Online Appendix

Do Strict Capital Requirements Raise the Cost of Capital? Bank Regulation, Capital Structure, and the Low Risk Anomaly[1]

Malcolm Baker
Harvard Business School and NBER

Jeffrey Wurgler
NYU Stern School of Business and NBER

January 28, 2015

Abstract

Traditional capital structure theory in frictionless and efficient markets predicts that reducing banks' leverage reduces the risk and cost of equity but does not change the overall weighted average cost of capital, and thus the rates for borrowers. We test these two predictions. We confirm that the equity of better-capitalized banks has lower beta and idiosyncratic risk. However, over the last 40 years, lower risk banks have higher stock returns on a risk-adjusted or even a raw basis, consistent with a stock market anomaly previously documented in other samples. The size of the low risk anomaly within banks suggests that the cost of capital effects of capital requirements is large enough to be relevant to policy discussions. A calibration assuming competitive lending markets suggests that a binding ten percentage-point increase in Tier 1 capital to risk-weighted assets more than doubles banks' average risk premium over Treasury yields, from 40 to between 100 and 130 basis points per year, and presumably raises rates for borrowers to a similar extent. A broader implication is that the low risk anomaly is a powerful motive for firms with low risk assets, like many financial firms, to lever, and also an integrated theory that helps explain the low leverage puzzle among non-financial firms, especially those with high asset risk.

---

[1] For helpful comments we thank Yakov Amihud, Jon Bernstein, Robin Greenwood, Alec Guzov, Victoria Ivashina, Randall Kroszner, Luc Leaven, Dave Lesmond, Thomas McGuire, Hamid Mehran, Antony Saunders, David Scharfstein, Amit Seru, Adi Sunderam, Jeremy Stein, Robert Turley, Sir John Vickers, seminar participants at Harvard Business School, HEC Montreal, NYU Stern School of Business, Tulane University, University of Michigan, University of Notre Dame, Yale University, the NBER, the Jackson Hole Finance Group, University of Chicago, Vienna University, and especially Sam Hanson. We thank Alex Guzov and Robert Turley for excellent research assistance. Baker and Wurgler also serve as consultants to Acadian Asset Management. Baker gratefully acknowledges financial support from the Division of Research of the Harvard Business School.

I. Introduction

The instability of banks in the financial crisis has reignited debates about capital requirements. The issue is multidimensional, involving agency problems in banks, asymmetric information, international coordination and arbitrage, bank governance, tax benefits of debt, government subsidies, systemic risks and externalities beyond the financial sector, shadow banking, political pressures and regulatory capture, private versus social costs, and so on. But one of the ongoing concerns has been that capital requirements might affect banks' overall cost of capital, and therefore lending rates and economic activity.[2]

Many bankers appear to prefer lower capital requirements. They argue that because equity is more expensive than debt, more of it clearly raises the overall cost of capital. For example, according to a former managing director of JP Morgan turned policy analyst, "the first-order effect of increasing the ratio of common equity to total assets for banks from 5% to 30% would clearly be very high. Assume that the annual cost of bank equity is 5 percentage points higher than the after-tax cost of bank deposits and debt…" (Elliott (2013)). The CEO of Deutsche Bank states that heightened capital requirements "would restrict [banks'] ability to provide loans to the rest of the economy. This reduces growth and has negative effects for all" (Admati and Hellwig (2013), p. 5).

Economists, on the other hand, often view this argument as a fallacy. The textbook Modigliani-Miller logic is articulated by, for example, Admati, DeMarzo, Hellwig, and Pfleiderer (2011): "[B]ecause the increase in capital provides downside protection that reduces shareholders' risk, *shareholders will require a lower expected return to invest in a better*

[2] See Cummins, Hassett, and Hubbard (1994), Philippon (2009), Gilchrist and Zakrajsek (2012) and citations therein for evidence on the effect of costs of capital on business investment. Broader studies of the real effects of bank capital requirements include Van den Heuvel (2008), Macroeconomic Assessment Group of the Basel Committee on Banking Supervision (2010), Basel Committee on Banking Supervision (2010), Elliott (2009, 2010), and Santos and Elliott (2012).

capitalized bank" (p. 16, italics in original). In an efficient and integrated capital market—absent taxes and other distortions—the reduced cost of equity offsets its increased weight in the capital structure and leaves the overall cost of capital unchanged. Admati and Hellwig (2013) maintain that the considerable social benefits of capital requirements suggest raising the minimum equity to assets ratio to between 20% and 30% from its current single digits.

Real capital markets contain frictions and inefficiencies that challenge the Modigliani-Miller assumptions, however, so the relevance of the frictionless-irrelevance argument is not so clear. Many of these frictions have been studied, but there has been surprisingly little direct evidence on the basic proposition that reduced leverage reduces the cost of equity. In this paper, we study empirically how leverage has related to the risk and cost of bank equity and, in turn, to the overall cost of capital.

We are especially motivated by the possible interaction of capital requirements and the "low risk anomaly" within the stock market. That is, while stocks have on average earned higher returns than less risky asset classes like corporate bonds, which in turn have earned more than Treasury bonds, recent research emphasizes that the basic risk-return relationship *within* the stock market has historically been flat, if not inverted. Haugen and Heins (1975), Fama and French (1992), Baker, Bradley, and Wurgler (2011), and Baker, Bradley, and Taliaferro (2013) find a flat or negative relationship between a stock's systematic risk, as measured by its stock market beta, and its subsequent returns. Ang, Hodrick, Ying, and Zhang (2006, 2009) find a negative relationship between idiosyncratic risk and returns in the U.S. and many international stock markets. We review the growing literature on how a combination of behavioral investing patterns and limits on arbitrage might drive these patterns.

These patterns are interesting both for investment and for corporate and bank capital structure. Leverage makes equity riskier. Higher risk equity has an apparently lower risk-adjusted cost of capital. The implications for optimal capital structure, however, are a bit more subtle than the tax deductibility of interest, which taken by itself leads all firms to maximal leverage. To see the implications, suppose that debt is fairly valued, or at least not subject to the same exact low risk anomaly as equities are. Then, firms with low asset risk – a characteristic of simple banks who take deposits and make secured loans – have a much greater incentive to issue debt to increase the risk of their equity. They are replacing undervalued equity with fairly valued debt. Meanwhile, non-financial firms will end up with lower leverage ratios. Even though these firms – with much higher asset risk – can further increase the risk of equity with leverage, they are replacing overvalued equity with fairly value debt in the process. We show that this leads non-financial firms, in contrast to banks, to much lower levels of optimal leverage.

Studies suggest that there is a low risk anomaly on average within the stock market. The relevant question for bank capital requirements is whether this holds within banks specifically. Does the cost of equity fall with equity as Modigliani-Miller predicts? Or does it not fall by enough, or actually increase, as bankers and the low risk anomaly imply? Indeed, the low risk anomaly might not be present in banks at all. Relative to nonfinancial firms, their financial structure and risks are tracked in far greater detail by regulators and investors.

We use a large sample of historical U.S. data and proceed to test the two steps in the traditional argument. First, we relate bank equity betas estimated from CRSP to leverage ratios from quarterly reports. Second, we relate realized returns on equity to bank equity betas. We also replace beta with idiosyncratic risk. The two steps together then allow us to calibrate the effect of increased capital requirements on the cost of equity and, under certain assumptions, the overall cost of capital. We reach similar conclusions when we relate capital to returns directly over the sample with good data on risk-adjusted capital ratios.

We confirm that bank equity risk is sharply increasing in leverage. This is not surprising, and our work here extends that of Kashyap, Stein, and Hanson (2010). When capital is measured by the Tier 1 capital to risk-weighted assets ratio, the portfolio beta of the least-capitalized banks is 0.93 while the portfolio beta of the most-capitalized banks is 0.50. Higher capital ratios also predict lower idiosyncratic risk. Even this relatively large difference in beta is attenuated by two factors. Banks with riskier assets may choose to have larger capital cushions. This endogenous selection reduces the slope between beta and observed capital ratios. Indeed, within the largest banks, where the asset mix also includes investment banking, asset management, and other operations, the difference is smaller and less robust. Also, to the extent that debt is risky, some of the asset risk is borne by debt and not equity for the most leveraged banks. This type of risk sharing between debt and equity also flattens the empirical relationship. Yet it remains so strong that it is safe to conclude that leverage increases the risk of equity—which, of course, is theoretically required.

Does a reduction in beta translate to a reduction in the cost of equity? The answer from 40 years of U.S. stock returns is no. The low risk anomaly is actually a bit stronger within banks than other firms. High-beta banks returned less than low-beta banks, even on a raw basis, and even in a period of mostly rising equity markets. Value-weighted returns are, on average, 16 basis points per month higher for a portfolio of the lowest three beta deciles than for a portfolio of the highest three beta deciles. The spread between low and high idiosyncratic risk portfolios is 6 basis points per month. These effects are not mediated by capitalization. Controlling for a size factor increases the risk-adjusted differences, especially for idiosyncratic risk portfolios. More simply, beta is positively correlated with capitalization while idiosyncratic risk is negatively correlated, yet both risk types are negatively related to average returns.

We focus on the last 40 years of data because earlier stock returns data include only a small number of banks, rendering portfolio returns much less diversified and conclusions more tenuous. Nonetheless, results using the last 80 years of data are at least as strong. The empirical conclusion is that high-risk U.S. banks, like high-risk nonfinancial firms in the U.S. and other developed markets, have delivered equal or lower returns to shareholders than low-risk banks.

The last requirement for the low risk anomaly to affect the overall cost of capital concerns debt and equity market integration. If debt markets exhibit the same anomaly to the same degree, then capital structure remains irrelevant. Our own back-of-the-envelope calculations, as well as prior work, indicate that this is not the case. The low-risk anomaly is strongest in the stock market, and importantly the risk in equities – when transferred into the debt market – do not appear to be priced in the same way. If it were, high-risk debt would produce returns similar to low risk equity.

Putting the pieces together, the data suggest that more conservative capital structures reduce the risk of equity but may increase its cost, and the overall cost of capital, by bringing the low risk anomaly into play. To assess magnitudes, we focus on the beta anomaly and estimate how the overall cost of capital for a bank would have changed over this period given the hypothetical ten percentage-point increase in Tier 1 capital to risk-weighted assets experiment in Kashyap et al. (2010). A benchmark estimate of the pretax weighted average cost of capital for a typical bank implied by the Capital Asset Pricing Model over our sample period is 40 basis points per year above the risk-free rate. By reducing equity betas, banks with a full ten percentage point increase in Tier 1 capital would have added between 60 and 90 basis points to this spread, which would more than double the weighted average cost of capital over the risk-free rate to between 100 and 130 basis points. In a competitive lending market this would have translated to a similar increase in rates faced by borrowers. We examine the sensitivity of this calibration to assumptions about risky debt, the extent of a low risk anomaly in debt markets, and government insurance of bank debt. We find that the baseline calibration with riskless debt remains a reasonable estimate in the presence of such factors.

To summarize, our evidence suggests that the low risk anomaly may cause the cost of capital for banks to increase with capital requirements. It is separate from and presumably additive to other (private) costs of capital effects such as the lost tax benefits of debt (Kashyap et al. (2010)), reduced government subsidies, or foregone deposits made “cheap” as a result of their liquidity services (Allen and Carletti (2013), DeAngelo and Stulz (2013)). In the end, when all social and private benefits and costs are tallied, significantly increased capital requirements may well be desirable; our evidence suggests that one effect on the cost of capital, however, has been neglected and should be added to the debate.

Section II gives some background on the low risk anomaly and its implications for corporate capital structure. Section III describes stock returns and capital adequacy data. Section IV studies the connections between beta, capital levels, and costs of equity. Section V summarizes regulatory epochs and performs a calibration exercise. Section VI concludes with some tentative policy suggestions.

II. The Low Risk Anomaly in the Stock Market and Corporate Capital Structure

A. The Low Risk Anomaly in the Stock Market

Over the long run, riskier asset *classes* have earned higher returns in U.S. markets. From 1926 to 2012, small capitalization stocks provided higher but more variable returns than large capitalization stocks, which in turn were riskier and returned more than long-term corporate bonds, and so on down the list of increasingly safer asset classes of long-term Treasury bonds, intermediate-term Treasury bonds, and Treasury bills (Ibbotson Associates (2012)).

The historical risk-return tradeoff *within* the stock market is flat or inverted, however. The standard Capital Asset Pricing Model (CAPM) predicts that the expected return on a security is proportional to its systematic risk (beta). Investors are assumed to diversify away idiosyncratic risk so it does not affect their required returns. The “low risk anomaly” is the empirical pattern that stocks with higher beta, or higher idiosyncratic risk, have tended to earn lower returns.

To a greater or lesser extent, this failure of the traditional risk-return tradeoff appears within stock markets around the world and across different sample periods. Black (1972), Black, Jensen, and Scholes (1972), Haugen and Heins (1975), and Fama and French (1992) all noted the relatively flat relationship between expected returns and beta risk. More recently, Ang, Hodrick, Ying, and Zhang (2006, 2009) have emphasized the magnitude and robustness of the anomaly. Ang et al. (2009) find that stocks with higher idiosyncratic risk earn statistically significantly lower returns in each of the G7 countries and across 23 developed markets. Blitz and van Vliet (2007) and Baker, Bradley, and Taliaferro (2013) confirm the presence of the low risk anomaly within developed markets and Blitz, Pang, and van Vliet (2012) extend this to emerging markets. These patterns challenge not just the CAPM but any framework where risk and expected return are positively related.

The magnitude of the risk-return inversion is substantial. For example, Baker, Bradley, and Taliaferro (2013) find that a dollar invested in a low quintile beta portfolio of U.S. stocks in early 1968 grows to $70.50 by the end of 2011, a while dollar invested in a high beta portfolio grows to only $7.61. In a sample of up to 30 developed equity markets over a shorter period beginning in 1989, the comparable figures are $6.40 and $0.99. It is remarkable that a value-weighted portfolio of high-risk quintile stocks held for four decades did not earn a positive return even in nominal terms.

For our purposes, the precise origin of the low risk anomaly is not critical. What matters is whether it exists among banks and, if so, is likely to persist. Several explanations for the low risk anomaly have been put forth. A variety of evidence suggests that some individual investors have an irrational preference for volatile or skewed investments, due to overconfidence, as in Cornell (2008), or lottery preferences, as in Kumar (2009), Bali, Cakici, and Whitelaw (2011) and the cumulative prospect theory of Tversky and Kahneman (1992) as modeled by Barberis and Huang (2008). Leverage-constrained investors who pursue a strategy of seeking high returns from beta risk must invest in high-beta stocks directly, leading them to be overpriced relative to a leveraged position in low-beta stocks (Black (1972) and Frazzini and Pedersen (2013)).

One question is why more sophisticated investors do not take advantage of the anomaly. Institutional fund managers may prefer high-beta assets themselves because the inflows to performing well are greater than the outflows to performing poorly (Karceski (2002)). Another reason for a high-beta preference is when managers are rewarded for beating the market, which presumably has a positive risk premium, on a non-beta-adjusted basis (Brennan (1993) and Baker et al. (2011)). More generally, short-selling constraints inhibit sophisticated investors' ability to exploit the overpricing of high-beta stocks (Hong and Sraer (2012)).

Given that overconfidence and lottery preferences are intrinsic human attributes; that leverage and short-sale constraints are enduring features of the trading environment; that institutional investors and their incentives are becoming only more important over time; and that the low risk anomaly apparent within all-industry samples appears in long U.S. and international samples—it is reasonable to entertain the possibility that any low risk anomaly present within banks will persist.

A. The Low Risk Anomaly and Corporate Capital Structure

The low risk anomaly has parallel implications for investors and CFOs, if debt and equity markets are segmented in terms of the pricing of risk. Low risk stocks, at least with the benefit of hindsight, have been priced relatively cheaply, so their equity capital has been expensive. High risk stocks, by contrast, have been expensive, and the cost of equity for these firms has been comparatively low. If debt and equity markets were perfectly integrated, these differences in the cost of equity would have a meaningful impact on investment but not corporate capital structure. This is a simple repetition of the Modigliani and Miller theorem of capital structure irrelevance, which depends only on market integration not a rational tradeoff between risk and return. The cost of capital would vary somewhat pathologically with the risk of assets, but in a way that corporate managers could not control with financial structure.

If instead debt and equity markets are segmented, then the low risk anomaly in equity markets has interesting implications for capital structure that can reconcile the high leverage of financial institutions, whose asset risk is quite low as we show below, with the low leverage of some non-financial firms, whose asset risk is high.[3] This is easiest to illustrate with a few simplifying assumptions. We assume sufficient conditions for the CAPM to hold in rational

[3] The gap between the leverage of financial and non-financial firms is not entirely a puzzle. The high leverage of banks is consistent with their typically low risk assets (Gornall and Strebulaev (2014)) and so, at least directionally, standard tradeoff theory. Indeed, Gropp and Heider (2010) find that most cross-sectional determinants of capital structure have similar effects on banks and nonbanks. Furthermore, they find no evidence to support the popular suggestion that deposit insurance encourages additional leverage.

markets. Debt securities indexed below with a j are correctly priced by the CAPM, regardless of risk. There is a low risk anomaly, or mispricing, only in equity securities indexed below with an i. The low risk anomaly is the only friction that makes capital structure relevant. There are no taxes, transaction costs, issuance costs, incentive or information effects of capital structure, and no costs of financial distress or bankruptcy. The extent of the low risk anomaly within equity markets is measured by $\gamma < 0$.

$$r_i = (\beta_i - 1)\gamma + r_f + \beta_i r_p \text{ and } r_j = r_f + \beta_j r_p. \tag{1}$$

When $\gamma < 0$, the cost of equity for firms with betas greater than the market are lower than a rational CAPM benchmark. When $\gamma = -r_p$, the cost of equity is constant regardless of risk. This turns out not to be far from the empirical reality in the history of stock returns in the U.S. and in international markets.

Because all of the other Modigliani and Miller assumptions that guarantee capital structure irrelevance hold, a γ of zero means that the overall cost of capital depends only on the firm's asset beta. When there is a low risk anomaly, by contrast the weighted average cost of capital depends on leverage in the following way:

$$WACC = er_e + (1-e)r_d = r_f + \beta_a r_p + \beta_a \gamma - \gamma\left[e + (1-e)\beta_d(e, \beta_a)\right], \tag{2}$$

where e is the ratio of equity to total assets and debt beta, without any further loss of generality, is a function of leverage and the underlying asset risk. The second to last term (the asset beta times γ) is the uncontrollable reduction (increase) in the cost of capital that comes from having high-risk (low-risk) assets. The last term is the controllable cost of having too little leverage that arises only when equities contain a non-zero low risk anomaly.

