An Analysis of the Impact of "Substantially Heightened" Capital Requirements on Large Financial Institutions*

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Abstract: We examine the impact of "substantially heightened" capital requirements on large financial institutions, and on their customers. Our analysis yields three main conclusions. First, the frictions associated with *raising* new external equity finance are likely to be greater than the ongoing costs of *holding* equity on the balance sheet, implying that the new requirements should be phased in gradually. Second, the long-run steady-state impact on loan rates is likely to be modest, in the range of 25 to 45 basis points for a ten percentage-point increase in the capital requirement. Third, due to the unique nature of competition in financial services, even these modest effects raise significant concerns about migration of credit-creation activity to the shadow-banking sector, and the potential for increased fragility of the overall financial system that this might bring. Thus to avoid tilting the playing field in such a way as to generate a variety of damaging unintended consequences, increased regulation of the shadow-banking sector should be seen as an important complement to the reforms that are contemplated for banks and other large financial institutions.

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I. Introduction and Executive Summary

The purpose of this paper is to examine the impact of the imposition of "substantially heightened" capital requirements on large financial institutions, and on their customers. We focus almost exclusively on the cost side of the equation, taking as given that, all else equal, increased capital requirements offer a benefit in terms of increased systemic stability. Our analysis yields three principal conclusions.

1. Phase-in effects: In the short-to-medium run, banks may be reluctant to seek new external equity to comply with increased capital-ratio requirements. Thus if the new requirements are phased in too rapidly, banks may opt to meet these requirements by slowing the growth of their assets, rather than by adding new capital. This can lead to a contractionary effect on lending activity. A large body of empirical work, which we survey below, suggests that these short-to-medium run effects can be quantitatively significant. Thus there is a strong case to be made for phasing in the new requirements sufficiently gradually that banks can generate the necessary additional capital largely out of retained earnings.

2. Long-run steady-state effects: Much less is known about the long-run steady-state effects on lending activity associated with higher capital requirements. We argue that existing empirical data and techniques do not allow us to make a meaningful direct estimate of these effects. Thus we are left to make predictions based on calibrating a particular economic model, and our predictions are only as good as the assumptions that underlie this model. Using the well-known framework of Modigliani and Miller (1958), where the primary differences in the costs of debt and equity finance are due to differences in their tax treatment, we estimate that even proportionally large changes in the capital requirement are likely to lead to small long-run impacts on the borrowing costs faced by banks' customers. For example, even if the minimum capital ratio is raised by ten percentage points, our methodology suggests that loan rates will increase by something on the order of just 25-45 basis points.[1] Again, however, the caveat is that these estimates are model-dependent, and cannot be directly validated with a precise empirical experiment.

[1] Interestingly, our qualitative conclusions here are close to those reached in recent work by Elliott (2009, 2010), in spite of the fact that our calibration methodologies are quite different.

3. Competition, regulatory arbitrage, and unintended consequences: The above conclusions regarding long-run effects may appear surprising, even paradoxical. If significant increases in capital ratios have only small consequences for the rates that banks charge their customers, why do banks generally feel compelled to operate in such a highly-leveraged fashion, in spite of the obvious risks this poses? By contrast, non-financial firms tend to operate with much less leverage than financial firms, and indeed often appear willing to forego the tax (or other) benefits of debt finance altogether.

We argue that the resolution of this puzzle has to do with the unique nature of competition in financial services. Unlike in many other industries, the most important (and in some cases, essentially the only) competitive advantage that banks bring to bear for many types of transactions is the ability to fund themselves cheaply. Thus if Bank A is forced to adopt a capital structure that raises its cost of funding relative to other intermediaries by only 20 basis points, it may lose most of its business.[2]

On the one hand, this line of reasoning suggests that substantially heightened capital requirements have the potential to meaningfully increase overall social welfare—by stopping a systemically-dangerous form of competition, with only a relatively small adverse effect on the ultimate item of interest, namely loan rates. However, the danger is that, in the face of higher capital requirements, these same forces of competition are likely to drive a greater volume of traditional banking activity into the so-called "shadow banking" sector. For example, perhaps an increasingly large fraction of corporate and consumer loans will be securitized, and in their securitized form will end up being held by a variety of highly-leveraged investors (say hedge funds) who are not subject to the usual bank-oriented capital regulation. If so, the individual regulated banks may be left safer than they were before, but the overall system of credit creation may not.

The thrust of this argument is not that capital requirements should not be raised for large banking firms. Rather, it is that in doing so, very careful attention must be paid to not tilting the playing field in such a way as to generate a variety of damaging unintended consequences. As we argue in more detail below, this is likely to involve increased regulation of the shadow banking sector as a complement to the reforms that are contemplated for banks and other large

[2] Contrast this example with, say the auto industry, where cheap financing is only one of many possible sources of advantage: a strong brand, quality engineering and customer service, control over labor and other input costs, etc., may all be vastly more important to profitability than a 20 basis point difference in the cost of capital.

financial institutions. In particular, we suggest that it would be a good idea to establish regulatory minimum margin (or "haircut") requirements on asset-backed securities, so that any investor who takes a long position in credit assets, irrespective of their identity, cannot do so with an arbitrarily high degree of leverage.

