

STAFF MEMO

The rationale for central bank liquidity insurance and liquidity regulation

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INSURANCE AND LIQUIDITY
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Ylva Søvik¹

One of the core functions of a central bank is to provide liquidity insurance, often termed the lender of last resort (LLR) function. During and after the Great Financial Crisis (GFC) in 2007-09 central banks' role as liquidity insurers evolved. In the aftermath of the crisis, regulation of liquidity risk in the financial sector has been tightened, and central bank policies are under evaluation. This survey gathers insights from the literature on how to design central bank liquidity insuring policies: What institutions to insure, how to price central bank facilities, what collateral to accept, the size of operations, the degree to which they should be on-going facilities or contingent, and the interaction of our liquidity policies with regulation. Some fundamental trade-offs are identified and discussed.

Keywords: Liquidity insurance, Lender of last resort, financial crisis, liquidity regulation.

1. Introduction

One of the core functions of a central bank is to provide liquidity insurance, often termed the lender of last resort (LLR) function.² This is typically done through collateralized lending or open market operations. The task is embedded in many central banks' legal mandates or authorized policies. For instance, the Federal Reserve Act provides that Federal Reserve banks are "to furnish an elastic currency, to afford means of rediscounting commercial paper"³. The Bank of England directly defines providing liquidity insurance to the financial system as one of its tasks in the Red Book,⁴ and the Norwegian Central Bank Act establishes the authority of Norges Bank to give credit to financial institutions, and in particular to "extend credit on special terms when merited by special circumstances".⁵

¹ The views and conclusions in this publication are those of the author and do not necessarily represent those of Norges Bank. They should therefore not be reported as Norges Bank's views. I am grateful to Ragna Alstadheim, Bjørn Bakke, Tom Bernhardsen, Torbjørn Hægeland and Sindre Weme for useful comments and input.

² In this survey, we focus on the LLR function of the central bank, not the implementation of monetary policies, although as we will note, the same central bank facilities may have both LLR and monetary policy functions.

³<https://www.federalreserve.gov/aboutthefed/officialtitle.htm>.

⁴

<http://www.bankofengland.co.uk/markets/Documents/money/publications/redbook.pdf>

⁵ <https://lovdata.no/dokument/LTI/lov/2019-06-21-31>, § 3-1.

During and after the Great Financial Crisis (GFC) in 2007-09 central banks' role as liquidity insurers has evolved. During the crisis, new forms of liquidity insurance were provided and central bank tools that have traditionally been used mainly as monetary policy instruments were augmented in a manner that increased liquidity insurance to the central banks' counterparties. In the aftermath of the crisis regulation of liquidity risk in the financial sector has been tightened and central bank policies are under evaluation.⁶

Why do we care about liquidity risk? Frozen markets, deleveraging and bank insolvencies can create welfare losses in addition to the losses that can accrue directly to the financial institutions affected. The ability of the financial system to perform payments may be impaired, hampering all forms of trade in the economy. Credit supply may be reduced, which may slow investment growth and curtail consumers' ability to redistribute spending over time. Likewise, the financial systems ability to redistribute risk may be impaired. These possible real effects of liquidity problems and crises are why it may be beneficial with policies that provide liquidity insurance.⁷

What do we know about how these policies should be designed? In this survey I attempt to gather insights the literature may provide us with on central bank liquidity insuring policies: What institutions to insure, how to price central bank facilities, what collateral to accept, the size of operations, the degree to which they should be on-going facilities or contingent, and the interaction of our liquidity policies with regulation. It is mainly written for policy makers, but will not go into detailed design questions. Rather, we attempt to give the broad strokes of what economics and finance can tell us.

The survey is organized as follows. In section 2 I explain how liquidity risk arises and how it can lead to failing financial institutions and financial crisis. In section 3 I describe how the traditional lender of last resort function of a central bank can alleviate these problems. In section 4 I discuss the various tools the central bank can use for liquidity insurance. In section 5 I discuss how liquidity insurance and liquidity regulation interact.

⁶ For instance, the liquidity insurance provided by the Bank of England has been widened substantially since 2015 based on the evaluations of the Winter's commission report <https://www.bankofengland.co.uk/-/media/boe/files/news/2012/november/the-banks-framework-for-providing-liquidity-to-the-banking>

⁷ Freixas et al., 2000, Goodhart and Illing, 2002.

