Lastly, the reserve requirement ratio is negative and significant related to liquidity risk of commercial banks in Zimbabwe.

In a study conducted by Malik and Rafique (2013), bank specific and macroeconomic determinants of commercial banks' liquidity in Pakistan are examined over the period 2007 to 2011. Bank liquidity is measured in two separate ways, namely: cash and cash equivalents over total assets and advanced net of provisions to total assets. In order to account for the fact that the data is in panel form and indicates presence of heteroskedasticity, a fixed effect model with robust standard errors has been estimated by the authors. Fixed effects only include entity (bank) specific fixed effects. Bank specific variables used in the main regression analysis include: share of own capital on total assets, share of non-performing loan on total volume of loans, return on equity and the logarithm of total assets of the bank to account for size. Macroeconomic variables include: the inflation rate, the monetary policy interest rate and a dummy variable which accounts for the Asian financial crisis in 2008. The results indicate that both the share of own capital on total assets and return on equity are not significant

determinants of the two measures of bank liquidity. Moreover, the size of the bank, the monetary policy rate and the dummy variable are significant determinants of both measures of bank liquidity. However, inflation and non- performing loans to total loans appears to be a significant determinant of bank liquidity measured by cash and cash equivalents over total assets but does not appear to be significant for the other liquidity measure.

Loutskina (2011) studies the role of securitization in bank liquidity and funding management. In her paper she proposed an index which measures the potential to securitize loans of a certain type. She uses this index to demonstrate that securitization influences the banking sector in two ways: first, securitization reduces the need for bank to hold a (large) portion of liquid assets, because through securitization illiquid loans can be converted into liquid funds, which can be sold to acquire liquidity. In this way securitization can be seen as a substitute for holding liquid assets on the balance sheet. Furthermore, the process of securitization can be seen as an additional source of funding which enhances the banks' lending ability. Second, because securitization provides bank with an additional source of funding, banks are less sensitive to funding liquidity shocks. This latter argument has an other side of the medal: when banks are less sensitive to funding liquidity shocks, monetary policy, which would affect the banks' lending activity by influencing its funding constraints, would be less effective.

The paper of Haan & van den End (2011) empirically investigates the response of Dutch banks in funding liquidity shocks. The dynamic interrelations among instruments of bank liquidity management are modeled in a Vector Autoregressive (VAR) framework. According to the authors banks response to negative funding shocks in the following way: first, banks reduce lending when they face a negative funding shock. Second, banks conduct fire sales of securities (especially equity). Third, banks are hoarding liquidity, because of the precautionary savings motive, by holding central bank reserves and liquid bonds. Furthermore, the authors note that fire sales are not triggered by solvency constraints, but because of liquidity constraints.

In the paper of Bonner et al. (2015) the determinants of liquidity holdings of 7000 banks from 30 OECD countries over a ten year period are assessed, using balance

sheet data. Their main question is if the presence of liquidity regulation substitutes or complements bank's incentives to hold liquid assets. Their measure of liquid assets consists of cash and due from banks over total assets, which is by definition equally liquid in all markets. As a robustness check, the authors use another widely used measure of liquidity namely, liquid assets over total assets. Independent variables used in their main regression consist of measures of bank specific variables like profit and capital ratio, contextual factors like concentration of banks and the degree of disclosure. Furthermore, macroeconomic and financial development measures are taken into account in their main regression. The authors conclude that in absence of liquidity regulation, bank specific and country specific factors are the main determinants of bank's liquidity holdings. When liquidity regulation is present, most of these factors are substituted by liquidity regulation, while size and disclosure requirement remain significant.

Together, all these studies indicate that there is no standard in measuring (market or funding) liquidity. Different measures have been used in several studies on banks' liquidity. Collectively, these studies outline a critical role for the use of three main factors explaining banks' liquidity, namely: bank specific factors, macroeconomic factors and monetary policy factors.

2.8 Research hypotheses

Considering the review of the related literature above, one can see that there has not been a study which specifically relates bank quality to market- and funding liquidity. This paper tries to relate bank quality to the use of market- and funding liquidity. This study makes a distinction between "high" quality banks and "low" quality banks [3]. Bond credit ratings of banks are a proxy for the quality of the bank. Credit ratings of banks depend on several factors. One of them is assets quality. Poor asset quality raises several risks for the bank. Subsequently, "high" quality banks have in general an asset portfolio of higher quality compared to "low" quality banks. This mechanism will affect the way banks respond to a need for liquid assets (for instance cash). In general,

[3]Where this distinction depends on, can be read in the next section

banks have two options to obtain liquid assets. First, they can sell their assets in order to obtain cash (market liquidity) or second, they can borrow against their assets, and pledge those assets as collateral, to obtain cash (funding liquidity). Executing the first option generates opportunity costs for banks; the forgone earnings if assets were not being sold. One could consider that being a high quality bank, measured by credit rating of those banks, implies that these banks have ceteris paribus assets of higher quality and better investment opportunities compared to low quality banks.[4]. In this way, one can argue that selling assets (for instance loans) to obtain cash generates a higher opportunity costs for high quality banks with respect to low quality banks [5]. Moreover, if (making use of) funding liquidity is being considered, there are also differences in costs of (making use of) funding liquidity between "high" quality banks and "low" quality banks. "High" quality banks have generally lower cost to obtain secured loans as their assets (used as collateral) are of better quality which reduces margins. Furthermore, the interest rate could possibly be lower for high quality banks as their overall risk is lower. Combining the two mechanisms provided above leads to the theoretical conclusion that if "high" quality banks need liquidity in the form of cash, they prefer making use of funding liquidity channels rather than market liquidity channels. Above theory leads to the following hypotheses:

Hypothesis 1 High quality banks make less use of the market liquidity channel in comparison with low quality banks

Hypothesis 2 High quality banks make more use of the funding liquidity channel in comparison with low quality banks

[4]It could also be argued that high quality banks perform better than low quality banks in terms of their profitability and efficiency.

[5]The opportunity costs for the high quality bank are twofold. First it represents the forgone return on a assets that has been sold. Second, it represents the opportunity costs of holding cash on the balance sheet, as they have good investment opportunities.

3 Data

In order to make a distinction in the way high and low quality banks in the USA make use of their market- and funding liquidity in periods before, during and after the crisis, this research will focus on quarterly data of the years 2001 till 2014. The year 2001 is a good starting point, because it is after the internet crisis. The period between 2001 and 2007 will be considered as the pre-crisis period, while the period 2010 till 2013 will be considered as the post crisis period. The data set used in this research is unbalanced for 109 banks, as not all banks report over the used time period, and covers 64 quarters in total.

In order to make a statement about the quality of the bank (high or low), data of bond credit ratings of these banks are used as a proxy for bank quality. Data of bond credit ratings are obtained from the Compustat S&P Rating Database. In this research, the ratings of S&P will be considered, as their main focus is the United States and because S&P is one of the biggest rating agencies in the world. Output from the Compustat S&P Rating Database resulted in multiple observations per quarter, while output from the Compustat Bank database (financial variables) resulted in one single observation per (end of the) quarter. In order to match these data, the last available credit rating observation per quarter has been used. In this way it was possible to match bond credit ratings to financial variables. The type of banks that are considered, consist of banks with SIC codes between 6000 and 6200 (see Appendix) and are for instance commercial banks, investment banks, saving banks, cooperative banks and real estate & mortgage banks. Other kind of banks, like asset management companies, securities firms and trust companies, have a different objective in for instance holding liquid assets or obtain funding with respect to the more conventional kind of banks. Incorporating these kinds of banks into the analysis raises the possibility of biased results, as incorporating these kind of banks causes heterogeneity between banks not caused by our main focus, namely the use of market- and funding liquidity and bank quality.

To use the data of the bond credit ratings in the econometric model of this research

(see section 4), the alphabetic data will be transformed into numerical data which is very common in the literature (see section 2.6). The twenty-two rating groups are transformed into numerical data where 1 represents the highest rating available (1=AAA) and 22 the lowest rating available (22=D). With regard to the distinction between a high and low quality bank, a dummy variable has been used in the main regression specifications. This dummy has the value 1 for high quality banks and zero otherwise. In order to make this distinction between high and low quality banks, statistics are obtained about the distribution of the bond rating data (see Appendix). It appears that the distribution of bond credit ratings has a median of 7 and a mean of 7.85. This corresponds to the A- credit rating. Thus, banks with bond credit ratings higher than A- are considered as "high" quality banks, while banks with credit ratings lower or equal to A- are considered as ''low" quality banks.

In order to get an unbiased view of the way "high" and "low" quality banks make use of their market- and funding liquidity in periods before, during and after the crisis, some control variables must be incorporated in the empirical model used. These control variables contain measures of three main factors, namely:

- Bank specific factors
- Macroeconomic factors
- Monetary policy factors

Bank specific factors include:

- measures of size (natural logarithm of total assets)
- profitability (net interest margin)
- capital adequacy (risk adjusted capital ratio)
- business model of the bank, which in case of differenced values also represents loan growth (loans over deposits)
- riskiness with respect to maturity mismatch (deposits over loans)

These financial variables are obtained from Compustat Banks, contain quarterly data and are in panel data form.

Macroeconomic factors include:

- measures of crisis periods (NBER crisis dummy)
- measure of financial stress (tedspread).

The tedspread data has been retrieved from the St. Louis Fed database.

Monetary policy variables include:

- the monetary policy rate of the FED (federal funds rate)

This data has been retrieved from the St. Louis Fed database and contains quarterly data.

The original data of both the macroeconomic - as monetary policy factors were in time series format and thus not differs between banks. This means that each time series is repeated for each cross-section unit (bank).

The main objective of this study is to investigate the relationship between being a ''high quality" bank or ''low quality" bank with respect to the way in which market liquidity and funding liquidity are being used by these banks. Market liquidity and funding liquidity both appear as dependent variables in the main regression specifications. Market liquidity is defined as its most "safe" definition for liquidity, namely a ratio of cash and due from banks over total assets. Cash is per definition always liquid in all kinds of markets. If banks make use of their funding liquidity channel, secured borrowing is being affected. Secured borrowing describes the process of borrowing money where the borrower pledges an asset as collateral. Due to the lack of data on actual secured borrowing in the COMPUSTAT database, debt over total assets minus cash has been used as a proxy for funding liquidity. The denominator of this variable represents assets that are eligible as collateral. So, in summary, the proxies for both market liquidity (named mliq) and funding liquidity (named fliq) are equal to:

$$mliq_t = \frac{cashanddue frombanks_t}{totalassets_t}$$

$$fliq_t = \frac{debt_t}{totalassets_t - cash_t}$$

In this research, both the level values of market- and funding liquidity as well the first differences of market- and funding liquidity are being considered. The latter is being used to consider differences between high quality and low quality banks with respect to the trend of market- and funding liquidity over the tame frame used. In this way I asses if, besides a possible difference in level values of market- and funding liquidity between bank quality, there is also a difference in the use over time of market- and funding liquidity. Hence, the first difference of $mliq$ (named $marketliq$) and the first difference of $fliq$ (named $fundingliq$) are specified as follows:

$$marketliq_t = \Delta mliq_t = \frac{cashanddue frombanks_t}{totalassets_t} - \frac{cashanddue frombanks_{t-1}}{totalassets_{t-1}}$$

$$fundingliq_t = \Delta fliq_t = \frac{debt_t}{totalassets_t - cash_t} - \frac{debt_{t-1}}{totalassets_{t-1} - cash_{t-1}}$$

Note that using a proxy is always caused by the fact that the exact variable one wants to measure is not available. Therefore, there always exists some kind of measurement error when using proxies. This is also the case when using the proxies specified above, as making use of funding liquidity (obtaining cash by secured borrowing) also raises the ratio of $mliq$ as both the numerator and denominator rise with the same amount. However, the rise of this ratio is much stronger in case a bank makes use of market liquidity, as then only the numerator rises.

3.1 Variable description

On the following page a description of the variables used in this research can be found. The table describes the name of the variable, the computation of the variable and the source of the variable. Both the variables used in the main regression specifications and the variables used in the robustness checks are explained.