Organization of the Paper

The analysis that supports these conclusions consists of the following parts.

Section II: Conceptual framework: why is equity capital costly?

We begin by discussing the primitive forces that make equity capital more expensive to banks than either short or long-term debt finance. A crucial distinction here is that between stock and flow costs of equity finance, or equivalently between balance-sheet and new-issuance costs. Stock costs are factors like taxes and agency conflicts that make equity capital more expensive to a bank on an ongoing basis, no matter how the equity comes to be on the balance sheet (i.e., even if the equity is accumulated over time via retained earnings). Stock costs thus create a *permanent* wedge when regulatory capital requirements are raised, irrespective of the length of any phase-in period. By contrast, flow costs are costs specifically associated with the process of raising new external equity, and hence can be avoided via an appropriate phase-in period that allows banks to gradually accumulate equity capital via retained earnings. An oft-cited source of flow costs is asymmetric information: firms don't like to issue new public equity because this can be interpreted by the market as a negative signal, and thereby knock down their stock price.

The distinction between stock and flow costs is important in interpreting the empirical evidence. For example, a variety of data (to be discussed in Section III) make it clear that when banks experience adverse shocks to their capital, they cut lending. This evidence is thus pretty decisive in establishing that flow costs are important—i.e., that they inhibit banks from immediately offsetting a shock to capital by raising new equity externally, and therefore lead to significant effects on lending activity. But the evidence does not speak nearly as clearly to the magnitude of stock costs. Thus it is harder to make the empirical case that a properly phased-in increase in capital requirements will lead to a large permanent increase in banks' weighted average cost of capital.

Section III. Evidence on the effects of shocks to bank capital

We survey the large empirical literature that shows how adverse shocks to bank capital can impact lending and broader economic activity. As emphasized above, this evidence is more convincing in establishing the importance of flow costs of equity, as opposed to stock costs: it clearly suggests that jacking up capital requirements in too much of a hurry could be damaging, but it would be a stretch to use it to argue that, in a long-run steady-state, permanently higher capital ratios would have a major effect on lending.

Section IV. Long-run steady-state effects

A. Calibration of magnitudes. As noted above, it is difficult to predict the long-run steady-state impact of an increase in capital requirements on loan rates based simply on an analysis of historical data. As an alternative, we adopt a model-based calibration approach. This approach requires us to take a stand on: i) what source of financing is displaced at the margin when a bank increases its level of equity capital; and ii) what the effective net cost difference is between equity and this alternative source.

In our baseline calibration, we assume that an increase in capital requirements leads banks to replace *long-term debt* financing with equity. This seems like a reasonable assumption, particularly given that for the largest banks, long-term debt as a fraction of assets is roughly 14%—suggesting that there is plenty of room for long-term debt to absorb the regulatory change without forcing banks to alter their use of (ostensibly cheaper) short-term debt.[3] Moreover, in the spirit of Modigliani-Miller (1958), we assume that the only net difference in financing costs associated with this change in capital structure comes from the tax advantage of debt. This leads us to estimate that each one-percentage point increase in capital requirements raises the rate on bank loans by 2.5 basis points. Thus even a relatively radical ten-percentage point increase in the capital ratio would lead to only a 25 basis-point increase in loan rates.

In an alternative, more aggressive calibration, we assume that an increase in capital requirements leads banks to replace *short-term wholesale debt* financing with equity. (This assumption is perhaps more naturally interpreted as capturing the combined effects of a change in capital requirements along with a new liquidity requirement that caps the ratio of short-term

[3] As of 2009Q4, large U.S. BHCs – those with more than $10 billion in assets – together controlled $14.555 trillion in assets and had $2.057 trillion in long-term debt outstanding. Long-term debt includes the sum of other borrowed money with a remaining maturity of one year of more, subordinated notes, and trust preferred securities.

bank debt to total debt.) We also assume that, in addition to the tax advantage, short-term debt is cheaper for a bank than long-term debt because it offers investors a liquidity and/or surety advantage that they are willing to pay a premium for. Taken together, and erring on the side of overstating magnitudes, these two assumptions together imply that each one-percentage point increase in capital requirements now raises the rate on bank loans by 3.5 basis points. So the effect in the more aggressive scenario is clearly stronger, though still small in absolute terms.

Again, these estimates are only as good as the model that underlies them. The key assumption that we rely on in adopting the Modigliani-Miller approach is that when a bank shifts to a capital structure with more equity financing, its cost of equity falls, so that the overall effect on its weighted average cost of capital is less than would obtain in a world in which the cost of equity was a fixed constant, independent of capital structure. The reasoning is that as a bank delevers, its equity becomes less risky, so investors should rationally demand a lower risk premium for holding the equity. Although it is hard to fully validate this assumption empirically, we are able to present some supporting evidence, showing that the stock returns of less-levered banks do indeed tend to exhibit both less volatility and a lower beta with respect to the aggregate stock market.

