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Overview

A financial sector crisis was at the heart of the 2007–09 Great Recession in the United States and most other industrial economies.[1] Since the crisis, policymakers have pursued regulatory reforms designed to strengthen the banking sector, in order to reduce the chances of repeating that economic disaster.

These reforms have focused on increasing the required level of equity capital of banks. For the largest banks, deemed "global systemically important banks" (G-SIBs), major economies have also agreed to require an additional layer of protection in the form of "total loss-absorbing capacity" (TLAC) that is approximately equal to the amount of equity capital required. The extra protection is in the form of subordinated debt and contingent convertible (CoCo) debt, which converts into equity if certain adverse thresholds are breached.

Apart from higher equity and other TLAC, the reforms have also included the introduction of yearly stress tests, in which bank supervisory agencies review whether banks could withstand adverse shocks to the economy. In the United States, reform has also included curtailment of proprietary trading (the "Volcker rule"), as well as the requirement that large banks develop "living wills" that permit orderly "resolution" (the managed winding-down of an effectively bankrupt bank) to avoid catastrophic collapses such as that of Lehman Brothers in 2008.

1. Among major high-income economies, only Australia, Canada, Finland, Japan, New Zealand, and Norway escaped a banking crisis in this period (although Japan experienced a crisis in the late 1990s). See table 4.1 in chapter 4.

Equity capital is important because it is the cushion of assets in excess of liabilities that can be drawn down before a bank hits the point of insolvency. Equity is obtained either by issuing new shares or retaining earnings (rather than paying them out in dividends). Since the Great Recession, banks have increased equity capital mainly through retained earnings rather than new issuance, which would dilute existing shareholders and, at least initially, would have been on relatively unfavorable terms given market conditions (see Cohen 2013).

In 1988 the Group of Ten advanced industrial countries adopted the first Basel Accord on minimum bank capital requirements, motivated in part by the need to create a level playing field among internationally active banks. The agreement set a minimum capital requirement of 8 percent of risk-weighted assets for bank "capital," generously defined to include intangible good will and certain subordinated debt.[2] A revised Basel II agreement in 2004 sought to refine the risk weighting of assets, including through the use of internal models of risk by (typically larger) banks themselves.

The Great Recession precipitated tougher rules. In late 2010 the Basel Committee on Banking Supervision issued the Basel III rules (BCBS 2010b). They effectively set a minimum of 7 percent of risk-weighted assets for most banks but use a much stricter definition of capital (tangible common equity) than Basel I and Basel II had. For G-SIBs the minimum was set at 9.5 percent.

In late 2015 the Basel III rules were extended to require TLAC amounting to 18 percent of risk-weighted assets for G-SIBs (FSB 2015c). New rules constraining the use of banks' internal models for estimating risk weights had been scheduled to be completed by the end of 2016. However, disagreement between European and US negotiators and uncertainties associated with the new administration in the United States left this important modification of the Basel rules still unfinished by April 2017.[3]

The purpose of this study is to quantify the costs and benefits to the economy from requiring additional bank capital in order to determine whether Basel III struck the right balance between increased financial system

2. However, core tier 1 capital excluding goodwill was to be at least 4 percent of risk-weighted assets. Tier 2 capital included hybrid instruments with equity-like characteristics as well as subordinated debt with maturity of at least five years. Risk weights were set at zero for sovereign debt of all OECD countries, and 50 percent for fully secured mortgage loans on residential property (BCBS 1988).

3. Bankers have called the prospective rules "Basel IV," implying a further increase in capital requirements. Regulators have resisted this sobriquet, arguing that the purpose of the revisions is to reduce disparities in risk-weight outcomes across banks' models, not to raise the overall average for capital ratios (Caroline Binham and Laura Noonan, "Basel Committee Fail to Sign off on Latest Bank Reform Measures," *Financial Times*, November 30, 2016). For further discussion, see chapter 7.

safety and potential costs to economic activity. In an early response, the Institute of International Finance (a leading global association of private financial firms) projected that the increase in borrowing costs imposed on economies by the new requirements would cause output in the main industrial countries to decline by about 3 percent from levels it would otherwise have reached by 2015 (IIF 2011, 55). At the opposite extreme, a study by two prominent academic experts argues that the new requirements are far too lenient. Admati and Hellwig (2013, 179) argue that banks should be required to hold 20 to 30 percent of their total assets as equity, which would amount to about 35 to 55 percent of risk-weighted assets for US and euro area banks.

There was thus nearly an order of magnitude difference between the implied optimal levels for equity capital in this technical dispute, an unusually wide divergence for a central variable of economic policy.[4] This gap cried out for further analysis.

Plan of the Study and Principal Findings

A core argument in the Admati-Hellwig view is that financial theory posits that there should be no cost at all from higher equity and less debt leverage because of the Modigliani-Miller (M&M) theorem whereby capital structure is "irrelevant" (Modigliani and Miller 1958). The proposition is that equity investors will be satisfied with a lower rate of return if the firm has more equity and less debt, because the riskiness of the firm will have declined, and that the resulting decline in the unit cost of equity investors demand will be just enough to offset the shift from low-cost debt to higher-cost equity. The first central question in this policy area, then, is whether this theorem is operationally reliable for banks or breaks down in practice.

