What Binds? Interactions between Bank Capital and Liquidity Regulations

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Abstract

We present a simplified framework in which the risk-weighted capital ratio, the leverage ratio, the liquidity coverage ratio, and the net stable funding ratio are all related to a small set of fundamental bank balance sheet characteristics. Using this framework, we then examine the interactions among the requirements to help understand which are likely to bind and how they affect different bank business models. Our analysis allows us to conclude that the two liquidity requirements almost surely will never bind at the same time and helps us to understand how stress tests can change which capital requirement binds.

Introduction

The regulatory framework embodied in Basel III constrains the composition of banks' balance sheets. It has four parts. Two are related to capital and two to liquidity. The capital regulations include a risk-weighted requirement that forces banks that have riskier assets to hold more capital, as well as an unweighted leverage requirement that ties the level of capital to the overall size of the bank (including off-balance sheet items). These rules, which are designed to ensure sufficient buffers should banks face losses, are the outgrowth of decades of experience dating back to the original agreements in the 1975.[1]

In describing the early days of the Basel Committee, Charles Goodhart (2011) notes that the original intent was to have a liquidity requirement to complement the capital requirement. But international agreement proved elusive until the completion of Basel III in 2010. Current standards include two liquidity regulations, the liquidity coverage ratio and the net stable funding ratio.[2] These rules are intended to ensure that banks can withstand funding reductions such as deposit withdrawals or liquidity demands arising from off-balance sheet activities.

The development and calibration of the four capital and liquidity regulations has largely proceeded independently. While the officials understand the interactions – for example, that higher capital levels reduce liquidity needs – there has been little attempt to study the full interactions between all of them. The purpose of this note is to provide a stylized framework for examining the overall impact of the regulatory system. The main contribution is to describe how the requirements interact so that we can

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[1] See Basel Committee on Banking Supervision (2011).

[2] See Basel Committee on Banking Supervision (2013, 2014).

study why and when which of them is likely to bind. These observations can be helpful understanding how both how bank business models may evolve and how different types of banks will perform in different stress scenarios.

Before getting to the details of our stylized model, it is useful to have a sense of why the requirements are structured the way that they are. To understand the logic behind the capital and liquidity requirements, we need to think about the fundamental functions of a bank. Following Pozsar, Adrian, Ashcroft and Boesky (2012), these are credit transformation, liquidity transformation, maturity transformation, and access to the payments system. Each transformation function generates returns by producing assets with a characteristic that diverges from that of liabilities: credit transformation produces assets that are riskier than liabilities; liquidity transformation, where assets are less liquid than liabilities; and maturity transformation, in which assets are longer term than liabilities. And access to the payments system comes from providing liabilities that are accepted as payment.

A traditional bank performs all of these intermediation functions— funding long-term, illiquid, risky assets with short-term, liquid, safe liabilities. A combination of limited liability and the government safety net (in the form of deposit insurance and other implicit guarantees), can mean that a bank's owners and managers reap the benefits of their success but not the full costs of their failures, so they will tend to engage in too much credit transformation, too much liquidity transformation, and too much maturity transformation; too much relative to what society ideally needs.

Conversely, if information problems hamper the ability of a bank to issue equity, then the scale of intermediation could be lower than society would prefer. Mandating higher capital ratios in this situation could allow them to issue equity that would be free of adverse selection and increase the amount of intermediation. So regardless of whether decentralized allocations lead to too little or too much intermediation, one can imagine a role for regulation.

The liquidity requirements attend to concerns with the levels of liquidity and maturity transformation, with the liquidity coverage ratio (LCR) aimed at the former and the net stable funding ratio (NSFR) at the latter. The capital requirements simply say that equity must be greater than a fraction of the sum of assets, weighted or unweighted by their riskiness. The liquidity requirements are different. The LCR says that a weighted sum of assets must be greater than a weighted sum of liabilities. And NSFR reverses this, stating that a weighted sum of liabilities must be greater than a weighted sum of assets. As we will see, the fact that the LCR and NSFR effectively reverse the inequality between assets and liabilities creates some complications.

