Simplifying Basel III:
On the Interactions Between Capital and Liquidity Requirements

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Abstract

The centerpiece of the Basel bank regulations is a set of two capital regulations and two liquidity regulations. All four requirements share a common algebraic formulation: each states that the weighted average of a bank's assets must be either greater than or less than the weighted average of its liabilities. This implies that at most one capital and one liquidity requirement can bind at a time. Using this framework, we show that regulators can tighten requirements *either* by strengthening risk-weighted capital requirements *or* by increasing liquidity coverage ratio requirements. That is, capital and liquidity requirements act as substitutes. This framework helps organize discussions on regulatory reform, especially those seeking to simplify the rules without reducing resilience. Applying it to 87 of the largest European banks, we find that most are closest to a combination of the risk-weighted capital requirement and the liquidity coverage ratio requirement. We discuss what this implies for the ongoing debate over regulatory reform. Finally, we show that composite capital and liquidity stress tests can differ substantially from individual ones.

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I. Introduction

Commercial banks provide a variety of services. One critical function is to screen and monitor borrowers to provide loans that increase the overall supply of credit beyond what it would be if savers could only lend directly. In addition, they create demandable claims that support payments and contingent credit via loan commitments. But this structure, the issuance of runnable liabilities to fund the purchase of risky assets, makes banks fragile. This fragility leads to well-known externalities – bank runs, fire sales and credit crunches to name a few. The response, embodied in the Basel III standards, is a set of four regulatory ratios, two relating to capital and two relating to liquidity, that seek to limit the externalities.

Importantly, standard setters developed capital and liquidity regulations independently. That is, without explicit consideration for how they might interact. Policymakers are now actively debating whether the requirements are overly complicated and whether it is possible to simplify them without compromising the improved resilience these rules have delivered.[1] This paper offers a framework for thinking about these tradeoffs.

To see the challenge in concrete terms, consider the capital regulations. Each one may seem straightforward on its own, but the implementation is quite complex. There are at least three concepts of capital (common equity, tier 1, and total) and two of assets (with and without risk weights). On top of this, banks face various buffers (for systemic risk, countercyclical purposes, and institution-specific supervisory add-ons). Banks rightly complain that compliance with this system is difficult and costly. Seeking some simplification is natural.

Simplification, however, must begin with a holistic view of the requirements to determine which are necessary and which may be redundant. Continuing to develop regulations in isolation, without an encompassing framework, risks creating a system with inefficient overlaps and overlooked vulnerabilities.[2]

To put it slightly differently, the regulatory system is like a complex machine. Before removing any parts, you need a map of the whole device — a holistic view showing how the parts interact — so you can tell which components are redundant and which are load-bearing (the binding constraints).

In this paper, we develop a unified framework for capital and liquidity requirements that helps us to understand how they interact.[3] We then use this structure to interpret ongoing debates over regulatory reform. We start by observing that we can express each capital and liquidity requirement as a simple linear inequality in which the weighted average of a bank's liabilities must be greater than (or less than) the weighted average of its assets. This is obvious and well-understood for the two capital requirements: the leverage ratio requirement (LEV) and the risk-weighted assets requirement (RWA). They each state that a weighted average of assets must be less than the bank's equity funding.

The same is true for the liquidity requirements. To see this, note that the liquidity coverage ratio (LCR) requires that the weighted average of liabilities (outflows under stress) be less than the weighted average of assets (safe assets designated as high quality). Similarly, the net stable funding ratio (NSFR)

[1] See, for example, ECB (2025a, 2025b), EBA (2025), Clerc et al. (2025) and Federal Reserve Board (2026).
[2] Recent analysis in EBA (2024) identifies such overlaps and potential duplications between capital (going concern) and resolution (gone concern) rules.
[3] This paper extends the framework in Cecchetti and Kashyap (2018).

states that a bank's required stable funding (a weighted average of assets) must be less than available stable funding (a weighted average of debt plus equity).

As we show, when combined with the simple balance sheet identity – that assets must equal debt plus equity – the arithmetic structure of the requirements implies that only one capital requirement and only one liquidity requirement can bind at a time.[4] The first of these is a statement of the obvious: either the leverage ratio or the risk-weighted capital requirement binds, not both. The second point is subtler, but as we show, except in very unusual circumstances, only one of the liquidity requirements binds at a time.

We proceed by deriving a set of conditions that express all four requirements as restrictions on combinations of (i) the degree to which the bank's funding comes from non-equity sources, i.e., deposits and bonds (debt) and (ii) the riskiness of the bank's assets. Combinations in which a significant fraction of a bank's funding is runnable, and the bulk of its assets are very risky, make a bank exceedingly fragile. The regulatory requirements aim to prevent banks from pursuing this type of balance-sheet configuration. In doing so, however, the constraints can exclude certain types of business models. We ask whether this is a feature or a bug.

The remainder of the paper has two main parts. In the first, we present a stylized model of a bank balance sheet to show how to express the capital and liquidity requirements in a unified fashion. Assuming a bank maximizes its return on equity, we can use this description to identify the combination of debt funding and asset riskiness that maximizes profits. A bank that is maximizing its return on equity will operate at a point where one capital requirement and one liquidity requirement bind, and the other two are slack.

We then turn to data on EU banks, examining their balance sheet composition to see which requirements are more relevant for distinct types of banks. Using data for 87 of the largest European banks, we show that the RWA and LCR requirements are the two most relevant constraints. Indeed, moderate increases in LCR run-off rates would suffice to make the NSFR redundant for every bank in the sample. We then examine stress tests, calculating for each bank the maximum sustainable capital loss before hitting the risk-weighted capital requirement and the maximum deposit outflow before hitting the liquidity coverage ratio requirement. Finally, because capital and liquidity requirements are substitutes, we compare individual stress tests with a composite test that combines the two. Considering the requirements jointly makes a substantial difference, especially for capital stress.

[4] The statement that only one capital requirement binds is true even if we were to consider the various requirements that utilize alternative measures of capital.

II. Related Literature

Regulators and industry groups have actively debated the efficacy and costs of the Basel regulations. Much of this debate focuses on simplifying the rules. For example, in December 2025, the European Central Bank's High-Level Task Force on Simplification published 17 recommendations, which the ECB's Governing Council endorsed (ECB 2025). These recommendations aim to streamline the regulatory, supervisory, and reporting framework while maintaining bank resilience. In the United States, where policymakers have not yet finalized the Basel III rules, the banking regulators are requesting comments on their proposed reforms.[5] These efforts reflect a recognition that the rules, as implemented in most jurisdictions, are exceedingly complex and cumbersome. The debate focuses on compliance costs rather than on whether the requirements contain redundancies. Importantly, concerns about how regulators have calibrated capital levels also drive some of the push for reform. Cecchetti, Kress, and Schoenholtz (2025) provide a comprehensive assessment of the Basel III Endgame debate, demonstrating how industry opposition effectively stalled the US implementation of international standards. They argue that the debate unnecessarily conflated two distinct questions: whether the United States should comply with international regulatory standards and whether it should raise capital requirements for large banks. The EBA (2024) identified overlaps and potential duplications between capital (going concern) and resolution (gone concern) rules, providing further impetus for simplification.

An emerging body of literature that examines interactions among bank regulatory requirements is more directly relevant to our analysis. The March 2023 banking turmoil, which saw the failure of Silicon Valley Bank and Credit Suisse, prompted the Basel Committee (2023) to issue a comprehensive report documenting how business model vulnerabilities and supervisory shortcomings contributed to these failures. The report emphasizes that a rules-based approach alone cannot appropriately identify, assess, and mitigate key risks to bank safety and soundness—supervisory judgment must complement minimum standards.

Vo (2021) surveys the growing literature on interactions between capital and liquidity requirements. Several recent papers are particularly relevant. Clerc, Lecarpentier, and Pouvelle (2025) analyze how a bank with a mean-variance objective function maximizes profits in the face of two capital and two liquidity regulations. They estimate the impact of these different regulatory requirements on lending growth using a panel of 54 French banks since 2014. Their results indicate that four pairwise interactions, most involving the leverage ratio, significantly affect lending growth. They find that requirements are more likely to interact when banks have low regulatory ratios and during periods of financial stress. More specifically, their results highlight a significant partial substitutability among the leverage ratio, the LCR, and the NSFR for weakly capitalized banks during stress periods.

Behn, Corrias, and Rola-Janicka (2019) examine the interaction between the LCR and NSFR for euro area banks and conclude that the two liquidity requirements are complementary, constraining different types of banks in different ways. Our analysis reaches a different conclusion: while the two requirements do bind for different banks, we show that a modest tightening of the LCR would bring the NSFR-bound banks inside the LCR constraint as well. Sundaresan and Xiao (2024) investigate how liquidity regulation

[5] See https://www.federalreserve.gov/newsevents/pressreleases/bcreg20260319a.htm for an overview of the proposals.

affects bank lending and provide evidence that the LCR requirement significantly reduced liquidity risks at regulated banks. However, they also find that the mandated liquidity buffer appears to crowd out bank lending and to shift liquidity risks to banks not subject to liquidity regulation. Sharma and Chauhan (2023) examine data from 688 commercial banks in 10 developing economies from 2014 to 2021 and find that bank lending responds positively to regulatory capital and the LCR, but negatively to the NSFR. These findings suggest that short-term and long-term liquidity requirements affect bank behavior differently.

Xing, Wang, and Stanley (2020) investigate interactions between capital and liquidity regulation and find that the impact depends on banks' balance sheet structure and business models, focusing on how the regulations affect the money supply rather than lending or risk-taking. Buckmann et al. (2023) show that capital and liquidity regulations help identify weak banks that failed during the global financial crisis. Hirtle and Plosser (2026) show that studying funding risks for bank liabilities simultaneously with credit and interest rate risks for bank assets yields a very different picture of overall bank risk. Their stressed "economic capital" variable, which embodies these adjustments, does a much better job of predicting banks that fail compared to standard regulatory variables.

