IMF STAFF DISCUSSION NOTE

Benefits and Costs of Bank Capital

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March 2016

SDN/16/04

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Authorized for distribution by Giovanni Dell'Ariccia

JEL classification number: G20

Keywords: Bank Capital; TLAC; Financial Regulation

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[2] We thank Olivier Blanchard, Charles Calomiris, Michaela Erbenová, Mark Flannery, Aditya Narain, Maurice Obstfeld, Antonio Pancorbo, Thomas Philippon, Sunil Sharma, and José Viñals for useful comments, and Nicola Babarcich, Paola Ganum, and Yangfan Sun for excellent research assistance.

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EXECUTIVE SUMMARY

Few issues have elicited a more contentious debate than the appropriate level of capital requirements. Proponents of stricter regulation point to the risks associated with high bank leverage and the exorbitant costs of the global financial crisis. Opponents of higher capital requirements argue that these may significantly increase the cost of bank credit and hinder economic activity.

This paper contributes to the debate by assessing the benefits of bank capital in terms of its ability to absorb losses. Its findings support the range of loss absorbency suggested by the Financial Stability Board (FSB) and the Basel Committee for systemically important banks. We measure these benefits against the yardstick of how much capital would have been needed to avoid imposing losses on bank creditors or resorting to public recapitalizations in past banking crises. The paper also looks at the welfare costs of tighter capital regulation by reviewing the evidence on its potential impact on bank credit and lending rates.

Our analysis of how capital increases banks' capacity to absorb losses and the associated benefits is subject to several caveats. First, the analysis is based on a macro approach, given the dearth of bank-level data on losses during crises. Second, it relies on the precision and comparability of available (country-level) data on nonperforming loans and loss given default ratios in past banking crises, and on other balance sheet parameters employed to convert losses into capital needs. Reassuringly, different exercises lead to similar conclusions. With these caveats in mind, the paper reaches the following tentative conclusions.

First, based on our methodology, capital in the range of 15–23 percent of risk-weighted assets would have been sufficient to absorb losses in the majority of past banking crises (at least in advanced economies). Further capital increases would have had only marginal effects on preventing additional crises, suggesting that this level of loss-absorption capacity is, on average, appropriate for advanced economies. That said, from a regulatory standpoint, appropriate capital requirements may be below this range, as banks tend to hold capital in excess of regulatory minima, and other bail-in-able instruments can contribute to loss-absorption capacity.

Second, institutional and regional factors might lead to variations in the appropriate levels of capital and loss-absorption capacity across jurisdictions. For instance, emerging markets have, on average, suffered greater bank losses (relative to bank assets but not to GDP) during crises and imposed tighter requirements. The extent to which institutional improvements (in regulation, supervision, resolution, and governance) can help reduce the required levels of loss absorption is an open question.

Third, the short-term costs of transitioning to higher capital standards might be substantial and much higher than long-term costs. Any new regulatory minima should therefore be imposed gradually, when conditions allow, and over a relatively long period of time. However, experience shows that when regulators set new minimum capital requirements based on solid economic and financial foundations, markets tend to anticipate full compliance with new standards ahead of phase-in periods. Also, supervisors should encourage banks to increase loss absorption by raising equity (through new issuance or retained earnings) rather than shrinking assets, so as to avoid reduced credit availability.

Finally, tighter requirements on banks may provide stronger incentives for regulatory arbitrage and increase the risk that activities might migrate to unregulated or less regulated financial intermediaries (the so-called shadow banking system). In that context, it is essential to widen the perimeter of prudential and macroprudential regulation.

I. INTRODUCTION

Few issues in the postcrisis policy debate have been more contentious and elicited a wider range of firmly held views than the appropriate level of bank capital. On one side, proponents of stricter regulation emphasize the risks and inefficiencies associated with high leverage and point to the exorbitant costs of the crisis (Admati and Hellwig 2014). On the other, opponents of higher capital requirements believe that these would significantly increase the cost of financial intermediation and hinder economic activity (Institute of International Finance 2015). Further, they argue, they might push intermediation out of the banking system and into unregulated entities, possibly increasing systemic risk.

According to the prevalent view, prior to the crisis relatively stable regulatory bank capital ratios masked increasing risks from off-balance-sheet activities, securitization, and housing-related credit. In response, Basel III raised minimum bank capital requirements from 8 percent to up to 15.5 percent of risk-weighted assets, when all surcharges are activated (see Table 1). It also introduced a leverage ratio requirement and raised the quality of capital by requiring a larger fraction of capital to consist of tangible common equity and by tightening eligibility requirements for instruments that count as capital. Some jurisdictions opted for even higher standards. For example, Switzerland is enforcing 19 percent capital ratios for its largest banks. The impact of these changes is already visible in the evolution of capital ratios for large banks in advanced economies in America, Europe, and Asia (Figure 1).

Against this background, a key policy question for bank regulation is whether these reforms have gone too far or not far enough. Put differently: what is the socially optimal level of bank capitalization? Providing an answer to this question would require defining a social welfare function and estimating the effect of bank capital on the cost and availability of credit, the probability and severity of banking crises, and the impact of banking crises on output and output volatility. The results of this type of exercise (discussed in Section IV) can be precise but highly dependent on the models and parameters chosen.

This paper focuses on the less ambitious task of estimating what capital buffers would have been sufficient to prevent bank creditors (or taxpayers) from losing money during past banking crises. Put differently, how much capital would it have taken to absorb all bank losses through equity? This admittedly incomplete perspective has the benefit of largely reducing the number of assumptions relative to general equilibrium models, thus increasing the robustness of our findings.

Using alternative approaches, we find that, in advanced economies, the marginal benefits of increases in capital are high initially, but decline rapidly once banks' risk-weighted capital ratios reach the 15–23 percent level (depending on the underlying assumptions). The reason is that capital levels within this range would have been sufficient to absorb losses in most banking crises in advanced economies. Protecting against the most extreme crises would have required substantially more capital, while such crises have been very rare in advanced economies. The discontinuity is less pronounced and occurs at a higher capital level for emerging and developing economies, where banking crises have more often been associated with large bank losses. This asymmetry is not surprising given the structural differences between the two country groups. It highlights the complementarity of capital and institutional improvements (in regulation, supervision, resolution) in order to reduce expected bank losses in a possible banking crisis. Further, reminiscent of the debate about sovereign debt sustainability, it stresses the correlation between the magnitude and frequency of macroeconomic shocks and the size of the buffers necessary to confront them.

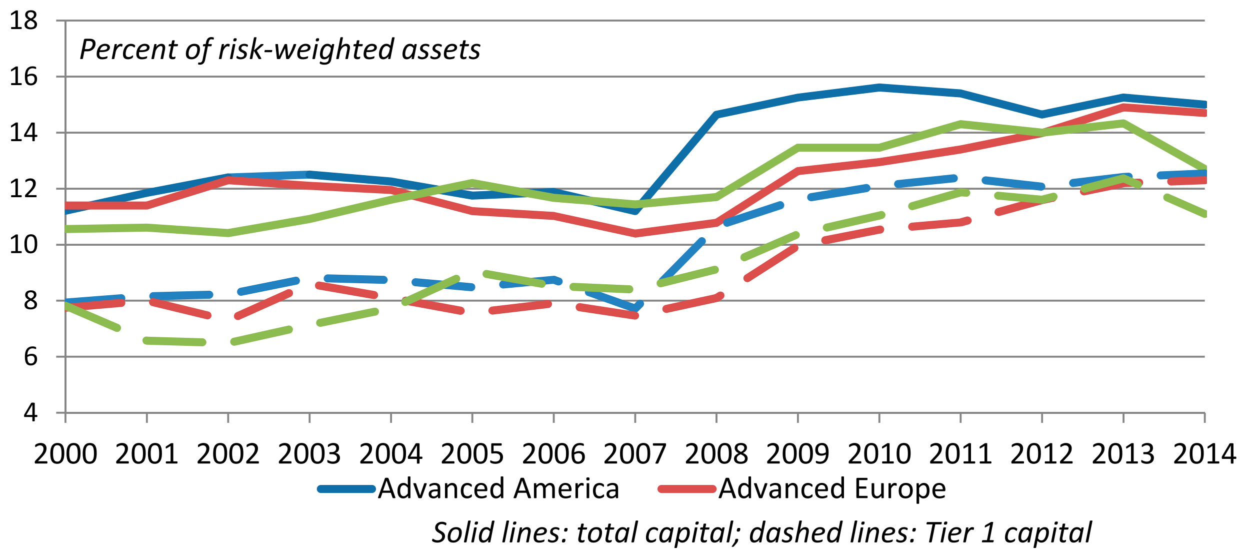
Table 1. Basel I, Basel II, and Basel III Capital Requirements
(Percent of risk-weighted assets)

	Basel I	**Basel II**	**Basel III** 1/
Quantity of Capital			
Minimum Total Capital	8.0	8.0	8.0
Capital Conservation Buffer 2/	n/a 3/	n/a	2.5
Minimum Total Capital Plus Conservation Buffer	n/a	n/a	10.5
Countercyclical Buffer 2/	n/a	n/a	0–2.5
Global Systemically Important Banks (G-SIB) Surcharge 2/	n/a	n/a	1–2.5
Minimum Total Capital Plus Conservation Buffer, Countercyclical Buffer, and G-SIB Charge	8.0	8.0	11.5–15.5
Leverage Ratio 4/	n/a	n/a	3.0
Quality of Capital			
Minimum Common Equity Capital 5/	n/a	n/a	4.5
Minimum Tier 1 Capital	4.0	4.0	6.0
Hybrid Capital Instruments with Incentive to Redeem 6/	Eligible	Eligible	Not eligible

Sources: BIS 2011 and 2013.
Note:
1/ Effective as of 2019. In the interim, several phase-in arrangements are in force.
2/ Consisting of tangible common equity.
3/ Not applicable.
4/ Ratio of Tier 1 capital to total assets.
5/ Goodwill and deferred tax assets are to be deducted in the calculation of common equity Tier 1 capital.
6/ Hybrid capital instruments with an incentive to redeem through features such as step-up clauses, which, under Basel II counted toward Tier 2 capital and up to 15 percent of the Tier 1 capital base, will no longer be eligible as capital. Under Basel III only dated subordinated debt will be deemed Tier 2 capital.