B. Bank capital ratios across time and space. We present some descriptive statistics on bank capital ratios at different periods in history, and for banks of different types. The striking observation here is that there have been times when banks have operated with much more capital than they do today. Moreover, there does not seem to be any significant correlation in the time-series data between capital ratios and various measures of lending spreads, such as the difference between the prime lending rate and the Treasury-bill rate. While obviously crude, these findings fit with the conclusion from our calibration exercise, namely that higher capital ratios need not imply large effects on loan rates.

At the same time, the data hint at the idea that, the stronger are the forces of competition, the more banks are driven in the direction of high leverage. In particular, we find that smaller banks tend to operate with lower leverage than their larger counterparts. One might conjecture that the reason that smaller banks are able to maintain lower leverage is because they tend to focus on a type of lending that is more relationship-dependent, for which customer switching costs soften the degree of competition. Whereas larger banks, whose business is by nature more

transactional, face more intense competition, both from within the banking sector as well as from non-bank providers of finance such as the corporate bond market or the shadow banking sector.

Section V. Competition, regulatory arbitrage, and unintended consequences

A. Evidence on the competition hypothesis. In an effort to test the above competition hypothesis more carefully, we study the response of bank capital structure to exogenous deregulatory shocks, such as changes in intrastate or interstate branching regulations. Our estimates suggest that an increase in competitive pressure brought about by deregulation leads banks to significantly increase their leverage. Moreover, this increase in leverage is most pronounced among those banks in a given market that were initially the most conservatively financed. Thus the data appear to support the idea that the competitive environment exerts an important influence on bank capital structure.

B. Evidence on regulatory arbitrage. We describe in some detail how competitive pressures have in the past led banks to use various off-balance sheet structures (e.g. conduits and SIVs funded by asset-backed commercial paper) in an effort to evade regulatory capital requirements. While these specific forms of regulatory arbitrage can presumably be shut down going forward, the broader point is that the financial sector is continually adapting to the regulatory environment, and if anything, the pace of innovation on this dimension is likely to accelerate as capital requirements become more burdensome. Of particular concern is the possibility that the next round of innovation will lead to an increase in the share of credit creation that is not just off of banks' balance sheets in a technical sense, but that has migrated away from the banking sector altogether.

II. Conceptual Framework: Why is Equity Capital Costly?

The point of departure for our discussion is Modigliani and Miller's (1958) famous analysis of capital structure, henceforth M-M. M-M showed that under certain idealized conditions, a firm's capital structure is irrelevant for its operating decisions. In the banking context, this would imply, e.g., that the rate that a firm charges on its loans should be *independent* of its ratio of equity to assets. The idealized conditions are stringent—they include no taxes, symmetric information, rational risk-based pricing, and the notion that a firm's cashflows are fixed and independent of its financial policy. Thus they are obviously not meant to be an accurate representation of reality. Rather, the usefulness of the M-M approach derives from the fact that it forces one to be precise about which of the deviations from the idealized conditions is at work, which allows for a more disciplined analysis of the economic effects associated with changes in capital structure.

In particular, the M-M paradigm exposes the logical weakness associated with the following informal reasoning: "Equity is more expensive than debt because it is more risky. Thus if a bank is forced to rely more heavily on equity to finance itself, its overall cost of finance will go up, and it will have to charge more for its loans." The fallacy here is that the risk of equity, and hence the required rate of return on equity, depends on the bank's leverage. While equity is always more risky than debt, the riskiness of a bank's equity declines as its leverage falls. (We will demonstrate that this holds empirically below.) Indeed, when all of the idealized conditions set out by M-M hold, this effect is just enough to offset the increased weight of the more-expensive equity in the capital structure, so that the overall cost of capital *stays fixed* as bank leverage varies.

With this caveat in mind, we now discuss the various deviations from M-M's idealized conditions that are likely to be of most importance in a banking context. We group these deviations into two categories: those that are relevant for thinking about flow costs of new external equity finance; and those that are relevant for thinking about long-run stock costs of holding equity on the balance sheet.

A. Sources of Flow Costs of Raising External Equity Finance

The leading flow-cost theory is due to Myers and Majluf (1984), who emphasize the asymmetry of information between better-informed management and less-well-informed outside

investors. If management acts on behalf of existing shareholders, then a choice to raise new equity will be taken as a negative signal by outsiders, since management will be more inclined to sell stock when they think it is overvalued as opposed to undervalued. As a result of this signaling effect, new issues will tend to be associated with negative stock-price impacts, a pattern which has been repeatedly documented in the data. And anticipating the negative market response, management will be reluctant to move forward with an equity issue in the first place. This reasoning forms the basis for a "pecking-order" account of capital structure, according to which firms are not averse to having an equity-heavy capital structure if they can accumulate this equity over time via retained earnings, but where a firm that finds itself in an overly-levered position may prefer to skimp on new investment (i.e., on new lending in a banking setting) rather than actively using external equity issues to adjust back towards a more desirable leverage ratio.

