Heidorn, Thomas; Buschmann, Christian

Working Paper

The liquidity reserve funding and management strategies

Frankfurt School - Working Paper Series, No. 210

Provided in Cooperation with:
Frankfurt School of Finance and Management

Suggested Citation: Heidorn, Thomas; Buschmann, Christian (2014) : The liquidity reserve funding and management strategies, Frankfurt School - Working Paper Series, No. 210, Frankfurt School of Finance & Management, Frankfurt a. M.

This Version is available at:
https://hdl.handle.net/10419/95974

Frankfurt School – Working Paper Series

No. 210

The Liquidity Reserve
Funding and Management Strategies

by Christian Buschmann & Prof. Dr. Thomas Heidorn

April 2014

Frankfurt School of
Finance & Management
Bankakademie | HfB

Sonnemannstr. 9 – 11 60314 Frankfurt am Main, Germany
Phone: +49 (0) 69 154 008 0 Fax: +49 (0) 69 154 008 728
Internet: *www.frankfurt-school.de*

Abstract

This paper investigates the managing strategies of a bank's liquidity reserve in the broader context of the role of asset-liability management according to the liquidity issues of a banking organisation. Several types of liquidity are presented and how these are interconnected and how they might affect a financial institution's liquidity risk. When managing the liquidity reserve and its included assets, the following influencing factors need to be taken into account: Firstly, the banking organisation itself, with its business model, funding structure and related types of risk; secondly, national and international regulatory requirements have to be fulfilled and lastly, financial market behaviour and its participants need to have carefully watched and anticipated, in order to manage the risk which might arise from the liquidity reserve itself.

Key words: Asset Liability Management, Liquidity Management, Liquidity Reserve, Reserve Assets

JEL classification: G18, G20, G24, G28

ISSN: 1436-9753

Contact:

Prof. Dr. Thomas Heidorn
Professor für Bankbetriebslehre
Frankfurt School of Finance & Management
Sonnemannstraße 9-11
60314 Frankfurt am Main
Phone: +49-69-154008-721
t.heidorn@frankfurt-school.de

Dipl.-Kfm. (FH) Christian Buschmann, M.Sc.
Group Treasury – Global Liquidity & Risk Management
Commerzbank AG
Mainzer Landstraße 153
60327 Frankfurt am Main
Phone: +49-69-136-46389
christian.buschmann@commerzbank.com

This working paper is developed from a chapter by Andreas Hauschild and Christian Buschmann titled 'Strategies for the Management of Reserve Assets' in *The Handbook of ALM in Banking* edited by Andreas Bohn and Marije Elkenbracht-Huizing (London; Risk Books, 2014).
We like to thank Commerzbank's Andreas Hauschild, Hans-Georg Otten and Lisa Cycon as well Barclay's Andreas Bohn for their helpful comments and discussions.

Content

1. Introduction

From the 1950s onwards, it could be seen that on a bank's asset side of the balance sheet there would be a portfolio of sovereign bonds and bills. This changed in the first decade of the 21st century. With the flawed thinking that market liquidity can be taken for granted this practise of holding assets of sovereign debtors felt into disuse in favour of holding higher yielding bank bonds and corporate bonds. This would have been attractive from the return point of view, as government debt carries lower returns than bank debt.[1]

Prior to the 2007–8 financial crisis, the assumption of granted liquidity was somehow correct: financial markets were liquid and funding was easily available at low cost, but the emergence of the crisis showed how rapidly market conditions can change, leading to a situation that several institutions, regardless of their capital levels, experienced severe liquidity issues, forcing either an intervention by the responsible central bank or a shutdown of the institution.[2]

Analogously to the thinking about market liquidity, banks did not consider a proper liquidity management as a crucial part of their daily operations but rather had a quite pragmatic approach on measuring and managing their liquidity.[3] This resulted in a more-or-less non-systematic view of liquidity risk as part of a bank's asset–liability management.[4] As a logical consequence of this, the financial crisis showed that a sustainable liquidity management is crucial for a bank's survival.[5] The crisis emphasised the importance of a proper liquidity management for financial institutions as well as regulators.[6]

If market turmoil can bring the global financial system to its knees, then it is important to enhance the understanding of mechanisms of liquidity and manage the respective risk properly.[7] In 2007–8 many banks relied heavily on wholesale deposits and faced serious trouble as investors lost confidence in markets and financial institutions. For this reason many banks found that many instruments for which has previously been a liquid market could only be sold at fire-sale prices. Even under "normal" market conditions, the liquidity needs of a financial institution are somehow uncertain. Therefore, banks must assess a worst-case liquidity scenario and make sure that they can en-

[1] See Choudhry 2012, p. 622.
[2] See Bonner and Eijffinger 2012.
[3] See Baretzky 2012, p. 62.
[4] Before the financial crisis, liquidity and liquidity risk were regarded as concomitant with other types of risk such as market risk, credit risk or operational risk, even by the literature. See Schulte and Horsch 2004, p. 52; Leistenschneider 2008, p. 172.
[5] See Bodemer 2011, p. 282.
[6] See Hull 2010, p. 385.
[7] See Fecht et al 2011, p. 6.

dure such a scenario by either borrowing cash externally or converting assets into cash.[8] The latter is the primary objective of a bank's liquidity reserve. Corresponding to the events in 2007–8, we want to outline the importance of liquidity management with a special focus on the management of the liquidity reserve of a financial institution and, in particular, on the strategies related to such a risk management approach.

The remainder of this working paper is organised as follows: The following section deals with the basics of asset and liability management, liquidity management and related regulatory provisions. The third section discusses several strategies how a bank can manage its liquidity reserve. The fourth and last section concludes this paper.

2. Asset and Liability Management and Bank's Liquidity Management

In the following, we first give a brief overview of banks' asset and liability management, before defining the term "liquidity" and how banks can manage their liquidity in general. Subsequently, we discuss the regulator's view of banks' liquidity management, in particular the liquidity ratios introduced under the Basel III framework.

2.1 Bank's Asset and Liability Management

Asset–liability management (ALM) is a generic term used to denote high-level management of a bank's assets and liabilities and their related risks. Moreover, it is a strategy-level discipline but operates at business-line level and, in addition, it is a tactical issue as well. The principal function of an ALM desk or treasury desk[9] in general is managing the bank's interest rate risk and liquidity risk.[10] ALM is neither a subset of market risk nor a trivial approach that can be bypassed by implementing more sophisticated market risk and credit risk modelling.[11] In a properly integrated banking function, the treasury desk will have a mandate to cover all aspects of the bank's operations.[12]

The financial crisis enhanced and reinforced the role of ALM as a critical function within financial institutions. Good asset–liability management addresses mismatched risks in its two primary dimensions: interest rate risk and liquidity risk.[13]An ALM desk is supposed to manage both

[8] See Hull 2010, p. 385.
[9] The terms "ALM desk" and "treasury desk" should be used synonymously in this paper.
[10] See Choudhry 2011, p. 144.
[11] See Bessis 2010, p. 268.
[12] See Choudhry 2011, p. 144.
[13] See Bessis 2010, p. 268.

types: while the former is the risk of changes in asset and liability values due to changes in interest rates and therefore cash flow impact on both sides of a bank's balance sheet (as well as present value changes), the latter refers to market liquidity and the ease with which assets can be turned into cash or, better, liquidated to maintain the bank's liquidity position.[14] Hence, ALM gives an overall picture of a bank's short-term and long-term liquidity positions and its profile in all relevant currencies.[15]

2.2 Bank's Liquidity Management

The meaning of the term "liquidity" itself is not commonly agreed. Its complexity is based upon the fact that several different definitions of "liquidity" can be identified in literature and in practice.[16] If we take a closer look at the existing and commonly used definitions, several dimensions will be recognised: within the financial system three broad types of liquidity can be distinguished: central bank liquidity, funding liquidity and market liquidity; these capture sufficiently the workings of the financial system on an aggregate level.[17] The links between these liquidity types are quite dynamic, complex, and strong. Hence, they can have positive or negative effects on the stability of a financial system. In smooth financial periods the effects are positive and help to redistribute liquidity within the financial system in an efficient and unobstructed way, so that, overall, liquidity does not matter.[18] While funding liquidity and market liquidity are crucial elements of a bank's liquidity management which heavily rely on the bank's business model, and therefore are intrinsically linked to both sides of bank's balance sheet, economic/central bank liquidity is measured by money supply and is influenced by a country's economic growth and stability, monetary circulation and monetary policy.[19]

Funding liquidity and market liquidity[20] relate to the mix of assets a bank holds and various funding sources, in particular, the bank's liabilities which must be meet when they come due.[21] Therefore, a bank's funding liquidity relies on both idiosyncratic liquidity risk arising from the

[14] See Choudhry 2011, p. 211ff.
[15] See Bessis 2010, p. 268.
[16] See Heidorn and Schäffler 2011, p. 310.
[17] See Nikolaou 2009, pp. 42ff. Often, the term "economic liquidity" refers to central bank liquidity and "funding liquidity" is often called institutional liquidity. The terms "central bank liquidity" and "economic liquidity" as well as "funding liquidity" and "institutional liquidity" are used equivalently in this work. See also Heidorn and Schäffler 2011, p. 310.
[18] See Nikolaou 2009, pp. 42ff.
[19] See Schäffler 2012, p. 12; Farag *et al* 2014, p. 36.
[20] For a detailed description of the mechanics and the measurement of market liquidity see Hull 2012, pp. 447ff.
[21] See Farag *et al* 2014, p. 36.

bank's operations and market liquidity risk, and both risks are connected to several other risks as well.

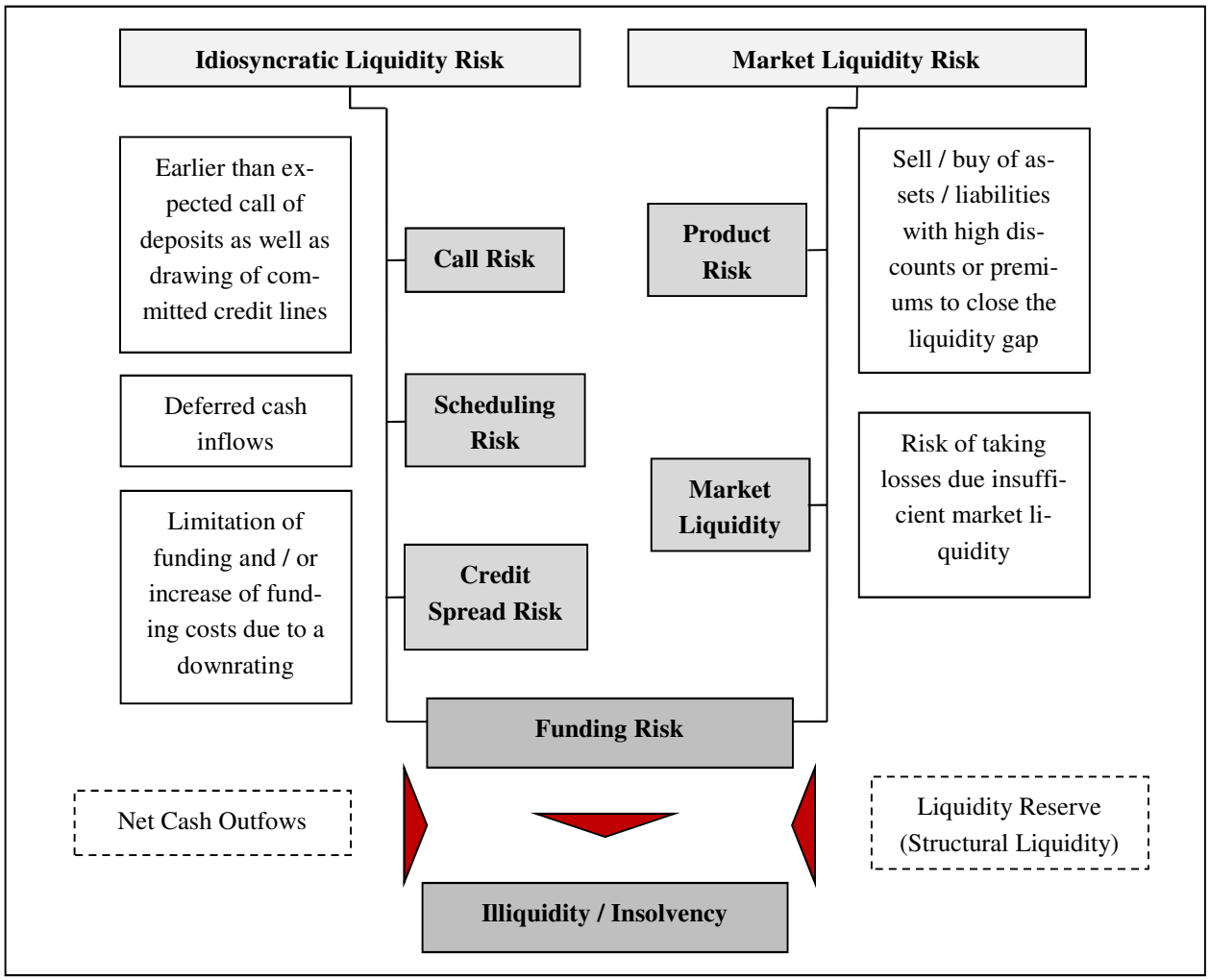


Figure 1: Liquidity Risk's Complexity [22]

As can be seen in Figure 1, all of the of shown risks can potentially significantly affect the funding liquidity of a bank insofar as the outcome of the net cash outflow or misallocation of the liquidity reserve lead to illiquidity and therefore insolvency of the bank. This is, by the way, a fundamental difference from other types of risk, such as market risk, credit risk or operational risk. While these risks can be covered by the bank's capital, they are limited to funding liquidity risk. The risk of illiquidity and insolvency is crucially existence threatening for a financial institution. While the other above mentioned risks may also generate tremendous losses, which a financial in-

[22] Based on Hauschild and Buschmann 2014, p. 330.

stitution is normally able to neutralise during the rest of a business year, no bank has such a period of grace with liquidity risk: Illiquidity and therefore insolvency is sudden and irreversible.[23]

While before the financial crisis liquidity management was more-or-less regarded as an unsystematic part of ALM, it turned out during the crisis that sustainable liquidity (risk) management is crucial for a bank's survival in a market-wide stress. The complexity of liquidity risk is based, as implied above, on its interdependence with other types of risk, e.g., interest rate risk, credit risk and operational risk.[24] We regard funding liquidity as the ability to settle obligations immediately. Consequently, a bank is illiquid if it is unable to settle obligations in time: in this case, the bank defaults.[25] Given this definition, it can be said that a bank's funding liquidity risk is driven by the possibility that over a specific horizon the bank does not have the ability to meet its obligations when they become due.[26]

From our point of view, liquidity is the ability to fund increases in assets and meet obligations at reasonable cost as they become due. Banks can mitigate the shown types of liquidity risk in the two following ways: On the one hand side, banks can try to attract stable funding sources, which are less likely to flow out during crisis times and can hold a portfolio of highly liquid assets as well as a certain amount of cash. The latter can be used when their liabilities fall due. This portfolio of liquid assets is particularly important, if a bank is unable to roll over / refund its current funding sources or if other assets are not easy to liquidate.[27] By doing this, a proper liquidity risk management should seek to ensure a bank's ability to continue to do this. This involves meeting uncertain cash flow obligations that depend on external events as well as on market participants' behaviour. Maturity transformation (transformation of short-term deposits into long-term loans), being the fundamental role of banks, exposes them to liquidity risk, the risk that demands for repayment outstrip the capacity to raise new liabilities or liquefy assets.[28] Good liquidity risk management estimates future cash flow requirements under both normal and stressed conditions. This presents a challenge even under favourable market conditions, as it requires the ability to draw information from various operations of the bank and assess the impact of external events on the availability of funding liquidity. This challenge increases during stressed conditions, as the assumptions underlying liquidity risk may change, notably through changes in counterparty behaviour and market conditions that