Chapter 2 provides a critical review of the literature on capital requirements. Chapter 3 begins the quantitative analysis with an empirical test of the M&M theorem for US banks. With an estimate in hand for the effective degree of the M&M "offset" (extent to which higher quantity of equity is offset by lower unit cost), chapter 4 turns to quantification of benefits and costs of higher bank capital and identifies the optimal capital ratio. Chapter 5 addresses TLAC requirements, both surveying the literature and providing new evidence on the losses of the largest US banks in the Great Recession, to determine whether they had engaged in excessive risk taking as a result of too big to fail (TBTF) incentive distortions. Chapter 6 critiques the recent empirical literature maintaining that there is already too much

4. Using the 7 percent tangible common equity benchmark, the gap between Admati-Hellwig and Basel III was 5- to 8-fold in one direction, and there was a considerable gap between the IIF and Basel III in the opposite direction.

finance, based on statistical correlations of growth with indicators of financial depth. If it were the case that finance is excessive, the curbing of bank activity by higher capital requirements might bring a supplementary benefit by shrinking finance back to the optimal size, but the tests in chapter 6 do not support this implicit proposition. Chapter 7 summarizes the study's main findings.

The principal quantitative findings of this study are as follows:

- Only about 45 percent of the M&M risk offset attains in practice (chapter 3).
- Each percentage point increase in capital required relative to total assets (not risk-weighted assets) reduces the long-run level of GDP by 0.15 percentage points (chapter 4).
- A banking crisis imposes damage equal to about two-thirds of one year's GDP in present-value terms, including longer-term effects (chapter 4).
- The optimal level of tangible common equity is 7 to 8 percent of total assets, corresponding to 12 to 14 percent of risk-weighted assets (chapter 4).
- Correspondingly, the optimal capital ratio is about one-third larger than the target set in Basel III (13 percent of risk-weighted assets compared with 9.5 percent for tangible common equity for G-SIBs). In practice, however, US banks hold close to the optimal amount, because they maintain a cushion above the required minimum (chapter 4).
- In the Great Recession, the largest US banks did not experience losses that were proportionally significantly greater than those of medium-size banks, casting doubt on the proposition of excessive risk taking spurred by TBTF incentive distortions (chapter 5).
- New tests cast doubt on the too much finance literature (chapter 6).

Salient Themes in the Literature

Chapter 2 frames the issues and examines the state of analytical work in a critical review of the literature. It surveys four categories of studies: "heuristic seawall" studies, calibrated studies of transitional costs, calibrated long-term cost-benefit studies, and a variant of calibrated studies using dynamic stochastic general equilibrium models.[5]

The analysis of Admati and Hellwig (2013) is prominent in the first group. It is based on the observation of higher historical levels of bank capital;

5. Studies in a fifth category, on TLAC, are surveyed in chapter 5.

the argument that banking is no different from other corporate sectors, where much higher equity capital is common; a strong M&M assumption; and the argument that analysis should be based on social costs, correcting for the distortion of tax deductibility of debt interest but not equity earnings. I argue that banking is different, if only because more than half of its production activity is inherently financed by debt in the form of deposits and that it would not be optimal to apply social pricing to one sector while leaving the financing cost distortion unchanged in the rest of the economy.

An important study in the first group is an IMF-based analysis by Dagher et al. (2016). It uses a seawall approach to examine what levels of capital would have been required to cover 85 percent of bank losses in past banking crises based on nonperforming loan data and alternative assumptions about the loss incidence of nonperforming loans.

Two studies stand out in the second set of studies, on transitional effects. Based on a large number of macroeconomic models, the Macroeconomic Assessment Group (MAG 2010) estimates that the phase-in of Basel III requirements would temporarily reduce output by a maximum of about 0.25 percentage point from baseline after three years. As noted, the IIF (2011) instead estimated an output loss more than an order of magnitude larger. Writing in late 2014, Cecchetti (2014) pronounced that "the jury is in" and that the effects had been even milder than anticipated by the Macroeconomic Assessment Group. The exceptionally low interest rate environment in this period may cloud this diagnosis, however. Cohen (2013) provides support for the moderate or low-cost diagnosis. He finds that banks adjusted mainly by building up retained earnings, thereby avoiding the most severe adverse effects from either sharp reductions in outstanding claims or forced recourse to high-cost share issuance under adverse conditions.

In the third group of studies, the preeminent calibrated long-term study remains the Long-Term Economic Impact (LEI) analysis of the Basel Committee on Banking Supervision (BCBS 2010a). Placing the median long-term cost of a banking crisis at 63 percent of one year's GDP and considering the extent of reduction in probability of a crisis at successive levels of bank capital, the study shows a wide range over which higher tangible common equity capital would be socially beneficial, with the optimal level at 13 percent of risk-weighted assets.

An important study by Miles, Yang, and Marcheggiano (2012) places the desirable range at 16 to 20 percent of risk-weighted assets. The median estimate across 16 leading studies (including those in the seawall and dynamic stochastic general equilibrium groupings) places the optimal capital ratio at 13 percent for common equity tier 1 capital relative to risk-weighted assets (see table 2.1 in chapter 2).

My estimates (in chapter 4) are also at this level: 12 to 14 percent of risk-

weighted assets (7 to 8 percent of total assets). This outcome is the same as that of the BCBS (2010a), even though I allow for a considerable (45 percent) M&M offset. The production function approach of Miles, Yang, and Marcheggiano (2012), which I use, generates a substantially larger adverse impact on output from a given rise in average borrowing cost than does the compilation of macroeconomic models. Those models may inappropriately incorporate monetary policy feedbacks and may not be designed to capture the effects of permanent long-term reductions in available capital stock as opposed to short-term fluctuations in demand.