Thus according to the Myers-Majluf model, if a bank with an 8% ratio of equity to risk-weighted assets were to suddenly find its regulatory minimum ratio raised to 12%, it might be reluctant to make the adjustment by raising new external equity, and instead might shrink its assets—even when the loans that get cut in the process would otherwise be thought of as positive-net-present-value investments. In this sense, the Myers-Majluf model offers a clear caution against overly-rapid phase-in of higher capital standards. At the same time, it does not suggest any reason to think that gradually-phased-in standards would retard loan growth. In the context of the example above, if banks are given time to move from 8% to 12% largely via retained earnings, they will choose to do so without cutting back on positive-NPV loans.

B. Sources of Balance-Sheet Costs of Holding More Equity

As described above, the leading theory for why equity is more expensive than debt on a steady-state, ongoing basis, has to do with corporate income taxes, and the fact that interest payments on debt are tax-deductible, while dividend payments on equity are not. An appealing feature of this theory is that it lends itself to easy measurement. Given the corporate tax rate, it is straightforward to compute the annual value of the tax shields associated with debt finance, and this is the primary method we rely on in our calibrations below.

One caveat, however, is that such calculations are likely to yield an *upper bound* on the tax advantages of debt, because they account only for the fact that debt is tax-favored at the issuer level. As emphasized by Miller (1977), there is an offsetting advantage to equity finance

at the investor level, in that the income to equity holders is often more lightly taxed.[4] Because the magnitude of this offset is hard to estimate precisely, and is the subject of some controversy, we ignore this complication in what follows. Again, this will have the effect of overstating the tax benefits of debt, and thereby yielding an estimate of the impact of higher capital requirements that is, if anything, biased upward.

More recent research has suggested other violations of the M-M conditions that might make debt, and in particular short-term debt, an attractive form of finance for banks. Diamond and Rajan (2001) argue that, given the easily transformable nature of their assets, banks are vulnerable to agency problems on the part of their management. In other words, management may take risks that are not in the interests of bank investors, or otherwise mismanage the assets. Diamond and Rajan argue that short-term debt mitigates this value-destroying behavior, because the looming threat of a run disciplines management. While this theory is appealing and likely captures an important element of truth, there has thus far been little evidence that allows one to quantify its effects.

An alternative point of view is offered by Gorton (2010), Gorton and Metrick (2009), and Stein (2010). These papers argue that banks benefit from issuing collateralized short-term debt—as in, e.g., repo finance—because this debt commands a "money-like" convenience premium based on its relative safety and the transactions services that safe claims provide. With some assumptions, this effect can be roughly bounded. Krishnamurthy and Vissing-Jorgensen (2010) estimate that Treasury securities impound a money-like convenience premium of approximately 72 basis points, above and beyond what would be expected in a standard risk-vs.-return asset-pricing setting. Of this, they attribute roughly 46 basis points to the superior liquidity of Treasuries, and 26 basis points to their "surety" value—the fact that Treasuries offer an absolutely certain nominal return. To the extent that banks can create similarly money-like short-term claims, they may be able to capture some fraction of the 72 basis-point premium that Krishnamurthy and Vissing-Jorgensen estimate for Treasuries. We take advantage of this insight in an alternative version of our calibrations below.

[4] For example, much of the return to investors on equity comes in the form of capital gains, which can be deferred, thereby allowing for a form of tax-free compounding.

III. Evidence on the Effects of Shocks to Bank Capital

A. Identification Issues

In this section, we review the large empirical literature that explores how adverse shocks to bank capital may impact lending and broader economic activity.[5] There are two generic challenges to proving and quantifying these linkages. We begin with a description of these conceptual problems and then provide a succinct description of some representative studies.

The first problem is showing that a change in capital is causing a change in lending, rather than reflecting it. As economic conditions deteriorate banks generally experience loan losses that reduce their capital and find that lending opportunities worsen as well. Thus, there are good reasons to expect to find that declines in capital will happen in tandem with falling loan volumes and slower economic growth, but in this scenario the causation is running from economic conditions to capital changes. The goal in many studies is to purge these effects to deduce whether capital impaired banks are cutting lending to deserving borrowers.

Broadly speaking there are three ways that economists have tried to infer the direction of causation. One approach is to look for "natural experiments" where a shock to capital happens because of reasons that have nothing to do with lending opportunities. In this case, any change in lending that follow the change in capital can be confidently assumed to have been caused by the capital shock. We consider this approach to be the most convincing way to solving the problem.

A second strategy is to assume that rebuilding capital differs across banks in predictable ways. Provided that lending opportunities are the same for all banks, then studying the cross-bank differences in loans granted following a change in capital that affects many banks can uncover the effects of the capital shock. The plausibility of this strategy hinges on the credibility of the two maintained assumptions. In particular, do banks differ only in their ability to raise capital, or are there other factors that distort lending opportunities in systematic ways so that loan volumes may reflect these other factors and not just capital differences? As we explain below, each study of this type is subject to alternative interpretations, but the fact that so many deliver similar answers suggests to us that they are informative.

The third approach relies on statistical assumptions to resolve the interpretation. These studies essentially rule out the reverse causation by attempting to control directly for effects of

[5] See Sharpe (1995) for a survey of the work on this issue through the 1990s.

the economy on capital. We view these studies as the least convincing of the three because in most cases it is easy to find problems with the controls and with imperfect controls the interpretation is clouded.

