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Capital Requirements and Bailouts

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Abstract

We use balance sheet data and stock market data for the major U.S. banking institutions during and after the 2007-8 financial crisis to estimate the magnitude of the losses experienced by these institutions because of the crisis. We then use these estimates to assess the impact of the crisis under alternative, and higher, capital requirements. We find that substantially higher capital requirements (in the 20% to 30% range) would have substantially reduced the vulnerability of these financial institutions, and consequently they would have significantly reduced the need of a public bailout.

Keywords: Financial crises, Too big too fail

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1 Introduction

The goal of this paper is to provide a simple evaluation of the impact of changing capital requirements on the stability of the U.S. banking system. Our starting point is the recent report on "Ending Too Big to Fail," produced by the Federal Reserve Bank of Minneapolis (2016). The report proposes a substantial increase in the capital requirements of the U.S. banking system, and it argues that this increase would improve the resiliency of financial institutions in the face of a severe financial shock, such as the 2008 crisis. Improving the resiliency of these institutions in turn makes the need for another public bailout of the financial system less likely. The Minneapolis report estimates the impact of the increase in capital requirements using international evidence on financial crises in OECD countries, as discussed in Dagher et al (2016). In this work we conduct a similar exercise, but instead of data on aggregate losses suffered by countries during financial crises, we use data from large U.S. financial institutions during the 2008 financial crisis. The advantage of using data on financial institutions, besides providing an additional check of the results in the report mentioned above, is that we can look beyond aggregate outcomes and assess how changing capital requirements would change the distribution of losses across financial institutions during a crisis.

The idea behind our exercise is simple. We model a bank as an institution that starts with some capital, raises some liabilities, and invests these resources in risky assets. During a financial crisis, many banks experience losses on their assets and, if the ratio of capital to assets is too low, they might not be able to repay their liabilities, triggering financial instability. Our study uses data on the experience of major U.S. financial institutions during the 2008 financial crisis to estimate shocks to their net worth, and it uses some simple modeling to assess how these shocks would have affected these institutions under alternative (higher) capital requirements. The analysis will estimate these shocks using two independent methodologies. The first is based on balance sheet data from large U.S. bank holding companies, as reported in the FR Y-9C data set of the Federal Reserve. The second is based on stock market data for top U.S. bank holding companies. At the end of this paper, we will report results under both methodologies and contrast our findings with those of the Minneapolis Fed report. Results obtained with both methodologies are similar and confirm the findings of the Minneapolis Fed report. Higher capital requirements can significantly reduce the probability of a systemic banking crisis and hence of a public bailout of the banking system. Quantitatively, however, to achieve a sizeable reduction in the probability of a bailout, capital requirements should be increased significantly, in the 20% to 30% range.

There are two important caveats regarding our findings. The first is that throughout the analysis, we assume that in response to higher capital requirements, banks will change their capital structure but will not change the riskiness of their investment choices. This is clearly an important limitation of our analysis. Notice, though, that it is not clear how endogenizing the risk choice of banks would change our results. It is conceivable that in response to higher capital requirements (and thus less leverage), banks would choose more risky investments to compensate the reduction in risk forced by the lower leverage. It is also possible that, having more of their own capital at stake, banks might choose less risky investments. Overall, we think that understanding how the portfolio choices of banks respond to capital requirements is important for a full assessment of the impact of changes in this regulation. However, our analysis that abstracts from these choices still constitutes a useful first step. The second caveat is that we do not consider the costs of increasing capital requirements. This obviously does not mean that we think that increasing capital requirements imposes no costs on the banking system and on the economy as a whole. The Minneapolis Fed report, as well as many other studies discussed below, contains an extensive analysis of these costs, and those studies can meaningfully compare benefits and costs toward a theory of optimal capital requirements. Our goal here is more modest: it is simply to assess how much higher capital requirements would improve the stability of the financial system.

The effect of increasing capital requirements on the stability of the financial system has been the subject of an intense academic and policy debate, particularly after the 2008 crisis. On the academic side, many studies argue that a substantial increase in capital requirements would improve the stability of the financial system (see, e.g., Admati et al., 2017 or Egan et al., 2017), while other studies focus on the potentially high costs of increasing capital requirements (see, e.g., Van den Heuvel, 2008). There are also quantitative structural studies, which develop fully fledged equilibrium models of an economy with a banking sector and can produce an evaluation of the full impact of higher capital requirements, in terms of both increased stability and higher costs. Among those studies the findings are mixed, with some studies (e.g. Begenau, 2016) finding that the benefits of increasing capital requirements likely exceed the costs, while others (e.g., Corbae and D'Erasmo, 2014) finding that increasing capital requirements would have high output costs for the economy as a whole. On the policy side, a number of studies (see e.g., the works by the Basel Committee on Banking Supervision, 2010a,b, 2011) evaluate the impact of increasing capital requirements on banks. Our paper contributes to this line of work, using a different methodology and different data.

The paper is structured as follows. Section 2 outlines the general framework, and Sections 3 and 4 discuss the two methodologies and the key findings. Section 5 presents some additional evidence in support of our findings, and Section 6 concludes.

2 A simple framework

We model a bank (indexed by i) as an institution entering each period t with capital K_{it}, liabilities (deposits or other forms of borrowing) L_{it}, and assets A_{it} such that

$$K_{it} + L_{it} = A_{it}.$$

During period t, the bank invests its assets in several projects (loans, financial assets, etc.) that yield a stochastic payoff, and it pays interest on its liabilities. We focus on the risk of banks not being able to repay their liabilities. Such a possibility could induce bank failures, panic, and systemic crisis. In particular, we assess how imposing a higher capital requirement on banks (i.e. banks using fewer liabilities and more of their own capital to finance their investments) affects this risk.