The optimal capital structure minimizes this last term, by satisfying the first order condition for *e*. With the extra assumption of a differentiable debt beta, the optimal capital ratio *e** satisfies:

$$-\gamma\left[1-\beta_d\left(e^*,\beta_a\right)+\left[1-e^*\right]\beta_d'\left(e^*,\beta_a\right)\right]=0 \text{ or } \beta_d^*\left(\beta_a\right)=1+\left[1-e^*\left(\beta_a\right)\right]\frac{\partial\beta_d^*\left(e^*\left(\beta_a\right),\beta_a\right)}{\partial e}. \quad (3)$$

As is immediately apparent, the actual size of the low risk anomaly does not matter. This is somewhat of a technicality, though. If there were other unrelated frictions associated with leverage, like taxes or the costs of financial distress, then both the existence and size of the low risk anomaly would be relevant.

Observation 1: A firm will issue as much risk-free debt as possible and a bit more. This is another simple observation. As long as the debt beta is zero, the first order condition cannot be satisfied. At a zero debt beta, the left side of Equation (3) is positive. In other words, issuing more equity at the margin will raise the cost of capital. At first blush, this would seem to deepen the low leverage puzzle.[4] One might ask why nonfinancial firms do not increase their leverage ratios further to take advantage of the low risk anomaly: It is initially unclear how the low leverage ratios of nonfinancial firms represent an optimal tradeoff between the tax benefits of interest and the costs of financial distress, much less an extra benefit of debt arising from the mispricing of low risk stocks.

The answer contained in Equation (3) is that many low leverage firms—e.g. the stereotypical unprofitable technology firm—start with a high asset beta or overall asset risk, so their assets are already quite risky at zero debt. Even at modest levels of debt, meaningful amounts of risk are transferred from equity to debt.

[4] See Graham (2000) on the low leverage puzzle.

The problem of minimizing the cost of capital will generally have an interior optimum, which can be verified by testing the second order condition. The first derivative of the debt beta with respect to capital *e* is negative. While there is no tidy, general formula for the debt beta, any reasonable model features a debt beta that is increasing in leverage. The second derivative of the debt beta with respect to capital is also positive, and the intuition is not much more subtle. The marginal reduction in the debt beta per unit increase in *e* is falling as *e* rises. In other words, the debt beta is convex in *e*. This must also be true with some generality, because the debt beta cannot fall below zero. A negative first derivative and a positive second derivative makes the second order condition positive and any solution to Equation (3) is a minimum.

We can then sign the change in optimal leverage as a function of the underlying asset beta, taking the derivative of *e** with respect to the asset beta.

$$\frac{de^*}{d\beta_a} = -\left[-2\frac{\partial\beta_d(e^*,\beta_a)}{\partial e} + (1-e^*)\frac{\partial^2\beta_d(e^*,\beta_a)}{\partial e^2}\right]^{-1}\left[-\frac{\partial\beta_d(e^*,\beta_a)}{\partial\beta_a} + (1-e^*)\frac{\partial^2\beta_d(e^*,\beta_a)}{\partial e\partial\beta_a}\right] \quad (4)$$

While this expression appears complicated, it is not too difficult to sign. The first term in braces is simply the second order condition, which we know is positive, with the logic above. The second term in braces is in general negative. All else equal, debt betas are increasing in asset betas, so the first term is negative. For the second term also to be negative, the sensitivity of the debt beta to the asset beta must fall as capital rises. As the firm gets better capitalized, the asset risk no longer matters as much. We know that at the limit, asset risk does not matter at all, so this also seems general. A negative times a negative times a positive is a positive. This means that optimal capital is increasing in asset betas. High asset beta firms carry less debt, when subjected to a low risk anomaly, than do low asset beta firms, restated as Observation 2.

Observation 2: The optimal leverage ratio is decreasing in asset beta. There is a simple intuition. Risk is overvalued in equity securities and fairly valued in debt securities. Ideally, to minimize the cost of capital, risk is concentrated in equity. This leads to the first result that firms will issue as much risk-free debt as possible. This lowers the cost of equity by increasing its risk without any inefficient transfer of risk from equity to debt. However, once debt becomes risky, further increases in leverage have a cost. Shifting overvalued risk in equity securities to fairly valued risk in debt increases the cost of capital. For firms with high-risk assets, this cost is high even at low levels of leverage. For firms with very low risk assets, this cost remains low until leverage is high.

Observation 3: The optimal leverage ratio can be reframed as a target level of debt risk. The first order condition in Equation (3) can be rearranged as the choice of a debt beta, consistent with the notion that firms target debt ratings, not leverage ratios per se. As already noted, the derivative of the debt beta is negative, making the optimal debt beta less than one, regardless of asset risk. If the first dollar of debt were to have a beta greater than or equal to one, then a firm would choose zero debt, or possibly hold excess cash, to lower its asset risk and its marginal debt beta. More generally, the target debt beta depends on asset risk:

$$\frac{d\beta_d^*}{d\beta_a} = -\frac{\partial e*(\beta_a)}{\partial \beta_a}\frac{\partial \beta_d^*(e*(\beta_a),\beta_a)}{\partial e} +$$

$$\left[-e*(\beta_a)\left(\frac{\partial^2 \beta_d^*(e*(\beta_a),\beta_a)}{\partial e^2}\frac{\partial e*(\beta_a)}{\partial \beta_a} + \frac{\partial^2 \beta_d^*(e*(\beta_a),\beta_a)}{\partial e \partial \beta_a}\right)\right]. \quad (5)$$

Riskier firms target somewhat lower credit ratings. The first term is positive, because equity capital *e** is increasing in asset risk and debt betas are decreasing in capital. The second term is also weakly positive, because the second derivative and the cross partial derivative are both negative as discussed above and equity capital cannot go below zero. Negative debt is possible, but not negative equity. Taking only the low risk anomaly into account, riskier firms will target lower credit ratings, but this is attenuated by a more conservative leverage choice.

To go further than these three directional results, we need to specify the debt beta as a function of asset risk and leverage. A leading candidate for the functional form of debt betas is the Merton (1974) model. This does not give us a very tractable formula to differentiate, but it is easy to solve numerically. To keep things simple, we use the Black and Scholes (1973) assumptions and a single liquidation date, five years forward, with a contractual allocation of value between debt and equity and no costs of financial distress. For each level of leverage, we compute the value of debt, the value of equity, and the equity beta using the Merton model. The value of equity is then modified using the low risk anomaly in Equation (1). An equity beta less than one lowers value. An equity beta greater than one raises value.

Using this procedure, Figure 1 shows firm value as a function of leverage for a variety of asset risk levels. Because the only effects here are through the weighted average cost of capital, with no cash flow effects, a firm value maximum is equivalent to a weighted average cost of capital minimum. Panel A shows raw value levels and Panel B shows value levels relative to the maximum for each asset risk. This second figure removes the level effect of asset risk. Under a low risk anomaly, high asset risk means higher valuations, at any level of leverage, which is apparent in Panel A.

These figures illustrate the effects of a low risk anomaly on capital structure choice. Firms that start with a high asset beta have only modest incentives to issue debt. A small exogenous cost of accessing the debt markets might lead them to zero debt. By contrast, firms that start with a low asset beta have a very strong incentive to issue debt. These sorts of firms make good targets for leveraged buyouts if they have low leverage. Regulating these firms – in the sense of requiring them to de-lever significantly – imposes large losses in private value, if there is a low risk anomaly in equities. As we will show below, banks meet these criteria, in the sense of having very low asset risk, and we use this fact along with an estimate of γ to calibrate the cost of capital effects of regulation.

III. Data

We require data on stock returns, risk, and bank capital structure.

A. Banks, Betas, and Returns

Estimating the relationship between expected equity returns—alternatively, the required return on equity or the cost of equity—and beta requires both a long time series of returns and a large number of banks to provide breadth in beta. Our main sample for the returns analysis includes almost 4,000 publicly traded banks or bank holding companies that make an appearance in over 40 years of returns data.

We gather bank stock prices and returns data from January 1931 through December 2011 from the Center for Research in Securities Prices (CRSP) database. We focus our attention on the second half of the sample, the most recent 40.5 years starting in July 1971. We save the full sample as a robustness check, because there are relatively few publicly traded banks in the early CRSP years, rendering the beta portfolios undiversified and highly volatile.[5] We identify banks using the set of four-digit SIC codes suggested in Fama and French (1997) plus the three-digit

[5] After July 1971, there are at least 70 firms in the sample. Prior to July 1971, there are between five and 69 banks, with an overall average of 22.

SIC code corresponding to bank holding companies.[6] The primary sample includes bank-months for which we can compute a valid beta, with at least 24 monthly holding period return (CRSP: RET) observations, a valid market capitalization, with a nonmissing price (PRC) and shares outstanding (SHROUT) observation, and at least one holding period return following a valid beta. Due to the return requirements, the bank-months we follow run from February 1970 through December 2011.

The main sample of banks is broken down by decade and SIC in Table 1. Holding companies are the most numerous group, followed by savings institutions, commercial banks, state banks in the Federal Reserve System, national commercial banks, S&Ls, and national banks in the Federal Reserve System. A total of 3,952 banks appear at some point in our CRSP sample.

Summary statistics for this sample are in Table 2. The bank-month observations are divided by pre-ranking risk measures. Pre-ranking beta is computed for each bank-month by regressing a minimum of 24 months and a maximum of 60 months of trailing holding period returns in excess of the riskless rate on the corresponding CRSP U.S. value-weighted market holding period returns (CRSP: VWRETD, also in excess of the riskless rate, and provided by Ken French). We also take the root mean squared error from these regressions as our measure of idiosyncratic risk. This pre-ranking beta is what we will use to rank banks when tracking subsequent returns. We will consider forward (realized) betas and idiosyncratic risk as well when correlating beta and capital ratios.

It is worth noting at the outset that bank betas on an equal weighted basis are relatively low. The overall median is only 0.67. There is also ample spread on pre-ranking equity beta among our bank sample. The mean pre-ranking beta among the bottom three deciles is 0.18 and

[6] We exclude a small number of firms included in Fama and French's definition of banks: those with SIC classifications as Federal Reserve Banks, Foreign Banks, Functions Related to Deposit Banking, Nondepository Credit Institutions, Federal Credit Agencies, or FNMA. Including these firms has no effect on our results.

the mean among the top three deciles is 1.37. More importantly, we will see that this pre-ranking spread leads to differences in realized portfolio betas of approximately 0.6. Another important pattern from Table 2 is the correlations between risk measures and capitalization. Beta is higher for large banks, while idiosyncratic risk is lower. As we shall also see, the risk measures imply similar conclusions for leverage and returns, suggesting that the results are not being mediated by capitalization.

In total, this broad sample contains up to 272,031 bank-months for our beta and returns analysis. We also use three control variables common in the analysis of the cross-section of stock returns; e.g. Fama and French (1992) and Jegadeesh and Titman (1993). As suggested above, higher-beta banks tend to be larger market capitalization. This is the opposite of the negative correlation between beta and market capitalization among nonfinancial firms. Bank holding companies may have units such as investment banking where profits are more correlated with the overall stock market. Also, smaller firms, with less geographic and product diversification, may choose less risky operations with endogenously higher capital. To the extent that the endogenous link is through idiosyncratic risks, not beta, this is a useful form of identification for us.

We also compute book-to-market equity ratios. Book equity data are available for a subset of stocks from Compustat, sourced from Moody's. We follow the definition of book equity from Ken French's data library. Within each beta group there is skewness in book-to-market; it will come as no surprise that some banks have seen the market value of their assets deteriorate faster than they were marked down. The median ratio across beta groups is an identical 0.76. Another control variable is return momentum, defined as usual as the total stock return over the prior twelve months excluding the most recent one.

Figure 2 shows the time series of the average betas in each quantile. In an average year there is a spread of around 1.0 between the average beta in the top three deciles and the bottom three deciles. The average CRSP market return over the riskless rate is 6% and the standard deviation is 18% over our sample period, suggesting meaningful dispersion in CAPM-based expected equity returns and very wide dispersion in market-driven realized returns. There is a jump in the number of smaller banks in 1973, when Nasdaq-listed firms first appear in the CRSP database. This influx of typically lower-beta banks brings down average betas significantly in the early years, to a range and spread that has remained fairly stable since the mid-1970s.

B. *Bank Capital*

We are able to gather capitalization data for a subset of the CRSP sample from the quarterly call reports data in the WRDS Bank Regulatory database. We use the CRSP PERMCO to bank RSSID ID link table available from March 1996 through December 2010 that is provided by WRDS; we start at 1996 with the introduction of granular capital data. In cases of multiple RSSIDs per PERMCO, we aggregate RCFD data items across RSSIDs. An alternative approach that yields similar results (unreported) is to use the quarterly Compustat data items on capital adequacy for banks. Our overall coverage is slightly better using the aggregation of call reports. Finally, we merge CRSP PERMCOs to PERMNOs.

We consider five common capital ratios to determine which measure of equity best lines up with equity beta. The ratio of total equity capital (RCFD3210) divided by average total assets (RCFD3368) is the simple shareholder equity ratio. Tier 1 capital (RCFD8274, which is first available in March 1996) to average total assets is called the leverage ratio. Total risk-based capital (RCFD3792) to assets puts the sum of Tier 1 and Tier 2 capital in the numerator. Tier 1 capital to total risk-weighted assets (RCFDa223) is the critical Tier 1 capital ratio. Total risk-based capital to total risk-weighted assets is called the total capital ratio. Scaling by risk-weighted assets helps to address the possibility that asset beta may differ across our sample.

We distribute these quarterly capital data across relevant months to yield an intersection of 74,105 bank-months with the basic returns data set. Table 3, Panel A, shows the distribution of these measures of bank capital. The sample is divided each month into ten deciles of capital adequacy. We report the median and market-capitalization weighted mean ratio within each decile. In this somewhat heterogeneous sample of banking institutions, the average capital ratios in the highest decile are typically around twice those of the lowest decile. The highest spread appears in the ratio Tier 1 capital to risk-weighted assets, which over this period was widely regarded as the most important measure of capital by market participants. See the Appendix for capital structure data on the largest bank holding companies as of the end of 2011.

IV. Analysis

We wish to study whether the combination of an exogenous increase in capital requirements and the low risk anomaly would increase the overall cost of capital for banks. The first step is to ask whether heightened capital requirements would reduce equity risk for banks. The second is to ask whether the low risk anomaly holds within banks. In general, we focus on beta risk, where the Modigliani-Miller logic best applies, but also explore idiosyncratic risk.

A. Predictions: Capital Adequacy, Beta, and Returns

In efficient capital markets, higher capital ratios will be associated with lower equity betas and lower equity returns, all else equal. Capital structure is endogenous, however, so we cannot use the cross-sectional relationship between capital ratios and beta to measure the causal effect of an increase in capital requirements. These effects tend to attenuate the relationship between capital ratios and equity beta. So, if there is a meaningful difference between endogenously selected capital ratios and empirical equity betas, we can be comfortable that exogenous effects would be at least as large.

Figure 3 shows some basic predictions for how leverage affects equity betas. Writing the definition of asset beta as a weighted average of equity and debt betas, with *e* being the ratio of equity to total assets and the inverse of *e* leverage, and rearranging, yields

$$\beta_e = \tfrac{1}{e}\beta_a - \left(\tfrac{1}{e} - 1\right)\beta_d \,. \tag{5}$$

With approximately riskless debt, the last term drops out and the relationship between equity beta and leverage is linear with a slope of asset beta, as shown with the solid line in Figure 3.[7] The effect of risky debt is apparent at high leverage, where debt's beta rises and causes equity's beta to rise less than linearly, as indicated by the dashed line on the right-hand side of Figure 3.

When banks differ in their asset betas, endogenous leverage choice due to financial distress costs leads to an additional effect that flattens the predicted relationship between equity beta and leverage. Banks with high asset betas, and therefore high equity betas for any given leverage, will tend to choose lower leverage. Similarly, and reinforcing the risky debt effect, banks with low asset betas, and thus low equity betas for any given leverage, may choose higher leverage.[8] To summarize, the dashed line in Figure 3 is what we would expect from this real-

[7] As a reminder, the weighted average of equity and debt betas equals asset beta by identity, in the same way that the beta of any portfolio is the weighted sum of the betas in the portfolio. The CAPM is not required for its validity. Also note that a debt tax shield do not alter this formula as long as the bank continuously rebalances its debt to maintain a constant debt to value ratio; the tax shield asset is as risky as the operating assets.

[8] We are obviously not developing a complete theory of bank versus nonbank capital structures. Many other frictions drive a wedge between their equilibrium behaviors. Our discussion is pertinent to behavior across banks.

world combination of risky debt and endogenous capital structure choice. The coefficient in a regression of equity betas on inverse capital ratios is likely to be somewhat lower than the asset beta, particularly for extreme levels of leverage.

This discussion also suggests why we want to go from capital adequacy to returns in two steps—from capital to beta, and from beta to returns—as opposed to directly from capital to returns. As explained above, capital is endogenous in a way that may attenuate the results we are looking for: High capital firms tend to have riskier assets to start with. Critically, however, this endogenous selection of capital will be apparent in betas, i.e. an attenuated link between capital and beta. From a regulatory perspective we wish to understand the effect of an exogenous increase in capital requirements. In that case, beta will fall, and then we can use the beta effects to infer the ultimate effects of higher capital. The capital data therefore is in place to estimate a reasonable *lower* bound for the link between capital requirements and beta, and then we can use the returns data to get at the link between beta and returns.[9]

Still, this leaves open the possibility that there is a low risk anomaly generally, but that there is no low risk anomaly with respect to explicit leverage decisions. In other words, the link between beta and returns is flat, only for variation in beta that is not induced by changes in leverage, or in the case of banks capital requirements. So, we also repeat our portfolio tests on capital sorted portfolios for the shorter window from 1996 through 2011 where we have risk-weighted leverage data to work with. We defer this analysis until Table 9 below.

B. Capital Adequacy and Beta

[9] A more practical constraint is that fifteen years of capital data are not enough for sufficiently reliable estimates of average returns on different risk categories of banks.

