The Interplay between Liquidity Regulation, Monetary Policy Implementation and Financial Stability[*]

Todd Keister
Department of Economics
Rutgers University
todd.keister@rutgers.edu

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Abstract

I outline a simple framework for thinking through how the Basel III liquidity regulations – in particular, the Liquidity Coverage Ratio (LCR) – will impact short-term interest rates and the process of monetary policy implementation. This framework suggests that a regulatory premium may arise in some market interest rates, creating a new wedge in the monetary transmission mechanism. I discuss ways in which a central bank could react to this new wedge, highlighting what may be a fundamental tension between implementing monetary policy effectively and using liquidity regulation to promote financial stability.

1. Introduction

The new international regulatory framework for banks known as Basel III updates existing standards for capital requirements while introducing new standards for regulating and evaluating banks' leverage and liquidity. In this paper, I discuss some potential unintended consequences of the new liquidity standards, focusing on the Liquidity Coverage Ratio (LCR). The LCR aims to encourage banks to hold a more liquid portfolio of assets and to limit their reliance on very short-term liabilities. Specifically, it requires each subject bank to hold enough high-quality liquid assets that it could survive a 30-day period of stressed financial conditions – including a partial run by its depositors and other short-term creditors – without having to sell illiquid assets and thereby contribute to fire-sale conditions.[1]

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[1] Basel III also introduces a second liquidity standard, the Net Stable Funding Ratio (NSFR), which focuses on a one-year time horizon and establishes a minimum level of stable funding for a bank as a function of the liquidity characteristics of its assets and activities. Initial implementation of the LCR began in 2015 and it is scheduled to be fully in effect by 2019. Initial implementation of the NSFR is scheduled to begin in 2018.

While the aim of the LCR is to promote financial stability, it could potentially have spillover effects onto the process by which central banks implement monetary policy. In many jurisdictions, this process involves setting a target for the interest rate in an interbank market, where banks borrow and lend central bank reserves from one another. Because these reserves are high-quality liquid assets, the new LCR requirement will potentially change the demand for funds in this interbank market and, hence, affect the market interest rate. Moreover, a central bank's monetary policy operations, which are used to steer the market interest rate toward the target value, may alter banks' LCR positions and, therefore, have a different impact than in the past. The LCR requirement may also generate incentives for some financial institutions to engage in forms of regulatory arbitrage that move short-term maturity transformation outside of the regulated banking system. These linkages suggest that the new regulation may have subtle consequences that could potentially alter the effectiveness of central banks' monetary policy operations and raise financial stability concerns.

In this paper, I present a simple analytical framework that is useful for thinking through the interplay between the LCR requirement, the process of monetary policy implementation, and financial stability. I focus on the pattern of equilibrium interest rates that arises when a central bank operates a corridor system of monetary policy implementation. I first describe this pattern in the absence of liquidity regulation, which corresponds to a fairly standard discussion of the relationship between market interest rates and the quantity of reserves supplied by the central bank. This discussion is consistent with a variety of underlying models of the trading process in interbank markets; I take a reduced-form approach here to present the key insights from these models with a minimum of technical detail.

I then discuss how imposing an LCR requirement can introduce a new regulatory premium in some market interest rates. To the extent that the LCR requirement factors into banks' decisions, interbank loans whose maturity falls outside of the 30-day window used in the LCR calculation will become more valuable for the borrowing bank and more costly for the lending bank. In contrast, the value of an interbank loan with a maturity of less than 30 days is largely unaffected by the new regulation. As a result, a regulatory premium will arise in the interest rates of loans that improve the LCR positon of the borrowing bank. The size of this premium will reflect the scarcity value of what I call excess *LCR liquidity* in the banking system.

The LCR premium could potentially create an important new wedge in the monetary transmission mechanism. To the extent that the size of this new wedge is large and/or variable over time, central banks may need to take it into account when setting the course of monetary policy. I discuss two very different ways in which a central bank might choose to deal with this wedge. The first approach is passive: the central bank does not try to influence the size of the LCR premium, but reacts to changes in this premium when setting its target interest rate. The other approach is active in the sense that the central bank structures monetary policy operations with the aim of directly influencing the LCR premium and thereby maintaining firmer control over financial conditions.