The last group of studies, the dynamic stochastic general equilibrium models, provides methodologically elegant but ultimately less credible estimates of optimal capital requirements. One study concludes that capital requirements were already too high before the Great Recession. None of the main dynamic stochastic general equilibrium models incorporates the centerpieces of this issue: the response of the probability of a banking crisis to capital levels and the economic cost of a banking crisis. Instead, they are driven by such influences as an initial phase of benefit from reducing excessive risk taking as capital rises followed by a phase of cost to output from reduced capital stock.

Testing Modigliani-Miller for Banks

Chapter 3 uses data on 51 large US banks in 2001–13 to test the M&M theorem. With assets ranging from about $6 billion to $2.4 trillion, these banks accounted for about 75 percent of the total assets of US banks (including noncommercial bank subsidiaries of bank holding companies) in 2013.

The discussion begins with the question of whether the banking sector is special. The ratio of total assets to equity capital has typically been only about 3:1 for the nonfinancial sector but about 10:1 or higher for banking. In their analysis of equity returns, Fama and French (1992, 429) specifically excluded financial firms, because they judged that the high leverage normal for the sector did not have the same meaning of distress as in nonfinancial firms. The major product of banks—liquid deposit services to customers—constitutes debt, making them inherently different from nonbanks with respect to the ratio of debt to equity (Herring 2011, DeAngelo and Stulz 2013).

Those empirical tests of M&M for banking that have been conducted, moreover, have typically sought to identify the influence of the capital structure irrelevance theorem by calculating the relationship of bank "beta" coefficients to leverage ratios (capital relative to assets).[6] In the capital asset

6. Beta is a measure of relative volatility. It tells the percent by which the stock price rises when the overall market rises by one percent, or falls when the overall market falls by 1 percent.

pricing model (CAPM), the unit cost of equity equals the risk-free rate plus the firm's beta coefficient multiplied by the excess of the diversified market yield over the risk-free rate (equity premium). Although tests do tend to find that bank beta coefficients are related to leverage, the underlying CAPM framework is known to perform poorly in explaining cross-section stock returns (Fama and French 1992). In any event, the original model of Modigliani and Miller (1958) provides a much more direct estimating form, and the tests in chapter 3 apply this form.

In those tests the cost of equity capital is estimated as a linear function of the ratio of debt to equity. The constant in the resulting equation should be the return to capital in the banking sector. The coefficient on the ratio of debt to equity should be the difference between this return and the interest rate on debt.

The tests in chapter 3 apply two alternative measures of equity cost: the inverse of the price-to-earnings ratio and the ratio of net earnings to the book value of equity. For both the data are constrained to force the observed equity cost to no less than the risk-free rate plus 100 basis points, so that negative earnings instances (concentrated in 2007–10) do not give misleading signals of returns demanded by investors. Although about 8 percent of bank-year observations show negative earnings, only 1 percent of the sample had losses exceeding 3 percent of bank assets, suggesting a lower needed seawall than typically perceived.

The estimates show a statistically significant coefficient of equity cost on leverage for one of the specifications (net earnings relative to book value of equity). Using the average coefficients estimated for the two specifications, and considering the base levels of equity cost and likely levels for interest rates on debt, a 15 percentage point increase in the ratio of equity capital from an illustrative base level of 10 percent (as proposed by Admati and Hellwig 2013) would raise the average cost of capital to banks by a central estimate of 62 basis points. If there were no M&M effect at all, the corresponding increase would be 112 percent, so the estimated M&M offset amounts to 0.45. Slightly less than half of the cost impact of higher capital requirements would thus be offset by the lower unit cost of equity thanks to lower risk.

Calculating the Optimal Capital-to-Assets Ratio

Chapter 4 presents a model estimating the optimal capital-to-assets ratio, using as a key input the M&M offset coefficient estimated in chapter 3. The cost of a higher capital ratio to the economy stems from the increase in the unit cost of capital to borrowing firms and households, the consequential reduction in the economywide stock of capital, and hence the reduction of

future output from its baseline path. The benefit of higher capital requirements comes from the crisis damage avoided, equal to the reduction in the probability of a banking crisis multiplied by the long-term cost of a banking crisis.

The chapter first develops new estimates of damage from banking crises. The analysis takes account of the fact that output may have been above potential before the crisis. It also points out that even if output does not return to its baseline trend for potential by the fifth year of the crisis, the shortfall would not be perpetual, because the forgone capital stock sacrificed to the recession would not have had an infinite life. Based on past banking crisis episodes, and allowing a 15-year capital life following the recession to calculate lingering costs, I estimate that the typical long-term cost of a banking crisis in an advanced industrial economy has been 64 percent of one year's GDP, almost identical to the median estimate in the Basel Committee's Long-Term Economic Impact analysis (BCBS 2010a).