It is important to interpret carefully how our empirical findings relate to actual capital regulation. First, our results relate to levels of bank capital rather than minimum capital requirements. Banks tend to maintain buffers over minimum capital requirements, and can draw on those buffers in stressed periods. Thus capital requirements can be below the range identified in our analysis. Second, while this paper focuses exclusively on bank capital as a means to absorb losses, other bail-in-able instruments can contribute to loss-absorption capacity. Then, from a regulatory standpoint, appropriate capital requirements may be below our estimated capital range.

Figure 1. Tier 1 and Total Capital Ratios for Large Global Banks since 2000



Sources: Bankscope; and IMF staff calculations.

Recent proposals related to the total loss-absorbing capacity (TLAC) suggest complementing bank capital with other explicitly bail-in-able instruments, such as junior bonds not held by other banks or systemic institutions (FSB 2014). The relative benefits and costs of bail-in-able instruments compared with bank equity in providing loss absorption capacity are subject to debate (see Zhou and others 2012; and Flannery 2014 for a discussion).[2] This paper abstracts from the issue of which instruments can provide the loss-absorption capacity. Although focusing on bank capital is the most conservative approach, the results may be reinterpreted as applying to other TLAC instruments.

The paper also reviews existing empirical evidence on the costs of higher capital requirements. In that context, it finds that in steady state the aggregate costs of increased capital requirements are likely to be small. However, it also suggests that costs during the transition are likely to be much higher and highlights the significant degree of uncertainty surrounding these estimates.

[2] Estimates by the FSB micro/macro impact group in the context of the Quantitative Impact Study of the TLAC proposals point to a modest increase in lending spreads resulting from the new TLAC regulations, ranging from 6 to 20 basis points, depending on the different proposals on the final TLAC requirements

The paper proceeds as follows. Section II reviews the benefits and costs of bank capital. Section III presents estimates of bank capital ratios sufficient to absorb losses in past banking crises using alternative approaches. Section IV reviews evidence on the costs of bank capital. Section V concludes.

II. Theoretical Background: The Benefits and Costs of Bank Capital

Higher bank capital requirements have several benefits from a financial stability perspective, but might also impose certain costs on banks and society.

In an idealized Modigliani-Miller (1958; henceforth MM) world without tax deductibility of interest rate costs, bankruptcy costs, or agency problems, bank leverage does not affect social welfare (or bank profits). In this world, capital requirements are at the same time costless and irrelevant. In practice, however, several frictions imply that the MM paradigm does not apply (at least to banks), and that capital may affect the way banks behave and their profitability. In particular, asymmetric information entails significant agency problems, and externalities magnify the social cost of bank failure. Then, capital can play an important role in aligning banks' incentives with social welfare.

A. Benefits

First, capital serves as a buffer that absorbs losses and reduces the probability of bank failure. This protects bank creditors and, in systems with explicit or implicit public guarantees, taxpayers. Second, capital has a preventative role by improving incentives for better risk management. When asymmetric information prevents creditors from pricing bank risk taking at the margin, banks operating under the protection of limited liability will tend to take excessive risks. Capital can limit these excesses by increasing shareholders' "skin in the game": the amount of equity at risk in the event of bank failure (Myers and Majluf 1984; Marcus 1984; Keeley 1990; Esty 1998; Matutes and Vives 2000; Hellmann, Murdock, and Stiglitz 2000; Repullo 2004). This includes the role of bank capital in helping minimize market discipline distortions associated with deposit insurance and implicit government "too-big-to-fail" guarantees.[3]

Market forces push banks to maintain some positive level of capital. For example, higher capital helps banks attract funds (Holmstrom and Tirole 1997), maintain long-term customer relationships (Allen, Carletti, and Marquez, 2011), and carry risks essential to lending (Calem and Rob 1999; Perotti, Ratnovski, and Vlahu 2011). However, it is widely accepted that these forces are not sufficient to ensure that the market equilibrium bank capital levels deliver a welfare-maximizing allocation. Put differently, due to frictions, the private return to capital is lower than the social return. Thus, banks will tend to hold less capital than what is socially

[3] Some have argued that how bank ownership is distributed matters. When bank equity is held by outside investors with high risk preferences or concentrated ownership, it may increase bank risk taking (Laeven and Levine 2009). Indeed, passive outside investors are likely to have a limited disciplining role.

optimal. This provides a rationale for regulation aimed at increasing bank capital relative to the laissez-faire equilibrium (this typically comes in the form of risk-weighted minimum capital requirements and more recently of caps on leverage ratios).

B. Costs

In analyzing the costs of bank capital it is important to distinguish between the transition impact and steady-state impact of higher capital requirements. The costs associated with the transition to heightened capital requirements are not relevant at the steady state. These are costs stemming from raising new external equity or reducing the growth of assets. Equity issuance is subject to nonnegligible underwriting fees, usually of 5–7 percent. Also, there are signaling costs: issuing equity may require substantial discounts when incumbent investors and managers have information about the firm that new equity investors do not have (Myers and Majluf 1984). Therefore, one would expect that any rapid increase in mandatory capital ratios would take place at least partially through an adjustment of bank assets, with potentially large negative effects on credit and macroeconomic performance.

In principle, these transition costs could be mitigated by giving banks time to adjust their balance sheets gradually. This might enable banks to increase capital using retained earnings or external capital issuance timed to beneficial market conditions. In practice, however, this may prove difficult to the extent that market pressures might force banks to adjust rapidly to the new capital standards.

The steady-state costs of higher capital requirements are those that occur after a permanent change in the funding mix of banks is completed. Some of the costs associated with a heavier reliance on equity are similar for banks and nonfinancial firms. For example, in many jurisdictions, debt has a more favorable tax treatment than equity (De Mooji 2011). Aside from tax issues, equity can be more costly if, due to various frictions, a decrease in leverage does not lower the required return on equity.

In addition, some of the costs associated with more equity are specific to the banking system. The most notable cost stems from the fact that deposits and other debt liabilities often benefit from subsidized safety net protections, including deposit insurance and too-big-to-fail subsidies that benefit bank debt more than bank equity (Kane 1989). Junior debt-holders and uninsured depositors suffered minimal losses during the recent crisis, especially when compared with shareholders. As a result, banks' overall costs of funding may increase with greater equity finance. While it is important to recognize that this increase is primarily a private cost to banks, it might have welfare implications if it affects the cost and availability of bank credit (and, with distortionary taxation, expected bail-outs).

Other notable costs stem from the fact that, whereas for a nonfinancial firm leverage is a funding decision, for a bank its debt is also an output. The literature suggests that some economic agents, so-called cash investors, value bank debt for its high (often immediate, for deposits) liquidity and safety. When banks replace debt with equity, this destroys some economic value intrinsic to bank debt (Song and Thakor 2007; DeAngelo and Stulz 2013).[4] This reduces the cash investors' surplus, along with bank profits, and can harm bank borrowers through a higher cost of credit.

The existing literature has put forward several reasons why some investors value liquid and nominally safe assets such as bank debt. The hypotheses include liquidity insurance and convenience (Bryant 1980; Diamond and Dybvig 1983; Gorton and Pennacchi 1990; Caballero and Krishnamurthy 2008), agency costs in the money management of corporations and sovereigns that make them eschew any investment risk (Caballero and Krishnamurthy 2009), or the usefulness of risk-insensitive claims as a transactions medium (Dang and others 2014). Empirical studies document the demand for safe and liquid assets (Gorton, Lewellen, and Metrick 2012), confirming the presence of cash investors in financial markets.[5] Greenwood, Hanson, and Stein (2010) and Krishnamurthy and Vissing-Jorgensen (2012) estimate the risk-adjusted premium of Treasuries over other bonds to be negative 50 to 70 basis points; this can also be taken as an estimate of the funding cost advantage inherent in safe and liquid bank debt.

Finally, a related but separate issue is the role short-term debt can play in disciplining banks (Calomiris and Kahn 1991; Diamond and Rajan 2000; Kashyap, Rajan, and Stein 2008). This relates more to the composition of bank debt than bank leverage per se. The argument is that without demandable debt that gives creditors the ability to "run" on weak banks, banks would engage in riskier behavior. However, the crisis raised questions related to the role that short-term debt can play in protecting financial stability: it provided little discipline before the crisis, but contributed to extreme, across-the-board runs once the crisis hit (Krishnamurthy 2010; Huang and Ratnovski 2011; Gorton and Metrick 2012). Moreover, it is unclear why market discipline cannot be provided by only small amounts of short-term bank debt.

C. Systemic Implications

The analysis of the costs and benefits of bank capital acquires additional dimensions when the focus shifts from the stability of individual institutions to that of the financial system as a whole.

Individual bank distress may propagate to other banks through direct interbank exposures, fire sales, and contagious panics (Allen and Gale 2000; Gale and Özgür 2005; Admati and others 2010; Admati and Hellwig 2014). Then, a bank's higher capitalization, by reducing the probability of its distress, helps avoid the associated systemic spillovers.

Moreover, competitive pressures may act as a systemic multiplier of the beneficial effects of individual banks' capital. Weak or "zombie" banks taking excessive risks (including by reducing lending standards and intermediation margins) may force healthy ones to engage in similar practices to protect their market share. And, to the extent that bank shareholders and creditors cannot fully evaluate a bank's risk-adjusted performance, similar pressures will bear as bank

[4] Of course, banks need to maintain some equity to ensure that their debt is safe and liquid in most states of the world (Hellwig 2014). But equity above that would crowd out socially valuable bank debt.