Comparing the advantages and disadvantages of these two approaches highlights what may be an important tension between monetary and financial stability policy. To implement monetary policy effectively, a central bank will naturally tend to design its operations and facilities in ways that encourage the transmission of changes in its targeted interest rate to other rates in the economy. From this point of view, arrangements that ensure any regulatory premium associated with the LCR is small and stable over time will look attractive. When this premium is small and stable, however, banks may have little incentive to hold a more liquid portfolio of assets or to limit their reliance on short-term liabilities. In other words, policies chosen to enhance the transmission of monetary policy decisions may potentially undermine the regulation's goal of promoting financial stability. Further research is needed to understand how a central bank can best manage this tension.

2. Implementing monetary policy in the pre-crisis period

I begin by describing the pattern of equilibrium interest rates on interbank loans that arises in an environment where there is no LCR requirement. Rather than presenting a particular model of interbank trading in detail, I discuss the basic relationships that emerge from a range of models.[2] I first focus on the market for overnight interbank loans and then extend the framework to include term loans.

[2] A variety of models of banks' liquidity management and equilibrium in the market for interbank loans have been developed, going back to the early work of Poole (1968). See Ennis and Keister (2008) for a non-technical introduction to this literature.

2.1 The overnight market

For concreteness, consider a central bank that implements monetary policy using a corridor system, in which it makes two standing facilities available to banks. At one of these facilities, the central bank offers overnight loans to banks at an interest rate r_{DW}; I refer to this facility as the *discount window*. At the other facility, the central bank pays *interest on the excess reserves* that banks hold on deposit with it overnight at the rate r_{IOER}.[3] This second interest rate is lower than the first, that is,

$$r_{DW} > r_{IOER}.$$

In normal times, a bank will not be willing to pay an interest rate higher than r_{DW} in the market, since doing so would be more expensive than borrowing from the central bank.[4] Similarly, a bank would not be willing to lend at an interest rate below r_{IOER}, since doing so would yield a lower return than simply holding the funds in its account at the central bank. The market interest rate on overnight interbank loans will thus tend to lie within the “corridor” formed by these two administered rates.

The market interest rate will adjust within this corridor so that the supply of interbank loans equals the demand for them. Each bank will supply or demand loans depending on how its current excess reserves position (which can be either positive or negative) compares with its desired position, which may include a precautionary buffer as well as additional reserves for the purpose of making payments efficiently. The equilibrium interest rate in this market will, therefore, depend on the total quantity of excess reserves in the banking system. When this quantity is significantly negative, many banks will find themselves facing a deficiency in their reserve requirement or otherwise in need of reserves.[5] The efforts of these banks to borrow funds in the interbank market will drive up the interest rate until it is close or equal to the interest rate charged by the central bank, r_{DW}. In contrast, if the quantity of excess reserves is very large,

[3] I do not specify the interest rate paid by the central bank on *required* reserves, which may differ from r_{IOER}, because it has no effect on market interest rates in the basic framework I present here.

[4] I abstract here from the issue of *stigma*, whereby a belief that borrowing from the central bank will be perceived as a sign of weakness can potentially lead banks to borrow in the market at a rate higher than r_{DW}. See Ennis and Weinberg (2012) and Armantier et al. (2015) on this issue.

[5] I assume the reserve requirement is based on a bank’s demandable liabilities in a previous period and, therefore, is already determined when interbank trading takes place. The analysis is exactly the same if reserve requirements are zero and is broadly similar if reserve requirements must be met on average over a maintenance period. See, for example, the discussion of the latter case in Section 4 of Ennis and Keister (2008).

banks will find that they are easily meeting their reserve requirements and payments needs and holding excess reserves beyond their desired buffers. Banks will seek to lend out these unwanted reserves in the interbank market and, collectively, their efforts will drive the market interest rate down until it is close or equal to the interest rate paid by the central bank, r_{IOER}. In between these extremes, there is a downward-sloping relationship between the equilibrium interest rate on interbank loans, r^*, and the total quantity of excess reserves, as depicted in Figure 1.

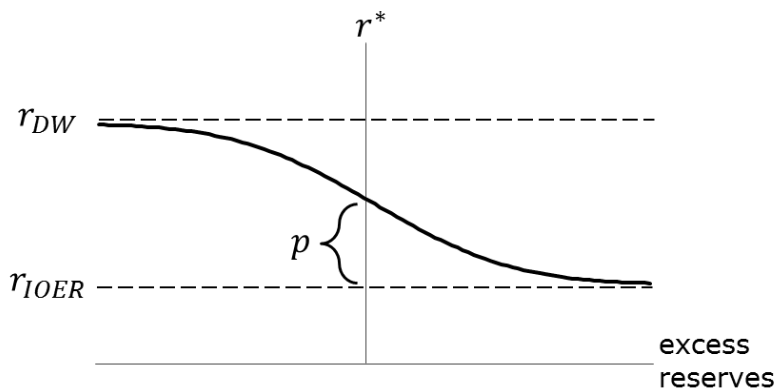

Figure 1: The equilibrium interest rate in the overnight market

The equilibrium interest rate depicted in Figure 1 can be expressed as the sum the interest rate on excess reserves paid by the central bank, r_{IOER}, plus a *reserve premium*, denoted p,