Table 1: Variable description

Variable name	Computation	Source
mliq	Cash and due from banks over total assets	Compustat Banks
fliq	Debt over (total assets- cash and due from banks)	Compustat Banks
matketliq	Quarterly difference in mliq	Compustat Banks
fundingliq	Quarterly difference in fliq	Compustat Banks
L.Hqualitybank	(Lagged value of) a dummy representing a high quality bank	Compustat Banks
Hbank_Crisis	Interaction effect of L.Hqualitybank and L.Crisisdummy	Compustat Banks NBER
size	Natural logarithm of Total Assets	Compustat Banks
Dsize	Quarterly difference in size (t - t_{-1})	Compustat Banks
racr	Risk adjusted capital ratio	Compustat Banks
Dracr	Quarterly difference in racr (t - t_{-1})	Compustat Banks
nim	Net interest margin	Compustat Banks
Dnim	Quarterly difference in nim (t - t_{-1})	Compustat Banks
loanstoassets	Total loans over total assets	Compustat Banks
Dloanstoassets	Quarterly difference in loanstoassets (t - t_{-1})	Compustat Banks
depositsloans	Total deposits over total loans	Compustat Banks
Ddepositsloans	Quarterly difference in depositsloans (t - t_{-1})	Compustat Banks
L.Crisisdummy	(Lagged value of) dummy representing 1 in crisis periods	NBER
fedfund	Federal funds rate	St. Louis Fed database
changefedfund	Quarterly difference in fedfund (t - t_{-1})	St. Louis Fed database
tedspread	Ted spread	St. Louis Fed database
changetedspread	Quarterly difference in tedspread (t - t_{-1})	St. Louis Fed database
Variables used in robustness check		
mliq+	(Cash and due from banks + Federal funds sold and Seurities purchased under the agreement to resell) over total assets	Compustat Banks
fliq-	Securities sold under the agreement to resell over total assets	Compustat Banks
marketliq+	Quarterly difference in mliq+	Compustat Banks
fundingliq-	Quarterly difference in fliq-	Compustat Banks
Hqualitybank2	Dummy representing a high quality bank (1 if >A-)	NBER
Hbank2_Crisis	Interaction of (lagged) Hqualitybank2 and (lagged) Crisisdummy	Compustat Banks NBER
H[..]bankshort1	Dummy representing a high quality bank, short term bonds	Compustat Banks
H[..]short1_Crisis	Interaction of the lag of H[..]bankshort1 and lag of Crisisdummy	Compustat Banks
bmodel	net interest income over net income (loss)	Compustat Banks
Dbmodel	Quarterly difference in bmodel	Compustat Banks
QdiscAV	FED discount rate (average quarterly value)	Compustat Banks
changeQdiscAV	Quarterly difference in QdiscAV	Compustat Banks
diffStress	Quarterly difference St. Louis Fed financial market stress indicator	St. Louis Fed database

3.2 Expected signs

In table 2, the expected signs of the main regression specifications are being specified. These expected sings are mostly based on the related literature of section 2.

Table 2: Expected signs

Variable name	**Expected sign mliq**	**Expected sign fliq**	**Expected sign marketliq**	**Expected sign fundingliq**
L.Hqualitybank	-	+	-	+
Hbank_Crisis	+	-	+	-
size	+	+		
Dsize			+	+
racr	+	-		
Dracr			+	-
nim	-	+		
Dnim			-	+
loanstoassets	-	-		
Dloanstoassets			-	-
depositsloans	+	-		
Ddepositsloans			+	-
L.Crisisdummy	+	-	+	-
fedfund	-	+		
changefedfund			-	+
tedspread	-	+		
changetedspread			-	+

3.3 Descriptive statistics

Table 1, 2, 3 and 4 represent the descriptive statistic of each variable used in this research. The descriptive statistics are grouped by ‘’high” quality banks and ‘’low” quality banks to give some first insight across the differences between these two groups. Furthermore table 1 and 2 represent the descriptive statistics for the level values of market- and fundingliq (mliq and fliq respectively) and table 3 and 4 represent the descriptive statistics for the quarterly difference in market- and funding liquidity (market liquidity and funding liquidity respectively).

Table 3: Summary statistics "low" quality banks (≤A-) and level values

Variable	Mean	Std. Dev.	Min.	Max.	N
mliq	0.04	0.033	0.003	0.327	2251
fliq	0.077	0.076	0	0.603	2211
Hbank_Crisis	0.003	0.056	0	1	2251
size	10.019	1.065	7.445	14.666	2251
racr	14	3.225	7.62	44.07	2251
nim	3.566	0.854	-1.68	13.1	2251
loanstoassets	0.631	0.117	0.121	0.962	2251
depositsloans	1.154	0.343	0.266	3.545	2251
LCrisisdummy	0.158	0.365	0	1	2251
fedfund	1.64	1.752	0.07	5.26	2251
tedspread	0.423	0.478	0.15	3.35	2251

Table 4: Summary statistics "high" quality banks (>A-) level values

Variable	Mean	Std. Dev.	Min.	Max.	N
mliq	0.078	0.083	0.002	0.41	1504
fliq	0.092	0.076	0	0.533	1488
Hbank_Crisis	0.172	0.377	0	1	1504
size	12.113	1.313	8.82	15.171	1504
racr	13.468	2.176	9.16	22	1504
nim	2.89	1.135	0.690	7.100	1504
loanstoassets	0.532	0.178	0.044	0.950	1504
depositsloans	1.61	1.709	0.083	16.326	1504
LCrisisdummy	0.173	0.378	0	1	1504
fedfund	1.813	1.823	0.07	5.26	1504
tedspread	0.461	0.501	0.14	3.35	1504

Table 5: Summary statistics "low" quality banks (≤A-) and quarterly difference values

Variable	Mean	Std. Dev.	Min.	Max.	N
marketliq	0	0.016	-0.085	0.138	2174
fundingliq	-0.002	0.034	-0.375	0.283	2116
Hbank_Crisis	0.003	0.057	0	1	2174
Dsize	0.015	0.055	-0.203	0.791	2174
Dracr	0.01	1.208	-22.48	18.28	2174
Dnim	-0.015	0.272	-3.58	3.69	2174
Dloanstoassets	0	0.023	-0.148	0.294	2174
Ddepositsloans	0.003	0.072	-0.538	1.395	2174
LCrisisdummy	0.159	0.366	0	1	2174
changefedfund	-0.086	0.444	-1.66	0.52	2174
changetedspread	-0.008	0.439	-2.27	2.18	2174

Table 6: Summary statistics "high" quality banks (>A-) quarterly difference values

Variable	Mean	Std. Dev.	Min.	Max.	N
marketliq	0	0.02	-0.132	0.147	1292
fundingliq	-0.001	0.026	-0.293	0.303	1292
Hbank_Crisis	0.168	0.374	0	1	1292
Dsize	0.022	0.064	-0.498	0.744	1292
Dracr	0.058	0.789	-4.9	4.9	1292
Dnim	-0.013	0.241	-2.3	1.73	1292
Dloanstoassets	0	0.021	-0.181	0.094	1292
Ddepositsloans	0.009	0.429	-5.350	4.4	1292
LCrisisdummy	0.17	0.375	0	1	1292
changefedfund	-0.087	0.463	-1.66	0.570	1292
changetedspread	-0.004	0.438	-2.27	2.18	1292

4 Methodology

The data of this research contains different observations for different time periods for different banks and is therefore in panel data format. One of the main advantages of panel data is that panel data allows controlling for omitted (mis-measured or unobserved) variables by making use of either fixed effects or random effects models.

As explained in the previous section, both market liquidity and funding liquidity measurements appear as dependent variables in this research and can either be specified in level values ($mliq_{it}$ and $fliq_{it}$) or in first difference values ($marketliq_{it}$ and $fundingliq_{it}$). In this way I follow the approach of Aspachs et al (2005) in which both level values of liquidity and changes in liquidity are being considered. In this way, the effect on being a high quality bank on level values and first differences of market liquidity and funding liquidity are being explored. The main variable of interest is a dummy representing a ''high quality" or ''low quality" bank and control variables are an element of three different factors representing bank characteristic, macroeconomic environment and monetary policy. The two main general models for this study have the following form:

$$y_{it} = \alpha_i + \beta_1 Quality_{it-1} + \beta_2 Quality_{it-1} * Crisis_{t-1} + \beta_3 Crisis_{t-1} + \beta_4 X'_{it} + \beta_5 Z'_t + \epsilon_{it} \quad (1)$$

$$\Delta y_{it} = \alpha_i + \beta_1 Quality_{it-1} + \beta_2 Quality_{it-1} * Crisis_{t-1} + \beta_3 Crisis_{t-1} + \beta_4 \Delta X'_{it} + \beta_5 \Delta Z'_t + \epsilon_{it} \quad (2)$$

Where y_{it} refers to the variables $mliq_{it}$ and $fliq_{it}$ of the ith bank at time t. α_i captures the time invariant bank unobserved fixed effect, $Quality_{it-1}$ refers to a lagged dummy variable which is equal to one when the bank is of high quality, $Quality_{it-1} * Crisis_{t-1}$ captures the interaction effect of being a high quality bank in a crisis period as $Crisis_{t-1}$ is a lagged dummy variable which is equal to one in crisis periods, X'_{it} is a matrix containing bank specific control variables, while Z'_t is a matrix containing macroeconomic

and monetary policy control variables.

Δy_{it} refers to the variables $marketliq_{it}$ and $fundingliq_{it}$. Moreover, $\Delta X'_{it}$ represents quarterly differences in bank specific control variables, while $\Delta Z'_t$ represents quarterly differences in macroeconomic- and monetary policy control variables.

The reason to include the lag of the dummy variable Quality ($Quality_{it-1}$) instead of the value at time t ($Quality_{it}$) is due to endogeneity concerns; more specifically the presence of reverse causality. This matter will further be explained in section 4.5.1. The reason why the lagged value of the crisis dummy ($Crisis_{t-1}$) is being used instead of the value at time t is because it appeared that the lagged value of the crisis dummy performed better in estimating equations (1) and (2) in comparison to the value at time t. This can be due to some adjustment affect as it can be possible that banks do not respond instantly on a crisis period, but need some time to adjust their market- and funding liquidity positions.

4.1 Fixed effects estimator or random effects estimator

Fixed effects regression reduces the potential for endogeneity in the form of omitted variable bias in comparison to standard OLS regression, because fixed effects regression only considers the "within variation" between banks. When performing a standard OLS regression, the "across variation" will also be considered. In this way, levels of financial variables of different banks will be compared in relation with different levels of credit ratings. This means that a relationship (i.e. coefficient) will be specified that is possibly biased, because the composition of the bank's balance sheet might be affected by (unobserved time-invariant) internal characteristics of banks such as clientele base, management team and mainstream availability of the lending opportunities, as mentioned by Loutskina (2010). The bank fixed effects regression absorbs all the "across variation" between banks, by specifying fixed intercepts for different banks, so that all the "within variation" can be captured by the (coefficients of the) financial variables. Either estimating fixed effects or a random effects model involves Least Squares Dummy Variables (LSDV) instead of Ordinary Least Squares (OLS).

Both fixed and random effects account for unobserved heterogeneity between cross

sections. However, one of the main difference between using the random- or fixed effects model is the assumption on how unobserved factors correlate with the independent variables [6]. The main assumption of the random effects estimator is that unobserved factors are not correlated with the independent variables used. When this assumption is met, the random effects estimators produces unbiased estimates of the coefficients, produces smaller standard errors than the fixed effect model and uses all the data available (Verbeek, 2008). However, the main assumption in the random effects model is very strong and within the scope of this paper not likely to be met. The fixed effect estimator does not require being uncorrelated with the independent variables used in the regression specification and is therefore from a theoretical point of view more suitable for this research.

In order to econometrically test if the fixed effects model or random effects model have to be chosen, the Hausman test has been performed. The null hypothesis of the Hausman tests is in favor of the random effect model estimator. The result of this test indicates that fixed effect model estimators have to be used. The result of the Hausman test can be found in the Appendix.

4.2 Bank fixed effects and/or time fixed effects

As highlighted above, bank fixed effect account for unobserved internal characteristics of banks. Besides cross section (bank) fixed effects, one can also incorporate time fixed effects in the main regression specification. Time fixed effects can be used to control for (unobserved) time-specific effects which affects all entities (banks) in the same way. So, by including dummies for every quarter in the dataset, time fixed effects have been incorporated in the model. In order to statistically test if the incorporation of time fixed effects is necessary, a Wald test has been performed in order to check if the coefficients of time fixed effects are equal to zero. The results indicate that time fixed effects have to be incorporated into the main regression analysis.