The channel that we are interested in is how equity affects beta. Table 3, Panel B, shows the relationship between capital measures and realized beta. The equal-weighted columns indicate that across all banks and for all capital measures, higher capital is associated with lower beta. We highlight the popular Tier 1 ratio, which generates the largest spread on beta as well as on capital. It is not surprising that the pure equity in the Tier 1 ratio (despite including some preferred equity) spreads beta better than other measures. Subordinated debt of the sort that is included in Tier 2, for example, provides a broader notion of capital but cannot reduce the beta of equity by nearly as much as more equity. Kashyap et al. (2010) focus on larger banks and use Computstat data on bank equity, and they document a relationship between beta and total equity to total assets. The more detailed breakdown afforded by the use of call reports data suggests that Tier 1 equity is by far the most important for spreading beta.

The value-weighted differences in Panel B show that the link between beta and capital adequacy ratios is weaker for larger banks. It is precisely in these banks where one would expect the endogenous selection of leverage to be apparent, because the asset mix is much more variable. For example a bank with a high capital ratio might nonetheless have a high beta, because it derives more profit from higher beta activities like investment banking and brokerage. Still, the difference in realized beta as a function of the Tier 1 ratio is statistically and economically meaningful even in value-weighted terms.

The significant spread in capital ratios suggests that some banks may not face binding leverage constraints, but this is misleading. We review actual regulatory requirements in the calibration, but note here that falling below regulatory minima subjects U.S. banks to Prompt Corrective Action restrictions, including ceasing dividends, filing and implementing a capital restoration plan, and prohibiting acceptance, renewal, or rolling-over of broker CDs. It may also force a return to the equity markets with an obvious lemons problem. Even falling below the higher standard of “well capitalized” triggers an increase in deposit insurance premia. Given the consequences of falling short, the overwhelming majority of banks maintain a sizable buffer over the well-capitalized boundary, not just the regulatory minimum. The precise buffer presumably varies with asset risk, perceived access to the equity market, capital structure adjustment costs, and other factors.[10] In short, it is difficult to know how much less than one-for-one leverage decreases with capital requirements, but they will most likely have some effect even on banks that are already well above heightened regulatory percentages.[11]

To obtain a precise estimate of the linear relationship between forward (realized) beta and equity capital we can go beyond decile sorts. For idiosyncratic risk in particular, which cancels out in portfolios, we must look at the full cross section of beta and root mean squared error measured at the stock level. Table 4 shows regression results of forward beta and idiosyncratic risk on inverse equity capital, the specification suggested by Equation (1), for all banks. We use the Fama-MacBeth (1973) procedure, which gives equal weight to each cross section, in the estimation, and we also use two-dimensional clustering, which corrects the standard errors of a single regression for correlated residuals for different time periods for the same firm or for different firms at a point in time. Figure 4 shows a third approach to tease out some of the nonlinear effects in Figure 3. These are kernel regressions of the same relationship for all banks and for banks only in the top half by market capitalization.

Recall the discussion of the predictions in Figure 3. If variation in leverage were exogenous and debt were riskless, we would expect the slope in a regression of equity betas on

[10] See Aiyar, Calomiris, and Wieladek (2012) for evidence based on the UK’s unique experiment where capital requirements were varied both across banks and over time.

[11] We are grateful to Sam Hanson for the discussion in this paragraph.

inverse capital ratios to equal the average bank asset beta, and we would expect the intercept to be exactly zero. Both endogenous leverage choices and measurement error in capital cause the slope to be attenuated and the intercept to be positive. Consistent with measurement error, we find lower slopes for cruder measures of assets and equity capital. Consistent with the presence of endogenous leverage choices, the intercept is somewhat greater than zero even for the Tier 1 to risk-weighted assets ratio and there is attenuation in the slope in Figure 4 for very low levels of leverage. A rough correction is to run this regression while forcing the intercept to be zero. This raises the lower bound estimate for asset beta to 0.074, which is the measured slope of the line in Panel A of Figure 4.

This will be convenient for benchmarking in our calibration below. If bank assets have an inherent beta of 0.074 and the CAPM holds in frictionless capital markets, the pre-tax weighted average cost of capital for banks should have exceeded the risk free rate by 0.074 times the market risk premium, or approximately 40 basis points annually (= 45 x 12 x 0.074) using the market risk premium from Ken French's data library of 45 basis points per month from July 1971 through December 2011. This matches the estimation period that we will use below and roughly corresponds to the approach in Damadoran (2012).[12] For the full CRSP history and the same asset beta, the corresponding figure was 57 basis points annually.

In results available upon request, we confirm the relationships between capital and future beta using Compustat's reported Tier 1 capital ratio (CAPR1Q) and total risk-based capital ratio (CAPR3Q). The slope coefficients and explanatory power are slightly lower in the Compustat data, suggesting that the call reports data is slightly more accurate.

[12] Damodaran's approach is simple, but it is easy to find higher or lower estimates based on other methodologies or samples. The equity premium "puzzle" literature regards the historical premium as too high to be explained with standard intertemporal models (Mehra and Prescott (1985)). See Mehra (2008) for an overview.

Finally, the bottom panels of Table 4 show that greater capital is also associated with higher idiosyncratic risk, at least for capital measures scaled by risk-weighted assets. The strongest relationship is between idiosyncratic risk and total risk-based capital to risk-weighted assets, which, like Tier 1 capital to risk-weighted assets, also spreads beta well. Overall, capital ratios are somewhat more tightly linked to beta than to idiosyncratic risk.

C. The Low Risk Anomaly Within Banks

The relationship between leverage and equity beta is consistent with the textbook Modigliani-Miller argument and essentially mechanical. The next question is whether this can be expected to reduce the cost of equity, as theory also predicts. Here the theory is not quite as strong, because it relies on the efficient pricing of CAPM risks across banks. The empirical alternative is that there is a low risk anomaly in banks similar to that in other firms.

Table 5 runs cross-sectional Fama-MacBeth regressions of monthly returns on beta deciles. Under the CAPM, the coefficient on beta should reveal the market risk premium. Because of measurement error and skewness in beta, book-to-market, and momentum, we run these regressions using deciles instead of raw values. We are using beta deciles here, not beta per se, an approximate relationship to keep in mind is from Table 2, which shows that a movement of about seven deciles corresponds to an increase in pre-ranking beta of 1.2 and a difference in realized portfolio betas shown below of approximately 0.6. (The use of deciles or individual beta estimates is immaterial to the results; it is convenient to use deciles in subsequent analyses and we keep them here for consistency.)

In the univariate regression of returns on beta decile alone, however, the point estimate is actually negative. Adjusting the point estimate to be in units of beta thus does not help us get to a plausible market risk premium. In the multivariate regression where we make the assumption that size, book-to-market, and return momentum are risk factors that need to be controlled for, there is also no meaningful relationship between beta and returns. For example, adjusting the (statistically insignificant) point estimate to be in units of realized beta implies an implausibly small market risk premium of around 1% per year, far lower than realized market returns over the same or longer periods.

In Table 6, we follow beta-sorted portfolios, and once again find no evidence of a positive relationship between beta and returns. We again divide stocks into three groups according to pre-ranking beta. Importantly, sorting stocks leads to a reliable difference in realized betas. The low beta, equal-weighted (value-weighted) portfolio has a realized CAPM beta of 0.56 (0.71) and the high beta portfolio has a beta roughly twice as high. This doubling in systematic risk should in theory lead to higher average returns over a period when equity returns overall were positive. Yet, the monthly returns in excess of the riskless rate are the same or lower for high beta stocks.

Figure 5 shows these results in terms of cumulative raw returns, and also suggests why there is no statistical significance in raw returns differences—there are periods where low beta stocks underperform and risky stocks of both banks and nonbanks outperformed low risk stocks. One can view this either as a brief confirmation of the CAPM or an exceptional bubble which, when removed, strengthens the conclusions of a low risk anomaly elsewhere.

Risk-adjusted underperformance is mechanically much greater and is also statistically significant. For a basic market model and value weighting, the underperformance rises to 41 basis points per month. For a Fama-French three-factor model, the underperformance rises further to 46 basis points per month. Equal weighting stocks within each portfolio leads to similar conclusions. Figure 6 plots Figure 5 in differences of cumulative arithmetic returns (not compounded) between the low and high risk portfolios. The risk-adjusted return differences do not appear to be concentrated in any single period. Indeed for value-weighted portfolios the difference rises steadily throughout the sample period. There is an interesting episode during the financial crisis. In the early stages of the crisis, low risk banks outperformed high risk banks on a raw basis, as one might expect during a large market decline. However, starting in March 2009, during the so-called "junk rally," low risk banks underperformed on both a raw and risk-adjusted basis as the riskiest banks made a dramatic recovery.

Turning to idiosyncratic risk in Table 7 shows that this side of the low risk anomaly also holds in banks. Here, the results are stronger in equal weighted portfolios. High idiosyncratic risk underperformed low idiosyncratic risk by 28 basis points per month in raw terms, 46 basis points per month in beta-adjusted returns, and 76 basis points per month in Fama-French three-factor model adjusted returns. Qualitatively similar but quantitatively smaller patterns obtain for value-weighted portfolios. Examining idiosyncratic returns has an important side benefit. As mentioned earlier, large banks have higher beta but lower idiosyncratic risk. The fact that the returns (and leverage) results are similar for both measures suggests that the conclusions apply both to large and small banks. It also suggests the interpretation that the three-factor results are statistically stronger precisely because they remove extra random variation that arises from the exposure to the size factor, isolating the low risk anomaly from the size anomaly.

In Table 8, we extend the sample back to 1931 for beta-sorted portfolios and idiosyncratic risk sorted portfolios, and we show results for the full sample of CRSP stocks. As mentioned above, the bank portfolios contain relatively few banks in early years. Nontheless, the low risk anomaly is as large economically in the full sample as in the last 40 years, and results within banking stocks alone are consistent with those found in earlier research using the entire CRSP sample.

In a final robustness check described in the previous section, we examine the link between capital ratios and risk-adjusted returns directly, rather than through the two-step process that we have relied on so far. This is an important check because it helps deal with the possibility that there is a low risk anomaly that flattens the link between beta and returns but that this anomaly is for some reason only relevant for variation in beta that does not come from leverage changes. There are two limitations to this test. One is conceptual: risk weighting may not be perfect, so we may be mismeasuring leverage and, in particular, endogenous leverage might limit our ability to detect a leverage effect. This is particularly acute for larger and more complex banks, where equity risk is determined by asset mix across brokerage, asset management, and investment banking, not only traditional lending activity. Capital ratios from the call reports are likely a poor instrument for capturing variation in risk. The other limitation is empirical: we have risk adjusted capital calculations for a short period of time. There is enough data to estimate second moments, including betas, but perhaps not enough to measure means accurately. Again, this is likely more acute with value-weighted portfolios given the concentration in this industry.

With these caveats in mind, we form capital sorted portfolios and show the alphas and betas in Table 9. The top panel shows equal weighted portfolios that emphasize those banks where there was a cleaner link between risk and capital ratios. The bottom panel shows value-weighted portfolios. The results help to confirm the two-step logic. Capital is related to risk, as we showed earlier, and moreso in smaller and simpler banks. And, the risk-adjusted returns are lower for higher risk banks, with statistical significance in equal-weighted portfolios. If anything given the somewhat more modest variation in risk across capital sorted portfolios, relative to pre-ranking beta sorted portfolios, the low risk anomaly is economically larger.

V. Calibration

We now explore the quantitative effects of a hypothetical shift in capital requirements on the spread between banks' weighted average cost of capital and the riskless rate. We first review the current regulatory environment to provide some context. We then proceed in three steps. First, we consider the simple case where there is a low risk anomaly in equities, but banks are otherwise able to raise risk-free and correctly priced debt. We also relax the assumption of risk-free debt, but retain the assumption of efficiency in the debt market. Second, we layer on the possibility of a low risk anomaly for debt as well as equity securities. Third, we briefly consider the effects of a government guarantee on bank debt. In each case, we maintain the assumption that this is a purely ceteris paribus shock to capital requirements and that banks' asset betas remain fixed. In the conclusion, we comment on how some banks may be able to modify their business mix to "adapt" to such a policy shift.

A. Regulatory Capital Requirements

While countries have differed in the speed of reforms to capital requirements and their implementation details, the broad trend has been toward stricter requirements. Basel I, agreed in 1988, defined Tier 1 and Tier 2 capital as well as risk-weighted assets, and required a minimum of Tier 1 capital to risk-weighted assets of 4% and a total of Tier 1 and Tier 2 capital of 8% (ratios here and below are also scaled by risk-weighted assets unless otherwise specified). Basel II, agreed in 2006, attempted to address deficiencies of Basel I by modifying the risk-weighting scheme and introducing a 2% requirement of common-only Tier 1 capital. Basel III, developed in 2011, further revised the definitions of risk-weighted assets, raised the required common Tier 1 ratio to between 7% to 9.5% depending on market conditions, raised the required Tier 1 ratio to between 8.5% to 11%, and raised the total capital requirement to between 10.5% and 13%. As a backstop, Basel III also introduces a minimal requirement of 3% leverage ratio, defined as Tier 1 capital to total (non-risk weighted) assets. (The U.S. Federal Reserve had long maintained a minimal leverage ratio requirement of 4%.) The U.S. Federal Reserve intends to transition to essentially the Basel III rules in phases, with full implementation now expected in 2019.[13]

Such regulations are the outcome of interactions among regulators, politicians, investors, and bankers, each with somewhat different preferences and proposals. In recent years, some have argued for raising the common Tier 1 ratio all the way up to 30% (Elliott (2013)). Accordingly, we follow Kashyap et al. (2010) and assume that regulators impose a 10% increase of capital requirements in the form of common equity. We assume that this is a fully binding and immediate increase from current levels for every bank. But it might, very roughly speaking, be viewed as the difference between a benchmark with no capital requirements and the current regime. We do not estimate the effect of any specific reform proposal, but our hypothetical change appears to fall in the relevant range in light of various policy proposals.

Although we focus on capital requirements in this paper, we note that liquidity requirements of the sort called for in Basel III may also activate the low risk anomaly. Holding additional cash or liquid instruments reduces asset beta and overall risk, thus equity beta and idiosyncratic risk, which may then increase the cost of bank equity.

[13] See Saunders and Cornett (2010) and Yang (2012) for details on the recent history of banking regulation.

B. *The Effect of Higher Capital Requirements on the Weighted Average Cost of Capital*

We start by supposing that the CAPM holds, but with a low risk anomaly as in Equation (1).[14] In other words, higher beta equities underperform their CAPM benchmark and lower beta equities outperform their CAPM benchmark. Repeating the earlier discussion, returns are assumed to take the following linear form:

$$r_i = (\beta_i - 1)\gamma + r_f + \beta_i r_p, \tag{6}$$

where β_i is the β of any equity *i*, r_f is the risk free rate, r_p is the market risk premium, and $\gamma = \frac{d\alpha}{d\beta} < 0$ measures the extent of the low risk anomaly. Note that Baker et al. (2011) derive a pricing equation of exactly this form when investment is delegated to an investment manager with a typical information-ratio objective. (That is, to maximize the return on the portfolio in excess of a benchmark divided by the standard deviation of the portfolio return over the benchmark.) Again, as we did before in Equation (1), assume that debt indexed by *j* is correctly priced by the CAPM at:

$$r_j = r_f + \beta_j r_p. \tag{7}$$

We relax this assumption in an extension below.

The cost of capital for a bank is the weighted average of the cost of debt r_d and the cost of equity r_e, as we computed in Equation (2) above and repeat here:

$$WACC = er_e + (1-e) r_d = r_f + \beta_a r_p + \beta_a \gamma - \gamma \left[e + (1-e)\beta_d \right], \tag{8}$$

where *e* is the ratio of equity to total assets and β_a is the β of the banks' operating assets which we assume is invariant to its capital structure.

[14] Interestingly, the CAPM has a special formal status in the Federal Reserve. Congress requires that the Federal Reserve banks provide payment services at a price that recoups what a private-sector provider would obtain. In practice, a simple beta-one CAPM is a fundamental element of this estimate.

We are interested in how the cost of capital changes with a change in capital requirements that moves the bank from its old level of capital *e* to a new regulatory level *e**. Differencing Equation (8), evaluated at the new and old levels of capital, and substituting out the equity beta, leads to the following increase in the cost of capital:

$$\Delta WACC = \gamma\left(e - e^* + (1-e)\beta_d - (1-e^*)\beta_{d^*}\right). \tag{9}$$

A special case is when the debt is riskless, in both capital regimes, so that $\beta_d = \beta_{d^*} = 0$. This means that the change in the cost of capital is simply $\gamma(e - e^*)$, which is greater than zero for increases in the ratio of equity *e*. In general, we believe that the effects of changing debt betas are likely to be small. Given that bank equity betas are somewhat less than 1.0 on average, and equity ratios are in the range of 8 to 19 percent in Table 3, estimates of β_a for banks are quite small, estimates of β_d are by definition smaller, and differences in β_d are smaller still. Even so, this simplified measure of the change in the cost of capital under the assumption of riskless debt should be viewed as an upper bound. When debt shares the asset risk with equity, the impact of an increase in capital requirements on equity betas is mitigated somewhat.

We can use Table 4 to get a rough sense of the size of $\gamma = \frac{d\alpha}{d\beta}$. In Figure 7 Panel A, we plot the estimated alphas and betas from Table 6, separately for CAPM and Fama-French three factor regressions. The CAPM betas range from 0.56 for an equal-weighted portfolio of low beta banks to 1.27 for a value-weighted portfolio of high beta banks. The corresponding three factor betas range from 0.55 to 1.32. The portfolio alphas range from -48 basis points per month for the value-weighted portfolio of high beta banks, controlling for the size and book-to-market factors, to 34 basis points per month for the equal-weighted portfolio of low beta banks, controlling only for the market factor. The figure shows simple regressions of alpha on beta for the two sets of portfolio alphas and betas. The historical slope estimates of $\gamma = \frac{d\alpha}{d\beta}$ are -68 and -75 basis points per month.

Assuming riskless debt, this assumed linear relationship between beta and alpha indicates that a 10 percentage point increase in required equity capital would be associated with an 82 (= 68 x 12 x 0.1) to 90 basis point increase in the weighted average cost of capital, and, assuming competitive lending markets, a corresponding increase in spreads.