$$r^* = r_{IOER} + p. \tag{1}$$

When a bank borrows funds at the interest rate r^*, it knows that it can hold any excess reserves on deposit at the central bank overnight and earn r_{IOER}. The premium p is defined to be the difference between these two rates, that is, the net cost to the bank of obtaining excess reserves. A bank is willing to pay this cost because reserves provide liquidity services: they help banks avoid unexpected reserve deficiencies, make payments, etc. In equilibrium, the reserve premium p reflects the marginal value of these liquidity services to each bank and depends critically on the total quantity of excess reserves available. When excess reserves are scarce, the reserve premium is large and, hence, the market interest rate is well above r_{IOER}. When excess reserves are more plentiful, in contrast, the reserve premium diminishes and the market interest rate falls toward r_{IOER}, as shown in Figure 1.

Different models of interbank trading deliver different functional forms for the reserve premium p. In some models, the premium will depend on factors other than the total quantity of excess reserves, such as the distribution of those reserves across banks at the beginning of the trading session. Other models introduce costs of holding reserves and other features to the environment to explain why some market interest rates may lie below r_{IOER} when the quantity of excess reserves is large enough. These models aim to be consistent with the fact that the federal funds rate, which includes lending by some non-bank institutions, has been consistently below the interest rate paid by the Federal Reserve on excess reserves in recent years.[6] For the discussion in this paper, the precise shape of the function p is not important. The key point is that the size of this premium depends in a clear and predictable way on the total quantity of excess reserves, which can be closely controlled by the central bank using monetary policy operations.

Monetary policy implementation can be thought of as the process by which the central bank uses the tools at its disposal (open market operations, the choice of the interest rates r_{DW} and r_{IOER}, etc.) to influence the equilibrium value of the reserve premium p and thereby steer the market interest rate r^* to the desired target level. In a symmetric corridor system, the central bank aims to make the this premium equal to half of the difference between r_{DW} and r_{IOER}, so that the market interest rate lies at the midpoint of the corridor (as shown in the example in Figure 1). A central bank could also use an asymmetric corridor with r_{IOER} set to zero, for example, as was the case for the Federal Reserve prior to 2008. In a floor system of monetary policy implementation, the central bank sets r_{IOER} equal or very close to its target for the market interest rate and aims to keep the quantity of excess reserves sufficiently large to drive the reserve premium close to zero.

2.2 The term market

For analyzing the effects of liquidity regulation, it is useful to extend this simple framework to include a term structure for interbank interest rates. Of particular importance for studying the effects of the LCR requirement will be to distinguish between interest rates for loans of less than 30 days and loans of greater than 30 days. I will focus the discussion here on the relationship

[6] If all banks trade in a centralized interbank market, the initial distribution of reserves does not affect equilibrium outcomes; see Bech and Keister (2017). Recent papers that study models with decentralized trade in which the equilibrium reserve premium is a more complex function of initial conditions include Ennis and Weinberg (2012), Afonso and Lagos (2015), and Bech and Monnet (2016), among others. Papers that modify the basic model to explain very low market interest rates and other phenomena from the post-crisis period include Bech and Klee (2011), Martin *et al.* (2016), Vari (2016) and Armenter and Lester (2017).

between the overnight interest rate r and a single term interest rate r_T, where the term is some length longer than 30 days.

To simplify the presentation, assume the central bank sets a target for the overnight interest rate and that this target is expected to remain constant over the term in question.[7] Then the equilibrium interest rate on term loans can be written as the overnight interest rate plus a *term premium* that I denote by τ,

$$r_T^* = r^* + \tau. \tag{2}$$

The term premium τ reflects the extra compensation a lender receives for making a term loan rather than an overnight loan that is repeatedly rolled over. I will assume the term premium is independent of the forces that determine the overnight interbank rate, particularly the quantity of excess reserves. Combining equations (1) and (2), we can write the equilibrium interest rate on term interbank loans as the interest rate paid by the central bank on excess reserves plus both the reserve premium and the term premium,

$$r_T^* = r_{IOER} + p + \tau. \tag{3}$$

This expression neatly illustrates the three distinct benefits a bank receives when borrowing at term: it receives reserves that it can hold at the central bank and earn interest rate r_{IOER}, these reserves provide additional liquidity services worth p, and the fact that the loan need not be repaid until the end of the term is worth an additional τ. The expression also shows how changes in the central bank's policy tools (monetary policy operations, r_{IOER}, etc.) affect term interest rates in exactly the same way that they affect the overnight interest rate in equation (1).