2. Liquidity risk and financial crisis

2.1. What is liquidity and liquidity risk?

In order to understand why publicly provided liquidity insurance may be beneficial we need to understand what liquidity risk is and how it may arise. Financial liquidity is typically categorized in terms of market liquidity and funding liquidity.⁸ As we will see these are closely intertwined properties in practice, but the distinction can be useful for analytical purposes. Market liquidity is how easy it is to trade an asset, typically measured by bid-ask spreads of assets (the price of transactions), the price impact of large trades, and volumes of trade of assets.⁹ Funding liquidity is the ease with which an institution can fund itself, typically measured by the spread paid for funding above a risk free rate and credit risk compensation. Market liquidity risk is the risk that an asset may become difficult and/or expensive to trade, and funding liquidity risk is the risk that an institution may have trouble funding itself, or that funding becomes very expensive.

2.2. What drives liquidity risk?

The *market liquidity* of an asset depends in large part on the belief of the participants in the market for the asset. To put it coarsely: If all agents believe that the asset will be liquid in the future, it will be liquid today. If all agents believe that the asset will be difficult to sell in the future, it will be difficult to trade today. This entails that changes in market liquidity can be large and abrupt.¹⁰ Furthermore, liquidity risk will depend on the risk to the fundamental value of the asset: An asset that has a highly uncertain value will typically be less liquid than assets that have very low risk, since high liquidity of an asset today depends on the predictability of the value of the asset in the future.¹¹ Liquidity risk is normally reflected in the price of an asset: If an asset is expected to be difficult to sell at a later date, investors will demand compensation for this, - a so-called liquidity premium.

To understand *funding liquidity* risk, let us first focus on banks, which are the main counterparties of central banks and the overridingly important financial institutions in most financial systems. Banks provide services to the public such as access to liquid instruments that can

⁸ An excellent discussion of the two liquidity concepts can be found in Brunnermeier and Pedersen, 2009.

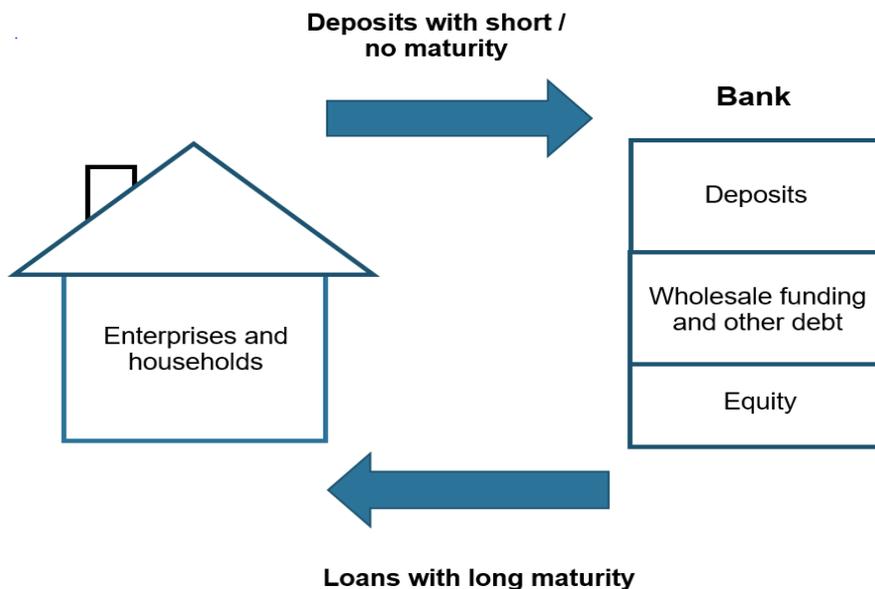
⁹ Lybek and Sarr, 2002, provide a survey of market liquidity measures.

¹⁰ Morris and Shin, 2004.

¹¹ However, there are some assets with more uncertain value than others that are more liquid, such as stocks that are highly traded compared to some fairly secure but illiquid bonds.

easily be used for payment services (deposits),¹² they screen and monitor borrowers for risks¹³, and through this combination they conduct maturity transformation, that is they borrow short term and lend long term.¹⁴ This is illustrated in Chart 1. There are benefits from providing these services in combination,¹⁵ but this also exposes banks to funding liquidity risk.

Chart 1 Maturity transformation



Banks' main assets, loans, are typically not very liquid. If a bank were to sell them this would require a substantial discount compared to holding them to maturity.¹⁶ On the other hand, banks' main liability, deposits, is available on demand and thereby in effect on a first come, first served basis. This creates the possibility of bank-runs: Large and rapid withdrawals of deposits from a bank. Such withdrawal of funding may require the bank to sell some of its assets at a discount to meet demand, and this may make the bank insolvent (the value of the remaining deposits is larger than the remaining assets). If for some reason bank customers expect that there may be large withdrawals from a bank they have an incentive to withdraw before that bank becomes insolvent, which may lead depositors to withdraw their

¹² See for instance Carlson et al., 2016 for evidence that safe, short term assets have an intrinsic value.