3 Using balance sheet data

In this exercise, our sample is the 25 largest U.S. bank holding companies in the FR Y-9C data set of the Federal Reserve, ranked by their 2006 assets. This is the same data used by the Board of Governors (2015) to assess capital requirements on global systemically important bank holding companies. We follow these banks for 14 years, from 2001 to 2015 (see the appendix for the list of bank holding companies). As one may expect, in such a time horizon, there is large attrition in the banking industry due to bankruptcy, mergers, or acquisitions. Nevertheless, using this approach, we need balance sheet data after the crisis, so we focus on banks that are in the sample for the entire period. As a result, this approach might underestimate the losses of bank holding companies.[1]

We define the market value of capital for bank i in period t as follows:

$$K_{it}^{M} = \sum_{j=0}^{\infty} \left(\frac{1}{1+r_B} \right)^{j} R_{it+j}^{K} K_{it}, \tag{1}$$

where r_B is the rate at which the markets discount the future returns of the bank, and R_{it}^{K} is the return to capital of bank i at time t. The market value of capital captures the value of investing K_{it} units of bank capital. A large drop in the market value of capital per unit of capital, $\frac{K_{it}^{M}}{K_{it}}$, will signify trouble for bank i. In this section, we will be using balance sheet data to infer the impact of the financial crisis that started in 2007 on the subsequent returns to capital $\{R_{i2007+j}^{K}\}_{j=0}^{\infty}$ and, through equation 1, on the market value of banks. First, notice that returns to capital can be computed as

$$R_{it}^{K} = \frac{I_{it}}{K_{it}}, \tag{2}$$

where I_{it} represents net income of bank i in period t.

We start by estimating the **crisis returns** using balance sheet data. We then estimate the **no-crisis returns**, under the assumption that the financial crisis never took place.

[1] In the alternative methodology discussed in Section 4, we use stock market data during the crisis, and therefore we can include institutions that did not survive after the crisis.

Finally, we compute **counterfactual returns** (both crisis and no-crisis), which are returns that the bank would have experienced had the crisis occurred (or not occurred) with different capital requirements.

3.1 Returns and losses

For each of the banks in our sample, we simply compute crisis returns to capital, R^K_{it}, for $t = 2001, 2002, ..., 2015$, plugging reported figures for net income and for book value of capital into equation 2. We denote with $\bar{R}^K_{it}$ (no-crisis return) the return bank i would have earned in period t on its assets had the 2008 crisis not happened. We compute this return simply by taking an average of bank returns before the crisis, that is, over the 2001 to 2006 period:

$$\bar{R}^k_{it} = \frac{1}{6}\sum_{j=2001}^{2006}\frac{I_{ij}}{K_{ij}},$$

where $t = 2007, 2008, ...$.

Figure 1 plots the time series for crisis and no-crisis returns to capital, averaged across all banks in our sample. Note that, during the financial crisis and immediately afterward, banks experience a significant drop in average returns. For a few years after the crisis returns stabilize but typically remain below their pre-crisis level. The key objects of study in this methodology are the losses of each bank (i) at the start of the crisis (t^*), which we define as

$$Loss_i = \frac{\bar{K}^M_{it^*} - K^M_{it^*}}{K_{it^*}},$$

where $\bar{K}^M_{it^*}$ is the no-crisis market value of capital (i.e., the market value of bank capital had the crisis not occurred, or just before the crisis hit) and K^M_{it} is the crisis market value (i.e., the market value of the bank as the crisis hit), and each bank realizes that from t^* on, it will face lower returns on its capital. Using equation 1, it is easy to show that

$$Loss_i = \sum_{j=0}^{\infty}\left(\frac{1}{1+r_B}\right)^j [\bar{R}^K_{i,t^*+j} - R^K_{i,t^*+j}]. \quad (3)$$

