Safe Capital Ratios for Bank Holding Companies

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Revised Draft: July, 2017

At one level, the story on capital and liquidity ratios is very simple: From the viewpoint of the stability of the financial system, more of each is better.…

But at what level should capital and liquidity ratios be set?
Stanley Fischer, Vice-Chairman FRB, Martin Feldstein Lecture July 10, 2014

Abstract
This paper gives institution specific quantitative answers to Fischer's question "at what level should capital ratios be set?" based on (1) the FED Stress Tests 2015 (2) VLab's Systemic Risk measures and (3) our CM (Craine-Martin) estimates.

An appropriate regulatory capital ratio (equity to assets) needs to be high enough to discourage excessive risk taking by financial institutions and to protect taxpayers from private financial institutions' losses but low enough to encourage their intermediation and lending function. It's a delicate balance.

We compare Safe Capital Ratios for 18 Bank Holding Companies. The goal of the Federal Reserve Stress Tests, VLab's measure of systemic risk, and our estimates is to determine a safe capital buffer so that a bank can absorb losses in a crisis—like the Gt Recession—and continue to lend to creditworthy customers without government assistance.

It turns out that the accounting convention—market value used by Vlab and CM vs book value used by the FED—makes an enormous difference. Book value capital ratios hardly move in response to severe economic distress. As a result the leverage ratio (what the FED calls the book equity to book assets ratio) used by the FED is a useless macroprudential signal of bank distress. In contrast, market value capital ratios used by Vlab and CM move a great deal in response to current and anticipated economics distress making them a valuable macroprudential signal.

Section I: Introduction

In July of 2008—three months before the Lehman Brothers' bankruptcy led to the financial panic—the average capital/asset ratio for the twenty riskiest US financial institutions[1] was 5.6%. Lehman held less than 2% capital. Freddie Mac and Fannie Mae, which the government took over, had 0.6% and 1.3% capital. A small decline in asset value and many financial institutions would be insolvent. Government bailouts or massive failures and the collapse of the financial system were inevitable. In October 2008 Lehman failed and financial markets froze. In November the US Congress hastily passed the three-quarter trillion dollar Troubled Asset Relief Program (TARP) to bailout the banks.

[1] According to VLab—see Section III for details on VLab.

The financial sector panic and the worst recession since the Great Depression spurred financial regulatory reform—the 2000 page Dodd-Frank act in the US and Basel III (since Basel I & II didn't work) for international banks. Basel III introduced a minimum "leverage ratio" that requires banks to have equity that is 3% of assets[2], and the US Federal Reserve imposed a minimum leverage ratio[3] of 6% on eight systemically important banks. These are not onerous regulatory capital ratios. But what's most unusual is that banks have a capital requirement. No institutions other than financial institutions have capital requirements.

Section II reviews why banks need regulatory capital ratios. Increasing the debt to equity ratio increases the risk of default and makes debt and equity riskier. Riskier debt normally carries a higher risk premium which gives firms an incentive to limit borrowing. But governments explicitly, or implicitly, guarantee bank debt because the failure of a systemically important institution leads to widespread losses that are far greater than the losses to the institution's equity and debt holders. The debt guarantee is a subsidy to banks that encourages them to hold excessive debt, which makes them excessively risky. An appropriate regulatory capital ratio makes the banks less risky—that's the point—and reduces the value of the subsidy which banks don't like. Section II also summarizes Admati and friends (2011, 2013) refutation of the financial industry arguments that higher regulatory capital ratios would undermine banks' intermediation function and seriously damage the economy. But what is an appropriate safe capital ratio? Admati and friends say 20-30%. A 2017 Minneapolis FED study recommends 23% for covered banks and 38% for "too big to fail" banks. The institution specific safe capital ratios found in this paper are much lower, averaging 11%-16%.

Section III presents and compares three quantitative measures of institution specific safe capital ratios. Engle and friends (Brownlees and Engle 2012, 2017), (Acharya, Engle, and Richardson 2012) (Acharya, Engle, and Pierret 2014) develop the notion of a safe capital ratio that we use. A safe capital ratio is a capital ratio so that in a severe downturn—similar in magnitude to the 2008 Great Recession—the institution will retain a sufficient capital buffer so that it can continue its intermediation function without a government bailout. A goal of Federal Reserve stress tests also is to find a sufficient capital ratio to withstand a stressful period. We compare Engle and friends, our (CM), and the FED Stress Test implied safe capital ratios.

Engle and friends and we use an econometric model to forecast the market value of bank holding company equity value (market capitalization) in a severe downturn. The FED Stress Test methodology is much different. The FED focuses on the bank holding company's balance sheet. They project the BHC's book income and detailed asset losses over the downturn and add it to the current book (accounting) value of the bank holding company's equity to obtain the book value of equity. Section III details the differences in methodology and gives the safe capital ratio results for December, 2014.

The safe capital ratios implied by FED stress tests are much less sensitive to a severe downturn than CM's and VLab's. The standard deviation CM's and Vlab's implied safe capital ratio minus their initial capital ratio is over 7%. For the 2015 DFAST results the standard deviation of the implied safe capital ratio minus their initial capital ratio is only 2%. When subjected to a severe recession in the stress tests the implied individual bank safe capital ratios don't move much--they stay close to their initial value. In contrast, the implied safe capital ratios for Vlab and CM move a lot.

The sources of the difference between CM-VLab's implied safe capital ratios and the Fed Stress Test implied safe capital ratios are hard to pinpoint. One crucial difference is that the Fed Stress Tests calculate the book value of the capital ratio while CM and VLab calculate the market value of the capital ratio. Section IV isolates the effect of book vs market value accounting from the model specification and forecasts by presenting the *realized* book and market value capital ratios over the Gt Recession. Realized book value capital ratios show almost no variation over the Gt Recession and generally indicate that the banks were

[2] See, .bis.org/publ/bcbs270.pdf. The traditional definition of the leverage ratio is assets/equity so Basel III "leverage ratio" is the reciprocal of the traditional definition.

[3] See https://www.fdic.gov/regulations/resources/director/regcapintfinalrule.pdf for a detailed description of Tier 1 capital and the various regulatory capital ratios.

well capitalized. Realized market value capital ratios, on the other hand, clearly show that most bank holding companies were in deep distress after Lehman Brothers failed.

Book value accounting measures used in the FED stress test provide little useful macroprudential information to regulators because they don't move. Market value capital ratio measures as in Vlab and CM, in contrast, give strong macroprudential warnings to regulators.

Section V gives the summary and conclusions.