[23] See Heidorn and Schäffler 2011, pp. 313ff; Schäffler 2012, pp. 11ff; Nikolaou 2009, pp. 10ff.
[24] See Bodemer 2011, p. 282.
[25] See Drehmann and Nikolaou 2009, pp. 10ff.
[26] See Choudhry 2012, p. 590.
[27] See Farag *et al* 2014, p. 36.
[28] See Basel Committee on Banking Supervision 2008a, p. 2.

affect the liquidity of financial instruments and the availability of funding. These factors cause different and significant challenges for banks in assessing their liquidity risk and for supervisors in the evaluation of risk management and respective controls.[29]

As implied, liquidity risk automatically arises from a bank's normal operations. Usually, liquidity risk is associated with a funding gap: excess assets over liabilities. But it can also be the other way around: excess liabilities over assets. So, there's a liquidity risk in any case: either funding must be obtained or surplus assets must be laid off.[30] In this sense, the term "liquidity management" describes the continuous and dynamic process of raising and lying off funds, depending on whether the bank is long or short of cash that day. Regarding liquidity management, the principal task of bank's treasury desk is to "square off" the bank by the end of each day, ensuring that the bank's net liquidity position is at least zero. Therefore, and because every position taken today creates a funding requirement at its maturity date, liquidity management is very short term as well as long term. The ALM desk must be aware of its future funding or excess cash positions and act accordingly.[31] Within its liquidity management mandate, it is also the ALM desk's duty to maintain liquidity at times of crisis, and more specifically to maintain crisis prevention and crisis survival. Potential liquidity crisis have to be addressed with conservative assumption in stress tests to ensure that the bank's liquidity reserves consists of qualitative and quantitative sufficient assets.[32]

2.3 Regulatory View on Liquidity Management

The 2007–8 financial crisis was caused by uncertainty over the solvency of financial institutions and primarily took place in the wholesale funding markets.[33] The Basel III framework seeks to address this liquidity risk through the liquidity coverage ratio (LCR), a liquidity requirement, and the net stable funding ratio (NSFR), which is, roughly speaking, a restriction on maturity mismatches that limits the volume of refinancing becoming due each period.[34] Hence, both measures try to promote short-term as well as long-term funding resilience, whereas the Basel Committee tries to operationalise the LCR in the first place.[35]

[29] See Basel Committee on Banking Supervision 2008a, p. 2.
[30] See Choudhry 2012, p. 151.
[31] See Choudhry 2011, p. 153.
[32] See Müller and Wolkenhauer 2008, p. 232.
[33] See Gatev and Strahan 2006; Huang and Ratnovski 2011.
[34] See Ratnovski 2013, p. 3; Basel Committee on Banking Supervision 2013a, p. 1.
[35] See Bouwman 2013, p. 29.

Even though treasury desks run some currency exposures, e.g., transferring liquidity from a currency that is available to one which is needed, and liquidity risk is measured, monitored, reported and managed in various currencies[36], both ratios create a kind of single-currency liquidity model. By focusing on a single currency, which is likely to be the bank's home currency, these ratios primarily refer to liquidity risks arising from certain products and counterparties. It is quite likely that the introduction of LCR and NSFR will challenge banks' asset–liability management.[37]

2.3.1 The Financial Crisis and new (Inter)National Liquidity Standards

The financial crisis was a catalyst for significant bank regulation reforms, as the pre-crisis regulatory framework turned out to be inadequate in coping with large financial shocks. The Basel III framework envisions a rise in bank capital requirements and the introduction of new liquidity requirements.[38]

Prior to the financial crisis, interbank markets were among the most liquid in the financial sector. They play a key role in a bank's liquidity management and, as implied before, in showing the relationship of economic and funding liquidity in the transmission of monetary policy. As the financial crisis worsened in September 2008, the interbank market's liquidity dried up as banks preferred to hoard cash instead of lending it out, even at short maturities.[39] Central banks' massive injections of liquidity did little to restart interbank lending. The failure of the interbank market to redistribute liquidity became a key feature of the crisis.[40] But not only the interbank market showed massive turbulences: simultaneously to the disruption of the interbank money market, funding cost of banks on both sides of the Atlantic, as Figure 2 exemplified shows, sprung to unprecedented highs.[41]

[36] See Matz 2011, pp. 294, 506.
[37] See Kleffmann *et al* 2011, p. 1.
[38] See De Nicolò *et al* 2012, p. 2.
[39] See Heider *et al* 2009, p. 7. In particular, maturities longer than a few days experienced considerable pressures. In addition to that, the way secured/collateralised money markets operate has changed significantly since the crisis. Haircuts have changed, and lower rated assets have become more difficult to borrow against. Central banks have introduced a wide range of measures to try to improve the functioning of the money markets See Allen and Carletti 2008, p. 2. For a complete overview of the course of the financial crisis, see, for example, Bank for International Settlements 2008, pp. 99ff and 2009, pp. 16ff.
[40] See Heider *et al* 2009, p. 7.
[41] Here, we assume credit default swap spreads as a good proxy bank's funding costs.

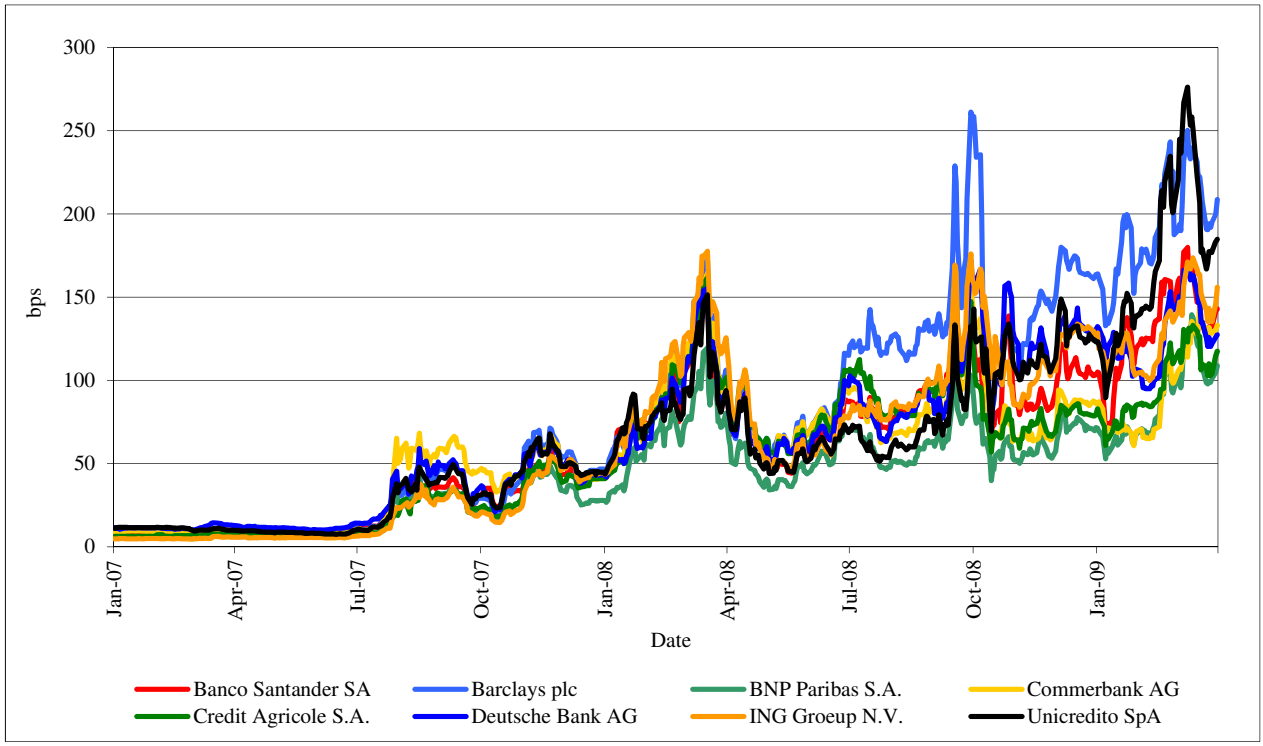


Figure 2: 5Y Senior-CDS-Spreads of selected EURIBOR-Panel-Banks [42]

Due to the economic consequences of the financial crisis, national regulators felt impelled to overhaul their respective liquidity frameworks. We shall only briefly address the German regulatory view of liquidity in this analysis.[43] Moreover, the Basel III measures introduced regarding liquidity will be discussed.

In Germany, banks' liquidity management is primarily regulated by the "minimum requirements for risk management" (*Mindestanforderungen an das Risikomanagement*, or *MaRisk*), which set out the qualitative requirements of paragraph 25a of the German Banking Act (*Kreditwesengesetz*, or *KWG*) in greater detail. Under the *MaRisk* requirements, banks must ensure that they are able meet their financial obligations when they come due.[44] More specifically, Section BTR 3.1 of *MaRisk* describes general liquidity requirements that must be met by all financial institutions in Germany.[45] In addition, Section BTR 3.2 regulates publicly traded banks; in order to safeguard their

[42] Bloomberg L.P. 2014.

[43] Other national regulatory requirements for a bank's liquidity management can be taken from Bergner *et al* 2014; Bouwman 2013 as well as Hauschild and Buschmann 2014.

[44] The MaRisk's provisions also include various conclusions from international regulatory discussion papers: Basel Committee on Banking Supervision 2008b, Committee of European Banking Supervisors 2009, 2010.

[45] This includes the preparation of a liquidity overview, the performance of appropriate stress tests, the preparation of contingency plans and the incorporation of liquidity-related cost–benefit considerations in the management of the institutions' business activities. See Bundesanstalt für Finanzdienstleistungsaufsicht 2013.

solvency, these institutions must maintain an adequate liquidity reserve consisting of cash and highly liquid assets for at least one week, as well as using other assets for at least one month.[46]

As stated earlier, the Basel Committee for Banking Supervision (BCBS) drafted a new regulatory framework (Basel III) from 2008 onwards in order to achieve a more stable and less vulnerable banking system as a response to the financial crisis. In addition to new rules for capital and leverage, the framework also specifies short term and long-term liquidity requirements as key concepts to reinforce the resilience of banks to liquidity risks.[47] The LCR has been developed to promote the short-term resilience of the liquidity risk profile of banks, whereas the NSFR should promote more medium- and long-term funding of the assets and activities of banking organisations.[48] As shown in Figure 3, the fundamental differences between the LCR and NSFR are quite obvious: while the LCR is designed to cope with short term liquidity, the NSFR focuses on a bank's longer-term strategic, structural liquidity.

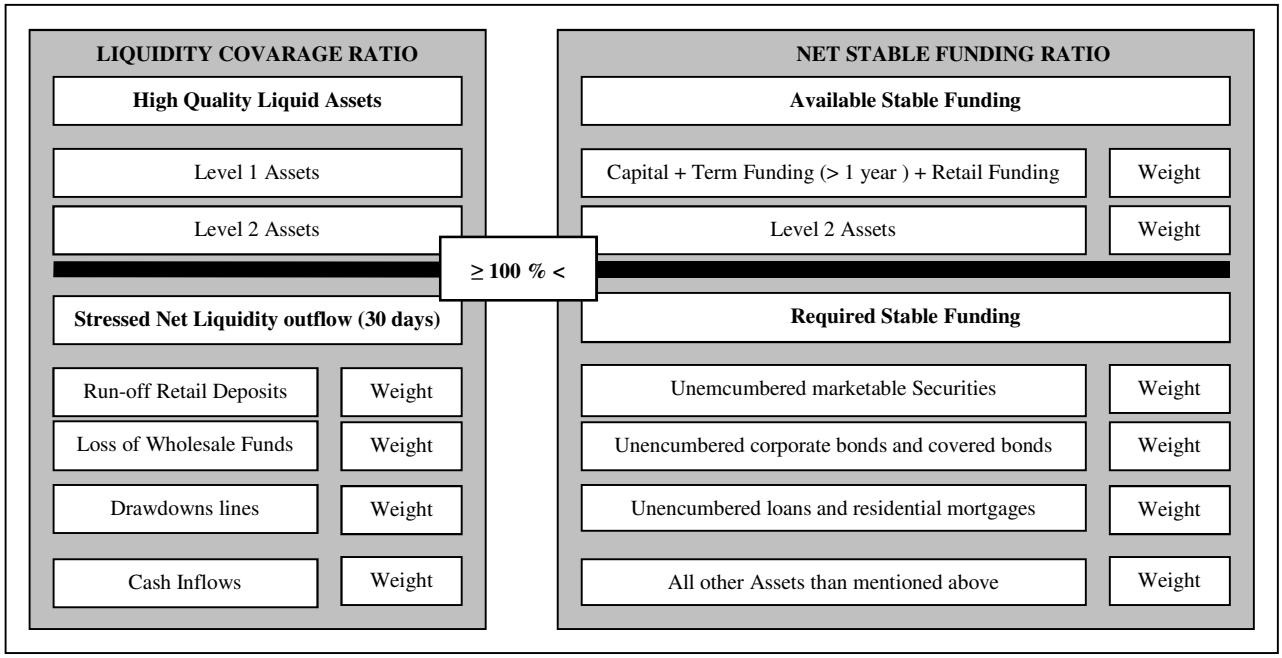


Figure 3: Structure and Calculation Method of LCR and NSFR [49]

With the introduction of an internationally harmonised quantitative liquidity requirement new regulatory framework, the Basel Committee meets concerns of a paper in which deficiencies in

[46] See Bundesanstalt für Finanzdienstleistungsaufsicht 2013. *MaRisk*'s liquidity requirements will be described in greater detail later in this paper (see pp. 22ff).
[47] See Bonner and Eijffinger 2012.
[48] See Basel Committee on Banking Supervision 2013a, pp. 3, 25.
[49] Based on Hauschild and Buschmann 2014, p. 335.

market practices are highlighted. These globally harmonised liquidity standards will replace national liquidity regulations within the foreseeable future.[50] Both measures have to fulfil continuously and to be reported to the respective regulator on a monthly basis at least.[51] This is a unique supervisory step and apart from a few exceptions, there is wide consensus about the rationale and merits of the new liquidity requirements and especially the LCR.[52] Basel III will be transposed into European law by way of the Capital Requirements Directive (CRD IV) as well as the Capital Requirements Regulation (CRR).[53] Basel III's main liquidity measures will be discussed in the following two sections with a predominant focus on the liquidity coverage ratio.

2.3.2 Short Term Liquidity: Liquidity Coverage Ratio (LCR)

The liquidity coverage ratio is a short-term ratio, which requires financial institutions to hold an amount of high-quality liquid assets (HQLA) at least equal to their net cash outflows over a 30-day stress period.[54] The LCR metric promotes short-term resilience to liquidity shocks and, by setting a limit for it, ensures that a sufficient amount of HQLA is maintained by a bank to offset cash outflow in a stressed environment. The LCR identifies the amount of unencumbered, high quality liquid assets required to offset net cash outflows arising in a short-term liquidity stress scenario. A regulatory limit for the LCR ensures that banks meet this requirement continuously.[55] Lastly, the introduction the official introduction of LCR has fostered banks to build up and strengthen their liquidity reserves.[56]

The stress scenarios specified by national regulators contain both institutional or idiosyncratic stresses and systemic shocks. These stress scenarios are based primarily on the financial crisis.[57] A time horizon of 30 days[58] was chosen with the assumption that during this period of time a stressed bank as well as regulators and the central bank take sufficient measures to overcome the

[50] See Bundesanstalt für Finanzdienstleistungsaufsicht 2013.
[51] See Seifert 2012, p. 311.