The next step is to identify the relationship between the probability of crisis and the level of the capital ratio. I apply the schedule of this relationship reported by the Basel Committee (BCBS 2010a), which is based on cross-country regression models and models of banking system contagion from interbank exposures. There is a relatively rapid drop-off in the probability of crisis as the capital ratio increases. For tangible common equity, an increase in the ratio of capital to risk-weighted assets from 7 to 8 percent reduces the annual probability of crisis from 4.6 to 3.0 percent in the BCBS schedule; the probability falls to 1 percent when the capital ratio reaches 11 percent, and it declines by only another 0.1 percent (from 0.4 to 0.3 percent) when the increase is from 14 to 15 percent. I adopt this degree of curvature but set the base probability at 2.6 percent rather than 4.6 percent (for 7 percent capital to risk-weighted assets), because I see the relevant period as considerably longer (1977–2015) and hence the baseline annual frequency of banking crises as lower (given the concentration of crises in 2007–08). The overall result is a sharply concave curve relating benefits to higher capital ratios (see figure 4.2 in chapter 4).

The analysis then incorporates the cost to the economy of higher capital requirements. Using the same production function framework proposed by Miles, Yang, and Marcheggiano (2012), I set the proportional output loss equal to the proportional rise in the unit cost of capital multiplied by the product of the elasticity of output with respect to capital and the elasticity of substitution between capital and labor, all divided by unity minus the elasticity of output with respect to capital. The derivative of this cost turns out to be a constant that is influenced by the shares of bank and nonbank finance, the gap between the unit cost of equity capital and the cost of debt to banks, and the M&M offset coefficient. At the central values, this con-

stant turns out to be a loss of 0.15 percent of GDP for each percentage point increase in the required ratio of capital to total assets.

There is thus a straight-line upward-sloping cost curve for the capital requirement. The optimal level for the capital ratio will then be where the slope of the concave benefits curve is identical to the slope of the cost line. The central value for the M&M offset is set at 0.45, based on the results of chapter 3. Using low, central, and high variants for this parameter and six others (loss from crisis, unit cost of equity to banks, coefficient for spillover to capital cost in nonbank lending, elasticity of output with respect to capital, elasticity of substitution between capital and labor, and crisis probability curve), the analysis generates 2,187 possible outcomes for the capital ratio at which marginal benefits equal marginal costs. The median outcome is 6.9 percent of total assets; the 75th percentile outcome is 7.9 percent. The main result is thus that the optimal capital ratio is 7 to 8 percent of total assets, corresponding to 12 to 14 percent of risk-weighted assets (using the ratio of risk-weighted assets to total assets in euro area and US banks).

Total Loss-Absorbing Capacity

Chapter 5 considers the role of TLAC—namely, CoCos, contingent write-down debt, and subordinated debt—as essentially buffers that are imperfect substitutes for equity but have a lower cost. The minimum requirement for the large G-SIB banks is 9.5 percent of risk-weighted assets for tier 1 common equity; their TLAC requirement is a minimum of 18 percent of risk-weighted assets.[7] In effect, the G-SIBs are required to arrive at total equity and quasi-equity that amounts to twice their tier 1 common equity.

A substantial body of literature applies to TLAC. Much of it concerns the disciplinary role of subordinated debt. There seems to be little recognition in the literature, however, that the mobilization of nonequity TLAC in a crisis could cause problems of its own. With respect to CoCos, the most likely holders are hedge funds, which would be fleet of foot in an incipient crisis, causing a plunge in CoCo prices as well as the stock prices of the banks in question (Persaud 2014). A taste of this phenomenon occurred in early 2016, when concerns arose that one of the largest European banks (Deutsche Bank) would be unable to make a coupon payment on contingent write-down debt because certain triggers appeared imminent (see appendix 5A). As for outright subordinated debt that is eligible to qualify as

7. This requirement is to be met by 2022. The target is to be firm specific. The average for eight US G-SIBs is 19.9 percent. The highest is for JPMorgan Chase, at 23.5 percent (Financial Stability Board press release, November 9, 2015, and Federal Reserve press release, October 30, 2015).

TLAC, virtually none of the literature seems to focus on the fact that the writing down of subordinated debt is equivalent to a haircut in a default. Yet the whole purpose of regulatory structure should be to avoid the bankruptcy of banks and hence any need for default and haircut. Once again the problem is a shock to confidence in the banking system if the point of bankruptcy is reached. Much of the political pressure for TLAC seems to turn on the desire to avoid taxpayer bailouts of banks, but countenancing bankruptcy of banks for this purpose instead of increasing equity and avoiding bankruptcy constitutes a risky strategy.

On the disciplining role of subordinated debt, Ashcraft (2008) finds such a role before the Basel accord but not thereafter. He attributes the change to the Basel requirement that tier 2 subordinated debt cannot include restrictive covenants. Evanoff, Jagtiani, and Nakata (2011) find that for banks, spreads on subordinated debt are indeed related to risk (as indicated by nonperforming loans and other measures) and argue that the stronger relationship found for the subsample of banks with recent issuance means that a mandatory requirement for subordinated debt should not be rejected because past signals have seemed too noisy to justify such a change. Calomiris and Herring (2013) state the case for CoCos in terms of imposing strong incentives on management to recapitalize rather than waiting too long.