3. The effects of liquidity regulation

What changes within this simple framework when a new regulation like the Liquidity Coverage Ratio is introduced? As described above, the LCR requires each subject bank to hold a sufficient quantity of high-quality liquid assets to cover the net outflows it would experience in a 30-day stress event. This requirement can be written as

$$LCR = \frac{\text{High quality liquid assets } (HQLA)}{\text{Net Cash Outflows } (NCOF)} \geq 1. \tag{4}$$

[7] This assumption only serves to simplify the analysis by eliminating the need to introduce notation for expected changes in the overnight interest rate over the duration of the term loan.

The numerator of this ratio is the total value of the bank's stock of high-quality liquid assets ($HQLA$) at the end of a given day, which includes its holdings of qualifying sovereign bonds and excess reserves.[8] The net cash outflows ($NCOF$) in the denominator are determined by assigning runoff rates to each of the different types of liabilities issued by the bank. For example, retail deposits that are covered by a government-sponsored deposit insurance program can be assigned a runoff rate as low as 3%, meaning that only 3% of these deposits would be expected to be withdrawn in the 30-day stress event. Retail deposits not covered by deposit insurance would be assigned a higher runoff rate, while the runoff rate on wholesale deposits would be even higher, reflecting the tendency for these deposits to react quickly to changes in market or bank-specific conditions.

Instead of working directly with the ratio in equation (4), it is useful to focus on the difference between the numerator and the denominator, which I call the bank's *excess LCR liquidity*, and to write the requirement as

$$\text{Excess LCR Liquidity} \equiv HQLA - NCOF \geq 0. \tag{5}$$

Of particular importance for the analysis here is how interbank borrowing and lending affects a bank's excess LCR liquidity. First, note that borrowing or lending overnight has no effect on this measure. If a bank borrows \$1 million overnight, for example, its stock of HQLA increases by \$1 million, but it also has a new cash outflow of \$1 million on the following day. Since both terms increase by the same amount, the measure of excess LCR liquidity in equation (5) is unchanged. The same logic applies to any borrowing with a maturity that falls inside the 30-day window established by the LCR. Conversely, if a bank lends \$1 million overnight, the bank's stock of HQLA declines by \$1million but it has a cash inflow of the same amount the next day. Because this inflow decreases the bank's net cash outflows in the stress scenario, the bank's excess LCR liquidity is again unchanged.[9]

When a bank borrows or lends at a term that falls outside of the 30-day window, in contrast, this activity will change its excess LCR liquidity. When a bank borrows \$1 million for at least 31 days, for example, its stock of HQLA increases by \$1 million without any corresponding

[8] I assume that reserves held to meet reserve requirements are not included in the calculation of a bank's HQLA, but including them in the calculation would not change anything in the framework presented here. In practice, the LCR rules give local supervisors some discretion on whether to include required reserves in HQLA.
[9] The LCR rules place some restrictions on the degree to which a bank can use anticipated inflows to offset outflows in the calculation of NCOF. For the purposes on the discussion here, I assume these restrictions are not binding.

increase in the NCOF measure. Similarly, when a bank lends at a term of 31 days or longer, its HQLA decreases with no corresponding inflow that would decrease the NCOF measure. In other words, in addition to bringing the benefits discussed in the previous section and captured in equation (3), term borrowing in the interbank market now brings the extra benefit of improving a bank's LCR position.

This reasoning helps us see how the LCR requirement will affect equilibrium interest rates in the interbank market. Since overnight borrowing and lending have no effect on a bank's LCR position, the interest rate in the overnight market is not directly affected by the new regulation; it is still given by equation (1). The interest rate for term interbank loans, in contrast, has a new component, denoted $\hat{p}$, that I call the *LCR premium*,

$$r_T^* = r_{IOER} + p + \hat{p} + \tau. \tag{6}$$

The LCR premium measures the value of an additional dollar of term borrowing that comes from increasing a bank's excess LCR liquidity as measured in equation (5). Banks value this liquidity precisely because it helps ensure that they will satisfy the new requirement.