¹³ Diamond, 1984, Gale and Hellwig, 1985, Mayer, 1988, Hellwig, 1991, Holmström and Tirole, 1997.

¹⁴ See Freixas and Rochet, 1997, for a more detailed analysis of what role banks play in the financial system, and why their services create value.

¹⁵ See for instance Calomiris and Kahn, 1991, Diamond and Rajan, 2001, Flannery, 1994, and Kashyap et al, 2002, on why combining services as banks do creates value.

¹⁶ One reason for this is that the screening and monitoring done by banks create private information, and this poses a risk to a potential buyer of a loan portfolio of receiving bad loans for which they will require a discount. This is the classic lemons problem as coined by Akerlof, 1970.

deposits as quickly as possible if such expectations arise. This is a bank-run, and the possibility of this equilibrium, where a solvent bank becomes insolvent due to withdrawals, was first modeled by Diamond and Dybvig, 1983.

Bank runs are not the only mechanisms by which poor funding liquidity combined with low market liquidity of assets can result in failures of otherwise viable institutions. Fire sales are large sales of assets in a short period of time, and can lead to substantial losses for the sellers as prices fall due to the sales, and furthermore spill-over to other market participants holding the same assets. This occurs when there is low market liquidity for the assets, so that the price impact of sales is large, while some asset owners experience poor funding liquidity, forcing them to sell despite the unfavorable market conditions.¹⁷ This may again be due to problems such as one-sided markets (where there are only sellers and none or few buyers),¹⁸ complex financial product design,¹⁹ or a high degree of uncertainty about asset values as discussed before. Highly leveraged institutions are more vulnerable to fire sales, since they more easily will be forced to sell and become insolvent more quickly.²⁰ Fire sales can destroy value if there are cost to insolvency and bank closure, if fire sales lead assets to be held by agents that can generate less value from them than the original owner, for instance due to asymmetric information, or if fire sales lead to reductions in other, more productive investments.²¹

¹⁷ Diamond and Rajan, 2011.

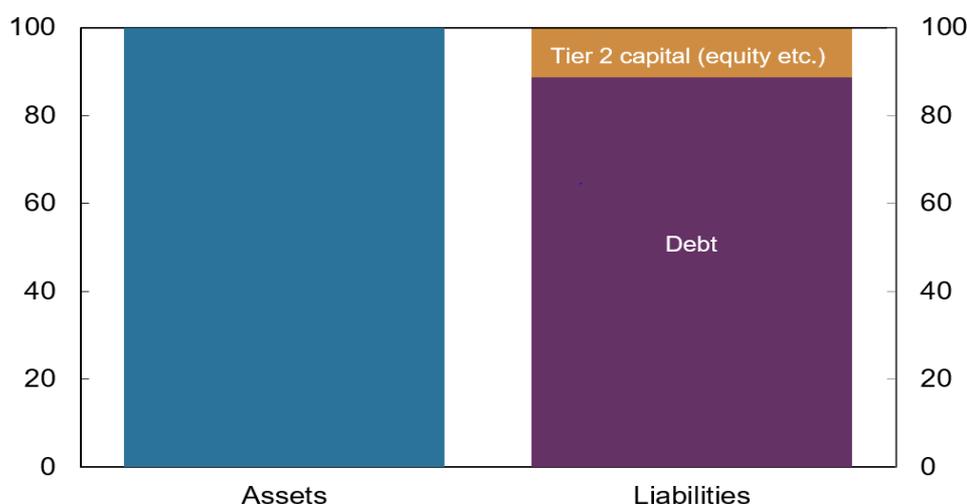
¹⁸ Shleifer and Vishny, 1997, provide a model for how one-sided markets may occur.

¹⁹ Brunnermeier and Oehmke, 2009, provide a model of how markets can crash due to product complexity.

²⁰ Losses for banks during bank runs can be due to forced fire sales of security holdings, and sales of loan portfolios at a discount may be viewed as a form of fire sale.

²¹ See Allen and Gale, 1994, Calomiris and Gorton, 1991, Diamond and Rajan, 2011. Shleifer and Vishny, 1992, Stein, 2012. Duarte and Eisenbach, 2015, provide estimates of the vulnerability of US financial institutions to fire sale losses.

Chart 2 Leverage in Norwegian banks at year-end 2017



Source: Norges Bank

There are a number of mechanisms that can further amplify liquidity problems in markets or financial institutions. As mentioned the leverage of institutions is important as it determines the vulnerability to runs or fire-sales. Leverage is the ratio of debt to capital (the leverage ratio is the inverse: ratio of capital to debt). Typically, banks have a leverage of 10-30 (leverage ratio of 3-10 percent). This is illustrated for Norwegian banks in Chart 2.