As argued above, banks may not rapidly offset shocks to their capital because asymmetric information makes it costly for them to raise external equity. Importantly, heightened macroeconomic or financial uncertainty may amplify these informational asymmetries, making it particularly costly for banks to raise capital during economic downturns. Since much of the variation in the historical data is from times when it was arguably most costly for banks to raise external equity (e.g. the 1990 recession), estimates of the impact of capital shocks on loan supply drawn from the existing literature probably represent an *upper bound* on the plausible phase-in effects from heightened capital requirements.[6]

The other broad challenge is to show that changes in loan supply impact firm investment or household spending. Many studies only show how capital shocks alter lending by some group of banks leaving open the question of whether borrowers who fail to get loans can find financing elsewhere. Borrowers can draw down savings, approach other banks, or turn to non-banks (or even markets) to maintain spending. Moreover, even if one can establish that some borrowers cut back their spending because of a lack of financing, there is the additional possibility that others in the economy will offset the change. For example, if some firms cut investment, their competitors might increase it so that aggregate investment is not changed.

Because of the inherent difficulty in accounting for these possibilities, it is not easy to generically summarize the strategies adopted to determine spending effects. Many studies presume that bank lending is essential for certain types of borrowers (e.g. small firms or poor consumers), but even if these effects are documented, potential substitution effects can offset them. So, it is not surprising that the literature reaches very different conclusions about the effects of changes in loan supply on the economy. Given the diversity of estimates and caveats associated with each, it would be misleading to claim that the literature has reached a verdict on the magnitude of this channel. So we will be very terse in reviewing these estimates.

[6] For instance, even if one concludes that the introduction of Basel I played a role in exacerbating the purported "credit crunch" of the early 1990s, it doesn't follow that a well-designed phase-in of substantially higher capital requirements in the coming years would lead to a similar credit crunch. In some sense, it may have simply been unlucky that Basel I went into effect just prior to a global macroeconomic slowdown.

B. Estimates of Capital Effects on Bank Lending

The cleanest study of these effects is by Peek and Rosengren (1997) who exploit an interesting natural experiment involving the U.S. branches of Japanese banks to identify how shocks to capital impact loan supply. Basel I allowed Japanese banks to count their significant unrealized gains on common equity holdings as Tier 2 capital. Branches and subsidiaries of Japanese banks expanded aggressively in the U.S. in the 1980s, accounting for 18% of C&I loans by 1990. When Japanese stock market lost half of its value between 1989 and early 1992, the capital ratios of many large Japanese banks fell below the 8% Basel I minimum. Peek and Rosengren (1997) exploit these fact and find that a 1 %-point decline in the Japanese parent's capital ratio results in 6% decline in loans at the branch (the decline is roughly 4% of branch assets). This identification strategy plausibly isolates shocks to bank loan supply from shocks to loan demand, allowing the authors to estimate how bank capital impacts loan supply.[7]

Houston, James, and Marcus (1997) use another clever identification strategy to isolate shocks to bank capital that are plausibly unrelated to lending opportunities. Specifically, they show that loan growth at all banks owned by a single BHC is impacted by capital shocks at other banks and non-bank affiliates owned by the BHC. For instance, loan growth at well capitalized subsidiaries is 5 percent per year lower when the holding company capital is below the regulatory minimum.

Bernanke and Lown (1991) is representative of the many studies that compare different groups of banks to assess the importance of capital shocks on lending. In this study they compare lending by large and small banks in New Jersey during the 1990-91 recession to infer the connection between capital ratios and loan growth. They observe that loan growth for large banks is unrelated to capital while there is a highly statistically significant connection for small banks. Assuming large banks have better access to capital, this difference would be consistent with a "capital crunch" hypothesis. But other interpretations are possible too. For instance, it could be that large banks have different loan markets than small banks.

Many other studies of this type rank banks relative to target levels of capital and hypothesize that banks that are close to the target will have lending that is more sensitive to capital than those banks with surplus capital. Two highly cited studies of this type are by

[7] Interestingly, the behavior of U.S. subsidiaries of Japanese banks, which are separately capitalized, is far less sensitive to parent's financial conditions than U.S. branches which are not separately capitalized.

Hancock and Wilcox (1993, 1998). Both studies find significant correlations between capital relative to target and lending. But the size of the effects varies substantially over time. For instance, during the 1990-91 recession sensitivity of lending to capital is roughly three times higher for large banks than in 1991-92.