Finally, we note that the Basel Committee on Banking Supervision's most recent monitoring report (BCBS 2024), finds that in mid-2023 the weighted average LCR stood at 134.8% for a group of 112 large internationally active banks, and 200.8% for a group of 65 smaller banks, while the weighted average NSFR remained stable at around 123.7% for the group of large banks—all well above minimum requirements.

III. The setup

Our goal is to characterize the four Basel III regulatory requirements in a comparable way. To do this, we start with a stylized balance sheet with two categories of liabilities, debt (deposits plus bonds), and equity, and two types of assets (high risk and low risk).

In the appendix, we show that this simplification comes with no loss of generality. In particular, one can start with a much more granular collection of assets and liabilities and then aggregate them into the categories we analyze in the body of the paper. For instance, a bank may hold many different types of high-risk assets, but the regulations specify how to treat each, so we can collapse them into a single composite variable.

To see how our framework works, we begin with a stylized balance sheet (normalizing total assets to 1):

Table 1: Stylized Balance Sheet

Assets		Liabilities + Equity	
Low Risk	$1-\phi$	**Deposits + Bonds**	β
High Risk	ϕ	**Equity**	$1-\beta$

We define three quantities:

ϕ = ratio of high-risk assets to total assets
β = the share of deposits plus bonds in total funding
$1-\beta$ = the share of equity in total funding

In what follows, we refer to non-equity funding, deposits plus bonds (β), as *debt* financing.

Our goal is to characterize all four requirements as restrictions on two quantities — the share of high-risk assets a bank holds and the share of debt financing it chooses — and to show how these constrain combinations of ϕ and β. We do this first for the two capital requirements, and then for the two liquidity requirements.

A. Capital requirements

Capital requirements depend on three regulatory parameters:

$\mathcal{L}$ = the leverage ratio requirement
$\mathcal{R}$ = the risk-weighted asset requirement
μ = the risk weight for risky assets

The **leverage ratio requirement** states that the share of equity in total assets (which is also total debt plus equity), 1-β, must be less than or equal to the leverage requirement, $\mathcal{L}$:

(1) $(1-\beta) \geq \mathcal{L}$.

To facilitate comparison with the other regulations, we rewrite this as:

(2) $\beta \leq (1-\mathcal{L})$. (LEV)

Next, we can write the **risk-weighted requirement** as:

(3) $(1-\beta) \geq \mathcal{R}(\mu\phi)$.

This says that the percentage of equity must also exceed a percentage $\mathcal{R}$, based on risk-weighted assets (the product of the regulatory risk-weights μ and the share of risky assets ϕ). So

(4) $\beta \leq (1-\mathcal{R}\mu\phi)$. (RWA)

This constraint is a bit subtler than the leverage regulation because it connects the level of debt financing to the structure of the asset side of the balance sheet. The asset structure must be such that, for a given level of equity, the RWA constraint is satisfied.

Below, after describing the data, we discuss managerial balance sheet choices that leave banks operating at some distance from their minimum regulatory requirements. For now, we say that one ratio is "binding" relative to another based purely on the gaps between observed ratios and regulatory requirements. We recognize that managerial preferences can create headroom relative to different requirements that may also be empirically important in shaping bank behavior.

In the context of these two regulations, which constraint is closer to binding depends on comparing the leverage ratio requirement ($\mathcal{L}$) to the product of the risk-weighted capital requirement ($\mathcal{R}$), the risk weight on risky assets (μ) and the percentage of risky assets (ϕ). For indicative values, such as a leverage ratio of 0.03, an RWA requirement of 0.12, and an average risk weight (or risk weight density) of 0.5, the cut-off at which the relevant constraint switches is 0.5. With low percentages of risky assets, and these indicative values of $\mathcal{L}$, $\mathcal{R}$ and μ, the LEV requirement (2) will be binding. Once ϕ exceeds 0.5, then the RWA requirement becomes relevant and the formula in (4) binds.

B. Liquidity requirements

The liquidity requirements are a bit more complicated because the **liquidity coverage ratio** and the **net stable funding ratio** depend on a number of regulatory parameters. Table 2 displays the full set of these, and for completeness, includes the average risk weight on high-risk assets (μ) that plays a role in the risk-weighted capital requirement.

Table 2: Stylized Balance Sheet with Regulatory Parameters

Assets					Liabilities + Equity			
	Fraction of Total Assets	Risk Weight	HQLA weight	Required Stable Funding		Fraction of Total Assets	Run-off rate	Available Stable Funding
Low Risk	1-ϕ	0	ω	0	**Deposits + Bonds**	β	α	δ
High Risk	ϕ	μ	0	η	**Equity**	1-β	0	1

The parameters for the liquidity requirements are as follows[6]:

α = the run-off rate for deposits plus bonds for the LCR
ω = the fraction of safe assets that count as high-quality liquid assets for the LCR
η = the fraction of high-risk assets that require stable funding for the NSFR
δ = the fraction of deposits and bonds that serve as available stable funding for the NSFR
(Note that equity is 100% stable funding.)

We can now express the liquidity coverage ratio and the net stable funding ratio as functions of these parameters in a form that allows us to further restrict the combinations of β and ϕ that comply with the regulations.

The LCR states that runnable liabilities – the fraction of debt financing (β) times the runoff rate (α) – must be less than the quantity of high-quality liquid assets (1-ϕ)ω:

$$(5)\quad (1-\phi)\omega \geq \alpha\beta$$

Which we rewrite as

$$(6)\quad \beta \leq \frac{(1-\phi)\omega}{\alpha} \qquad \text{(LCR)}$$

Looking at equation (5), we see that the (β,ϕ) combinations that meet the LCR shrink or grow depending on the ratio of the run-off rate relative to the degree to which safe assets count as HQLA, (α/ω). As this ratio rises, the value of ϕ that is consistent with β=1 falls.

[6] For expositional purposes, we are assuming that high-risk assets do not count at all towards the HQLA and that there are no off-balance sheet assets. We relax these assumptions when we move to our empirical calculations. See Appendix 2 for details.

Finally, the NSFR states that available stable funding – equity plus a fraction δ of debt financing – must be at least as large as required stable funding:

(7) $\delta\beta + (1-\beta) \geq \eta\phi$.

This implies that

(8) $\beta \leq \frac{1-\eta\phi}{1-\delta}$. (NSFR)

Equation (8) gives the combinations of (β,ϕ) that move along a line that depends on the required and available stable funding factors (η,δ). For example, the higher the required stable funding factor for a given available stable funding factor and fraction of high-risk assets, the more equity funding the bank needs to meet the requirement. Similarly, the higher the available stable funding factor, for a given required stable funding, the less equity funding the bank needs.

As mentioned earlier, our stylized balance sheet intentionally aggregates assets and liabilities into four simple quantities. Realistically, banks hold a broad array of assets and issue numerous types of debt. Each asset has its own risk weight (μ), its own level of required stable funding (η), and its own fraction that qualifies as HQLA (ω). Similarly, for deposit and bond liabilities, each has its own run-off rate (α) and fraction that qualifies as available stable funding (δ). As we show in Appendix 1, our representation implies that each parameter in the simple model is a quantity-weighted average of the more detailed parameters the bank faces. That is, the various parameters in the model – μ, ω, α, and δ – are (hyper)parameters that the bank can change (within limits) by adjusting the composition of its underlying assets or the composition of its debt financing. This means that the algebraic expressions for the four requirements – LEV, RWA, LCR, and NSFR – are bank-specific.

While we could write the model in a more granular form, the added complexity does not yield additional insights. To see why, consider the case of the risk-weight for risky assets (μ). As we show in Appendix 1, the parameter in the simple model is a share-weighted average of the individual assets' underlying risk weights. We could then ask how the requirements change when an underlying risk weight changes. But since banks can control the composition of their assets – and, for banks using the internal ratings-based approach (IRB), can influence the risk weights themselves – we cannot answer this question without additional assumptions about bank behavior. Similarly, for liquidity requirements, banks will adjust the composition of their balance sheets in response to changes in run-off rates, HQLA weights, and the like. So, absent additional information, we also cannot isolate the impact of changing these regulatory parameters. Of course, the more granular representation does permit us to make the empirical calculations match the actual regulatory requirements.

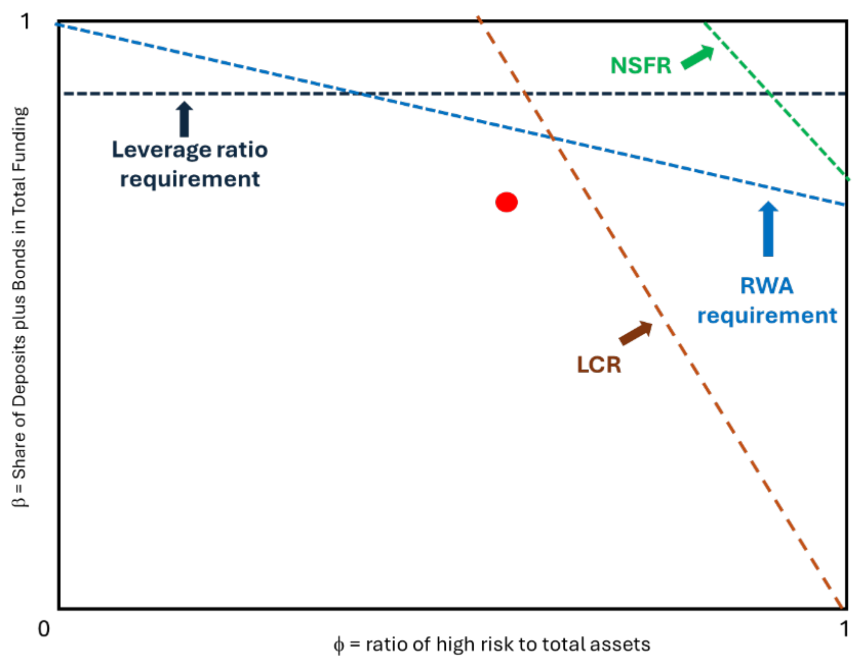
C. Putting the capital and liquidity requirements together

Looking at the expressions for the four requirements – equations (2), (4), (6) and (8) – we see that they are all functions of two quantities: the share of liabilities in total funding (β) and the ratio of high risk assets to total assets (ϕ). This means that we can draw them in a simple two-dimensional diagram with ϕ on the horizontal axis and β on the vertical axis. Both ϕ and β are shares of total assets, so each lies in the unit interval.