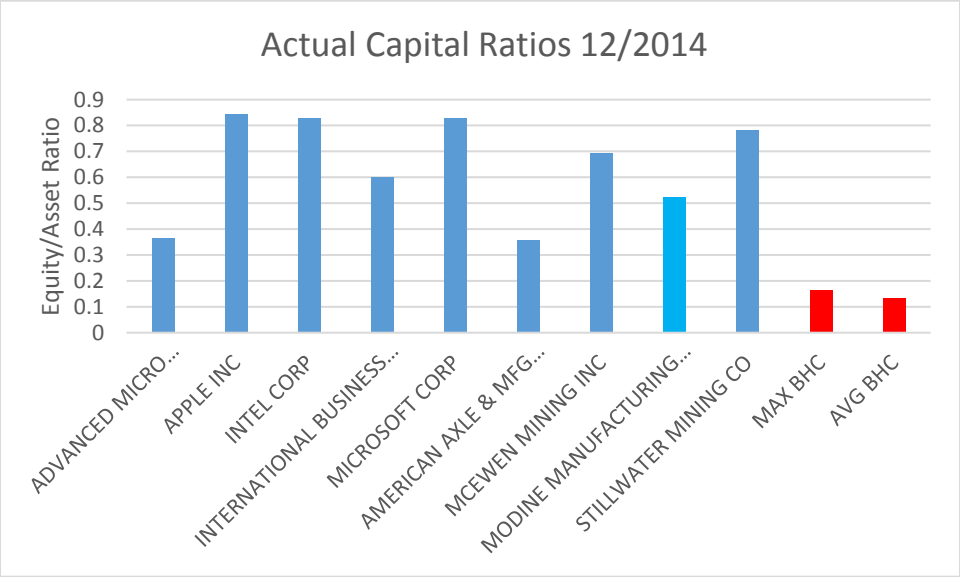
Section II: Regulatory Capital Ratios

Basel III introduced a minimum "leverage ratio" that requires banks to have Tier1 equity that is 3% of total assets, and the US Federal Reserve imposed a minimum Tier1 leverage ratio of 6% on eight systemically important banks effective 2018. No institutions other than financial institutions have capital requirements. This section looks at why financial institutions have and need capital requirements.

Do Depository Institutions hold less Capital?

Figure II.1 shows actual capital ratios (ACRs)—equity/assets ==((current equity market capitalization)/(current equity market capitalization + book value of debt))--for nine well known US firms and the maximum and average of the bank holding company's actual capital ratio [4] as of December 2014 (see Table III.2 for a full list of the 18 bank holding companies).

Figure II.1



[4] This is the capital ratio used by VLab and us and commonly used in finance.

The bank holding companies' capital ratios are very low relative to other firms.[5] The two bars on the far right summarize the bank holding companies. The maximum[6]—Wells Fargo—is 16% while the minimum for the other firms—American Axle & MFG—is 36%. And the average capital ratio for the bank holding companies is only 13% while the average is 65% for the other firms.[7]

Why Do Depository Institutions hold less Capital?

The famous Modigliani-Miller theorem proves that—given perfect markets—it is the value of the firm (expected discounted future payoffs) that matters and the financing mix of equity/debt is irrelevant. Increasing the debt/equity ratio increases the expected return and risk to equity. It also increases the risk of the debt and the default premium which makes it more expensive for firms to borrow. In equilibrium firms are indifferent to the financing mix. Of course actual markets don't meet the assumptions of the MM theorem. But by eyeball econometrics the institutions—except for bank holding companies—in Figure II.1 don't violate the MM theorem. Advanced Micro Devices has 36% capital and Intel has 80%--they each manufacture computer chips. There is no pattern to the other institutions' capital ratios either except for bank holding companies'.

The government debt guarantee for financial institutions breaks the natural market equilibrating mechanism by making depository institutions' debt default free. With the guarantee depository institutions can increase the expected return to equity (and risk) without having to pay the cost of higher default premiums on their debt. And when things go badly the government absorbs the loss[8] while when things go well the financial institution takes the gain.

The debt guarantee is a subsidy to financial institutions, see Appendix I for an analytic representation of the subsidy. It encourages financial institutions to hold excessive debt and take excessive risk. Figure II.2 shows the capital ratios for the twenty riskiest financial institutions[9] one quarter before the financial meltdown in October 2008.

FIgure II.2 Capital Ratios for Financial Institutions 07/2008

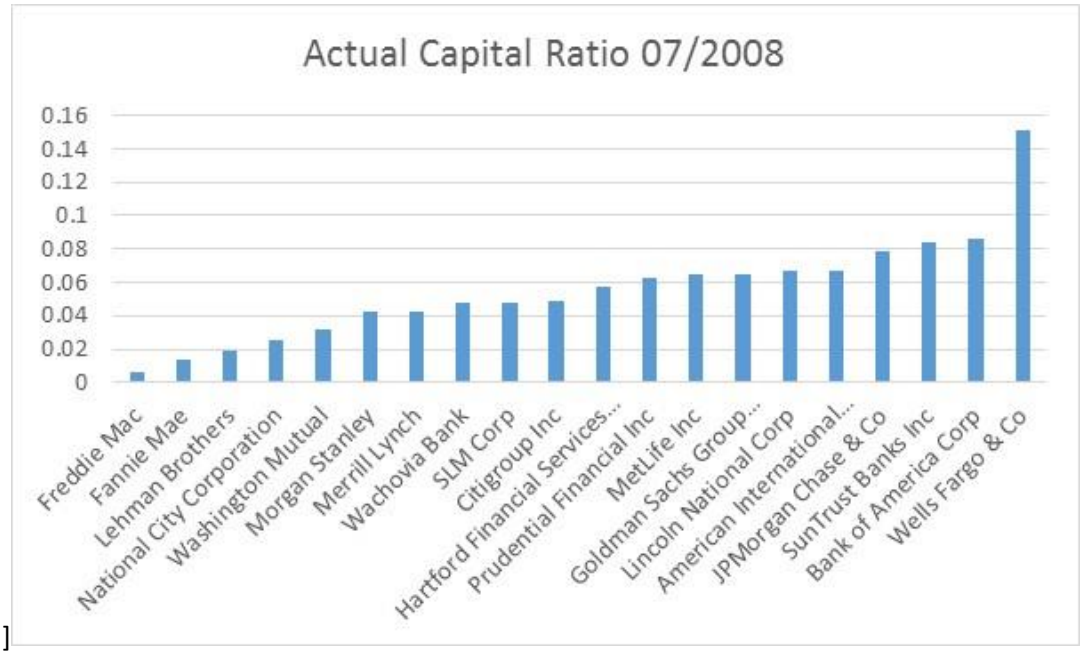
[5] Even hedge funds have much higher capital-asset ratios than banks, see Ang, el al 2011, Figure 7. Figure 7 shows leverage ratios (traditional definition of leverage—the asset to market value of equity ratio). The hedge funds' leverage ratios are measured on the left vertical axis and the financial firms on the right vertical axis with a separate scale since the financial firms' leverage is so much greater than the hedge funds.

[6] This excludes American Express that had a capital ratio of 42% which is a registered BHCs, but whose core business is credit card processing and debt.

[7] This is not the result of cherry picking the data. The exact numbers will change with time periods and comparison groups, but depository institutions have the lowest capital ratios.

[8] The FDIC has shown that it can and will close smaller depository institutions. In general, smaller institutions pay more for their debt, hold more equity, and are less risky, see VLab SRISK ranking for 75 financial institutions.

[9] This is from VLabs' Systemic Risk calculations—see Section III.