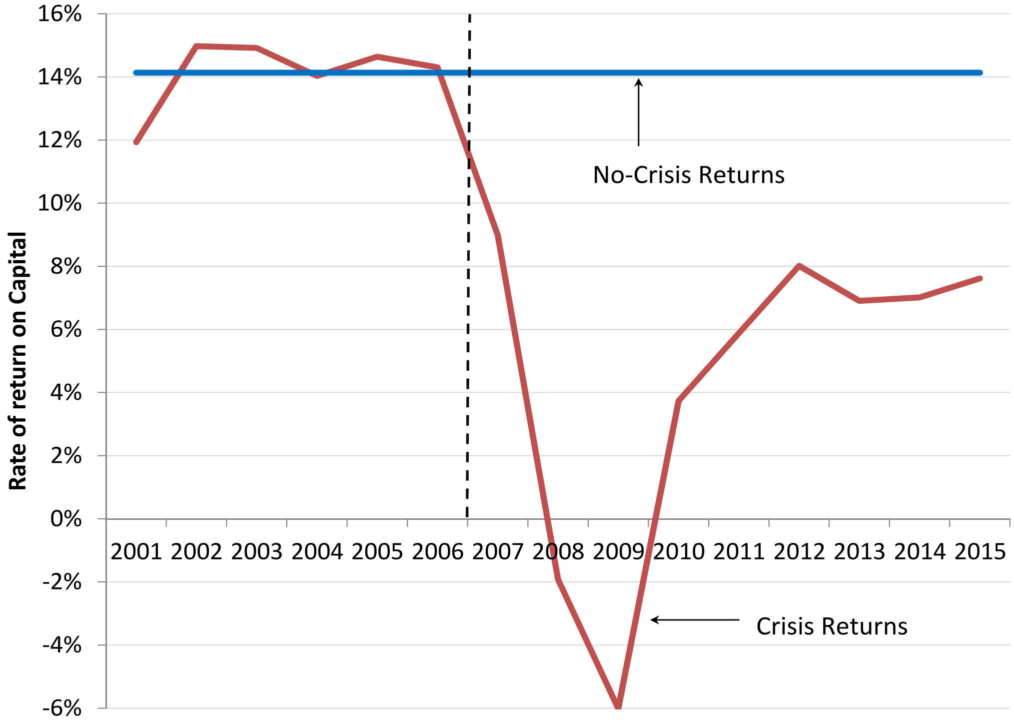

Figure 1: Crisis and No-Crisis Returns to Capital

That is, the losses are just the net present value of the difference between the no-crisis and the crisis returns to capital. Equation 3 shows that in order to measure losses for each bank, two additional elements are needed. The first is a measure of r_B, that is, the market discount rate for bank profits. The second is a measure for the realized returns to capital after 2015. We calibrate r_B so that the pre-crisis, average market-to-book ratio $\frac{\bar{K}_{it}^M}{K_{it}} = \sum_{j=0}^{\infty} \left(\frac{1}{1+r_B} \right)^j \bar{R}_{it+j}^K$ implied by equation 1 matches the average market-to-book value of capital for the banks in our sample in 2006, which is equal to 2.02. This procedure yields a value of $r_B = 7\%$. Regarding the post-2015 returns to capital, Figure 1 shows that, several years past the crisis, average returns to capital do not return to the no-crisis levels. The returns are still depressed for two reasons. First, banks are possibly still suffering the consequences of the recession. Second, stricter regulations in the banking sector do not allow banks to become as leveraged, and as a result, banks cannot be as profitable as they were before the crisis. For the purposes of our question (i.e., how big are the losses faced by banks during crises?), this distinction is not essential, and moreover, given the high estimate of the market discount rate r_B, estimates of losses are not very sensitive to different assumptions regarding post-2016 returns to capital.[2] For these reasons, we simply assume that from 2016 on, $R^K_{it+j} = \bar{R}^K_{it+j}$,, that is, returns to bank capital will go back to their pre-crisis level. In Figure 9 in the appendix, we show how our key results are not significantly affected when we assume that bank losses persist after 2015 and, at the same time, bank future returns are discounted by markets at a lower rate.

We can now use equation 3 to construct estimates of losses for each bank in our sample. The dark bars in Figure 2 represent the histogram of these losses. Notice how a majority of institutions experienced losses that exceeded 50% of their capital, and for five of these banks, losses surpassed their book value of capital. We believe this evidence helps in understanding why a bailout of the U.S. financial system was indeed carried out in 2008.

In the next section, we will move on to analyze how a stricter capital requirement would have altered the size and distribution of losses across these banks.

3.2 Capital requirements

To see how capital requirements affect losses, first consider that returns to capital can be rewritten as follows:

$$R^K_{it} = \frac{I_{it}}{K_{it}} = \frac{R^A_{it} A_{it} - rL_{it}}{A_{it} - L_{it}}, \tag{4}$$

where R^A_{it} is the return on assets and r is the interest rate on liabilities. We will think of changes in the capital requirement as a reshuffling of capital and liabilities in a way that leaves total assets, return to assets, and interest on liabilities unaffected. In particular,

2 We believe that assessing how much of the losses suffered by banks during the crisis were due to the anticipation of future regulation would be a very interesting extension of this work.

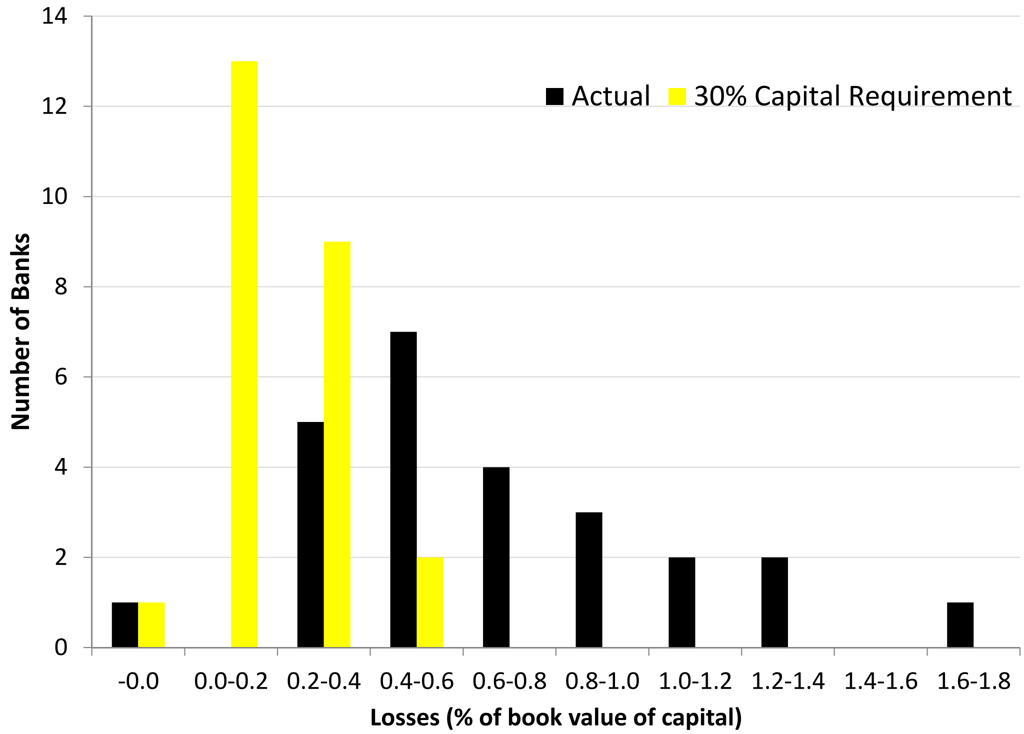

Figure 2: Histogram of losses experienced by major U.S. banks

for a θ% capital requirement the new liabilities will be

$$L_{it}^{req}(\theta) = \min\{L_{it}, (1-\theta)A_{it}\}.$$

A θ% capital requirement implies that liabilities have to be less than $(1-\theta)$% of assets. Then the return to capital with the new requirement, which we will denote by $R_{it}^{K}(\theta)$, will be,

$$R_{it}^{K}(\theta) = \frac{R_{it}^{A}A_{it} - rL_{it}^{req}(\theta)}{A_{it} - L_{it}^{req}(\theta)}$$

In order to compute $R_{it}^{K}(\theta)$, we will use the assumption that interest on liabilities r is invariant to θ (we fix it at 2%) and that the return on assets is also independent from θ (we compute the return using equation 4 as $R_{it}^{A} = \frac{I_{it}+rL_{it}}{A_{it}}$). Note two important things here. First, if the bank is very well capitalized, then a change in θ will not affect the return to capital at all. This is because the bank is already satisfying the capital requirement. Second, suppose that the capital requirement is actually binding for a bank. Increasing the requirement increases the return to capital when $R^A_{it} > r$ and decreases it when the converse is true. Therefore, stricter capital requirements will imply that banks are more profitable in bad times and less profitable in good times. In Figure 3 we plot average returns to capital for all the banks in our sample under no capital requirements (the top line, which is equal to the actual returns to capital) and under progressively stricter capital requirements. As the figure shows, with stricter capital requirements banks are less profitable in good times (when returns on assets are high) but experience a less severe decline in returns during crises, when returns to assets are low.