In equilibrium, the LCR premium $\hat{p}$ reflects the marginal value of excess LCR liquidity to each bank and depends critically on the total quantity of excess LCR liquidity in the banking system. If the banking system as a whole is facing an LCR shortfall, the LCR premium will be large as the efforts of banks to borrow at term to improve their LCR position push up the term interbank interest rate r_T^*. If the banking system has an abundance of LCR liquidity, in contrast, banks will find that they are easily meeting the LCR requirement and will seek to lend funds out at term to benefit from the premium $\hat{p}$. Collectively, these efforts will drive the term interest rate down until the LCR premium disappears. Notice the symmetry between the LCR premium and the reserve premium: $\hat{p}$ reflects the degree of scarcity of excess LCR liquidity in the banking system in much the same way that p reflects the degree of scarcity of excess reserves. In this sense, the effect of the new regulation on market interest rates can be analyzed in a familiar way.

There is, however, an important difference. While the quantity of excess reserves can be tightly controlled by the central bank using monetary policy operations, the quantity of excess LCR liquidity is determined by a wide range of factors outside the control of the central bank. For example, fiscal policy has a strong influence on excess LCR liquidity because the supply of outstanding government bonds is an important component of the total supply of HQLA. The demand for these government bonds by other investors is also important; a flight-to-quality episode will tend to decrease the supply of HQLA available to the banking system and thus increase the LCR premium. In general, the equilibrium value of the LCR premium will depend on the cost banks face when increasing their excess LCR liquidity in other ways, such as by substituting HQLA for other assets on their balance sheet, expanding their balance sheet to hold more HQLA, or changing the structure of their liabilities to decrease their NCOF. Any event that changes these costs will also create a change in the equilibrium value of the LCR premium.

There is still a clear sense in which the central bank can move all market interest rates up and down, of course. For example, as shown in equations (1) and (6), an increase in the interest rate paid on excess reserves will lead to an increase in both overnight and term interest rates. However, the introduction of the LCR requirement brings with it a new *wedge* in the monetary policy transmission mechanism. If the central bank keeps the overnight interest rate close to a fixed target, then changes in the LCR premium will create changes in term interest rates that are disconnected from the stance of monetary policy. Given that the LCR premium will depend on a wide variety of factors, it seems possible that the size of this wedge could be large in some situations and could vary substantially over time.

How should a central bank react when this new LCR premium appears in market interest rates? In the remainder of the paper, I address this question in the context of the simple framework developed here.

4. Dealing with the LCR premium

There are several ways in which a central bank could adjust its monetary policy framework to take account of the wedge created by the LCR premium. I divide these possibilities into two broad categories, which I label “passive” and “active”.

4.1 A passive approach

In a passive approach, the central bank would not try to directly influence the size of the LCR premium $\hat{p}$. Instead, it would view this premium as a market-determined factor and would react to changes in it by adjusting its target for the overnight interest rate. For example, if a sharp increase in the LCR premium leads to higher term interest rates and tighter financial conditions than the central bank views as appropriate, it could choose to lower its target for the overnight interest rate to mitigate or offset the increase in term rates.

This passive approach mirrors the way a central bank typically reacts to changes in other spreads in financial markets. If broad financial conditions tighten for whatever reason, a central bank will often lower its target interest rate as a way of mitigating the effects of this tightening. In this sense, the passive approach appears to be a natural extension of current practice. However, I see three potential problems with this approach.

(i) To the extent that the LCR premium is variable over time, it may require the central bank to make frequent changes in its announced target for the overnight interest rate.

Frequent changes in the target rate may present a communication challenge for the central bank. Will it be able to effectively communicate the intended stance of monetary policy and the rationale for changes that are merely reactions to variation in the LCR premium? Legislative efforts that would require the Federal Reserve to state its policy in terms of a Taylor-type rule could exacerbate this problem, as such rules tend to ignore financial conditions altogether. If the clarity and effectiveness of a central bank's communication is undermined by the need to react to a variable LCR premium, the passive approach could bring substantial costs.

(ii) To the extent that the LCR premium is large at times, it will make the effective lower bound on nominal interest rates more binding.