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These capital ratios are extremely low—the institutions rode the government guarantee for the maximum benefit. Fannie Mae had 1.3% capital and Freddie Mac had only 0.6%. The government took Freddie and Fannie over and honored their debt. Of the twenty institutions only two went bankrupt so that debtholders suffered a loss—infamous Lehman Brothers who held a meager 1.9% capital and plunged world financial markets into a panic, and Washington Mutual (3% capital) who succumbed to an orderly death when the FDIC it took over. But the 18 others survived or at least their debtholders didn't suffer. Bank of America—with considerable pressure from regulators—bought Countrywide and Merrill Lynch. Wells Fargo bought Wachovia. And PNC Financial bought its rival National City Bank using Troubled Asset Relief Program (TARP)[10] bailout funds. Of the remaining seven depository institutions all of them received TARP bailout funds. And American International Group, an insurance company that wrote credit default swaps on mortgage backed securities (a default guarantee) purchased by many depository institutions received a huge bailout from the Federal Reserve[11].

Why do Governments Guarantee Financial Institution Debt?

The Great Depression and the Great Recession provide ample evidence that when the financial sector collapses the collapse of the real sector will follow. When a systemically important financial institution fails the damage extends far beyond its creditors and shareholders. Intermediation is a critical function in modern economies. The failure of Lehman Brothers, a medium size investment bank, froze overnight credit markets worldwide[12]. Governments and Central Banks properly take measures to avoid the failure of institutions spreading to the rest of the financial market. After bank runs in the Great Depression led to the failure of many banks—small and large, some solvent some insolvent—the US enacted Federal Deposit Insurance—an explicit debt guarantee. Since then, implicit debt guarantees are more common--the TARP bailout, Freddie and Fannie, and the coerced acquisitions of Bear Stearns, Merrill Lynch, and others.

[10] The Troubled Asset Relief Program—a program hastily enacted in November of 2008 to limit the financial collapse by bailing out banks.
[11] The AIG bailout represented indirect support for the US and foreign banks that held the mortgage-backed securities.
[12] Lehman froze financial markets because of the opaque web of debt connections. When Lehman declared bankruptcy it was immediately clear who they owed and how much—these creditors would have to wait and get less than they loaned. What froze the market is the fear that if Lehman's creditors didn't get paid, then they would default and their creditors wouldn't get paid so they would default, and so on.

Why Government Debt Guarantees justify Regulatory Capital Requirements

The debt guarantee provides a subsidy to the institution that encourages them to take on excessive debt and risk—and they do, see Figure II.2. The debt guarantee interferes with the normal market mechanism that equilibrates more debt with a higher risk premium which gives firms a market incentive to limit debt. To offset the market failure introduced by the government debt guarantee the government needs regulatory capital requirements that impose a lower limit to the capital(equity)/asset ratio.

Section III presents quantitative estimates of a safe capital ratio (SCR).

Financial Industry Arguments against higher Regulatory Capital Requirements

Debt guarantees are a subsidy to financial institutions and higher regulatory capital ratios reduce the value of the subsidy. Of course the industry vigorously opposes any effort to increase regulatory capital ratios[13]. Admati and friends—Admati, DeMarzo, Hellwig, and PFIederer (2011), and Admati and Hellwig (2013)--present the earliest analytic and logical arguments to refute the financial sector's claims that a higher regulatory capital ratio—higher equity—is too expensive and will damage the economy.

This subsection summarizes the industry's claims and Admati and friends' refutation. See their papers and book for convincing detail.

Industry Arguments and Admati and Friends' Response

- Increased regulatory capital ratios would force banks to hold in reserve funds that otherwise would be lent.
    - This represents an incredulous failure to understand basic accounting and economics—or cynical attempt to mislead the naïve (legislators?) who don't understand basic accounting and economics. Firms fund assets with liabilities—debt and equity. A large portion of bank *assets* are loans to the public[14]. Increasing bank liabilities by adding equity gives the bank additional funds to lend, not less.
- Increased regulatory capital ratios would increase banks' funding costs because equity requires a higher return than debt.
    - This is a slightly more subtle argument. Equity and debt returns normally contain a risk premium. Higher debt/equity ratios make debt and equity riskier which implies higher risk premiums. The M-M theorem shows that with perfect markets firms are indifferent between debt and equity financing. The government debt guarantee for financial institutions transfers the debt risk to the government (public) so that banks get to pay the default free interest rate on their debt. So yes, equity financing for banks is more expensive than subsidized debt financing. But a higher regulatory capital ratio would make banks less risky—that's the point—and it would reduce banks' incentive to take excessive risk since the owners would bear more of the risk—not the taxpayers. Less risky banks reduce the value of the debt guarantee subsidy. So the banking industry vigorously lobbies against higher regulatory capital ratios.
- Increased regulatory capital ratios would increase banks' funding costs because debt has favorable tax shields.

[13] See Chari & Kehoe (2016) for a more recent "rigorous" derivation that regulatory capital ratios can offset the subsidy of the debt guarantee.

[14] Bank loans are liabilities to the public, but loans are assets to the bank. The public owes the value of the loan to the bank.

- This is true. The US tax codes favor debt over equity financing because companies can deduct interest payments as an expense while dividend payments are not tax deductible. However, the tax code applies to all industries. The government guarantee of bank debt—not the tax code—drives depository institutions to use excessive debt financing, see Figure II.1.

III. What is the Appropriate Regulatory Capital Ratio?

Section II show that government and/or central bank debt guarantees provide a subsidy to financial institutions that encourages them to hold excessive debt. The data confirm that bank holding companies have much more debt relative to equity than other institutions. More debt means more risk. Appropriate regulatory capital ratios are a way to balance the perverse incentive created by the debt guarantee. But, as Stanley Fischer asked "what is the appropriate capital ratio?" The Federal Reserve declared that large depository institutions would have to meet a "leverage" ratio (a capital ratio) of 5% and systemically important bank holding companies—eight at present—would have to meet a 6% "leverage" ratio—by 2018. Admati and friends want 20% capital. And the Federal Reserve Bank of Minneapolis, in a study released January 2017, wants even higher capital ratios. They recommend that covered banks hold capital of 23% of risk-weighted assets and "too big to fail" banks to have 38% capital.

Engle and friends (Brownlees and Engle 2012, 2017), (Acharya, Engle, and Richardson 2012), (Acharya, Engle, and Pierret 2014) develop a quantitative notion of a safe capital ratio. A safe capital ratio is a capital ratio set so that in a severe downturn—similar in magnitude to the 2008 Great Recession—the institution can continue to function as a financial intermediary without government assistance.

In this Section we present and compare three quantitative measures of institution and state specific Safe Capital Ratios—Vlab (Engle and friends), CM (Craine-Martin), and FED stress tests.

Engle and friends and we use an econometric model to forecast the market value of bank holding company equity (market capitalization) during a crisis. The major methodological difference between Engle et al and us is that Engle et al use a bivariate specification and we use a multivariate specification. The FED Stress Test methodology is very different. The FED focuses on the book value of the bank holding company's balance sheet data. They project net income and assets over the stress test horizon. Section III.1 details the differences in methodology and Section III.2 gives the safe capital ratio results.