[5] The hypothesis of investors' preference for safe and liquid assets is also often used in the analysis of shadow banking; see Claessens and others (2013); Gennaioli, Shleifer, and Vishny (2012, 2013).

managers at healthy banks attempt to match the riskier banks' profitability (Caballero, Hoshi, and Kashyap 2008).

The level and distribution of capital across a banking system may also matter. Sufficient aggregate capital may enable strong banks to acquire weak institutions (Acharya, Engle, and Richardson 2012). However, in the presence of externalities and informational asymmetries that prevent the reallocation of credit, the distribution of capital across banks can be critical. For instance, healthy banks may curtail lending if they expect macroeconomic conditions to be negatively affected by the reduction in credit supply due to weakness at other banks. Then, a relatively poorer real-sector performance resulting from the contraction in aggregate credit would confirm their expectations and validate their strategy (Bebchuk and Goldstein 2011). Related, the risk of contagion associated with weakness at a systemic bank may reduce the incentives for acting prudently at other banks (Dell'Ariccia and Ratnovski 2013).

On the cost side, higher bank capital requirements may affect the allocation of activities across different financial intermediaries. In particular, "too high" capital requirements may trigger a migration of activities from banks to less-regulated parts of the financial system and thus increase systemic risk (Goodhart 2010; Martin and Parigi 2013; and Plantin 2014).[6]

Therefore, overall, although it is important that banks have sufficient capital, excessively high requirements can also be costly. Thus, there is likely an interior optimum as to the desirable bank capital ratios. The next section outlines exercises that aim to gauge where that interior optimum might be, by looking at how much bank capital would have been sufficient to prevent a wide range of past banking crises.

III. HOW MUCH BANK CAPITAL IS ENOUGH?

The analysis in Section II suggests that bank capital levels position a banking system on a trade-off between financial stability and the cost of financial intermediation. Implicit in this trade-off is the notion that there exists an "optimal" level of capital that maximizes some aggregate welfare function with output growth and volatility as ultimate arguments and bank stability and the cost and availability of credit as intermediate ones.

In practice, however, estimating the optimal level of bank capital is likely an impossible task ex ante. It requires defining a social welfare function and estimating the effect of bank capital on the cost and availability of credit, the probability and severity of banking crises, and the impact of credit availability and banking crises on output and output volatility. Such an exercise would require several simplifying and perhaps undesirable assumptions, and its results would necessarily be too model-, bank-, and sample-specific to provide convincing policy guidance.

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[6] Another argument against "too high" bank capital is that while higher capital requirements reduce bank risk, they may at the same time increase borrowers' risk. This may occur when high capital requirements dampen interbank competition, increasing the cost of credit and inducting risk shifting by bank borrowers (Hakenes and Schnabel 2011; Boyd and De Nicolo 2005). Or it may occur when high capital makes banks tolerant of risky lending, and firms take risk without the fear of being denied credit (Gornall and Strebulaev 2013).

Against this background, this section focuses on the less ambitious task of estimating what capital buffers would have been sufficient to fully absorb bank losses during past banking crises and to avoid public recaps. We abstract from the potential role that other bail-in-able securities can have in absorbing losses. Hence, as discussed before, the findings in this section may be reinterpreted through the lenses of TLAC. Further, the analysis does not consider explicitly the costs of bank capital, including its impact on bank lending; these are reviewed in Section IV. We also do not consider the effects of higher bank capital on the incentives of bank shareholders and managers (Laeven and Ratnovski 2014). To the extent that higher capital reduces banks' risk-taking incentives, the benefits of bank capital would be higher compared with those identified by our analysis. Put differently, our estimates of the marginal benefits of bank capital are conservative because they do not incorporate possible incentives effects.

With these caveats in mind, we find that, in advanced economies, the marginal benefits of increasing bank capital decline substantially after it reaches 15–23 percent of risk-weighted assets (depending on the underlying assumptions). That is, a loss-absorption capacity of 15–23 percent of risk-weighted assets (RWA) would have been sufficient in a large proportion of banking crises, but extreme left-tail crises would have required substantially higher levels. As already noted, these estimates abstract from the disciplining role higher capital may offer in preventing crises through "skin-in-the game" effects. Accordingly, the "true" bank capital necessary to fully absorb losses could be somewhat lower.

A. Sufficient Levels of Capital in Past Banking Crises

The first approach considers the capacity of banks to absorb loan losses. We consider loan losses in past banking crises and ask how much capital banks would have needed to absorb loan losses and maintain positive equity, hence avoiding losses creditors (Ratnovski 2013). We continue to abstract from the loss-absorption capacity provided by other bail-in-able liabilities. We also abstract, in this exercise, from potential differences in accounting and prudential requirements regarding nonperforming loan (NPL) ratios across countries and over time, an issue that is hard to circumvent.

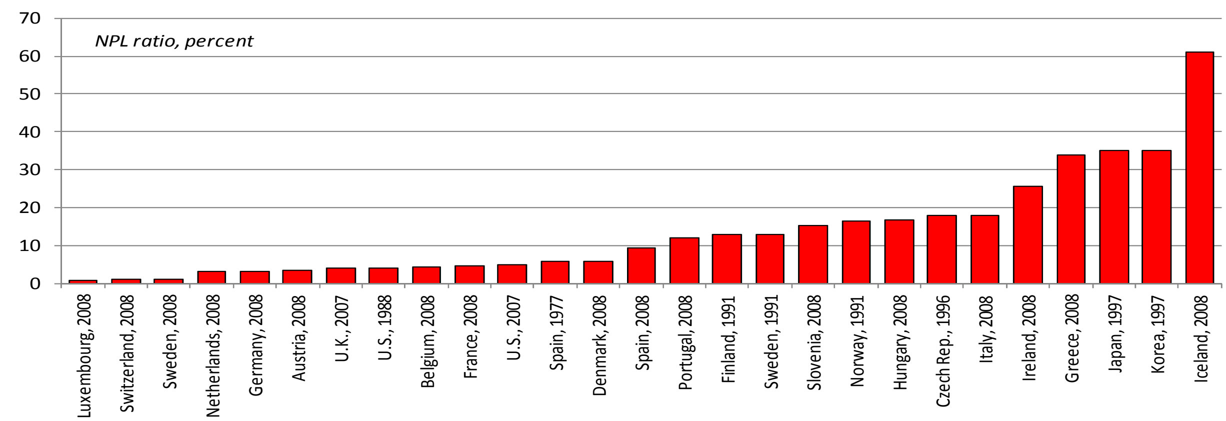
We proceed in four steps. First, we compile data on NPL ratios during banking crises. Figure 2 shows peak NPL ratios during crises: panel A for crises in countries in the Organization for Economic Co-operation and Development (OECD) only, panel B for all banking crises since 1970, both based on data from Laeven and Valencia (2013).[7] Second, we convert NPLs into loan losses. To obtain loan losses, the NPL ratio needs to be adjusted for loss given default (LGD). Unfortunately, there is little cross-country data on loss given default. As a proxy, we use estimates for the United States suggesting that the mean loss given default over 1970–2003 varied between 50 percent on average in normal times and up to 75 percent in downturns (Schuermann 2004; Shibut and Singer 2014; Johnston Ross and Shibut 2015). Part of these losses can be absorbed by prior provisioning. In the United States, loan loss provisioning

[7] Laeven and Valencia (2013) define a banking crisis as an event that meets two conditions: 1) significant signs of financial distress in the banking system (as indicated by significant bank runs, losses in the banking system, or bank liquidations); and 2) significant banking policy intervention measures in response to significant losses in the banking system.

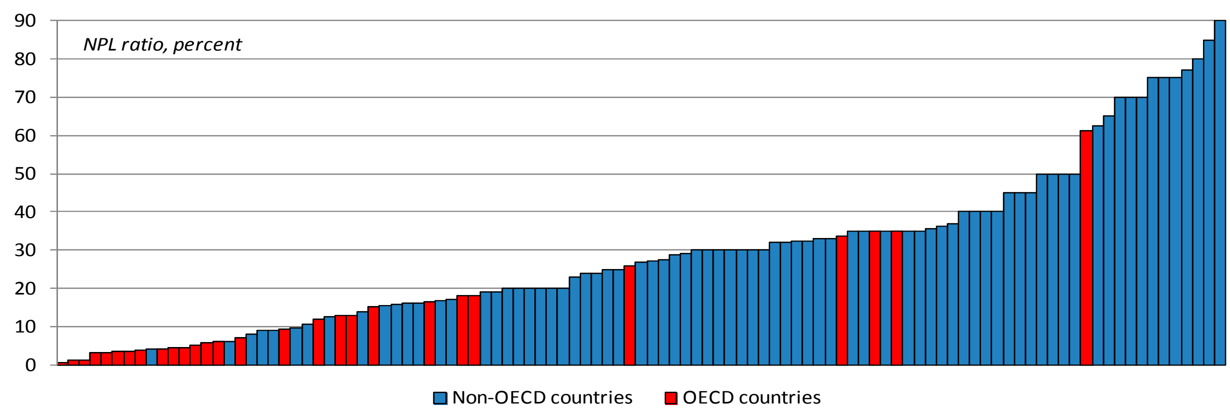
averaged about 1.5 percent historically. In Spain, dynamic provisioning achieved similar buffers prior to the 2008 financial crisis (Saurina 2009). Therefore, loan loss reserves of about 1.5 percent seem a reasonable assumption. Table 2, baseline column, illustrates our calculation of the capital necessary to cover a given share of NPLs in total bank assets. There, a hypothetical 18 percent NPL ratio corresponds to 9 percent loan losses, and loan losses net of provisions of 7.5 percent of total assets.[8]

Figure 2. Peak Nonperforming Loan (NPL) Ratios in Banking Crises

Panel A. Peak NPL Ratios in Banking Crises in OECD Countries



Panel B. Peak NPL Ratios in Banking Crises in All Countries



Sources: Laeven and Valencia 2013; IMF Financial Soundness Indicators; and IMF staff calculations.
Note: In panel A, years represent the onset of the crisis; NPLs are shown for the peak year of the crisis.