As a robustness test, Panel B plots the analogous results from Table 6-style regressions that exclude two prominent crisis periods, October 1989 through October 1990 and January 2007 through February 2009. It is not the case that the underperformance of high-beta banks is due to exceptionally poor performance during crises, and the anomaly is roughly linear whether one includes or excludes such periods.

Finally, in Figure 8 we substitute the data from Table 7 with comparable estimates using the entire CRSP universe of financial and nonfinancial firms. If anything, the low risk anomaly is actually stronger in banks than nonfinancial firms. Using the linear, all-CRSP slope estimates, a 10 percentage point increase in required equity capital is associated with a weighted average cost of capital increase of 61 to 65 basis points. So, the range of estimates using a linear empirical model of only banking stocks or all US stocks and using a simple CAPM or a three-factor model, is from 60 to 90 basis points.

Of course, there are presumably limits to these effects. A deeply undercapitalized bank with extraordinarily risky equity (and somehow granted a reprieve from FDIC seizure) has a cost of equity that is hard to measure and may or may not be extremely low. At the other end of the spectrum, the equity of an otherwise typical bank with no debt at all will be so transparently low risk that investors may already be categorizing it as effectively low cost, high-grade debt.

Because our sample does not include banks with no debt or with no equity, our evidence speaks only to the observed and empirically relevant range.

C. *Extension 1: Adding a Low Risk Anomaly for Debt*

The calibration is greatly simplified with the assumption of fairly priced and riskless debt. The important assumption, though, is not that debt is riskless but that the debt and equity markets are not efficiently integrated. If the two markets are integrated and a single Equation (6) governs the pricing of debt and equity, then the Modigliani and Miller theorem is restored and the cost of capital for banks is simply equal to:

$$WACC = (\beta_a - 1)\gamma + r_f + \beta_a r_p, \tag{10}$$

which is independent of the chosen capital structure *e*. This is illustrated in the first panel of Figure 9. There is a low risk anomaly, but it prices both debt and equity with the same return generating process. What is needed is segmented equity markets, so that the expected return on debt does *not* fall on an extension of the line that relates beta and return in the equity market. This sort of segmentation is illustrated in the second panel of Figure 9.

Given the magnitude of the low risk anomaly within equity markets, this sort of debt market integration suggests an implausibly large expected return on debt. An investment grade debt security, say with a beta equal to 0.1, would have an expected alpha of 0.9 x 68 = 61 to 0.9 x 75 = 68 basis points *per month* according to Equation (6) and Figure 7, and all debt securities, with βs well below 1, would offer large, risk-adjusted expected returns. Spreads on corporate debt are smaller than this by an order of magnitude, so integrated markets of this sort are not likely to be empirically relevant.

Figure 10 casts further doubt on integrated low risk anomalies. We compute betas and average returns for government and corporate debt over the matching period, and plot these along with the quintile equity portfolios computed as in the fifth and sixth columns of Table 6. This gives us a sufficient number of stocks to compute quintile portfolios going back to the beginning of the CRSP sample. Two observations are worth making. First, the corporate bond data point falls below the extended security market line computed from the equity market in both samples. Second, while the corporate bond returns still fall above the theoretical security market line, this appears to be entirely due to a term premium in both government and corporate bonds.

We consider these two observations somewhat more formally in Table 10. In each panel, we simultaneously estimate market models for the portfolios of all CRSP stocks that we considered in Table 8 alongside the corporate bond returns from Ibbotson and Associates. Recall that we divide the CRSP universe into three groups in Table 8 according to pre-ranking beta. We test the difference between the high and low risk stock portfolios as we did before. We also compute an alpha and beta for corporate bonds and test the difference from the low risk stock portfolio. In the first panel we estimate a simple market model over the most recent half of the CRSP sample. The alpha of the corporate bond portfolio is 5.7 basis points higher than the low risk stock portfolio, which is itself a statistically significant 18.6 basis points. This offers a bit of hope for an integrated low risk anomaly.

Then in the final two columns, we extrapolate where the alpha ‘should be’ if there were an integrated low risk anomaly present across stock and bond returns. Using the difference in point estimates between the low risk and high risk portfolios, alpha should rise by 52.6 basis points, or 37.7 divided by 0.72, for each unit reduction in beta. So, the simple alpha of the corporate bond portfolio, with a beta that is 0.50 lower, should be 26.3 basis points higher than the alpha of the low risk portfolio. In other words, the actual alpha of 5.7 falls 20.6 basis points short of this integrated markets target. In this case, the actual and extrapolated alphas are close enough together that we cannot reject integration at conventional levels of statistical significance. To compute a p-value we draw from a multivariate normal distribution using the OLS estimates and covariances for the coefficients in the first three columns. For each of 10,000 draws, we compare the actual and extrapolated alpha. A one-tailed p-value of 0.141 indicates that approximately 1,410 of the random draws feature an actual alpha that is higher than the extrapolated alpha.

A caveat to this analysis is that a portion of the return on corporate bonds during this period reflects falling inflation, not an integrated low risk anomaly. In the second panel, we also control for the term premium on government bonds, with this in mind. As Baker and Wurgler (2013) show, there is a statistically strong link between bond returns and the cross-section of stock returns. The low risk stock portfolio is exposed to government bond returns to a much greater degree than the high risk stock portfolio. The t-statistic is greater than 10. However, this explains only a small portion of the low risk anomaly. By contrast, the exposure to government bond returns explains the entire alpha on corporate bonds. The alpha on corporate bonds is now 12.1 basis points *lower* than the low risk stock portfolio, while it ‘should be’ 20.9 basis points higher. The gap of 33.0 basis points is now statistically significant, with a p-value of 0.014.

Over the full history, when the performance of government bonds was more modest, we reject integration for both a simple market model, with a p-value of 0.029, and one that includes government bond returns. The latter is shown in the third panel, with a p-value of less than 0.01. In short, while there is a link between government bonds and low risk stocks, there is otherwise little evidence of a common low risk anomaly across debt and equity markets. This means reducing the risk of corporate equity by substituting equity for corporate bonds would not have left the overall cost of capital unchanged.

More plausible is a low risk anomaly that holds within each asset class, along the lines of Frazzini and Pedersen (2013), but not across asset classes. Baker, Bradley, and Wurgler (2012) emphasize that an upward sloping risk and return relationship holds across asset classes, ranging from government securities to small cap stocks. This means Equation (7) could be modified as follows for the pricing of debt securities *j*:

$$r_j = \left(\beta_j - \overline{\beta}_j\right)\gamma_d + r_f + \beta_j r_p, \tag{11}$$

where it is the difference of an individual debt security's β_d from the average of all debt securities (not 1) that determines the extent of mispricing. Now the overall cost of capital equals:

$$WACC = er_e + (1-e)r_d = r_f + \beta_a r_p + \beta_a \gamma - \gamma\left[e + (1-e)\beta_d\right] - \gamma_d\left[(1-e)\overline{\beta}_d - (1-e)\beta_d\right]. \tag{12}$$

The analogue of Equation (9), in the analytically simple case where the extent of the low risk anomaly per unit change in β is the same within each asset class, so that $\gamma = \gamma_d$, the change in the cost of capital as leverage changes, is:

$$\Delta WACC = \gamma\left(e - e^*\right)\left(1 - \overline{\beta}_d\right), \tag{13}$$

which is greater than zero for increases in the ratio of equity *e*. If the low risk anomaly for debt is centered on a much lower average beta, than the effects are broadly similar to the case where there is no low risk anomaly in debt markets.

The terms that depend on the change in the debt beta drop out, because there are exactly offsetting effects. On the one hand, the debt becomes safer, sharing some of the risk reduction in equity as leverage decreases and thus mitigating the increase in the cost of equity. This is the impact shown within the first term of Equation (12), multiplied by γ, and it arises because the equity beta falls less than linearly in the inverse of the leverage ratio, and the cost of capital rises by less than in the case of riskless debt. On the other hand, because there is less of the now safer, lower β, debt, the cost of capital rises by more than in the case of riskless debt. Because of the low risk anomaly within the debt markets, safer debt is more expensive on a risk-adjusted basis. These two effects offset exactly, when the extent of the low risk anomaly is the same within the two asset classes. When the low risk anomaly is smaller in debt markets, the effect of changing debt betas on mitigating the rise in the cost of equity is larger, so that an increase in capital increases the cost of capital by less than in the case where $\gamma = \gamma_d$ and the simplified expression is an upper bound effect.

The simplified expression $\gamma(e - e^*)(1 - \overline{\beta}_d)$ contains an extra term added to the case of correctly priced, riskless debt. It measures the extent to which the two markets are not integrated, in other words the difference between the pricing of debt and equity in Equations (6) and (7) and in Equations (6) and (11). If the markets are perfectly integrated, so that $\overline{\beta}_d = 1$, then the Modigliani and Miller theorem holds. If there is a separate low risk anomaly within each asset class, so that $\overline{\beta}_d << 1$, the effects are slightly smaller than in the riskless debt case.

D. Extension 2: Adding Government Subsidies

The analysis so far considers situations where the government is not involved in insuring the debt of banks. Deposit insurance means that a bank can issue risky debt at the riskless rate of return. It means Equation (7) for the pricing of debt securities *j* can be modified to:

$$r_j = -\beta_j r_p + r_f + \beta_j r_p = r_f. \tag{14}$$

For the bank, the result is something very similar to the riskless case, except that the debt, despite being priced as riskless, shares some of the risk of equity, mitigating the effect of the low risk anomaly on the cost of equity:

$$\Delta WACC = \gamma\left(e - e^*\right) + \left(\gamma + r_p\right)\left(\left(1-e\right)\beta_d - \left(1-e^*\right)\beta_{d^*}\right). \tag{15}$$

If $\gamma = -r_p$, which is empirically not far from the estimates derived for γ, then the effect on bank cost of capital is the same as it was in the riskless case. Again, there are two offsetting effects for the bank. As r_p increases, the effect of leverage on the cost of capital is larger than in the riskless case. This is intuitive: lower leverage means that the bank gets a smaller subsidy from the government. There is less debt overall and the debt that remains requires a smaller subsidy. As γ increases in absolute value, the effect of leverage on the cost of capital is smaller than in the riskless case. This is because the impact of debt sharing in the risk of equity is magnified relative to the riskless case where there is no risk sharing.

Another conclusion from Equation (15) is that the government subsidy falls, of course, as capital increases, but there is an additional increase in the cost of capital that is not zero-sum between the government and banks, because their cost of equity capital increases.

E. Summary of the Calibration

Heightened capital requirements will, in the presence of a low volatility anomaly in stocks, increase the weighted average cost of capital for banks. Table 11 summarizes the theoretical analysis. So long as capital markets are segmented, the basic effect is simply the product of the percentage point increase in equity capital times the excess risk-adjusted performance per unit of beta. For a binding 10 percentage point increase in capital, point estimates for these effects are in the range of 60 to 90 basis points, depending primarily on whether we rely on the general pattern in all stocks or the experience of banks alone. These are attenuated in the case of risky debt or when there is a more modest low volatility anomaly in debt markets as well. It seems likely that this attenuation is slight, in large part because bank debt betas overall are small.

To put 60 and 90 basis points in some perspective, recall that our asset beta estimate for banks was 0.074. With the historical risk premium, this suggests a pre-tax weighted average cost of capital under the CAPM of around 40 basis points per year above the risk-free rate over the same 40-year period. Relative to this spread, the effects of significantly heightened capital requirements when combined with the historical low volatility anomaly are considerable. They suggest more than doubling the weighted average cost of capital, when it is measured as a premium over the risk-free rate, to 100 to 130 basis points.

VI. Conclusion and Policy Implications

Regulators and bankers are concerned about the effect of capital requirements on the cost of capital and lending rates, among other consequences. Standard theory maintains that this is naïve in perfect and efficient capital markets, because increased capital will reduce the beta and thus the cost of equity, leaving the overall cost of capital unchanged. We find that this theory does not line up well with the data for banks. While less leverage reduces equity risk, this in turn puts the low risk anomaly into play. In an 80-year sample, lower risk banks have the same or higher stock returns than higher risk banks. Therefore, reducing equity beta will reduce the cost of equity only if long-term (and worldwide, based on other evidence) patterns are reversed.

In a simple calibration that uses the long-term historical relationship between risk and return, we find that a binding ten percentage-point increase in the required Tier 1 capital to risk-weighted assets ratio would have increased the overall cost of capital by approximately 90 basis points. Given the relatively low estimate for the beta of bank assets overall, this would more than double the spread of the cost of capital over the risk-free rate. Such an effect would put banks at a larger competitive disadvantage relative to a less-regulated shadow banking system.

The broader implications of the low risk anomaly for corporate capital structure have been unexplored. We show in this paper that the low risk anomaly, with one simple and empirically validated mechanism, simultaneously provides: a powerful motivation to lever for banks and other firms with low risk assets; a source of value creation for private equity financed leveraged buyouts; and a reason for higher risk, non-financial firms to avoid debt entirely.

While we encourage more research on the basic links between leverage and the cost of capital in both banks and nonbanks, with the results in hand we discuss some tentative policy implications. We assume conservatively that the anomaly itself is due to market features and investor behavior and cannot be reversed via policy. The main issue is then how to keep banks' equity "attractively risky" without reducing their stability.

One possibility is that smaller and narrower banks be given relatively less stringent capital requirements. Our results speak most clearly to the regulation of relatively narrow banks, because they have fewer ways of increasing the risk of their assets through altering the business mix toward, for example, brokerage, underwriting, sales and trading, or proprietary trading. Banks are indeed clever to adapt their business mix to minimize the impact of capital requirements (Duchin and Sosura (2014)). To some extent, this is already a regulatory trend in that banks designated as systemically important, which generally also have diverse lines of business, are subject to somewhat stricter capital requirements. Our evidence can be seen as an additional reason to differentiate between traditional banks and these broader institutions.

Another possibility is to consider unsecured debt or hybrid debt more flexibly in the calculation of the capital of bank holding companies, and maintain strict capital requirements for the bank subsidiary. Depending on their features, these instruments may qualify only as Tier 2 or Tier 3 capital. Of course, regardless how they are considered for regulatory purposes, it is important that such instruments do not exhibit a low risk anomaly to the same degree. Our evidence suggests that this is unlikely to be the case. This approach also requires clear rules on resolution.

We repeat the qualification given in the introduction. When all other private and social costs and benefits are totaled up, strict capital requirements may well remain desirable. Our contribution is to point out that based on the available evidence, the low volatility stock market anomaly may produce an underappreciated and potentially significant cost to add to this calculus.

References

Admati, Anat R., P. M. DeMarzo, M. F. Hellwig, and P. C. Pfleiderer. "Fallacies, Irrelevant Facts, and Myths in the Discussion of Capital Regulation: Why Bank Equity is Not Expensive." Stanford University working paper (2011).

Admati, Anat R., M. Hellwig. The Bankers' New Clothes. Princeton: Princeton UP (2013).

Aiyer, Shekhar, C. W. Calomiris, T. Wieladek. "Does Macro-Pru Leak? Evidence from a UK Policy Experiment." Columbia University Graduate School of Business working paper (2012).

Allen, Franklin, E. Carletti. "Deposits and Bank Capital Structure." University of Pennsylvania working paper (2013).

Ang, Andrew, R. Hodrick, Y. Xing, X. Zhang. "The Cross-Section of Volatility and Expected Returns." Journal of Finance 61 (2006), pp. 259-299.

–. "High Idiosyncratic Volatility and Low Returns: International and Further U.S. Evidence." Journal of Financial Economics 91 (2009), pp. 1-23.

Baker, Malcolm, B. Bradley, R. Taliaferro. "The Low Risk Anomaly: A Decomposition into Micro and Macro Effects." Harvard Business School, working paper (2013).

Baker, Malcolm, B. Bradley, J. Wurgler. "Benchmarks as Limits to Arbitrage: Understanding the Low-Volatility Anomaly." Financial Analysts Journal 67 (2011), pp. 40-54.

Baker, Malcolm, and J. Wurgler. "Comovement and Predictability Relationships Between Bonds and the Cross-Section of Stocks." Review of Asset Pricing Studies 2 (2012), pp. 57–87.

Bali, Turan, N. Cakici, R. Whitelaw. "Maxing Out: Stocks as Lotteries and the Cross-Section of Expected Returns." Journal of Financial Economics 99 (2011), pp. 427-446.

Barberis, Nicholas, M. Huang. "Stocks as Lotteries: The Implications of Probability Weighting for Security Prices." American Economic Review 98 (2008), pp. 2066-2100.

Basel Committee on Banking Supervision. "An Assessment of the Long-term Economic Impact of Stronger Capital and Liquidity Requirements." Bank for International Settlements mimeo (2010).

Black, Fischer. "Capital Market Equilibrium with Restricted Borrowing." Journal of Business 45 (1972), pp. 444-455.

Black, Fischer, M. C. Jensen, M. Scholes. "The Capital Asset Pricing Model: Some Empirical Tests." In M. C. Jensen, ed., Studies in the Theory of Capital Markets. New York: Praeger (1972), pp. 79-121.

Black, Fischer, Myron Scholes, "The Pricing of Options and Corporate Liabilities." Journal of Political Economy 81 (1973), pp 637-659.

Blitz, David, P. V. Vliet. "The Volatility Effect: Lower Risk Without Lower Return." Journal of Portfolio Management 34 (2007), pp. 102-113.

Blitz, David, J. Pang, P. V. Vliet. "The Volatility Effect in Emerging Markets." Robeco Asset Management, working paper (2012).

Brennan, Michael. "Agency and Asset Pricing." University of California, Los Angeles, working paper (1993).

Cornell, Bradford. "The Pricing of Volatility and Skewness: A New Interpretation." California Institute of Technology working paper (2008).

Coval, Joshua, J. Jurek, E. Stafford. "The Economics of Structured Finance." Journal of Economic Perspectives 23 (2009), pp. 3-25.

Cummins, Jason G., K. A. Hassett, R. G. Hubbard. "A Reconsideration of Investment Behavior Using Tax Reforms as Natural Experiments." Brookings Papers on Economic Activity 2 (1994), pp. 1-74.

Damodaran, Aswath. "Equity Risk Premiums (ERP): Determinants, Estimation and Implications – 2012 Edition." NYU Stern School of Business working paper (2012).

DeAngelo, Harry, R. M. Stulz. "Why High Leverage is Optimal for Banks." Ohio State University working paper (2013).