[52] See Borio 2009, p. 8; Basel Committee on Banking Supervision 2008a, p. 4; Bonner and Eijffinger 2012.
[53] See Bundesanstalt für Finanzdienstleistungsaufsicht 2013.
[54] See Basel Comittee on Banking Supervision 2013, p. 1.
[55] See Choudhry 2012, p. 664.
[56] See Bohn and Tonucci 2014, p. 61.
[57] In this case, the forms of liquidity shown in Figure 13.1 are stressed.
[58] This 30-day time horizon is often called the "survival period" or "survival horizon" and it is included in existing regulatory regimes: even though it is not explicitly mentioned, Germany's *MaRisk* requires a survival period of a month, with the further requirement that a bank survive a liquidity stress of seven days without assistance by the central bank. The term "survival period" itself was introduced by the Committee of European Banking Supervisors. See Bundesanstalt für Finanzdienstleistungsaufsicht 2013; Committee of European Banking Supervisors 2009, p. 5; Matz 2011, p. 62.

liquidity shortage.[59] In contrast to the Basel Committee, other national regulators, like the British Financial Services Authority (FSA), have stipulated a 90-day test period when calculating the LCR.[60] This is important because the outflow value denominator drives the liquidity reserve's size requirement.[61] Under Basel III the LCR is calculated as[62]

$$(1) \qquad \frac{Stock\ of\ High\ Quality\ Liquid\ Assets}{Stressed\ Net\ Cash\ Outflows\ over\ a\ 30-day\ time\ period} > 100\%\ ^{63}$$

The rules on how to define an asset as high-quality and liquid and to construct a stressed cash outflow are pretty detailed, specific and are governed by the following principles. First, the stock of high-quality liquid assets should have a low credit risk and market risk, ease and certainty of valuation. The stock of HQLA is divided into two subgroups: Level 1 assets (cash, central bank reserves) and Level 2 assets in which the stock should contain at least of 60% of Level 1 assets; the remainder can be Level 2 assets (Table 1).[64]

Level 1 Liquid Assets	Level 2 Liquid Assets
- Cash - Central Bank Reserves - Marketable Securities representing claims on sovereign, central banks, and similar institutions - Government or central bank debt issues in the domestic currency	- Sovereign or agency assets qualifying for 20% risk-weighting - Corporate and Covered Bonds

Table 1: LCR Liquid Assets [65]

Second, the main assumption in the denominator is that the reason for the 30-day time period is both an idiosyncratic and a market-wide liquidity shock. This assumption has to be imple-

[59] See Basel Committee on Banking Supervision 2013b, p. 4.
[60] See Financial Services Authority 2008, pp. 38ff.
[61] On the reasonably safe assumption that a liquidity stress will last more than 30 days, we believe that the FSA standard is more conservative than the Basel Committee's approach, but also more expensive and therefore difficult to adopt in practice, even though some others believe that the FSA standard should be adopted as an industry standard. See Choudhry 2012, p. 664. In addition to that and even though the LCR is an international liquidity measure, it will not implemented in the United States like it already implemented in Europe. For the interaction of LCR with the US-American Dodd-Frank-Act see Bouwman 2013 pp. 30ff.
[62] See Basel Committee on Banking Supervision 2013a, p. 3.
[63] See Basel Committee on Banking Supervision 2010, p. 3.
[64] See Choudhry 2012, p. 664.
[65] Based on Hauschild and Buschmann 2014, p. 337.

mented in a bank's stress-test scenarios.[66] As can be seen from the preceding remarks, the LCR increase banks' liquidity-risk-bearing capacity under short-term liquidity shocks.[67]

Whereas the composition of the HQLA-portfolio depends on the characteristics of the comprised securities, the calculation of the stressed net cash outflow is subjected to certain provisions which are shown in Table 2.

Funding Sources	**Run-Off-Assumption within 30 days**
Retail deposits, unsecured funding from small business customers	Stable: 5% Less stable: 10%
Unsecured wholesale funding provided by non-financial corporate, sovereigns, central banks and agencies	25% Operational relationship 75% of "others" where deposits mature or are callable
Unsecured wholesale funding provided by others (including financial institutions)	100% where deposits mature or are callable
Secured funding arrangements	0% backed by sovereign or central bank debt meeting the same criteria as Level 1 assets 100% for all other liabilities maturing
Embedded credit-rating downgrade triggers	100% of posted collateral in the of 3-notch credit rating downgrade.
Derivatives and associated collateral valuation changes: Collateral that is required following changes in derivatives mark-to-market values to be determined by national regulators	20% add-on is required where derivative collateral is not comprised of cash or High-quality sovereign debt
Asset Backed Commercial Paper conduits and similar vehicles	100% where debt matures or is callable
Required liquidity cover for bank liquidity and backstop credit lines given non-financial corporations, sovereigns and financial institutions	100% liquidity facilities 10% credit facilities 100% for both provided by financial institutions

Table 2: Stressed Net Outflow Provisions of LCR [68]

As can be seen in Tables 1 and 2, the calculation formula of the liquidity coverage ratio applies certain weighting factors for the HQLAs as well as the stressed cash outflow to keep the evaluation scope of the single positions as small as possible. In addition, several other restrictions have

[66] See Choudhry 2012, p. 664.
[67] See Brzenk *et al* 2011, p. 6.
[68] Based on Hauschild and Buschmann 2014, p. 338.

to be taken into account, such as cutting cash inflows by 75% of the total cash outflows, so that there is always an imputed liquidity gap. In order to close this gap, a liquidity reserve is required.[69]

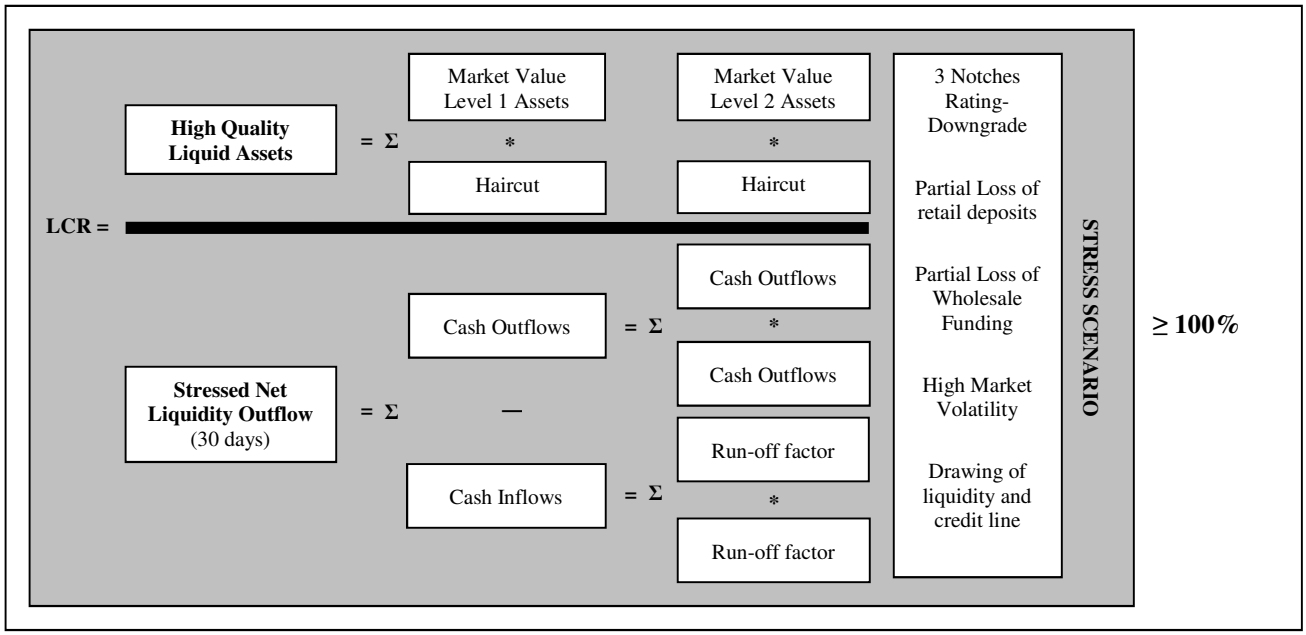


Figure 4: Design of LCR in detail [70]

As is quite obvious from Figure 4, the Basel Committee developed the LCR to promote the short-term resilience of a bank's liquidity risk profile. This standard aims to ensure that a bank has an adequate stock of unencumbered high-quality liquid assets 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 within a 30-calendar-day liquidity stress scenario.[71] The LCR metric indirectly provides short-term protection to liquidity shocks and identifies the required amount of unencumbered, high-quality highly liquid assets required to neutralise short-term liquidity stress-scenario-driven net-cash outflows.[72]

2.3.3 Longer Term Liquidity: Net Stable Funding Ratio (NSFR)

The NSFR promotes funding resilience over the longer term. Setting a funding limit ensures sufficient long-term funding to support the bank's balance-sheet development.[73] By introducing the

[69] See Kleffmann *et al* 2011, p. 2.
[70] Based on Hauschild and Buschmann 2014, p. 339.
[71] See Basel Committee on Banking Supervision 2013b, p. 1.
[72] See Choudhry 2012, pp. 663ff.
[73] See Choudhry 2012, p. 666.

NSFR, the Basel Committee targeted banks' structural, medium-term and long-term liquidity positions by limiting their maturity transformation.[74] So, the NSFR strengthens a bank's medium- and long-term funding at the expense of short-term funding, which was not reliable in the financial crisis.[75] In particular, the NSFR will require banks to maintain a stable funding profile in relation to the composition of their assets and off-balance sheet activities. This specific funding profile is intended to reduce the likelihood that market disruptions will erode a bank's liquidity position in a way that would increase the risk of its failure and potentially lead to broader, market-wide systemic stress.[76] Therefore, the NSFR defines the minimum acceptable amount of stable funding based on the liquidity characteristics of a bank's assets and activities over a one-year horizon. The NSFR was designed to act as a minimum enforcement mechanism to complement the shorter-term LCR and reinforce other supervisory efforts by promoting structural changes in the liquidity risk profiles of banks away from short-term funding mismatches and towards more stable, longer-term funding of assets and business activities.[77] Therefore, the metric measures the amount of stable funding as a proportion of the total requirement for such funding. It is typically used to monitor and control the level of dependency on volatile short-term wholesale markets, as a key of the structural balance-sheet ratio[78] and is basically calculated as[79]

$$(2) \qquad \frac{Available\ Amount\ of\ \ Stable\ Funding}{\mathrm{Re}quired\ Amount\ of\ \ Stable\ Funding} > 100\% \ ^{80}$$

In contrast to the cash flow view of LCR and as can be seen in Table 3, NSFR focuses on balance sheet items. Therefore, balance-sheet data can be used to calculate the NSFR; this is not possible for the LCR.[81] In essence, the purpose of the NSFR is to control the level of maturity transformation that a bank undertakes. Although it can be considered draconian, its implementation might reduce liquidity risk expose in the banking system as a whole.[82]

[74] See Basel Committee on Banking Supervision 2010, p. 25.
[75] See Seifert 2012, p. 336.
[76] See Basel Committee on Banking Supervision 2014, p. 1.
[77] See Basel Committee on Banking Supervision 2010, p. 25.
[78] See Choudhry 2012, p. 666.
[79] See Basel Committee on Banking Supervision 2010, p. 25.
[80] See Basel Committee on Banking Supervision 2014, p. 4.
[81] See Seifert 2012, p. 311.
[82] See Choudhry 2012, p. 668.

Available Stable Funding	Required Stable Funding
– 100% of total Tier 1 and Tier 2 capital an preferred Stock – 100% of liabilities with a contractual maturity greater than one year – 85% of "stable" retail and small business deposits with maturities less than one year – 70% of "less stable" retail and small business deposits with maturities less than one year – 50% of large corporate deposits with maturity less than one year	– 0% Cash, securities with a maturity less than one year, inter-bank loans with a maturity less than one year, securities held with an offsetting reverse repo – 5% unpledged high-quality liquid securities (similar definition to central bank eligible collateral) – 20% of corporate and covered bonds with proven record of liquidity (e.g. no major increase of repo haircut in the last 10 years) – 50% other corporate bonds, gold, equities, loans to corporate with maturity less than one year – 85% retail loans with maturity less than one year – 100% of all loan with a with maturity greater than one year – 10% of all undrawn committed credit lines and overdraft facilities – 100% of percentage of guarantees, uncommitted credit lines, letters of credit, money markets mutual fund repo obligations and so on

Table 3: NSFR Stable Funding Calculation [83]

Albeit the intended benefits, it is the large weakness of the NSFR (as well as of the LCR) is that either the ratios or the model in combination just focus on one currency and not at the multicurrency liquidity risk a bank is normally exposed to.

3. Strategies for the Management of the Liquidity Reserve

In general, banks experience liquidity stress when the actual cash flows differ from the expected ones. This is notably through changes in counterparty behaviour and market conditions that affect the liquidity of financial instruments and the availability of funding.[84]

One of the clearest lessons from the financial crisis was that many types of assets considered hitherto to be liquid were in fact not truly liquid. During the last quarter of 2008 many banks could not sell or repo parts of their assets. Therefore, most of funding instruments banks used were not or just limited available.[85] As the previous section implies, banks need a liquidity reserve to be truly

[83] Based on Hauschild and Buschmann 2014, p. 340.
[84] See Matz and Neu 2007, p. 103.
[85] See Heidorn and Schäffler 2008, p. 24.

liquid and capable of being used to generate funding liquidity under all market circumstances.[86] In such market turmoil a bank's liquidity reserve is the most reliable funding source.[87] In the following, we shall show the overall concept of a liquidity reserve, how a liquidity reserve should be composed and how the size of the liquidity reserve is properly calculated. Lastly, we shall show some strategies to manage the liquidity reserve in an efficient way.

In the following, we shall show the overall concept of a liquidity reserve, how a liquidity reserve should be composed and how the size of the liquidity reserve is properly calculated. Lastly, we shall show some strategies to manage the liquidity reserve in an efficient way.

3.1 The Liquidity Reserve

3.1.1 Overview and Concept

It is quite obvious that in a liquidity crisis, banks are strictly required to honour their obligations at any time and therefore it can be, depending on the intensity of the stress, that liquidity is more important than profitability and therefore greater financial losses have be taken into account when liquidating assets to ensure sufficient liquidity.[88] According to bank-specific liquidity risks, the liquidity reserve should limit a bank's funding risk. Therefore, a bank should hold a quantitatively and qualitatively sufficient liquidity reserve, also known as "liquid asset reserve", "liquidity reserve", "liquidity portfolio" or "portfolio of reserve assets", which should be used to acquire funding on a sudden and pretty short-term basis.[89] Hence, the liquidity reserve has to be thoroughly and forward-looking managed in order to ensure that, to the maximum extent possible, assets will be available in times of financial stress.[90] Funding that is generated through usage of these assets is also called "crisis liquidity". The overall amount of crisis liquidity limits a bank's funding risk and should be sized individually for any financial institution.[91] This will be discussed later in this very analysis.