The approach of offsetting the effects of an increase in the LCR premium by decreasing the overnight rate will only be effective if the central bank is actually able to lower the overnight rate. As has become abundantly clear in recent years, the lower bound on nominal interest rates can be a serious constraint on monetary policy. Regardless of where this bound lies (at or somewhat below zero), a large LCR premium will make the economy more likely to hit the bound following a negative shock. As a result, events in which the central bank's ability to use conventional monetary policy is impaired will become more frequent. Moreover, in these events, the passive approach loses all power and changes in the LCR premium will directly translate into changes in financial conditions.

(iii) A large LCR premium also represents an arbitrage opportunity that potentially raises financial stability concerns.

Some financial institutions, including banks below a certain size and non-bank institutions, are not subject to the LCR requirement. If these institutions are able to borrow and lend freely with banks subject to the LCR requirement, a clear arbitrage opportunity arises. Suppose the institution that is not subject to the LCR requirement borrows funds overnight from a subject bank and lends the same funds back for a 31-day term. The combined effect of these trades would be to increase the excess LCR liquidity of the subject bank by generating a cash inflow on the following day together with a cash outflow that lies outside of the 30-day window.[10] The arrangement lowers the excess LCR liquidity of the other institution by the same amount, but that fact is of no concern since the institution is not subject to the LCR requirement. When the LCR premium $\hat{p}$ is large, this type of arrangement could generate substantial gain for both parties.

The LCR rules place some limits on banks' ability to use this type of arrangement, chiefly by imposing an upper bound a bank's ability to use anticipated cash inflows to offset its measured net cash outflows. However, the total scope for this activity, and the amount by which it could be used to increase subject banks' excess LCR liquidity, may be substantial. If so, these arrangements would imply that the LCR requirement is not decreasing the amount of short-term maturity transformation in the overall financial system, but is instead encouraging this activity to move outside of the LCR-regulated banking system.[11] Such a situation raises clear financial stability concerns.

To summarize, an LCR premium that is large and/or variable over time may create communication problems for the central bank, increase the likelihood of monetary policy being impaired by the lower bound on nominal interest rates, and create financial stability concerns by moving short-term maturity transformation outside of the regulated banking system. There are ways of mitigating each of these concerns, of course. An enhanced communication framework that stresses the importance of term interest rates may be useful, for example.[12] A central bank could also set a higher inflation target with the aim of decreasing the likelihood that the

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[10] The term loan could be structured with an "evergreen" clause, so that the maturity automatically resets to 31 days every morning and, hence, remains outside of the window for the LCR calculation until either party takes action to prevent the renewal.

[11] Even if the LCR requirement does not decrease the total amount of short-term maturity transformation, it may still improve financial stability by changing the *distribution* of excess LCR liquidity across banks. This point is illustrated in Bech and Keister (2017); see especially Appendix B.

[12] One such option would be to directly target a term interest rate that includes the LCR premium rather than an overnight interest rate that does not.

overnight interest rate will run up against the effective lower bound. Additional regulatory and supervisory activity could attempt to limit the build-up of short-term maturity transformation at institutions not subject to the LCR requirement. However, each of these policies would bring its own difficulties and unintended consequences. For this reason, a central bank may want to consider taking a more active approach to managing the size of the LCR premium. I discuss some possibilities for doing so next.

4.2 Active approaches

In an active approach, the central bank designs its monetary policy operations with the aim of directly influencing the size of the LCR premium. In some ways, aiming to actively manipulate the LCR premium $\hat{p}$ for monetary policy purposes mirrors central banks' traditional approach of influencing the overnight interest rate by actively manipulating the reserve premium p. As discussed above, however, there is a key difference. The size of the reserve premium depends critically on the quantity of excess reserves in the banking system, which can be tightly controlled by the central bank. The size of the LCR premium, in contrast, depends on the quantity of excess LCR liquidity in the banking system, which is determined by a wide variety of factors, most of which are outside of the control of the central bank.

Despite the fact that it cannot directly control the supply of excess LCR liquidity, the central bank can take actions that influence this amount at the margin. In this section, I describe three types of operations that could potentially be used to implement an active approach and discuss their advantages and disadvantages.

(A1) The central bank could conduct open market operations against non-HQLA assets.

When the central bank purchases assets that do not fully count as HQLA in banks' LCR calculations, and pays for this purchase with newly-created reserves, it increases the stock of HQLA available in the financial system. This increased stock of HQLA will tend to increase banks' excess LCR liquidity and, therefore, lower the equilibrium value of the LCR premium. Selling non-HQLA assets will have the opposite effect, making excess LCR liquidity scarcer and raising the equilibrium value of the LCR premium. Such operations thus allow a central bank to push the LCR premium in either direction, although it may not be able to control it with the same precision as the reserve premium.