Berrospide and Edge (2009) and Francis and Osborne (2009) are two recent contributions of this type and use a common approach to examine how loan growth is impacted by estimated capital deficits. They assume that capital ratios follow a partial adjustment process $K_{i,t} - K_{i,t-1} = \lambda \cdot (K^*_{i,t-1} - K_{i,t-1}) + \varepsilon_{i,t}$ and that target ratios depend on firm variables $K^*_{i,t-1} = \alpha_i + \boldsymbol{\theta}'\mathbf{x}_{i,t-1}$, so that $K_{i,t} = \lambda\alpha_i + (1-\lambda)K_{i,t-1} + \lambda\boldsymbol{\theta}'\mathbf{x}_{i,t-1} + \varepsilon_{i,t}$.[8] Using the estimated target ratios from this regression, they measure capital surpluses as $Z_{i,t} = (K_{i,t} - \hat{K}^*_{i,t}) / \hat{K}^*_{i,t}$ and estimate $\Delta L_{i,t} = \alpha_i + \beta \cdot Z_{i,t} + \sum_{j=1}^{4} a_j \Delta L_{i,t-j} + \sum_{j=1}^{4} \mathbf{b}'_j \mathbf{m}_{t-j} + \boldsymbol{\theta}'\mathbf{x}_{i,t-1} + \varepsilon_{i,t}$ where $\mathbf{m}$ is a set of macro variables (Fed Funds, GDP growth, inflation, and lending standards). The assumption is that the macroeconomic variables control sufficiently for the effect of these factors on capital and loans so that the remaining connection between the two can be interpreted causally.

Berrospide and Edge (2009) estimate this model using quarterly bank holding company data on 165 large BHCs from 1994 to 2008. Their estimates imply that a bank with an 11% capital ratio and a target ratio of 10% (i.e. a capital surplus of (11% - 10%)/10% = 10%), would have incremental loan growth of 1% over the following year relative to a bank with zero surplus. Francis and Osborne (2009) estimate a similar model for a set of U.K. banks from 1996 to 2007. One benefit of their setting is that U.K. supervisors maintain different capital targets for individual banks and the authors use confidential data on these targets to see how a bank's estimated internal target responds to changes in supervisory targets. Their first stage estimates suggest that if supervisors raise a bank's regulatory target by 1%, the bank's model-implied internal target rises by 0.65%. They then estimate how bank assets, loans, and capital respond to estimated capital deficits or surpluses. Their estimates imply that a bank with a 11% capital ratio and a target ratio of 10% (i.e. a capital surplus of (11% - 10%)/10% = 10%), would grow loans

[8] This partial adjustment formulation was developed in Flannery and Rangan (2006) and used in Flannery and Rangan (2008).

by 0.5%, assets by 0.6%, and risk-weighted assets by 1.0% and would shrink its capital by 1% over the following year relative to a bank with zero surplus.

These papers and others (such as Brinkmann and Horvitz (1995), Ediz, Michael, and Perraudin (1998), Hancock, Laing, and Wilcox (1995), and Ito and Saaski (2002)) all find that capital shocks matter for lending. While each can be interpreted in ways that cast doubt on the causal interpretation of the correlation between lending and capital, collectively they paint a very consistent picture that seems hard to dismiss. However, the magnitudes of the effect vary across studies, so we do not suggest that they agree on this dimension.

Our conclusion from a reading of all three types of studies is that there is little doubt that shocks to capital lead banks to adjust their lending. The magnitude of the estimates varies, but it seems safe to conclude that a substantial increase in capital requirements, if implemented abruptly would likely reduce lending.

C. Effects of Lending on Economic Activity

Even if capital constrained banks cut their loans, in order for this to have real effects it must be the case that customers are not able to offset this by borrowing in securities markets or from other unconstrained intermediaries. Here we briefly describe the various ways that past studies have tried to deal with this challenge.

Peek and Rosengren (2000) show that the exogenous loan supply documented in Peek and Rosengren (1997) impacted real activity in U.S. states where Japanese branches had a significant market presence. Specifically, they run state-level panel regressions of measures of real estate activity on lending activity by Japanese banks, state-level asset quality measures for all banks, and state and national economic indicators. They instrument for state-level Japanese lending activity using variables that capture the health of the relevant Japanese parents and changes in Japanese land prices and find that lending by Japanese branches is positively related to state-level real estate activity.

The more typical approach builds on the purely statistical approach described above. For example, Berrospide and Edge (2009) estimate a simple time-series vector autoregression that includes three standard macro variables (GDP growth, inflation, and the Fed Funds rate) and three banking related variables (aggregate loan growth at banks and thrifts, aggregate bank equity-to-assets, and senior loan officer opinion survey of lending standards). They make some

fairly strong assumptions so they can interpret the reduced form as a structural VAR.[9] They find that loan growth rises and lending standards loosen following a positive shock to capital. GDP also rises. Their estimates imply that the Treasury's Capital Purchases Program in the late 2008 and early 2009 would have raised loan growth by 3.7% which is 3-4 times larger than what they found in their bank-level estimates described earlier. However, echoing the findings in Morgan and Lown (2006), Berrospide and Edge find that innovations to lending standards play a much larger role in explaining loan growth and GDP growth than innovations to bank capital.

There are other studies that find negligible effects of bank capital on economic activity. For instance, Levintal (2009) examines the panel of OECD countries from 1979-2003 and, controlling for lagged ROA, finds that lagged capital has no significant effect on future real GDP growth in a host of dynamic panel regressions.

Thus, despite the importance of the question of how an under-capitalized banking system influences the economy, the literature on this question remains relatively open. Given the many steps that need to be confirmed to arrive at an estimate, this is perhaps not surprising.