Duchin, Ran, D. Sosyura. "Safer Ratios, Riskier Portfolios: Banks' Response to Government Aid." Journal of Financial Economics (forthcoming, 2014).

Elliott, Douglas J. "Quantifying the Effects on Lending of Increased Capital Requirements." The Brookings Institution mimeo (2009).

Elliott, Douglas J. "A Further Exploration of Bank Capital Requirements: Effects of Competition from Other Financial Sectors and Effects of Size of Bank or Borrower and of Loan Type." The Brookings Institution mimeo (2010).

Elliott, Douglas J. "Higher Bank Capital Requirements Would Come at a Price." Brookings Institute Internet posting. http://www.brookings.edu/research/papers/2013/02/20-bank-capital-requirements-elliott (February 20, 2013).

Fama, Eugene F., K. R. French. "The Cross-Section of Expected Stock Returns." Journal of Finance 47 (1992), pp. 427-465.

Fama, Eugene F., K. R. French, “Industry Costs of Equity.” Journal of Financial Economics 43 (1997), pp. 153–193.

Fama, Eugene F., J. D. MacBeth. “Risk, Return, and Equilibrium: Empirical Tests.” Journal of Political Economy 81 (1973), pp. 607-636.

Frazzini, Andrea, L. H. Pedersen. “Betting Against Beta.” NYU Stern School of Business working paper (2013).

Gilchrist, S., J. W. Sim, and E. Zakrajsek. “Misallocation and Financial Market Frictions: Some Direct Evidence from the Dispersion in Borrowing Costs.” Review of Economic Dynamics 16 (2013), pp. 159-176.

Gornall, Will, I. A. Strebulaev. “Financing as a Supply Chain: The Capital Structure of Banks and Borrowers.” Stanford Graduate School of Business working paper (2014).

Graham, John, “How Big Are the Tax Benefits of Debt.” Journal of Finance 63 (2000), pp. 1901-1941.

Haugen, Robert A., A. J. Heins, “Risk and the Rate of Return on Financial Assets: Some Old Wine in New Bottles.” Journal of Financial and Quantitative Analysis 10 (1975), pp. 775-784.

Hong, Harrison, D. Sraer. “Speculative Betas.” Princeton University working paper (2012).

Ibbotson Associates, 2012, *Ibbotson SBBI 2012 Classic Yearbook* (Morningstar, Chicago).

Jegadeesh, Narasimhan, S. Titman, “Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency.” Journal of Finance 48 (1993), pp. 65-91.

Karceski, Jason. “Returns-Chasing Behavior, Mutual Funds, and Beta’s Death. “ Journal of Financial and Quantitative Analysis 37 (2002), pp. 559-594.

Kashyap, Anil K., Stein, J. C., and S. Hanson. “An Analysis of the Impact of ‘Substantially Heightened’ Capital Requirements on Large Financial Institutions.” Harvard University working paper (2010).

Kumar, Alok. “Who Gambles in the Stock Market?” Journal of Finance 64 (2009), pp. 1889-1933.

Macroeconomic Assessment Group of the Basel Committee on Banking Supervision. “Assessing the Macroeconomic Impact of the Transition to Stronger Capital and Liquidity Requirements – Final Report.” Bank for International Settlements mimeo (2010).

Mehra, Rajnish. Handbook of the Equity Risk Premium. Amsterdam: Elsevier, 2008.

Mehra, Rajnish, E. C. Prescott. “The Equity Premium: A Puzzle.” Journal of Monetary Economics 15 (1985), pp. 145-161.

Merton, Robert C. “On the pricing of corporate debt: The Risk Structure of Interest Rates.” Journal of Finance 29 (1974), pp. 449–470.

Philippon, Thomas. “The Bond Market’s q.” Quarterly Journal of Economics 124 (2009), pp. 1011-1056.

Santos, Andre Oliveira, D. Elliott. “Estimating the Costs of Financial Regulation.” IMF Staff Discussion Note (2012).

Saunders, Anthony, and M. Cornett. Financial Institutions Management: A Risk Management Approach. Seventh Edition. New York: McGraw-Hill (2010).

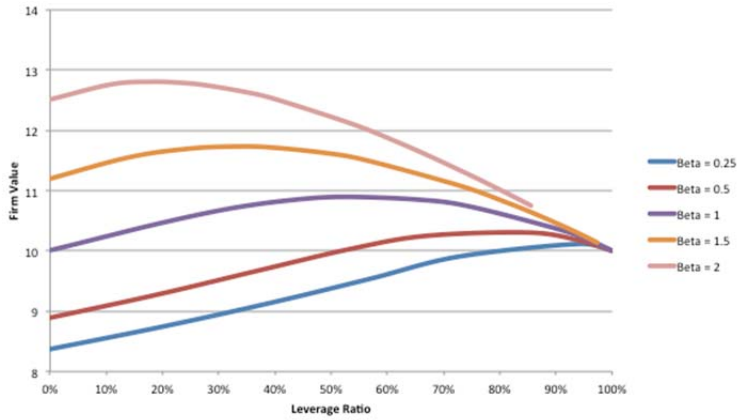
Tversky, Amos, D. Kahneman. “Advances in Prospect Theory: Cumulative Representation of Uncertainty.” Journal of Risk and Uncertainty 5 (1992), pp. 297-323.

Van den Heuvel, Skander J. “The Welfare Cost of Bank Capital Requirements.” Journal of Monetary Economics 55 (2008), pp. 298-320.

Yang, Emily. “Bank Capital and Regulation.” Federal Reserve Bank of New York presentation http://www.newyorkfed.org/education/pdf/2012/Yang_bank_capital_regulation.pdf. (March 20, 2012).

Figure 1. Value Effects of Leverage When There is a Low Risk Anomaly in Equities. We compute firm value for firms with five different levels of asset beta. Each firm has a normally distributed terminal value five years hence, with a contractual distribution of value between debt and equity and no costs of financial distress or tax effects. The value of each firm would be exactly \$10, regardless of leverage, if there were no low-risk anomaly. Volatility is equal to asset beta times the sum of a market volatility of 16% plus an idiosyncratic firm volatility of 20%. The risk free rate is 2%. We compute the value of equity, the value of debt, and the equity beta under the Merton model with no low risk anomaly. We compound this equity value using the CAPM expected return with a market risk premium of 8% over five years, and then present value this future equity value using the discount rate from Equation (1) with a γ of 5%. This is the adjusted equity value. Firm value is the adjusted equity value plus the value of debt. Leverage is computed using these market values.

Panel A. Absolute Firm Value



Panel B. Firm Value Relative to the Maximum

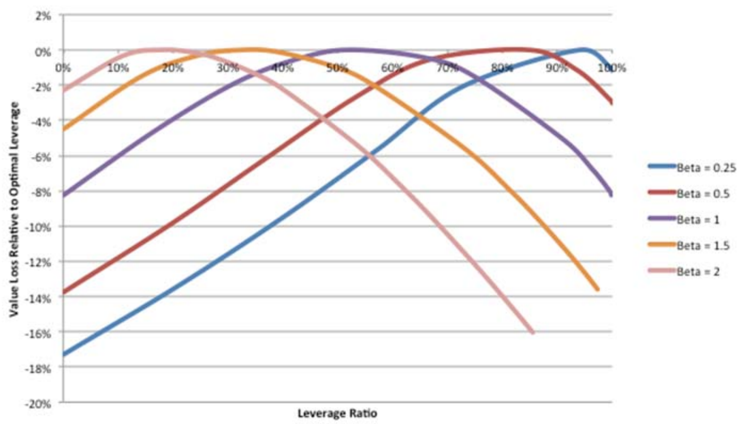


Figure 2. Pre-ranking Beta in the Banking Industry, Value-Weighted. Value-weighted pre-ranking beta, July 1971 through December 2011. We define the banking industry as the union of the banking SIC codes from Ken French's definition of 48 industries and the three-digit SIC 671, which includes bank holding companies. Pre-ranking beta is computed by regressing a minimum of 24 months and a maximum of 60 months of trailing holding period returns (RET) on the corresponding CRSP value-weighted market holding period returns (VWRETD). The sample is divided into low (bottom 30%), medium (middle 40%), and high (top 30%) portfolios according to pre-ranking beta. The sample includes firms for which we can compute a valid beta, with at least 24 monthly holding period return (RET) observations, a valid market capitalization, with a nonmissing price (PRC) and shares outstanding (SHROUT) observation, and at least one holding period return following a valid beta.

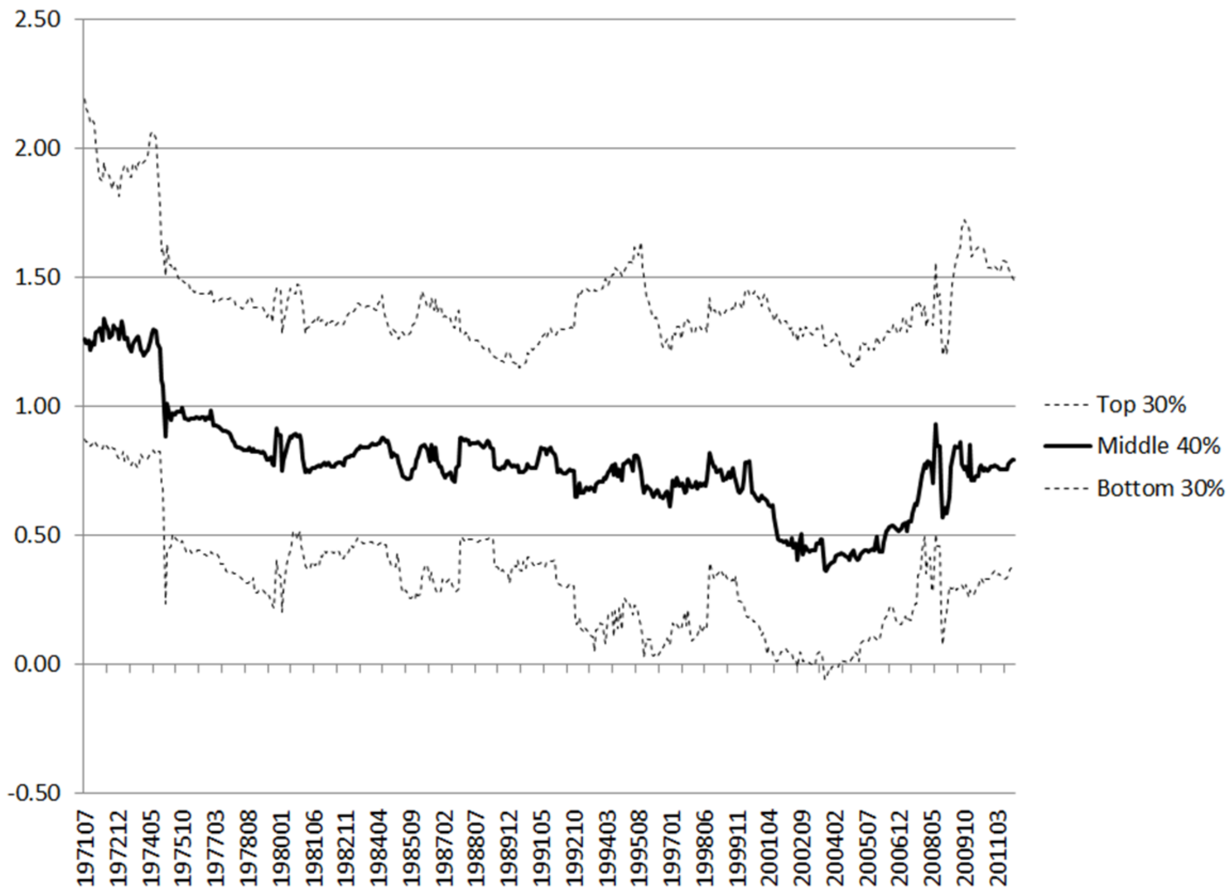


Figure 3. Bank Capital and Beta: Empirical Predictions. Exogenous changes in the inverse capital ratio on the x-axis should be associated linearly with increases in equity beta if the changes in capital are exogenous and the debt is approximately risk free. The slope is equal to the asset beta. Endogenous leverage choice, where a bank chooses higher or lower leverage to match its asset beta risk, or risky debt will both tend to flatten the predicted relationship.

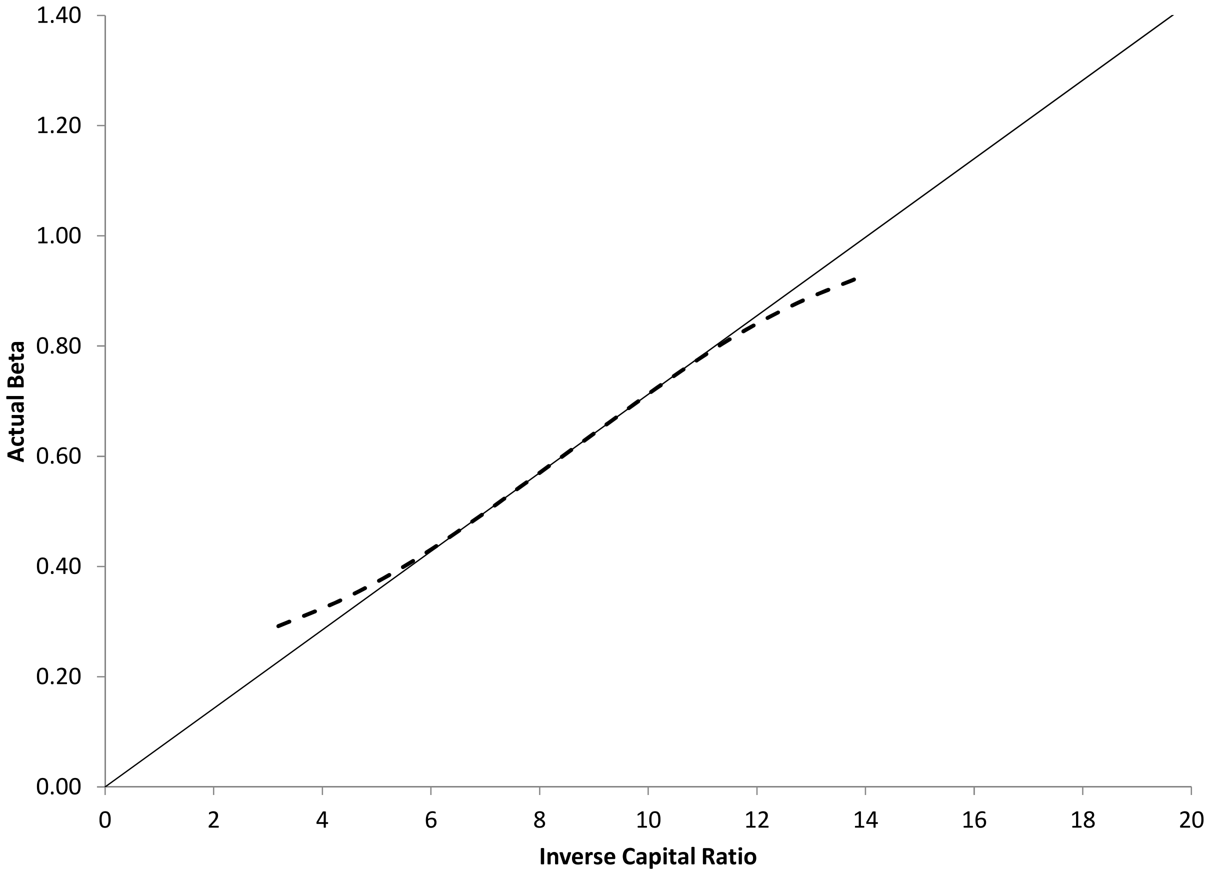
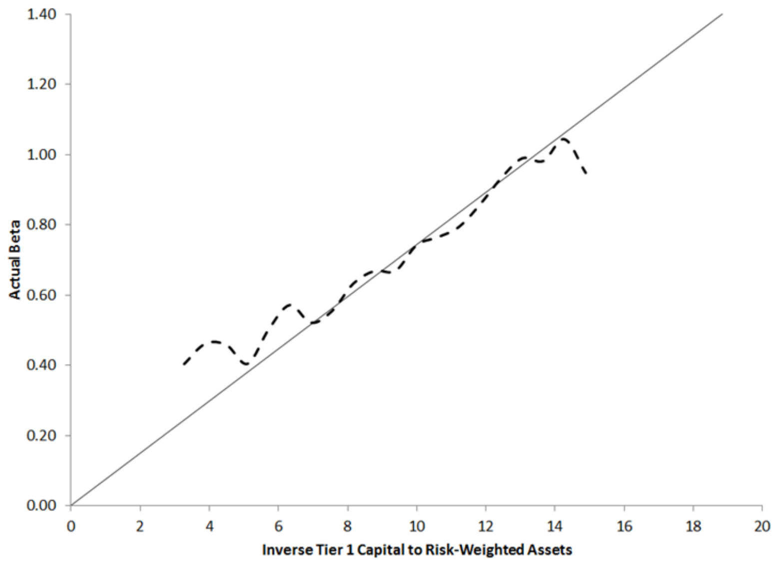


Figure 4. Kernel regressions of future beta on the inverse capital ratio. The dependent variable is the forward beta, computed by regressing a minimum of 24 months and a maximum of 60 months of future holding period returns (RET) in excess of the riskless rate on the corresponding CRSP value-weighted market holding period returns (VWRETD, also in excess of the riskless rate). The independent variable is the ratio of total risk-based capital (RCFD3792) to Tier 1 capital (RCFD8274). Panel A includes all banks. Panel B includes only banks above the median market capitalization in each month. The local polynomial regressions use a Epanechnikov kernel, with 20 bins and smoothing interval of 0.1.