Leverage also plays a role in activating and propagating financial crisis: Empirical studies suggest that banks, broker-dealers and some asset managers manage their balance sheets in a pro-cyclical way: That is, when asset values fall they will reduce their balance sheets, and when asset values increase they will increase their balance sheets (Adrian and Shin, 2010). This means that leverage is held constant or increased in response to increasing asset prices and vice versa. For instance mark-to-market accounting and capital requirements can cause such pro-cyclicality. If this behavior is ubiquitous among financial intermediaries, a drop in asset values can lead to further drops in the value of these assets as financial intermediaries deleverage and assets sales ensue. This may lead to a downward spiral of falling asset prices and deleveraging.

As demonstrated by the case of fire sales, market liquidity and funding liquidity often reinforce each other. Another mechanism by which market and funding liquidity can reinforce each other is through the use of collateral: A haircut or margin (the difference between the value of the collateral and the loan) is applied to protect the lender against the risk that the collateral may fall in value. If an asset becomes less liquid this may lead to an increase in haircuts against the asset as collateral, and hence reduces the ability of institutions to raise funding against these assets, that is, their funding liquidity is reduced. If funding becomes more costly or less abundant, institutions may reduce their

investments, for instance in those assets that they use as collateral for their funding or in interbank loans. This can again reduce the market liquidity of the assets and the funding liquidity of all institutions. If this leads to severe funding problems institutions may be forced to start selling assets with low market liquidity leading to further drops in asset prices. This situation may force institutions to liquidate more assets, which can make asset prices, and financial intermediaries plummet even further leading into so-called *liquidity spirals*.²² These mechanisms are also prevalent in derivative markets where margins are posted for out-of-the money positions. If the margins become large enough (as the position is sufficiently out-of-the money), this may cause one of the counterparties to become illiquid and default on the margin.

These spirals may be particularly severe if there are bank failures. First, the failure of one bank is likely to lead to losses in other banks as banks often have exposures to each other for instance through interbank lending. Second, banks invest in similar assets such that uncertainty about the solvency of one bank can lead to uncertainty about the solvency of other banks. Third, bank failures can lead depositors in other banks to fear runs and failures on other banks simply through beliefs as in a bank-run described above. In general a liquidity crunch can be further worsened by financial institutions' incentive for a precautionary hoarding of liquidity.²³ Hoarding of liquidity by banks has been documented empirically for the GFC.²⁴

3. Lender of last resort

3.1. How does the lender of last resort work?

The possibility of bank-runs gives a rationale for deposit insurance: If a deposit insurer can convince depositors that they will be made whole if there is a bank-run, a run may be thwarted.²⁵ Central bank lending can have the same effect: If the central bank is willing to lend money to the bank against the loan book or other illiquid assets as collateral, the bank will be less likely to become insolvent from a run.²⁶ If investors expect that central bank lending will be sufficient to avoid insolvency, the existence of this lending, so-called lender of last resort (LOLR), can thwart a run in the first place similarly to deposit insurance.

²² See Brunnermeier and Pedersen, 2009, and Uhlig, 2010, for a description of these mechanisms in detail, and see Copeland et al., 2014, for an empirical study. Again these mechanisms are closely related to those found in a fire sale.

²³ See Gale and Yorulmazer, 2013.

²⁴ See Acharya and Merrouche, 2013, and Ashcraft et al., 2011.

²⁵ See Santos, 2006, for a survey on how deposit insurance can alleviate bank-runs and how it is implemented in different countries.

²⁶ Depending on the central banks haircuts and pricing of loans, which we will get back to.

This leads to two of the tenants of the so-called Bagehot (1837) rules - the most widely recognized definition of good practice for LOLR-policies: “Central bank should lend freely (against good collateral to solvent banks)”; and, “The policy needs to be credible such that a central bank should announce its readiness to lend without limits.” The rules reflect that if the central bank is to be effective at stopping liquidity problems in one institution or a market from leading to a crisis, it needs to be credible that lending will be sufficient to avoid a negative dynamic from evolving. Since expectations play a great role in bank runs and other mechanisms generating liquidity problems and crisis, the effectiveness of the lender of last resort relies on whether it convinces market participants that lending will be sufficient to keep markets and institutions liquid.

3.2. Costs of central bank liquidity insurance

There are a number of problems that arise from providing liquidity insurance. First, a threat that short term creditors may withdraw their funding, may be *beneficial* as it can enhance the credit quality of banks’ loan portfolios through market discipline.²⁷ Second, the threat of a bank run give banks incentives to commit to creating liquidity and providing liquidity insurance for depositors by holding liquidity buffers.²⁸ Hence banks may self-insure by holding enough highly liquid assets to avoid becoming illiquid. If a central bank takes over a substantial part of banks’ liquidity risk, banks may relax their due diligence activities and take excessive liquidity risk.²⁹ These are the moral hazard effect of liquidity insurance; liquidity insurance increases financial institutions incentives to take risk.