[8] These estimates are based on losses on loans, not on the rest of bank balance sheet. "The rest" today represents about 50 percent of assets of an average large bank, half in trading assets and securities and half in cash and interbank claims (King 2010). Trading securities can experience larger losses, while cash and interbank claims are safer than loans during crises. One could refine the estimate of capital needs by detailing bank asset structure with associated crisis losses and risk weights using country-specific information.

Third, we compute capital ratios that would enable banks to absorb the estimated losses and remain in positive equity. For this, we take bank capital equivalent to loan losses net of provisions and add an additional 1 percent of capital as a margin of safety.[9] We convert resulting unweighted capital needs into risk-weighted capital by applying a 1.75 ratio of total assets to risk-weighted assets, corresponding to the average such ratio for U.S. banks (Le Lesle and Avramova 2012). In the baseline example of Table 2, to cover with a margin of safety of 7.5 percent loan losses net of provisions, a bank needs an 8.5 percent leverage ratio, corresponding to an approximately 15 percent risk-weighted capital ratio.

Table 2. Example: Capital Needed to Absorb Nonperforming Loans (NPLs) Equal to 18 Percent of Assets

Parameters	Baseline	Higher Loss Given Default	Higher Total Assets/Risk-Weighted Assets	Higher Margin of Safety
		Values (in percent)	Values (in percent)	Values (in percent)
1. NPLs during a Banking Crisis	18.0	18.0	18.0	18.0
2. Loss Given Default	50.0	**75.0**	50.0	50.0
3. Loan Losses (1 * 2) (Mean point)	9.0	13.5	9.0	9.0
4. Absorbed by Prior Provisioning	1.5	1.5	1.5	1.5
5. Loan Losses Net of Provisions (3 – 4)	7.5	12.0	7.5	7.5
6. Margin of Safety (Residual Capital)	1.0	1.0	1.0	**3.0**
7. Capital to Assets Ratio or Leverage Ratio (5 + 6)	8.5	13.0	8.5	10.5
8. Total Assets/Risk-Weighted Assets	175.0	175.0	**250.0**	175.0
9. Capital Ratio (percent of Risk-Weighted Assets) (7 * 8)	14.9	22.8	21.3	18.4

Source: IMF staff calculations.

Overall, the baseline formula that converts loan losses in a banking crisis into the risk-weighted capital ratios needed to absorb them is the following:

$$\text{Bank capital} = (\text{NPL} * \text{LGD} - \text{Provisions} + 1 \text{ percent}) * (\text{Total assets} / \text{RWA})$$

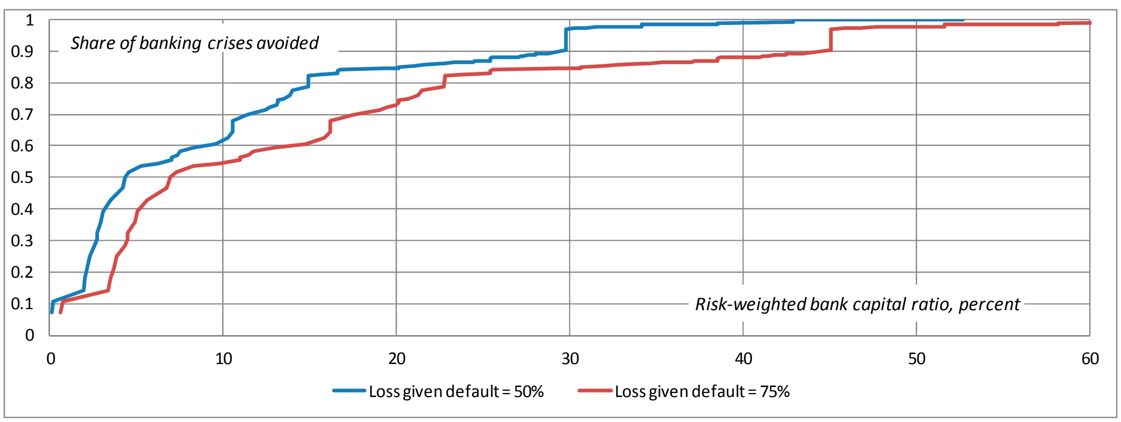
Finally, we use the distribution of NPL ratios in past banking crises to map a given bank capital ratio into the share of banking crises in which it could fully absorb losses. Figure 3 reports the share of advanced economy banking crises in which banks would have maintained positive equity as a function of hypothetical bank risk-weighted capital ratios. We plot the function for the mean value LGD (50 percent) and LGD during crises (75 percent).[10]

[9] An additional justification for the margin of safety is that losses may be asymmetrically distributed among banks, so some banks may have higher losses than suggested by average NPL numbers.
[10] Note that the 75 percent LGD is a high estimate; it reflects loans that defaulted and were written off during crises; allowing a longer workout period lowers LGD even in crisis times (Johnston Ross and Shibut 2015).

The baseline schedule (blue) suggests that, in OECD countries, the marginal benefit of additional capital from a loss-absorption point of view is relatively high until 15 percent risk-weighted capital ratio (which enables banks to absorb losses in 85 percent of banking crises, assuming a loss given default ratio of 50 percent). The marginal benefit of additional capital declines rapidly after that. This means that attempting to absorb bank losses in a few exceptionally extreme crises requires very high capital ratios. Notably, this result is relatively close to the model-based estimates in BIS (2010) that suggest that capital of 15 percent would avoid imposing losses on creditors in about 90 percent of banking crises.

In interpreting these estimates, it is useful to recognize considerable uncertainty about the magnitude of some of the coefficients. This implies that "sufficient" loss-absorbing capital is better discussed in terms of ranges than point estimates. For example, loss given default rates of 75 percent rather than 50 percent are conceivable (and might prevail in the context of systemic crises).[11] With such parameters, the risk-weighted capital necessary to absorb losses in 85 percent of historical crises in OECD countries (red line in Figure 3) would rise from 15 percent to about 23 percent, as shown in the second column of Table 2. Consistently, the point in the schedule after which the marginal benefits of higher capital decrease also rises. Obviously, higher-than-average recovery rates would lead to lower estimates.

Figure 3. Share of Banking Crises without Creditor Losses (OECD countries), Based on the Loss Absorption Capacity of Bank Capital



Sources: Laeven and Valencia 2013; IMF Financial Soundness Indicators; and IMF staff calculations.
Note: Based on 28 banking crises in OECD countries.

An additional source of uncertainty is the conversion of raw leverage ratios into risk-weighted capital ratios, which varies across countries (Le Lesle and Avramova 2012). Our baseline estimate uses a conversion ratio of 1.75 consistent with our use of U.S. data for the loss given default estimates. Obviously, a higher conversion rate would mechanically imply higher capital needs. The third column of Table 2 shows an example where the conversion ratio is 2.5, leading to a capital ratio of 21 percent. That said, to the extent that such higher conversion ratio

[11] It is also conceivable that loss given default rates might vary nonlinearly with the extent of the losses.

corresponded to safer bank portfolios, it would arguably have to be matched with lower loss given default estimates; thus partly compensating for its direct effect.[12] Related, banks engaging in "strategic risk weighting" as some observers have suggested (Enrich and Colchester 2012; Mariathasan and Merrouche 2014) would also affect the "true" conversion ratio. We also acknowledge that the choice of the safety margin is rather arbitrary but variations within reasonable bounds (fourth column of Table 2) will not significantly affect our range of required bank capital.

Also, as already mentioned, our analysis equates bank losses with loan losses; more precisely, we assume that banks accrue losses uniformly across different assets on their balance sheet. This implies that we will tend to overestimate capital needs when losses are concentrated on loans and underestimate them when they are concentrated on securities (such as was the case for many advanced economies in the global financial crisis). Nevertheless, our benchmark parameters for loan losses exceed losses on securities in the United States during the global financial crisis (Berrospide 2013) and losses assumed as part of the Dodd-Frank stress tests under the "severely adverse scenario." Also, to the extent that some of the losses recorded from past crises were due to interbank exposure, our methodology might overestimate capital buffer needs. In contrast, capital buffers would have to be higher in the presence of nonlinear multipliers associated with bank-sovereign linkages in fiscally vulnerable settings (in this paper, we abstract from such nonlinearities).

Further, we base our analysis on average NPL ratios in the banking system.[13] In practice, losses at individual banks may differ significantly from the country mean, and thus our methodology will underestimate the level of capital necessary to preserve positive equity across the entire system. We address this issue further in the next section. That said, the average level of capital needed to maintain positive equity remains informative as to the overall capacity of the banking system to absorb losses and may affect the authorities' ability to confront the crisis, including by facilitating takeovers of weaker banks by stronger ones.

To assuage some of the concerns related to the parameter uncertainty in our analysis, in the next section we contrast these results with those from an alternative methodology focused on fiscal

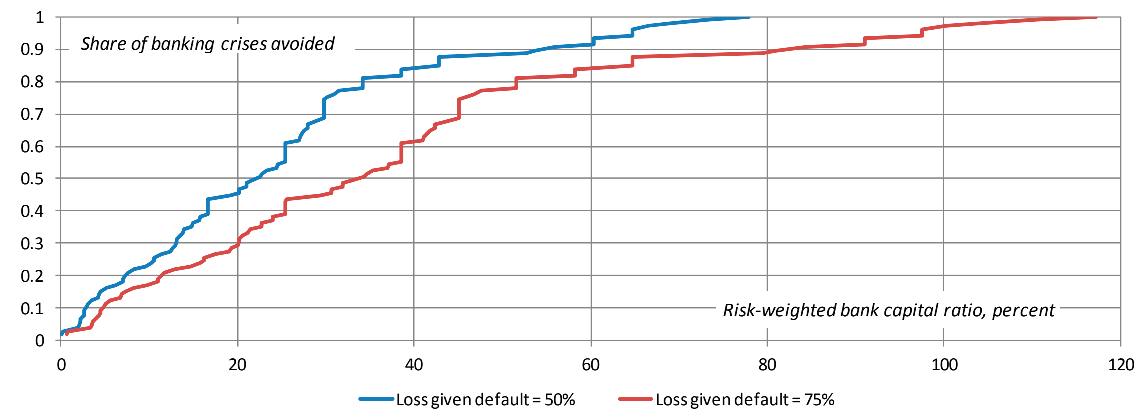
[12] It is useful to compare the parameters underlying our analysis with the parameters from recent U.S. and European bank stress tests. In the 2015 U.S. stress test (FRB 2015), the "severely adverse scenario" led to 4.5 percent loan losses and a loss of 5.5 percentage points of risk-weighted bank capital. In the 2014 European Banking Authority stress test (EBA 2014), the "adverse scenario" led to 2.3 percent loan losses that induced a loss of 4.4 percentage points of bank capital. Two observations are worth emphasizing: First, loan losses corresponding to the 85th percentage of banking crises (as used in our analysis) are two to four times as high as losses in the U.S. and European stress tests (which, being stress tests over plausible outcomes, consider relatively milder scenarios than those of a full-blown crisis). This highlights the conservative nature of our estimates. Second, our analysis employs a coefficient of 1.75 to convert loan losses into losses in risk-weighted capital; this is in between the coefficients of 1.25 and 1.9 implied by U.S. and European stress tests. (A smaller coefficient in U.S. stress tests is a product of low predicted losses on bank securities holdings.)