Figure 1 shows a representative case, where we represent each requirement as a dashed line. To see how this works, we consider each requirement in turn. Starting with the leverage ratio requirement, this is the dashed black horizontal line at the point where β is equal to one minus the requirement. That is, the line shows $\beta=(1-\mathscr{L})$. So, if the leverage ratio requirement is 3%, this line will be horizontal at 0.97. The requirement implies that the bank must operate in the area below this line.

Next comes the RWA requirement – the light blue dashed line. When the bank holds no risky assets at all (and since we ignore operational risk), the requirement allows the bank in this limiting case to operate without any capital funding. That is, the line goes through the point where ϕ=0 and β=1. As the share of risky assets increases, so we move to the right in the figure, the amount of required capital increases. Looking at equation (4), we see that the slope of this line is the product of the risk-weight (μ) and the risk-weighted requirement level ($\mathscr{R}$). Again, to meet this requirement, the bank must operate in the region below the light blue dashed line.

Figure 1: Representative case for capital and liquidity requirements



Source: A representative case based on equations (2), (4), (6), and (8). The red dot is the hypothetical location of a representative bank.

Turning to the LCR in equation (6), note two things: higher equity means lower deposit plus bond funding, and more risky assets mean fewer safe assets that count as HQLA. As the fraction of bonds and deposits falls, the amount of safe assets can fall, and the share of risky assets can rise. When there are no safe assets left, the bank must be entirely equity financed. The bank must operate to the left of the brown dashed line.

Finally, we have the NSFR, the dashed green line. The slope of the line depends on the required levels of stable funding and the amount of available stable funding. The location of the NSFR relative to the other three constraints, however, is complicated. It may or may not intersect the LCR, and if it does, its slope can be steeper or flatter than that of the LCR. In Figure 1, we draw the most common case where the

NSFR constraint lies entirely above and to the right of the LCR. In this configuration, provided a bank complies with the other regulations, the NSFR never binds.

Keep in mind that virtually all the parameters in our simple model – the average risk weight on high-risk assets (μ), the run-off rate on deposits plus bond liabilities (α), the HQLA weight (ω), and even the risk-weighted capital requirement ($\mathcal{R}$) – vary across banks. That is, each individual bank will have its own version of Figure 1.

D. Implications of the model

Before turning to the data, we make a few observations. First, a bank will be bound by at most one capital and one liquidity requirement. To understand why, consider the case of the bank operating at the point shown by the red dot in Figure 1. This bank is inside the allowable area. As the bank moves up and to the right, it will eventually hit either the RWA, the LCR, or the point where the two lines cross.

Second, provided that no constraints are binding, the bank has voluntary/managerial buffers. For the hypothetical representative bank in Figure 1 (the red dot), the vertical distance to the RWA line and the horizontal distance to the LCR measure these buffers. These are only buffers relative to the requirements we consider here. Banks may be bound by some other balance sheet requirement. For example, EU banks face a minimum requirement for own funds and eligible liabilities (MREL) that we discuss below.[7]

Third, capital and liquidity requirements operate as substitutes. To see why, imagine that regulators desire to further de-risk bank balance sheets, increasing some combination of capital and high-quality liquid assets, and in this way moving banks down and to the left in the figure. Two straightforward ways to do this are through tightening either the risk-weighted capital requirement (RWA), or the liquidity coverage ratio (LCR).

Figure 2 shows how this works. Tightening the RWA by increasing the product of risk weights and the capital requirement $\mathcal{R}\mu$ rotates the dashed blue line to the left (clockwise). With the rotation, the RWA line cuts through the LEV line further to the left, making it less likely that the leverage ratio requirement is the tighter capital constraint.

Turning to the liquidity requirements, tightening the LCR by increasing the run-off rate, α,rotates the brown line down (counterclockwise). While it is not immediately apparent, given the way we have drawn this picture, tightening the LCR also makes it less likely that the NSFR will be the tighter constraint for the bank.[8]

Putting these observations about the RWA and LCR requirements together, we note that if authorities wish to further constrain bank balance sheet composition, they can do it either by tightening the risk-

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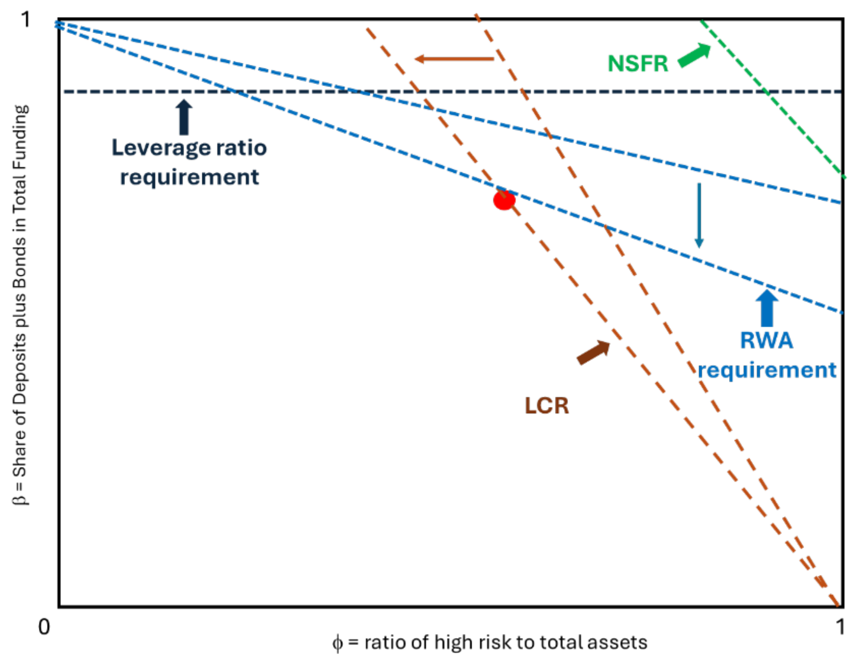
[7] In our formulation, the MREL requirement looks quite a bit like the NSFR, except that it is potentially far more likely to be further toward the origin and thus potentially binding.

[8] If the green line is further down and to the left, intersecting the brown LCR line and one of the capital requirements, tightening the LCR so that it rotates counterclockwise clearly makes it less likely that the NSFR will come into play.

weighted capital requirement or by tightening the liquidity requirement. These two operate in very similar ways, so at the aggregate level we can think of them as substitutes.[9]

Figure 2: Tightening Risk-weighted capital and the Liquidity coverage ratio requirements



Source: A representative case based on equations (2), (4), (6), and (8). The shifts in the RWA and LCR lines are examples, and the red dot is the location of a representative bank.

Finally, and related to the previous point, we note these observations also have implications for capital and liquidity stress tests. Capital stress tests do two things: they impose losses on the bank, increasing the share of debt funding and increasing risk weights. The first moves the red dot in Figure 2 up and to the left, while the second rotates the RWA line clockwise. Similarly, liquidity stress tests involve a combination of deposit outflows and increases in the run-off rate α.[10] This moves the red dot in Figure 2 down and to the right, while rotating the LCR counterclockwise. These facts can be helpful to keep in mind in considering the design of stress tests.

[9] Of course, from the point of view of the different bank business lines, they are not perfect substitutes. For example, tighter RWA requirements tend to discriminate against riskier forms of lending, such as loans to highly leveraged or unrated corporates. Higher leverage ratio requirements reduce the banks' ability to hold low-risk assets, such as government bonds, securitized loans, or repo lending. And more stringent liquidity rules limit the banks' ability to invest in long-maturity or other less liquid assets, or the use of less stable wholesale funding sources. Thus, by adjusting the different rules, the regulators can try to steer the composition of the banks' balance sheets in certain directions.

[10] For a discussion of liquidity stress tests, see Baudino et al. (2024).

Summing up, there are three primary ways regulators can keep banks from operating in the top right corner of the figure, where they have both volatile funding and high levels of risky assets. Authorities can

1) increase the leverage ratio requirement, shifting the black line down (not shown in the figure);
2) increase risk weights or the RWA requirement, rotating the blue line clockwise;
3) increase run-off rates (or restrict HQLA eligibility), rotating the brown line counterclockwise.

From an individual bank's perspective, the quantitative impact of each of these will depend on the bank's balance sheet composition and business model.[11]

E. Bank profit maximization

Finally, what drives a bank to pursue combinations of risky assets and runnable debt that push it towards the top-right corner of Figures 1 and 2? Suppose that a bank chooses the levels of β and ϕ, the share of deposit funding and the ratio of risky to total assets, to maximize only its return on equity. With information on interest income associated with low- and high-risk assets, as well as the interest cost for deposit and bond liabilities, we could add negatively sloped iso-profit lines to Figures 1 and 2. Since risky assets have a higher expected return than safe assets, and debt has a lower cost than equity funding, profits increase as the bank moves up and to the right in the diagram. So, in the absence of any constraints, the bank will operate as close to the top-right corner as possible – that is, the profit-maximizing balance-sheet configuration. With the regulatory constraints – and without any buffers – the bank will instead choose to operate at the point where the iso-profit line is tangent to the boundary of the region outlined by the combined regulatory constraints.

[11] There is also the possibility of making the NSFR more restrictive by either increasing required stable funding factors or reducing available stable funding factors. But as we will see, empirically the NSFR currently plays virtually no role, so we ignore this possibility.