[6] Another main difference between random and fixed effects is of inference. Fixed effects only supports inference about the dataset used, while random effects allows to infer something about the population as a whole

4.3 Homogeneity assumption

In panel analysis and more specifically when applying fixed effects estimations, the homogeneity assumption regarding the independent variables[7] is important. This homogeneity assumption states that the coefficient of all independent variables are the same across cross sections (banks). In other words:

$$\beta_i = \beta \quad \forall i = 1, ..N \tag{3}$$

If equation (3) holds then all cross-section units have the same β in equation (4):

$$y_{i,t} = \alpha_i + \beta X_{i,t} + \epsilon_{i,t} \tag{4}$$

In case the homogeneity assumption does not hold, beta's differ between cross section units. This implies that equation (4) becomes:

$$y_{i,t} = \alpha_i + \beta X_{i,t} + \beta X_{i,t}(\beta_i - \beta) + \epsilon_{i,t} \tag{5}$$

As can be seen from eq (5) there is an addition term $\beta X_{i,t}(\beta_i - \beta)$, which belongs to the error term of the model if homogeinity was (falsely) assumed:

$$y_{i,t} = \alpha_i + \beta X_{i,t} + \underbrace{\beta X_{i,t}(\beta_i - \beta) + \nu}_{\epsilon_{i,t}} \tag{6}$$

To test if homogeneity between coefficient of cross-section units (banks) can be assumed, a poolability F test can be performed, taking into account both ''pooled" errors and individual error terms. The null hypothesis has the following form:

$$H_0 : \beta_i = \beta \quad \forall i = 1, ..N \tag{7}$$

[7]In a fixed effect model, these cross section and time effects are included as dummy variables and

Note however that when a static panel regression specification is being used, a false homogeneity assumption still provides consistent estimates for the individual cross section units (banks) since the bank-specific β could be either higher or lower than estimated β from the static panel model. As can be seen from equation (6), the estimated β is still consistent, as the addition term $\beta X_{i,t}(\beta_i - \beta)$ belongs to the error term. Nonetheless, false homogeneity can cause autocorrelation in the error terms. This can be seen by lagging equation (6) one period, so that we obtain:

$$y_{i,t-1} = \alpha_i + \beta X_{i,t-1} + \beta X_{i,t-1}(\beta_i - \beta) + \epsilon_{i,t-1} \tag{8}$$

As $\beta X_{i,t-1}(\beta_i - \beta)$ and $\beta X_{i,t}(\beta_i - \beta)$ are very similar and both part of the error term, it is highly likely that $cov(\epsilon_{it}, \epsilon_{it-1}) \neq 0$ so that there is autocorrelation in the error terms. However, in a static panel data model autocorrelation would not cause inconsistency in the mean group estimator as long that this variable is not related to the error term.

4.4 Regression diagnostics

4.4.1 Test for multicollinearity

The independent variables used in the main regression specification could be correlated in such a way that multicollinearity problems exist. Multicollinearity refers to the fact that independent variables are strongly, hence not perfectly related to each other. When multicollinearity is present, the information decreases regarding the effect of the independent variables on the dependent variables. This can imply that independent variables seem to be unrelated to the dependent variables, while in fact they are related. It is not clearly defined in the literature how much correlation between independent variables causes multicollinearity problems. Hair et al (2006), Malhotra (2007) and Kennedy (2008) suspect multicollinearity problems when correlation between inde-

thus not part of the independent variables

pendent variables ranges between 0.7 and 0.9. According to Gujarati (2004) there are several ways to test for multicollinearity problems, including analyzing the condition index (CI) , variance inflation factor (VIF) and the explanatory variables correlation coefficients (CC). The latter method has been used in this research. The results from the correlation matrix indicate that there are three variables which have a correlation coefficient between 0.62 and 0.667, namely the variables: size, L.Crisisdummy and loanstoassets. First, note that the maximum value of correlation of 0.667 is below the threshold value of 0.7 indicated by Hair et al (2006), Malhotra (2007) and Kennedy (2008). However, to rule out any possibility of multicollinearity in the main regression specification a robustness check with other independent variables has been performed (see section 6). In this robustness check the variable bmodel (business model) has been used instead of loanstoassets to account for this possible collinear relation with the variable depositsloans. Moreover, regression specifications without the variable size and the interaction term between Bank quality and a crisis period ($Hbank_Crisis$) is being estimated and there was no change in the results [8]. The correlation matrix between the independent variables can be found in the Appendix.

4.4.2 Test for heteroscedasticity

If residuals of the main regression specification do not have a constant variance over time, heteroscedasticity is present in the data. Heteroscedasticity implies that the goodness of fit of the specified model changes across the distribution of the independent variable. The conventional OLS standard error of β is given by: $[\sigma_\beta^2]_{conv} = \frac{1}{n}\frac{\sigma_e^2}{Var(x_i)}$ where σ_e^2 is the residual of the model. From this formula we can see that the standard errors of the independent variables depend on the residuals of the model. This implies that the standard errors of the independent variable are being influenced if heteroscedasticity is present. To control for the presence of heteroscedasticity, White Heteroskedastic Consistent standard errors (robust standard errors) could be used in the main regression specification. The white test has been performed on the main

[8] these estimations are not represented in the robustness checks section, but can be requested from the author.

regression specification with conventional OLS standard errors in order to check if the conventional OLS standard errors in combination with the main model, suffer from heteroscedasticity. The results indicate that the conventional OLS standard errors in combination with the main regression specification have heteroskedastic error terms. Therefore White Heteroskedastic Consistent error terms have been used in all regression specifications. The results of the white tests can be found in the Appendix.

4.4.3 Test for serial correlation

If the residuals of the main regression specification are correlated with each other, serial correlation (autocorrelation) could be present in the data. A Woolridge test on the main model (equation 1) has been performed, without the fixed effects and with conventional OLS standard errors. The results indicate that this model suffers from serial correlation (see Appendix). If serial correlation is present in the data, standard errors of the model could be biased and therefore causes the results to be less efficient. Serial correlation in panel data could be present due to various reasons. One of the most important reasons why serial correlation could be present is because of omitted variables. However, by using entity (banks) fixed effects model, most of the unobserved (time invariant) variables are accounted for and therefore not present in the error term. This reduces the possibility of serial correlation in the model. To see why, consider an error term ϵ_{it} which consist of some time invariant unobserved variable α_i and other unobserved factors υ_{it}. So, $\epsilon_{it} = \alpha_i + \upsilon_{it}$. In this way error terms can easily be correlated since the unobserved factor is common across error terms. When one accounts for this unobserved factor, only υ_{it} remains. Subsequently, υ_{it} is being expected to be equal to 0, which results in no serial correlation between error terms. To account for both heteroscedasticity and serial correlation, robust standard errors and a fixed effect model have been used in the main regression specifications.

Auto regressive (AR) process Note that even the inclusion of bank fixed effects, where the unobserved time invariant variable α_i is taken out of the error term, still not perfectly ensures that the error terms are uncorrelated (so that $cov(\epsilon_{it}, \epsilon_{it-1}) \neq 0$).

Error terms can be correlated of order p, which means that the error term follows an AR process of order (p):

$$\epsilon_{it} = \phi_1 \epsilon_{it-1} + \phi_2 \epsilon_{it-2} + ... + \phi_p \epsilon_{it-p}$$

Where no autocorrelation implies $H0 = \phi_1 = \phi_2 = ... = \phi_p = 0$
Note that the use of a regression specification with variables in first differences implies a transformation of the basic model in levels in such a way that the error terms are not correlated anymore. To see this, consider a simple model with AR(1) error term autocorrelation:

$$Y_{it} = \alpha + \beta_1 x_{it} + u_{it} \quad t = 1, .., T \;\; i = 1, .., N$$

$$u_{it} = \phi_1 u_{it-1} + \epsilon_{it}$$

Lagging the model one period, results to the following expression:

$$Y_{it-1} = \alpha + \beta_1 x_{it-1} + u_{it-1}$$

Assume that $\phi \approx 1$, as estimates of ϕ are often close to 1, and subtract$Y_{it-1)}$ from Y_{it} to get the first difference and remember that $u_{it} = \phi_1 u_{it-1} + \epsilon_{it}$ gives:

$$\begin{aligned} \Delta Y_i &= \Delta \beta_1 x_i + u_{it} - u_{it-1} \\ &= \Delta Y_i = \Delta \beta_1 x_i + u_{it-1} + \epsilon_{it} - u_{it-1} \\ &= \Delta Y_i = \Delta \beta_1 x_i + \epsilon_{it} \end{aligned}$$

So in the last term we can see that only ϵ_{it} is left and there is no autocorrelation in the error term anymore.

However, above approach relies on the assumption that $\phi = 1$. To rule out any

possibility of serial correlation, I estimated a dynamic panel data model with a lagged dependent variable as a robustness check (see section 6). Incorporating a lagged dependent variable can also remove or reduce the serial correlation in the model. To see this, assume a model where Y_{it} actually depends on the lagged dependent variable Y_{it-1} [9], but where this lagged dependent variable is not explicitly incorporated in the model, such that is part of the error term u_{it}:

$$Y_{it} = \alpha + \beta x_{it} + \underbrace{Y_{it-1} + \epsilon_{it}}_{u_{i,t}}$$

Lagging above equation by one period gives:

$$Y_{it-1} = \alpha + \beta x_{it-1} + \underbrace{Y_{it-2} + \epsilon_{it-1}}_{u_{i,t-1}}$$

So, it can be noticed that ϵ_{it} depends on ϵ_{it-1} by substituting the equation of Y_{it-1} above into the equation below:

$$\epsilon_{it} = Y_{it} - (\alpha + \beta x_{it} + Y_{it-1})$$

Including a lagged dependent variable as an explanatory variable in the regression, avoids that Y_{it-1} becomes part of the error term. This dynamic panel data model is estimated in section 6.5 of the robustness checks.

4.4.4 Testing for a unit root for the variables used

When using panel data in research, one should consider the possibility that variables used in the main regression specification are non-stationary and thus follow a particular trend. This is especially true for economic time series data. Variables are stationary when they converge to a constant mean (steady state level), after they are being hit by a random shock. So this means that shocks will have a transitory effect. Variables

[9] With regards to the dependent variables used in this research, one can argue that the market liquidity of bank i at time t depends on the market liquidity of bank i at time t_{-1} which captures some short run mechanism. The same applies to funding liquidity.

can also be trend stationary, which implies that there steady state values are trending downward or upward. So, the mean trend of these series is deterministic and once the trend is accounted for and removed from the data, the residual series will be a stationary stochastic process. On the other hand, variables can be non-stationary. These variables have a stochastic trend, which in case of a shock have a permanent effect. Incorporating non-stationary variables in a regression could lead to a spurious regression with an high R^2, while the variables are in fact unrelated. If a variable appears to be non-stationary, one could difference this variable so that the differenced value of this variable appears to be stationary. In order to test if variables used in the main regression specification are stationary, the Augmented Dicky Fuller test has been used under the null hypothesis that the variable contains a unit root (is non-stationary). The results of the variables used in the main regression indicate (see Appendix) that only the variable (Total) assets has a unit root[10]. However, this variable is not directly incorporated in any regression specification, because it is either used in ratios or when the natural logarithm of the assets (size) has been taken (both are I(0)).

4.5 Endogeneity concerns

4.5.1 Reverse causality

One of the main endogeneity concerns relating to this research is the presence of reverse causality between the quality of the bank and the use of market- and funding liquidity. For example, one could also think of a regression where (the use of) market liquidity and funding liquidity affect bank quality through higher credit ratings. Thus, solely regressing the bank quality at time t on the market- or funding liquidity at time t, would only yield a correlation between bank quality and the use of market and funding liquidity. To address this issue the lagged value of the "high" or "low" quality bank dummy variable is used. The level of market- or funding liquidity at time t cannot influence the bank quality at time t_{-1}, while bank quality at time t_{-1} could possible influence market- or funding liquidity at time t. In this way, the effect of bank quality

[10]the variable diffStress is also I(1), but used in the robustness checks. See section 6.

on market- or funding liquidity can be measured, without reverse causality concerns. So, identifying the relationship between bank quality at time t_{-1} and market- and funding liquidity at time t is aimed to find a causality.

4.5.2 Omitted variable bias

In a standard OLS regression, omitted variable bias is a serious and much highlighted concern. Omitted variable bias could lead to either an underestimation or overestimation of the real effect, if the omitted variable is both related to the variable of interest and the dependent variable [11]. However, the panel data structure of this research allows capturing unobserved time invariant heterogeneity between banks by using cross section (banks) fixed effects. In this way, this unobserved time invariant heterogeneity between banks is not present in the error term, which reduces the risk of omitted variable bias. However, there is still the possibility of omitted variable bias if there exists some unobserved time varying heterogeneity for banks which is related to both the dependent variable and the variable of interest. However, incorporating time fixed effects addresses this issue.