Section IV. Long-Run Steady-State Effects

In this section, we discuss the steady-state costs of *holding* more equity capital on the balance sheet, and how these might ultimately impact the cost of credit for bank customers. As we have been emphasizing throughout, these costs are conceptually quite different from the costs of *raising* additional equity capital.

A. Validating the Modigliani-Miller Conservation of Risk Premise

As described above, our methodology is based on the Modigliani-Miller framework. Central to this framework is the *principle of conservation of risk*. This principle implies that as a bank reduces its leverage, and moves to a more equity-heavy capital structure, its equity becomes less risky, and therefore requires a lower return. To understand the idea, it is useful to consider a concrete example. Suppose we have a bank that initially has a ratio of equity to assets of 8%,

[9] Specifically, the authors assume that financial variables do not contemporaneously affect macro variables, but that macro variables do contemporaneously affect financial variables. They also assume that loan growth contemporaneously affects standards and capital, but not vice versa, and that changes in capital contemporaneously impacts standards, but not vice versa.

and a stock market beta of 1.0. Suppose further, just to keep the example simple, that its debt can be thought of as approximately riskless. Now we double the bank's equity ratio, to 16%. What should happen to its beta? If the underlying riskiness of the bank's assets has not changed—i.e., if total risk is conserved—this risk is now spread over an equity cushion that is twice as large. Thus each dollar of equity only bears half as much risk as before. So we would expect the bank's equity beta to fall in half, to 0.5.

This prediction can be tested empirically. Using Compustat and CRSP, we form an annual panel of publicly traded banking firms from 1976-2008.[10] For each bank, its market beta (β) as well as its idiosyncratic return volatility (σ) is estimated using monthly regressions over a trailing 24-month period. In order to compute β and σ, we require that a firm has valid returns for at least 12 of the previous 24 months. We restrict our attention here to large banks, defined as those with assets greater than $10 billion in 2008 dollars.

We estimate:

$$\hat{\beta}_{i,t} = a_{\beta,t} + b_{\beta} \cdot (BE_{i,t-1} / BA_{i,t-1}) + c_{\beta} \cdot \ln(BA_{i,t-1}) + d_{\beta} \cdot \ln(BE_{i,t-1} / ME_{i,t-1}) + \varepsilon_{i,t}^{\beta} \qquad (1)$$

as well as:

$$\hat{\sigma}_{i,t} = a_{\sigma,t} + b_{\sigma} \cdot (BE_{i,t-1} / BA_{i,t-1}) + c_{\sigma} \cdot \ln(BA_{i,t-1}) + d_{\sigma} \cdot \ln(BE_{i,t-1} / ME_{i,t-1}) + \varepsilon_{i,t}^{\sigma}. \qquad (2)$$

Here $BE_{i,t-1} / BA_{i,t-1}$ is the ratio of book equity to book assets, $\ln(BA_{i,t-1})$ is the log of book assets (in 2008 dollars), and $\ln(BE_{i,t-1} / ME_{i,t-1})$ is the log book-to-market equity ratio. The regressions include year effects, so the identification is coming from cross-sectional variation in equity-assets and $\hat{\beta}$ (or $\hat{\sigma}$). To limit the impact of outliers or reporting errors, we throw out outlying observations where $BE_{i,t-1} / BA_{i,t-1}$ is above the 99th percentile. Standard errors are robust to clustering at both the year-level (i.e. cross-sectional correlation across firms) and at the firm-level (serial correlation for a given firm) as in Thompson (2010).

Table 1 shows that both $\hat{\beta}$ and $\hat{\sigma}$ are, as predicted, decreasing in the ratio of equity-to-assets. The results are strongly statistically significant. Moreover, we can compare the estimated magnitudes to those predicted based on the conservation-of-risk principle. To do so,

[10] Banking firms are defined as those with 4-digit SIC codes between 6011 and 6059 or between 6120 and 6129. As a result, the sample includes both bank holding companies and thrift holding companies.

note that the median ratio of equity-to-assets for our sample of large banks is roughly 7%, and the median beta is roughly 0.90. According to the theory, if we double the equity ratio to 14%, the beta should fall in half, to 0.45. In column (1) of the table, we see a coefficient on the equity ratio of -0.045. This coefficient implies that if the equity ratio goes up by 7 percentage points, beta will fall by 0.32 to 0.58 (since 0.045*7 = 0.32). In other words, the empirical magnitudes are broadly in line with what is predicted by the conservation-of-risk principle

Of course, there are a number of caveats to this very simple analysis. For example, banks with different risk profiles may choose different capital structures, so one has to be careful in interpreting a correlation between risk and leverage in a causal manner, as we do. In addition, even if bank risk falls immediately as capital buffers increase, it may take some time for market participants to fully recognize this fact, and hence for required returns on equity to adjust. Nevertheless, these results give us some empirical support for using the M-M framework as a basis for our calibrations, particularly for the purposes of a long-run steady-state analysis.

B. Calibration of Magnitudes

The following table displays the results of our calibrations under three different scenarios. In each case, we ask what the incremental effect of a given increase in the required ratio of equity to assets will be on a bank's weighted average cost of capital (WACC), and by extension, on the rates it charges on the loans it makes. In doing so, we are assuming that all increases in cost of capital get passed on one-for-one to loan customers, which can be thought of as a crude worst-case scenario from the perspective of lending rates.