A stylized bank balance sheet

To start, consider a bank that has a variety of assets on and off the balance sheet, some liabilities, and capital. It is useful at the outset to divide the assets into to three types: relatively safe, high-quality liquid assets; on-balance-sheet risky assets; and off-balance sheet assets. Since the safe assets include reserves, we label them as R. We take there to be n risky assets, which we label A_i. And the q off-balance sheet assets (converted to the same units as those on the balance sheet) are labelled $OBSA_s$. On the liability side, we assume there are three types of securities – deposits D_j, bonds B_k and equity E. The division of liabilities between deposits and bonds is a short-hand. Deposits are those liabilities that are runnable, so they that are subject to the liquidity coverage ratio (LCR). And bonds are long-term liabilities that provide available stable funding in the computation of the net stable funding ratio (NSFR)

– so "core deposits" would be bonds in our nomenclature. Using this notation, a bank's balance sheet looks like this:

Table 1: A General Bank Balance Sheet	
Assets	**Liabilities**
R	D_1
A_1	D_2
A_2	$\vdots$
$\vdots$	D_p
A_n	B_1
	B_2
$OBSA_1$	$\vdots$
$OBSA_2$	B_m
$\vdots$	
$OBSA_q$	E

To simplify the balance sheet, we define the following aggregates:

$D = \sum_j D_j$, the simple sum of all deposits;

$B = \sum_k B_k$, the sum of long-term liabilities;

$A = \sum_i A_i$, the simple sum of on-balance-sheet risky assets.

$L = \sum_i r_i^A A_i$, the level of on-balance-sheet risk-weighted assets; and

$OBSA = \sum_s OBSA_s$, the total of off balance sheet assets;

Combining these, we can rewrite the balance sheet in Table 1 in the stylized form in Table 2.

Table 2: A Stylized Bank Balance Sheet	
Assets	**Liabilities**
Reserves/HQLA (R)	Deposits (D)
On balance sheet risk-weighted assets (L)	Long-term Liabilities (B)
Other Assets (OA=A-L)	
Off balance sheet assets (OBSA)	Equity (E)

Other assets (OA), is the difference between total on-balance-sheet risky assets (A) and risk-weighted assets (L). Keep in mind that overall accounting identity is that $R+A=D+B+E$, but the balance sheet in

Table 2 allows us to keep track of all the variables that enter the various regulations that we will consider.

Regulatory requirements

We now turn to the capital and liquidity regulations. It is straightforward to write each of the four regulations in terms of the general balance sheet, so we start there. For capital, the risk-weighted requirement says that equity must be equal to or greater than a weighted average of the on-balance-sheet risky assets (A_i) and off-balance sheet assets ($OBSA_j$) , where the weights reflect the riskiness of each item. Taking r_i^A and r_j^O to be the risk weights, the risk-weighted capital requirement takes the form:

1) $$E \geq \gamma \left[\sum_i r_i^A A_i + \sum_j r_j^O OBSA_j \right],$$

where γ is the required ratio, a number like 10%.

Using the same notation, since the leverage ratio applies to all assets – safe, risky and off-balance sheet – we can write it as

2) $$E \geq \delta [R + A + OBSA],$$

where δ is the unweighted leverage ratio requirement, a number like 5%.

Turning to the liquidity requirements, the LCR states that a bank must hold high-quality liquid assets (which have labeled as R) to cover outflows in a 30-day stress scenario measured.[3] It applies both to runnable deposit liabilities and to contingent assets such as committed lines of credit and liquidity needed for derivatives transactions. Defining the l_j's and l_s's as the LCR runoff rates on liabilities and off-balance sheet assets, we can write this as:[4]

3) $$R \geq \sum_j l_j^d D_j + \sum_s l_s^o OBSA_s .$$

Finally, the NSFR states that available stable funding (a weighted average of long-term liabilities) must be at least equal to required stable funding (a weighted average of long-term assets). We can write this as:[5]

4) $$\sum_k a_k^B B_k + \sum_j a_j^D D_j + E \geq \sum_i f_i A_i$$

Where the f_i's are the weights used to compute required stable funding, and the a_k^B's and the a_j^D's are the weights used to compute available stable funding for the two classes of liabilities.

[3] The debate on how to ensure that the liquidity required under the LCR is usable in crisis continues. Goodhart (2008) discusses the problem by analogy with a law that there always has to be one taxi at the train station, so the final taxi in the queue can never be used. As Diamond and Kashyap (2016) note, if the idea of the regulation is to ensure banks can withstand withdrawals, the buffer has to be made useable. If, by contrast, the purpose of the liquidity requirement is to dissuade withdrawals, then usability is less of an issue.