Prelude

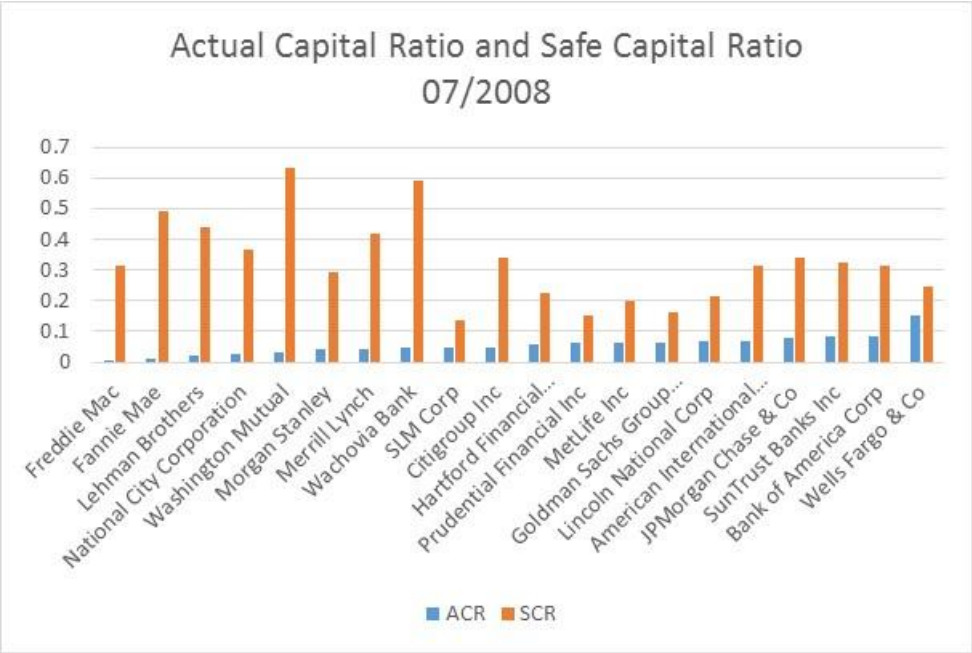
Engle and friends organized and contribute to VLab which has a treasure of data easily accessible online,

http://vlab.stern.nyu.edu/analysis/RISK.USFIN-MR.MESSIM

that is updated weekly.

Figure III shows the actual capital ratios, illustrated in Figure II.2 below and the safe capital ratios (explained in Section III.1) for the twenty systemically riskiest US Financial institutions according to VLab's estimates as of July, 2008—the eve of the financial meltdown.

Figure III: Actual and Safe Capital Ratios 07/2008



The safe capital ratios—the large orange bars—are enormous relative to the actual capital ratios (the small blue bars)—the two largest safe capital ratio spikes, Washington Mutual and Wachovia, are at 60%. The FDIC closed Washington Mutual and Wells Fargo—with considerable encouragement from the FED—bought Wachovia. The VLab measure of systemic risk indicates these twenty institutions were extremely risky in July of 2008. [15] And subsequent events proved they were.[16] All of the depository institutions—except Washington Mutual which the FDIC closed--got Troubled Asset Relief Program bailout funds—or were bought by another bank. As a consequence of the bailouts and the Great Recession, financial oversight got stronger—Dodd, Frank in the US and Basel III internationally. Now regulated financial institutions hold substantially more capital. But do they hold enough?

Section III.1 Safe Capital Ratio Estimates

Vlab and Craine-Martin

The development of Safe Capital Ratios begins with Acharya, Pedersen, Philippon, and Richardson's (2010) behavioral structural model that links systemic risk[17] to bank capital shortages. A capital shortfall is when the market capitalization of bank *i* falls below a capital buffer of *k%* of assets. A bank's capital shortfall contributes to systemic risk when most banks are in trouble. They define bank *i*'s contribution to systemic risk, SRISK,

[15] VLab uses a rolling sample and estimates that only use information that was available at the time. VLab's implied safe capital ratios are based on forecasts of the expected capital shortfall.
[16] Brownlees and Engle (2017) provide compelling evidence showing that their measure of systemic risk is an accurate predictor of trouble.
[17] Hansen (2012) has a clear paper on "The Challenges in Identifying and Measuring Systemic Risk". In Hansen's taxonomy the approach in this paper equates systemic risk with lower tail risk.

$$SRISK_i = E(k * \text{assets}_i - \text{equity}_i \mid \sum_i^N equity_i \le k * \sum_i^N assets_i) \qquad 3.1$$

as bank *i*'s expected capital shortfall *given a crisis when the banking sector also suffers a capital shortfall*. Notice this is a lower tail definition of systemic risk. A bank that falls below the safe capital buffer in normal times does not contribute to systemic risk because in normal times it can sell assets and continue to borrow, or gets bought by a competitor, or even if it fails doesn't cause risk to the system. It's only when most banks are in difficulty that each bank's shortfall contributes to systemic risk.

Brownlees and Engle's (2012a) make Acharya, el al's (2010) static measure of systemic risk a dynamic operational tool by 1. generalizing the aggregate banking sector capital shortfall in a crisis to an equity market crisis and 2. quantifying it by estimating a dynamic reduced form model for bank capital shortages.

They define an equity market crisis as when **the cumulative market return falls by more than 40% over a six month horizon.**[18] Since bank returns are positively correlated with the market return and most have a *Beta* greater than one Brownlees and Engle's definition of an equity market crisis encompasses Acharya, et al's (2010) notion of an aggregate banking sector shortfall.

Bank *i*'s equity (market capitalization) in a crisis declines by the fall in its cumulative equity return times current equity value. Brownlees and Engle define the *expected* cumulative fall in bank *i's* return as the long run marginal expected shortfall, $LRMES_{it}$. Bank *i's* contribution to *SRISK* becomes,

$$\begin{aligned} SRISK_{i,t} &= E_t(k * assets_{i,t+H} - equity_{i,t+H} \mid \text{equity crisis}) \\ &= E_t(k(debt_{i,t+H} + equity_{i,t+H}) - equity_{i,t+H} \mid \text{equity crisis}) \\ &= k * debt_{i,t} - (1-k) * (1 - LRMES_{i,t}) * equity_{i,t} \end{aligned} \qquad 3.2$$

a linear function of the long run marginal expected shortfall (*LRMES)* and the observable market value of equity and book value of debt[19]. Quantifying *SRISK* only requires an estimate of the *LRMES.*

Calculating the Long Run Marginal Expected Shortfall (LRMES)

Step 1: Model of bank returns

Brownlees and Engle, and Craine and Martin estimate a model of equity returns for the market and the banks,

$$\begin{aligned} \boldsymbol{r}_t &= \boldsymbol{\Sigma}_t^{1/2} \boldsymbol{\zeta}_t \\ \boldsymbol{\zeta}_t &\sim \boldsymbol{F} \end{aligned} \qquad 3.3$$

[18] The S&P500 return fell by 40% over the 6-month period at the worst of the financial meltdown from September 2008-February 2009.
[19] The book value of debt measures the bank's legal obligation that is relevant for solvency. And no good measures of the market value of banks debt exist.

where *r* is a vector of demeaned logarithmic returns containing the market return and the bank holding companies' returns and $\Sigma^{1/2}_t$ is the lower triangular Cholesky decomposition of the conditional covariance matrix Σ_t . The market return is at the top of the Cholesky triangle[20]. ζ_t is a corresponding vector of mean zero uncorrelated disturbances, with distribution *F* , that are independent over time but not of each other.

The conditional variances are estimated as univariate asymmetric GARCH processes. The corresponding conditional correlation matrix is estimated with a DCC specification.