Penalty pricing can reduce the problem of moral hazard, as it increases the price of having to resolve to central bank liquidity insurance. This is the second Bagehot tenant: “Central bank should lend at a penalty rate to banks that are illiquid.” However, there is a trade-off as penalty creates disincentives for institutions to borrow in crisis, which may reduce the effectiveness of LOLR, and correct prices can be difficult to set.³⁰

Another problem with providing liquidity insurance is that central banks will typically have trouble distinguishing solvent but illiquid versus insolvent banks.³¹ Lending against collateral reduces the risk of supporting insolvent banks and protects central banks against risk.³² This is contained in the latter half of the first tenant of Bagehot: “Central bank should lend freely *against good collateral to solvent banks*”.

²⁷ Calomiris and Kahn, 1991.

²⁸ Diamond and Rajan, 2001.

²⁹ Borio & Zhu, 2008.

³⁰ Kahn and Santos, 2005, Bindseil and Jablecki, 2011, BoE Red Book, 2015

³¹ Goodhart and Schoenmaker, 1995.

³² For an extensive discussion of collateral and hair cut regimes before and during the GFC see Chailloux et al., 2008.

However, liquidity and solvency interact,³³ and central banks value illiquid assets imperfectly, particularly in crisis.³⁴ Since only a small part of banks' assets is typically posted as collateral, a drop in value of its remaining assets may well lead to insolvency even if the collateral of the central bank is intact. High haircuts on collateral can alleviate these problems, and higher haircuts can reduce moral hazard problems as they reduce the provided liquidity insurance. These advantages to higher haircuts must be traded off against the effectiveness of the LOLR in hindering liquidity problems from escalating.³⁵

Avoiding loans to insolvent banks suggests that central banks should supervise banks. These benefits need to be traded off against potential costs such as possible distortions in monetary policy decisions. This may justify that an independent supervisor or other entity such as the deposit insurer carry out supervision.³⁶ Liquidity regulation may also improve solvency assessments, since CB has more time and hence information to make the assessment.³⁷ We will get back to liquidity regulation in the final section.

Central banks can have incentives to lend to or bail-out insolvent banks if they are systemic, i.e. closing them will lead to financial crisis,³⁸ reflecting that bail-out may be optimal in certain situations.³⁹ However, central bank bail-outs have the specific cost that it reduces the credibility that central bank lending is only to solvent banks. Hence future lending may become less efficient at thwarting liquidity crisis, since lending may be interpreted as attempts to save insolvent banks. This problem may be reduced if there is a resolution regime, making it possible for the authorities to use other means to keep an insolvent bank's operations running than central bank lending. Hence a resolution regime may enhance the credibility that the central bank will not lend to insolvent institutions.⁴⁰

3.3. Who should central banks provide liquidity insurance to?

Above we described deposit insurance and central bank lending as substitutes. However, central bank lending may be a necessary addition to deposit insurance.⁴¹ For instance, banks have other investors than

³³ Diamond and Rajan, 2006, Morris and Shin, 2016.

³⁴ Bordo 1990.

³⁵ Bindseil, 2015.

³⁶ See Santos, 2006, and Kahn and Santos, 2010, for a further discussion of these institutional issues.

³⁷ See Santos and Suarez, 2014.

³⁸ Goodhart and Huang, 1999.

³⁹ Keister, 2016

⁴⁰ Basel Committee on Banking Supervision, 2014.

⁴¹ Sleet and Smith, 2000, Kahn and Santos, 2001.

depositors that can run since banks typically issue a host of short term liabilities such as interbank loans and commercial paper.

Furthermore, other financial institutions than banks can experience liquidity problems due to similar mechanisms as described above. For instance, broker-dealers are levered and may be susceptible to fire sales.⁴² Money market funds have experienced runs in recent times.⁴³ Central counterparties may experience liquidity problems if there is a large-scale crisis.⁴⁴ During the GFC many central banks extended LOLR facilities to avoid that illiquidity in markets lead to a deepening of the crisis, and after the crisis some central banks have made both broker dealers and central counterparties eligible for LOLR.⁴⁵

The extent to which it is appropriate for the central bank or another institution to insure against liquidity risk depends on whether institutions are subject to liquidity risk and there are similar welfare consequences if these types of institutions experience liquidity problems as for banks. Institutions that have the potential to generate substantial losses to society if they fail are called systemically important.⁴⁶ Liquidity provisions are more likely to be effective in stopping crisis from spreading due to liquidity problems in such institutions, if the central bank can commit to providing liquidity before the problem arises and is able to assess whether institutions are solvent or not. Therefore, these institutions should also be subject to similar regulation and supervision as banks.⁴⁷

4. Central bank liquidity insurance tools

A central bank typically has a range of facilities or operations through which it can provide liquidity insurance. The degree of liquidity insurance depends largely on the collateral that is accepted and the haircuts that are required. The wider the collateral and the lower the haircuts, the more insurance is provided. Central bank facilities can be categorized as follows:

- Emergency Liquidity Facilities (ELA) provide liquidity insurance to individual financial institutions at central banks' discretion. These facilities have LOLR as their sole purpose and in general

⁴² Copeland et al., 2014.