The liquidity reserve's allocation is mainly driven by internal and external factors: internal factors are a bank's risk–return considerations, capital charges on the assets held in the liquidity reserve and how much accounting volatility the bank wants to have on its books. The latter clearly

[86] See Choudhry 2012, p. 622.
[87] See Matz and Neu 2007, p. 103.
[88] See Müller and Wolkenhauer 2008, p. 244.
[89] We view all of these terms as synonymous.
[90] See Bohn and Tonucci 2014, p. 62.
[91] See Heidorn and Schäffler 2008, p. 27.

depends on the IFRS categories in which the bank booked these assets.[92] Lastly, the bank's risk appetite plays an important role. In addition, external factors are mainly driven by market conditions: here, we must focus on the market's credit cycle, e.g., how expensive is cash in comparison to bonds or how expensive are covered bonds and corporate bonds in comparison to sovereign bonds or agency bonds?

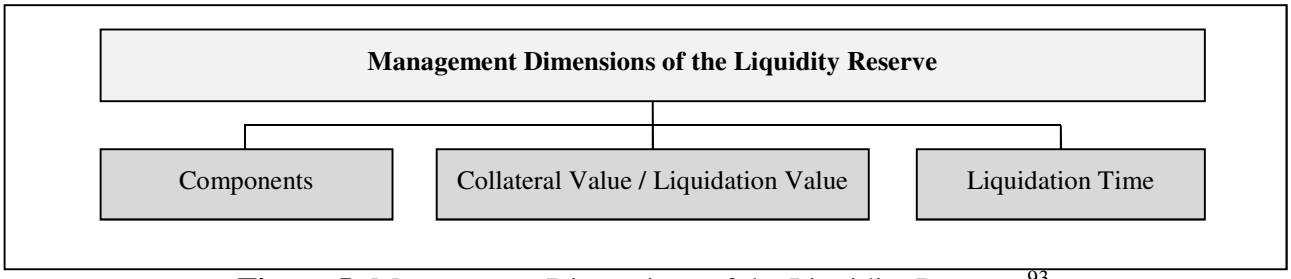


Figure 5: Management Dimensions of the Liquidity Reserve [93]

When composing the liquidity reserve, we must take these factors into account and make a trade-off between the liquidation time frame and liquidation value of the single components (Figure 5). A high liquidation time frame is associated with high(er) value losses. So, liquidation time frame and liquidation value are negatively correlated.[94] The main criterion when selecting of the components of the liquidity reserve is optimal liquidisation. This can be achieved by using publicly traded securities with high market volumes and low bid–ask spreads as well as cash, central bank deposits, other central bank eligible assets or committed credit and liquidity lines.[95] By generating additional crisis liquidity via the liquidity reserve, a bank gains time to trigger further contingency measures, such as reorganising its business model, reshuffling its funding structure or both. Therefore, the size and structure of the liquidity reserve determines how quickly a bank needs to act.[96]

According to the Committee of European Banking Supervisors (CEBS), the liquidity reserve is defined as the excess liquidity available outright to be used in liquidity stress situations within a given short-term period (Table 4). In other words, it is the availability of liquidity, which obviates the need to take any extraordinary measures.[97]

[92] International Accounting Standard 39 ("Financial instruments: recognition and measurement"; IAS 39) categorise financial instruments into five different categories: loans and receivables (L&R), held to maturity (HtM), held for trading (HfT); available for sale (AfS); other liabilities (OL). See Subramani 2009, p. 6.
[93] Based on Hauschild and Buschmann 2014, p. 344.
[94] See Müller and Wolkenhauer 2008, p. 240.
[95] See Heidorn and Schäffler 2008, p. 27.
[96] See Bessis 2010, p. 286; Matz 2011, p. 62.
[97] See Committee of European Banking Supervisors 2009, p. 10.

Category	Guideline	Description / Contents
Liquidity Reserve	**Guideline 1**	A liquidity reserve represents available liquidity, covering the additional need for liquidity that may arise over a defined short period of time under stress conditions.
	Guideline 2	Institutions should apply three types of stress scenarios: idiosyncratic, market specific, and a combination of the two. The core of the idiosyncratic stress should assume no rollover of unsecured wholesale funding and some outflows of retail deposits. The market-wide stress should assume a decline in the liquidity value of some assets and deterioration in funding-market conditions.
Time Horizons	**Guideline 3**	A survival period of at least one month should be applied to determine the overall size of the liquidity reserve under the chosen stress scenarios. Within this period, a shorter time horizon of at least one week should also be considered to reflect the need for a higher degree of confidence over the very short term.
Composition of the Reserve	**Guideline 4**	The liquidity reserve should be composed of cash and core assets that are both central bank eligible and highly liquid in private markets. For the longer end of the reserve, a broader set of liquid assets might be appropriate, subject to the bank demonstrating the ability to generate liquidity from them under stress within the specified period of time.
	Guideline 5	Credit institutions need to manage their stocks of liquid assets to ensure, to the maximum extent possible, that they will be available in times of stress. They should avoid holding large concentrations of particular assets, and there should be no legal, regulatory, or operational impediments to using these assets.
	Guideline 6	The location and size of liquidity reserves within a banking group should adequately reflect the structure and activities of the group in order to minimize the effects of possible legal, regulatory or operational impediments to using the assets in the reserve.

Table 4: Guidelines on Liquidity Reserves & Survival Periods [98]

Because all banks are subject to the same regulation, they are likely to hold the same assets as liquidity reserves and therefore be equally affected when a market-wide stress occurs. This leads to another type of liquidity risk, which we have not mentioned before: so-called "liquidity black holes".[99] These arise when several market participants want to sell the same assets at the same time, with the consequence that there are no longer any buyers in the market, or vice versa. Thus, liquidity dries up very quickly and these assets lose their original purpose. In this situation banks can only

[98] Based on Hauschild and Buschmann 2014, p. 343.
[99] See Duttweiler 2009, p. 6. Moreover, liquidity black holes are often referred to as a "crowded exit". See Hull 2012, p. 462.

generate liquidity by taking heavy losses on their fire-sold assets; therefore, it is crucial that the liquidity reserve is broadly diversified.[100]

3.1.2 Asset Allocation and Size of the Liquidity Reserve

When composing the liquidity reserve, it is useful to think of liquidity and illiquidity in terms of how much sellers might lose if they need to sell immediately, as opposed to engaging in a costly and time-consuming search for buyers.[101] With the focus on constant funding liquidity, the ALM desk will define the size of the liquidity reserve itself with respect to the bank's business model, the intensity of the assumed market disruptions and, of course, regulatory requirements. So, with the size and composition of the liquidity reserve, a bank defines its own ability to sustain an idiosyncratic liquidity stress or market-wide disruption or both.[102] Consequently, most of the assets in the liquidity reserve are high-quality highly liquid (HQHL) assets.[103] Most relevant for the asset allocation of the liquidity reserve are what we call "off-balance liquidity consumers", which do not require continuous funding, but might generate huge and unexpected liquidity gaps.[104]

In a liquidity stress scenario, the liquidity reserve must be able to offset tremendous losses of funding during a bank run[105], as well as unforeseen liquidity gaps that might be inherent in the bank's balance sheet. With this in mind, the composition of the liquidity reserve depends on the assets' ability to generate liquidity during crises. This is primarily done by broad and deep markets with assets of high creditworthiness. In this way, the composition itself determines how much liquidity can be generated during a crisis. This volume is also determined by the potential haircut of the single assets. The haircut is reciprocal to the credit quality of the asset: the better the creditworthiness, the smaller the haircut, and therefore the better the fungibility.[106]

As the previous section shows, holding liquid assets is ruled by a tight regulatory regime. Therefore, based on market experience as well as common sense, we wish to show several regulatory requirements that are quite similar in general, but differ in detail: according to module BTR 3.1 of the *MaRisk*, financial institutions are expected to check whether they can meet their liquidity

[100] See Hull 2010, p. 398.
[101] See Fabozzi *et al* 2010, p. 174.
[102] See Bessis 2010, p. 286.
[103] See Heidorn and Schäffler 2008, pp. 27ff.
[104] Some good examples of liquidity consumers are margin calls from an exchange or compensation from protection sold on credit default swaps when the reference entity defaults. See Heidorn and Schäffler 2008, pp. 27ff.
[105] For a detailed description of bank runs and related liquidity management constraints see Bergner *et al* 2014. For the mechanics of large-bank failures see Duffie 2011.
[106] See Sauerbier *et al* 2008, pp. 93ff.

needs in a stressed market environment. In particular, banks have to check the fungibility of their held assets. Moreover, they have to check how reliable their funding sources are. In order to offset sudden and unexpected liquidity deterioration, banks are required to hold an individually sufficient and sustainable liquidity reserve of highly liquid and unencumbered assets. This administrative directive applies for all banks in Germany. For publicly traded banks *MaRisk*'s module BTR 3.2 specifies that these banks have to overcome a liquidity shortage of at least one week by holding cash and highly liquid assets which are central bank eligible and can be sold in a stressed market environment without any significant losses. The bank has to potentially survive this survival period without any assistance by the central bank. For a time frame larger than a week, other assets can also be used, as long as they can be liquefied within a one-month time frame.[107]

3.1.3 Securities of the Liquidity Reserve

On the basis of the previous remarks, it is obvious that the liquidity reserve should be composed of cash and highly liquid assets. A bank must be able to sell or repo the latter under stressed market conditions. These assets have to be of the kind that will not be affected by a large downwards valuation akin in a fire sale. They should be as credit risk-free as possible and should not have any correlation with the financial sector.[108] Consequently, the question is which securities are truly liquid. In the 2007–8 financial crisis only high-quality sovereign bonds had this characteristic. But here, the liquidity-black-hole problem arises: when all banks hold the same sovereign securities, markets might be trapped in the liquidity black hole when the next liquidity crisis emerges. That is why regulators allow securities other than sovereign securities in the liquidity reserve. According to the Basel Committee, these securities should be traded in large, deep and active repo or cash markets. Moreover, they should have a proven record as a reliable source of liquidity in the markets (repo or sale) even during stressed market conditions with individually defined haircuts over a predefined period of time.[109]

Unfortunately, the degree of liquidity changes with market conditions and it is a matter of observable historical record that only the assets that maintained liquid under any all market conditions were sovereign bonds. Given that liquidity of other types of assets changes according to mar-

[107] See Bundesanstalt für Finanzdienstleistungsaufsicht 2012.
[108] See Choudhry 2012, p. 627.
[109] See Basel Committee on Banking Supervision 2013b, pp. 12ff.

ket conditions, banks should estimate the level of liquidity pertaining at any time, an assessment that will help them determine the level of liquidity of their non-government assets.[110]

Liquidity can be measured directly and indirectly. So, there are several direct measures like the bid–ask spread or the so-called non-default-component (NDC)[111], which is included in the asset-swap spread, as well as indirect proxies such as age and tenor, issue and trading volume or yield and price volatility. The liquidity measures are generally accepted by market participants, whereas liquidity proxies are primarily based on empirical evidence (Table 5).[112]

Measure	Liquidity
Bid-Ask-Spread	The smaller the bid-ask-spread the higher a bond's liquidity
Non-Default-Component (NDC)	The smaller the NDC the higher a bond's liquidity
Proxy	**Liquidity**
Age	The "younger" the bond, the higher a its liquidity
Tenor	The shorter the tenor, the higher a bond's liquidity
Issue volume	The greater the issue volume, the higher a bond's liquidity
Trading volume	The larger the trading volume, the higher a bond's liquidity
Yield	The smaller the yield, the higher a bond's liquidity
Price volatility	The smaller the price volatility, the higher a bond's liquidity

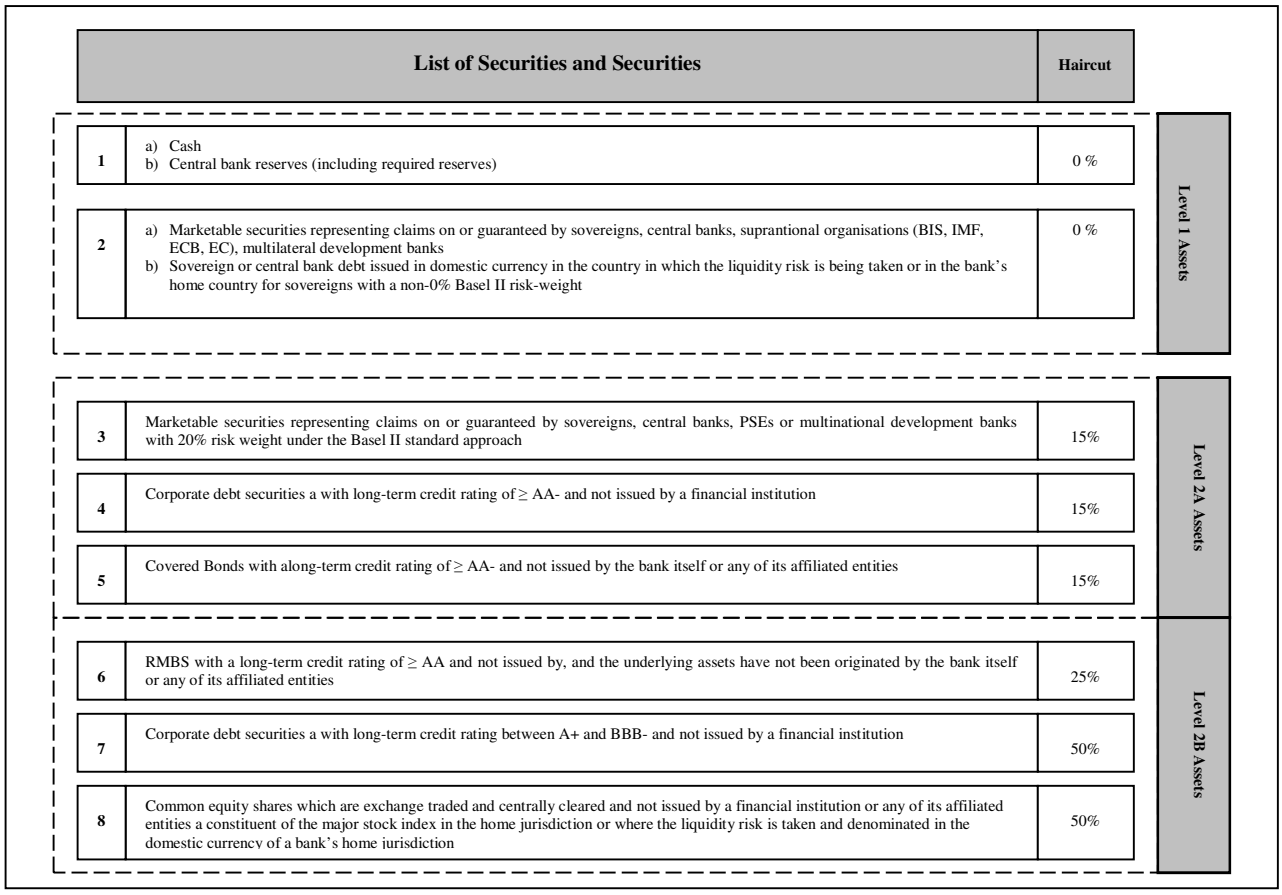
Table 5: Liquidity Measures and Proxies[113]

The composition of the securities or products of the liquidity reserve are pretty simple to explain. As shown in the previous sections, regulatory requirements are quite similar. Given that the Basel III provisions will be adapted by national regulators, we believe that banks will be expected to hold securities which are described in the numerator of the liquidity coverage ratio in an appropriate size (Figure 6).[114] The composition of the liquidity reserve with a given regulatory framework can be considered as a passive management strategy.