[13] We recognize that NPL ratios might not be fully cross-country comparable, another compromise necessary in order to conduct cross-country analysis.

injections into banks during the 2008 crisis. This alternative method gives very similar results, reinforcing the conclusions reached in this section.

The difference between our capital need estimates for OECD and non-OECD countries stems from generally higher NPL ratios in banking crises in non-OECD countries (see Figure 2 panel B). In principle, higher NPLs, all else equal, call for higher levels of capital to absorb them. This is highlighted in Figure 4, which suggests that capital ratios in the 15–23 percent range would have been sufficient to absorb losses in only about half of all banking crises once non-OECD countries are considered. This asymmetry reflects the fact that during banking crises, bank losses tend to be larger in emerging markets and low income countries. This is nt surprising once one observes that in these countries, macroeconomic shocks tend to be larger, credit tends to be less diversified, and institutional factors lead to larger loss given default ratios.

Figure 4. Share of Banking Crises without Creditor Losses (all countries), Based on the Loss Absorption Capacity of Bank Capital



Sources: Laeven and Valencia 2013; IMF Financial Soundness Indicators; and IMF staff calculations.
Note: Based on 105 banking crises in all countries in the sample.

Consistent with this view, non-OECD countries (on average) have been imposing higher capital requirements on banks. In 2010, the minimum capital ratios in OECD countries were almost uniformly 8 percent. In contrast, the median minimum capital ratio in non-OECD countries was 10 percent. Moreover, almost a quarter of non-OECD countries had a minimum capital ratio of 12–15 percent, or 50 percent higher than what was typical in OECD countries (Barth and others 2013).

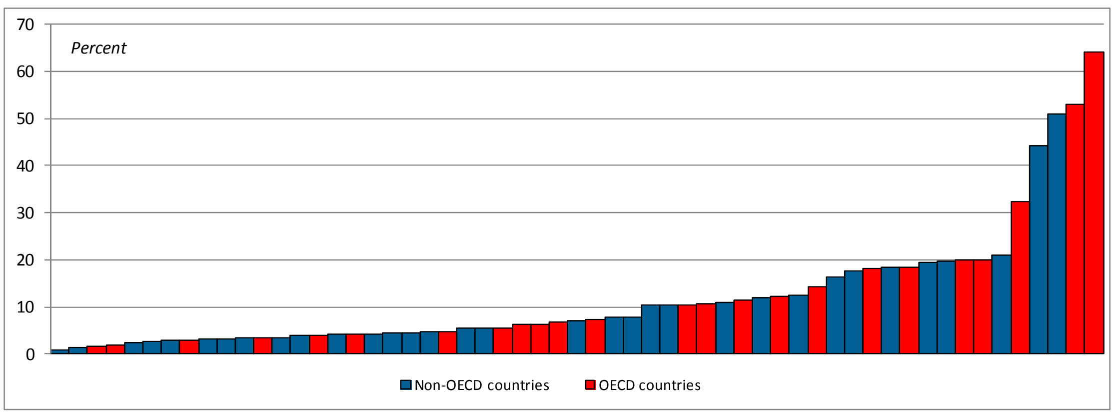
That said, there are a number of caveats.

First, banks in non-OECD countries tend to hold fewer risky securities on their balance sheets than banks in OECD countries. This was, for example, the case during the 2008 crisis. Thus, NPL losses are a more comprehensive loss statistics, and our capital-needs estimates are more conservative for non-OECD than for OECD countries.

Second, all estimation parameters (loss given default, provisions, conversion rates) for non-OECD countries are subject to greater uncertainty and heterogeneity than those for OECD countries. This possibly includes greater heterogeneity in accounting classification and provisioning regimes.

Third, non-OECD countries tend to have much smaller banking systems relative to GDP than OECD countries, leading to relatively similar shares of NPLs to GDP (Figure 5). This means that when bank losses exceed the absorption capacity provided by capital, their impact on the economy (and thus the fiscal accounts) is likely also to be smaller. Everything else equal, this implies that ex post cleanup operations are likely to be less onerous in non-OECD countries than in countries with larger banking systems. For instance, given the smaller size of their banking systems, had non-OECD countries imposed bank capital ratios in the 15–23 percent range, in 80 percent of banking crises, losses exceeding the absorption capacity of capital would have been within 3 percent of GDP. From a financial stability viewpoint, this factor can offset to some degree the higher macroeconomic volatility of emerging market countries.

Figure 5. Non-performing Loans as a Share of GDP in OECD vs. Non-OECD Countries



Sources: Laeven and Valencia 2013; IMF Financial Soundness Indicators; and IMF staff calculations.

Two points of caution: First, the potential fiscal costs of bank cleanups in emerging market economies are destined to increase beyond this estimate, as many have recently experienced rapid credit growth, making current ratios of bank credit to GDP higher than past averages suggest. Second, the estimate should not give rise to complacency, as bank losses in the remaining 20 percent of banking crises (often, twin crises) would have been substantial.

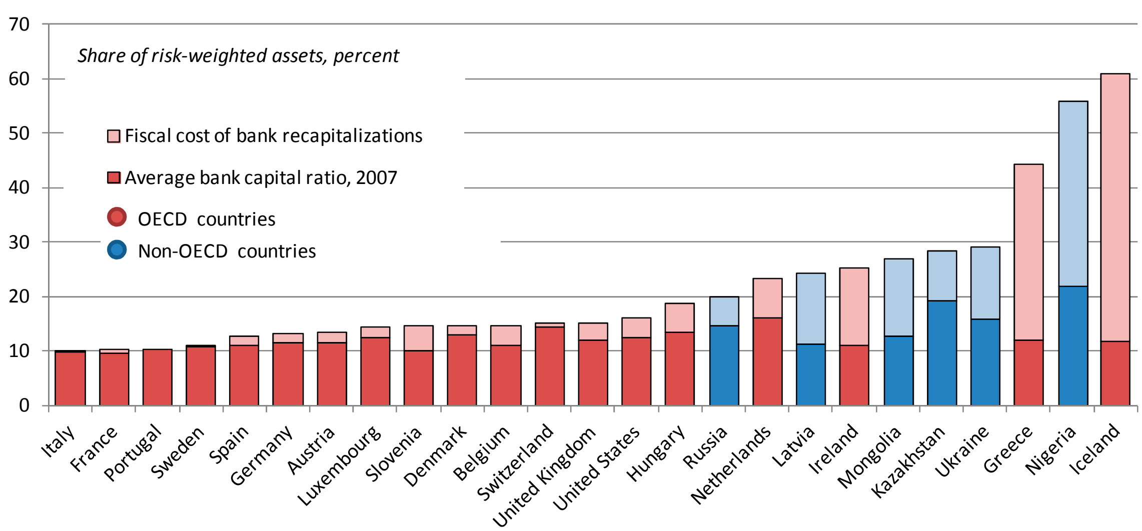
Finally, even if we took the higher capital needs in non-OECD countries at face value, a strategy complementing higher capital ratios would be to reduce potential NPLs through institutional improvements (in regulation, supervision, resolution). Overall, therefore, desirable bank capital levels in OECD and non-OECD countries might be closer than they appear from our analysis.

B. Capital Sufficient to Avoid Public Recapitalizations of Banks

The next approach considers how much capital banks would have needed to avoid public recapitalizations during past crises. The working assumption is that, historically, postcrisis bank recapitalizations brought banks to the minimum level of capital needed to restore viability. If this assumption is correct, and if prior to the crisis banks had had capital equivalent to the sum of actual precrisis capital and the postcrisis public capital injection, then, other things remaining equal, no public recapitalizations would have been required. It is under these simplifying assumptions that we reach our empirical measure of the level of bank capital sufficient to avoid recapitalizations.

We combine data from Bankscope on average capital ratios in 2007 for countries whose banking systems experienced a crisis over the period 2007–13 with data from Laeven and Valencia (2013) on the fiscal outlays associated with bank recapitalizations (with both variables being expressed as percentages of total risk-weighted assets of the banking system in each country). The sum of precrisis bank capital levels and public bank recapitalization injections is shown in Figure 6.