Panel A. All banks



Panel B. Large banks

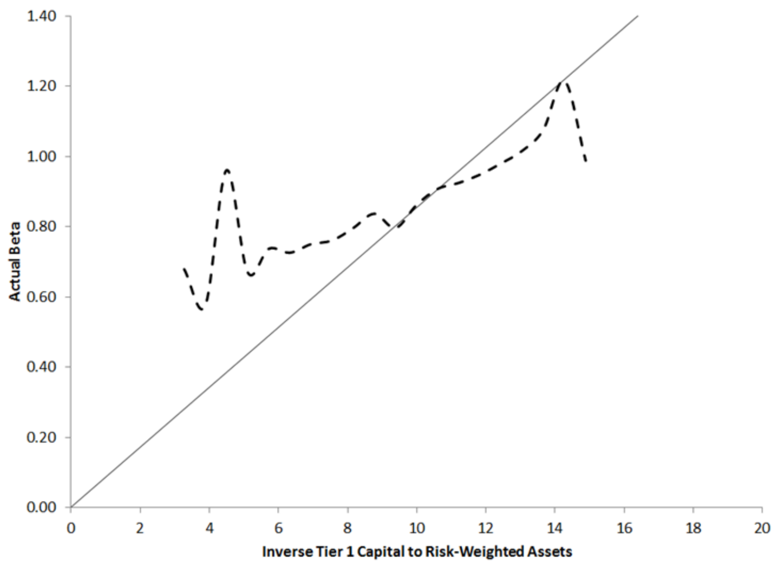
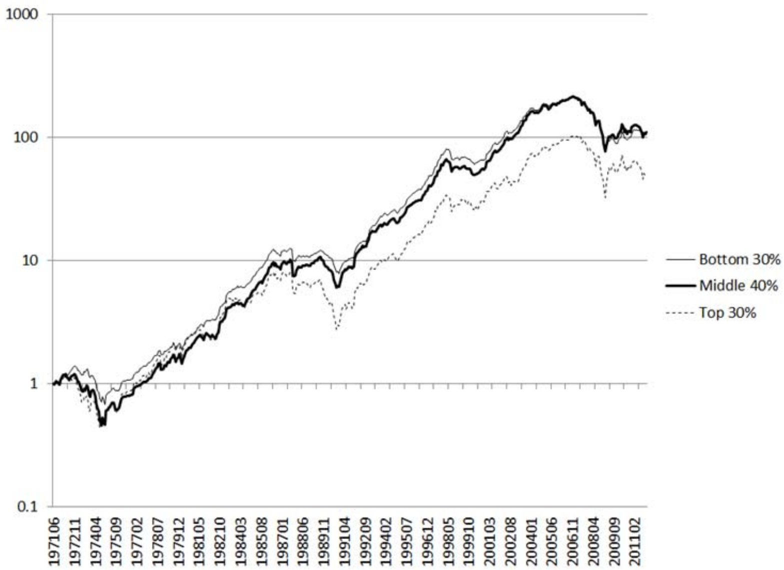


Figure 5. Beta Sorted Portfolio Returns. Portfolio returns for low, medium, and high beta bank stocks. Each portfolio total return is computed using either equal or value weights. The sample is divided within each month into low (bottom 30%), medium (middle 40%), and high (top 30%) portfolios according to pre-ranking beta. Pre-ranking beta and the sample are described in Table 2.

Panel A. Equal Weighted Portfolio



Panel B. Value Weighted Portfolio

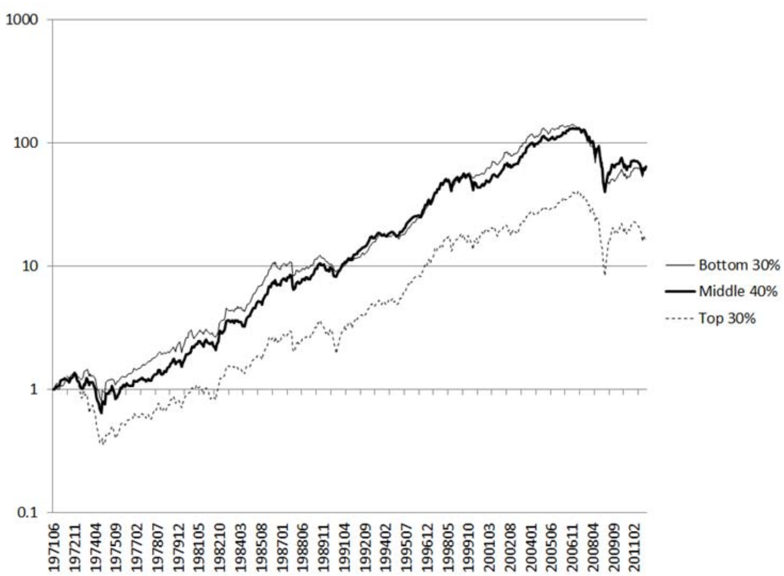
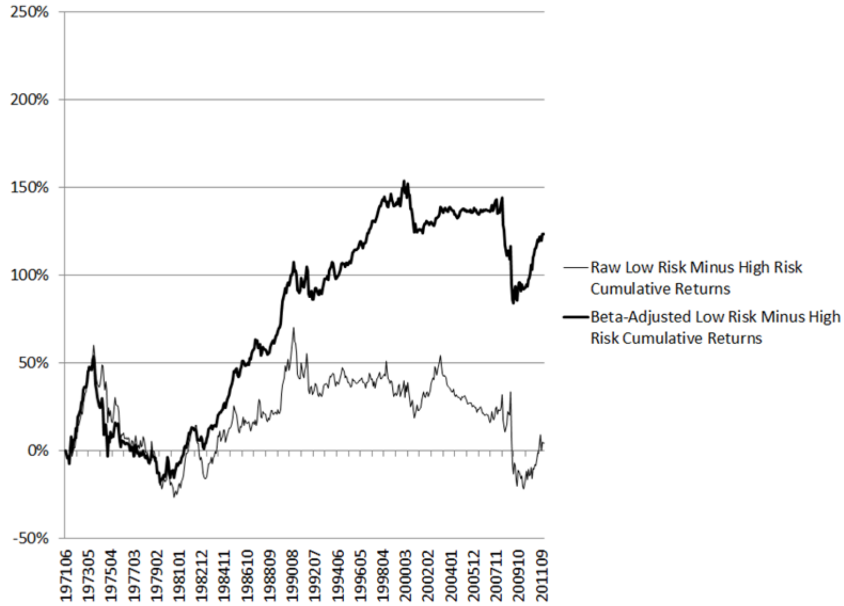


Figure 6. Differences in Beta Sorted Portfolio Returns. Difference in cumulative returns between low and high beta bank stock portfolios. Each portfolio total return is computed using either equal or value weights. The sample is divided within each month into low (bottom 30%) and high (top 30%) portfolios according to pre-ranking beta. The cumulative difference in these portfolio returns is plotted below, in raw returns and beta-adjusted returns. Pre-ranking beta and the sample are described in Table 2.

Panel A. Long/Short, Equal Weighted



Panel B. Long/Short, Value Weighted

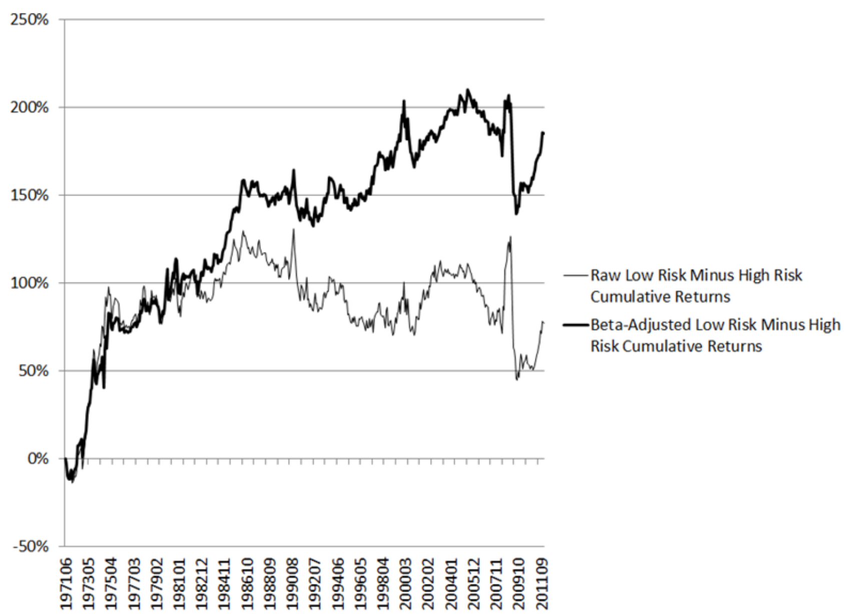
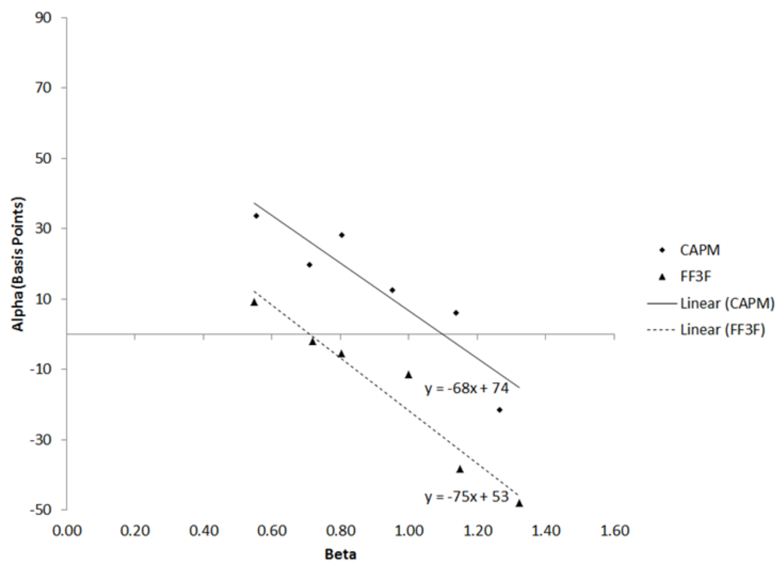


Figure 7. The Estimated Size of the Low Beta Anomaly in the Banking Industry. Plots of CAPM and Fama-French 3-Factor alpha and beta for six portfolios. The alphas and betas are described in Table 6. Slopes from linear regressions of alpha on beta are shown on the plots. Panel A shows the results for the banking industry as defined in Table 1. Panel B excludes the peak to trough periods in the middle bank portfolio from October 1989 through October 1990 and from January 2007 through February 2009. Excluding the periods of poor ex post performance increases the alpha estimates.

Panel A. Banks



Panel B. Banks, Excluding Two Crisis Periods

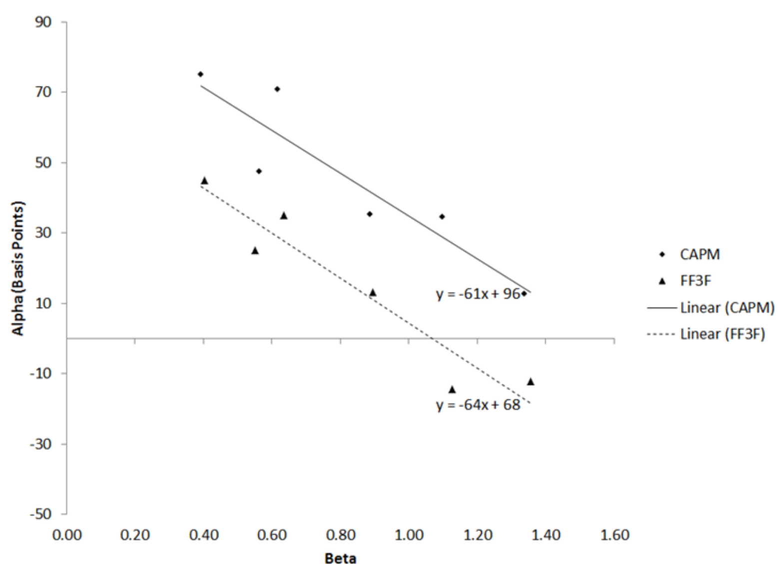


Figure 8. The Estimated Size of the Low Beta Anomaly for All Firms. Plots of CAPM and Fama-French 3-Factor alpha and beta for six portfolios. The alphas and betas are estimated as in Table 6, but for all CRSP firms. Slopes from linear regressions of alpha on beta are shown on the plots.

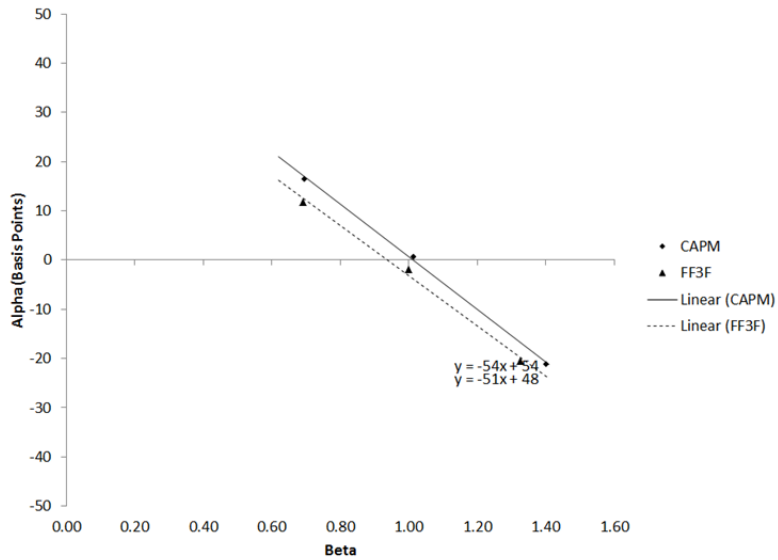
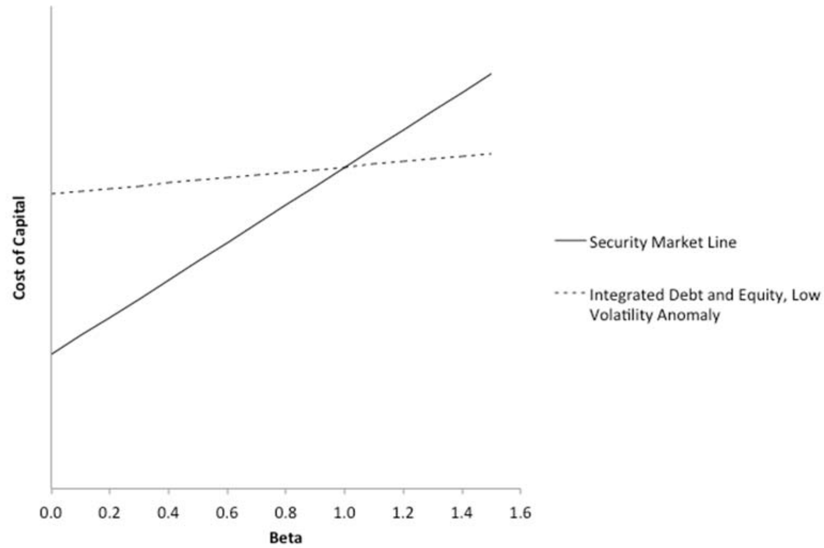


Figure 9. Segmented Debt and Equity Markets. For the low risk anomaly to impact the cost of capital, debt and equity markets must be segmented. Panel A shows a low risk anomaly that extends across asset classes, e.g. from safe debt with very low beta to equity with higher beta, rendering capital structure irrelevant. Panel B shows segmented debt and equity markets, but with a low risk anomaly appearing within each market.

Panel A. Integrated Debt and Equity Markets



Panel B. Segmented Debt and Equity Markets

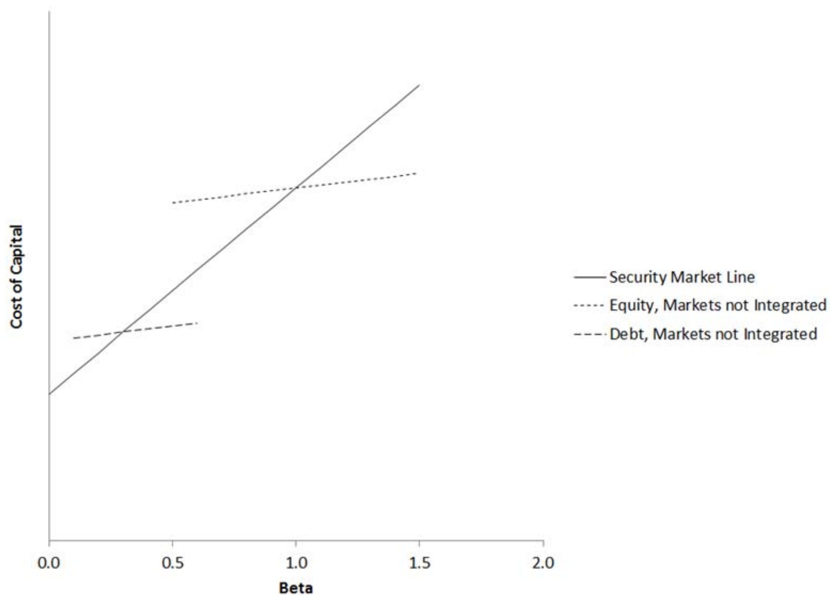
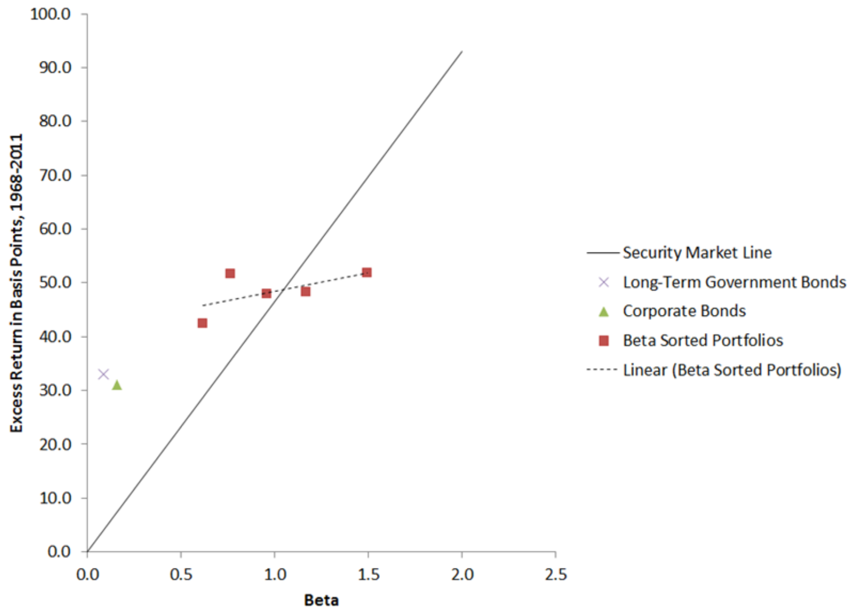


Figure 10. Bond Returns and the Low Risk Anomaly in Stocks. Plots of average returns and CAPM betas for five equity portfolios sorted into quintiles using pre-ranking betas as well as long-term corporate and government bonds from Ibbotson and Associates. The returns and betas are estimated as in Table 6, but using quintiles and all CRSP firms for the equity portfolios. An empirical security market line using the five equity portfolios is plotted using a linear fit through the five data points on stocks.