Figure 3: Impact of Stricter Capital Requirements on Rate of Return to Capital

Once we have time series for returns to capital under alternative capital requirements for all the banks in our sample, we can readily use the methodology described above to define no-crisis returns under alternative requirement $\bar{R}^k_{it}(\theta) = \frac{1}{6}\sum_{j=2001}^{2006} R^K_{i,j}(\theta)$ and then compute losses for each bank i under alternative capital requirement $Loss_i(\theta)$ as

$$Loss_i(\theta) = \sum_{j=0}^{\infty} \left(\frac{1}{1+r_B}\right)^j [\bar{R}^K_{i,t^*+j}(\theta) - R^K_{i,t^*+j}(\theta)].$$

The lighter bars in Figure 2 show the distribution of losses that banks would have experienced had the 2008 crisis happened under much higher capital requirements. The figure highlights that with stricter capital requirements, banks would experience much smaller losses, with no bank experiencing a loss that exceeds the value of its capital.

3.3 Bailout probabilities

In order to obtain a simpler measure of how much a higher capital requirement is going to affect the probability of a bailout, conditional on a banking crisis like the one of 2008 happening again, we define $p(\theta)$ to be the probability of a bailout conditional on a crisis happening when the minimum capital requirement is θ, and we compute it as

$$p(\theta) = \frac{\sum_i Losses_i(\theta)}{\sum_i Losses_i(\theta = 0)}. \tag{5}$$

The numerator in expression 5 is the losses of banks with the capital requirement being θ, and the denominator is the realized losses of banks during the crisis. Notice that when $\theta = 0$, $p(\theta) = 1$. That is, if there is no minimum capital requirement, then, conditional on having a crisis like the one U.S. banks experienced in 2008 a bailout would happen with certainty. As θ increases, aggregate losses are reduced, and the probability of a bailout, conditional on a crisis, $p(\theta)$ falls.

We want to stress again that underlying the derivation of equation 5 is the assumption that banks do not systematically alter their behavior when they face an alternative minimum capital requirement. In particular, we assume that they do not change the value of the assets they hold, that they will receive the same income stream, and that they keep the same risk profile in their assets. In other words, we assume that banks satisfy the capital requirement simply by substituting capital for liabilities. These assumptions are potentially important and a nonrealistic simplification. Nevertheless, we believe our exercise represents a necessary first step in quantifying the effectiveness of higher capital requirements.

In Figure 4, we show how the probability of at least one bailout happening over the next 100 years varies with the minimum capital ratio target. Underlying the derivation of the curve is an unconditional probability of a crisis of 2.2% per year, which is the same probability used in the Minneapolis Fed study. The conclusion from this picture is that a capital requirement just slightly above 10% (the level advocated by some policy makers and representatives of the banking industry) would not be very effective in increasing the resiliency of U.S. financial institutions. The reason for this result is that such a requirement would not significantly change the distribution of losses faced by major financial institutions, should a crisis like the one in 2008 happen again. The figure also suggests that in order to achieve a substantial reduction in the losses faced by banks in a crisis (and hence a substantial reduction in the probability of a bailout conditional on a crisis), a much higher capital requirement would be necessary.

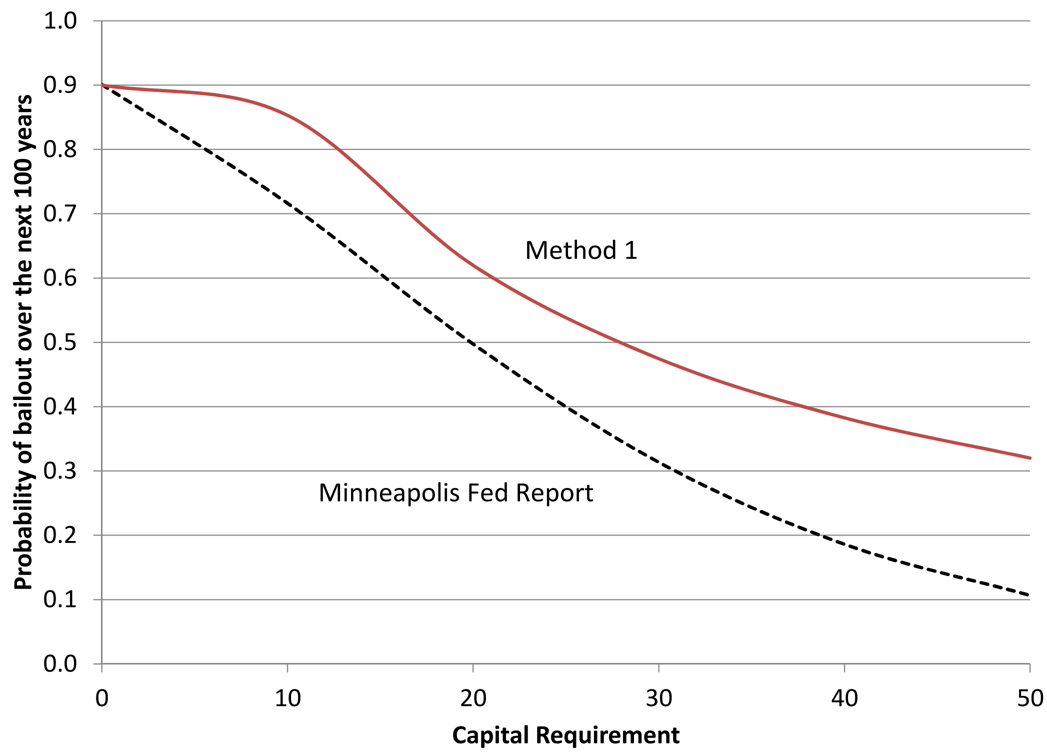

Figure 4: Capital Ratios and Probability of Bailout in the next 100 years: method 1

4 Using stock market data

In this section we conduct an exercise similar to the one in Section 3, using stock market and balance sheet data for the set of 26 *government-backed large financial institutions*, which include the 18 bank holding companies that participated in the 2013 Fed stress tests plus the 8 financial institutions that were hard hit by the 2008 crisis (see the full list in the appendix). The same group of bank holding companies was used in Atkeson et al. (2013).