In the area of TBTF, the literature has tended to use the "ratings uplift" difference between "support" and "stand-alone" ratings of banks by major rating agencies as a measure of the implicit TBTF subsidy. Marques, Correa, and Sapriza (2013) find that bank "*z*-scores" or distance to insolvency ratios (return on assets plus capital-to-assets ratio, normalized by standard deviation of return on assets), are negatively related to the TBTF subsidy as measured by the ratings uplift. Afonso, Santos, and Traina (2014) similarly find risk taking as measured by impaired loans or net charge-offs to be significantly related to the ratings uplift. An important caveat to this literature, however, is that some studies find that by 2013 the bond spread advantage of TBTF firms had swung to a disadvantage, suggesting that reforms such as living will resolution plans required of large banks in the United States and the prospect of new mandatory bail-ins in the euro area's banking union reforms may have already substantially reduced the TBTF subsidy.

On economies of scale, Wheelock and Wilson (2012) and Hughes and Mester (2013) find important economies of scale in banking. Davies and Tracey (2014) argue that these economies disappear if social pricing is applied to the costs of funds, but their result is subject to the well-known problem that estimation using a single parametric (translog) function rather than nonparametric techniques yields misleading results (McAllister and McManus 1993). Moreover, in their simulation reestimating returns to scale replacing large banks' actual cost rates with median rates for banks

under $100 billion in assets, Hughes and Mester (2013) find little change in their returns to scale estimates—the opposite of the social pricing finding in Davies and Tracey (2014).

Chapter 5 closes with a test for the experience of US banks in the Great Recession. It examines the change in net earnings as a fraction of assets from 2006–07 to 2008–10 for 16 TBTF banks with assets of more than $100 billion and compares it to the change for the next 34 largest banks. If the largest banks had engaged in excessive risk taking as a consequence of the TBTF subsidy, one would have expected them to have incurred substantially larger losses than the next tier of banks. But a simple test for significant difference of means fails to show any difference between the two groups. The implication is that the portrait of excessive risk taking may have been overdone, and correspondingly that the largest banks may place a greater weight on "charter value" (emphasized in earlier literature) relative to TBTF profits than generally recognized.[8] It may also be appropriate to pay closer attention to economies of scale, another controversial aspect of the literature.

Too Much Finance?

Chapter 6 addresses the recent literature purporting to identify a negative influence of high levels of financial intermediation on growth. If one believes that the financial sector is already too large in the major economies and is suppressing potential growth, the appropriate measure of the benefits of higher capital requirements would need to incorporate an economic gain from the fact that they would tend to reduce the size of the financial sector. The issue is thus highly germane to the policy debate on capital requirements, although it is virtually absent from the capital requirements literature and has instead proceeded on a separate path in the cross-country growth literature.

However, the analysis of chapter 6 suggests that the too much finance studies may be mistaking correlation for causation. Across countries, the depth of financial intermediation increases as per capita income rises. But the rate of growth per capita tends to decline as per capita income rises, reflecting the process of convergence. One could mistakenly conclude as a result that "too many doctors" or "too many telephones" or "too much R&D" cause growth to decline, as rising levels of these variables per capita also tend to accompany higher per capita incomes. For the purposes of identifying optimal capital requirements for banks, evidence of too much finance is insufficiently robust to welcome shrinkage of financial intermediation as a side benefit of raising capital requirements further.

8. Charter value is the value of being able to continue doing business in the future.

Framing Issues

Several key contextual issues should be kept in mind in interpreting the results of this study.

Lender of Last Resort and Resolution of Large Banks after Dodd-Frank

The Dodd-Frank Act of 2010 imposed new constraints on the ability of the Federal Reserve to act as the lender of last resort. At the same time, it emphasized and created a special framework for the resolution (expedited bankruptcy workout) of large banks. It gives the Federal Deposit Insurance Corporation (FDIC) Orderly Liquidation Authority (OLA), which it implements through the Single Point of Entry (SPOE) approach. Under this approach bank holding companies would become effectively bankrupt even as their subsidiaries would be kept in regular operating condition. Because of the possibly narrower scope for crisis response than in the Great Recession, and in view of the possibility that resolution of the largest banks under the new arrangements could well be far less seamless and more traumatic to the system than assumed under OLA and SPOE, Dodd-Frank increases the importance of preventing crises through the adequate capitalization of banks.

Risk-Weighted versus Total Assets

Under the 1988 Basel I agreement, standardized risk weights were applied (to five different risk categories) to arrive at risk-weighted assets (RWA). Required capital was then set at 4 percent of risk-weighted assets for tier 1 capital (equity and retained earnings). An additional 4 percent was required in supplementary tier 2 capital (subordinated long-term debt, hybrid instruments, and general provisions).

In 1996 an amendment to the agreement provided for weights based on market risk to be applied to the securities held in banks' trading books (as opposed to the "banking" portfolio meant to be held to maturity). It also allowed the largest banks to determine their risk weights using their internal (typically value at risk) models (Neumann and Turner 2005). The final Basel II rules issued in 2004 provided for the use of internal models for credit risk as well as market risk. The shift to internal models was especially important for European banks that were moving from commercial to universal banking.[9]

In part because of the resulting incentive to apply less conservative in-

9. In addition to commercial lending, universal banks are active in investment banking, insurance, and other financial services such as wealth management and underwriting.

ternal models, the clear correlation between capital to risk-weighted assets and capital to total assets ratios that had existed across major European banks in 1996 became a random scatter by 2002 (Bayoumi forthcoming). By 2002 the two measures were still closely correlated for mainly commercial banks, but the universal banks had much lower ratios of equity to total assets and no clear correlation between the two concepts; by 2008 the positive relationship had broken down even for European commercial banks.