Figure 6. Precrisis Bank Capital and Fiscal Recapitalization Expenses in Banking Crises in 2007 Onward

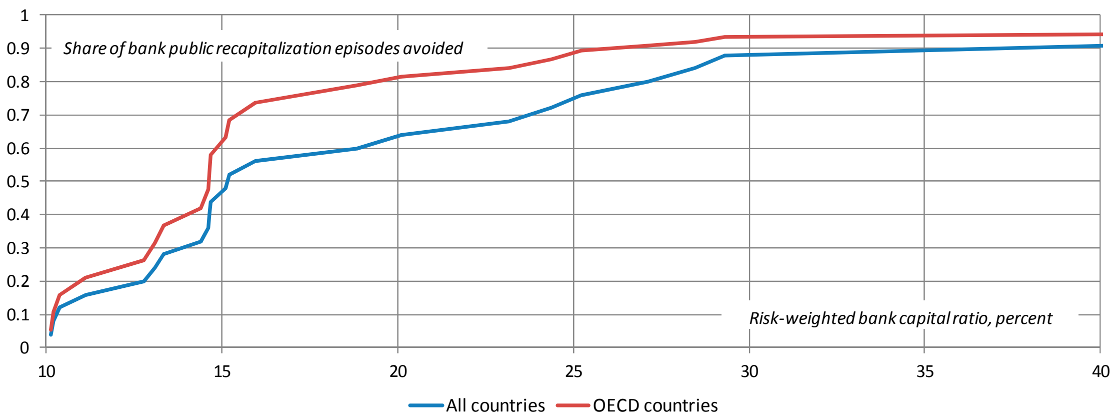


Sources: Bankscope; Laeven and Valencia 2013; and authors' calculations.

Figure 7 uses the data summarized in Figure 6 to relate hypothetical precrisis bank capital levels to the share of public recapitalization events that they would have helped avoid.

Consistent with our previous findings, the marginal benefit of additional capital in terms of avoiding public recapitalization episodes is relatively high until 15–17 percent risk-weighted capital ratios (which help avoid public recapitalizations in 75 percent of banking crises). The marginal benefit of bank capital declines rapidly after that. Similar to the earlier exercise based on NPLs, the capacity of bank capital to avoid public recapitalizations is lower in non-OECD countries.

Figure 7. Share of Public Recapitalizations Avoided, Depending on Hypothetical Precrisis Bank Capital Ratios



Sources: Bankscope; Laeven and Valencia 2013; and authors' calculations.

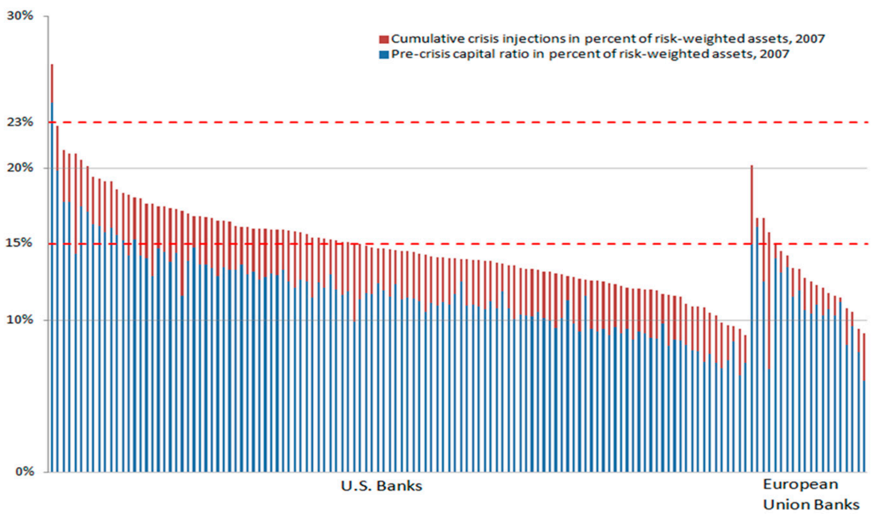
As discussed earlier, one shortcoming of our analysis stems from the fact that country-level averages can mask significant variation at the bank level. For this purpose we examine government capital injections during the recent crisis in some large European and U.S. banks (for which data are publicly available). Following the approach in this section, Figure 8 plots, at the bank level, the sum of the precrisis capital and capital injections during the crisis (both in percent of precrisis RWA). The figure suggests that a capital ratio of 15 percent in 2007 would have avoided the need for capital injection in almost 55 percent of cases in the United States and 75 percent of cases in Europe (based on sample of available data) while a capital ratio of 23 percent would have eliminated the need for injection in virtually all cases.[14] While the 55 percent figure in the case of the United States might seem low, note that this is based on the lower bound of our range. Further, the Capital Purchase Program's terms were relatively attractive to avoid stigmatizing participating banks as being weak (Swagel 2009).

In conclusion, our analysis suggests that, in advanced economies, the marginal benefits of bank capital decline substantially after 15–23 percent risk-weighted capital ratios: additional capital becomes less effective in avoiding banking crises (based on absorbing NPLs) and public

[14] We recognize the incompleteness of the data especially in the case of European banks. The data on capital injections in European banks are taken from estimates by Fratianni and Marchionne (2013), merged with bank financials from SNL Financial, and cover injections only between November 2008 and January 2010. The data on U.S. injections are from SNL Financial and are based on the Troubled Asset Relief Program (TARP). To arrive at our estimate of capital needed, we add the capital ratio to RWA assets in 2007 (precrisis) to the ratio of the sum of injections over RWA of 2007.

recapitalizations. As discussed before, this abstracts from the costs associated with higher capital requirements. We turn to these in what follows.

Figure 8. Precrisis Bank Capital and Capital Injections during the Crisis



Sources: Fratianni and Marchionne 2013; SNL Financial; and authors' calculations.

IV. How Costly Are Higher Capital Requirements?

In the previous section, we explored the benefits of higher bank capital in terms of increased financial stability and reduced expected crisis-associated fiscal outlays. Yet, we said nothing about the effects that this higher capital (if imposed through regulatory requirements) would have on the availability and cost of bank credit, and, ultimately, on macroeconomic performance. We explore these issues in this section.

As discussed in the theory section, it is useful to separate the transitional effects of an increase in capital requirements from the steady-state consequences. In that context, as discussed below, evidence of high transitional costs stands in stark contrast with extremely low estimates of the steady-state effects of higher capital ratios.

The literature on the steady-state costs of capital is relatively thin, reflecting the difficulty in estimating such costs. In particular, because of relatively stable capital regulation over the past few decades, there is a dearth of data that could help identify the exogenous effect of a change in capital requirements. Most studies have relied on calibrated general equilibrium models or exploited the cross-sectional and time series variability of bank capital within a given regulatory framework. However, since this variability reflects banks' endogenous choices (how much capital to hold in excess of regulatory minima) rather than regulatory changes, we can expect the impact of a regulatory mandated increase in capital to be larger than the estimates obtained in such studies.

A larger literature (generally employing tighter identification strategies than the literature on steady-state costs) documents the transitional costs of changes in bank capital. This literature often exploits bank-level shocks to capital—resulting either from losses or idiosyncratic (bank-level) regulatory actions—to identify the exogenous effects of tighter capital regulation on the availability and cost of bank credit. The problem with these estimates is that they rely on sudden changes in bank capital, events that mostly characterize banks that are in some state of distress. Many of the challenges associated with raising capital under these circumstances are not relevant for evaluating the effects of gradual changes in capital regulation that would affect an entire banking system. For instance, in the short term, distressed banks may be more likely to meet tighter regulatory requirements by reducing the asset side of their portfolios more than they would if they were fully sound and could raise capital gradually over time. Similarly, the stigma attached to a bank trying to raise capital in isolation is unlikely to apply in a context of system-wide regulatory reform. It follows that estimates based on short-lived bank-level shocks are likely to overestimate the steady-state costs of higher capital requirements. The literature also does not provide a guide as to how these transition costs vary depending on macroeconomic conditions and between rapidly growing emerging markets and advanced economies.

A. Steady-State Cost of Capital

As a first pass, raw evidence from U.S. data suggests only a very weak relationship between bank capital and lending rates. Panel regressions employing loan-level data from a large set of U.S. banks for the 1996–2011 period show that a 1 percentage point higher Tier 1 capital ratio is associated with loan rates that are 2.5 basis points higher (Table 3). These regressions, however, do not identify the direction of causality in this relationship. More important, the results are largely determined by relatively small variations in bank capital not associated with regulatory actions. Put differently, they reflect the effects of banks optimizing their balance sheet structure within set regulatory parameters, rather than those of a discrete shift in regulation.

The key question, however, is to what extent a policy-imposed increase in the capital requirement would increase the total funding costs of banks. If capital is indeed more costly than debt, then an increased reliance on capital would increase the overall cost of funding. However, this ignores the key premise of MM, who show that under a set of ideal assumptions, an increase in a firm's capital reduces its riskiness and thus its cost of borrowing. Under MM's assumptions, this effect fully offsets any potential increase in the total funding cost from a shift in funding structure, making an increase in capital essentially costless to banks and inconsequential to lending rates. Therefore, the extent of the MM offset—that is, the degree to which MM holds—is a crucial question.