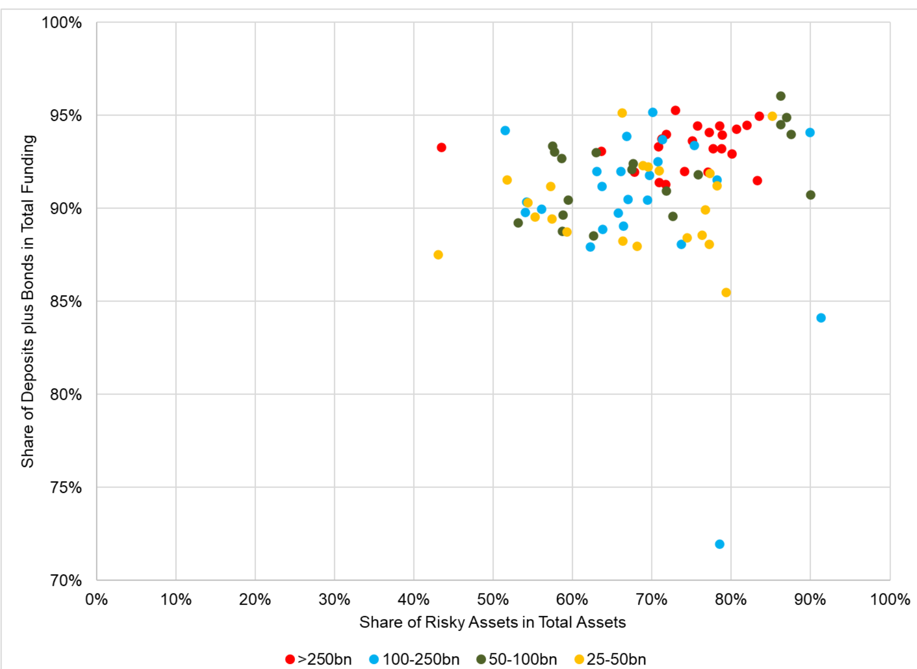
IV. Empirical Exploration

Using information from the end of 2024, we apply the insights from our simple setup to describe 87 of the largest banks in the European Union. These banks all have assets of €25 bn or more and account for over 92% of the EU banking system's total assets of € 28.5 trillion.[12]

Starting with the raw data, in Figure 3 we plot the fraction of risky assets (ϕ) on the horizontal axis against the fraction of deposits plus bonds (β) on the vertical axis.[13] The 24 largest banks, those with assets exceeding €250 billion (red dots), tend to be in a narrow vertical range from 91% to 95% (meaning that their equity funding accounts for 5% to 9% of total assets). The next group, the 24 banks with assets between €100 and €250 billion (blue dots), have a much broader range from 72% to 95%. The remaining banks, those with assets of less than €100 billion (which account for about 10% of total assets), are even more diverse.

The working hypothesis is that as profit-maximizing banks move up and to the right in the figure, they have less stable funding, less loss-absorbing equity, and more risky assets. So, the goal of regulation is to move banks down and to the left. The banks in the upper right, say with more than about 80 % risk assets and more than 93 % deposits plus bonds, seem exceptionally risky.

Figure 3: Raw data by size category



[12] As is the case in many jurisdictions, the EU banking system is very highly concentrated, with the top 10 banks accounting for more than half of total assets, and the top 25 accounting for 75% of total assets.

[13] We draw our data from separate templates of the common reporting (COREP) framework designed for other purposes. So, to make them compatible with our simple model, we need to make a series of approximations and simplifications before recalculating the various balance sheet quantities required for our analysis. That is, we recomputed the Tier 1 ratio, leverage ratio, LCR, and NSFR consistently for every bank in the sample.

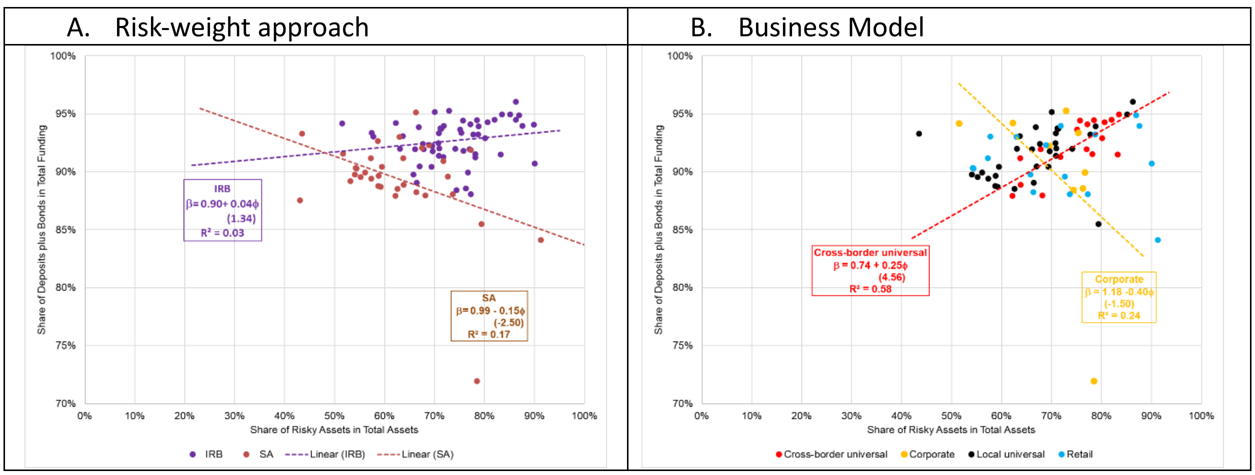
Source: Authors' calculations using EBA data.

Interestingly, although the largest banks generally have less equity, there is quite a bit of dispersion in the share of risky assets even among these banks. Once we restrict attention to the region of the figure that includes only the exceptionally risky banks, there are banks from all four size groups in it. This leads us to consider other characteristics of the data.

A. Classifying banks by risk-weighting approach and by business model

In addition to size, we can also divide banks using two other classification schemes: by the risk-weighting approach they use and by their business model. Banks can choose between two methods to determine the risk weights that form the basis for their RWA calculations. Under the standardized approach (SA), risk weights come from a common scheme that supervisors calibrate; under the internal ratings-based (IRB) approach, banks estimate the key regulatory parameters using internal models approved by supervisors. In our sample of 87 EU banks, 32 use the standardized approach, and 55 use the IRB method. Second, following Cernov and Urbano (2018), we classify 74 banks into four broad categories: cross-border universal banks, local universal banks, corporate banks, and retail banks. The remaining 13 banks are either very specialized niche models or not straightforward to classify.[14]

Figure 4: Banks by risk-weighting approach and business model



Source: Authors' calculations using EBA data.

In Figure 4, we plot the raw data for the banks in each group. Panel A divides the full sample into the SA and IRB banks, while Panel B divides them by business model. The IRB banks tend to cluster towards the top-right, with riskier assets and less equity funding than the SA banks. Remarkably, all of the exceptionally risky banks are IRB banks. The bulk of the exceptionally risky banks tend to be universal

[14] Cernov and Urbano (2018) identify 14 categories: Cross-border universal banks, Local universal banks, Consumer credit banks (including automotive banks), Cooperative banks/ savings and loans associations, Savings banks, Mortgage banks taking retail deposits, Mortgage banks not taking retail deposits – pass-through financing, Private banks, Merchant banks, Leasing and factoring, Public development banks, Central counterparties (CCPs), Custodian institutions, including central securities depositories (CSDs), Pass-through financing (excluding mortgage banks). We merge these into four categories and omit the banks labeled as "other" or "not classified". The 13 banks whose business models we are unable to categorize primarily use the standardized approach and have low levels of risky assets.

banks, though there is a mix of cross-border and local varieties, and both a single retail bank and a single corporate bank operate in that region.

In each panel, we add simple linear regression lines to show how banks of different types vary. For the SA banks (brown dots), we see that there is a clear negative correlation between the percentage of debt funding and the fraction of risky assets.[15] In other words, the SA banks that are taking more risk on the asset side of the balance sheet also have more equity in their funding mix. This is consistent with the intent of the post-GFC regulations. There is no slope for the analogous line for the IRB banks (purple dots). So, for these banks, the differences in capital funding do not reflect the degree of asset risk.

To keep Panel B readable, we show only the regression lines for universal cross-border banks and the corporate banks – the slopes for the other two categories are insignificantly different from zero. The corporate banks show no significant relationship between the share of risky assets and debt funding. In contrast, the slope for the universal cross-border banks is *positive*. Moreover, the R^2 of that regression line is 58%, indicating a strong correlation. This implies that, among this set of banks, those that take more asset risk have also been able to fund themselves with more bonds and deposits. Although such banks may be very profitable, our presumption is that this pattern would not please regulators.

Interestingly, if we replace ϕ with the actual risk-weighted asset ratio on the horizontal axis, the positive slope for cross-border universal banks reverses — these banks line up along a downward-sloping line, as if operating along their RWA constraint. One interpretation is that these banks use the flexibility of the IRB approach to calibrate their risk weights so as to operate close to the constraint, creating more flexibility in choosing their preferred combination of asset risk and leverage.

We can use diagrams like these to examine which constraints appear more important for each type of bank. To do this, we construct a set of composite banks where we calculate total-asset-weighted averages of the various regulatory ratios. We do this using the more granular, extended model described in Appendix 2.[16]

The six panels of Figure 5 show the results. Several common themes emerge. First, the RWA requirement is always below the LEV requirement. Therefore, if we consider going straight up in the figure, the bank hits the RWA constraint before it hits the LEV constraint. Second, the LCR lies to the left of the NSFR line. Thus, if we move horizontally to the right, the bank hits the LCR requirement first. For IRB banks in particular, the NSFR line lies considerably to the right of the LCR line. These impressions do not merely reflect the aggregation into composite bank types. We can draw a similar picture for each of the 87

[15] The slope of the regression line for SA banks remains negative and significantly different from zero even when we drop the couple of observations that have the most extreme values for ϕ or β.