When composing the liquidity reserve, a benchmark has to be set from a return point of view. Often, a liquidity reserve's benchmark is the bank's own sovereign. In the case of a German bank, this would be German Bunds or French treasury bonds (Obligations Assimilables du Trésor,

[110] See Choudhry 2012, p. 625.
[111] The non-default component is the difference between the asset-swap spread and a maturity-matching CDS spread of the same entity. It quantifies the non-credit-risk related part of any asset-swap spread and can be simplified seen as a liquidity measure. See Heidorn and Rogalski 2010, pp. 8ff.
[112] Examples of papers that deal with diverse liquidity measurement methods are Chakravarty and Sarkar (1999), Houweling *et al* 2002, Chordia *et al* 2003 and Jankowitsch *et al* 2002.
[113] Based on Hauschild and Buschmann 2014, p. 347.
[114] The "appropriate size" of the liquidity reserve an how to calculate it will be discussed in the following section.

or OAT) for French banks. The reasons why these government bonds of the bank's home country are the benchmark are pretty simple: First, they are by definition risk-free for them and, second, they have, according to the Basel III regime, the lowest haircut. Therefore, a bank's liquidity reserve is always home-biased and its returns clearly depend on their home-countries yields because it presumably consists mostly of sovereign bonds.



	List of Securities and Securities	Haircut	
1	a) Cash b) Central bank reserves (including required reserves)	0 %	Level 1 Assets
2	a) Marketable securities representing claims on or guaranteed by sovereigns, central banks, suprantional organisations (BIS, IMF, ECB, EC), multilateral development banks b) Sovereign or central bank debt issued in domestic currency in the country in which the liquidity risk is being taken or in the bank's home country for sovereigns with a non-0% Basel II risk-weight	0 %	
3	Marketable securities representing claims on or guaranteed by sovereigns, central banks, PSEs or multinational development banks with 20% risk weight under the Basel II standard approach	15%	Level 2A Assets
4	Corporate debt securities a with long-term credit rating of ≥ AA- and not issued by a financial institution	15%	
5	Covered Bonds with along-term credit rating of ≥ AA- and not issued by the bank itself or any of its affiliated entities	15%	
6	RMBS with a long-term credit rating of ≥ AA and not issued by, and the underlying assets have not been originated by the bank itself or any of its affiliated entities	25%	Level 2B Assets
7	Corporate debt securities a with long-term credit rating between A+ and BBB- and not issued by a financial institution	50%	
8	Common equity shares which are exchange traded and centrally cleared and not issued by a financial institution or any of its affiliated entities a constituent of the major stock index in the home jurisdiction or where the liquidity risk is taken and denominated in the domestic currency of a bank's home jurisdiction	50%	

Figure 6: Composition of the Liquidity Reserve according to Basel III / LCR in detail [115]

When selecting the securities the bank has to choose the maturity of the reserve assets. Principally, there is nothing like an optimal tenor for the liquidity reserve. Therefore, it is more advisable to choose maturities that fit the requirements for reserve assets best. Regarding liquidity characteristics, the benchmark of every liquidity reserve is cash. Cash has no duration and no risk or return. Consequently, the liquidity reserve's asset duration depends first on its optimal added returns

[115] Based on Hauschild and Buschmann 2014, p. 349. Albeit this listing of assets which meet the theoretical liquidity characteristics seems to be quite logical in the first place, it was outpaced by market reality: A study undertaken by the European Banking Authority (EBA) in 2013 turned that, among others, equity shares are, based on EBA's empirical and principles-based analysis, insufficient liquid for their intended purpose. See European Banking Authority 2013, p. 24.

over cash. The assets' durations depend primarily on their liquidity. As implied in Table 5, shorter maturities are more liquid than longer ones. For this reason, shorter maturities should be preferred over longer ones. In addition, market depth plays an important role: when composing the liquidity reserve, maturities with high market depths should be selected and these are by trend shorter maturities.

3.1.4 Calculating Size of the Liquidity Reserve

When calculating the size of the liquidity reserve, the indispensable condition is simply how long will the bank last in a liquidity crisis. This consideration determines the length of the bank's survival period and consequently the size of the liquid asset reserve. As implied, a bank's liquidity reserve should be composed of assets that other financial institutions and cash lenders would accept as collateral in a financial crisis, which suggest only sovereign issuers. Thus, a benefit of holding government bonds, on both individual and aggregate levels, is that this forces banks to develop their liquidity risk management ability and run a tighter ship with respect to their liquidity policy. This is because regulators will insist on a higher liquidity reserve as a proportion of total assets, for those firms with structural liquidity problems or following poor liquidity policy; in other words and as a logical consequence of this, the more liquidity risk a bank runs, the larger the liquidity reserve should be.[116]

The exact proportion of a bank's balance sheet that is held as the liquidity reserve is a function of the bank's business operations and their resulting liquidity risk on both sides of the balance sheet, i.e., for both lending business and funding. As presented above, the given length of the survival period and percentage of overall long-term funding determine the size of the liquidity reserve: the more long term funding is available and the shorter the set survival period, the smaller the liquidity reserve.[117] Moreover, the liquidity reserve is also a function of the type of bank funding: retail funding is regarded as more stable than wholesale funding; therefore, the more a bank relies on wholesale funding, the greater the liquidity reserve should be and vice versa.[118]

As a consequence of the remarks above, setting the framework for calculating the liquidity reserve a bank needs to determine their actual retail funding as well as whole funding with its respective maturities, whereby the ALM desk sets the desired survival period in accordance to regula-

[116] See Choudhry 2012, p. 622.
[117] Here, there is a difference between the lengths of the regulators' specified survival periods: While Germany's *MaRisk* and Basel III require a survival period of a month or 30 days respectively, UK's FSA recommends a survival period of 90 days. See Hauschild; Buschmann 2014, p. 305.
[118] See Choudhry 2012, p. 631.

tory requirements. Once these features have been set, a bank needs to ensure that their IT systems are able to produce projections of expected cash flows, broken down into time buckets, financial instruments and business lines, and precisely all sources of liquidity risk. These cash flow scenarios need to be accompanied by a description of the alternative funding sources that are available to meet liquidity needs. This will include the liquidity reserve. The liquidity reserve will be the first port of call for the bank's counterbalancing capacity and therefore exists to enable the bank to continue its normal business operations during an idiosyncratic or market-wide stress. By running a conservative liquidity management approach, a bank has a greater chance of surviving a liquidity stress.[119]

Bank-specific stress-test results are the prime driver of the size of the liquidity reserve. The largest cash flow gap determines the required size of the liquidity reserve. The cash flow analysis should be made at a granular level, so that, when determining cash flows and counterbalancing capacity, a bank identifies contractual and behavioural flows and applies a conservative assumption of liabilities' behaviour when estimating its liquidity position. When assessing cash flows, the bank calculates the sum of the expected outflows and subtracts this from the sum of expected inflows.[120]

Moreover, the proportion of the bank's balance sheet that is dedicated to the bank's liquidity reserve is a function of a number of factors, including the composition of its funding and structural limitations in its ability to raise liabilities.[121] The size of the liquidity reserve should be determined according to the funding gap under stress conditions over a specified survival period. This time horizon as well as the related liquidity reserve should not supersede or replace other measures taken to manage the net funding gap and funding sources, and the institution's focus should be on surviving well beyond the stress period. Therefore, the survival period should only be the period during which an institution can continue operating without needing to generate additional funds and still meet all its obligations.[122]

As funding liquidity risk is a bank-specific characteristic, financial institutions are expected to tailor their liquidity management, stress tests and, of course, their liquidity reserve to their specific business model. This does not preclude approaches that aim to capture liquidity risk factors that are common to all banks. The combination of tiered market structure and concentration of activity imply that the potential severity of contagion is higher for banking groups than for small banks at

[119] See Choudhry 2012, pp. 631ff.
[120] See Choudhry 2012, p. 632.
[121] See Choudhry 2012, p. 623.
[122] See Committee of European Banking Supervisors 2009, p. 10.

the fringe of the market. Liquidity risk varies across credit institutions, and the underlying risk should be properly reflected in the size of a bank's liquidity reserve. All material sources of liquidity risk should be included under any approach, regardless of their nature as liabilities or assets, on-balance-sheet or off-balance-sheet, currency denomination, etc.[123] So, in general, from an individual perspective, the ideal size of the liquidity reserve can be determined by the marginal benefits of maintaining a portfolio of reserve assets and its marginal costs. Cost and benefits need to be equal.[124]

3.2 Managing Strategies

As argued in the previous section, the composition of the liquidity reserve within a certain regulatory framework can be interpreted as a passive management strategy. In this section some active management strategies will be presented: first, the funding strategy with its related rationales, and then the liquidity reserve's related spread strategies.

3.2.1 Funding Strategy

Although short-term funding is cheaper than longer-term funding, the liquidity reserve has to be funded on a long-term basis as the following strongly simplified example shows. Let us assume that a bank holds loans and securities that serve as the bank's liquidity reserve. As shown in Figure 7, these assets are diversified and cost-efficiently funded by interbank deposits, repurchase agreements for the loans and medium-term and long-term funding for the liquidity reserve.

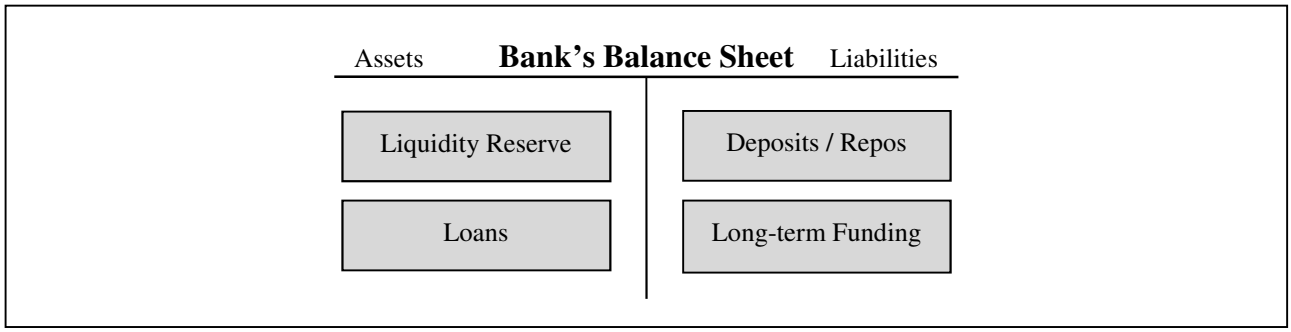


Figure 7: Simplified balance sheet before liquidity stress [125]

[123] See Committee of European Banking Supervisors 2009, p. 11.
[124] See Bohn and Tonucci 2014, p. 62.
[125] Based on Hauschild and Buschmann 2014, p. 353.

Whatever the nature of the liquidity stress, it is quite likely that the unsecured interbank funding will dry up, and only limited funding via repurchase agreements is available.[126] In such a case the liquidity reserve will be depleted. As Figure 8 shows, this is accompanied by balance-sheet contraction and safeguarding of the loans' funding by medium-term and long-term.

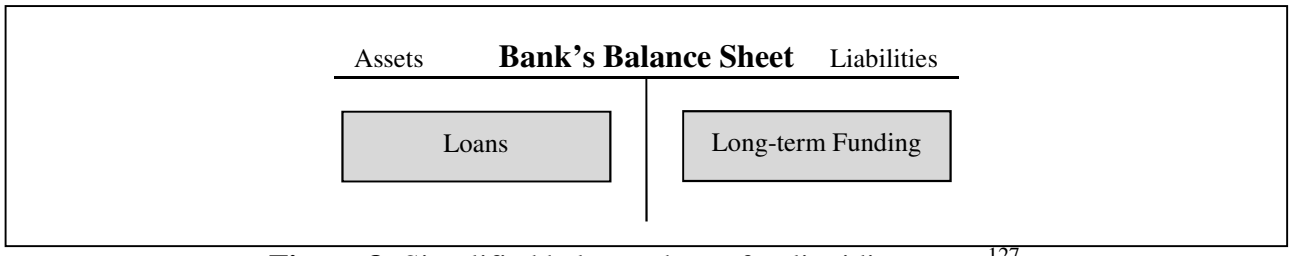


Figure 8: Simplified balance sheet after liquidity stress [127]

The example given above shows two essential aspects of how a bank's liquidity reserve works: First, the actual liquidity reserve is generated on the liability side of a bank's balance sheet by issuing long-term debt, e.g., senior unsecured debt, and is "parked" through HQHL-securities on the bank's asset side. Therefore, the liquidity reserve serves as some kind of liquidity repository and clearly shows that, as already mentioned in section 2.2, bank's liquidity is clearly linked to both sides of the balance sheet. As long as there is no liquidity stress, the bank is likely to run a pro forma negative maturity transformation by financing intended short-term assets in the long term. In a stress environment, the long-term funding will be used to fund the bank's normal lending business. This simple example shows that funding of the liquidity reserve by repurchase agreements is impractical because the liquidity reserve's purpose is to generate crisis liquidity. This can only be achieved by using long-term debt. By using repurchase agreements, someone gives a collateralised loan: the bank receives cash and gives away a bond. This is not a liquidity creation in a narrower sense, as the bond must somehow be funded and therefore no additional liquidity will be generated from the bank's perspective. Moreover, repurchase agreements will not be renewed in an idiosyncratic or market-wide liquidity stress.

Second, through its negative maturity transformation and due to its high fungibility and good rating with low short-term yields, crisis liquidity is a relatively expensive form of liquidity.

[126] See Müller and Wolkenhauer 2008, p. 240.
[127] Based on Hauschild and Buschmann 2014, p. 353.

So, a trade-off between liquidity and return has to be made.[128] This trade-off is inevitable. By holding a large enough liquidity reserve, banks can buy time until the liquidity stress ends. The negative carry from, or the funding costs of, these assets can be seen as insurance premium for the resulting contribution to the bank's liquidity.[129] As stated, by using its liquidity reserve, a bank buys time to reshuffle its business model and adjust their funding strategies to the new market environment. Therefore, the set-up of a new liquidity reserve has to reflect new market conditions, e.g., some securities may be left out, whereas others might be included because they remained liquid in a preceding market stress.

As implied and due to negative maturity transformation, it is quite likely that holding a liquidity reserve generates some basis risks. In addition, loans contain a bundle of risks such as credit risk and interest rate risk.[130] Even though they are tradable, bonds can be seen as a loan, and therefore they create such risks. The adequate management of these risks will be discussed in the following sections.

3.2.2 Managing Basis Risk

In ALM, another important source of interest rate risks are basis risks, which arise from rates earned and paid on different instruments with similar re-pricing characteristics but whose correlation is imperfect meaning their rates differ by a certain spread. When interest rates change, these differences can give rise to unexpected changes in the cash flows and earnings spread between assets and liabilities and off-balance-sheet instruments of similar maturities or re-pricing frequencies.[131] There are several situations in which banks are exposed to basis risks. Despite several available definitions, we think that basis risk derives from imperfect correlations between two rates, e.g. benchmark rates like Euro Interbank Offered Rate (EURIBOR) and London Interbank Offered Rate (LIBOR), to which financial instruments are linked.[132] Therefore, basis risk can emerge when banks are exposed to spreads between floating rates indexed to different re-pricing schedules or to the same re-schedule in different currencies. Such spreads are quoted for the related hedging derivatives, e.g. a floating-floating swap paying the three-month rate (3m) and receiving the six-month

[128] See Hull 2010, p. 393.
[129] See Matz 2011, p. 288.
[130] See Wall and Shrikhande 2000, p. 1.
[131] See Leistikow 2014, p. 5.
[132] For a detailed description of several types interest rate related basis risks see Gentili and Santini 2014, p. 88.