Brownlees and Engle estimate a set of bivariate models—the market return and a bank return. The bivariate specification is a dynamic CAPM model. The market return summarizes the systematic shock. The covariance among banks returns is implicitly restricted to the product of their market *Betas*,

$$E(r_{it}, r_{jt}) = \sigma_{it}\rho_{it}\sigma_{jt}\rho_{jt} = \beta_{it}\beta_{jt}Er_{mt}^{\ 2} = \beta_{it}\beta_{jt}\sigma_{mt}^{\ 2}$$

$$\beta_{l,t} = \mathrm{cov}_t(\mathrm{r}_{l,t}, r_{m,t}) / \sigma^2_{\ mt} = \frac{\rho_{lt}\sigma_{lt}}{\sigma_{mt}}$$

Craine and Martin estimate the multivariate model which does not restrict the covariance among bank returns. We thought this would be important especially in a crisis where losses at one bank may directly affect another bank. It turned out not to matter.

Step 2: Calculating the Expected Shortfall--LRMES

The long run (6-month) marginal expected shortfall (LRMES) is calculated by dynamically simulating the model many times and averaging the returns of institution *i* in a crisis. In simulating the model the shocks are obtained by bootstrapping the residuals and updating the conditional covariance matrix in (3.3). The 6-month simulated return on each bank holding company is computed as the cumulated sum of the daily returns over the period

$$R_{it:t+H-1} = \exp\left\{\sum_{\tau=1}^{H} r_{it+\tau-1}\right\} - 1 \qquad 3.4$$

The long run marginal expected shortfall is,

$$LRMES_{it-1} = \frac{\sum_{s=1}^{S} R_{it:t+H-1} I(R_{mt:t+H-1} < C)}{\sum_{s=1}^{S} I(R_{mt:t+H-1} < C)}, \qquad 3.5$$

the average cumulative loss *given* a cumulative drop in the market return of at least 40%, i.e., where *C* = -40%.

A Safe Capital Ratio

Achraya, Engle, and Richardson (2012) propose the safe capital ratio (SCR) that sets the systemic risk (SRISK) to zero for each bank,

[20] CM also use the principal root of the covariance matrix, which does not require ordering the variables as the Cholesky decomposition does. The choice of which method is selected to extract the root of the covariance matrix doesn't make much difference in the results.

$$\mathrm{SCR}_{i,t} = \frac{equity_{i,t}}{equity_{i,t} + debt_{i,t}} \text{ so that SRISK} = 0 \qquad 3.6$$

Manipulating equation (3.2) gives the safe capital ratio (SCR) as a function of the long run marginal expected shortfall (LRMES), (eq 8 in Achraya, Engle, and Richardson)

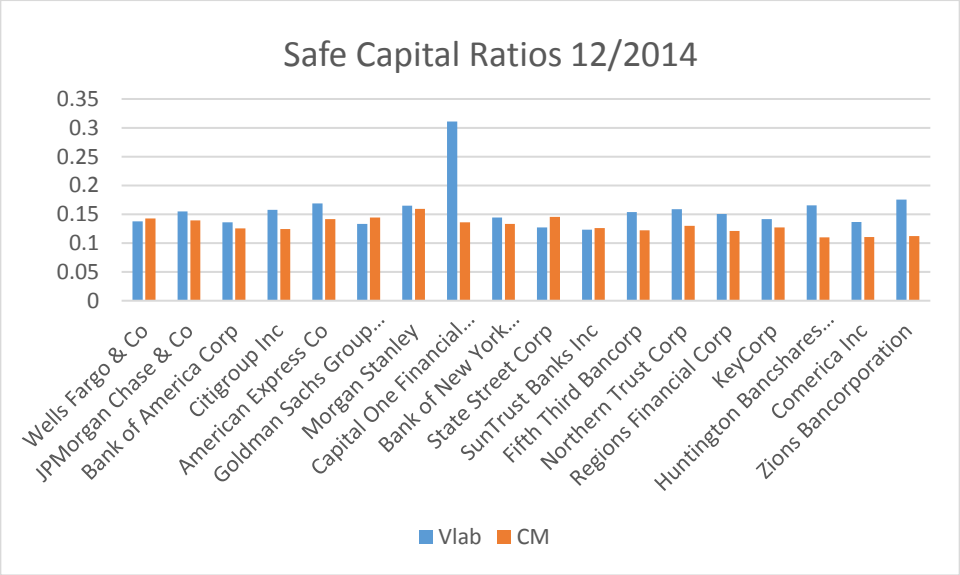
$$SCR_{i,t} = \frac{k}{1-(1-k)LRMES_{i,t}} \qquad 3.7$$

where *k* is the safe capital buffer. Engle and Friends choose a buffer of 8%.

Results

Figure III.1 shows the safe capital ratios estimated by Vlab and CM as of 12/2014 for 18 bank holding companies. The bivariate and multivariate specifications give essentially the same results.

Figure III.1



The median SCR for Vlab is 15% and for CM is 13%. The only large discrepancy is for Capital One which is fundamentally a credit card company not a traditional bank.

III.2 FED Stress Test Estimates of Safe Capital Ratios

The goal of the FED Stress tests, Vlab's systemic risk measure and our estimates is the same,

"Capital is central to a BHC's ability to absorb losses and continue to lend to creditworthy businesses and consumers…..For this reason, the Federal Reserve has made assessments of capital planning and analysis of capital adequacy on a post stress basis a cornerstone of its supervision of the largest and most complex financial institutions."[21]

But methodologies are very different. VLab and CM only use estimated BHC's equity market return losses conditional on a severe downturn in the market return. In contrast, the Dodd-Frank Act Stress Test 2015 builds up the book value of BHC (DFAST 2015 p 10) from detailed micro models to project the book accounting values for the losses on the bank holding company's major asset categories and its net income,

The models are intended to capture how the balance sheet, RWAs, and net income of each BHC are affected by the macroeconomic and financial conditions described in the supervisory scenarios, given the characteristics of the BHCs' loans and securities portfolios; trading, private equity, and counterparty exposures from derivatives and SFTs; business activities; and other relevant factors.

The FED stress tests provide valuable *microprudential* information on the bank loan portfolio. The tests breakdown loan losses into seven detailed categories—first lien mortgages, junior liens and HELOFs (home owner lines of credit), commercial and industrial, commercial real estate, credit cards, other consumer, other. The FED invests great effort to ensure that its loan loss forecasts are accurate, e.g. see Hale, et al (2015).

The BHC's asset values projections are much less detailed. Assets are projected from different models that relate industry-wide loan and non-loan growth to broader economic variables, see DFAST 15, Balance Sheet Items and Risk-Weighted Assets, pp 62-63. The industry loan and asset growth rates projections over the stress test horizon use the macroeconomic variables in the supervisory scenario. Over this horizon, each BHC is assumed to maintain a *constant share* of the industry's total assets.

FED Stress Test Scenarios

DFAST calculates book income and losses using two scenarios—a "Severely Adverse Scenario" and an "Adverse Scenario", see DFAST 2015 Supervisory Scenarios pp5-6,

Supervisory scenarios include trajectories for 28 variables. These include 16 variables that capture economic activity, asset prices, and interest rates in the U.S. economy and financial markets and three variables (real gross domestic product (GDP) growth, inflation, and the U.S./foreign currency exchange rate) in each of the four countries/country blocs.