4.5.3 Measurement error

Measurements error in panel data could lead to serious concerns, due to the attenuation bias which biases the coefficient towards zero. However, a distinction has to be made between measurements errors in the independent variable or dependent variable. There is no reason to assume that there is a systematic measurement error in the independent variables used in this thesis.

As for the purpose of this paper, only secured funding is of interest in our measures for funding liquidity. However, as of the lack of secured funding data, debt in current liabilities over total assets minus cash is used as a proxy for funding liquidity. Debt in current liabilities does also consist of non-secured funding. Therefore, measurement error in the dependent variable funding liquidity is present due to the proxy used.

[11] So if $cov(x_i, \epsilon) \neq 0$

This measurement error does only leads to biased results if the measurement error is correlated with the independent variables. See the Appendix for the proof of this conclusion.

5 Results

Table 7 and table 8 present the main results. Note that results shown in table 7 present results of the dependent variables market- and funding liquidity in level values, while table 8 present results of the variables market- and funding liquidity in quarterly first difference values to account for the increase/decrease in the trend of either market- and funding liquidity. Most of the independent and control variables coincide with respect to the dependent variables in terms of level measures or quarterly differences measures, except for the dummy representing bank quality and the dummy representing a crisis period (and the interaction term of these variables).The dummy variables representing either bank quality or a crisis period are in lagged values to account for possible endogeneity problems or to account for an adjustment process respectively, as described in section 4. As previously mentioned, the dummy variable *Hbankquality* equals one if a bank has a credit rating higher than A-.

5.1 Results in level values

The results of table 7, column 1 and 2 indicate that being a high quality bank has a negative, hence small [12], impact on the level of (market) liquid assets of a bank with respect to a low quality bank. This is in line with the hypothesis of this paper. The variable *Hbankcrisis*, which represents the interaction effect of a crisis period and the dummy variable representing bank quality, is positive which could indicate that in crisis periods high quality banks hold more liquid asset, however this variable is not significant. Furthermore, in times of crisis, the level of liquidity is generally

[12]Note that this is the effect on the ratio of cash and due from banks over total assets. For example, consider a low quality bank with 7 billion USD in cash and due from banks (this is the average value in the sample of this thesis) and 270 billion USD of total assets. A high quality bank, with on assumption the same amount of assets, has according to this results a lower ratio of *mliq* by 0.0049. This implies

higher for high quality banks. Moreover, nearly all control variables have the expected signs: the net interest margin of banks is negatively related to holding liquid assets and this confirms the opportunity cost argument. Moreover, banks with more loans tend to have less liquid assets, which confirm that holding liquid assets and loans can be viewed as substitutes. On the other hand, banks which rely more on deposits as a source of funding, tend to have more liquid assets. This supports the view that maturity transformations bears a risk for banks, where banks have to hold liquid assets in order to take into account the possibility that depositors can immediately liquidate their deposits. Moreover, larger banks (in terms of total assets) and banks with a higher risk adjusted capital ratio (racr) tend to have more liquid assets. This latter result is in line with the literature described in section 2.7. According to the financial fragility hypothesis, banks with a lower RACR tend to favor liquidity creation. This means that banks with an higher RACR deter liquidity creation. When less liquidity is created by banks, this means that they keep more liquid assets in their portfolio, resulting in the positive relationship found between the variable *racr* and *mliq*. However, as can be seen from the descriptive statistics in section 3.3, high quality banks have on average a lower RACR in this sample. Statistics regarding the RACR of top rated banks (AA+ - A-) per rating group can be found in the Appendix. These statistics support the conclusion that the highest rated banks have a lower RACR [13]. For instance, it can be the case that banks which are in the highest rating class, do not feel the need to take on new equity, because this is more costly then taking on other sources of funding (debt or deposits). This in turn deteriorates their risk adjusted capital ratio ,but this not necessarily means that these bank have an asset portfolio of bad quality. The results of the statistics explained above seem to negatively relate the RACR and the credit ratings in this sample. From this perspective onward, the results are in line with the my hypothesis, as high quality banks make less use of the market liquidity channel, which can be explained by for instance their lower RACR which boosts liquidity creation according to the literature (see section 2.7) and thus lowers liquid assets held by the

that this banks has 34.3 million less cash and due from banks compared to the low quality bank. Namely, $\frac{\frac{x}{270000000000} - \frac{70000000000}{270000000000}}{\frac{70000000000}{270000000000}} = -0.0049$ gives $x = 6965700000$

[13] This implies that a high quality banks does not necessarily need a high RACR

bank.

With respect to the macroeconomic and monetary policy factors nearly all variables have the expected sign as well. The variable *tedspread*, which indicates stress in financial markets, has a negative effect on the level of liquid assets of banks. This could indicate that in times of financial stress, interbank borrowing tightens as banks are less willing to make loans to each other and thereby making it harder for banks to obtain liquidity in the form of cash. On the other hand, one can think of a scenario that banks hold more liquid assets in times of financial stress (as also pointed out in section 2.7.1), to protect themselves from large amounts of money which can be withdrawn by depositors. This seems not to be the case in this model and time frame used. The coefficient of the federal funds rate indicates that monetary tightening, by raising the federal funds target rate, has a negative impact on the level of market liquidity. This could be explained by the fact that obtaining liquid assets becomes more expensive for banks when the federal funds rates increases (ceteris paribus). Furthermore, in times of crisis, loan demand diminishes (resulting in a higher level of liquid assets) and the FED is more likely to lower interest rates. This could also result in a negative relationship between the federal funds rate and the level of market liquidity.

In column 2 of table 7 the regression specification is estimated with the inclusion of time fixed effects [14]. As time fixed effects can vary over time, but not between banks, all variables which only vary between time, but not between banks, have to be deleted out of the regression specification. The results of column 2 table 7 indicate that the inclusion of time fixed effects does not change the results in terms of significance and expected signs. There are only some very small differences in the magnitude of the coefficients, which can be explained by very small difference between including time fixed effects or including time series variables (i.e. column 2 vs column 1) [15].

With respect to the results of column 3 in table 7 it can be noticed that being a high quality bank raises the level of funding liquidity. This is in line with the hypothesis of

[14] time fixed effects are added in the model by incorporating time dummies for every quarter between 2001 and 2014.

[15] The time dummies capture all heterogeneity over time, while in case of adding time variables only the heterogeneity of these variables is taken into account. This could explain the small difference in the magnitude of the coefficients

this paper, although this result should be interpreted with caution as will be explained below. On the other hand, in times of crisis, this effect diminish to nearly zero indicating that in periods of crisis there is nearly no difference between high quality and low quality banks with respect to the level of funding liquidity [16]. On first sight this result seems trivial. However, one could think of a scenario where banks do not want to obtain secured funding in times of crisis as they do not want to pay a higher price for secured funding taking into account of which quality they are. In times of a financial crisis and financial market stress, margins rise and obtaining secured funding becomes more expensive. This could also hold for high quality banks due to asymmetric information. Therefore, it could be the case that high quality banks prefer to sell their assets, in times of crisis, when they need cash instead of obtaining secured funding. Moreover, it appears that size is negatively related to the level of funding liquidity in column 3 of table 7. As the expected sign of size was not known, it is not possible to conclude about the sign obtained in this regression with respect to the expected sign. Furthermore, the coefficient of the net interest margin is nearly zero and insignificant, but positive as expected. The coefficient of the $RACR$ is nearly zero in column 3 of table 7, hence it is negative. This is in line with what was expected. The coefficient on loans to assets is negative and significant, indicating that banks which hold more loans tend to have a lower level of funding liquidity. This is as expected as holding liquid assets and making loans can be viewed as substitutes. Furthermore, banks which have more deposits tend to have less levels of funding liquidity. This result is in line with the expected sign of this variable, as deposits and secured funding can be viewed as funding substitutes for banks. With respect to the dummy representing periods of crisis, the results are as expected. This also applies for the federal funds rate and the variable *tedspread*, which are respectively positively, negatively and significant related to levels of funding liquidity.

[16] note that the coefficient of interaction term $Hbank_Crisis$ represents the effect on funding liquidity when being a high quality bank in times of crisis. Hence the total effect on funding liquidity if being a high quality bank in times of crisis (ignoring the control variables) is: $\alpha_i + \beta_1 + \beta_2 + \beta_3$ while for a low quality bank in times of crisis this is: $\alpha_i + \beta_3$. If $\beta_1 + \beta_2 \approx 0$ and α_i is the same between these two banks, then the total effect on funding liquidity in crisis periods is the same between high- and low quality banks.

Table 7: Results in level values

VARIABLES	(1) mliq	(2) mliq	(3) fliq	(4) fliq
L.Hqualitybank	-0.00490***	-0.00416***	0.0111***	-0.00314
	(0.00162)	(0.00151)	(0.00323)	(0.00329)
Hbank_Crisis	0.00153		-0.0132***	
	(0.00277)		(0.00457)	
size	0.00379**	0.00554**	-0.0255***	0.0327***
	(0.00162)	(0.00223)	(0.00320)	(0.00439)
nim	-0.00342***	-0.00434***	5.05e-06	-0.00509**
	(0.00132)	(0.00134)	(0.00247)	(0.00255)
racr	0.00166***	0.00184***	-0.000870	0.00122*
	(0.000378)	(0.000391)	(0.000644)	(0.000672)
loanstoassets	-0.0460***	-0.0427***	-0.242***	-0.153***
	(0.0132)	(0.0140)	(0.0258)	(0.0253)
depositsloans	0.0279***	0.0280***	-0.0269***	-0.0259***
	(0.00397)	(0.00396)	(0.00510)	(0.00475)
L.Crisisdummy	0.00571***		0.0184***	
	(0.00175)		(0.00360)	
fedfund	-0.00148***		0.00394***	
	(0.000299)		(0.000636)	
tedspread	-0.00303**		-0.00112	
	(0.00118)		(0.00234)	
Constant	-0.00252	-0.0178	0.538***	-0.0825
	(0.0230)	(0.0304)	(0.0384)	(0.0506)
Observations	3,755	3,817	3,699	3,761
Adjusted R^2	0.822	0.824	0.606	0.640
Bank FE	YES	YES	YES	YES
Quarter FE	NO	YES	NO	YES
# of Banks	129	129	129	129

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 8: Results in quarterly first difference values

VARIABLES	(1) Market liquidity	(2) Market liquidity	(3) Funding liquidity	(4) Funding liquidity
L.Hqualitybank	-0.00198*	-0.00119	-0.00191	-0.000965
	(0.00111)	(0.00108)	(0.00225)	(0.00217)
Hbank_Crisis	0.00147		0.00253	
	(0.00177)		(0.00336)	
Dsize	0.0404***	0.0407***	0.0574**	0.0565**
	(0.00919)	(0.00931)	(0.0266)	(0.0274)
Dnim	-0.000618	-0.000656	-0.000675	0.000655
	(0.00144)	(0.00141)	(0.00173)	(0.00187)
Dracr	0.00104**	0.00108**	0.000353	0.000379
	(0.000522)	(0.000516)	(0.000891)	(0.000902)
Dloanstoassets	-0.169***	-0.170***	-0.170***	-0.189***
	(0.0248)	(0.0253)	(0.0366)	(0.0386)
Ddepositsloans	0.0132***	0.0130***	-0.0139***	-0.0130***
	(0.00260)	(0.00253)	(0.00393)	(0.00393)
L.Crisisdummy	0.000566		-0.00265	
	(0.00129)		(0.00298)	
changefedfund	-0.000788		-8.97e-05	
	(0.000841)		(0.00164)	
changetedspread	4.46e-05		0.00393**	
	(0.000917)		(0.00175)	
Constant	9.91e-05	0.00357**	-0.00155	-0.00283
	(0.000513)	(0.00147)	(0.00102)	(0.00560)
Observations	3,466	3,520	3,408	3,462
Adjusted R^2	0.138	0.157	0.034	0.037
Bank FE	YES	YES	YES	YES
Quarter FE	NO	YES	NO	YES
# of Banks	109	109	109	109

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

As the federal funds rate increases, obtaining liquid assets becomes more expensive. As a substitute of unsecured funding, secured funding can rise. This explains the negative relationship between the federal funds rate and funding liquidity. The positive relationship between the variable *tedspread* and funding liquidity can be explained by the same argument as for the dummy representing crisis periods; in times of stress in financial markets, obtaining secured funding becomes more difficult which decreases the level of funding liquidity.