(6m) EURIBOR rate, or a cross-currency swap exchanging euro payment with US dollar payments with six month floating interest exchanges.[133]

As a consequence of the financial crisis, many different anomalies appeared in the interest rate market. One of these are basis spreads. These appeared for exchanging floating payments with different tenors between single-currency interest rate instruments.[134] The crisis increased the volatility of the quoted basis spreads which were previously essentially stable. Since mid-2007, basis spreads have become and fundamental variable and a top priority for bank's ALM.[135] As shown in the following Figure 9, in the time before the financial crisis basis spreads were negligible. They appeared when swap rates of the same tenor but different reference rates/money market indexes diverged.

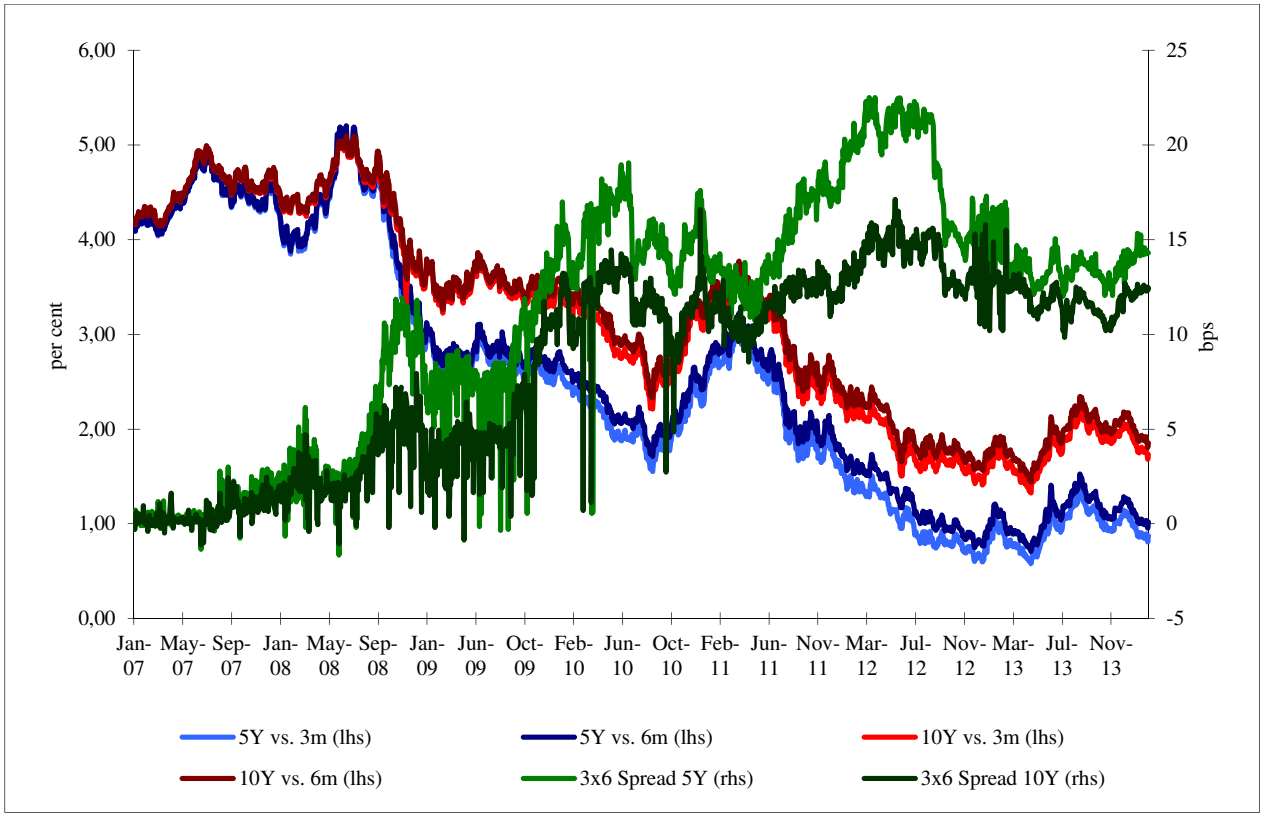


Figure 9: Spread of 5y and 10y swap rates indexed to 3m and 6m EURIBOR [136]

[133] See Gentili and Santini 2014, p. 88.
[134] See Morini 2009, p. 2; Amentrano and Bianchetti 2009, p. 3.
[135] See Gentili and Santini 2014, pp. 88ff.
[136] Bloomberg L.P. 2014.

The basis swap emerged from these basis spreads. In contrast to a "conventional" interest rate swap, a basis swap has two floating legs that are linked to two different money market indexes. A basis swap should eliminate the bank's basis risk between the bank's income and expense cash flows. In Europe, most basis swaps are linked to LIBOR or EURIBOR, but with different maturities, for instance one leg might be at the three-month tenor and the other at the six-month tenor. In such a swap the basis and the payment frequency are different: one leg pays interest on a quarterly basis, whereas the other pays on a semi-annual basis (3x6 basis swap). By having different payment frequencies one party has a higher level of counterparty risk and hence, a higher credit risk – this materialised in the financial crisis.[137]

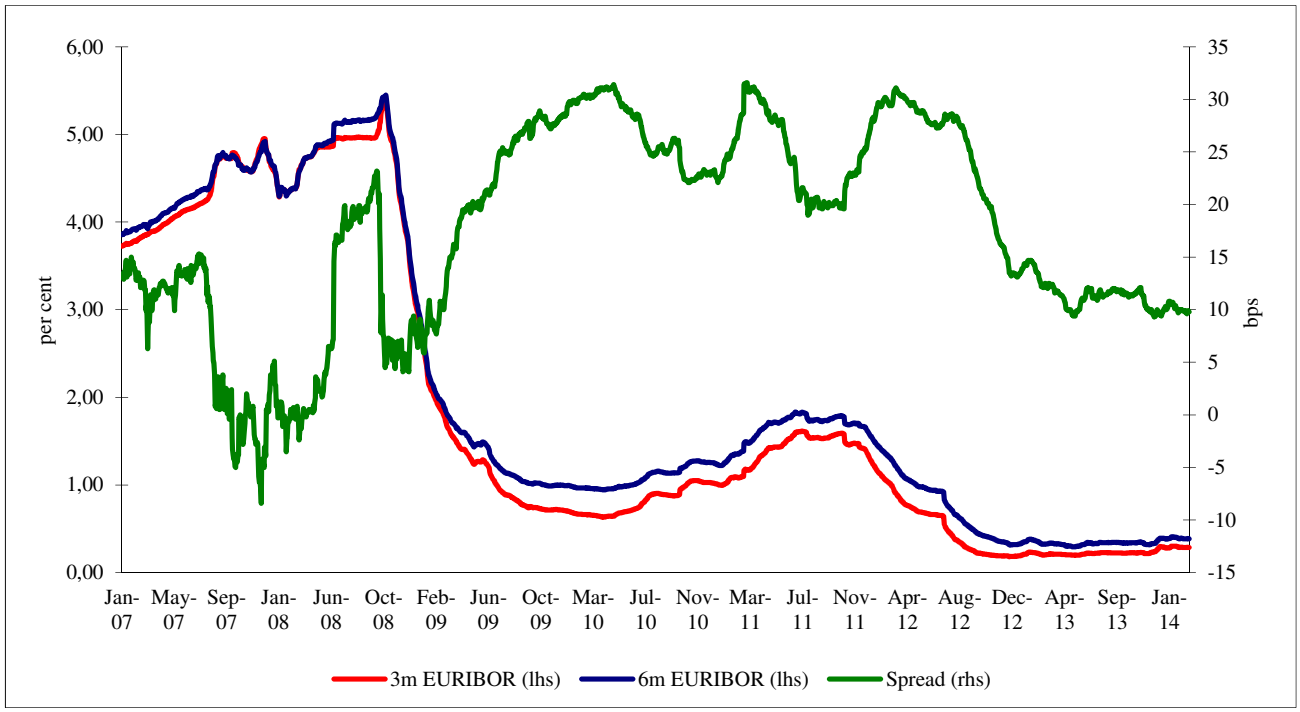


Figure 10: 3m and 6m EURIBOR and the corresponding spread [138]

As Figure 10 shows, the volatility of the 3x6 EURIBOR basis spread reflects the anticipated liquidity risk in the money market and the corresponding preference of banks for receiving payments with higher frequency, e.g., quarterly instead of semi-annually. In addition, there are other

[137] See Choudhry 2007, p. 656.
[138] Bloomberg L.P. 2014.

indicators of regime changes in the interest rate markets, such as the divergence between deposit rates and overnight indexed swap (e.g., EONIA[139]-Swap) rates with the same maturity (Figure 11).

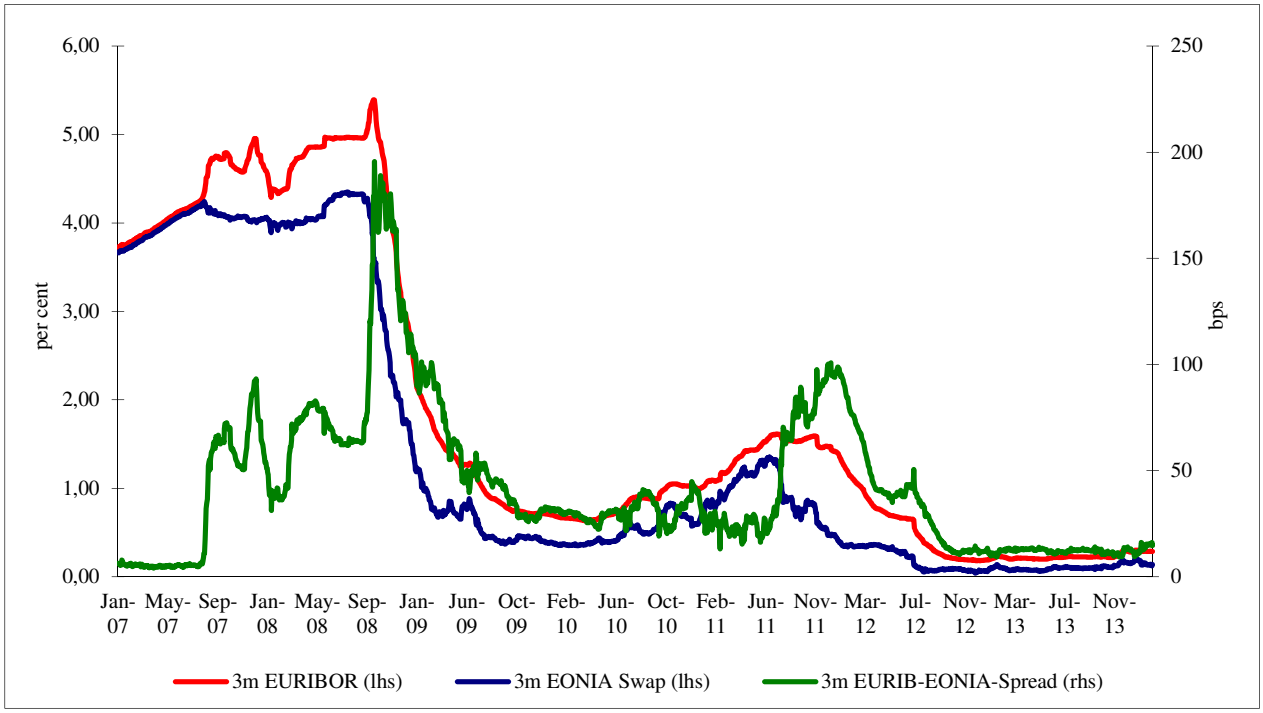


Figure 11: 3m EURIBOR Fixing vs. 3m EONIA swap rate [140]

These interest rate differentials are not completely new in the market: non-zero basis swap spreads were already quoted and understood before the crisis, but their magnitude was very small and therefore traditionally was neglected.[141]

The interbank money market is an unsecured and short-term market. With the emergence of the financial crisis banks were uncertain about forthcoming losses, which caused them to be reluctant to lend to each other in money markets and to fear counterparty risks. As a result basis spreads of interbank short-term interest rates widened.[142] So here the observed money market basis swap can be seen first as a built-in credit premium – the credit premium built into a particular rate index differs from that built into another[143] – and second as a liquidity premium or, better, a liquidity spread – by being unsecured and short term, money market deposits clearly affect the LCR's de-

[139] The Euro OverNight Index Average (EONIA) represents the effective one day (overnight) interest rate in the euro area.
[140] Bloomberg L.P. 2014.
[141] See Amentrano and Bianchetti 2009, p. 3.
[142] See Hirvelä 2012, p. 1.
[143] See Tuckman and Porfirio 2003, p. 3.

nominator. The longer the maturity of the trade, the greater the spread is. Therefore, banks have become keener to relieve the LCR ratios that subsequently determine the spread: the extent of the spread complies with its LCR relief. Thus, we believe that these observed spreads will definitely remain in the future.

Since their (observable) emergence, basis spreads have been quoted by the swap desks of market participants and basis swaps have become a real hedging instrument of basis risks. If assets are floating rate, there is less concern over the interest rate risk because of their frequent resets. This also applies for floating rate liabilities but only insofar as these match the floating rate assets. Floating rate liabilities issued to fund fixed rate assets create forward risk exposure to rising interest rates. Even if both assets and liabilities are floating, they can still generate interest rate risk: this is simply a basis risk and might be inherent in a bank's liquidity reserve, and presumably arises from the bank's internal transfer price curve.

In Europe, securities are normally traded versus 6m-EURIBOR or 6m-LIBOR respectively. So, when buying an asset for the liquidity reserve in an asset-swap package, which eliminates most of the potential interest rate risk, it is quite likely that the reserve asset will be swapped against one of these benchmarks.[144] Assuming that liquidity reserve is funded according to the bank's internal transfer price curve on a quarterly basis (versus 3m-EURIBOR), an interest rate spread risk will arise according to the explanations given above: if assets pay 6m-EURIBOR and matching term liabilities are referenced to 3m-EURIBOR, there is a basis risk. Here, liquidity risk is eliminated but interest rate spread risk remains.[145]

The liquidity reserve will benefit if the basis spread between three month EURIBOR and six-month EURIBOR widens, because the portfolio's 6m-EURIBOR asset-fixing will gain a relative advantage over the 3m-EURIBOR liability-fixing. Here, it would be useful if the ALM desk hedged a broader basis or, in other words, the performance of the liquidity could be stabilised by using basis swaps. The risk the bank faces is that the spread between the six months and the three months rates will change. The bank can use basis swaps to make floating rate payments on a semi-annual basis (because this is the rate which determines how much the bank receives on a bond) and receive floating payments on a quarterly basis (because this is the rate that determines the bank's funding cost).[146] This hedging strategy can be implemented by using overlay hedges on the overall

[144] We believe that it is absolutely in appropriate to willingly take outright interest rate risk in the liquidity reserve. If a bank really needs to use the liquidity reserve to generate additional liquidity, the asset's (fire) sale has to proceed with a minimum of P&L and accounting effects. The only acceptable remaining risk is basis risk.
[145] See Choudhry 2012, p. 360.
[146] See Fabozzi *et al* 2010, p. 619.

basis risk structure of the liquidity reserve. Here, the fixings of the portfolio determine the hedges. Properly implemented, these hedges can generate extra return in the liquidity reserve and hence minimise its costs.