4.1 Distance to insolvency

The key relations used for our analysis are equations 6 and 7 below (see Atkeson et al. 2013 for a formal derivation):

$$
\begin{aligned}
V_{K_{it}} &= V_{A_{it}} - V_{L_{it}} \qquad (6)\\
\underbrace{\log\left(\frac{1}{\sigma_{K_{it}}}\right)}_{\substack{\text{Distance to}\\ \text{Insolvency}}} &= \underbrace{\log\left(\frac{V_{K_{it}}}{V_{A_{it}}}\right)}_{\substack{\text{Capital/Asset}\\ \text{Ratio}}} + \underbrace{\log\left(\frac{1}{\sigma_{A_{it}}}\right)}_{\text{Asset Safety}} \qquad (7)
\end{aligned}
$$

Equation 6 simply states that the market value of the capital of bank i in period t, V_{Kt}, is given by the value of its assets V_{Ait} minus the value of its liabilities V_{Lit}. Equation 7 relates a measure of financial soundness of the bank (i.e., distance to insolvency) to two factors. The first is the ratio of the value of bank capital to the value of its assets, that is, its leverage. This is related to the financial soundness of the bank since the less leveraged the bank is, that is, the smaller the fraction of liabilities to total assets, the more likely it is that the bank will be able to pay its liabilities. The second, denoted asset safety, is the reciprocal of the riskiness of the bank's assets (i.e., $\sigma_{A_{it}}$). The riskier a bank's assets are (i.e., the higher $\sigma_{A_{it}}$ is) the more likely it is that the bank's returns will not be large enough to pay for liabilities, resulting in a shorter distance to insolvency.

Distance to insolvency (the term on the left-hand side of equation 7) can be estimated using stock market return data for the bank holding companies. We use data from the Center for Research in Security Prices (CRSP) database on daily returns to capital to construct this measure of variance in monthly returns. To make things concrete, in Figure 5 we plot the log of the median distance to insolvency for all the institutions in our sample. As has been been shown in the literature a distance to insolvency below zero is an indication of high vulnerability, that is, that the institution is on the verge of insolvency. The plot shows how the bulk of the U.S. financial institutions during the financial crisis of 2008 were indeed on the verge of insolvency.

We have shown that distance to insolvency can be measured directly from the data. The next object in equation 7 that we calculate is the ratio of bank capital to bank assets. We measure the value of equity of a bank holding company as the total market

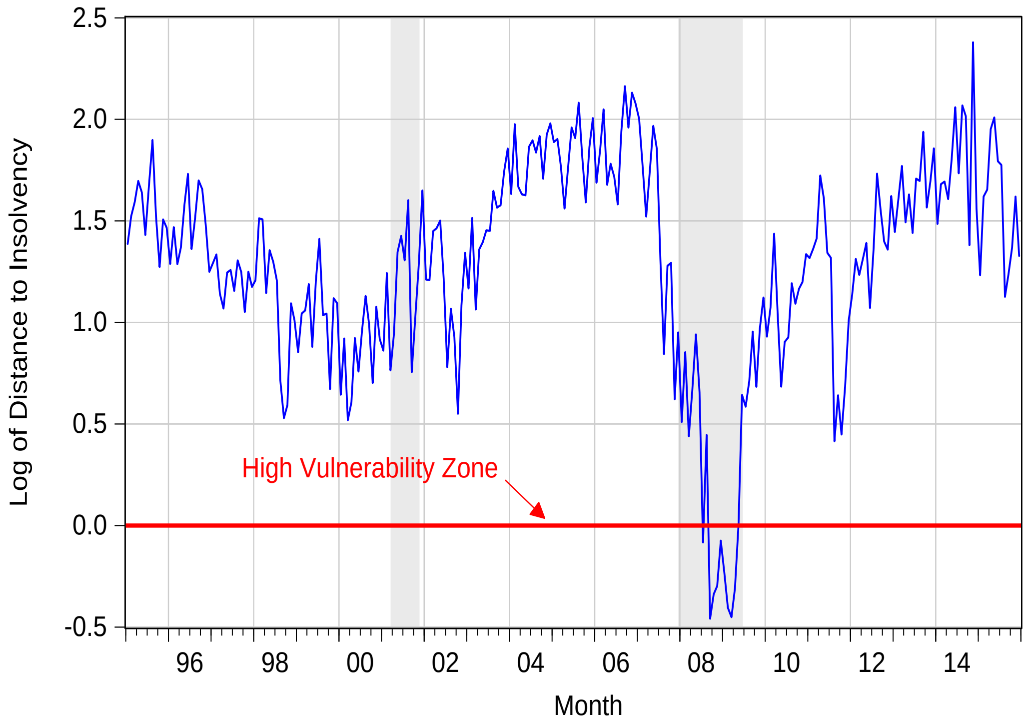

Figure 5: Median Distance to Insolvency

capitalization as reported in CRSP, and we obtain the value of liabilities for these companies from the COMPUSTAT database. Using these measures, we can now calculate the capital-to-asset ratio of a bank. The only unknown left in equation 7 is asset safety, $\frac{1}{\sigma_{A_{it}}}$, which we can now back out using the equation.