Column 4 of table 7 present the results of the estimated model for funding liquidity when time fixed effects are included. There are several conspicuous results. First of all, the dummy representing bank quality changed sign and is no longer significant. Second, both *size* and *RACR* changed sign but remain significantly related to the level of funding liquidity. Third, the coefficient on the net interest margin has become negative and significant instead of zero and insignificant. These results could indicate various conclusions: first, it could be the case that including time fixed effects accounts for many unobserved effects, which vary over time but are the same for banks, which not have been incorporated in the regression which excludes time fixed effects. Therefore results can differ between these two regression specifications. Second, the significant relationship found in column 3 of table 7 is biased, due to omitted variable bias or a measurement error. As the influence of being a high quality bank is not consistent with including or excluding time fixed effects, one should be cautious in interpreting the results of column 3 of table 7.

5.2 Results in quarterly first difference values

The results of the quarterly differences regression specifications are presented in table 8. The results of table 8 column 1 indicate that being a high quality bank has a negative effect on the use of market liquidity with respect to a low quality bank. This is in line with the hypothesis of this paper. Furthermore, all control variables are in line with the results of column 1 of table 7 (the levels specification) in terms of (expected) signs. Besides, the control variables have nearly the same magnitudes. In column 2 of table 8 the results are presented when time fixed effects are included. While all

control variables have the same sign and significance, the variable of interest changes from significant at the 10 percent level to insignificant.

The results of the quarterly differences regression specifications in terms of funding liquidity are presented in column 3 and 4 of table 8. Column 3 presents the results excluding time fixed effects but incorporating time series variables. Column 4 present the results in case time fixed effects are included in the regression specification. The results of column 3 indicate that being a high quality bank does not influence the use of funding liquidity; hence the sign is not as expected. Furthermore, the interaction effect of being a high quality bank and a crisis period is negative, as was the case in the level specification. Moreover, the coefficients on the control variables coincide with column 3 of table 7 with respect to *nim*, *RACR*, *deposits to loans, loans to assets, the crisis dummy, and the federal funds rate*. The coefficients of the variables *tedspread* and *size* differ in sign between column 3 of table 8 and column 3 of table 7. This could again indicate that the results with respect to the regression specifications of $fliq$ should be interpreted with cautiousness. With respect to the regression specification of column 4 of table 8, which includes time fixed effects, the results seem more consistent between the inclusion of time fixed effects or exclusion of time fixed effects with respect to the obtained results of column 4 of table 8 and column 4 of table 7. There is no change in sign between these two models and the quality of the banks seems still not influence the use of funding liquidity.

5.3 Summary of the main results

The results of table 7 indicate that there is a significant difference in the level of (market) liquid assets between high quality and low quality banks. This result is robust to including time fixed effects. With respect to the level of funding liquidity, the results should be interpreted with more caution, as this results is not robust when time fixed effects are included. The results of table 8 indicate that there is little evidence that there exists a difference between the use or trend of market liquidity between high quality banks and low quality banks. The variable of interest which represents bank quality is significant at the 10 percent level, however this significance is not present

when time fixed effects are included. With respect to the use or trend of funding liquidity, there is no evidence that there is a difference between high quality and low quality banks.

6 Robustness checks

This section provides several robustness checks, in order to assess the robustness of the obtained results in the previous section. First of all, I assess the robustness of the results when other control variables are being used. Second, the robustness regarding the construction of the independent dummy variable is being examined. Third, S&P short term bond credit ratings are being used as a proxy for bank quality instead of S&P long term bond credit ratings. Fourth, the robustness of the construction of the dependent variables is being assessed by using other measures of market liquidity and funding liquidity. Lastly, I assess how results are being driven by potential serial correlation in the main regression specification in levels, by including a lagged dependent variable and thus estimating a dynamic panel data model.

6.1 The incorporation of other control variables

In order to assess the vulnerability of the obtained results in section 5 to the control variables used, different variables of the three main control factors (bank-, macroeconomic- and monetary policy factors) are incorporated in the main regression specifications.

1. Bank specific factors:

    - The share of interest income to non-interest income and interest income instead of loans to total assets is being used to capture the business model of the bank (*bmodel*).

2. Macroeconomic factors:

    - The St. Louis Fed financial market stress indicator is used instead of the tedspread, as in indicator of the stress in financial markets. As this is a

non-stationary variable and integrated of order 1 (I(1)) the difference of this indicator is taken into account in both the level and first difference specifications.

3. Monetary policy factors:

   - The discount rate is being used instead of the federal funds rate, to capture the monetary policy of the FED.

The results of this first robustness check are presented in table 9 (level values) and table 10 (quarterly first difference values). Table 9 indicates that the variable of interest, the dummy representing bank quality, is robust to incorporating other control variables. However, the magnitude of this variable is somewhat stronger in case of the $mliq$ regression specifications and somewhat weaker in the $fliq$ specifications with respect to table 7. Furthermore, the interaction effect of a crisis period and the dummy representing bank quality, $HbankCrisis$, is negative and significant in table 7 but not in table 9. This means that this interaction effect should be considered with caution. When considering the signs and significance of the control variables, almost all control variables have the expected sign and did not change with respect to table 7. The coefficient of the variable *diffStress* is very close to zero, although slightly positive. This contradicts the sign of the coefficient of the variable *tedspread* which was negatively related to (market) liquidity. However, as explained in section 2.7.1 the tedspread and market liquid assets can both be negatively as positively related and a change of sign does not change the main results.

The results of table 10 indicate that bank quality influences the use of market liquidity in case no time fixed effects are being used. This was found in table 8 of the main results as well. Note that in table 10 the dummy variable representing bank quality has a somewhat larger magnitude, but is significant at the 5 percent level instead of the 10 percent level in table 8. However, when time fixed effects are being incorporated in the regression specifications, this variable loses his significance. Therefore, the results in table 10 column 1 with regards to $Hqualitybank$ should be interpreted with cautiousness.

With respect to the results of column 3 and 4 of table 10 there are no surprises, as the quality of the bank seems not to influence the use of funding liquidity in accordance with the main results.

6.2 Changing the construction of the dummy variable representing bank quality

A different construction of the dummy variable, which represents bank quality, has been applied, to assess if the used construction of the dummy variable in the main model has influenced the results. The bank quality dummy used in this robustness check qualifies high quality banks as banks with a credit rating higher than or equal to BBB- and banks with a credit rating lower than BBB- as low quality banks (as opposed to the construction in the main results where the dummy variable was equal to unity when the bank had a rating higher than A-). This coincide with the S&P investment and sub-investment qualification of bond credit ratings.

The results are presented in table 11 and 12. The results in table 11 indicate that changing the construction of the dummy variable does not change the sign and significance of the variable of interest, $Hqualitybank2$. However, the magnitude of this variable is somewhat larger in table 11. Furthermore, nearly all control variables have the same sign, magnitude and significance as in the main regression specification in section 5, table 7. The only exception is the dummy representing crisis periods, which changed sign. Striking is the result of columns 3 and 4 of table 11, where $Hqualitybank2$ is now significantly and positively related to the level of funding liquidity. This can be due to the fact that the distribution between "high" and "low" quality banks is not as equal as the distribution used in the main results, where this distribution was made upon the median of the credit ratings in the dataset instead of an exogenous threshold value (investment and sub-investment grade). This unequal distribution of "high" and "low" quality banks could lead to a sample bias which is turn influences the result. However, as $mliq$ seems robust to changes in either the independent variables and the construction of the dummy representing bank liquidity, this results could be

Table 9: Results in level values

VARIABLES	(1) mliq	(2) mliq	(3) fliq	(4) fliq
L.Hqualitybank	-0.00435***	-0.00438***	0.0129***	-0.00315
	(0.00163)	(0.00151)	(0.00330)	(0.00329)
Hbank_Crisis	0.00183		-0.0102**	
	(0.00280)		(0.00463)	
size	0.00172	0.00680***	-0.0329***	0.0327***
	(0.00161)	(0.00220)	(0.00330)	(0.00439)
nim	-0.00494***	-0.00570***	-0.00658***	-0.00510**
	(0.00143)	(0.00144)	(0.00246)	(0.00255)
racr	0.00170***	0.00195***	-0.000715	0.00122*
	(0.000373)	(0.000392)	(0.000653)	(0.000672)
bmodel	9.35e-06*	9.67e-06*	2.98e-06	-1.46e-06
	(4.79e-06)	(5.20e-06)	(1.17e-05)	(8.59e-06)
depositsloans	0.0306***	0.0303***	-0.0138***	-0.0259***
	(0.00379)	(0.00375)	(0.00436)	(0.00475)
L.Crisisdummy	0.00274		0.0141***	
	(0.00169)		(0.00337)	
QdiscAV	-0.00187***		0.00277***	
	(0.000289)		(0.000557)	
diffStress	0.000300		-0.000322	
	(0.000863)		(0.00127)	
Constant	-0.00517	-0.0556**	0.477***	-0.0824
	(0.0222)	(0.0259)	(0.0382)	(0.0506)
Observations	3,782	3,844	3,723	3,760
Adjusted R^2	0.828	0.830	0.585	0.639
Bank FE	YES	YES	YES	YES
Quarter FE	NO	YES	NO	YES
# of Banks	124	124	124	124

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 10: Results in quarterly difference values

VARIABLES	(1) market liquidity	(2) marketliq	(3) fundingliq	(4) fundingliq
L.Hqualitybank	-0.00245**	-0.00159	-0.00217	-0.00149
	(0.00112)	(0.00110)	(0.00223)	(0.00220)
Hbank_Crisis	0.00128		0.00247	
	(0.00182)		(0.00337)	
Dsize	0.0593***	0.0602***	0.0770***	0.0764***
	(0.00900)	(0.00909)	(0.0262)	(0.0264)
Dnim	-0.00147	-0.00160	-0.00116	-0.000410
	(0.00163)	(0.00160)	(0.00169)	(0.00185)
Dracr	0.00173***	0.00179***	0.000944	0.00116
	(0.000464)	(0.000466)	(0.000843)	(0.000865)
D.bmodel	-7.10e-06	-5.84e-06	-1.48e-06	-1.00e-06
	(7.58e-06)	(7.43e-06)	(5.37e-06)	(5.40e-06)
Ddepositsloans	0.0161***	0.0158***	-0.0111***	-0.0102***
	(0.00246)	(0.00241)	(0.00360)	(0.00353)
L.Crisisdummy	0.000971		-0.00275	
	(0.00131)		(0.00266)	
changeQdiscAV	-0.000873		-0.000503	
	(0.000698)		(0.00147)	
diffStress	0.000754		-0.00146	
	(0.000788)		(0.00107)	
Constant	-0.000128	0.00398**	-0.00194*	-0.00239
	(0.000530)	(0.00164)	(0.00104)	(0.00559)
Observations	3,496	3,551	3,434	3,489
Adjusted R^2	0.100	0.120	0.019	0.021
Bank FE	YES	YES	YES	YES
Quarter FE	NO	YES	NO	YES
# of Banks	107	113	107	113

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

more safely interpreted, in terms of the estimated sign, as opposed to the results of $fliq$ which seems much less robust to these changes. Nonetheless, the estimated magnitude of bank quality on market liquidity is in comparison with the other results rather high. Taking into account the relationship found for $fliq$ and above argument regarding the unequal distribution, one should not put too much weight on the estimated magnitude found.

With respect to the quarterly difference values, in table 12, the results are not surprising. Bank quality does not significantly influence the use of market liquidity or funding liquidity. This also applies to column 1, where no time fixed effects are being incorporated. There is not a significant change in the sign, significance and magnitude of the control variables in table 12.