We use the results from the Severely Adverse Scenario which resembles the Gt Recession—the simulation period lasts 9 quarters (the Gt Recession officially lasted 8 quarters), equity values fall by 60% in the first year, house prices decline by 25%, the unemployment rate increases by 4% and GDP falls by 4.5%--see DFAST 2015 for more detail. The Severely Adverse Scenario depicts a truly severe recession. Notice that the Severely Adverse Scenario is a much worse crisis scenario lasting longer and specified more comprehensively than the crisis used by Vlab and CM which only specifies a 40% decline in equity values over two quarters.

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Tier1 Leverage Ratio

The Tier1 Leverage Ratio, aka Capital Ratio, is the ratio of the BHC's Equity to Assets.

The FED STRESS TEST results report the actual book capital ratio at the beginning of the test, the minimum projected capital ratio and the projected terminal capital ratio (the final value at the end of the 9-quarter stress test). We use the minimum capital ratio to calculate the implied safe capital ratio[22].

[21] Comprehensive Capital Analysis and Review 2015, Board of Governors of the Federal Reserve System, p 1.

FED STRESS test Safe Capital Ratio: We calculate the Safe Capital Ratio implied by the STRESS TEST as,

$$SCRFED = ACRFED - ShortfallFED$$

where $ACRFED \equiv$ Actual book value Capital Ratio in 09/2014

$ShortfallFED \equiv$ minTier1 Capital Ratio - 8%

III.2 Results

This proportion compares the implied safe capital ratios from the three techniques. We used 18 bank holding companies where the VLab data and our data overlap with the FED Stress tests (2015).[23] The bank holding companies include the eight banks that the FED designates systemically important.

Table III.2 Summary of Results: 12/2014

	Actual Capital Ratios (ACR)		Safe Capital Ratios - ACR		
Institution	Vlab&CM	FED Tier1 Lvg=ACR	Vlab	CM	FED
Wells Fargo & Co	0.1636661	0.096	-0.0260	-0.0210	0.0160
JPMorgan Chase & Co	0.0925069	0.076	0.0622	0.0468	0.0340
Bank of America Corp	0.0907441	0.079	0.0452	0.0346	0.0290
Citigroup Inc	0.0893655	0.09	0.0683	0.0351	0.0340
American Express Co	0.41841	0.116	-0.2498	-0.2770	-0.0340
Goldman Sachs Group Inc/The	0.0974659	0.09	0.0360	0.0469	0.0260
Morgan Stanley	0.0929368	0.082	0.0719	0.0664	0.0350
Capital One Financial Corp	0.1519757	0.106	0.1587	-0.0157	0.0010
Bank of New York Mellon Corp/The	0.1160093	0.058	0.0284	0.0173	0.0280
State Street Corp	0.1145475	0.064	0.0129	0.0307	0.0320
SunTrust Banks Inc	0.1172333	0.095	0.0063	0.0087	0.0040
Fifth Third Bancorp	0.1237624	0.098	0.0299	-0.0018	0.0030
Northern Trust Corp	0.1340483	0.079	0.0246	-0.0040	0.0060
Regions Financial Corp	0.1246883	0.11	0.0259	-0.0039	0.0040
EKeyCorp	0.1317523	0.112	0.0099	-0.0044	-0.0130
Huntington Bancshares Inc/OH	0.1287001	0.098	0.0366	-0.0188	0.0000
Comerica Inc	0.1204819	0.108	0.0162	-0.0099	-0.0090
Zions Bancorporation	0.1072961	0.119	0.0683	0.0046	0.0210
Average	0.1341995	0.0931111	0.0236	-0.0036	0.0121
median	0.118858	0.0955	0.0291	0.0014	0.0110
std	0.0739	0.0175	0.0785	0.0729	0.0194

Comparing the results it's important to keep in mind that the FED uses book value accounting data for everything. Vlab and CM use the market value of equity.

[23] The FED STRESS Tests report results for 31 BHCs. 21 of those overlap with VLab's data. Three of these BHCs are headquartered in Europe so that CRSP does not report their return data. That leaves 18 BHCs with overlapping return data.

The most strikingly different statistics in Table III.2 are the standard deviations in the bottom line. The standard deviations of the market based measures almost are four times as large as the book value measures. Book values don't move.

The first two columns give the standard deviations of the actual capital ratios around the sample mean—a measure of variation across banks. The book value measures of banks actual capital ratios are clustered close to the mean. The market value measures show much wider dispersion across banks. The last three columns measure the sensitivity of an individual bank's Safe Capital Ratios to distress—(the Safe Capital(i) – Actual Capital Ratio(i)). Notice that the average deviation across banks is small for the book value measure (column 7) is close to the average deviation for the market value measures (columns 5 and 6). But again the standard deviation—dispersion—is four times as large for the market based measure as the book value measure. The Severely Distressed Scenario in the FED's test didn't require each bank to alter their initial capital level very much to achieve a Safe Capital ratio. In contrast, the market based measures--Vlab and CM—call for much larger changes for each bank to achieve a Safe Capital Ratio.

Section IV emphasizes the fact that book value capital ratios are insensitive to economic conditions with an application.

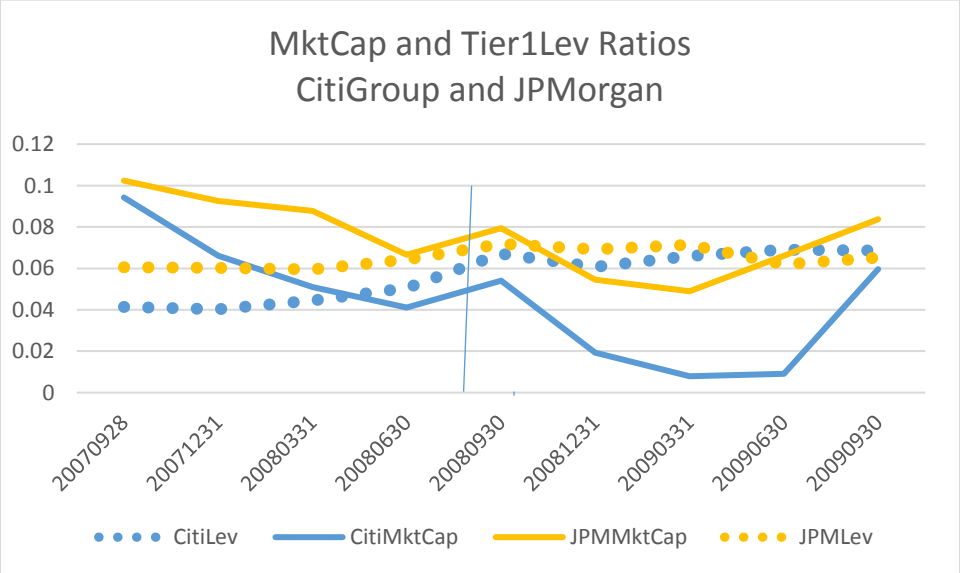
IV: Book vs. Market Values

Vlab and CM use the market value of equity and they get essentially the same results. The FED stress tests use book value of assets, and rely on different models and methods and get different results. Precisely identifying the sources of the different results for the calculated Safe Capital Ratios is nearly impossible.