[4] A summary of the LCR run-off rates is in Annex 4 of Basel Committee on Banking Supervision (2013).

[5] A summary of the NSFR weights used to compute required and available stable funding is in Tables 1 and 2 of Basel Committee on Banking Supervision (2014)

Each of these, equations (1) to (4), can be expressed using the simplified balance sheet in Table 2. For the capital requirements, this is straightforward:

(i) $E \geq \gamma(L + \psi\, OBSA)$ risk-weighted capital

where $\sum_j r_j^O OBSA_j \approx \psi OBSA$; and

(ii) $E \geq \delta(R+A+OBSA)$ leverage ratio requirement.

The liquidity requirements are a bit more complicated to write simply. To do it, we make the following approximations:

$$\sum_j l_j^d D_j \approx \alpha D \text{ and } \sum_s l_s^o OBSA_s \approx \omega OBSA,$$

where the parameter α is the average of the LCR runoff rates on runnable liabilities and ω is the average of the runoff rate on off-balance sheet items.

Using these approximations, we can the liquidity requirements as

(iii) $R \geq \alpha D + \omega$OBSA liquidity coverage ratio.

For the NSFR, we need three more approximations,

$$\sum_k a_k^B B_k \approx \eta^B B,\ \sum_j a_j^D D_j \approx \eta^D D \text{ and } \sum_i f_i A_i \approx \beta A.$$

The parameters η^B, η^D and β are averages of the NSFR available and required stable funding factors, respectively. This allows us to write

(iv) $\eta^B B + \eta^D D + E \geq \beta A$ net stable funding ratio.

Finally, we have the balance sheet identity:

(v) $R+A = B+D+E.$

At this point, there are four asset categories (R, L, A and $OBSA$) and three liability categories (D, B and E), for a total of seven variables. To reduce the dimensionality of the problem, we further assume that risk-weighted assets (L) and off-balance sheet assets ($OBSA$) are proportional to the level of on-balance-sheet risky assets:

$$L = \phi A \text{ and } OBSA = \theta A.$$

We suppose that for any given bank φ and θ would be stable over time, though across banks they might differ, perhaps substantially for banks with very different business models. For example, a broker-dealer bank would have very large off-balance sheet positions, while a more traditional commercial bank may not.

This allows us to rewrite the four regulatory requirements as:

(i')	$E \geq \gamma(\phi + \psi\theta)A$	risk-weighted capital,
(ii')	$E \geq \delta[R+(1+\theta)A]$	leverage ratio requirement,
(iii')	$R \geq \alpha D + \omega\theta A$	liquidity coverage ratio,
(iv')	$\eta^B B + \eta^D D + E \geq \beta A$	net stable funding ratio, and
(v')	$R + A = B + D + E$	balance sheet identity.

To examine the joint properties of these, we first normalize equity ($E=1$). This means that all of our quantities – reserves, risk-weighted assets, deposits and long-term financing, are measured relative to equity.

Next, to reduce the dimensionality of the problem further, we use the balance sheet identity. Eliminating B, the quantity of available stable funding, we can then rewrite *(i') to (iv')* as:

$$(i'') \quad \boldsymbol{A} \leq \frac{1}{\gamma(\phi + \psi\theta)}$$

$$(ii'') \quad \boldsymbol{R} + (1+\theta)\boldsymbol{A} \leq \frac{1}{\delta}$$

$$(iii'') \quad \boldsymbol{D} \leq \frac{1}{\alpha}\boldsymbol{R} - \frac{\omega\theta}{\alpha}\boldsymbol{A}$$

$$(iv'') \quad \boldsymbol{D} \leq \boldsymbol{R} + \left(\frac{\beta - \eta^B}{\eta^D - \eta^B}\right)\boldsymbol{A} - \left(\frac{1-\eta^B}{\eta^D - \eta^B}\right)$$

All bold characters (***A*, *D*,** and ***R***) represent quantities that are measured relative to equity.

Implications

The primary point of this short paper is to recognize that based purely on the algebraic manipulations and simple approximations that we have made, it is possible to express the four central regulations of the post-crisis international bank regulations in terms of our three transformed variables. This representation of the regulations delivers several implications that are perhaps surprising.