Table 11: Results in level values 1

VARIABLES	(1) mliq	(2) mliq	(3) fliq	(4) fliq
L.Hqualitybank2	-0.0179***	-0.0173***	0.0489***	0.0274***
	(0.00358)	(0.00352)	(0.00796)	(0.00752)
Hbank2_Crisis	0.0200***		0.0120	
	(0.00479)		(0.0203)	
size	0.00409**	0.00731***	-0.0263***	0.0272***
	(0.00161)	(0.00217)	(0.00316)	(0.00430)
nim	-0.00305**	-0.00407***	-0.00165	-0.00617**
	(0.00127)	(0.00131)	(0.00243)	(0.00254)
racr	0.00153***	0.00180***	-0.000517	0.00131*
	(0.000382)	(0.000392)	(0.000630)	(0.000673)
loanstoassets	-0.0526***	-0.0451***	-0.227***	-0.150***
	(0.0132)	(0.0138)	(0.0250)	(0.0251)
depositsloans	0.0275***	0.0277***	-0.0259***	-0.0257***
	(0.00394)	(0.00393)	(0.00504)	(0.00475)
L.Crisisdummy	-0.0123***		0.000293	
	(0.00461)		(0.0200)	
fedfund	-0.00133***		0.00361***	
	(0.000293)		(0.000643)	
tedspread	-0.00319***		-0.00134	
	(0.00116)		(0.00231)	
Constant	0.0137	-0.0196	0.497***	-0.0534
	(0.0234)	(0.0294)	(0.0384)	(0.0494)
Observations	3,755	3,817	3,699	3,761
Adjusted R^2	0.824	0.825	0.614	0.642
Bank FE	YES	YES	YES	YES
Quarter FE	NO	YES	NO	YES
# of Banks	129	129	129	129

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 12: Results in quarterly difference values

VARIABLES	(1) Market liquidity	(2) Market liquidity	(3) Funding liquidity	(4) Funding liquidity
L.Hqualitybank2	-0.00332	-0.00285	-0.00320	-0.00233
	(0.00230)	(0.00238)	(0.00346)	(0.00355)
Hbank2_Crisis	0.00664**		-0.00251	
	(0.00311)		(0.0183)	
Dsize	0.0407***	0.0409***	0.0578**	0.0567**
	(0.00919)	(0.00929)	(0.0267)	(0.0274)
Dnim	-0.000673	-0.000690	-0.000662	0.000627
	(0.00146)	(0.00142)	(0.00173)	(0.00187)
Dracr	0.00103**	0.00108**	0.000367	0.000377
	(0.000516)	(0.000514)	(0.000896)	(0.000901)
Dloanstoassets	-0.169***	-0.169***	-0.169***	-0.189***
	(0.0246)	(0.0252)	(0.0372)	(0.0390)
Ddepositsloans	0.0133***	0.0130***	-0.0139***	-0.0130***
	(0.00260)	(0.00253)	(0.00392)	(0.00393)
L.Crisisdummy	-0.00511*		0.000870	
	(0.00305)		(0.0184)	
changefedfund	-0.000749		-6.14e-05	
	(0.000840)		(0.00163)	
changetedspread	3.76e-05		0.00394**	
	(0.000919)		(0.00175)	
Constant	0.00247	0.00591**	0.000711	-0.000919
	(0.00219)	(0.00274)	(0.00316)	(0.00656)
Observations	3,466	3,520	3,408	3,462
Adjusted R^2	0.138	0.157	0.034	0.037
Bank FE	YES	YES	YES	YES
Quarter FE	NO	YES	NO	YES
# of Banks	109	109	109	109

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

6.3 S&P short term bond credit ratings

In order to assess if the use of long term bond credit ratings instead of short term bond credit ratings, as proxy for bank quality, has influenced the results, the latter will be used as proxy for bank quality. Short term bond credit ratings refer to obligations due shorter than 365 days, while long term bond credit ratings refer to obligations due in longer than 365 days. Moreover, short term bond credit ratings consist of only 6 separate credit ratings, while long term credit ratings cover 22 separate credit ratings. The definition of the different short term credit ratings can be found in the Appendix. The construction of the dummy variable representing bank quality, using short term bond credit ratings has been performed the same way as in the main model; the median value of the distribution of this rating has been calculated in order to distinguish "high" quality banks and "low" quality banks. The median rating corresponds to the A-2 rating and as in the construction of $Hqualitybank$ in the main model, this median value belongs to the group "high" quality banks. So, banks with a short term credit rating above A-3 are considered as high quality banks, while banks of a credit rating of A-3 and lower are considered as low quality banks.

The results are presented in table 13 and 14. The results of table 13, column 1 and 2, indicate that changing the construction of the proxy for bank quality, does not change the results. The variable of interest has the same sign and significance and has nearly the same magnitude. Moreover, all control variables have the same sign, significance and nearly same magnitude as in table 7. However, the inclusion of short term bond credit ratings instead of long term bond credit ratings implies that bank quality does not influence the level of funding liquidity, as can be seen in column 3 and 4 of table 13.

The results of table 14 once again confirm that bank quality is not related to the use or trend of market- and funding liquidity, while the control variables are not different as the results of the main regression specification of table 8.

6.4 Other measures of market- and funding liquidity

To assess the influence of the construction of the dependent variables on the results, different measures of both market and funding liquidity are used. In the main model the narrowest definition of market liquidity has been used, namely cash and due from banks over total assets. A more broad definition of market liquidity is used as a robustness check, which includes cash and due from banks plus federal funds sold plus securities purchased under the agreement to sell (REPO's) over total assets. The two latter can also be viewed as liquid assets, as federal funds sold represents loans to other banks with a very short time horizon. The same applies to REPO agreements, as they are usually being bought back over a one night horizon. In contrast to the construction of market liquidity in the main model, funding liquidity has been specified very broadly, namely debt over total assets minus cash. To capture a more narrow definition of funding liquidity, only securities sold under the agreement to resell over assets minus cash is considered as a robustness check.

The results are presented in table 15 and 16. The results in table 15 indicate that changing the construction of both market- and funding liquidity does not change the results with respect to the level of market liquidity and bank quality. However, it does change the results regarding the level of funding liquidity and bank quality. The magnitudes obtained in column 1 and 2 of table 15 are somewhat larger than in the main results of table 7. The fact that a broader definition of liquidity has been used can be reason for this. In column 3 and 4 can be noticed that bank quality in negatively related to funding liquidity. This contradicts both the other results and the hypothesis of this paper. This result can be due to the fact that a very narrow proxy of funding liquidity has been used or that bank quality and funding liquidity are not (positively) related as indicated by previous results. Nonetheless, nearly all control variables have the same sign, significance and magnitude as in table 7 of section 5. Only size, appears to be non-related to the level of market liquidity in column 1 of table 15, while it is significantly and positively related to the level of market liquidity in column 1 of table 7. The results of table 16 are in line with the results of the previous robustness checks; bank quality does not influence the use of market- and funding liquidity.

Table 13: Results in level values

VARIABLES	(1) mliq	(2) mliq	(3) fliq	(4) fliq
L.HqualitybankShort1	-0.00576**	-0.00609***	0.00404	0.00101
	(0.00239)	(0.00224)	(0.00553)	(0.00495)
Hqualityshort1_Crisis	-0.000648		0.00805**	
	(0.00215)		(0.00407)	
size	0.00287*	0.00436**	-0.0252***	0.0319***
	(0.00164)	(0.00221)	(0.00327)	(0.00424)
nim	-0.00384***	-0.00453***	0.000609	-0.00531**
	(0.00135)	(0.00133)	(0.00251)	(0.00255)
racr	0.00169***	0.00186***	-0.000831	0.00123*
	(0.000381)	(0.000394)	(0.000646)	(0.000672)
loanstoassets	-0.0495***	-0.0436***	-0.242***	-0.153***
	(0.0133)	(0.0139)	(0.0261)	(0.0253)
depositsloans	0.0273***	0.0280***	-0.0260***	-0.0260***
	(0.00398)	(0.00396)	(0.00514)	(0.00476)
L.Crisisdummy	0.00652***		0.00865**	
	(0.00197)		(0.00345)	
fedfund	-0.00158***		0.00410***	
	(0.000300)		(0.000646)	
tedspread	-0.00280**		-0.00277	
	(0.00125)		(0.00253)	
Constant	0.0145	-0.000901	0.532***	-0.0754
	(0.0236)	(0.0301)	(0.0402)	(0.0503)
Observations	3,692	3,817	3,637	3,761
Adjusted R^2	0.822	0.824	0.605	0.639
Bank FE	YES	YES	YES	YES
Quarter FE	NO	YES	NO	YES
# of Banks	129	129	129	129

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 14: Results in quarterly difference values

VARIABLES	(1) marketliq	(2) marketliq	(3) fundingliq	(4) fundingliq
L.HqualitybankShort1	-0.000687	-0.000312	-0.000569	0.00165
	(0.00208)	(0.00196)	(0.00312)	(0.00289)
Hqualityshort1_Crisis	0.00158		0.00822**	
	(0.00145)		(0.00349)	
Dsize	0.0389***	0.0404***	0.0553**	0.0561**
	(0.00915)	(0.00926)	(0.0266)	(0.0273)
Dnim	-0.000477	-0.000658	-9.50e-05	0.000677
	(0.00146)	(0.00141)	(0.00173)	(0.00187)
Dracr	0.000977*	0.00108**	0.000236	0.000363
	(0.000522)	(0.000515)	(0.000899)	(0.000901)
Dloanstoassets	-0.169***	-0.170***	-0.179***	-0.190***
	(0.0249)	(0.0253)	(0.0369)	(0.0387)
Ddepositsloans	0.0132***	0.0130***	-0.0139***	-0.0130***
	(0.00264)	(0.00253)	(0.00399)	(0.00393)
L.Crisisdummy	0.000419		-0.00546*	
	(0.00130)		(0.00282)	
changefedfund	-0.000393		0.00205	
	(0.000938)		(0.00192)	
changetedspread	4.53e-05		0.00410**	
	(0.000921)		(0.00177)	
Constant	-8.54e-05	0.00338	-0.00196	-0.00472
	(0.00195)	(0.00221)	(0.00296)	(0.00622)
Observations	3,406	3,520	3,348	3,462
Adjusted R^2	0.134	0.157	0.036	0.037
Bank FE	YES	YES	YES	YES
Quarter FE	NO	YES	NO	YES
# of Banks	108	109	108	109

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 15: Results in level values

VARIABLES	(1) mliq+	(2) mliq+	(3) fliq1+	(4) fliq1+
L.Hqualitybank	-0.00787***	-0.00883***	-0.0107***	-0.0177***
	(0.00179)	(0.00166)	(0.00385)	(0.00407)
Hbank_Crisis	-0.00253		-0.00490	
	(0.00374)		(0.00504)	
size	-0.000852	0.00903***	-0.0158***	0.0171***
	(0.00241)	(0.00284)	(0.00287)	(0.00498)
nim	-0.00270*	-0.00461***	-0.00860**	-0.00917***
	(0.00160)	(0.00170)	(0.00364)	(0.00347)
racr	0.00212***	0.00285***	0.00223*	0.00309**
	(0.000537)	(0.000559)	(0.00114)	(0.00120)
loanstoassets	-0.123***	-0.107***	-0.147***	-0.116***
	(0.0168)	(0.0182)	(0.0291)	(0.0271)
depositsloans	0.0166***	0.0167***	-0.0183***	-0.0197***
	(0.00498)	(0.00494)	(0.00405)	(0.00391)
L.Crisisdummy	0.00698***		0.00372	
	(0.00202)		(0.00422)	
fedfund	-0.000146		0.00246***	
	(0.000403)		(0.000884)	
tedspread	-0.00334**		-0.00373	
	(0.00148)		(0.00236)	
Constant	0.122***	0.0178	0.322***	-0.0309
	(0.0337)	(0.0405)	(0.0360)	(0.0563)
Observations	3,338	3,392	1,904	1,953
Adjusted R^2	0.824	0.827	0.542	0.558
Bank FE	YES	YES	YES	YES
Quarter FE	NO	YES	NO	YES
# of Banks	123	123	106	106

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 16: Results in quarterly difference values

VARIABLES	(1) Market liquidity-	(2) Market liquidity-	(3) Funding liquidity-	(4) Funding liquidity-
L.Hqualitybank	-0.00145	-0.000514	0.000170	0.00141
	(0.00124)	(0.00124)	(0.00158)	(0.00170)
Hbank_Crisis	0.00108		-0.00439	
	(0.00202)		(0.00409)	
Dsize	0.0399***	0.0400***	0.000386	0.00144
	(0.0136)	(0.0136)	(0.0130)	(0.0133)
Dnim	-0.00172	-0.00198	0.000750	0.00108
	(0.00163)	(0.00161)	(0.00142)	(0.00151)
Dracr	0.00136*	0.00146*	0.000743	0.000806
	(0.000806)	(0.000815)	(0.00103)	(0.000981)
Dloanstoassets	-0.302***	-0.304***	-0.0863*	-0.0949**
	(0.0291)	(0.0300)	(0.0441)	(0.0442)
Ddepositsloans	0.0113***	0.0116***	-0.00362***	-0.00360***
	(0.00255)	(0.00250)	(0.00120)	(0.00131)
L.Crisisdummy	-0.00117		0.00692*	
	(0.00137)		(0.00374)	
changefedfund	-0.000712		0.000880	
	(0.00102)		(0.00154)	
changetedspread	-0.000890		0.000625	
	(0.000903)		(0.00122)	
Constant	-1.04e-05	0.00364*	-0.00192**	0.00229
	(0.000605)	(0.00202)	(0.000750)	(0.0112)
Observations	3,093	3,139	1,409	1,442
Adjusted R^2	0.193	0.207	0.008	0.008
Bank FE	YES	YES	YES	YES
Quarter FE	NO	YES	NO	YES
# of Banks	104	104	68	68

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

6.5 Dynamic panel data model

The last robustness check that is performed, serves only for the basis to minimize any concerns regarding the fact that serial correlation in the main model influences the results. This is performed by incorporating the lagged dependent variable ($mliq$ or $fliq$) as an independent variable and thereby estimating a dynamic panel model (see also section 4.4.3). As the regression specifications in quarterly first difference values already controls for some presence of serial correlated errors, these specification are not being considered in this robustness check. More specifically, the following model is estimated:

$$y_{it} = \alpha_i + \theta_1 y_{it-1} + \beta_1 Quality_{it-1} + \beta_2 Quality_{it-1} * Crisis_{t-1} + \beta_3 Crisis_{t-1} + \beta_4 X'_{it} + \beta_5 Z'_t + \epsilon_{it} \quad (9)$$

Where the only difference between equation 9 and equation 1 of the main model is the incorporation of the lagged dependent variable as independent variable, where θ_1 represents the coefficient on the lagged dependent variable in this dynamic panel model and y can either represent $mliq$ or $fliq$. Furthermore, as Nickell (1981) showed in his influential paper, including fixed or random effects in a dynamic panel data model can possibly bias the results. This is known as the Nickell bias. An explanation why this is not a concern for this research can be found in the Appendix.