Hoenig (2013) argues that the low risk weights on AAA collateralized debt obligations (such as mortgage-backed securities) and the zero weights on sovereign debt induced banks to leverage these assets excessively onto their balance sheets even as the risks of these asset classes escalated. Using data for G-SIBs in 2012, he shows that the leverage ratio of tier 1 capital to total assets provides a relatively good statistical explanation of market expectations of default frequency and credit default swap spreads whereas the ratio of tier 1 capital to risk-weighted assets does not.

Similarly, Goldstein (2017) is acerbic in his critique of risk-weighted assets. He strongly favors capital requirements based on total rather than risk-weighted assets.

The divergence between the two capital measures was most pronounced for investment banks, in part reflecting the fact that in the United States they were regulated by the Securities and Exchange Commission (SEC) rather than the Federal Reserve (which regulates the largest banks) or the Comptroller of the Currency (which regulates other banks). US commercial banks have been subject to prompt corrective action triggered by a leverage ratio of 5 percent for high-quality capital relative to total assets, whereas investment banks (and investment bank subsidiaries of the largest bank holding companies) have not. Thus whereas the largely commercial bank Wells Fargo reported risk-weighted assets equal to 84 percent of total assets in 2008, universal bank JPMorgan Chase reported this ratio at 57 percent and investment bank Morgan Stanley reported it at 42 percent, according to SEC 10-K reports. The potential for a distorted picture from the risk-weighted ratio is highlighted by the fact that in mid-2007 the reported tier 1 capital ratio was actually higher for ill-fated Lehman Brothers (11 percent of risk-weighted assets) than for Wells Fargo (8.5 percent) (Kato, Kobayashi, and Saita 2010). In Europe universal banks with large investment bank operations tended to have much lower risk weighting than standard commercial banks. Thus by 2008 the ratio of risk-weighted to total assets at Deutsche Bank was only about 1.7 percent whereas the same ratio for Italian bank Intesa Sanpaolo was about 8 percent (Bayoumi forthcoming).

In the United States, the minimum leverage ratio for a bank holding company with more than $500 million in assets is 3 percent for "strong" bank holding companies and 4 percent for all others. Bank holding com-

panies with weaknesses or in the process of rapid expansion are expected to hold capital "well above" these levels (FDIC 2015). For a bank to be considered well capitalized, it must pass a leverage ratio threshold of 5 percent (a buffer of 2 percent above the Basel III minimum). Below this threshold, "prompt corrective action" can involve restrictions on dividends, buybacks, and discretionary bonus payments. In 2014 US regulators increased this threshold to 6 percent for insured depository bank subsidiaries of the largest bank holding companies (institutions with $700 billion or more in assets) and set the leverage ratio at 5 percent for these institutions (including their nonbank subsidiaries) as a whole (Comptroller 2014). These "supplementary" leverage ratios use the Basel III definition of exposure for the base; they thus include not only balance sheet assets but also off-balance-sheet assets, such as derivatives and repo-style transactions (Davis Polk 2014). The enhanced supplementary leverage ratio of 6 percent for US G-SIBs thus adds a buffer of 3 percentage points to the Basel III requirement of 3 percent.

The main analysis of this study is conducted using the metric of tangible common equity capital relative to total assets, a "leverage" capital ratio. However, the comparisons frequently translate this measure into what would be the corresponding average ratio of the same capital concept to risk-weighted assets, as the Basel III requirements are stated principally against risk-weighted assets.[10] The average relationship used in chapter 4 is that a given ratio of capital to risk-weighted assets will be 1.78 times the corresponding leverage ratio of capital to total assets (based on BCBS 2010a estimates for US and euro area banks). In principle, it would be desirable to have reliable risk weightings. In practice, there seems to have been sufficient distortion in understatement of risk, especially in investment bank operations, particularly after the shift to internal models in Europe by 2005, that there is much to be said for giving at least equal attention to the capital to total assets ("leverage") ratio as to the capital to risk-weighted assets ratio.

Goldstein (2017) makes a strong case that risk weighting and the use of internal models have caused risk-weighted assets to be much less reliable than total assets as the basis for determining capital needs. He argues that risk-based capital ratios were less successful in predicting bank failures in the 2007–10 crisis than simple leverage ratios. He notes that for 17 major international banks, the risk-weighted assets/total assets ratio fell from 70 percent in 1993 to 40 percent in 2011, without any evidence of an accompanying shift toward safer banking practices. He notes the critique in the Liikanen Report (2012) that the banks with the lowest risk-weighted assets/total assets ratios are those with the largest share of trading assets in total

10. In contrast, the Basel III leverage ratio is relatively low and typically not a binding constraint.

assets. He cites the observation by Hoenig (2013) that the very low 7 percent risk weighting on AAA collateralized debt obligations induced excessive investment in these instruments before the crisis.

One approach to imposing more discipline on risk weightings would be to place a floor on the admissible ratio of risk-weighted to total assets. On average, US and European banks have had a risk-weighted assets/total assets ratio of about 55 percent (see chapter 4). Regulators could impose a minimum of, say, 45 percent of total assets as the regulatory measure of risk-weighted assets in cases where banks' internal models indicated a lower ratio. An alternative approach would be to specify that for regulatory purposes, the risk-weighted assets/total assets ratio for a particular asset category can be no lower than a specified percentage point shortfall from the standard risk weighting for that category for banks not using internal models (say, 10 percentage points).