4.2 A counterfactual exercise

The exercise of backing out asset safety enables us to conduct our key counterfactual exercise. That is, we can now evaluate how the soundness of financial institutions would have changed during a crisis had the United States implemented regulations that forced banks to have higher capital requirements. We compute log distance to insolvency for a counterfactual capital-to-asset ratio θ for each bank holding company in our sample (i.e. $DI_{it}^{CF}(\theta)$) using equation 7:

$$\underbrace{DI_{it}^{CF}(\theta)}_{\substack{\text{Log Distance to} \\ \text{Insolvency (CF)}}} = \underbrace{\log\left(\max(\frac{V_{K_{it}}}{V_{A_{it}}},\theta)\right)}_{\substack{\text{Capital/Asset} \\ \text{Ratio (CF)}}} + \underbrace{\log\left(\frac{1}{\sigma_{A_{it}}}\right)}_{\text{Asset Safety (Data)}} \tag{8}$$

Once we have the counterfactual distance to insolvency for each institution in each period as the function of the capital-to-asset ratio, we can derive a relation similar to the one derived in Figure 4. In particular, for any minimum capital requirement θ, we can relate distance to insolvency to the probability of a bailout $p(\theta)$ simply by using the following formula:

$$p(\bar{\theta}) = \frac{DI_{Med}^{Data}}{DI_{Med}^{CF}(\theta)}, \tag{9}$$

where DI_{Med}^{Data} is the median distance to insolvency in the data computed in the months of the financial crisis (September 2008 through April 2009) and $DI_{Med}^{CF}(\theta)$ is the same measure computed under the counterfactual (higher) capital requirement. Notice that if θ generates the same distance to insolvency as in the data during the crisis, then the probability of a bailout (conditional on the crisis) will be equal to 1. As higher counterfactual capital requirements are imposed, the counterfactual distance to insolvency becomes larger and the probability of a bailout falls. The logic once again is that higher capital requirements make the bank more able to withstand losses, and hence, conditional on a crisis happening, more banks are less likely to need public support.

Figure 6 plots how this probability of a bailout over the next 100 years changes as we increase the minimum capital requirement for all the institutions in our sample. The line labeled “Method 2” represents the probability computed stock prices (the methodology outlined in this section), while the line labeled “Method 1” is the same line plotted in Figure 4. The x-axis reports the average capital-to-asset ratio that would emerge in our economy under a given counterfactual minimum capital-to-asset ratio θ. Overall, this figure suggests that a modest increase in capital requirements (say, up to 12%) would achieve a moderate (around 10 percentage points) reduction in the probability of a bailout under both methods. In a sense, our findings are less optimistic than the ones by the Minneapolis Fed study on the effectiveness of small increases in capital requirements. In another sense, the figure suggests, more in line with the Minneapolis Fed study, that a more aggressive increase in the capital-to-asset ratio would achieve reductions in the probability of a bailout that are significantly more substantial and as large as 50 percentage points.

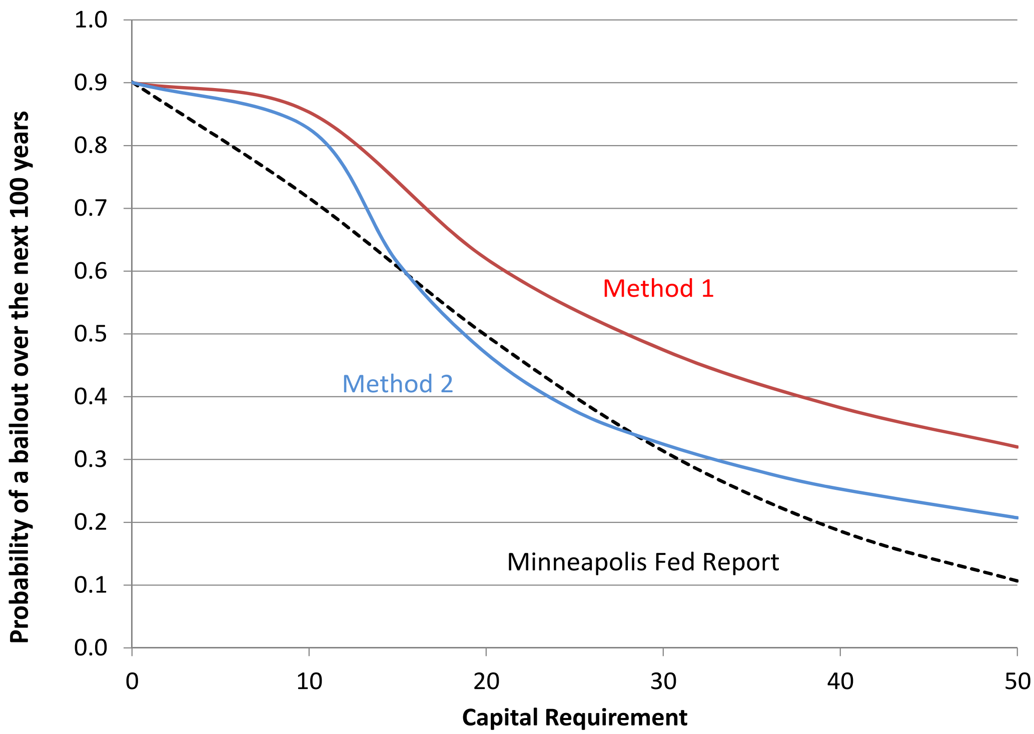

Figure 6: Capital-to-Asset Ratios and Probability of Bailout: Three different methodologies

5 Supporting Evidence

In this final section, we present some more direct evidence supporting our general claim that a higher capital-to-asset ratio would make banks safer. This evidence supports our view that forcing financial institutions to hold more capital will make them more resilient should the economy be hit by another big shock like the 2008 financial crisis.

We start with data used in the first methodology. In Figure 7, each dot represents a bank from the first sample. On the x-axis is the capital-to-asset ratio for the bank in 2005, before the crisis hit. The y-axis reports the loss of the same bank as a fraction of its initial capital (as computed in Section 3). The figure shows a negative relation between the two; that is, banks that were more capitalized before the crisis ended up suffering smaller losses during the crisis. The two lines represent the estimated relationship (using standard ordinary least squares and quantile regressions) between the losses and the log of the capital-to-asset ratio. The magnitude of the relation is economically significant. In particular the first two columns of table 1 show the result of regressing losses on 2005 log capital ratio. The coefficient of that regression (depending on the estimation method) is between 0.7 and 1, showing that, for example, an increase in the 2005 capital-to-asset ratio from 0.1 to 0.15 is associated with a reduction in losses of between 35% and 50%. As the R^2 of the OLS regression and the standard errors of the estimated coefficients suggest, the statistical significance of the relation is not overly strong. One possible reason is that in order to compute the losses, we had to restrict our sample to banks that survived the crisis, therefore biasing the result against finding an effect of capital in reducing losses. Another reason for the weakness of the relationship is that government intervention (more likely for poorly capitalized banks) tempered the realized losses.