⁴³ Duygan-Bump et al., 2013.

⁴⁴ Basel Committee on Banking Supervision, 2014.

⁴⁵ For instance, both broker-dealers and central counterparties are eligible for liquidity insurance at the Bank of England as stated in The Red Book. Mehrling, 2010, has argued that central banks should act as market makers of last resort.

⁴⁶ <http://www.fsb.org/what-we-do/policy-development/systematically-important-financial-institutions-sifis/>

⁴⁷ Basel Committee on Banking Supervision, 2014.

a wide range of collateral is accepted at the discretion of the central bank.

- Discount windows (DW) provide lending initiated by individual financial institutions at predetermined conditions and interest rates. These facilities often have both monetary policy and LOLR purpose, and collateral requirements vary substantially among central banks.⁴⁸
- Open market operations (OMO) are security purchases or loan auctions initiated by central banks, mainly to implement monetary policy. However, some central banks accept a wide range of collateral against these loans as well, hence including some liquidity insurance in these operations, and many central banks widened the accepted collateral in these operations during the financial crisis, hence extending the liquidity insurance provided.
- Market wide liquidity operations or facilities (MWLF) are provided by central banks to support market wide liquidity, not individual financial institutions. Temporarily accepting wide collateral against OMOs and giving longer term loans can be viewed as a form of MWLF. During the financial crisis many central banks operated so-called securities lending programs where financial institutions could exchange illiquid for liquid securities, or back-stop facilities where temporarily illiquid assets could be sold or borrowed against if their prices fell below certain thresholds.⁴⁹

The question is then what type of facilities should central banks use to alleviate liquidity problems?

One central question is whether loans should be provided to individual institutions (e.g. ELA and DW) or through market wide, competitive allocations (OMO and MWLF). Weaker institutions are more likely to resort to these facilities (so-called adverse selection) than strong institutions, particularly if loans are granted at a penalty rate. This is an argument for market wide, competitive allocations against high quality collateral.⁵⁰ For this reason, individual lending is also more likely to be taken as a sign of weakness, so-called stigma. This deterred banks from using the Fed's and BoE's discount windows during the GFC.

⁴⁸ For a brief overview see <http://libertystreeteconomics.newyorkfed.org/2016/02/counterparties-and-collateral-requirements-for-implementing-monetary-policy.html>. For a thorough discussion see Chailloux et al , 2008.

⁴⁹ See for instance https://www.federalreserve.gov/monetarypolicy/bst_crisisresponse.htm for an overview of Federal Reserve facilities.

⁵⁰ Goodfriend and King, 1988.

When competitive auctions were in place, banks were far more willing to borrow the liquidity they needed.⁵¹

If a bank is illiquid but not insolvent, it is not clear why it should not be able to attain funding from private sources. And it is not clear that the central bank is a better judge of the solvency of an institution than the institution's normal investors. Central bank supervision of banks may alleviate this problem, but it may also suggest that market wide liquidity allocation in response to aggregate increases in liquidity risk is preferable. If redistribution of liquidity among financial institutions is efficient, market wide liquidity allocation should also be a sufficient response to aggregate shocks.⁵² However, during periods of liquidity stress, markets may not redistribute liquidity efficiently, for instance due to hoarding behavior.⁵³ In that case access to individual loans may be necessary, and the existence of facilities to lend to individual institutions can increase the willingness to redistribute liquidity.⁵⁴

How large should market wide operations be in response to aggregate shocks, - that is how much reserves should be provided? If redistribution of reserves in interbank market is poor or costly ample reserves should be provided, in order to reduce the effects of hoarding and to reduce uncertainty. However, as this may require wider collateral or lower haircuts it must be weighed against the risk to the central bank providing loans to insolvent institutions and the costs of losses to the central bank.