[16] The extended model makes the following adjustments: (1) we include off-balance sheet exposures and deductions from equity associated with high-assets in the computation of the leverage ratio, (2) we allow for a risk weight on low-risk assets in the computation of the RWA, (3) we allow both low- and high-risk assets to have a weight in the computation of HQLA for the LCR, (4) we allow high-risk assets to generate inflows for the LCR, and (5) we allow both low- and high-risk assets to require some amount of stable funding in the computation of the NSFR. See Appendix 2 for details.

banks and do the same exercise. When we do, 71 of the 87 banks are closer to the RWA constraint than the LEV constraint, and 72 are closer to the LCR constraint than the NSFR constraint.[17]

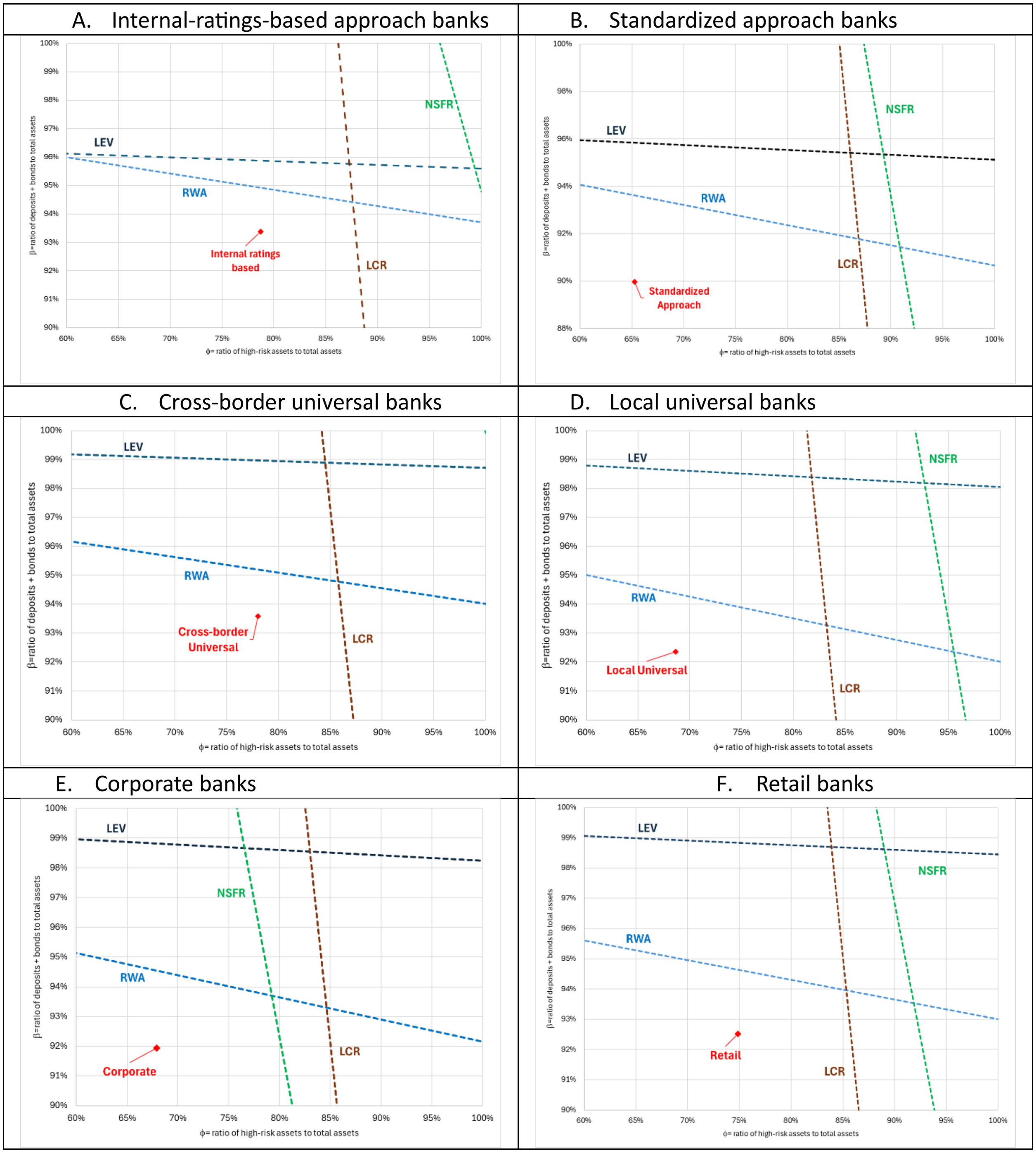
Looking more closely, we see that the cross-border universal banks are the riskiest entities by business model, with the largest quantity of high-risk assets and the least equity. The corporate banks are the safest, with the most capital and the least high-risk assets. The local universal banks and retail banks fall in between, with similar capital levels, but the retail banks have more high-risk assets. For these composite banks, the NSFR would not represent a constraint. Likewise, the leverage ratio for these aggregate banks would be of little consequence.

Only 10 banks in our sample are closer to the NSFR than the LCR, raising the question of whether the NSFR is redundant — and if so, how much tighter the LCR would need to be.[18] To answer this, some context is helpful. The LCR requires that the ratio of high-quality liquid assets to total net cash outflows over 30 days be at least 100%. The key parameter is the run-off rate α — the share of a bank's debt liabilities assumed to be withdrawn in a 30-day stress. It varies substantially across business models, ranging from 0.05 to 0.50 with a median of 0.15. Banks with low run-off rates have larger LCR buffers, which is why the NSFR rather than the LCR is the closer constraint for them. For each of the 10 NSFR-bound banks, we compute the run-off rate that would make the LCR stress test exactly as tight as the NSFR stress test. The required increases are modest. At the median, the run-off rate needs to rise by about one quarter — for example, from 0.15 to roughly 0.19. Even for the most-affected bank, the run-off rate would go from about 0.10 to 0.16, barely above the sample median. Moreover, the highest run-off rate needed across all 10 banks (0.36) is well within the existing range in the sample.

In other words, making the NSFR redundant would not require dramatically higher run-off rates; it would require narrowing the dispersion, ensuring that no bank has a run-off rate far below the sample norm. One straightforward way to do this would be to eliminate the cliff in the LCR at the 30-day horizon. Currently, liabilities maturing between 30 days and one year carry a zero run-off rate under the LCR but receive only partial credit as stable funding under the NSFR. Assigning a positive run-off rate to these intermediate maturities would raise the effective outflow rate, bringing the LCR closer to the NSFR without any change in the treatment of short-term liabilities. Of course, supervisors may value having two separately calibrated liquidity instruments for other reasons — but from a balance-sheet perspective, the NSFR adds no constraint that a modestly tightened LCR does not already impose. Whatever value that the supervisors perceive from the dual requirements should be compared to the reporting burden of keeping both regulations in place.

[17] To examine the proximity of banks to the constraints we construct a version of Figure 5 for each bank. We then draw a vertical and horizontal line through the dot representing the location of the bank in the (β,ϕ) plane and ask which requirement the line hits first. The vertical line hits either the RWA or the LEV requirement first. The horizontal line can hit the LCR, the NSFR, the RWA line, or the point where ϕ=1 (the edge of the box in the figure) first. Doing this for the 87 banks, we find that the vertical line hits the RWA constraint first in 71; while the horizontal line hits the LCR first in 72 cases, the NSFR first in 9 cases, and the RWA line in 6 cases. Dividing the banks by risk-weighting approach, of the 55 IRB banks 44 are closest to the RWA constraint and 44 are closest to the LCR constraint. For the 32 SA banks, 27 are closest to the RWA constraint and 28 to the LCR constraint.
[18] As we note in footnote 17 above, the remaining 6 banks of the 87 hit the RWA constraint before either the LCR or NSFR constraint.

Figure 5: Composite banks by risk-weight method and business model



Source: Lines use the expressions derived in Appendix 2 and composite banks constructed as total-asset-weighted averages from end-2024 EBA data. Note that for cross-border universal banks (panel C) the NSFR line is not in the allowable region, so it does not appear in the figure.

B. Traditional Capital and Liquidity Stress Testing

Next, we ask how much capital or liquidity stress banks can withstand before hitting the constraint imposed by the risk-weighted capital requirement or the liquidity coverage ratio. The supervisory norm is to do these stress tests independently, assessing the adequacy of capital and liquidity separately and in isolation. From the perspective of our framework, that seems odd for two reasons. One is that the regulations are related and involve some of the same balance sheet entities. The other is because it seems prudent to allow for the possibility that the kind of loan losses that arise in capital stress tests could also change the withdrawal behavior of some depositors. So, we proceed in steps. First, in this section, we follow the current methodology and show how to use our framework to analyze each stress individually. Second, in the next section, we take a holistic view that comes from our setup and study them jointly.

Starting with capital, we compute the maximum loss a bank can withstand before running into one of the constraints. To understand the computation, we can look back at equations (2) and (4), which we reproduce here:

(2) $\beta \leq (1-\mathscr{L})$ (LEV)

(4) $\beta \leq (1-\mathscr{R}\mu\phi)$ (RWA)

When a bank suffers a loss, both the level of capital funding and the level of risky assets fall. In the notation of the model, this means that the fraction of debt funding, β, rises and the quantity of risky assets ϕ, falls. For the leverage ratio, this means that the bank can suffer a loss equal to the value of Δ_{LEV} that solves

(2') $$\frac{\beta}{1-\Delta_{LEV}} = (1-\mathscr{L}) .$$

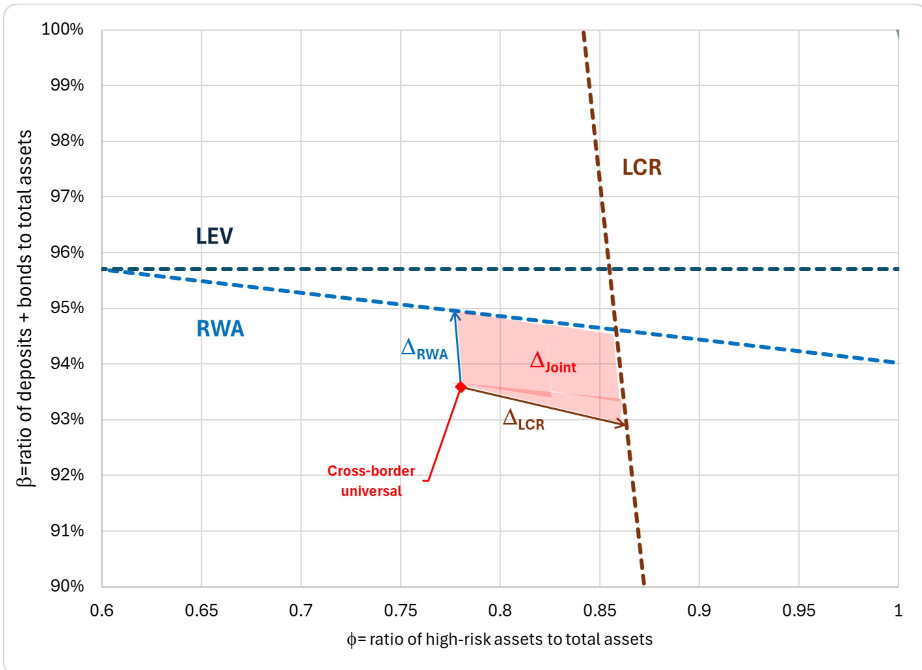
And for the risk-weighted capital requirement, it means the bank can lose the value of Δ_{RWA} that solves

(4') $$\frac{\beta}{1-\Delta_{RWA}} = \left[1 - R\mu\left(\frac{\phi-\Delta_{RWA}}{1-\Delta_{RWA}}\right)\right] .$$

When Δ_{LEV} is less than Δ_{RWA}, the leverage ratio binds first and vice versa.[19] In both calculations, we implicitly assume that management buffers are irrelevant, so that banks would be content to operate just barely above either constraint. We discuss a more realistic case with buffers in the section below.