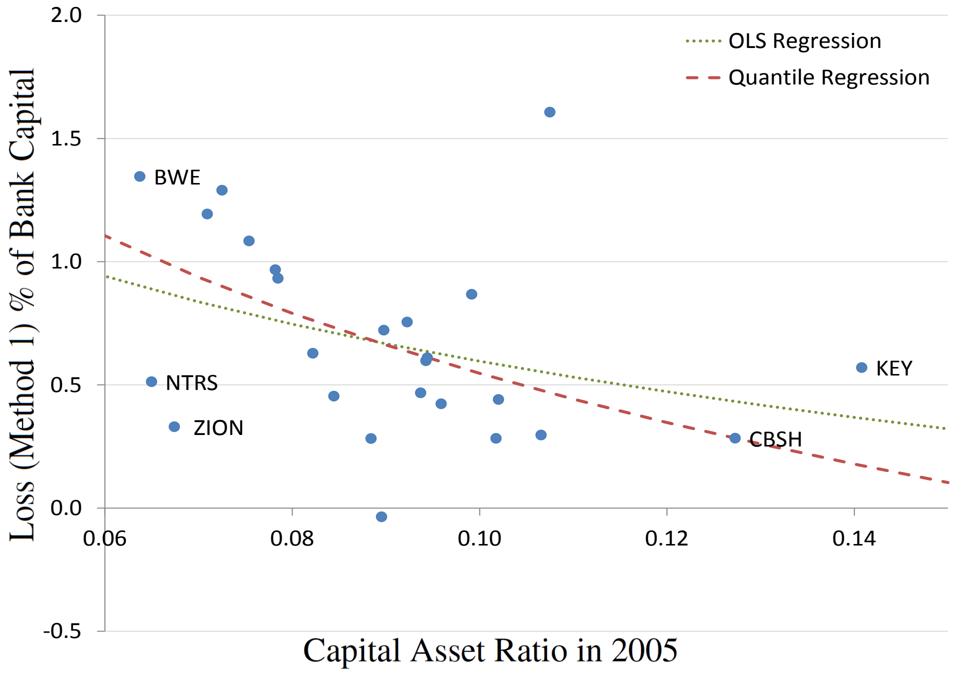

Figure 7: Capital-to-Asset Ratios and Losses (Measure 1)

Table 1. Capital-to-Asset ratios in 2005 and crisis outcomes

	Methodology 1		Methodology 2	
Indep. variable:	Losses (% of Capital)		Log Dist. to Insolv.	
Regression method:	OLS	QREG	OLS	QREG
Log (Cap Ratio)	-0.68	-1.09*	0.37***	0.44***
	(0.40)	(0.53)	(0.10)	(0.00)
Observations	25	25	25	25
R^2	0.11		0.38	

Note: All regressions include a constant. Standard errors in parentheses
*** $p<0.01$, * $p<0.1$

The second methodology uses the distance to insolvency as a measure of bank risk. The distance to insolvency is constructed using information on investors' beliefs of the risk faced by banks through bank prices. As a result, we do not need post-crisis information in order to compute losses, and thus our sample includes financial institutions that did not survive the crisis and its aftermath, such as Wachovia Corporation or Washington Mutual. Moreover, government bailouts play a smaller role on observed losses, as the effects of bailouts took some time to manifest. For these reasons, we think that the relation between pre-crisis capitalization and crisis losses is measured more accurately using data from our second methodology. In Figure 8 each dot represents an institution in our sample. The x-axis represents the capital-to-asset ratio for that institution in 2005 (i.e., the ratio $\frac{V_{K_{it}}}{V_{K_{it}}+V_{L_{it}}}$), while the y-axis reports the average distance to insolvency for that institution during the crisis (September 2008 through April 2009). As we expected, institutions that were better capitalized before the crisis had, on average, better outcomes (i.e., were farther away from insolvency) during the crisis. As in the previous case, the two lines represent the estimated relationship (using standard OLS and quantile regressions) between the log of the distance to insolvency and the log of the capital-to-asset ratio. The coefficients of the regressions are in this case strongly statistically significant. Their size (depending on the estimation method) is between 0.35 and 0.45, showing that, for example, an increase in the 2005 capital-to-asset ratio from 0.1 to 0.15 is associated with a reduction in the distance to insolvency of between 17% and 23%.