While the effect of this type of operation is conceptually clearest for the case of an outright purchase by the central bank, a similar effect could be achieved with temporary open market operations structured as repurchase agreements using non-HQLA assets. These operations would likely need to be structured with a term greater than 30 days so that the return leg falls outside of the LCR window. The European Central Bank's Long Term Refinancing Operations (LTROs) are an example of what this type of operation might look like in practice. This option points to another, closely-related possibility:

(A2) The central bank could offer term loans to banks against non-HQLA collateral.

The logic behind this second option is essentially the same as for the temporary open market operations described above. By offering loans of reserves with a term of longer than 30 days, and by accepting collateral for the loan that is not part of a bank's stock of HQLA, the central bank can increase banks' holdings of HQLA without creating a corresponding increase in net cash outflows. The Federal Reserve's Term Auction Facility (TAF), which operated from 2007 – 2010, might be a useful model for this option. Which of the two options is more effective will likely depend on institutional considerations. For example, if open market operations are conducted with non-bank counterparties (as in the U.S.), then lending to banks may be a more powerful tool as the excess LCR liquidity created by the operation will accrue directly to the borrowing bank. Leaving these institutional considerations aside, both options would give the central bank a tool with which it could aim to limit the size of LCR premium and stabilize its movements over time.

However, both of these types operations also affect the quantity of excess reserves. When the central bank offers term loans to banks in an effort to reduce the LCR premium $\hat{p}$, for example, the newly-created reserves will also reduce the reserve premium p and, hence, will tend to push the overnight interest rate below the central bank's target value. In addition, banks' demand for term loans from the central bank will be driven not only by LCR concerns, but also by their desire to hold excess reserves for the usual purposes. As a result, a central bank's efforts to influence the LCR premium $\hat{p}$ can end up creating an intricate interdependence between $\hat{p}$ and the reserve premium p. Bech and Keister (2017) study this interdependence in an explicit model of interbank lending and central bank operations. They show how a central bank may have difficulty controlling market interest rates and effectively implementing monetary policy when the LCR requirement is in place.

To avoid these problems, a central bank may want to design operations or facilities that allow it to influence the amount of excess LCR liquidity in the banking system without at the same time changing the quantity of excess reserves. One possibility is the following:

(A3) The central bank could operate a term bond-lending facility.

When banks face a shortage of LCR liquidity and the LCR premium increases, the central bank could offer to lend government bonds or some other highly-liquid asset from its balance sheet to banks against non-HQLA collateral. Doing so would directly increase the amount of HQLA, and hence of excess LCR liquidity, in the banking system without affecting the quantity of excess reserves. If the central bank wanted to be able to increase the LCR premium, it would need to have a stock of these loans in place in normal times, regularly rolling over, so that it could decrease that quantity when the LCR premium falls below the desired level. As with the operations described above, these loans would likely need to be offered at terms of greater than 30 days to avoid running off within the LCR calculation window. The Federal Reserve's Term Securities Lending Facility (TSLF), which operated from 2008 – 2010, and the Bank of England's Discount Window, which allows banks to borrow gilts against less liquid collateral, are possible models for this type of facility.

One appealing aspect of a term bond-lending facility is that it allows a central bank to neatly separate its attempts to influence different premia. There is also a nice symmetry to this approach. Central banks traditionally implement monetary policy by changing the quantity of excess reserves to affect the equilibrium reserve premium p. A term bond-lending facility allows the central bank to change the quantity of excess LCR liquidity in the banking system and thereby influence the LCR premium $\hat{p}$. Since $\hat{p}$ affects the transmission of monetary policy into all interest rates with a term greater than 30 days, this activity is can be seen as a natural extension of traditional monetary policy.

5. Four important questions

The discussion in the previous section focused on the feasibility of structuring a central bank's operations to directly influence the size of the LCR premium. Viewed from a narrow perspective, taking steps to control this premium seems useful and perhaps essential for effectively implementing monetary policy. Such control may also be important for limiting the incentive for short-term maturity transformation to migrate outside of the regulated banking system. Viewed more broadly, however, such steps raise some important questions that would need to be answered before a central bank could confidently adopt an active approach to managing the LCR premium.