The "Basel IV" revisions for risk weighting take the latter approach. They would include an "output floor" below which internal models would not be allowed to reduce the risk weight for the asset category in question; discussions among regulators reportedly involve a floor range of 60 to 90 percent of the standard weight. Although regulators have stated that the revisions should not "significantly raise overall capital requirements," some estimates find that for global banks outside the United States, the consequence could be an increase in measured risk-weighted assets of 18 to 30 percent. European banks in particular have opposed this approach, in part because the standardized risk weight for residential mortgages (35 percent) is far above internal model weights in major European countries where defaults have been rare.[11] In contrast, US regulators favor relatively high output floors, partly because the Collins Amendment of the Dodd-Frank Act requires that risk weights be no lower than the "generally applicable risk-based capital requirements" specified by federal banking agencies (Tahyar 2010).

Basel III falls farther below the optimal capital ratio identified in this study using the leverage ratio than using the ratio of capital to risk-weighted assets. Thus the optimal requirement identified in chapter 4 is 7 to 8 percent for tangible common equity relative to total assets and 12 to 14 percent for the average ratio of capital to risk-weighted assets. In comparison, Basel III sets the minimum leverage target at 3 percent of "exposure," including securities financing transactions and off-balance-sheet assets.[12]

11. "Basel Bust-Up," *Economist*, November 26, 2016, 67.

12. The shortfall from the optimal level is greater in the leverage target even after taking account of the fact that the denominator in the Basel III leverage ratio uses a wider definition of exposure than total assets. As a consequence, its 3 percent target corresponds to a somewhat higher capital to total assets ratio, especially for US banks.

A complication for risk weighting may have been created by the advent of quantitative easing, which caused massive amounts of excess bank reserves to build up at the Federal Reserve. In October 2008 the Federal Reserve began paying interest on excess reserves, which rose from about $2 billion in 2007 to $2.5 trillion in 2014. This structural change helps explain why there was no explosion in prices despite a large increase in the money base. Instead, there was a collapse in the money multiplier from the base to broad money. In contrast, there was only a modest decline in velocity (the ratio of GDP to broad money) (Cline 2015b). It is unclear that increased bank reserves came from corresponding reductions in bank holdings of government securities and other safe assets. If they did not, then the ratio of safe to total assets rose, arguably justifying a lower leverage ratio.

In August 2016 the Bank of England recognized the incongruity posed by much higher excess reserves when it decided to exclude reserves held at the central bank from the calculation of banks' leverage ratios. Although adopted in response to recession fears following the referendum to exit the European Union (Brexit), the decision makes this exclusion permanent.[13]

European versus US Banks

In addition to the flexibility in the application of internal risk-weight models, at least three other differences between European and US banks warrant mention for purposes of placing bank capital reform into context. The first is that banks are considerably more important to finance in Europe, whereas there is a much greater reliance on the corporate bond market and other nonbank sources of finance in the United States. Merler and Véron (2015) estimate that in 2014, in the euro area bank loans accounted for 88 percent of financing to nonfinancial corporations and debt securities only 12 percent, whereas in the United States the share of loans was only 30 percent and that of debt securities 70 percent. By implication, the stakes in ensuring the safety of the banking system are even higher in Europe than in the United States. Moreover, Europe would likely benefit from greater diversification away from banks toward capital markets. For the United States, a corresponding implication is that policymakers must pay special attention to the spillover effects of bank regulatory reform onto the nonbank (or shadow banking) financial sector.

A second difference is in the emerging approaches to resolution of large failing banks. Chapter 5 discusses this issue in the US context. In the euro area,

13. Huw Jones, "Bank of England Eases Banks' Capital Leverage Rule to Help Support Economy," Reuters, August 4, 2016.

resolution is to take place through the Single Resolution Mechanism within the EU Bank Recovery and Resolution Directive.[14] The Single Supervisory Mechanism, comprising the European Central Bank and national supervisory authorities, determines when a failing bank needs to be resolved. The Single Resolution Board (comprising representatives from the national authorities involved, the Single Resolution Mechanism, and the European Commission) decides whether and when to place the bank in resolution. If it determines that resolution is needed, the bank is either sold or divided into a new bridge "good bank" and a "bad bank," where shareholders and creditors cover losses on bad assets. Under conditions of systemic stress, the Single Resolution Mechanism can provide state assistance to recapitalize the bank, but only after shareholders and creditors (excluding insured depositors) first take a "bail-in" loss amounting to 8 percent of the bank's liabilities. After that threshold is reached, the system's Single Resolution Fund can contribute up to 5 percent of the bank's liabilities; still larger losses would require an additional round of creditor bail-in losses. Each member state is to set up financing arrangements funded by contributions from banks and investment firms, to reach a cumulative target of at least 1 percent of deposits over 10 years and merged into the Single Resolution Fund.[15] The more rigid bail-in requirements of the Bank Recovery and Resolution Directive may play a role in the lower ratios of share prices to book values observed in Europe than in the United States as of late 2016 (see appendix 5A).

In the United States, the FDIC has long experience in implementing resolutions of failing banks. In contrast, the Single Resolution Mechanism remains untested. The potential for friction between national authorities seeking greater flexibility to avoid politically unpopular bail-in of smaller creditors and the Single Supervisory Mechanism became evident in early 2016 in Italy.[16] In part because of such potential tensions, the scope for the mechanism to deliver "immaculate bankruptcy" for large banks seems unlikely to be much greater than that of the US mechanism resulting from Dodd-Frank.