Table 3. Pass-Through of Higher Capital to Loan Rates: Evidence from U.S. Commercial and Industrial Loans

	(1)	(2)
Tier 1 Capital Ratio	2.399*	4.646**
	[1.270]	[2.258]
Tier 1 Capital Ratio × Target Federal Funds Rate		-1.392***
		[0.223]
Target Federal Funds Rate	0.969***	1.096***
	[0.014]	[0.026]
GDP Growth	0.006	0.006
	[0.006]	[0.005]
National Bureau of Economic Research Recession dummy	-0.171***	-0.154**
	[0.060]	[0.061]
State Personal Income	-0.000**	-0.000***
	[0.000]	[0.000]
Change in Region Consumer Price Index	-0.037**	-0.038**
	[0.015]	[0.014]
State Unemployment Rate	0.104***	0.101***
	[0.013]	[0.013]
Change in State Housing Prices	-0.007	-0.008
	[0.006]	[0.006]
Bank and Loan Controls	Y	Y
Bank and State Fixed Effects	Y	Y
Observations	1,045,153	1,045,153
R^2	0.740	0.741
Number of Banks	639	639

Source: Dell'Ariccia, Laeven, and Suarez 2014.
Note: This table reports the results of estimating panel regressions of loan interest rates (in basis points) from the first quarter of 1996 to the fourth quarter of 2011. The dependent variable is the effective interest rate on a given loan, as reported in the Federal Reserve's Survey of Terms of Business Lending. Loans extended under commitment established prior to the current quarter are excluded from the sample. All regressions include state and bank fixed effects. Standard errors clustered by quarter are reported in brackets. *** indicates statistical significance at the 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

A number of studies attempted to shed light on the degree of MM offset, using modeling, calibration, and empirical methods. Overall, and despite variation in data and methods used to estimate the impact of higher capital on lending rates, the literature finds extremely small effects. The impact of a 1 percentage point increase in capital requirements on lending rates ranges from merely 2 basis points to 20 basis points (Table 4A).[15]

[15] For instance, Basel Committee on Banking and Supervision (2010) uses bank data from 13 OECD countries and assumes that the MM theorem does not apply. It finds that a 1 percentage point increase in capital requirement could lead to an increase in lending spreads by about 13 basis points. Kashyap, Stein, and Hanson (2010) use data for the U.S. and find that the MM theorem describes well the empirical relation between banks' leverage and the return on equity. Based on additional frictions, particularly the ones related to the difference in tax treatment between debt and equity, they find that a 10 percentage point increase in the capital requirement could lead to an increase in lending spreads by about 25–45 basis points. Baker and Wurgler (2013) also examine data from the United States but reach a different conclusion. They find that the reduction in risk in better capitalized banks is not associated with a reduction in the cost of equity. Nevertheless, their findings suggest a small impact on lending costs from a 10

(continued…)

The small magnitude of these estimates is consistent with prima facie historical evidence, showing that spreads between the reference and lending rates were not higher in periods when banks were much more highly capitalized (see Miles, Yang, and Marcheggiano 2012 for evidence from the United Kingdom and United States).

Based on these estimates, it would be relatively easy to argue for even higher bank capital ratios than the 15–23 percent range suggested in the previous section. However, three issues need to be taken into account. First, as discussed earlier, most of these estimates rely on relatively small variations in bank capital in excess of regulatory minima. To the extent that these reflect endogenously determined optimal liability structures, one can expect the impact of exogenous changes in regulation to be much larger. Second, the costs of bank capital may increase nonlinearly in the level of capital. This calls for caution in extrapolating observed low costs of capital into the costs of capital at substantially higher levels. Finally, it is also important to acknowledge the presence of some hard-to-measure unintended effects of higher bank capital requirements that could have important welfare implications, such as the role of bank debt as a safe asset for the economy, and the potential migration of lending to the shadow banking sector. These are issues related to the general equilibrium effects that will be discussed further in Section IV.C.

percentage point increase in the capital requirement, in the range of 60–90 basis points. See also Corbae and D'Erasmo (2014) and Carlson, Shan, and Warusawitharana (2013).

Table 4A. Estimate of the Steady-State Impact of Higher Capital Requirements on the Cost of Bank Credit

Paper	Data and method	Cost of capital
Elliot (2009)	U.S. banks, calibration.	↑ in 4 pp in ratio of equity over unweighted assets leads to ↑ of lending rates by 80 bps.
Basel Committee on Banking Supervision (2010)	Data on 13 OECD banks, 1993–2007, calibration. Assumes no MM effect and a full pass-through of cost of funding to lending rates.	↑ in 1 pp in capital req. leads to ↑ of lending rates by 13 bps.
Bank of England (2010)	U.K. banks, calibration.	↑ in 1 pp in capital req. leads to ↑ of lending rates by 7 bps.
Kashyap, Stein, and Hanson (2010)	U.S. banks, 1976–2008, calibration, assuming MM effect as supported by their data.	↑ in 10 pp in capital req. leads to ↑ of lending rates by 25–35 bps.
King (2010)	Data on 13 OECD banks, 1993–2007, calibration. Assumes no MM effect and a full pass-through of cost of funding to lending rates.	↑ in 1 pp in capital req. leads to ↑ of lending rates by 15 bps.
De Resende, Dib, and Perevalov (2010)	Canadian banks, general equilibrium model, calibration.	↑ in 6 pp in capital req. leads to ↑ of lending rates by around 7.5 bps and ↓ lending by 0.24% and ↓ GDP by 0.07%.
Slovik and Cournede (2011)	Data on OECD countries, 2004–06, calibration. Assumes no MM offset and a 100% pass-through.	↑ in 1 pp in capital req. leads to ↑ of lending rates by 16 bps.
Baker and Wurgler (2013)	U.S. banks, 1971–2011, empirical. Finds that lower systemic risk from high capital does not translate to a reduction in cost of equity.	↑ in 10 pp in ratio of equity over unweighted assets leads to ↑ of cost of capital by 60–90 bps.
Junge and Kugler (2013)	Swiss banks, 1999–2010, calibration. Estimate an MM offset of around 64%.	Halfing leverage ↑ of cost of capital by 14.1 bps and ↓ GDP by 0.45% assuming 100% pass-through.
Miles, Yang, and Marcheggiano (2012)	U.K. banks, 1997–2010, calibration. Estimate an MM offset between 45% and 75%.	Halving leverage ↑ lending spread by 6 bps if MM offset is 45% and pass-through is 33%, and ↓ GDP by 0.15%.
Corbae and D'Erasmo (2014)	Equilibrium model of banking industry dynamics calibrated with U.S. data.	↑ in 2 pp in capital req. leads to↑ loan interest by 50 bps and ↓ loan supply by nearly 9%.
Santos and Winton (2015)	U.S. banks, 1987–2007, empirical. They test the hypothesis that less capitalized banks charge higher rates on borrowers with no access to public debt markets.	↑ in 5 pp in capital req. leads to ↓ of lending rates to credit constrained firms by 15 bps.
Kisin and Manela (2015)	U.S. banks, 2002–2007, empirical, using a regulatory loophole prior to 2008.	↑ in 1 pp in capital req. leads to ↑ of lending rates by 0.3 bps and ↓ lending by 0.15%.

Note: MM refers to Modigliani and Miller, pp stands for percentage point, bps stands for basis points.

B. Costs of Transitioning to Higher Capital

A relatively large literature relies on episodes of shocks to bank capital to identify the exogenous effects of an increase in capital requirements on the supply of credit. Overall, these studies find evidence of large costs associated with transitioning to a regime with higher capital requirements (Table 4B). This stands in stark contrast with the estimates of small steady-state costs reported above. A 1 percentage point negative shock to capital (or increased capital requirement) is associated with a 5–8 percentage point contraction in lending volumes over the short term (see, for instance, Peek and Rosengren 2000; Brun, Fraisse, and Thesmar 2013; Aiyar, Calomiris, and Wieladek 2014; Eber and Minoiu 2015).[16]

Table 4B. Estimates of the Transitional Impact of Higher Capital Requirements on the Cost and Volume of Bank Credit

Paper	Data and method	Cost of capital
Furfine (2000)	U.S. banks, 1989 – 1997. Dynamic structural model estimated. Model produces a one – off drop during the first quarter.	↑ in 1 pp in capital requirement leads to ↓ in lending growth rate by around 5 percent in the first quarter.
Francis and Osborne (2009)	U.K. banks, 1996 – 2007, empirical.	↑ in 3 pp in capital requirement in three steps over 1996 – 2007 leads to ↓ lending by around 7 percent compared with the baseline.
Macroeconomic Assessment Group (2010)	Member countries using Financial Services Authority (FSA) approach. Calculating target capital ratios and studying the effect of	↑ in 1 pp in capital requirement implemented over 8 years, leads to, by the 35th quarter, ↑ 17 bps in lending spreads, ↓ in lending volume by 1.5 percent, ↓ GDP by 0.16 percent on average.
De Resende, Dib, and Perevalov (2010)	Canadian banks, general equilibrium model, calibration.	↑ in 6 pp in capital requirement with a phase in of 4 years has the following peak response: ↑ of lending spreads by almost 2 pp, ↓ lending by almost 2 percent, ↓ investment by 2.7 percent, ↓ GDP by 0.38 percent.
Institute of International Finance (2010)	Calibration on the three largest economies (G3), based on a series of regulatory changes including but not limited to, an increase in	↑ in 2 pp in capital requirement + other measures leads to, over the first 5 years, ↑ 132 bps in average lending spreads, ↓ in growth by 0.6 pp/year on average.
Maurin and Toivanen (2012)	European banks. Estimate the target capital and its impact on lending and asset growth.	1 pp capital gap dampens lending growth by 2 – 2.3 pp in the medium term.
Cohen (2013)	Data on 82 large global banks, 2009 – 12.	A 1 pp higher capital ratio at the start of the adjustment period is associated with a 3 pp higher rate of asset growth over the 3 years of adjustment.
Brun and others (2013)	France, 2006–12, transition from Basel I to Basel II, empirical.	↓ in 1 pp in capital requirement leads to ↑ of 5 percent in firm loan size over the short term.
Aiyar, Calomiris, and Wieladek (2014)	U.K. banks, 1998 – 2007, empirical, exploiting bank and time variations in capital requirements.	↑ in 1 pp in capital requirement leads to cumulative ↓ in lending growth rate 5.7 – 8 pp over the first 3 quarters.
Noss and Toffano (2014)	U.K. banks, 1986 – 2010, empirical.	↑ in 1 pp in capital requirement leads to ↓ in 4.5 percent lending volume over 3 years.
Mesonnier and Monks (2014)	European banks, 2011–12, empirical, studying the impact of European Banking Authority (EBA)'s 2011/12 Capital Exercise on	↑ in 1 pp in capital requirement leads to ↓ in 1.2 – 1.6 percent pp lower annualized loan growth, over 9 months.
Bridges and others (2015)	U.K. banks, 1990 – 2011, empirical.	↑ in 1 pp in capital requirement leads to ↓ in household secured lending growth rate by almost 1 pp and Commercial Real Estate (CRE) loan growth by 8 pp, during the first year. The first effect vanished within 3 years but some evidence that impact on CRE loan growth is

Note: FSA refers to Financial Services Authority, EBA to the European Banking Authority, CRE stands for Commercial Real Estate, pp for percentage point, and bps for basis points.