Panel A. Quintile Portfolios and Bond Returns, July 1971 through December 2011



Panel B. Quintile Portfolios and Bond Returns, January 1931 through December 2011

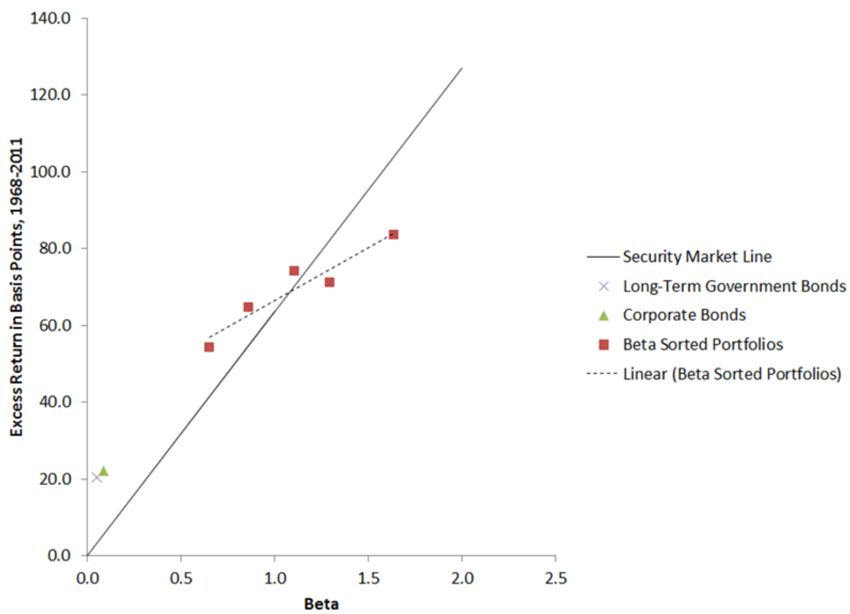


Table 1. Banking Industry. Number of firms in each industry group by decade and overall, July 1971 through December 2011. We define the banking industry as the union of the banking SIC codes from Ken French's data library definition of 48 industries and the three-digit SIC 671, which includes bank holding companies. The sample includes firms for which we can compute a valid beta, with at least 24 monthly holding period return (RET) observations, a valid market capitalization, with a nonmissing price (PRC) and shares outstanding (SHROUT) observation, and at least one holding period return following a valid beta. There are relatively few publicly traded banks in the first half of the CRSP sample, so we focus on the second half, using July 1971 as a start date. Table 8 shows the full sample as a robustness check.

		CRSP Firms				
SIC Code	**Industry**	**1971-1979**	**1980-1989**	**1990-1999**	**2000-2011**	**Total**
6000-6000	Depository institutions	0	0	1	2	**3**
6020-6020	Commercial banks	1	213	465	334	**597**
6021-6021	National commercial banks	0	4	51	144	**165**
6022-6022	State banks - Fed Res System	13	30	76	229	**276**
6023-6024	State banks - not Fed Res System	15	31	7	0	**33**
6025-6025	National banks - Fed Res System	62	120	45	4	**131**
6026-6026	National banks - not Fed Res System	0	1	2	0	**2**
6027-6027	National banks, not FDIC	0	1	0	0	**1**
6028-6029	Banks	1	1	7	46	**48**
6030-6036	Savings institutions	0	142	463	427	**674**
6040-6059	Other Banks	4	11	5	1	**13**
6060-6062	Credit unions	0	0	10	1	**10**
6120-6129	S&Ls	29	130	20	4	**142**
6130-6139	Agricultural credit institutions	0	1	1	0	**1**
6140-6149	Personal credit institutions (Beneficial)	23	21	47	40	**92**
6150-6159	Business credit institutions	9	33	56	56	**115**
6160-6169	Mortgage bankers	16	34	68	52	**119**
6170-6179	Finance lessors	0	0	3	1	**3**
6190-6199	Financial services	0	2	3	2	**7**
6710-6719	Holding offices	315	852	968	182	**1520**
	Total	**485**	**1,394**	**1,786**	**1,316**	**3,952**

Table 2. Summary Statistics: CRSP Data. Summary statistics by pre-ranking risk, July 1971 through December 2011. We define the banking industry as the union of the banking SIC codes from Ken French's definition of 48 industries and the three-digit SIC 671, which includes bank holding companies. Pre-ranking beta is computed by regressing a minimum of 24 months and a maximum of 60 months of trailing holding period returns in excess of the riskless rate on the corresponding CRSP value-weighted market holding period returns (VWRETD, also in excess of the riskless rate). Pre-ranking root mean squared error uses the residuals from these regressions. In the first two panels, the sample is divided within each month into low (bottom 30%), medium (middle 40%), and high (top 30%) portfolios according to pre-ranking beta. The last panel sorts by RMSE. Market capitalization is equal to price (PRC) times shares outstanding (SHROUT). Book-to-market ratio is the ratio of book equity to market capitalization. Book equity is computed as described in Ken French's data library. The sample includes firms for which we can compute a valid beta, with at least 24 monthly holding period return (RET) observations, a valid market capitalization, with a nonmissing price (PRC) and shares outstanding (SHROUT) observation, and at least one holding period return following a valid beta.

	Pre-Ranking Risk					
	N	**Bottom 30%**	**N**	**Middle 40%**	**N**	**Top 30%**
Panel A. Means, Pre-Ranking Beta Sorts						
Pre-Ranking Beta	82,082	0.18	109,456	0.68	80,493	1.37
Decile	82,082	2.00	109,456	5.50	80,493	8.99
Pre-Ranking Root Mean Squared Error (%)	82,082	8.05	109,456	8.37	80,493	10.94
Decile	82,082	4.69	109,456	5.15	80,493	6.69
Market Capitalization ($M)	82,082	210.6	109,456	702.8	80,493	3,012.0
Book-to-Market Ratio	54,356	1.39	86,643	1.87	66,955	3.63
Return from t-12 through t-2 (%)	81,312	12.62	109,075	14.00	80,135	14.06
Panel B. Medians, Pre-Ranking Beta Sorts						
Pre-Ranking Beta		0.21		0.67		1.27
Decile		2.00		5.00		9.00
Pre-Ranking Root Mean Squared Error (%)		6.89		7.35		9.43
Decile		4.00		5.00		7.00
Market Capitalization		47.3		95.8		196.1
Book-to-Market Ratio		0.76		0.76		0.76
Return from t-12 through t-2 (%)		8.86		11.11		10.29
Panel C. Means, Pre-Ranking RMSE Sorts						
Pre-Ranking Beta	82,420	0.56	109,288	0.71	80,323	0.95
Decile	82,420	4.52	109,288	5.45	80,323	6.50
Pre-Ranking Root Mean Squared Error (%)	82,420	5.39	109,288	7.94	80,323	14.26
Decile	82,420	2.00	109,288	5.50	80,323	8.99
Market Capitalization ($M)	82,420	2,172.5	109,288	1,141.1	80,323	409.5
Book-to-Market Ratio	66,126	1.77	84,061	2.23	57,767	3.04
Return from t-12 through t-2 (%)	82,048	13.52	108,730	14.00	79,744	13.14

Table 3. Capital Adequacy and Realized Portfolio Beta. The sample is divided within each month into ten decile portfolios according to capital. Each portfolio total return in excess of the riskless rate is computed using either equal or value weights. The first two columns use the ratio of total equity capital (RCFD3210) divided by average total assets (RCFD3368). The second two columns use Tier 1 capital (RCFD8274) in place of total equity capital. The third two columns use total risk-based capital (RCFD3792) in place of total equity capital. The fourth and fifth pairs of columns use total risk-weighted assets (RCFDa223) in place of average total assets. The sample runs from March 1996, the first date where RCFD8274 is available, through February 2011. It includes 74,105 firm-months for which we can compute capital ratios from the Federal Reserve Bank, a valid market capitalization, with a nonmissing price (PRC) and shares outstanding (SHROUT) observation, and at least one holding period return following a valid capital ratio.

Decile Sorts By:	*Equity to Assets*		*Tier 1 Capital to Assets*		*Risk-Based Capital to Assets*		*Tier 1 Capital to Risk-Weighted Assets*		*Risk-Based Capital to Risk-Weighted Assets*	
Decile	**Median**	**VW Mean**	**Median**	**VW Mean**	**Median**	**VW Mean**	**Median**	**VW Mean**	**Median**	**VW Mean**
Panel A. Capital Adequacy (%)										
1	6.58	6.58	6.15	6.27	7.02	6.78	8.24	8.16	10.26	10.45
2	7.54	7.60	6.84	6.85	7.81	8.05	9.30	9.30	10.79	10.91
3	8.05	8.03	7.23	7.27	8.27	8.44	9.77	9.85	11.17	11.23
4	8.46	8.66	7.55	7.55	8.62	8.74	10.17	10.30	11.54	11.55
5	8.82	8.92	7.88	7.87	8.94	9.03	10.61	10.83	11.93	12.00
6	9.19	9.25	8.21	8.24	9.27	9.39	11.11	11.29	12.41	12.38
7	9.64	9.94	8.59	8.66	9.67	9.73	11.70	11.90	12.98	13.01
8	10.17	10.74	9.09	9.05	10.16	10.19	12.51	12.60	13.77	13.70
9	11.00	10.92	9.81	9.95	10.87	10.78	13.94	14.02	15.18	15.17
10	13.24	15.26	11.45	14.33	12.51	13.74	17.26	18.36	18.45	19.82
10-1	**6.66**	**8.68**	**5.29**	**8.06**	**5.48**	**6.96**	**9.02**	**10.20**	**8.20**	**9.37**
Panel B. Realized Portfolio Beta										
1	0.80	1.20	0.86	1.35	0.78	0.97	0.93	1.24	0.76	0.80
2	0.65	1.18	0.74	1.12	0.64	0.88	0.82	1.16	0.75	0.89
3	0.60	0.78	0.68	0.95	0.65	1.04	0.67	1.29	0.71	1.00
4	0.65	1.04	0.67	0.92	0.65	1.19	0.66	1.11	0.70	1.11
5	0.70	1.11	0.66	1.05	0.64	1.12	0.63	0.96	0.67	1.06
6	0.70	1.05	0.69	1.12	0.68	1.07	0.69	0.98	0.73	1.19
7	0.66	1.26	0.60	1.00	0.63	1.16	0.61	0.76	0.64	1.14
8	0.59	1.19	0.64	1.02	0.63	1.10	0.63	0.92	0.64	1.14
9	0.66	1.03	0.54	0.81	0.71	1.23	0.50	1.08	0.55	1.03
10	0.63	1.23	0.57	1.24	0.63	1.27	0.50	0.91	0.49	0.96
10-1	-0.18	0.03	-0.28	-0.11	-0.15	0.30	-0.43	-0.34	-0.26	0.16
Panel C. T-Stat										
10-1	**[-1.8]**	**[0.3]**	**[-2.8]**	**[-1.1]**	**[-1.6]**	**[3.3]**	**[-4.0]**	**[-3.6]**	**[-2.5]**	**[1.5]**

Table 4. Bank Capital and Forward Systematic and Idiosyncratic Risk. Regressions of forward beta or idiosyncratic risk on measures of bank capital. The dependent variable in Panels A and B is the forward beta, computed by regressing a minimum of 24 months and a maximum of 60 months of trailing holding period returns in excess of the riskless rate on the corresponding CRSP value-weighted market holding period returns (VWRETD, also in excess of the riskless rate). The dependent variable in Panels C and D is the root mean squared residual from these regressions. Both are Winsorized at 1% and 99%. The first two columns use the ratio of total equity capital (RCFD3210) divided by average total assets (RCFD3368) as the independent variable. The second two columns use Tier 1 capital (RCFD8274) in place of total equity capital. The third two columns use total risk-based capital (RCFD3792) in place of total equity capital. The fourth and fifth pairs of columns use total risk-weighted assets (RCFDa223) in place of average total assets. The sample runs from March 1996, the first date where RCFD8274 is available, through December 2010. The last forward beta that we can compute is in December 2010, using CRSP data through December 2012.

	Equity to Assets		*Tier 1 Capital to Assets*		*Risk-Based Capital to Assets*		*Tier 1 Capital to Risk-Weighted Assets*		*Risk-Based Capital to Risk-Weighted Assets*	
	Coef	**[T]**	**Coef**	**[T]**	**Coef**	**[T]**	**Coef**	**[T]**	**Coef**	**[T]**
Panel A: Fama-MacBeth, Dependent Variable is Forward Beta										
Inverse Capital Ratio	0.011	[5.8]	0.031	[20.8]	0.011	[9.2]	0.058	[27.4]	0.056	[23.5]
Intercept	0.549	[18.6]	0.297	[12.4]	0.560	[31.3]	0.160	[7.2]	0.234	[11.2]
Observations		59,316		59,316		59,316		59,316		59,316
T		178		178		178		178		178
Average R-Squared		0.015		0.032		0.006		0.072		0.036
Panel B: Pooled with 2D Clustering, Dependent Variable is Forward Beta										
Inverse Capital Ratio	-0.011	[-1.5]	0.019	[2.9]	-0.003	[-0.4]	0.058	[8.0]	0.057	[5.9]
Intercept	0.802	[9.6]	0.442	[5.3]	0.714	[7.5]	0.154	[2.3]	0.225	[2.8]
Observations		59,316		59,316		59,316		59,316		59,316
Average R-Squared		0.002		0.007		0.000		0.045		0.023
Panel C: Fama-MacBeth, Dependent Variable is Forward RMSE (%)										
Inverse Capital Ratio	0.160	[7.7]	0.010	[0.5]	0.032	[1.2]	0.332	[11.0]	0.603	[13.4]
Intercept	7.669	[22.6]	9.318	[24.5]	9.078	[20.9]	6.462	[27.5]	4.656	[15.7]
Observations		59,316		59,316		59,316		59,316		59,316
T		178		178		178		178		178
Average R-Squared		0.028		0.013		0.019		0.024		0.036
Panel D: Pooled with 2D Clustering, Dependent Variable is Forward RMSE (%)										
Inverse Capital Ratio	-0.059	[-0.8]	-0.103	[-1.6]	-0.091	[-1.1]	0.363	[4.6]	0.678	[6.3]
Intercept	10.101	[11.0]	10.720	[12.4]	10.436	[10.9]	6.176	[9.3]	4.061	[5.2]
Observations		59,316		59,316		59,316		59,316		59,316
Average R-Squared		0.001		0.002		0.001		0.017		0.030

Table 5. Returns and Beta: Fama-MacBeth Regressions. Regressions of excess returns on pre-ranking beta and other deciles. Pre-ranking beta, market capitalization, book-to-market ratio, past returns, and the sample are described in Table 2.

Dependent Variable: Excess Return (Basis Points)	*Univariate*		*Multivariate*	
	Coefficient	**[T]**	**Coefficient**	**[T]**
Pre-Ranking Beta Decile	-0.5	[-0.19]	0.8	[0.33]
Log (Market Capitalization ($M))			-2.1	[-0.45]
Book-to-Market Ratio Decile			11.4	[5.95]
Return from t-12 through t-2 (%) Decile			15.3	[6.72]
Intercept	63.9	[3.98]	-65.4	[-1.05]
Observations		272,031		207,267
T		486		486
Average R-Squared		0.0203		0.0676

Table 6. Realized Returns and Risk: Beta Portfolios. Regressions of portfolio returns on market excess returns and the Fama-French factors, SMB and HML. Each portfolio total return in excess of the riskless rate is computed using either equal or value weights. The sample is divided within each month into low (bottom 30%), medium (middle 40%), and high (top 30%) portfolios according to pre-ranking beta. Pre-ranking beta and the sample are described in Table 2.

Panel A. Equal Weighted

	Bottom 30%		*Middle 40%*		*Top 30%*		*Top – Bottom*	
Basis Points	**Coefficient**	**[T]**	**Coefficient**	**[T]**	**Coefficient**	**[T]**	**Coefficient**	**[T]**
Mean Excess Returns								
	59.1	[3.42]	65.0	[2.90]	58.2	[1.93]	-0.9	[-0.05]
CAPM Regressions								
Market	0.56	[18.91]	0.81	[23.51]	1.14	[26.15]	0.59	[17.67]
Intercept	33.6	[2.55]	28.0	[1.82]	5.9	[0.30]	-27.7	[-1.86]
T		486		486		486		486
R-Squared		0.425		0.533		0.586		0.392
Fama-French 3-Factor Regressions								
Market	0.55	[21.59]	0.80	[28.96]	1.15	[32.29]	0.60	[18.63]
SMB	0.38	[10.46]	0.47	[11.74]	0.52	[10.24]	0.14	[3.08]
HML	0.46	[12.04]	0.65	[15.50]	0.89	[16.48]	0.43	[8.71]
Intercept	9.1	[0.82]	-5.6	[-0.45]	-38.3	[-2.44]	-47.4	[-3.33]
T		486		486		486		486
R-Squared		0.602		0.716		0.743		0.460

Panel B. Value Weighted

	Bottom 30%		*Middle 40%*		*Top 30%*		*Top – Bottom*	
Basis Points	**Coefficient**	**[T]**	**Coefficient**	**[T]**	**Coefficient**	**[T]**	**Coefficient**	**[T]**
Mean Excess Returns								
	52.2	[2.37]	56.1	[2.31]	36.4	[1.21]	-15.8	[-0.71]
CAPM Regressions								
Market	0.71	[19.17]	0.95	[28.87]	1.27	[35.73]	0.55	[12.93]
Intercept	19.6	[1.17]	12.4	[0.84]	-21.6	[-1.36]	-41.2	[-2.14]
T		486		486		486		486
R-Squared		0.432		0.633		0.725		0.257
Fama-French 3-Factor Regressions								
Market	0.72	[19.78]	1.00	[31.46]	1.32	[38.74]	0.60	[13.90]
SMB	0.20	[3.78]	-0.03	[-0.58]	-0.13	[-2.62]	-0.33	[-5.24]
HML	0.46	[8.33]	0.59	[12.35]	0.69	[13.41]	0.23	[3.57]
Intercept	-1.9	[-0.12]	-11.5	[-0.83]	-47.9	[-3.18]	-46.0	[-2.41]
T		486		486		486		486
R-Squared		0.492		0.684		0.762		0.291

Table 7. Realized Returns and Risk: Idiosyncratic Risk Portfolios. Regressions of portfolio returns on market excess returns and the Fama-French factors, SMB and HML. Each portfolio total return in excess of the riskless rate is computed using either equal or value weights. The sample is divided within each month into low (bottom 30%), medium (middle 40%), and high (top 30%) portfolios according to pre-ranking root mean squared error. Pre-ranking root mean squared error and the sample are described in Table 2.