[19] For the actual computations in the figure and the table, we use versions based on equations (A2.1) and (A2.2) in Appendix 2.

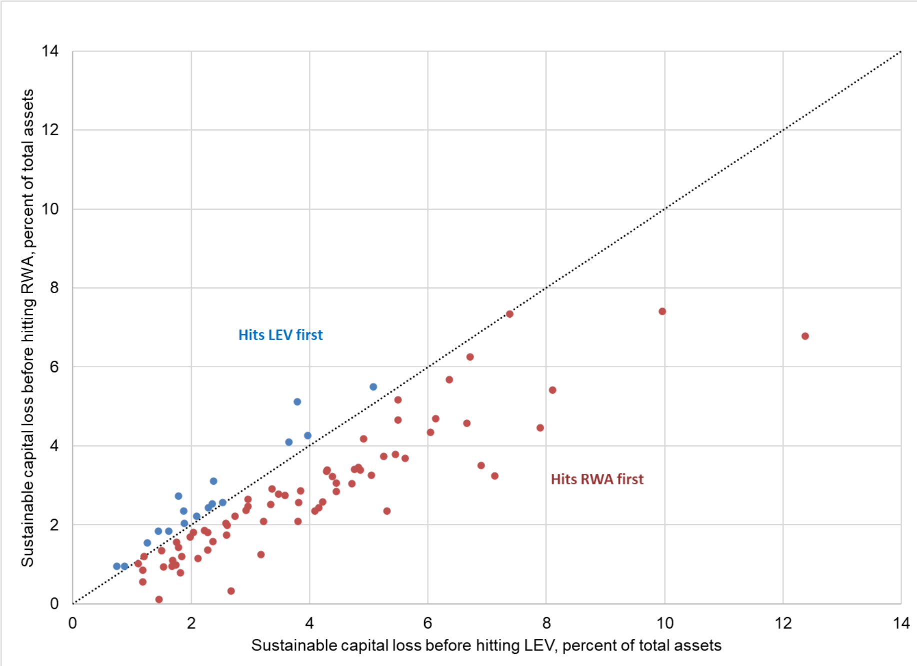
Figure 6: Individual capital and liquidity stress tests



Notes: The example is for the composite cross-border bank using end-2024 data from the EBA. Expressions for Δ_{RWA} and Δ_{LCR} are in equations (4') and (6') respectively.

We can see these two quantities in our simple diagram. We use the example of the composite cross-border universal bank in Figure 5C to draw Figure 6. The blue and brown arrows show increasingly severe capital and liquidity stress tests. The maximum sustainable loss or deposit outflow the bank can withstand occurs when these lines hit their respective dashed requirements. We first draw the case where the bank hits the RWA and LCR constraints. It is surely possible that losses could cause the bank to hit the leverage ratio requirement first, and changes in funding structure could result in the NSFR binding before the LCR. More generally, the bank can withstand any combination of asset losses and deposit run-offs that leaves it in the pink-shaded area in the Figure.

Figure 7: Sustainable losses based on LEV and RWA, percentage points

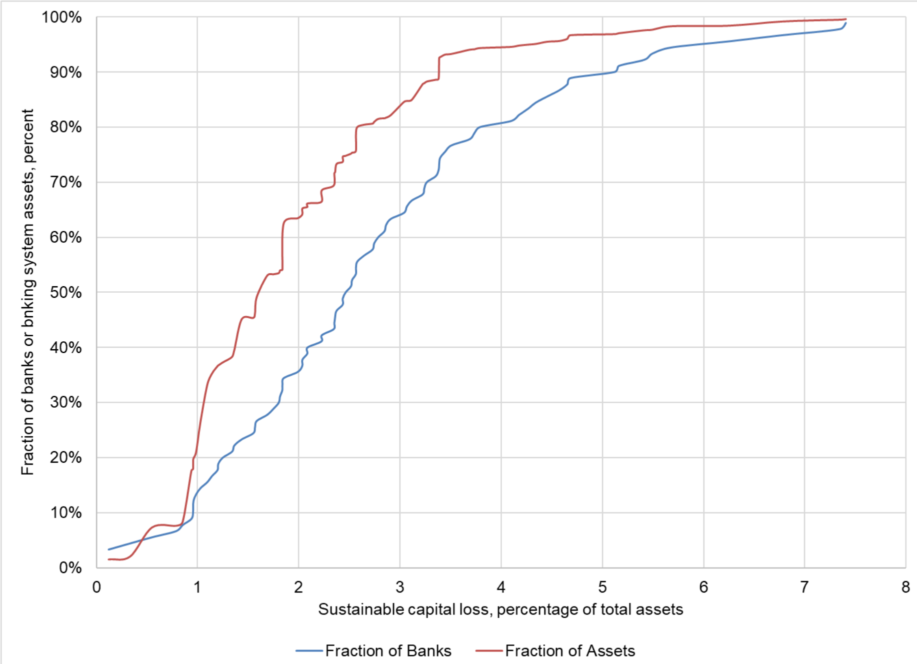


Source: Authors' calculations based on EBA data and equations (A2.1) and (A2.2).

Figure 7 plots the values of Δ_{RWA} on the vertical axis and Δ_{LEV} on the horizontal axis for the 87 banks analyzed above. We also include a 45-degree line in the figure. Banks above the 45-degree line will hit the RWA constraint first, and those below will hit the LEV constraint first. That is, for 70 out of 87 banks in our sample, a capital loss will cause them to hit their RWA constraint before they hit their LEV constraint. For the other 17, it is the reverse. That said, the losses must be quite large – the median value for Δ_{RWA} is 2.5 percentage points of total assets with an interquartile range of between 1.6 and 3.4 percentage points.

The 17 banks for which the leverage ratio binds first tend to be smaller (median assets of €56bn versus €129bn for the RWA-bound banks) and more specialized — cooperatives, mortgage and private banks. Because these banks have lower risk weights on both their safe and risky assets, their ratio of risk-weighted to total assets is just 0.27 compared with 0.40 for the RWA-bound banks. As a result, they actually report higher Tier 1 capital ratios (21% versus 18%) but lower leverage ratios (5.3% versus 6.9%) — their risk-weighted capital constraint is too loose to adequately limit their leverage, precisely the situation the leverage ratio requirement addresses.

Figure 8: Sustainable loss before banks hit the RWA requirement, cumulative distribution



Source: Values of the RWA requirement, $\mathcal{R}$, for which equation (A2.2) holds with equality based on EBA data.

We can also calculate the increase in the risk-weighted capital requirement $\mathcal{R}$ such that the bank exactly meets the RWA requirement. Figure 8 reports the cumulative distribution of banks ranked by the loss they can sustain before hitting their RWA requirement – the value of Δ_{RWA}.[20] The blue line shows the fraction of banks that hit the threshold, and the orange line shows the fraction of assets accounted for by banks that hit the threshold. This figure shows how much stress banks can withstand before breaching the requirement. So, for example, banks with half of the banking system's assets can withstand a loss of 1.7 percentage points of total assets or less before hitting the requirement – this is the point at which the orange line crosses the 50% threshold.

Next, we turn to liquidity stress and ask how big an outflow or deposit runoff banks can withstand before hitting their LCR. That is, the matching declines in deposits and HQLA that result in an LCR equal to 100 percent. In our model, this is the value of Δ_{LCR} that solves

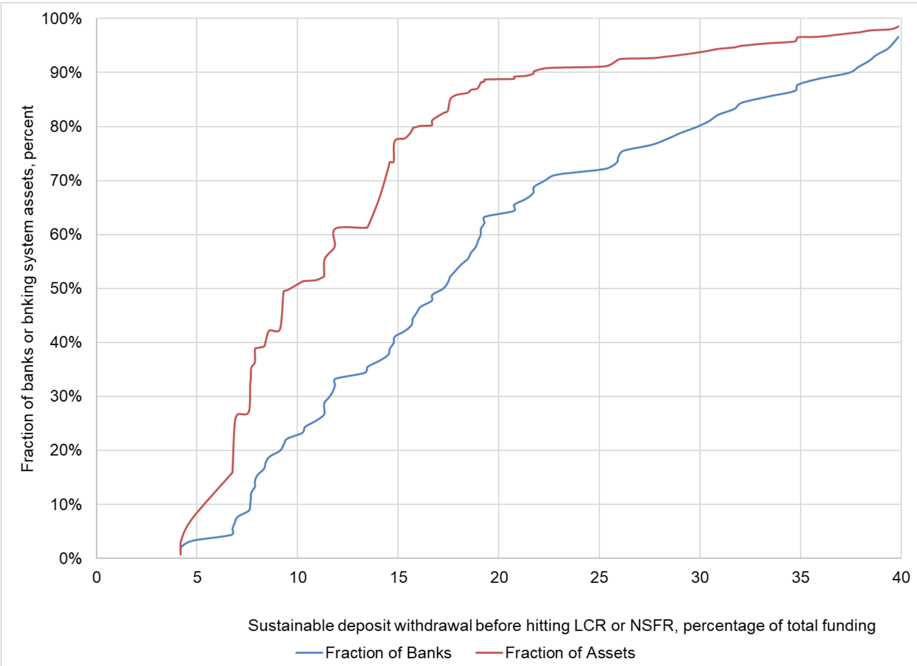
$$(6') \qquad \frac{\beta - \Delta_{LCR}}{1 - \Delta_{LCR}} = \left[1 - \left(\frac{\phi}{1 - \Delta_{LCR}}\right)\right]\frac{\omega}{\alpha}.$$

The results are in Figure 9.[21] These numbers are quite large. For example, the median (weighted by assets) is 10.2 percentage points of total assets, with a (weighted) interquartile range of 6.9 to 14.8

[20] We can do two similar computations, one that finds the value of $\mathcal{R}$ that leads the RWA requirement to bind, and a second for how high the risk weight μ has to be for banks to hit the RWA requirement. In both cases, the picture looks very similar, albeit with different scaling.
[21] In the calculations below, we use equation (A2.3).

percentage points. This reflects that banks holding 50% of banking system assets have an LCR exceeding 150%. Put another way, the banking system appears to have sizeable liquidity buffers.[22]

Figure 9: Sustainable deposit outflow before the LCR bind



Source: Authors' calculation based on EBA data. The values of Δ_{LCR} – the size of the outflow a bank can withstand before hitting the LCR – are based on equation (A2.3).