In addition to above example of 3x6 basis risk, another basis risk arises when reverse repos are used in the process of managing the liquidity reserve: due to the different bases between repos (which are overnight indexed rates (OIRs); e.g., EONIA) and their funding versus the money market index (e.g., 3m-EURIBOR), there will be an EONIA–EURIBOR spread risk as well. In contrast to the example given above, a widening of this spread would adversely affect the liquidity reserve's performance because funding would increase, compared with a shrinking EONIA-based income from the reverse repos. Therefore, the negative carry will increase further. To limit the negative carry and to stabilise the earnings from the liquidity reserve, a certain spread is necessary. For this purpose the treasury desk an use money market futures or forward rate agreements (FRAs) versus forward–EONIA swaps as short-term instruments or a combination of longer-term 3x6 basis swaps and EONIA–EURIBOR swaps with the same maturity.

3.2.3 Managing Credit Risk

Assuming from the previous section that the ALM desk has hedged all interest rate risks, credit risk still remains. Keeping in mind that the liquidity reserve should consist primarily of sovereign bonds, the management of the liquidity reserve faces a real challenge: historically, sovereign bonds of developed countries have been considered a safe and almost default-risk-free asset. With the introduction of the euro, European investors have largely diversified their portfolios by investing in non-domestic but euro denominated bonds. The stability of the euro area since the early 2000s explains this phenomenon: a European investor could prefer Italian BTPs over German Bunds, because they offered a better return for an incremented default risk which was considered to be negligible. Before the sovereign debt crisis, bond management in the euro area was principally explained by the search for better spreads. But the sovereign debt crisis in Europe led to a rediscovery of sovereign credit risk and led to a rethink about the management of bond portfolios by placing more emphasis on its credit risk management (Figure 12).[147]

[147] See Bruder *et al* 2011, p. 2.

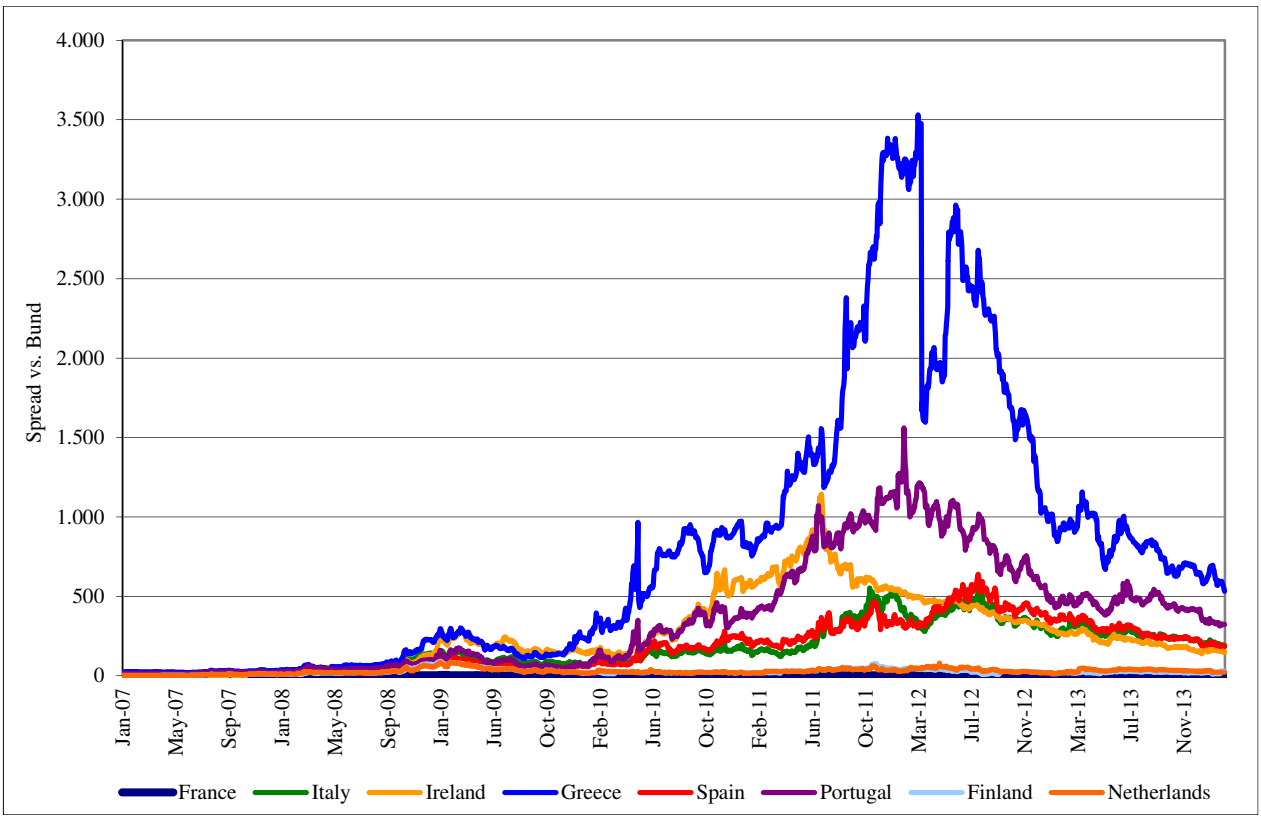


Figure 12: 10y EUR Sovereign Spreads towards German Bunds [148]

The debt crisis played havoc with the conception that the debt of major developed countries is almost free of credit risk. So, the creditworthiness of sovereign issuers is under increasing scrutiny and bond investors face a new challenge.[149] Empirical evidence suggests that diversification can indeed reduce credit risk and that the best way to achieve this is through cross-border investments. Smaller benefits are also obtainable through diversification across other dimensions, namely, industry sector, maturity and credit rating.[150] But by running a liquidity reserve consisting of sovereign bonds, credit risk management is a real issue for a bank's ALM desk.

Asset swaps are a common form of derivatives written on fixed rate bonds. It is common practise that banks buy bonds in an asset swap package. By doing so, banks separate the credit risk from the interest rate risk that is embedded in a fixed rate bond. Effectively, the interest risk of the bond is transferred from the investor to its swap counterparty, leaving the credit risk with the bond holder. Thus, asset swaps are mainly used to create positions that are similar to cash flow and risk

[148] Bloomberg L.P. 2014.
[149] See Bruder *et al* 2011, p. 2.
[150] See Varotto 2003, p. 36.

exposure of floating rate notes with only little interest risk remaining.[151] In order to offset mathematically the value of the all fixed and floating rate payments of the swap's lifetime, the so-called asset-swap spread (ASW spread) is calculated. The ASW spread reflects the difference between the bond's yield and the yield of maturity-matching benchmark in the same currency: the swap curve that is assumed to reflect the average rating of the banking sector.[152] Under the no-arbitrage assumption we can assume that investing in a floating rate note or investing in a credit-risky bond bought in an asset-swap package has the same economic risk profile as selling protection via credit default swaps.

A credit default swap (CDS) is a bilateral financial contract in which one counterparty (protection buyer) pays a premium (expressed in basis points) on an agreed notional amount in return for a contingent payment by the other counterparty (protection seller) following a so-called credit event of the reference entity.[153] As a result, the no-arbitrage assumption implies that the CDS premium should reflect the EURIBOR spread on an asset swap from the same credit-risky entity. Without going further into theoretical and mathematical detail and, for simplicity, disregarding collateral postings or counterparty risk, we assume that the ASW spread and the CDS-premium should be the same[154] to avoid arbitrage between cash bond markets and the derivatives market.

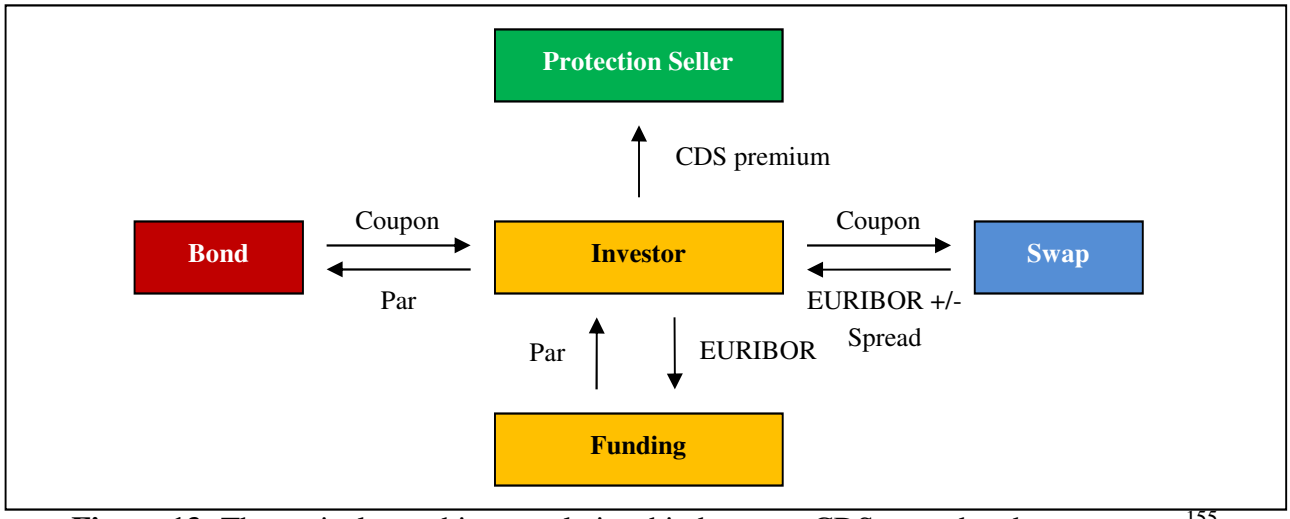


Figure 13: Theoretical no-arbitrage relationship between CDS spread and asset swaps [155]

[151] See Bomfim 2005, pp. 53ff.
[152] See Betz 2005, p. 46.
[153] See JP Morgan 1999, p. 12.
[154] See De Wit 2006, p. 5.
[155] Based on Hauschild and Buschmann 2014, p. 359.

As implied in Figure 13, a credit risk hedge of the liquid reserve is quite unfavourable from an earnings point of view. As stated before, crisis liquidity is the most expensive form of liquidity. The liquidity reserve generate earnings to the amount of the ASW spread on a gross basis and just to the amount of the difference of the ASW spread and its related funding cost on a net basis. Often this carry is negative: due to better credit ratings than banks, sovereign bonds often have negative ASW spreads; therefore, an additional hedge cost for the liquidity reserve's credit risk would be unjustifiably high.

Even though an outright credit risk hedge is not favourable, the liquid reserve's credit risk can be managed on a relative-value basis. Credit spread risk arises when the spread of a bond performs differently from the respective swap curve (e.g., changes in demand of a certain asset classes) or from its peer group (e.g., federal states, cantons or provinces versus central government or covered bonds versus agencies). Moreover, spread anticipation by market participants and changes in the regulatory environment cause credit spread risks. Lastly, the sovereign debt crisis caused a change in investor behaviour: investors are less willing to buy (government) bonds from Europe's most crisis-prone countries and are keener on buying bonds with shorter maturities.

From a market point of view, the absolute interest rate level influences credit spread. In a low interest rate environment, a credit spread performance of risk-free assets is limited but possible: after a credit spread performance (spread narrowing), there is the possibility of locking in the current credit spread level without changing the portfolio structure, e.g., selling bonds, by using credit default swaps. Again, this is done by overlaying hedges onto a certain debtor in the portfolio. This hedge position will make a profit when credit spreads widen again. The profit amounts to the difference between the locked-in spread and the spread observed in the market. Like the basis spread hedging, the credit spread can be used to minimise the portfolio costs.

Credit spread movements also have an impact on the repo market: credit spread widening or narrowing influences repo rates relative to their overnight interest rates, e.g., EONIA. Due to a lack of alternatives are an excessive anticipated credit risk in the unsecured money market, this might cause an excess demand in secured funding. As can be seen in the above examples, a bank's ALM desk needs to manage the credit (spread) on a relative-value basis rather than completely hedging credit risk through the use of credit default swaps. When managing the liquidity reserve on a relative value basis, the treasury desks need to consider two interrelated dimensions, credit risk and return, within the framework described above. This simply means that when two assets or securities with the same credit are available, the one with the higher return will be bought. In contrast to this,

when two assets have the same return, the one with the lower credit risk will be chosen. In addition, we believe that market saturation – how many more bonds by one issuer can be absorbed by the market – have also to be taken into account. Through this approach, optimisation takes place within or across the held assets.

4. Conclusion

As shown above, managing liquidity risk is a crucial part of a bank's asset–liability management. It ensures a bank's short-term solvency and long-term structural liquidity in line with both market prices and regulatory requirements.[156] Within its liquidity risk management mandate, an ALM desk is expected to maintain the bank's solvency at any time and in any imaginable market condition. To achieve this goal, banks are expected by national regulators to hold a portfolio of high quality and highly liquid assets as part of their liquidity reserve. In an idiosyncratic or market-wide liquidity stress, these assets will be sold in order to generate crisis liquidity to enable a financial institution to honour its obligations when they become due.

In this analysis, we briefly described the role of asset–liability management according to liquidity issues of a banking organisation. Several types of liquidity were presented and we described how these are interconnected and how they might affect a financial institution's liquidity risk. As a logical consequence of this, we presented regulatory provisions as well as the upcoming Basel III framework. The second part of this working paper was dedicated to the liquidity reserve itself: both its purpose and functionality and the components and adequate size of the liquidity reserve were discussed. The funding strategy, risk management strategies and liquidity reserve's performance were presented.

We have tried to put the role of management of the liquidity reserve into a broader context and to fill a gap in the literature: when managing the liquidity reserve and its included assets, the responsible persons have to take the following influencing factors into account:

- The banking organisation itself, with its business model, funding structure and related types of risk;
- National and international regulatory requirements have to be fulfilled;
- Market behaviour and its participants need to have carefully watched and anticipated, in order to manage the risk which might arise from the liquidity reserve itself.

[156] See Bodemer 2011, p. 306.

As we implied in this paper, and the financial crisis impressively showed, "liquidity" is not an absolute characteristic: it is relative. An asset can be liquid for a long period of time but become illiquid the next day.[157] We believe that the biggest risk arises from managing the liquidity reserve itself: an asset hitherto assumed liquid can suddenly turn out to be illiquid, either due to (regulatory) non-acceptance as a part of the liquidity reserve by national regulators or due to secondary market activity drying up. Because such assets would produce a calculated, expected, measured cash outflow in the LCR and NSFR ratios, it is quite likely that these assets have to be sold at a loss. By coping with these three factors, we believe that a bank's liquidity reserve can be properly managed.

In conclusion, we believe that the management of the liquidity reserve is a continuous process that has to be adjusted when it is necessary: the liquidity that arises from normal banking operations has to be monitored in almost the same way as the given regulatory framework and overall financial market conditions.

[157] See Matz 2011, p. 254.

References

Allen, F., and E. Carletti, 2008, "The Role of Liquidity in Financial Crises", URL: http://www.kc.frb.org/publicat/sympos/2008/AllenandCarletti.08.04.08.pdf.