Panel A. Equal Weighted

	Bottom 30%		*Middle 40%*		*Top 30%*		*Top – Bottom*	
Basis Points	**Coefficient**	**[T]**	**Coefficient**	**[T]**	**Coefficient**	**[T]**	**Coefficient**	**[T]**
Mean Excess Returns								
	70.8	[4.23]	67.6	[3.05]	42.6	[1.35]	-28.1	[-1.34]
CAPM Regressions								
Market	0.64	[27.31]	0.82	[25.24]	1.03	[19.50]	0.39	[9.02]
Intercept	41.3	[3.92]	29.9	[2.04]	-4.8	[-0.20]	-46.1	[-2.36]
T		486		486		486		486
R-Squared		0.607		0.568		0.440		0.144
Fama-French 3-Factor Regressions								
Market	0.65	[29.55]	0.82	[31.52]	1.02	[24.28]	0.38	[9.95]
SMB	0.17	[5.35]	0.43	[11.32]	0.80	[13.23]	0.63	[11.61]
HML	0.42	[12.70]	0.67	[16.92]	0.91	[14.24]	0.49	[8.50]
Intercept	22.0	[2.28]	-3.8	[-0.33]	-54.3	[-2.92]	-76.3	[-4.56]
T		486		486		486		486
R-Squared		0.682		0.741		0.670		0.393

Panel B. Value Weighted

	Bottom 30%		*Middle 40%*		*Top 30%*		*Top – Bottom*	
Basis Points	**Coefficient**	**[T]**	**Coefficient**	**[T]**	**Coefficient**	**[T]**	**Coefficient**	**[T]**
Mean Excess Returns								
	55.7	[2.26]	43.8	[1.56]	49.4	[1.42]	-6.3	[-0.29]
CAPM Regressions								
Market	1.02	[34.23]	1.16	[33.62]	1.32	[26.40]	0.30	[6.30]
Intercept	8.9	[0.66]	-9.2	[-0.60]	-11.0	[-0.49]	-19.8	[-0.94]
T		486		486		486		486
R-Squared		0.708		0.700		0.590		0.076
Fama-French 3-Factor Regressions								
Market	1.08	[37.65]	1.21	[38.06]	1.34	[29.36]	0.26	[6.00]
SMB	-0.27	[-6.60]	-0.03	[-0.69]	0.34	[5.20]	0.62	[9.86]
HML	0.51	[11.67]	0.71	[14.72]	0.87	[12.57]	0.36	[5.52]
Intercept	-7.9	[-0.62]	-38.1	[-2.71]	-51.7	[-2.56]	-43.9	[-2.29]
T		486		486		486		486
R-Squared		0.747		0.760		0.679		0.263

Table 8. Realized Returns and Risk: Robustness. Regressions of portfolio returns on market excess returns and the Fama-French factors, SMB and HML. Each portfolio total return in excess of the riskless rate is computed using either equal or value weights. The sample is divided within each month into low (bottom 30%), medium (middle 40%), and high (top 30%) portfolios according to pre-ranking beta or pre-ranking root mean squared error. Pre-ranking beta and root mean squared error and the sample are described in Table 2. All portfolios are value-weighted. The first four pairs of columns use only bank stocks, while the last two pairs of columns use the full CRSP sample.

	Beta: Top-Bottom, Bank Stocks, July 1971-December 2011		*Beta: Top-Bottom, Bank Stocks, January 1931-December 2011*		*Idiosyncratic Risk: Top-Bottom, Bank Stocks, July 1971-December 2011*		*Idiosyncratic Risk: Top-Bottom, Bank Stocks, January 1931-December 2011*		*Beta: Top-Bottom, All Stocks, July 1971-December 2011*		*Beta: Top-Bottom, All Stocks, January 1931-December 2011*	
Basis Points	**Coefficient**	**[T]**	**Coefficient**	**[T]**	**Coefficient**	**[T]**	**Coefficient**	**[T]**	**Coefficient**	**[T]**	**Coefficient**	**[T]**
CAPM Regressions												
Market	0.55	[12.93]	0.74	[18.59]	0.30	[6.30]	0.50	[9.47]	0.71	[19.47]	0.80	[37.92]
Intercept	-41.2	[-2.14]	-44.6	[-2.10]	-19.8	[-0.94]	-24.8	[-0.87]	-37.7	[-2.32]	-35.3	[-3.14]
T		486		972		486		972		486		972
R-Squared		0.257		0.263		0.076		0.085		0.439		0.597
Fama-French 3-Factor Regressions												
Market	0.60	[13.90]	0.64	[15.75]	0.26	[6.00]	0.18	[3.58]	0.63	[18.66]	0.70	[34.42]
SMB	-0.33	[-5.24]	-0.13	[-2.05]	0.62	[9.86]	1.04	[13.05]	0.25	[5.19]	0.35	[10.69]
HML	0.23	[3.57]	0.56	[9.73]	0.36	[5.52]	0.61	[8.51]	-0.17	[-3.23]	0.15	[5.30]
Intercept	-46.0	[-2.41]	-58.3	[-2.84]	-43.9	[-2.29]	-61.2	[-2.41]	-32.3	[-2.16]	-46.1	[-4.49]
T		486		972		486		972		486		972
R-Squared		0.291		0.320		0.263		0.273		0.540		0.671

Table 9. Realized Returns and Risk: Bank Capital Portfolios. Regressions of portfolio returns on market excess returns and the Fama-French factors, SMB and HML. Each portfolio total return in excess of the riskless rate is computed using either equal or value weights. The sample is divided within each month into high (top 30%), medium (middle 40%), and low (bottom 30%) portfolios according to Tier 1 capital divided by total risk-weighted assets. Capital ratios, the sample, and the link between capital ratios and beta are described in Table 3.

Panel A. Equal Weighted

	High 30%		*Middle 40%*		*Low 30%*		*Low – High*	
Basis Points	**Coefficient**	**[T]**	**Coefficient**	**[T]**	**Coefficient**	**[T]**	**Coefficient**	**[T]**
Mean Excess Returns								
	72.8	[2.53]	70.6	[1.99]	32.2	[0.69]	-40.6	[-1.52]
CAPM Regressions								
Market	0.54	[10.98]	0.65	[10.34]	0.81	[9.55]	0.27	[4.74]
Intercept	46.4	[2.07]	39.1	[1.38]	-7.1	[-0.19]	-53.5	[-2.11]
T		180		180		180		180
R-Squared		0.404		0.376		0.339		0.112
Fama-French 3-Factor Regressions								
Market	0.53	[13.74]	0.64	[12.30]	0.80	[10.48]	0.27	[4.91]
SMB	0.39	[7.86]	0.42	[6.32]	0.33	[3.38]	-0.06	[-0.81]
HML	0.50	[9.68]	0.59	[8.56]	0.65	[6.35]	0.15	[2.02]
Intercept	18.1	[1.03]	6.9	[0.29]	-38.9	[-1.11]	-57.1	[-2.26]
T		180		180		180		180
R-Squared		0.639		0.579		0.465		0.146

Panel B. Value Weighted

	High 30%		*Middle 40%*		*Low 30%*		*Low – High*	
Basis Points	**Coefficient**	**[T]**	**Coefficient**	**[T]**	**Coefficient**	**[T]**	**Coefficient**	**[T]**
Mean Excess Returns								
	60.0	[1.28]	51.2	[1.01]	43.9	[0.76]	-16.1	[-0.52]
CAPM Regressions								
Market	1.02	[14.35]	1.06	[13.08]	1.24	[14.00]	0.22	[3.22]
Intercept	10.5	[0.33]	-0.1	[0.00]	-16.3	[-0.41]	-26.8	[-0.87]
T		180		180		180		180
R-Squared		0.536		0.490		0.524		0.055
Fama-French 3-Factor Regressions								
Market	1.03	[16.01]	1.06	[15.25]	1.26	[15.94]	0.23	[3.52]
SMB	0.13	[1.63]	0.17	[1.98]	-0.10	[-1.03]	-0.24	[-2.81]
HML	0.56	[6.60]	0.73	[7.91]	0.63	[6.00]	0.07	[0.78]
Intercept	-12.9	[-0.44]	-30.7	[-0.96]	-35.4	[-0.98]	-22.5	[-0.74]
T		180		180		180		180
R-Squared		0.630		0.626		0.626		0.114

Table 10. Debt and Equity Market Segmentation. Regressions of portfolio returns on market excess returns and government bond excess returns. Each portfolio total return in excess of the riskless rate is computed using value weights. The sample is divided within each month into low (bottom 30%), medium (middle 40%), and high (top 30%) portfolios according to pre-ranking beta, using all CRSP stocks. We also compute the returns to corporate bonds in excess of the riskless rate using data from Ibbotson and Associates. Below we show the market beta, government bond beta, and the alpha (or intercept) for the Bottom 30% portfolio in absolute terms and for the Top 30% portfolio and corporate bonds in relation to the Bottom 30%. The final column compares the extrapolated alpha using the relationship between alpha and beta in the Bottom and Top 30% portfolios to the actual alpha for corporate bonds. In an integrated market, where the low beta anomaly holds equally in stock and bond markets, the actual and extrapolated betas are the same. There are 486 months in the first two panels and 972 in the second two panels.

	Bottom 30%		*Top - Bottom 30%*		*Corporate – Bottom 30%*		*Bottom 30% - Extrapolated Corporate*	
Basis Points	**Coef**	**[T]**	**Coef**	**[T]**	**Coef**	**[T]**	**Coef**	**[prob]**
CAPM Regressions, July 1971-December 2011								
Market	0.66	[34.18]	0.72	[26.27]	-0.50	[-18.34]		
Intercept	18.6	[2.05]	-37.7	[-2.94]	5.7	[0.45]	26.3	
Difference							-20.6	[p =0.141]
R-Squared								0.8193
CAPM Regressions with Government Bond Returns, July 1971-December 2011								
Market	0.65	[42.80]	0.74	[34.90]	-0.55	[-25.90]		
Bonds	0.17	[7.50]	-0.33	[-10.20]	0.61	[19.10]		
Intercept	13.6	[1.90]	-28.2	[-2.80]	-12.1	[-1.20]	52.5	
Difference							-64.7	[p =0.014]
R-Squared								0.892
CAPM Regressions with Government Bond Returns, January 1931-December 2011								
Market	0.71	[64.00]	0.80	[50.82]	-0.62	[-39.67]		
Intercept	14.3	[2.35]	-35.5	[-4.14]	2.4	[0.28]	27.7	
Difference							-25.3	[p =0.029]
R-Squared								0.8917
CAPM Regressions with Government Bond Returns, January 1931-December 2011								
Market	0.70	[72.84]	0.82	[59.86]	-0.65	[-47.83]		
Bonds	0.17	[8.06]	-0.35	[-11.63]	0.57	[18.86]		
Intercept	11.3	[2.16]	-29.5	[-3.98]	-7.3	[-0.99]	47.9	
Difference							-55.2	[p =0.003]
R-Squared								0.9195

Table 11. Theoretical Determinants of Changes in WACC. This table summarizes how the weighted average cost of capital depends on assumptions regarding the efficiency of the debt market, its integration with the equity market, and the existence of a government subsidy. To simplify notation, we define:

$$A(e,e^*) \equiv (1-e)\beta_d - (1-e^*)\beta_{d^*}$$

		Bank Debt		
Risk	**Pricing**	**Integrated Markets**	**Government Subsidy**	***ΔWACC***
Risky	Correctly Priced	No	No	$\gamma\left(e - e^* + A\left(e, e^*\right)\right)$
Risk Free	Correctly Priced	No	No	$\gamma\left(e - e^*\right)$
Risky	Low Beta Anomaly	No	No	$\left(e - e^*\right)\left(\gamma - \overline{\beta}_d \gamma_d\right) + A\left(e, e^*\right)\left(\gamma - \gamma_d\right)$
Risky	Low Beta Anomaly $\gamma = \gamma_d$	No	No	$\gamma\left(e - e^*\right)\left(1 - \overline{\beta}_d\right)$
Risky or Risk Free	Low Beta Anomaly	Yes	No	0
Risky	Correctly Priced	No	Yes	$\gamma\left(e - e^*\right) + A\left(e, e^*\right)\left(\gamma + r_p\right)$

Appendix: Sample Bank Data. Example beta, RMSE, and Tier 1 capital ratio for select large and small capitalization banks as of December 2011. The first panel lists banks with greater than $5 billion in market capitalization. The second panel lists banks with market capitalization between $75 and $125 million. Pre-ranking beta is computed by regressing a minimum of 24 months and a maximum of 60 months of trailing holding period returns in excess of the riskless rate on the corresponding CRSP value-weighted market holding period returns (VWRETD, also in excess of the riskless rate). Pre-ranking root mean squared error uses the residuals from these regressions. The first measure of capital adequacy is the ratio of total equity capital (RCFD3210) divided by average total assets (RCFD3368). The second replaces Tier 1 capital (RCFD8274) in place of total equity capital and uses total risk-weighted assets (RCFDa223) in place of average total assets. The third uses total risk-based capital (RCFD3792) in place of total equity capital.

		Risk		*Capital Adequacy (%)*		
Bank Name	**Market Cap**	**Beta**	**RMSE (%)**	**Equity to Assets**	**Tier 1 Capital to Risk-Weighted Assets**	**Risk-Based Capital to Risk-Weighted Assets**
Panel A. Large Capitalization Banks, Over $5 Billion						
CITIGROUP INC	122,000	2.42	14.52	11.20	15.09	16.91
FIFTH THIRD BANCORP	9,516	2.13	15.79	14.34	13.18	15.17
BANK OF AMERICA CORP	110,400	2.01	14.26	11.40	11.54	14.73
AMERICAN EXPRESS CO	52,027	1.91	11.00	19.22	18.26	19.53
CAPITAL ONE FINANCIAL CORP	17,011	1.65	11.73	15.29	11.94	16.31
STATE STREET CORP	21,687	1.31	8.70	10.80	18.14	19.99
WELLS FARGO & CO NEW	142,800	1.28	10.37	11.20	10.40	13.36
GOLDMAN SACHS GROUP INC	79,825	1.24	8.46	19.22	18.87	23.94
SUNTRUST BANKS INC	11,679	1.19	11.79	11.94	10.05	12.58
P N C FINANCIAL SERVICES GRP INC	28,314	1.14	8.82	15.41	12.18	15.49
MORGAN STANLEY DEAN WITTER & CO	37,005	1.14	12.26	12.17	16.70	19.49
JPMORGAN CHASE & CO	146,200	1.08	8.06	8.40	9.71	13.59
REGIONS FINANCIAL CORP NEW	6,758	1.01	13.27	11.92	11.68	14.93
COMERICA INC	6,440	0.99	8.03	11.04	10.27	14.29
U S BANCORP DEL	45,617	0.94	7.66	10.34	9.30	12.72
B B & T CORP	16,095	0.87	10.79	11.23	13.02	15.48
NORTHERN TRUST CORP	12,182	0.76	6.22	9.14	13.12	15.72
M & T BANK CORP	9,187	0.69	8.62	13.24	8.82	12.43
NEW YORK COMMUNITY BANCORP INC	7,318	0.68	6.57	14.40	13.51	14.18
BANK OF NEW YORK MELLON CORP	33,480	0.61	6.36	9.68	12.14	15.76
KEYCORP NEW	6,630	0.53	11.16	10.54	12.41	16.52

		Risk		*Capital Adequacy (%)*		
Bank Name	**Market Cap**	**Beta**	**RMSE (%)**	**Equity to Assets**	**Tier 1 Capital to Risk-Weighted Assets**	**Risk-Based Capital to Risk-Weighted Assets**
Panel B. Small Capitalization Banks, $75 to $125 Million						
HERITAGE COMMERCE CORP	97	1.54	15.61	13.06	16.83	18.10
FIRST BANCORP P R	77	1.05	19.07	7.63	10.28	11.57
NORTHRIM BANCORP INC	121	1.02	7.68	11.94	13.11	14.36
HERITAGE OAKS BANCORP	83	1.01	10.57	12.70	13.47	14.75
HORIZON BANCORP IND	84	0.90	8.40	9.40	12.70	13.95
ENCORE BANCSHRES INC	108	0.79	17.11	10.33	11.78	13.04
SOUTHERN NATIONAL BANCORP VA INC	85	0.76	9.86	15.82	19.74	20.99
MIDDLEBURG FINANCIAL CORP	97	0.70	7.74	8.40	12.28	13.54
MIDWESTONE FINANCIAL GRP INC NEW	124	0.68	11.79	9.61	11.96	13.21
ENTERPRISE BANCORP INC	106	0.62	6.77	9.04	10.11	11.42
BAR HARBOR BANKSHARES	104	0.62	5.25	9.38	13.72	15.56
N B & T FINANCIAL GROUP INC	78	0.60	5.28	10.30	15.44	16.31
MONROE BANCORP	76	0.58	20.92	8.28	12.44	13.71
PORTER BANCORP INC	121	0.56	9.05	11.30	12.79	14.72
B N C BANCORP	80	0.53	7.53	8.34	11.19	13.01
PREFERRED BANK LOS ANGELES	105	0.43	15.39	10.69	13.75	15.02
OHIO VALLEY BANC CORP	78	0.38	7.62	8.71	12.16	13.41
CHICOPEE BANCORP INC	76	0.32	3.27	13.35	16.14	17.11
WILBER CORP	100	0.28	11.38	8.29	13.22	14.48
B C B BANCORP INC	88	0.26	4.98	9.16	14.95	15.89
NORWOOD FINANCIAL CORP	78	0.18	5.26	12.35	17.94	19.23
CITIZENS HOLDING CO	87	0.17	8.90	8.96	14.82	16.07
CENTURY BANCORP INC	85	0.15	8.36	6.23	12.43	13.61
UNION BANKSHARES INC	80	0.15	4.25	9.21	13.90	15.10
HINGHAM INSTITUTION FOR SVGS MA	89	0.04	4.72	7.20	11.61	12.72