The results are presented in table 17 (page 58). The results in column 1 of table 17 indicate that being a high quality bank has a negative impact on the level of market liquid assets, at a 10 percent significance level. The magnitude of the variable $Hqualitibank$ is somewhat smaller than in comparison with table 7 of the main results. Moreover, the significance level of this variable has deteriorated to a p-value of 0.057 which lies in the 10 percent significance interval. It is somewhat remarkable that control variables such as nim, $racr$, $loanstoassets$ and $tedspread$ lost their significance. This can be due to the fact that including a lagged dependent variable as control variable could possible influence the results of other control variables as mentioned by Achen

(2001). This could possibly also be the reason why the variable *Hqualitybank* loses its significance when time fixed effects are being included[17]. However, this is not perfectly known as it could also be due to other reasons. Although, some control variables have lost their significance, they all have the same sign as in table 7 of the main results.

The results in column 3 of table 17 indicate that being a high quality bank has a positive impact on the level of funding liquidity. However, the variable *Hqualitibank* loses his significance when time fixed effects are included. In this case it is much more plausible that in fact the quality of the bank is not related to the level of funding liquidity, as previous results have highlighted that the findings in table 7 regarding bank quality and funding liquidity are not robust. Furthermore, all control variables have the same sign as in table 7 of the main results.

In the end, it could be considered as striking that the R-squared values in table 17 are much higher in comparison with table 7 of the main results. This can be explained by the fact that the inclusion of a lagged dependent variable as control variable improves the fit of the model as explained by Achen (2001). This explains the much higher R-squared values in table 17 as in comparison with table 7.

6.6 Summary of the robustness checks

In order to assess the robustness of the main results of section 5, this section has provided various robustness checks. The main conclusions of these robustness checks are as follows: high quality banks seem to use less market liquidity (measured by *mliq*) than low quality banks. This finding is robust to the incorporation of other control variables, a change in the construction of the dummy variable representing bank quality, the inclusion of S&P short term credit ratings, other measures of market- and funding liquidity and an estimation of a dynamic panel model equation. However, only in the case of the dynamic panel model setting, the inclusion of time fixed effects made the estimated effect insignificant. However, this result was only marginally insignificant, as can be read in the previous subsection.

[17]Note however that in this case the variable *Hqualitybank* has a p-value of 0.103, which is just a little above the threshold value of 0.10 to be significant at a 10 percent level.

With respect to the results in quarterly first differences ($marketliq$), to capture a difference in the trend usage of market liquidity between high quality and low quality banks, the results are less robust. The incorporation of time fixed effects together with the use of other control variables made the estimated effect between bank quality and $marketliq$ insignificant. For all other robustness checks, the results were even insignificant without and with the inclusion of time fixed effects.

The main results in section 5 already revealed that the estimated effects regarding bank quality and the level of funding liquidity ($fliq$) are not robust to the inclusion of time fixed effects. This raised doubts whether the estimated effect without the inclusion of time fixed effects, was robust. This section confirmed these doubts, as the estimated result between bank quality and $fliq$ seemed not robust. The inclusion of other control variables revealed the same results as in table 7; the inclusion of time fixed effect made the estimated effect insignificant. The same is true for the use of short term S&P credit ratings, where even the estimated effect without time fixed effects was insignificant. Notable were the obtained results for other measures of $fliq$, where bank quality and funding liquidity were negatively related, which contradicts the hypothesis of this paper.

The main results in table 8 of section 5 already indicated that there is no significant relationship between the trend usage of funding liquidity and bank quality. These results are even more supported in this section, where there was no robustness check which revealed a significant relation between bank quality and $fundingliq$.

Table 17: Results in level values

VARIABLES	(1) mliq	(2) mliq	(3) fliq	(4) fliq
L.mliq	0.771***	0.776***		
	(0.0208)	(0.0201)		
L.Hqualitybank	-0.00215*	-0.00174	0.00363*	0.000781
	(0.00113)	(0.00107)	(0.00208)	(0.00211)
Hbank_Crisis	0.00127		-0.00104	
	(0.00193)		(0.00308)	
size	0.00288***	0.00312*	-0.00323*	0.0136***
	(0.00110)	(0.00165)	(0.00172)	(0.00331)
nim	-3.89e-05	-0.000549	0.00267**	0.00131
	(0.000746)	(0.000735)	(0.00125)	(0.00124)
racr	0.000367	0.000440*	-0.000316	0.000251
	(0.000235)	(0.000253)	(0.000366)	(0.000375)
loanstoassets	-0.0121	-0.00911	-0.0946***	-0.0732***
	(0.00777)	(0.00798)	(0.0167)	(0.0155)
depositsloans	0.00788***	0.00769***	-0.0106***	-0.0105***
	(0.00190)	(0.00184)	(0.00250)	(0.00244)
L.Crisisdummy	0.00361***		0.00171	
	(0.00122)		(0.00241)	
fedfund	-0.000297*		0.00120***	
	(0.000179)		(0.000341)	
tedspread	-0.000773		0.00145	
	(0.000875)		(0.00165)	
L.fliq			0.746***	0.722***
			(0.0257)	(0.0274)
Constant	-0.0255**	-0.0237	0.116***	-0.0565*
	(0.0128)	(0.0196)	(0.0215)	(0.0327)
Observations	3,560	3,620	3,497	3,556
Adjusted R^2	0.930	0.933	0.851	0.856
Bank FE	YES	YES	YES	YES
Quarter FE	NO	YES	NO	YES
# of Banks	129	129	129	129

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

7 Conclusion, limitations and further research

This thesis has examined if bank quality influences the use of market liquidity and funding liquidity. This was especially interesting to consider as the importance of well-functioning liquid markets was reflected in the event of the 2007-2009 financial crises. The 2007-2009 financial crisis has shown that the absence of liquidity can affect banks through two different channels, with both different consequences for the banking system. With respect to these two channels, namely the market liquidity channel and funding liquidity channel as stated by Brunnermeier & Pedersen (2009), two hypotheses were posed. The first hypothesis stated that high quality banks make less use of market liquidity with respect to low quality banks. The results indicate that this hypothesis can be confirmed. The main results show that being a high quality bank, proxied by the bond credit rating, lowers the ratio of cash over total assets (market liquidity) by 0.00490. This result is robust to various robustness checks as the incorporation of other control variables, a different construction of bank quality, the use of short term bond credit ratings (instead of long term bond credit ratings), other measures of market liquidity and a dynamic panel model setting. Putting all the results together, the magnitude of the estimated effect of bank quality on market liquidity varies between -0.0179 and -0.00215. Excluding the large estimated effect found in case of another construction of bank quality; the results vary between -0.00787 and -0.00215, which is a more reliable and closer boundary.

The significant relationship between bank quality and market liquidity in level values does not hold, with regards to a difference in the trend or use of market liquidity (*marketliq*). As table 8 of the main results indicates some evidence for a difference in trend usage of market liquidity and bank quality, this results seemed not robust to various robustness checks.

The second hypothesis of this thesis stated that high quality banks make more use of funding liquidity in comparison with low quality banks. This hypothesis should be rejected as the results in table 7 of the main results seem not robust to different robustness checks. Note that the inclusion of time fixed effects in the main results

made the estimated effect of bank quality on funding liquidity already insignificant, indicating a weakly significant relationship found in the first place.

With respect to the trend usage of funding liquidity the same conclusion as above applies. The variable $fundingliq$ was already insignificantly related to bank quality in the main results and this did not change when performing various robustness checks.

The theoretical basis underlying the stated hypothesis, as explained in section 2.8, is not fully supported by the results. The level or market liquidity is indeed negatively related to high quality banks, indicating that high quality banks make less use of market liquidity channels when they need cash. However, it cannot be concluded that therefore high quality banks make more use of the funding liquidity channel. This leaves room for further research as the market liquidity and funding liquidity concepts highlighted by Brunnermeier & Pedersen (2009) can be further explored with regards to bank quality. Subsequently, the results found can be related to the new Basel III accord, as this accord possess new rules regarding liquidity as stated by the Liquidity Coverage Ratio (LCR). Forcing banks to maintain this LCR ratio can result in a disappearance of the difference in market liquidity between high quality and low quality banks. The effects of this on the banking sector can therefore be explored.

Further research in this topic can be both theoretical and empirical, the latter in the same vein as this thesis. For empirical research, it is of special importance that these studies can fully distinguish between the market liquidity- and funding liquidity channels, by making use of accurate data of for instance the amount of collateral pledged, secured funding operations or all liquid assets of a bank. At the same time, this is the main limitation of this research. I did not have the opportunity to collect accurate data for all banks, and therefore proxies had to be used. This will always yield less accurate results than when using the exact variable one wants to measure. However, by performing various robustness checks I wanted to rule out a significant relationship found in the main results, which is in fact not significant. Another limitation of this research is the external validity. All estimated effects are based on banks in the US economy. It is not known if the same results will apply to other banks in the global economy. This leaves room for further research as well.

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9 Appendix

Simplified balance sheet of a bank

ASSETS	LIABILITIES
• Reserves : ⇧ Cash in bank Deposits at the central bank Deposits at commercial banks Cash on collection • Others : ⇩ Loans Securities	• Capital • Borrowing Unsecured borrwoing Secured borrowing • Others
Balance sheet total: -	Balance sheet total: -

Figure 2: Under market liquidity

ASSETS	LIABILITIES
• Reserves : ⇧ Cash in bank Deposits at the central bank Deposits at commercial banks Cash on collection • Others : Loans Securities	• Capital • Borrowing : ⇧ Unsecured borrwoing Secured borrowing • Others
Balance sheet total: ⇧	Balance sheet total: ⇧

Figure 3: Under funding liquidity

Credit rating definitions S&P long term bonds

Category	Defenition
AAA	An obligation rated 'AAA' has the highest rating assigned by Standard & Poor's. The obligor's capacity to meet its financial commitment on the obligation is extremely strong.
AA	An obligation rated 'AA' differs from thehighest-rated obligations only to a small degree. The obligor's capacity to meet its financial commitment on the obligation is very strong.
A	An obligation rated 'A' is somewhat more susceptible to the adverse effects of changes in circumstances and economic conditions than obligations in higher-rated categories. However, the obligor's capacity to meet its financial commitment on the obligation is still strong
BBB	An obligation rated 'BBB' exhibits adequate protection parameters. However, adverse economic conditions or changing circumstances are more likely to lead to a weakened capacity of the obligor to meet its financial commitment on the obligation.
BB; B; CCC; CC; and C	Obligations rated 'BB', 'B', 'CCC', 'CC', and 'C' are regarded as having significant speculative characteristics. 'BB' indicates the least degree of speculation and 'C' the highest. While such obligations will likely have some quality and protective characteristics, these may be outweighed by large uncertainties or major exposures to adverse conditions.
BBB	An obligation rated 'BB' is less vulnerable to nonpayment than other speculative issues. However, it faces major ongoing uncertainties or exposure to adverse business, financial, or economic conditions which could lead to the obligor's inadequate capacity to meet its financial commitment on the obligation.
BB	An obligation rated 'B' is more vulnerable to nonpayment than obligations rated 'BB', but the obligor currently has the capacity to meet its financial commitment on the obligation. Adverse business, financial, or economic conditions will likely impair the obligor's capacity or willingness to meet its financial commitment on the obligation.