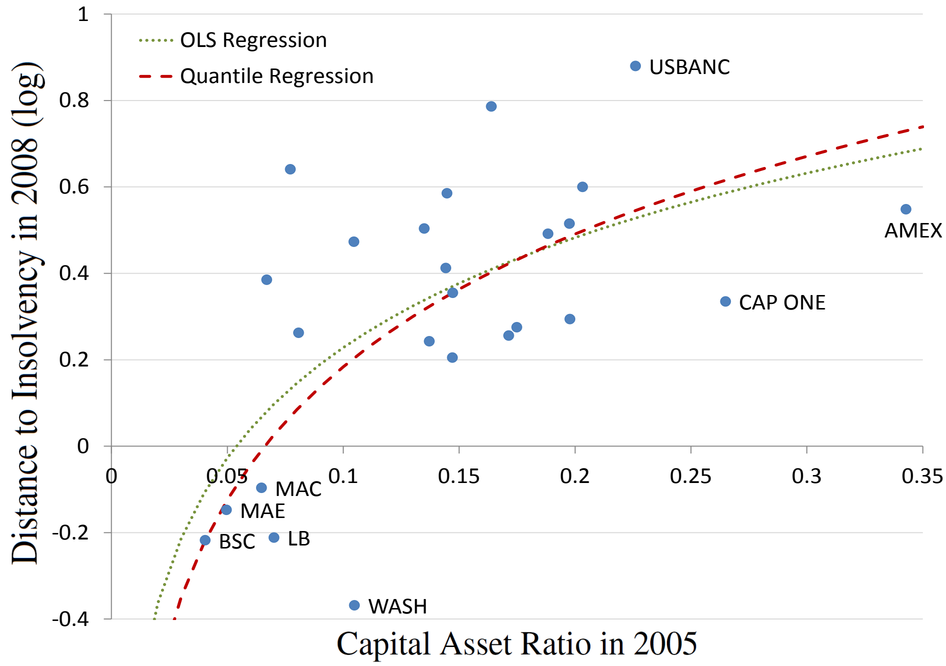

Figure 8: Capital-to-Asset Ratios and Distance to Insolvency

Obviously, this evidence is not conclusive on the causal effects of capital requirements; more capitalized banks might have fared better during the crisis because of some other third factor not captured by this simple analysis. Nevertheless, taken together with the analysis in the first two sections of this paper, the evidence builds the case that higher capital requirements would make banks more resilient in the face of another large crisis.

6 Conclusions

This study argues that higher capital requirements can be effective in improving the resilience of large financial institutions after adverse shocks to their assets, such as the 2008 crisis. Using a very simple model of large banks we show that higher capital requirements reduce the impact of crises through two channels: first they force banks to hold more of their own resources in order to cover their losses, and second by forcing banks to take on less leverage, they reduce the risk they face. This implies that with higher capital requirements, a financial crisis would not necessarily put many large financial institutions at risk of insolvency, and thus the probability that a crisis would require a public bailout can decrease significantly. We find that increasing capital requirements, say, from 10% to 20%, can reduce the probability of a public bailout in the next 100 years from over 80% to, depending on the methodology, 45% to 60%. We corroborate these findings by also showing that financial institutions that were better capitalized in 2005 experienced fewer losses during the crisis and a higher distance to insolvency. The study has not explored the effects that higher capital requirements would have on bank choices regarding the riskiness of their investments, nor has it studied the costs of higher capital requirements. We view these two issues as important and complementary to our findings.

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APPENDIX

Top 25 Bank Holding Companies (methodology 1)

Citigroup	Bank of Amer CORP	JPMorgan Chase & CO
Wells Fargo & CO	U S BC	Suntrust BK
Keycorp (KEY)	Fifth Third BC	PNC FNCL SVC GROUP
Comerica	BB&T CORP	Unionbancal CORP
Citizens FNCL GROUP	State Street CORP	Huntington BSHRS
M&T BK CORP	Northern TR CORP (NTRS)	Harris FC
Zions BC (ZION)	Popular	Compass BSHRS
Bancwest CORP (BWE)	First Horizon NAT CORP	Synovus FC
Commerce BSHRS (CBSH)		

Note: Acronyms used in Figure 7 in parentheses

Top 25 govt. backed financial institutions (methodology 2)

American Express (AMEX)	American International Group	Bank of America
Bank of New York	Branch Banking and Trust	Bear Stearns (BSC)
Capital One (CAP ONE)	City	Fifth Third BANCORP
Fannie Mae (MAE)	Freddy Mac (MAC)	Goldman Sachs
JP Morgan	Key Banks	Lehman Brothers (LB)
Merrill Lynch	Morgan Stanley	PNC Financial Services
Regions Financial CORP	Suntrust Banks	State Street Boston CORP
US BANCORP (USBANC)	Wachovia CORP	Washington Mutual (WASH)
Wells Fargo		

Note: Acronyms used in Figure 8 in parentheses

Sensitivity analysis to different assumptions on bank discounting and on post-crisis recovery

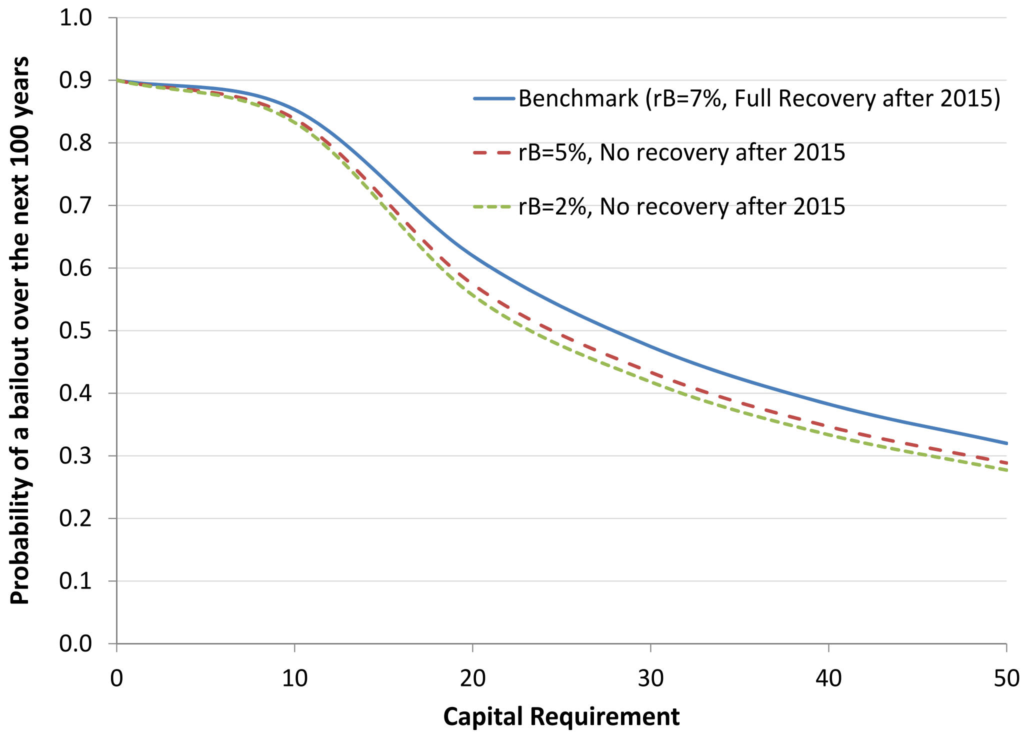

Figure 9: Probability of bailout using alternative parameter values in method 1