Another LOLR design issue is whether liquidity insurance should be on-going or contingent. ELA is typically contingent on an institution experiencing liquidity problems and are at central bank discretion, whereas the liquidity insurance embedded in OMOs when wide collateral is accepted is on-going. MWLF may be either on-going such as the long term repo facility currently provided by the Bank of England,⁵⁵ or contingent such as most of the facilities put in place during the GFC were.⁵⁶

As has been argued earlier the ability of central bank liquidity insurance to avert crisis is largely dependent on the credibility that sufficient liquidity will be provided. One benefit of on-going insurance is that it is likely to enhance such expectations. Studies of deposit insurance regimes during the GFC suggest that explicit regimes were more efficient at thwarting runs, and countries with implicit regimes put in place explicit regimes once the crisis hit.⁵⁷ This again suggests that

⁵¹ McAndrews et al., 2017.

⁵² Allen et al., 2009.

⁵³ Acharya and Merrouche, 2013.

⁵⁴ Acharya et al., 2012.

⁵⁵ Red Book, 2015

⁵⁶ See for instance

https://www.federalreserve.gov/monetarypolicy/bst_crisisresponse.htm for Federal Reserve facilities.

⁵⁷ Anginer et al., 2014.

implicit regimes were not sufficiently successful in reducing risk-taking (moral hazard), contrary to the pre-crisis idea of constructive ambiguity.⁵⁸ This experience may carry over to central bank liquidity insurance, and is a central argument for the current design of the BoE liquidity insuring regime.⁵⁹

On the other hand such on-going insurance will reduce institutions' incentives to self-insure, increasing the reliance on central bank liquidity insurance and possibly increasing risk taking.⁶⁰ This can be alleviated by stringent facility terms, but again the central bank may face time-consistency problems that lead banks to expect more lenient terms in crisis, and hence again to small buffers.⁶¹ A possible advantage of increased use of standing facilities is that it may enhance central bank surveillance of institutions as the central bank continuously values assets that are posted as collateral for the facilities. It could also enable a central bank to condition access to LOLR on the liquidity risk management of banks before a crisis.⁶² This may reduce institutions incentives to take excessive risks, but does incur operational costs for the central bank. Furthermore, it is difficult to design facilities a priori that can deal with any form of liquidity problems, and hence contingent facilities are likely to be needed in addition.

Another central bank tool that can increase redistribution of liquidity among banks is the interest rate: By reducing the return on the liquid asset reserves, the central bank can facilitate redistributions of liquidity. This goes against the Bagehot dictum of charging penalty prices, and reflects that in general there is a cost of penalty prices, that is, the central bank will to a lesser degree alleviate liquidity problems the higher the penalty. Low rates in situations with poor redistribution may however require interest rates to be higher in normal times when redistribution is good, in order for there to be incentives to hold sufficient liquidity in the system in total.⁶³

5. Liquidity regulation and central bank liquidity insurance

Fire sales and liquidity crisis entail that there are positive externalities between market agents from holding liquid buffers. At the same time holding liquid buffers is costly due to the liquidity premium, and hence there is an incentive for banks to take too much liquidity risk. Requiring banks to hold liquidity buffers can potentially alleviate this problem.

⁵⁸ Domanski et al., 2014.

⁵⁹ Red Book, 2015.

⁶⁰ Angier et al., 2014.

⁶¹ Cao and Illing, 2015, Farhi and Tirole, 2012.

⁶² Acharya, Shin and Yorulmazer, 2011, provide a model where such contingent liquidity support reduces the moral hazard problems related to LOLR.

⁶³ Diamond and Rajan, 2009.

Furthermore, the presence of liquidity insurance in the form of deposit insurance and central bank liquidity support creates moral hazard. And as discussed in section 4 there is a trade-off between reducing moral hazard through pricing, hair-cuts and collateral and credibly averting crisis in designing these facilities. In addition central banks can face time-consistency problems that lead them to give liquidity assistance at more lenient terms during stress and even support insolvent banks in crisis, particularly when there is no credible resolution regime in place (see section 3 and 4). These problems related to LOLR also suggest that regulatory measures are needed to contain build-up of liquidity risk in normal or boom periods.⁶⁴

Requiring liquidity buffers may also give central banks more time to assess the value of collateral and the solvency of banks in stress, which in itself can reduce moral hazard.⁶⁵ However, it is an open question whether banks will be able to use their liquidity buffers in periods of stress, since the use of these buffers may be a breach of regulation and a sign of weakness to the market.⁶⁶

Requiring banks to hold liquidity buffers, such as the Liquidity Coverage Ratio (LCR), or to use longer term funding, such as the Net Stable Funding Ratio⁶⁷, has costs.⁶⁸ These requirements reduce the ability of banks to perform long term lending: Placing assets as liquid buffers costs a liquidity premium compared to e.g. longer term lending. Requiring longer term debt increases funding costs due to duration premiums. Furthermore, regulating banks' liquidity risk may result in more maturity transformation being performed outside regulated banks.⁶⁹ Studies of the potential costs of liquidity regulation are so far inconclusive. Some suggest low costs⁷⁰, others find a potential for larger effects⁷¹. Furthermore, the LCR has only been in effect for a short period of time when this survey is written,⁷² and the NFSR is still under implementation. Hence empirical studies of the effects of these regulations are yet to come.