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14. See European Commission, *EU Bank Recovery and Resolution Directive (BRRD): Frequently Asked Questions*, Memo/14/297, 2014.

15. Gros and De Groen calculate that this magnitude should be broadly consistent with state funding that would be needed even under a scenario as severe as the Great Recession, thanks to the structure requiring bail-in (Daniel Gros and Willem Pieter De Groen, "The Single Resolution Fund: How Much Is Needed?" VoxEU, December 2015, http://voxeu.org/article/size-single-resolution-fund).

16. See Nicolas Véron, "Italy's Banking Problem Is Serious but Not Intractable," RealTime Economic Issues Watch, July 14, 2016, Peterson Institute for International Economics, https://piie.com/blogs/realtime-economic-issues-watch/italys-banking-problem-serious-not-intractable.

A third notable difference between European and US banks concerns accounting. European banks use International Financial Reporting Standards (IFRS); US banks use Generally Accepted Accounting Principles (GAAP). Primarily because IFRS does not permit the netting out of derivatives, the reported assets of European banks tend to be larger than would be reported under GAAP. Hoenig (2013) estimates that for the eight US G-SIBs, total assets in 2012 stood at $10.2 trillion under GAAP but would have been reported as $15.9 trillion under IFRS.

As it turns out, this divergence is not as problematic for capital requirements as might be feared. For risk-weighted assets, the risk-weighting process (rather than IFRS or GAAP) determines the outcome, so comparison of the risk-weighted assets denominator for European and US banks is not necessarily distorted. Although in principle the potential for distortion could be greater for the leverage ratio of capital to total assets, the Basel III leverage requirement to be introduced by 2017 pays explicit attention to the treatment of derivatives in a fashion that is comparable for European and US banks.[17] The principal caveat regarding accounting is thus that caution should be used when comparing European to US banks using publicly reported assets.

Stress Tests and Liquidity Requirements

Higher capital requirements are only part of the reform of banking systems in response to the financial crisis. Basel III also provides for higher liquidity standards. The liquidity coverage ratio requires that high-quality liquid assets must equal or exceed expected net cash outflows over a 30-day period under a stress scenario (BCBS 2013). The net stable funding ratio requires that over a longer period of one year, the available amount of stable funding equal or exceed the required amount of stable funding (BCBS 2014b).[18]

For their part, stress tests simulating the impact on banks from severe downturns in the economy have become a salient supervisory instrument

17. Bilateral netting of derivatives is allowed under the Basel III leverage requirement, but treatment of securities financing transaction exposures is stricter than under either IFRS or GAAP (BCBS 2014a).

18. Five "available stable funding" categories have "factors" that range from 100 percent for regulatory capital and liabilities with more than a one-year term to 50 percent for funding with residual maturity of less than one year from nonfinancial corporate customers or with maturities of 6 to 12 months from others and zero for lending not enumerated in higher-factor categories. Eight "required stable funding" categories have corresponding factors, such as zero for central bank reserves, 50 percent for high-quality liquid assets encumbered for 6 to 12 months and loans to financial institutions with residual maturities of 6 to 12 months, 65 percent for residual maturity of one year and risk weight of 35 percent or less (for example), and 100 percent for all assets encumbered for one year or more.

(see Goldstein 2017 for an extensive assessment). They played a key role in restoring confidence in US banks in 2009. Stress test results have determined whether banks are allowed to increase dividends and carry out buybacks, providing a strong incentive to meet capital levels and operational practices likely to pass the tests.[19]

Conclusion

The Basel III reforms requiring stronger capitalization of banks have not gone far enough: The additional gains from reducing crisis risk would outweigh the additional costs of more capital. The equity capital target for large banks needs to be set about a third higher than in Basel III to reach the point at which marginal costs equal marginal benefits. Tangible common equity needs to reach 7 to 8 percent of total assets (12 to 14 percent of risk-weighted assets) rather than the Basel III target of 9.5 percent of risk-weighted assets for the largest banks. A level of 13 percent of risk-weighted assets also seems to be emerging as a central estimate among a number of studies adopting alternative approaches (see table 2.1).

At the same time, the shortfall from optimal capitalization is far smaller than some critics have argued. Moreover, in practice the large US banks appear to be holding capital relatively close to the optimal level, reflecting a behavioral cushion. It would seem more prudent, however, to set the target as a requirement than to count on this voluntary behavior.

A natural question is why the TLAC target of 18 percent of risk-weighted assets would not effectively meet or even exceed the optimal capitalization level. The problem with this approach is that CoCos and subordinated debt raise the risk of panic dynamics and (in the case of subordinated debt) contagion associated with the bankruptcy implications of imposing debt haircuts. The principal role of the extra TLAC remains one of assuring taxpayers rather than ensuring systemic stability. By implication policymakers would do well to increase the equity component of the TLAC requirement, providing a larger buffer against potential bankruptcy while leaving some role for the disciplinary influence of nonequity TLAC.

19. In 2014, for example, Citigroup failed the stress test; its request to increase dividends and carry out buybacks was denied. Bank of America passed the stress test; it received approval for its first dividend increase since the financial crisis (Michael J. Moore and Elizabeth Dexheimer, "Citigroup Fails Fed Stress Test as BofA Gets Dividend Boost," Bloomberg, March 27, 2014).