However, we suspect that the accounting convention—book vs. market value is very important. We isolate the effect of book value accounting used by the FED from market value accounting used by Vlab and CM by looking at *actual* capital ratios over the Great Recession, September 2007—September 2009. The realizations don't depend on models or methods. They reflect the measured response to actual events.

Figure IV illustrates the book and market capital ratios for two of the largest bank holding companies. The blue lines represent CitiGroup and the yellow lines JPMorgan. CitiGroup and JPMorgan represent extremes. Analysts praised JPMorgan as a well-managed bank with appropriate risk controls and criticized CitiGroup for loose supervision and out of control traders.

Figure IV Capital Ratios CitiGroup and JPMorgan Sept 2007—Sept 2009



Yet their Tier 1 Leverage Ratios (book value capital ratios)--the dotted lines in Figure IV—look very similar over the period of the Gt Recession. More striking, neither signals distress during the most severe downturn since the Gt Depression. According to the Federal Reserve's strengthen new capital requirements which won't take effect until 2018 both banks were well capitalized for the worst part of the recession after Lehman failed in October 2008.[24] JPMorgan had a leverage ratio greater than 6% over the entire Gt Recession. CitiGroup enters the Gt Recession with a leverage ratio of only 4%, but reaches 6% by September 2008 and stays above 6% for the remainder of the recession.

In sharp contrast both banks market capital ratios (the solid lines) fell through most of the recession. After Lehman failed CitiGroup's market capital ratio fell precipitously from 5.5% to less than 1% by March 2009 which clearly signaled a bank in deep distress. JPMorgan's market capital ratio also fell from 8% to 5% indicating trouble, but not distress.

These results are robust. Appendix II has the additional data on the book value of assets—risk weighted and total assets—and the leverage ratio and risk weighted capital ratio from the Federal Reserve Y9C reports[25] and the market value of assets[26] from CRSP and Compustat. All of the eighteen bank holding companies in our sample got Troubled Asset Relief, a sign that they were in trouble. But none of the 18 bank holding companies book capital (leverage) ratios fall below 6% after 2008. (A sign that TARP worked?) But many of their market capital ratios fell well below 6%. (A sign that the market—who knew about the TARP bailouts—still believed the banks were in distress.)

The graph in this section and the data in Appendix II do not depend on models, estimation, or forecasts. It shows realizations of actual capital ratios. Book value capital ratios hardly react to the trauma of the Great Recession. Book value capital ratios are too insensitive to the stress test scenario events as shown in Section III, or actual economic events as shown here to be useful macroprudential indicators.

V Summary and Conclusions

Summary

Banks have much higher debt/asset ratios than any other industry—including hedge funds. Banks choose debt financing over equity because governments explicitly or implicitly guarantee bank debt knowing that the failure of a systemically important bank creates losses to society far greater than the losses to the bank's equity and debt holders. The guarantee is a subsidy to banks that encourages excessive debt financing which makes them excessively risky. A regulatory capital ratio resets the scales. But, it's a delicate balance. An appropriate regulatory capital ratio needs to be high enough to discourage excessive risk taking and to protect taxpayers from private financial institutions' losses but low enough to encourage financial intermediation and lending. This study presents three quantitative institution specific safe capital ratios—a sufficient capital buffer for a bank to withstand a crisis like the Gt Recession can continue to lend to creditworthy borrowers without government assistance—for eighteen large bank holding companies. The safe capital ratios are derived from the Federal Reserve Stress tests—DFAST 2015—from VLab's website—December 2014—and from CM's (Craine and Martin's) econometric model estimates.

[24] Both banks received TARP bailout funds in November 2008—as all of the 18 bank holding companies in our sample did—which immediately boosted their book equity.

[25] Data on the book value of assets and equity for all bank holding companies are available at https://www.chicagofed.org/banking/financial-institution-reports/bhc-data

[26] We use the terminology market value assets = market value of equity + book value of debt commonly used in finance.

The news in this paper:

1. The accounting convention: book value of equity that the FED uses to measure capital ratios vs. the market value of equity Vlab and CM use to measure capital ratios makes a huge difference. Book value equity hardly responds to severe economic events simulated in stress tests or in reality such as the Gt Recession. As a result, book value capital ratios (the FED calls them leverage ratios) are useless as macroprudential signals. Market value capital ratios, in contrast, respond quickly to current and anticipated economic events which makes them valuable macroprudential signals.
2. Vlab monthly publishes a treasure of data measuring the riskiness for US and foreign financial institutions. Brownlees and Engle(2017) show that SRISK (their measure of systemic risk) is a good predictor of actual bank distress. The estimate of the estimated long run marginal expected shortfall—LRMES—is the only unknown required to calculate SRISK and the safe capital ratio featured in this paper. Vlab estimates parsimonious bivariate dynamic CAPM models to calculate the LRMES. We thought a multivariate model that allowed for direct spillover from shocks among banks would provide a better estimate of LRMES. It turned out that the more complicated econometric model didn't change the estimates. The dynamic CAPM is good approximation and much easier to work with.

Conclusions

Theory shows that capital ratios play a major role in bank (self) regulation. And, policymakers are starting to recognize capital ratios as an important tool in the bank regulators' kit—e.g., the Minneapolis Fed study or the "House Financial Services's CHOICE Act". The hard part is to pick the correct regulatory capital ratio. Our results show that book value equity measures (used by the FED) do not respond to current economic events. Market value equity measures respond (and maybe overreact) to current and anticipated economic events. Vlab's estimates of systemic risk and the safe capital ratios should be part of policymaker's toolkit in addition to the FED stress test results. Furthermore, econometric model based estimates and stress tests provide a realistic method to guide flexible institution specific state dependent capital ratios as opposed to the one or two bucket choices in the existing and proposed regulations.

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Appendix I: Analytical basis for Financial Institution Regulatory Capital Ratios

This appendix is the foundation of the intuitive discussion in Section II. It proves the Modigliani-Miller theorem and shows that the government debt guarantee for financial institutions is a subsidy. And it shows that the value of the subsidy is increasing in the debt to equity ratio.

Modigliani-Miller Theorem

The M-M Theorem shows that it is the value of the firm, *V,* that matters. The financing mix--*E* ,equity, and *D,* debt—is irrelevant.

Modigliani and Miller published their Theorem and ingenious proof in 1958. The proof is as complicated as it is ingenious. Arrow and Debreu published their path breaking work on the existence and welfare properties of a competitive equilibrium in 1954. But financial economists and others did not realize the power, beauty, and simplicity of the A-D setup until years later. This Appendix proves M-M using A-D the contingent claims setup. I present a simplified two period version of the proof in Merton (1992) and Ljungqvist and Sargent (2004).

Assumptions: standard assumption for the existence of a competitive equilibrium.

Define:

p(s) == the Arrow-Debreu price of a contingent commodity in state s next period. The states, s, are stochastic and defined by a probability distribution. The price, p(s), incorporates time discounting and uncertainty.

x(s) == the net asset value of the firm next period in state s

n == the ***promised*** *payoff to debtholders in all states. If the firm cannot meet the promised debt obligation, then debtholders get the firm, worth x(s), and equity holders get nothing.*

Then,

$V = \sum p(s)x(s)$ the current value of the firm

$E = \sum p(s)\max(\mathrm{x(s)} - \mathrm{n}, 0)$ the current equity value (market cap) of the firm

$D = \sum p(s)\min(n, x(s))$ the current value of debt of the firm

The Modigliani-Miller Theorem

$V = E + D$

$$\sum_s p(s)x(s) = \left[\sum \mathrm{p(s)}\max((x(s) - n), 0) + \sum \mathrm{p(s)}\min(n, x(s)) \right]$$

The financing mix, *D/E,* is irrelevant. The proof is so deceptively simple it masks generality of the result.