C. Composite Stress Tests

The analysis by Hirtle and Plosser (2026) emphasizes the interconnections between risks to both the asset and liability sides of bank balance sheets. For example, they show that a spike in interest rates can impair asset values and change the value of the deposit franchise. As a result, it makes sense for supervisors to consider scenarios that unfold through multiple channels.

Our analysis supports this reasoning because the regulatory ratios for capital and liquidity are related in a very particular way. So, in assessing compliance, it is peculiar to ignore the interconnections. For stress testing, our framework suggests studying joint changes in asset losses and deposit outflows. Existing official-sector supervisory exercises do not provide much guidance on how to do this, but historical experience can help in designing such scenarios. In particular, many jurisdictions calibrate stress scenarios to be consistent with past crises, most notably the Global Financial Crisis (GFC). The goal is to see whether a replay of a severe scenario would require as much support as in the GFC.

The GFC provides good guidance on the types of loan losses that are possible, but unfortunately, liquidity regulations were not in place during the GFC, so we don't have corresponding information on liquidity

[22] An alternative to computing the size of the outflow is to calculate the increase in the run-off rate α that causes the LCR to bind. These values are quite large as well, with the median bank's run-off rate rising from 0.148 to 0.266 before they hit their LCR.

outflows in that event. One could look at more recent stress episodes, such as March 2020 (or in the U.S., March 2023), but these periods were short, so they don't provide much guidance on how a joint set of liquidity and capital stresses would unfold.

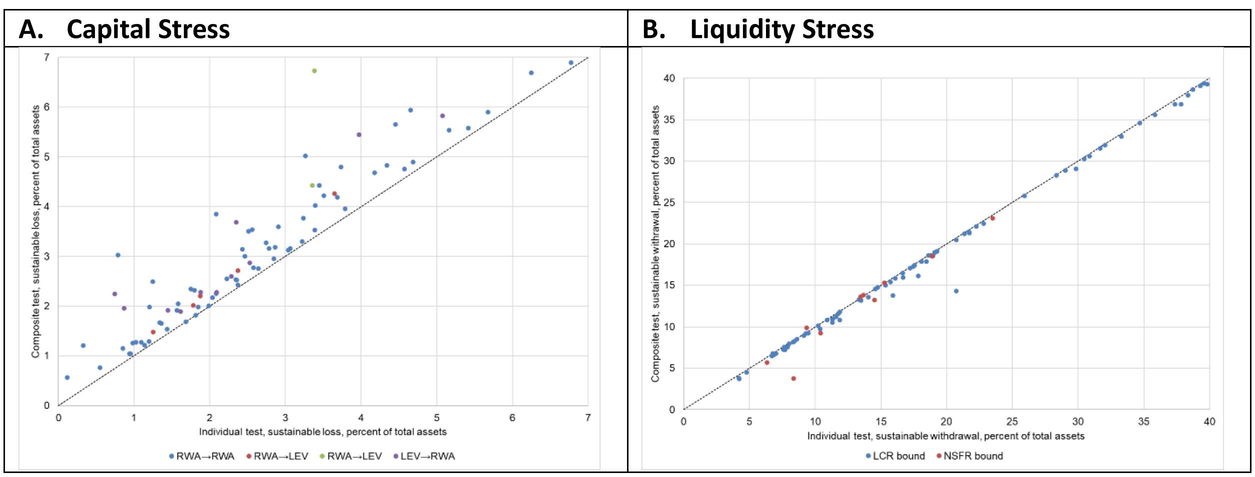
Nonetheless, the framework suggests some useful tests to consider. To see how, consider the impact of a capital stress test on a bank's liquidity ratio. In this case, the bank suffers equal losses to its risky assets and its equity funding. This leaves the bank with more deposits plus bonds (as a fraction of the now lower level of total assets), as well as more safe assets (again as a fraction of total assets). But since the run-off rate α is strictly less than one, this tends to relax the LCR. By contrast, a liquidity stress test in which there is a deposit runoff and a matching reduction in safe assets increases both risk-weighted assets and equity (again, both as a fraction of the now lower level of total assets). This can influence the RWA requirement, making it more or less binding.

Looking back at Figure 6, the composite stress test is the maximum sustainable loss and maximum deposit outflow that moves the bank to the point where the RWA and LCR lines cross. This is straightforward to compute from the following expressions:

(9) $$\phi_1 = \left(\frac{\phi_0 - \Delta^J_{RWA}}{1 - \Delta^J_{LCR} - \Delta^J_{RWA}} \right) \text{ and } \beta_1 = \left(\frac{\beta_0 - \Delta^J_{LCR}}{1 - \Delta^J_{LCR} - \Delta^J_{RWA}} \right)$$

where (ϕ_0,β_0) is the initial value for the fraction of risky assets and deposit plus bond funding, and (ϕ_1,β_1) is the point where the RWA and LCR lines cross.

Figure 10: Comparing composite with individual capital and liquidity stress tests



Notes: Plot of the individual stress test result against that from a composite stress test for capital and liquidity separately.

We examine the impact of moving from an individual test to a composite test in Figure 10. Panel A compares the individual capital stress test with the composite one, while Panel B compares the liquidity stress tests. For 72 of the 87 banks, the binding case is the one involving the RWA and the LCR, so the combined sustainable loss and deposit outflow occurs where these two constraints cross. The remaining cases are RWA/NSFR (9), LEV/LCR (5), and LEV/NSFR (1).

We find that conducting capital and liquidity stress tests jointly, rather than separately, makes a meaningful difference for the capital dimension but has almost no impact on the liquidity dimension.

When a bank simultaneously absorbs loan losses and suffers deposit outflows, its shrinking asset base relaxes the risk-weighted capital requirement. As a result, the joint test consistently allows banks to withstand larger capital losses than the standalone capital stress test would suggest — the median difference is 0.34 percentage points of total assets, with an interquartile range of 0.19 to 0.74 percentage points. For the liquidity dimension, the effect runs in the opposite direction but is small: the median difference is 0.24 percentage points.

The composite test can also change which capital constraint binds. Of the 17 banks individually bound by the leverage ratio, 12 switch to the RWA constraint in the composite test — all 12 end up in the RWA/LCR binding pair. The five that remain leverage-ratio-bound in both the individual and composite tests have the lowest ratios of risk-weighted to total assets in the sample (median 0.25): a cooperative, a mortgage bank, two local universal banks, and one unclassified bank. For these banks, risk weights are so low that even the composite test's relaxation of the RWA constraint does not bring it inside the leverage ratio.

In the other direction, one bank switches from RWA to LEV — in this case the composite test's binding pair involves the leverage ratio intersecting a liquidity constraint line before the RWA line does. This occurs because the composite test identifies the nearest intersection of a capital and a liquidity constraint, which may involve a different capital constraint than the one that binds in the standalone test.

The magnitude of the capital interaction varies systematically across banks. It is roughly twice as large for banks that use the standardized approach to risk-weighting as for those using internal ratings-based models (medians of 0.59 versus 0.27 percentage points, a difference that is highly statistically significant). It is also larger for smaller banks. Among the 87 banks, there is a clear positive relationship between bank size and the closeness of the individual and joint capital tests — larger banks show smaller differences between the two tests. Both patterns trace back to the same underlying feature: SA banks and smaller banks tend to hold proportionally more high-quality liquid assets than required, giving them larger liquidity buffers. Indeed, the strongest single predictor of the capital interaction is the bank's individual LCR stress test result, with a rank correlation of −0.70: banks with larger liquidity cushions show larger differences between the joint and individual capital tests. Cross-border universal banks, which are large and predominantly IRB, sit at the other end of the spectrum. For them, the interaction is smallest (median: 0.21 percentage points), and the individual and joint capital tests yield nearly identical results.

The liquidity interaction, by contrast, shows no meaningful pattern across bank size, business model, or risk-weighting approach. All groups cluster tightly around the same small positive difference. This reinforces the asymmetry of the finding: considering the two dimensions jointly meaningfully affects the capital stress test but not the liquidity stress test. The practical implication is that individual capital stress tests may overstate bank vulnerability by ignoring the offsetting effect of simultaneous deposit outflows on the risk-weighted capital constraint. This suggests that supervisors conducting capital stress tests should consider whether the scenario they are examining also involves liquidity stress — and if so, account for the interaction.

D. Buffers

All of our calculations thus far presume that the relevant constraints for the banks are the absolute regulatory minimum. For the RWA and LEV requirements, these minima may include supervisory sanctions that impose various constraints on banks. Moreover, the point of the Basel requirements is to ensure that banks are resilient enough to support the economy even under stress, allowing them to continue lending to creditworthy borrowers and providing other banking services. The goal goes beyond ensuring that banks are resolvable without a cost to the taxpayer.