First, and most obviously, we have four inequalities that restrict three variables. This means one must be redundant. By simply inspecting the final two expressions, it is clear that they cannot hold at the same time. That is, deposits (D) are either bound by the LCR (*iii*") or by the expression that comes from the NSFR (*iv*"). The conclusion is that it is impossible to construct a balance sheet where all four requirements bind simultaneously.

At first this may seem like a feature of the system rather than a flaw. Different banks have different balance sheet composition, so some will naturally be bound by one set of regulations, while others will be bound by a different set. The existence of overlapping and potentially redundant rules ensures that all institutions will have sufficient capital and liquidity buffers regardless of the structure of their business. But is this really the case?

It is often said that the LCR and the NSFR should be thought of as complementary regulations, where the LCR provides short-term stability that safeguards an institution against a run and the NSFR buys time

that could facilitate a resolution (or recapitalization) of a distress institution. The algebra that we have presented suggests this is not quite right. Instead one of them may be a binding constraint, while the other will be slack.

Second, looking across all 4 regulations it seems likely that the tightness of the different regulations will vary according to banks' business models. For instance, it is well understood that banks with large off-balance sheet positions or large amounts of high quality liquid assets, are more likely to be constrained by the leverage ratio than by the risk-weighted capital ratio. In some sense, the whole purpose of the leverage ratio is to make sure that banks that must hold some capital even if they have relatively few assets that are subject to credit risk.

The perhaps unintended consequence of this is that there is a spillover whereby the relative tightness of the capital regulations can influence which of the two liquidity regulations that are likely to be more onerous. Put differently, it is at least possible that because a bank is tightly bound by the leverage requirement, it might find itself facing very slack constraints on liquidity (or vice versa). If this were to be true, that will create incentives for a bank in that position to begin expanding into businesses that are liquidity intensive precisely because the costs to doing so would be especially low. So qualitatively this creates a force for banks to become more homogeneous. We can't say whether such incentives would promote financial stability, but it is presumably helpful to understand how they are working.

Finally, the interdependencies in the regulations can become relevant during the kind of stress tests that have been an important part of the macroprudential policy tool kit. In many jurisdictions, banks are required to undergo assessments of how the impact of macroeconomic scenarios on their level of capital. Typically the scenarios are intended to represent tail events where large dislocations are presumed in either financial markets or the aggregate economy (or both). If all banks can survive a simultaneously, common simulated severe adverse macroeconomic event and still meet regulatory requirements, the presumption is that the system as a whole is safe.

In principle, this surely makes sense. But in practice, we wonder whether the existence of overlapping requirements makes it very difficult for banks to do business. To see what we have in mind, consider a case in which the stress-test scenarios creates severe ratings downgrades for municipal and corporate credits. To give some sense of what can happen, note that under the standardized approach for assigning risk weights a downgrade of a corporate credit from AA- to BBB+ results in an increase in the risk weight from 20% to 100%.[6] That is, a four-notch downgrade increases the capital charge on a corporate bond by a factor of five!

The adverse scenarios in the stress tests typically include quite deep recessions – GDP drops, unemployment rate increases, house price declines, falling equity markets and rising corporate bond rates. So, while a large rating downgrade would naturally be a part of the scenario. But since the ratio of the risk-weighted capital ratio is roughly twice the leverage ratio, it is fairly easy to see how, if the capital charge on some assets quintuples, a bank that is constrained by the former at the start of the stress test could end up constrained by the latter. Is this the intent of the regulation that banks be constrained by one requirement in normal times and a different requirement under stress?

[6] Exhibit 29 in Moody's Investor Services (2016) reports that, over the 1983 to 2016 period, the one-year migration of a corporate bond from Aa3 to Baa1 (their equivalent of a shift from AA- to BBB+) averaged 0.251%. That is, roughly 1 in 400 bonds experiences such a downgrade in a given year.

Conclusions

We hope Charles appreciates our attempt to simplify the interpretation of these regulations in order to study their impact. His ability to cut through the details of complicated problems to provide guidance to policymakers is one of his many remarkable skills and has been an inspiration to all of us. We leave it to others to decide whether the properties that we have uncovered are desirable or not.

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