Why Debt Guarantees for Financial Institutions Require Regulatory Capital Ratios

Governments guarantee financial institutions debt because the failure of a significant financial institution spreads well beyond losses to the firm's equity and debt holders—a negative externality. But the debt guarantee is a subsidy to the financial institution, and the subsidy is increasing in value with the debt to equity ratio. So institutions with a guarantee have an incentive to hold excessive debt.

The guarantee makes the institution's debt default free. The value of the default free debt is,

$$D^{df} = n\sum p(s)$$

And as Merton (1977) shows the value of the firm's risky debt with a government guarantee equals the value firm's risky debt plus a put option with a strike price of the firm's promised debt payment, *n*,

$$\begin{aligned} D^{df} &= D(x(s), n) + Put(x(s), n) \\ &= \sum p(s)\left[\min(\mathrm{x(s)}, \mathrm{n}) + \max(\mathrm{n} - \mathrm{x(s)}, 0)\right] \end{aligned}$$

The guarantee violates the M-M perfect markets assumption. The equity value plus the value of the guaranteed debt of the financial institution is greater than the value of the firm,

$$V = E + D \le E + D + Put(x(s), n)$$

The debt guarantee is a subsidy to the institution. Merton proposed that the fairly priced deposit insurance premium equal the value of the put option, i.e., the value of the subsidy.

The value of the *Put*,

$$Put(n, x(s)) = \sum p(s)\max(\mathrm{n} - \mathrm{x(s)}, 0)$$

Is increasing in the promised debt payment, *n*, (the institution's debt).

An appropriate regulatory capital ratio reduces debt and the risk—which is the point. It also reduces the value of the subsidy.

Appendix II

Bank Holding Company data reported to Federal Reserve

Y9C Data

Source FRB.CH https://www.chicagofed.org/banking/financial-institution-reports/index

Date	Bank	Tier1 Capital	Risk Weighted Assets	Total Average Assets	Tier1 Risk-Based Capital Ratio	Tier1 Leverage Ratio
20070930	JPMorgan	$86,096	$1,028,551	$1,423,171	8.37%	6.05%
20071231	JPMorgan	$88,746	$1,051,879	$1,473,541	8.44%	6.02%
20080331	JPMorgan	$89,646	$1,075,697	$1,507,724	8.33%	5.95%
20080630	JPMorgan	$98,775	$1,218,431	$1,611,762	9.15%	6.43%
20080930	JPMorgan	$111,630	$1,377,060	$1,707,112	8.85%	7.18%
20081231	JPMorgan	$136,104	$1,337,480	$2,088,347	10.94%	6.92%
20090331	JPMorgan	$137,144	$1,277,106	$2,014,275	11.36%	7.13%
20090630	JPMorgan	$122,174	$1,260,237	$1,969,339	9.69%	6.20%
20090930	JPMorgan	$126,541	$1,237,760	$1,940,689	10.22%	6.52%
20070928	CitiGroup Inc	$92,370	$2,234,744	$1,261,790	7.32%	4.13%
20071231	CitiGroup Inc	$89,226	$2,216,505	$1,253,321	7.12%	4.03%
20080331	CitiGroup Inc	$99,088	$2,226,675	$1,285,580	7.71%	4.45%
20080630	CitiGroup Inc	$106,915	$2,119,295	$1,223,313	8.74%	5.04%
20080930	CitiGroup Inc	$137,362	$2,049,008	$1,175,706	11.68%	6.70%
20081231	CitiGroup Inc	$118,758	$1,954,846	$996,247	11.92%	6.08%
20090331	CitiGroup Inc	$121,925	$1,848,635	$1,023,038	11.92%	6.60%
20090630	CitiGroup Inc	$126,778	$1,836,432	$995,414	12.74%	6.90%
20090930	CitiGroup Inc	$126,285	$1,842,336	$989,711	12.76%	6.85%

					Tier1 Capital/ Risk-Weighted Assets	Tier1 Captial/ Tot Avg Assets

Publicly available Market Capitalization and Market Asset Data

Market Capitalization = Share Price*number shares/1000 (to match scale of COMPUSTAT data)

Source	CRSP	permno
	CitiGroup	70519
	JPMorgan	47896

Book Value of Debt = Book Value of Total Assets (AQT) - Book Value Common/Ordinary Equity (CEQQ)

Source	CompuStat	gvkey
	CitiGroup	3243
	JPMorgan	2968

"Market" Value of Assets = Market Capitalization + Book Value of Debt

Date	BANK	Market Cap	Book Eqiity	Book Assets	Book Debt	"Mkt" Assets	Mkt Cap Ratio
20070928	JPMORGAN CHASE & CO	155,050	119,978	1,479,575	1,359,597	1,514,647	10.24%
20071231	JPMORGAN CHASE & CO	146,622	123,221	1,562,147	1,438,926	1,585,548	9.25%
20080331	JPMORGAN CHASE & CO	145,881	125,627	1,642,862	1,517,235	1,663,116	8.77%
20080630	JPMORGAN CHASE & CO	117,568	127,176	1,775,670	1,648,494	1,766,062	6.66%
20080930	JPMORGAN CHASE & CO	182,345	137,691	2,251,469	2,113,778	2,296,123	7.94%
20081231	JPMORGAN CHASE & CO	117,681	134,945	2,175,052	2,040,107	2,157,788	5.45%
20090331	JPMORGAN CHASE & CO	99,886	138,201	2,079,188	1,940,987	2,040,873	4.89%
20090630	JPMORGAN CHASE & CO	133,063	146,614	2,026,642	1,880,028	2,013,091	6.61%
20090930	JPMORGAN CHASE & CO	172,325	154,101	2,041,009	1,886,908	2,059,233	8.37%

Date	Bank	Market Cap	Book Equity	Book Assets	Book Debt	"Mkt" Assets	Mkt Cap Ratio
20070928	CITIGROUP INC	232,162	126,913	2,358,266	2,231,353	2,463,515	9.42%
20071231	CITIGROUP INC	146,645	113,598	2,187,631	2,074,033	2,220,678	6.60%
20080331	CITIGROUP INC	112,350	108,835	2,199,848	2,091,013	2,203,363	5.10%
20080630	CITIGROUP INC	85,241	108,981	2,100,385	1,991,404	2,076,645	4.10%
20080930	CITIGROUP INC	111,685	98,638	2,050,131	1,951,493	2,063,178	5.41%
20081231	CITIGROUP INC	36,566	70,966	1,938,470	1,867,504	1,904,070	1.92%
20090331	CITIGROUP INC	13,948	69,688	1,822,578	1,752,890	1,766,838	0.79%
20090630	CITIGROUP INC	16,315	78,001	1,848,533	1,770,532	1,786,847	0.91%
20090930	CITIGROUP INC	110,741	140,530	1,888,599	1,748,069	1,858,810	5.96%