Amentrano, F. M., and M. Bianchetti, 2009, "Bootstrapping the Illiquidity, Multiple Yield Curves Construction for Market Coherent Forward Rates Estimation", URL: http://www.bianchetti.org/finance/bootstrappingtheilliquidity-v1.0.pdf.

Baretzky, P., 2012, "Bankbetriebliche Risiken" In Baretzky, P., *Praxis der Gesamtbanksteuerung: Methoden, Lösungen, Anforderungen der Aufsicht*, pp. 36–83 (Stuttgart: Schäffer- Poeschel).

Bank for International Settlements, 2008, "BIS 78th Annual Report", URL: http://www.bis.org/publ/arpdf/ar2008e.pdf.

Bank for International Settlements, 2009, "BIS 79th Annual Report", URL: http://www.bis.org/publ/arpdf/ar2009e.pdf.

Basel Committee on Banking Supervision, 2008a, "Liquidity Risk: Management and Supervisory Challenges", URL: http://www.bis.org/publ/bcbs136.pdf.

Basel Committee on Banking Supervision, 2008b, "Principles for Sound Liquidity Risk Management and Supervision", URL: http://www.bis.org/publ/bcbs144.pdf.

Basel Committee on Banking Supervision, 2010, "Basel III: International Framework for Liquidity Risk Measurement, Standards and Monitoring", URL: http://www.bis.org/publ/bcbs188.pdf.

Basel Committee on Banking Supervision, 2013a, "Basel III: The Liquidity Coverage Ratio and Liquidity Risk Monitoring Tools", URL: http://www.bis.org/publ/bcbs238.pdf.

Basel Comittee on Banking Supervision, 2013b, "Summary Description of the LCR", URL: https://www.bis.org/press/p130106a.pdf.

Basel Comittee on Banking Supervision, 2014, "Basel III: The Net Stable Funding Ratio", URL: http://www.bis.org/publ/bcbs271.pdf.

Bessis, J., 2010, *Risk Management in Banking* (Chichester: JohnWiley & Sons).

Betz, H., 2005, "Integrierte Credit Spread und Zinsrisikomessung mit Corporate Bonds". Dissertation. Frankfurt am Main.

Bergner, M., P. Marcus, M. Adler, 2014, "Bank Runs and Liquidity Management Tools". In A. Bohm and M. Elkenbracht-Huizing (ed), *The Handbook of ALM in Banking: Interest Rates, Liquidity and the Balance Sheet*, pp. 327 – 367 (London: Risk books).

Bodemer, S., 2011, "Steuerung der taktischen und strukturellen Liquidität und Einfluss anderer Risikenarten". In H. Braun and H. Heuter (ed), *Handbuch Treasury: Ganzheitliche Risikosteuerung von in Finanzinstituten*, pp. 281–308 (Stuttgart: Schäffer-Poeschel).

Bohn, A., and P. Tonucci, 2014, „ALM wihtin Constrained Balance Sheet". In A. Bohm and M. Elkenbracht-Huizing (ed), *The Handbook of ALM in Banking: Interest Rates, Liquidity and the Balance Sheet*, pp. 59 – 83 (London: Risk books).

Bomfim, A. N., 2005, *Understanding Credit Derivatives and Their Related Instruments* (Amsterdam: Academic).

Bonner, C., and S. Eijffinger, 2012, "Basel Liquidity Rules and Their Impact on the Interbank Money Market", URL: http://www.voxeu.org/article/impact-basel-liquidity-rules-interbank-money-markets.

Borio, C., 2009, "Ten Propositions about Liquidity Crises". BIS Working Paper 293, URL: http://www.bis.org/publ/work293.pdf.

Bouwman, C.H.S., 2013, "Liquidity: How Banks Create It and How It Should Be Regulated". Wharton Working Paper #13-32, URL: http://fic.wharton.upenn.edu/fic/papers/13/13-32.pdf.

Bruder; B., P. Hereil and T. Roncalli, 2011, "Managing Sovereign Credit Risk in Bond Portfolios", URL: http://mpra.ub.uni-muenchen.de/36673/1/MPRA_paper_36673.pdf.

Brzenk, T., M. Cluse and A. Leonhardt, 2011, "Basel III: Die neuen Baseler Liquiditätsanforderungen". Deloitte White Paper 37, URL: http://www.deloitte.com/assets/Dcom-Germany/Local%20Assets/Documents/15_ERS/2010/de_WP_ERS_FRS_WP3_%2006012011.pdf.

Bundesanstalt für Finanzdienstleistungsaufsicht 2012, Rundschreiben 10/2012 (BA) – „Mindestanforderungen an das Risikomanagement – MaRisk", URL: https://www.bafin.de/SharedDocs/Veroeffentlichungen/DE/Rundschreiben/rs_1210_marisk_ba.html

Bundesanstalt für Finanzdienstleistungsaufsicht 2013, "Liquidity Requirements", URL: http://www.BaFin.de/EN/Supervision/BanksFinancialServicesProviders/LiquidityRequirements/liquidityrequirements_node.html.

Chakravarty, S., and A. Sarkar, 1999, Liquidity inUSFixed Income Markets:AComparison of the Bid–Ask Spread in Corporate, Government and Municipal Bond Markets", URL: http://www.newyorkfed.org/research/staff_reports/sr73.pdf.

Chordia, T., A. Sarkar and A. Subrahmanyam, 2003, "An Empirical Analysis of Stock and Bond Market Liquidity", URL: http://www.newyorkfed.org/research/economists/sarkar/stkbon5.pdf.

Choudhry, M., 2007, *Bank Asset and Liability Management: Strategy, Trading, Analysis* (Singapore: JohnWiley & Sons).

Choudhry, M., 2011, *An Introduction to Banking: Liquidity Risk and Asset–Liability-Management* (Chichester: JohnWiley & Sons).

Choudhry, M., 2012, *The Principles of Banking* (Singapore: JohnWiley & Sons).

Committee of European Banking Supervisors, 2009, "Guidelines on Liquidity Reserves & Survival Periods", CEBS 9, URL: http://www.eba.europa.eu/documents/10180/16094/Guidelines-on-Liquidity-Buffers.pdf.

Committee of European Banking Supervisors, 2010, "Guidelines on Liquidity Costs Benefit Allocation", October 27, URL: https://www.eba.europa.eu/documents/10180/16094/cebs18_Guidelines.pdf.

De Nicolò, G., A. Gamba and M. Lucchetta, 2012, "Capital Regulation, Liquidity Requirements and Taxation in a Dynamic Model of Banking", IMF Working Paper WP/12/72, URL: http://www.imf.org/external/pubs/ft/wp/2012/wp1272.pdf.

De Wit, J., 2006, "Exploring the CDS-Bond Basis", Working Paper, URL: http:// www.nbb.be/doc/ts/publications/wp/wp104En.pdf.

Drehmann, M., and K. Nikolou, 2009, "Funding Liquidity Risk Definition and Measurement", ECB Working Paper Series, URL: http://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1024.pdf.

Duffie, D., 2010, *How Big Banks Fail, and what to do about it* (Princeton: Princeton University Press).

Duttweiler, R., 2009, *Managing Liquidity in Banks: A Top Down Approach* (Chichester: John Wiley & Sons).

European Banking Authority, 2013, "Report on appropriate uniform definitions of extremely high quality liquid assets (extremely HQLA) and high quality liquid assets (HQLA) and on operational requirements for liquid assets under Article 509(3) and (5) CRR", December 20, URL: https://www.eba.europa.eu/documents/10180/16145/EBA+BS+2013+413+Report+on+definition+of+HQLA.pdf.

Fabozzi, F. J., F. Modigliani and F. J. Jones, 2010, *Foundations of Financial Markets and Institutions* (Englewood Cliffs, NJ: Prentice-Hall).

Farag, M., D. Harland, D. Nixon, 2014, „Bank Capital and Liquidity". In A. Bohm and M. Elkenbracht-Huizing (ed), *The Handbook of ALM in Banking: Interest Rates, Liquidity and the Balance Sheet*, pp. 327 – 367 (London: Risk books).

Fecht, F., K. G. Nyborg and J. Rocholl, 2011, "The Price of Liquidity, the Effect of Market Conditions and Bank Characteristics". ECB Working Paper Series, URL: http://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1376.pdf.

Financial Services Authority, 2008, "Strengthening Liquidity Standards", Consultation Paper 08/22, URL: http://www.fsa.gov.uk/pubs/cp/cp08_22.pdf.

Gatev, E., and P. E. Strahan, 2006, "Banks' Advantage in Hedging Liquidity Risk: Theory and Evidence from the Commercial Paper Market", *Journal of Finance* 61(2), pp. 867–92.

Gentili, G., and N. Santini, 2014, "Measuring and Managing Interest Rate Basis Risk" In A. Bohm and M. Elkenbracht-Huizing (ed), *The Handbook of ALM in Banking: Interest Rates, Liquidity and the Balance Sheet*, pp. 85 – 122 (London: Risk books).

Hauschild, A.; C. Buschmann, 2014, "Strategies for the Management of Reserve Assets". In A. Bohm and M. Elkenbracht-Huizing (ed), *The Handbook of ALM in Banking: Interest Rates, Liquidity and the Balance Sheet*, pp. 327 – 367 (London: Risk books).

Heidorn, T., J. Birkmeyer and A. Rogalski, 2010, "Determinanten von Banken-Spreads während der Finanzmarktkrise", URL: http://www.frankfurt-school.de/clicnetclm/fileDownload.do?goid=000000208614AB4.

Heidorn, T., and C. Schäffler, 2008, *Liquiditätsrisiken managen* (Eschborn: Management Circle Edition).

Heidorn, T., and C. Schäffler, 2011, "Liquiditätsstresstests und Notfallplanung". In H. Braun and H. Heuter (ed), *Handbuch Treasury: Ganzheitliche Risikosteuerung von in Finanzinstituten*, pp. 309–43 (Stuttgart: Schäffer-Poeschel).

Heider, F., M. Hoerova and C. Holthausen, 2009, "Liquidity Hoarding, and Interbank Market Spreads: The Role of Counterparty Risk", URL: http://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1126.pdf.

Hirvelä, J., 2012, "Euribor Basis Swaps: Estimating Driving Forces", URL: http://epub.lib.aalto.fi/fi/ethesis/pdf/12839/hse_ethesis_12839.pdf

Houweling, P., A. Mentink and T. Vorst, 2002, "Is Liquidity Reflected in Bond Yields? Evidence from the European Corporate Bond Market", URL: http://129.3.20.41/eps/fin/papers/0206/0206001.pdf.

Huang, R., and R. L. Ratnovski, 2011, "The Dark Side of Bank Wholesale Funding", *Journal of Financial Intermediation* 20(2), pp. 248–63.

Hull, J. C., 2010, *Risk Management and Financial Institutions* (Chichester: JohnWiley&Sons).

Hull, J. C., 2012, *Risk Management and Financial Institutions* (Chichester: JohnWiley&Sons).

Jankowitsch, R., H. Mösenbacher and S. Pichler, 2002, "Measuring the Liquidity Impact on EMU Government Bond Prices", URL: http://symposium.fbv.unikarlsruhe.de/9th/papers/Pic_Jan_Moes.pdf.

JP Morgan, 1999, "The JP Morgan Guide to Credit Derivatives", URL: http://www.defaultrisk.com/J.P. Morganpp_crdrv121.htm.

Kleffmann, L., R. MarquardtandJ. Schuppert, 2011,"Neueaufsichtliche Liquiditätskennzahlen: Alles anders im strategischem ALM?". zeb/Themen, URL: http://www.zeb.de/customer/templates/media_get.php?mediaid=1158&fileid=2844&sprachid=1.

Leistenschneider, A., 2008, "Methoden zur Ermittlung von Transferpreisen für Liquiditätsrisiken". In P. Bartetzky, W. Gruber and C. S. Wehn (ed), *Handbuch Liquiditätsrisiko: Identifikation, Messung, Steuerung*, pp. 171–92 (Stuttgart: Schäffer-Poeschel).

Leistikov, V., 2014, "New Regulatory Development for Interest Rate Risk in the Banking".In A. Bohm and M. Elkenbracht-Huizing (ed), *The Handbook of ALM in Banking: Interest Rates, Liquidity and the Balance Sheet*, pp. 3 – 24 (London: Risk books).

Matz, L., 2011, *Liquidity Risk Measurement and Management: Basel III and Beyond* (Bloomington, In: Xlibris).

Matz, L., and P. Neu, 2007, "Liquidity Risk Management Strategies and Tactics", in L. Matz and P. Neu (eds), *Liquidity Risk Measurement and Management: A Practitioner's Guide to Global Best Practices*, pp. 100–21 (Chichester: JohnWiley & Sons).

Morini, M., 2009, "Solving the Puzzle in the Interest Rate Market", URL: http://bfi.cl/papers/Morini%202008%20%20Solving%20the%20puzzle%20in%20the%20interest%20rate%20market.pdf.

Müller K.-O., and K. Wolkenhauer, 2008, „Aspekte der Liquiditätssicherungsplanung", in: P. Bartetzky, W. Gruber, C. S. Wehn, (eds), *Handbuch Liquiditätsrisiko: Identifikation, Messung, Steuerung*, pp. 231 – 246 (Stuttgart: Schäffer-Poeschel).

Nikolaou, K., 2009, "Liquidity (Risk) Concepts Definitions and Interactions". ECB Working Paper Series, URL: http://www.ecb.eu/pub/pdf/scpwps/ecbwp1008.pdf.

Ratnovski, L., 2013, "Liquidity and Transparency in Bank Risk Management". IMF Working Paper, URL: http://www.imf.org/external/pubs/ft/wp/2013/wp1316.pdf.

Sauerbier, P., H. Thomae and C. S. Wehn, 2008, "Praktische Aspekte der Abbildung von Finanzprodukten im Rahmen des Liquiditätsrisiko". In P. Baretzky, W. Gruber and C. S. Wehn (eds), *Handbuch Liquiditätsrisiko: Identidikation, Messung, Steuerun*, pp. 79–120 (Stuttgart: Schäffer-Poeschel).

Schäffler, C., 2011, "Steuerung der Liquiditätsbvevoratung in Banken anhand eines quantitativen Transferpreismodells". Dissertation. Universität Köln.

Schulte, M., and Horsch, A., 2004, *Wertorientierte Banksteuerung II: Risikomanagement* (Frankfurt am Main: Frankfurt School).

Seifert, M., 2012, "Die neue Liquiditätsrisiko-Rahmenvereinbarung der BIS: Internationale Harmonisierung der Liquiditätsrisikoregulierung und -aufsicht". In S. Schöning and T. Ramke (eds), *Modernes Liquiditätsrisikomanagement in Kreditinstituten* (Köln: Bank-Verlag).

Subramani, R. V., 2009, *Accounting for Investments, Fixed Income Securities and Interest Rate Derivatives: A Practitioner's Handbook* (Chichester: JohnWiley & Sons).

Tuckman, B., and P. Porfirio, 2003, "Interest Rate Parity, Money Market Basis Swaps, and Cross-Currency Basis Swaps", June. Lehman Brothers Fixed Income Liquid Market Research.

Varotto, S., 2003, "Credit Risk Diversification: Evidence from the Eurobond Market", URL: http://www.bankofengland.co.uk/publications/Documents/workingpapers/wp199.pdf.

Wall, L. D., and M. M. Shrikhande, 2000, "Managing the Risk of Loans with Basis Risk: Sell, Hedge, or Do Nothing?", Working Paper 2000-25, Federal Reserve Bank of Atlanta, URL: http://www.frbatlanta.org/filelegacydocs/wp0025.pdf.