CCC	CCC,An obligation rated 'CCC' is currently,vulnerable to nonpayment, and is dependent upon favorable business,financial, and economic conditions for the obligor to meet its financial, commitment on the obligation. In the event of adverse business, financial, or,economic conditions,the obligor is not likely to have the capacity to meet,its financial commitment on the obligation.
CC	An obligation rated 'CC' is currently highly vulnerable to nonpayment
C	A 'C' rating is assigned to obligations that are currently highly vulnerable to nonpayment, obligations that have payment arrearages allowed by the terms of the documents, or obligations of an issuer that is the subject of a bankruptcy petition or similar action which have not experienced a payment default. Among others, the 'C' rating may be assigned to subordinated debt, preferred stock or other obligations on which cash payment shave been suspended in accordance with the instrument's terms or when preferred stock is the subject of a distressed exchange offer, whereby some or all of the issue is either repurchased for an amount of cash or replaced by otherinstrumentshaving a total value that is less than par
D	An obligation rated 'D' is in payment default. The 'D' rating category is used when payments on an obligation are not made on the date due, unless Standard & Poor's believes that such payments will bemade within five business days, irrespective of any grace period. The 'D' rating also will be used upon the filing of a bankruptcy petition or the taking of similar action if payments on an obligation are jeopardized. An obligation's rating is lowered to 'D' upon completion of a distressed exchange offer,whereby some or all of the issue is either repurchased for an amount of cash or replaced by other instruments having a total value that is less than par.
NR	This indicates that no rating has been requested, that there is insufficient information on which to base a rating, or that Standard & Poor's does not rate a particular obligation as a matter of policy.

Table 18: The ratings from 'AA' to 'CCC' may be modified by the addition of a plus (+) or minus (-) sign to show relative standing within the major rating categories. Source: S&P

Distribution credit ratings

Table 19: Summary statistics of SPLONG (long term credit rating)

variable	p1	p5	median	p75	p95
SPLONG	AA	AA-	A-	BBB	BB

SIC codes

Table 20: SIC codes 6000 until 6200

SIC code	Industry
6012	Pay Day Lenders
6021	National Commercial Banks
6022	State Commercial Banks
6029	Commercial Banks, NEC
6035	Savings Institution, Federally Chartered
6036	Savings Institutions, Not Federally Chartered
6099	Functions Related To Depository Banking, NEC
6111	Federal & Federally Sponsored Credit Agencies
6141	Personal Credit Institutions
6153	Short-Term Business Credit Institutions
6159	Miscellaneous Business Credit Institution
6162	Mortgage Bankers & Loan Correspondents
6163	Loan Brokers
6172	Finance Lessors
6189	Asset-Backed Securities
6199	Finance Services
6200	Security & Commodity Brokers, Dealers, Exchanges & Services

Regression Diagnostics

Results Augmented Dickey fuller test[18],Hausman test, White test and Wooldridge test

[18]Only the results of the time serie variables and dependent variables are presented in this table. The panel data variables are also tested on a unit root, but are by construction less likely to have a unit root. This was confirmed by the test results (not shown)

Table 21: Test results Augmented Dickey Fuller test

Variable	**Test statistic**	**Probabillity**	**Unit root**
CashandDuefromBanksTotal	Inverse chi-squared(270)=809.8294	0.0000	No
Assets Total	Inverse chi-squared(272)=228.0665	0.9754	Yes
Size (LN of Assets Total)	Inverse chi-squared(272)=377.67	0.0000	No
mliq	Inverse chi-squared(270)=,,940.4556	0,0000	No
fliq	Inverse chi-squared(262)=943.7981	0,0000	No
marketliq	Inverse chi-squared(266)= 5757.0099	0,0000	No
fundingliq	Inverse chi-squared(258)=5076.2822	0,0000	No
fedfund	Inverse chi-squared(292)=784.1678	0,0000	No
tedspread	Inverse chi-squared(292)=2689.3096	0.0000	No
	Robustness check variables		
mliq+	inverse chi-squared(252)=1025.5567	0.0000	No
fliq-	Inverse chi-squared(170)=460.8996	0.0000	No
QdiscAV	Inverse chi-squared(292)= 577.9346	0,0000	No
stress	Inverse chi-squared(292)=261.2306	0.9020	No
diffStress	Inverse chi-squared(286)=P,3351.6946	0.0000	No

Table 22: Hausman test, White test and Woolridge test

Model	**Test**	**H0**	**Test statistic**	**Prob.**
$mliq_{it}$	Hausman test	difference in coefficients not systematic	$chi^2(10) = 29.63$	0.0010
$mliq_{it}$	Modified Wald test for groupwise heteroskedasticity	$\sigma_i^2 = \sigma^2$ for all i	chi^2 (129),=,2.3e+05	0.000
$mliq_{it}$	Wooldridge test for autocorrelation in panel data	no first order autocorrelation	F(1,103) =80.424	0.000
$fliq_{it}$	Hausman test	difference in coefficients not systematic	$\text{chi}^2(10) = 43.55$	0.000
$fliq_{it}$	Modified Wald test for groupwise heteroskedasticity	$\sigma_i^2 = \sigma^2$ for all i	chi^2 (129) =,1.7e+05	0.000
$fliq_{it}$	Wooldridge test for autocorrelation in panel data	no first order autocorrelation	F(1,103) =41.031	0.000

Proof measurement error

Suppose one estimates a simple fixed effect regression model like:

$Y_i = \alpha_i + \beta X_i + \epsilon_i$

And suppose Y_i is measured with some error: $\widetilde{Y}_i = Y_i + \nu_i$. In our case $\widetilde{Y}_i$ refers to our proxy to funding liquidity, so secured debt, while Y_i refers to debt and ν_i is the measurement error.

β is estimated in the following way:

$$\begin{aligned}
\widehat{\beta} &= \frac{Cov(\widetilde{Y}_i, X_i)}{Var(X_i)} \\
&= \frac{Cov(Y_i + \nu_i, X_i)}{Var(X_i)} \\
&= \frac{Cov(\alpha_i + \beta X_i + \epsilon_i + \nu_i, X_i)}{Var(X_i)} \\
&= \frac{Cov(\alpha_i, X_i)}{Var(X_i)} + \beta \frac{Cov(X_i, X_i)}{Var(X_i)} + \frac{Cov(\epsilon_i, X_i)}{Var(X_i)} + \frac{Cov(\nu_i, X_i)}{Var(X_i)} \\
&= \beta \frac{Var(X_i)}{Var(X_i)} \\
&= \beta
\end{aligned}$$

So the estimation of β is unbiased as long as $\frac{Cov(\epsilon_i, X_i)}{Var(X_i)}$ is equal to zero (exogeneity) and $\frac{Cov(\nu_i, X_i)}{Var(X_i)}$ is equal to zero (measurement error is not related to the independent variables). Furthermore, $\frac{Cov(\alpha_i, X_i)}{Var(X_i)}$ is equal to zero by construction.

Pearson correlation matrix between independent variables

Table 23: Pearson Correlation Matrix

Variables	LHqualitybank	Hbank_Crisis	size	nim	racr	loanstoassets	depositsloans	LCrisisdummy	fedfund	tedspread
LHqualitybank	1.000									
Hbank_Crisis	0.335	1.000								
size	0.667	0.206	1.000							
nim	-0.327	-0.065	-0.414	1.000						
racr	-0.086	-0.091	-0.101	-0.122	1.000					
loanstoassets	-0.317	-0.064	-0.329	0.423	-0.229	1.000				
depositsloans	0.195	0.022	0.109	-0.285	0.190	-0.656	1.000			
LCrisisdummy	0.025	0.623	-0.029	0.016	-0.109	0.053	-0.044	1.000		
fedfund	0.040	-0.038	-0.113	0.070	-0.281	0.057	-0.059	-0.037	1.000	
tedspread	0.049	0.323	0.017	-0.030	-0.129	0.065	-0.040	0.473	0.178	1.000

Descriptive statistics RACR and top rated banks

Table 24:

Rating	Variable	Mean
AA+	racr	11.33857
AA	racr	12.16544
AA-	racr	13.32396
A+	racr	13.97186
A	racr	13.364
A-	racr	13.42733

Credit rating definitions S&P short term bonds

Table 25: Short term bond credit ratings S&P

Rating	Defenition
A-1	A short-term obligation rated 'A-1' is rated in the highest category by Standard & Poor's. The obligor's capacity to meet its financial commitment on the obligation is strong. Within this category, certain obligations are designated with a plus sign (+). This indicates that the obligor's capacity to meet its financial commitment on these obligations is extremely strong.
A-2	A short-term obligation rated 'A-2' is somewhat more susceptible to the adverse effects of changes in circumstances and economic conditions than obligations in higher rating categories. However, the obligor's capacity to meet its financial commitment on the obligation is satisfactory.
A-3	A short-term obligation rated 'A-3' exhibits adequate protection parameters. However, adverse economic conditions or changing circumstances are more likely to lead to a weakened capacity of the obligor to meet its financial commitment on the obligation.
B	A short-term obligation rated 'B' is regarded as vulnerable and has significant speculative characteristics. The obligor currently has the capacity to meet its financial commitments; however, it faces major ongoing uncertainties which could lead to the obligor's inadequate capacity to meet its financial commitments.
C	A short-term obligation rated 'C' is currently vulnerable to nonpayment and is dependent upon favorable business, financial, and economic conditions for the obligor to meet its financial commitment on the obligation.
D	A short-term obligation rated 'D' is in default or in breach of an imputed promise. For non-hybrid capital instruments, the 'D' rating category is used when payments on an obligation are not made on the date due, unless Standard & Poor's believes that such payments will be made within any stated grace period. However, any stated grace period longer than five business days will be treated as five business days. The 'D' rating also will be used upon the filing of a bankruptcy petition or the taking of a similar action and where default on an obligation is a virtual certainty, for example due to automatic stay provisions. An obligation's rating is lowered to 'D' if it is subject to a distressed exchange offer

Source: S&P website

Nickell bias in dynamic panel data models

In his innovative paper, Nickell (1981) showed that dynamic panel data models in combination with fixed effects or random effects can suffer from a bias. As mentioned in section 6.5, Nickell (1981) showed that dynamic panel data models in combination with fixed effects or random effects can have a bias. To see this, consider a standard dynamic panel data model with fixed effects below:

$$y_{i,t} = \alpha_i + \gamma y_{i,t-1} + \beta x_{i,t} + \epsilon_{i,t} \tag{10}$$

By construction, α_i is being correlated with $y_{i,t}$ and $y_{i,t-1}$. Since $y_{i,t-1}$ also consists of an error term ($\epsilon_{i,t-1}$) there is correlation between α_i and $\epsilon_{i,t-1}$ which causes an endogeneity problem. In this way the LSDV (or OLS) is not a consistent estimator in a dynamic panel data model. The within transformation does not solve this problem. Although it eliminates α_i, a new endogeneity problem arises:

$$(y_{i,t} - y_{i,t-1}) = \gamma(y_{i,t-1} - y_{i,t-2}) + \beta(x_{i,t} - x_{i,t-1}) + (\epsilon_{i,t} - \epsilon_{i,t-1}) \tag{11}$$

After the within transformation there is still the term $y_{i,t-1} - y_{i,t-2}$ in a dynamic panel data model which is correlated with $\epsilon_{i,t} - \epsilon_{i,t-1}$. The endogeinity problem is not solved. Nonetheless, according to Nickell (1981) the bias is given by:

$$p \lim_{N \to \infty} (\hat{a} - \alpha) = -(1 + \alpha)/(T - 1) \tag{12}$$

So, if T becomes infinitely large (T $\to\infty$) the bias diverges to zero. In this way, a larger time dimension (T) reduces the bias. There are several studies that argue that the Nickell bias becomes negible for T$\geq$ 30 (Kiviet, 1995; Judson and Owen, 1999; Bruno, 2005). As this study has a time dimension of 64 (T=64), large biases due to the Nickell bias can be neglected.