That said, resolution requirements can and do impose constraints on the structure of bank balance sheets. In Europe, banks must meet the minimum requirement for own funds and eligible liabilities (MREL), which sits alongside the Basel requirement. But the MREL rules are just another form of a capital requirement. That is, they state that a weighted average of liabilities – in this case, equity plus certain bonds – must exceed a weighted average of assets (in this case, risk weighted). This means that MREL fits neatly into our framework, and we can express it in the same form as the four Basel III requirements in Section 2. If we were to include this in our diagrams, banks might be closer to their MREL requirement than to any of the others. That is, banks' behavior reflects requirements beyond the Basel rules, and supervisory penalties can be important determinants of their balance sheet composition even when they operate well beyond the various regulatory minimum values. It is also possible that, for a variety of reasons, banks choose to maintain buffers above the regulatory minimum (managerial buffers).

Stress tests offer a way to learn about how banks address these issues. For example, the Bank of England's 2025 Bank Capital Stress tests provide some interesting insights into banks' attitudes towards buffers. In these tests, banks can make public statements describing steps they plan to take, such as canceling share repurchases or suspending dividends. If the Bank of England deems these commitments credible, then the banks can apply the capital they would preserve through actions to comply with the stress tests. As in most jurisdictions, the largest UK banks rarely fail stress tests. The banks' so-called Strategic Management Actions (SMAs), however, reveal the banks' willingness to get close to the regulatory minimum. So, information about the adoption of SMAs can quantify the effective headroom that banks feel they need to operate comfortably in stress.

For example, in the 2025 test, the Bank of England's stress test judged that Barclays' regulatory minimum was 7.2%; it would reach a minimum common Tier 1 equity capital ratio of 8.8% in the stress scenario. Barclays SMAs boosted that level to 9.3%. So, when assessing how much space Barclays would need to operate without supervisory interference, the 9.3% level is more appropriate than the 7.2% limit. This kind of information could help reassess how much space a bank has.

V. Conclusions

In this paper, we examined the relationship among the four capital and liquidity requirements included in the Basel III standards. We show how to represent them all in terms of debt financing (deposits plus bonds) and the fraction of risky assets to total assets. At most one capital and one liquidity constraint can bind at a time. In addition, we show that capital and liquidity requirements can act as substitutes. For example, should authorities wish to tighten requirements, further restricting the riskiness of assets and the run risk of liabilities, they can do so either by tightening risk-weighted capital requirements or by tightening the liquidity coverage requirement.

Applying the framework to the 87 largest EU banks requires us to combine data from separate reporting frameworks that were never designed to work together. We recalculate the four regulatory requirements for each bank and conclude that most banks are closest to a combination of the risk-weighted capital constraint and the liquidity coverage ratio. In addition, we find that the net stable funding ratio rarely plays a role. Indeed, moderate increases in LCR run-off rates would suffice to render the NSFR redundant for every bank in our sample.

Finally, we show how our framework helps us to understand capital and liquidity stress tests. We can compute the losses a bank can sustain before hitting a capital constraint and the outflow it can withstand before hitting a liquidity coverage ratio. But because capital and liquidity requirements act as substitutes, these stress tests interact. That is, a loss has implications for the bank’s ability to withstand an outflow, and vice versa. With this in mind, we examine the maximum joint loss and outflow that banks can withstand. While the impact of a loss on the bank's ability to meet its liquidity requirements is minimal, the reverse is not true. That is, outflows can have a relatively large impact on banks' ability to meet their risk-adjusted capital requirements.

Taken together, our results suggest that the four-requirement system effectively reduces to two binding constraints — the risk-weighted capital requirement and the liquidity coverage ratio — for the vast majority of large EU banks. The leverage ratio binds for only 17 of 87 banks in individual stress tests and fewer still in composite tests, while modest adjustment to the LCR run-off rates would make the NSFR redundant. This does not mean the other two requirements serve no purpose — they may bind for smaller banks outside our sample or under different economic conditions — but it does suggest where the scope for simplification is greatest.

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Appendix 1: A Generalized Balance Sheet

Consider a bank that has assets and liabilities. We divide assets into safe (S_i) and risky (R_i); and liabilities composed of deposits plus bonds (D_i), and equity (E). Using this notation, the bank's balance sheet looks like this:

Table A1: A General Bank Balance Sheet	
Assets	**Liabilities**
S_1	D_1
S_2	D_2
$\vdots$	$\vdots$
S_n	D_k
R_1	
R_2	E
$\vdots$	
R_n	

Before turning to the various regulatory requirements, note that balance sheet identity implies that

(A1.1) $$\left[\sum_i S_i + \sum_j R_j\right] = \sum_k D_k + E\,.$$

Dividing both sides by total assets, we can rewrite this as:

(A1.2) $$\left[\phi_s + \phi_R\right] = \beta + \varepsilon = 1\,,$$

where ϕ_S and ϕ_R are the fractions of safe and risky assets, respectively; β is the fraction of deposits plus bonds, and ε is the fraction of equity. Note that the balance sheet identity implies that this equals one.

We now use (A1.1) and (A1.2) as a basis for expressing the various requirements. Starting with capital, defining $\mathscr{L}$ as the required leverage ratio (e.g., 3% or 5%), the bank's balance sheet structure must meet the following

(A1.3) $$E \geq \mathscr{L}\left[\sum_i S_i + \sum_j R_j\right].$$

Dividing both sides by total assets, we can rewrite the leverage ratio requirement as

(A1.4) $\varepsilon \geq \mathscr{L} \;\Rightarrow\; \beta \leq (1-\mathscr{L})$ (LEV)

which is text equation (1).

Turning to the risk-weighted asset requirement (RWA), defining $\mathscr{R}$ as the required ratio (e.g., 8%or 10%), and μ_j as the risk weight for risky asset *j*, we can write

(A1.5) $$E \geq \mathscr{R}\sum_j \mu_j R_j\,.$$

Defining $\bar{R} = \sum_j R_j$ as the total quantity of risky assets, we can rewrite (A1.5) as

(A1.6) $E \geq \mathscr{R}\mu\bar{R}$,

where $\mu = \left[\sum_j \mu_j \frac{R_j}{\bar{R}}\right]$ is the share weighted average of the risk weights.

Dividing by total assets, we can write (A1.6) as

(A1.7) $\varepsilon \geq \mathscr{R}\mu\phi_R \Rightarrow \beta \leq (1\text{-}\mathscr{R}\phi\mu)$ (RWA)

Which is text equation (3).

Turning to the liquidity requirements, we can write the liquidity coverage ratio (LCR). Assuming deposits plus bonds (D_k) face run-off rates of α_k and that a fraction ω_i of safe asset S_i qualifies as high-quality liquid assets, we can write this as

(A1.8) $\sum_i \omega_i S_i \geq \sum_k \alpha_k D_k$

(We assume equity has a zero-run-off rate and that risky assets cannot serve as high-quality liquid assets.)

Defining $\omega = \left[\sum_i \omega_i \frac{S_i}{\bar{S}}\right]$ and $\alpha = \left[\sum_k \alpha_k \frac{D_k + B_k}{\bar{D} + \bar{B}}\right]$, and dividing by total assets, this becomes

(A1.9) $\omega\phi_S \geq \alpha\beta$

Using the balance sheet identity $[\phi_s + \phi_R] = 1$ and $\beta + \varepsilon = 1$, we can rewrite this as

(A1.10) $(1-\phi)\omega \geq \alpha\beta \Rightarrow \beta \leq \frac{(1-\phi)\omega}{\alpha}$ (LCR)

Which is text equation (5).

Finally, in this notation, we can write the NSFR as

(A1.11) $E + \sum_l \delta_l D_l \geq \sum_j \eta_j R_j$

Where the δ_l's are the available stable funding weights on the deposit plus bond liabilities and the η_j's are the required stable funding weights on the risky assets. (We assume for simplicity that safe assets have zero required stable funding.)

Defining weights with no subscripts as share weighted averages, and dividing by total assets, we can write this as:

(A1.12) $\delta\beta + (1-\beta) \geq \eta\phi \Rightarrow \beta \leq \frac{1-\eta\phi}{1-\delta}$

Which is text equation (7).

Appendix 2: The Empirical Model

To bring the model to the data, we need to make several modifications. For the capital requirements, we add off-balance sheet exposures (Offb) and deductions (ded) that influence the computation of the leverage ratio exposure measures.[23] With this modification, equation (2) for the leverage ratio becomes

(A2.1) $\beta < 1 - \mathscr{L}(1 + Offb) - ded * \phi$. (LEV)

For the risk-weighted capital requirement, we note that low-risk assets can carry a modest risk. Labeling this γ, equation (4) becomes

(A2.2) $\beta < (1 - \mathscr{R}\gamma) - [ded + \mathscr{R}(\mu - \gamma)]\phi$. (RWA)

We also make changes to the liquidity requirements. Specifically, we include the possibility that some high-risk assets can serve as HQLA, labeling the weights as θ, that a fraction σ of low-risk assets can require stable funding, and high-risk assets may have an inflow factor. Including these means that (A2.3) and (A2.4) become

(A2.3) $\beta < \frac{\omega}{\alpha} + \frac{(\theta + \tau - \omega)}{\alpha}\phi$ (LCR)

and

(A2.4) $\beta < \frac{(1-\sigma)}{(1-\delta)} + \frac{(\sigma - \eta)}{(1-\delta)}\phi$ (NSFR)

[23] A common observation is the item "Equity" from the Liability side is "in monetary terms" higher than the prudential definition of capital (Tier 1). Prudential deductions explain this difference. An example of such deductions is the IRB shortfall i.e., the difference between the expected loss (PD*LGD*EAD) and the provisions. If provisions do not fully cover the expected loss, supervisors deduct the difference from capital (CET1). IRB banks commonly keep sovereign exposures (low risk) under the Standard Approach so that high-risk assets generate most of the shortfall. Other deductions exist (for example stemming from securitizations) and normally they relate to high-risk assets. We assume that these deductions stem solely from high-risk assets.