Given the potential costs, is liquidity regulation the appropriate response to too high liquidity risk in the banking sector and the limitations and problems related to LOLR? Research on this is also inconclusive. To cite de Nicolo et al., 2016; "However, a well grounded theoretical rationale for liquidity requirements as *necessary*

⁶⁴ Diamond and Rajan, 2012.

⁶⁵ Santos and Suarez, 2014.

⁶⁶ Carlson, 2013.

⁶⁷ Basel III liquidity requirements Liquidity Coverage Ratio and Net Stable Funding Ratio are described in more detail in Basel Committee on Banking Supervisions, 2013, 2014.

⁶⁸ Segura and Suarez, 2016.

⁶⁹ Grochulski and Zhang, 2015.

⁷⁰ MAG 2010, Angelini et al 2011

⁷¹ IFF 2011 EBA Stakeholder Group 2012, Covas and Driscoll 2014

⁷² The LCR was implemented in the US in 2014, and in and Norway in 2015. NFSR was not implemented in any of these jurisdictions at the end of 2019.

complements to capital regulation, prompt corrective action, and LOLR-type policies has yet to be established.” The paper discusses a number of reasons for this. First, the desirability of liquidity regulation depends on how important maturity mismatches are for the occurrence of crisis, and how effective liquidity regulation is at reducing maturity transformation compared for instance to capital requirements. Goodhart et al, 2012, 2013, run simulations suggesting that liquidity requirements are more effective at reducing maturity mismatch than capital, but that liquidity requirements must be turned off in downturns to avoid fire sales. This also suggests that liquidity requirements may need to have a counter cyclical element. Empirical studies of the effects of introducing liquidity requirements that were in place before the LCR suggest that maturity transformation is affected, particularly though less reliance of short term funding.⁷³ On the other hand some studies⁷⁴ find strong correlation between banks solvency and liquidity, and this may lead highly capitalized banks to keep access to liquidity in stress. Admati et al., 2013, also suggest that higher capital will reduce likelihood of run and improve LOLR assessment, reducing the need for liquidity regulation. If capital requirements are not very costly, that is if equity is not very costly compared to debt, whereas liquidity requirements are, capital requirements may be more cost-effective than liquidity requirements.⁷⁵ It is also possible that the existence of prompt corrective action and resolution powers may be as effective in reducing moral hazard from LOLR as liquidity requirements.⁷⁶

Implementing liquidity requirements will affect implementation of monetary policy since relative interest rates may be affected. Introducing LCR is likely to increase term money market rates: If LCR is binding in some states, the overnight rate will be lower and the term premium higher (30-day loans) than without LCR.⁷⁷ This is because borrowing overnight becomes relatively more costly than term lending, since term lending (30-days or more) does not have to be matched by a buffer of liquid assets. The effect of OMO will also be affected, depending on what regulatory constraints are binding for banks and the type and structure of OMOs.

If regulation is optimally designed, this reflects a more correct pricing of liquidity risk. However we do not yet have analysis that point to the optimal design. Furthermore liquidity buffer regulation can lead to concentration risks as all banks are given an incentive to invest in similar assets. This may make formerly liquid assets illiquid in a new crisis.

⁷³ See Banerjee and Mio, 2014, Duijm and Wierts, 2016, Bonner and Eijffinger, 2016.

⁷⁴ Pierret, 2015.

⁷⁵ Adrian and Boyanchenco, 2013, on the other hand, find that liquidity regulations are less costly than capital requirements in their model.

⁷⁶ De Nicolo et al., 2014, Rocket and Vives, 2014.

⁷⁷ Bech and Keister, 2014

6. Concluding remarks

The short story is that research so far gives incomplete guidance on how central bank liquidity insurance and liquidity regulation interact and should be designed. The main trade-offs faced by policy makers are:

- There are externalities to financial agents' liquidity risk management that can lead to too much liquidity risk being taken, and that can justify public intervention and regulation. Authorities face a general trade-off between limiting risk of crisis vs limiting access to credit growth in the economy.
- Providing liquidity insurance through LOLR policies is a possible and widely used tool, but design varies greatly across central banks. Extensive lending in crisis can be necessary to thwart crisis but increases moral hazard problems. Regulation and supervision of insured institutions may alleviate moral hazard problems.
- In particular, liquidity regulation may dampen incentive problems, but create new problems and is unlikely to be a cure-all. We have little basis to regard current (or any other specific) liquidity regulation as optimally designed.

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