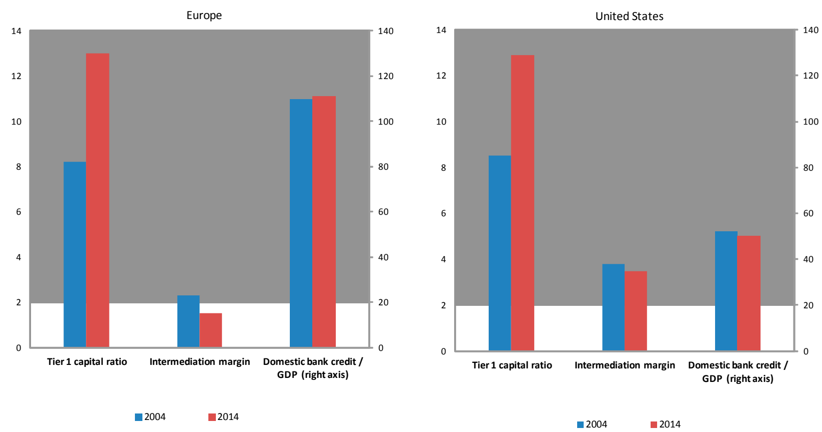
[16] Peek and Rosengren (2000) examine the changes in lending by Japanese branches and subsidiaries in the United States when the capital ratios of their parent banks fell below the 8 percent Basel I minimum following the Japanese stock market crash. Aiyar, Calomiris, and Wieladek (2014) exploit a policy experiment in the United Kingdom, between 1998 and 2007, which led the Financial Services Authority to vary individual banks' capital requirement. Brun, Fraisse, and Thesmar (2013) exploit the transition from Basel I to Basel II in France between 2006 and 2012. Eber and Minoiu (2015) analyze the impact of the phase-in of Europe's Single Supervisory Mechanism on bank balance sheets. They exploit a discontinuity in the assignment mechanism to show that, in anticipation of stress tests and stricter regulation, banks reduced leverage by shrinking assets (both loans and securities) and reducing reliance on market-based debt, rather than by increasing capital.

But there is also evidence that costs tend to be lower if one allows banks to adjust to the new regime more gradually. For instance, calibrated models for several OECD countries suggest that, on average, over eight years, a transition to a 1 percentage point higher capital requirement is associated with a 17 basis points increase in lending, a 1.5 percent decline in lending volume, and a 0.16 percent drop in GDP compared with the baseline (Macroeconomic Assessment Group 2010).

Similar to the case of steady-state costs, one should exercise caution in taking these estimates at face value, even when trying to evaluate the transitory cost of regulatory reform. The use of bank-level idiosyncratic responses provides a robust identification strategy for the exogenous effects of shocks to capital requirements for a specific bank. However, these estimates are hardly indicative of the costs associated with regulatory reforms. First, they generally rely on "natural experiments" conducted in the context of some degree of bank distress (that is, large losses or discretionary regulatory interventions). Effects would likely be smaller for healthy banks with access to equity markets. Second, as discussed above, the stigma associated with any individual bank attempting to raise equity is likely maximized under the circumstances considered by these studies. Again, this effect would likely be absent in the context of a system-wide regulatory reform.

Consistent with these considerations, an analysis of the increase in capital requirements in the wake of the global financial crisis suggests that the effects of tighter regulation on intermediation margins and the overall supply of bank credit have been limited (Cecchetti 2014). For instance, average risk-weighted capital ratios at large banks in the United States and Europe increased by almost 5 percentage points between 2004 and 2014. But credit-to-GDP ratios and intermediation margins remained virtually unchanged (Figure 9).

Figure 9. Bank Capital Ratios and Credit Provision, Pre- and Postcrisis



Sources: Averages for U.S. and European global systemically important banks (United States: Bank of America, Citigroup, JPMorgan Chase, Wells Fargo; Europe: Barclays, HSBC, Royal Bank of Scotland, BNP Paribas, Credit Agricole, Societe Generale, Deutsche Bank, and Credit Suisse). Domestic bank credit/GDP for Europe is the weighted average for France, Germany, and United Kingdom.

C. Insights from General Equilibrium Models

It is useful to compare the 15–23 percent bank capital ratio discussed in Sections III.A and B with results from calibrated dynamic general equilibrium models.

The general equilibrium literature that attempts to quantify the impact of bank capital on social welfare is thin but growing. Papers typically nest some of the opposing channels discussed in Section II in a dynamic general equilibrium model. A common trade-off in these models is that capital reduces bank risk taking and the risk of crises, and hence consumption volatility, but, by crowding out deposits, imposes costs in the form of reduced credit and output due to the liquidity preferences of cash investors.

Overall, this literature suggests that optimal bank capital can range from 8 to 20 percent (Van den Heuvel 2008; Nguyen 2013; Begneau 2014; Martinez-Miera and Suarez 2014; Mendicino and others 2015). The calibrated welfare effects of varying bank capital within that range in terms of higher lending rates and lost consumption are relatively small. The relatively wide range of the estimates for the optimal level of capital reflects the many degrees of freedom in model design and parameter calibration.[17] The 15–23 percent capital ratio suggested in Sections III.A and B is near the top of the range of optimal bank capital levels identified in general equilibrium models. But it is consistent with their predictions.

[17] For example, Begneau (2014) considers the possibility of substitution between bank funding and direct lending (which can point to the effects of migration of activities to shadow banking) and the effect where an increase in bank capital reduces the quantity of bank liquidity provision but increases its quality (making bank deposits safer and cheaper). Martinez-Miera and Suarez (2014) consider "last bank standing" effects: the benefits that well-capitalized banks derive from being able to survive a systemic shock and earn scarcity rents.

V. Conclusions

This paper explored how different levels of bank capital would have fared in past banking crises. Using alternative approaches, it finds that, for advanced economies, the marginal benefits of higher bank capitalization in terms of absorbing losses in banking crises are substantial at first, but decline rapidly once capitalization reaches 15–23 percent of risk-weighted assets. The reason is that protection against extreme crises requires substantially more loss absorption capacity, but at the same time, such crises are rare. The 15–23 percent estimate should be seen as a useful thought experiment with a conservative bend. In particular, the estimate does not take into account the potential reduction in risk taking induced by higher capital through "skin-in-the game" effects. Notably, the paper focuses exclusively on capital, and abstracts from the loss-absorption capacity that other bail-in-able securities may provide. Hence, these findings can be reinterpreted in terms of TLAC.

The 15–23 percent range is very similar to the 16–18 percent range for TLAC proposed by the FSB for global systemic banks. It is also consistent with the recent Federal Reserve's proposal of a TLAC amount of the greater of 18 percent of risk-weighted assets and 9.5 percent of total leverage exposure for global systemically important banks (Board of Governors of the Federal Reserve System, 2015).

Results are more nuanced for emerging markets and low-income countries. On the one hand, banking crises in these countries have historically been associated with greater bank losses. On the other, because banking systems in these countries tend to be smaller than in advanced economies, losses in excess of capital will likely represent a smaller share of GDP and thus might have more limited macroeconomic effects. In this context, the relative role of greater loss absorption capacity and improvement in governance and institutions aimed at reducing losses in crises should be the subject of future research.

The paper also reviewed empirical evidence on the costs of higher bank capital. Existing studies suggest that the costs of transitioning to higher bank capital might be substantial. When faced with the need to adjust their capital ratios quickly, banks are likely to constrain the supply of credit (as was likely the case in Europe already). Transition costs might be lower when capital adjustment is staggered or takes place in the upswing of the credit cycle. In contrast, the evidence overwhelmingly suggests that the steady-state (long-term) social costs of higher bank capital requirements, within our estimated range, are likely to be small.

The estimated loss absorption needs can be refined to allow for heterogeneity across banks and over time. Banks that are not systemically important (those that can be allowed to fail without major spillover effects) could be allowed to hold lower capital and loss-absorption capacity. Similarly, most banking crises follow periods of rapid credit growth, suggesting a role for countercyclical buffers (Borio 2014; Claessens 2014).

Overall, our analysis leads to the following tentative conclusions:

First, bank capital in the 15–23 percent range would have avoided creditor losses in the vast majority of past banking crises, at least in advanced economies. Increases in capacity to absorb losses beyond this are likely to provide limited benefits. Hence, given the uncertainty surrounding the long-term welfare costs of bank capital (and other bail-in-able instruments), a loss absorption capacity in the 15–23 percent range appears appropriate for banks in advanced economies. Again, translating these findings into regulatory recommendation requires taking into account that banks tend to hold capital in excess of regulatory minima and that other bail-in-able instruments may contribute to loss-absorption capacity. Thus, appropriate capital requirements may be well below this range.

Second, since the costs of transitioning to higher capital might be substantial, any new regulatory minima should be imposed gradually over a relatively long period of time. Also, supervisors should encourage banks to increase capital ratios by raising equity (through new issuance or retained earnings) rather than shrinking assets, so as to avoid reduced credit availability.

Third, tighter capital and loss absorption standards should be complemented by improvements in institutional settings (in regulation, supervision, resolution, and governance) in order to reduce possible losses in banking crises, especially in emerging markets.

Fourth, higher capital requirements may provide stronger incentives for regulatory arbitrage and increase the risk of activities migrating to unregulated or less regulated financial intermediaries (such as insurance companies or broker-dealers). In that context, it is essential that tighter capital and loss absorption requirements are complemented with measures that widen the perimeter of prudential and macroprudential regulation.

Finally, there is more to crisis prevention than improved capital buffers. This paper focuses on bank capital and loss absorption capacity, but several other regulatory steps can enhance financial stability. These include but are not limited to better standards for the quality of bank capital as well as—on the liquidity of assets—an improved approach to supervision including clearer mandates for regulators, a prudential regime that discourages regulatory arbitrage and incentives for excessive risk taking, and more efficient resolution mechanisms.

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