The first and perhaps most obvious question is: What level of $\hat{p}$ should the central bank aim for? The equilibrium LCR premium should presumably be positive, at least in situations where the banking system is relying on the central bank as a provider of excess LCR liquidity. A positive LCR premium gives banks an incentive to raise their LCR by other means, including directly holding more high-quality liquid assets. However, the desired value of the premium would not be so large as to limit the effectiveness of monetary policy or create strong incentives for undesirable regulatory arbitrage. How can policy makers identify a level for the LCR premium that strikes an appropriate balance between these competing concerns?

A second important question is: What non-HQLA assets should the central bank accept in its operations? This question is particularly salient if the central bank conducts outright purchases, since it would be directly taking the risks associated with these assets onto its balance sheet. Even if the assets are only used as collateral for loans made to banks in sound financial condition, however, the choice of what assets are accepted will affect the market prices of these assets and thus potentially impact the allocation of credit in the economy. Prior to the recent financial crisis, the Federal Reserve operated under a policy commonly referred to as "Treasuries-only" in large part to avoid making decisions that directly impact credit allocation.[13] Taking an active approach to managing the LCR premium would require the central bank to move away from such a policy and therefore face the difficult question of what non-HQLA assets to treat favorably.

[13] See, for example, the discussion in Broaddus and Goodfriend (2001).

Third, what size of operations will be needed to effectively control the LCR premium? Central banks have a great deal of experience using open market operations to control the reserve premium p and, therefore, had a fairly precise understanding of how the size of an operation affected market interest rates in the pre-crisis period. Moreover, the operations needed to implement monetary policy in that period were generally small compared to the overall size of the central bank's balance sheet. If the central bank chooses to use the type of operations discussed here to influence the LCR premium, there will be much more uncertainty about how large of an operation is needed to achieve the desired effect. Given that high-quality liquid assets, unlike reserves, are held by a wide range of institutions, the size of operation required to have a meaningful impact on the LCR premium may be much larger than the norm for pre-crisis operations. Precisely how large they would need to be and whether a central bank would be willing to undertake operations of the required size are important open questions.

The final question is the most difficult and perhaps the most important: To what extent does having the central bank "produce" excess LCR liquidity through these types of operations undermine the original goals of the Basel III liquidity regulations? There is an underlying tension between monetary policy and financial stability that runs through much of the discussion above. Consider, for example, how a policy maker might view the arrangement in which a bank subject to the LCR requirement lends overnight to a shadow bank and borrows the same funds back at term. A policy maker focused on monetary policy might view this activity as a positive development, since it will help keep the LCR premium low and stable over time. A low and stable LCR premium, in turn, helps ensure that changes in the overnight interest rate are cleanly transmitted to term interest rates. A policy maker focused on financial stability, in contrast, may view the activity as regulatory arbitrage that undermines the objective of reducing liquidity risk in the financial system. This same tension arises when evaluating the various options a central bank can use to actively influence the LCR premium. The term bond-lending facility described above, for example, seems likely to be helpful for the implementing monetary policy. But will this facility have a cost in terms of financial stability? In other words, is an outcome in which banks hold HQLA that has been borrowed from the central bank equivalent from a financial stability perspective to one in which banks own these assets outright? If not, how should policy makers balance the desire to implement monetary policy effectively against these financial stability concerns?

6. Concluding remarks

As with all new regulations, the Basel III liquidity standards will have unintended consequences and create a new set of policy challenges. While some of these consequences may be difficult to foresee, others can be at least partially anticipated. The Liquidity Coverage Ratio seems likely to have spillover effects onto the process by which central banks implement monetary policy in short-term money markets. These effects may not be apparent for some time, both because the requirement is being phased in gradually and because of the extraordinary policy actions taken by central banks in recent years. In particular, banks in many jurisdictions are currently holding large stocks of high-quality liquid assets in the form of excess reserves, which will tend to keep both the reserve premium p and the LCR premium $\hat{p}$ near zero. When the stance of policy begins to normalize and the size of their balance sheets moves closer to historical norms, however, central banks may face periods when the LCR premium becomes a significant factor. It seems prudent, therefore, to begin planning for such periods and to ask how central banks might change their operational procedures to maintain effective control over interest rates.

The simple framework I have presented here identifies a potentially important policy tradeoff. It shows how a central bank may be able to improve the transmission of monetary policy using operations that change the amount of excess LCR liquidity in the banking system. At the same time, though, these operations might undermine the financial stability objectives that motivated the adoption of the Basel III liquidity standards in the first place. More research – and the development of improved models – is needed to better understand the nature of this tradeoff and to help guide central banks through the challenges that lie ahead.

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