Increase in Required Ratio of Equity to Assets	**Increase in WACC: Equity Crowds out Long-Term Debt (Tax Effects Only)**	**Increase in WACC: Equity Crowds out Short-Term Debt (Taxes Plus 1% Money Premium)**	**Increase in WACC: Aggressive Case (Taxes Plus 2% M-M Violation)**
2%	5 bp	7 bp	9 bp
4%	10 bp	14 bp	18 bp
6%	15 bp	21 bp	27 bp
8%	20 bp	28 bp	36 bp
10%	25 bp	35 bp	45 bp

In the first scenario, the incremental new equity capital is assumed to displace long-term debt in the bank's capital structure. Following the traditional M-M plus taxes approach, the only effect on the WACC comes from the lost tax shields on the debt. If we assume that the coupon on the long-term debt is 7%, and given a corporate tax rate of 35%, each percentage point of increased capital raises the WACC by .07*.35 = 2.45 basis points. Thus even a relatively extreme ten-percentage-point increase in the capital requirement would only raise the WACC by about 25 basis points.

In the second scenario, the new equity capital is assumed to displace short-term debt; this might be loosely interpreted as capturing the joint effects of a simultaneous increase in capital and *liquidity* requirements. Here we assume that there is a non-risk-based "money" premium on wholesale short-term bank debt that reflects its usefulness as a transactions medium. (Think of the fact that bank commercial paper and repo is often held by money market mutual funds, who in turn issue checkable deposits.) As noted above, Krishnamurthy and Vissing-Jorgensen (2010) estimate that Treasury securities impound a money-like convenience premium of approximately 72 basis points, on top of what would be expected in a standard risk-vs.-return asset-pricing setting. In the spirit of generating an upper-bound estimate, we assume that the convenience premium on short-term bank debt is a full 100 basis points. Thus in this case, a ten-percentage-point increase in the capital requirement raises the WACC by an additional 10 basis points relative to the previous taxes-only case—so we are up to 35 basis points in total.

While we view the 35 basis-point figure as already likely to be on the high side, in the third scenario we add, somewhat arbitrarily, another 100 basis-point violation of the M-M assumptions. That is, we assume that, in addition to tax effects, each incremental unit of equity in the capital structure costs on net 200 basis points more than the debt it displaces (i.e., 100 basis points of money premium, plus another 100 basis points of arbitrary fudge factor). In this most aggressive calibration—which should be thought of as an intentionally loose upper bound—the impact of a ten-percentage-point increase in capital requirements on the WACC is 45 basis points.

C. Bank Capital Ratios Across Time and Space

A different way of coming at the question of the steady-state consequences of higher capital ratios is to examine the historical record. Figure 1, which is adapted from Berger,

Herring, and Szego (1995), plots the ratio of book equity to book assets for U.S. commercial banks from 1840 to 2009. Book capital ratios exceeded 50% in the 1840s and fell steadily for the next 100 years, reaching 6% by the 1940s. As noted by Berger et al, capital ratios fell noticeably following the passage of the National Banking Act of 1863, the Federal Reserve Act of 1914, and Federal Deposit Insurance Act of 1933. The National Banking Act and the Federal Reserve Act introduced forms of reserve requirements for national and member banks, respectively. The Federal Reserve Act also created the discount window and the Federal Deposit Insurance Act introduced deposit guarantees. Each of these regulations arguably lowered the costs of financial distress which would lead banks to hold less capital according to a textbook trade-off theory of capital structure.

Capital ratios rose from 6% to 11% from 1990 to 2009. This may reflect the fact that Basel I risk-based capital requirements were implemented in the U.S. from 1990 to 1992. Flannery and Ragan (2008) argue that conjectural government guarantees were weakened by FDIC Improvement Act of 1991 and the National Depositor Preference Act of 1993 which lead to increase market discipline by uninsured bank creditors and induced banks to hold more capital.[11,12] At the same time, banks were taking increasing risk off-balance sheet, suggesting that some of the observed increase in capital ratios since the early 1990s may be due to increased regulatory arbitrage and the mismeasurement of risks.

Capital ratios and the cost of bank credit, 1920-2009

Have these significant fluctuations in the amount of equity held by banks over time translated into meaningful differences in the cost of bank credit relative to a bank's own cost of funds? To gain some insight into these questions, we examine the evolution of three proxies for

[11] FDICIA introduced the Prompt Corrective Action regime and risk-based deposit insurance while the Depositor Preference Act made depositors senior in right of payment to a bank's other general creditors in the event of failure.

[12] Looking at data from the U.S., U.K. and Canada, Saunders and Wilson (1999) argue that 19th century banks held significant amounts of capital to ensure that their deposits were an informationally insensitive transaction medium a la Gorton and Pennacchi (1990). They suggest that industry consolidation and the introduction of Federal safety nets reduced the necessity of such high capital levels. Canadian and U.K. capital ratios fell in the early 20th century as their banking industries underwent significant consolidation. While the U.S. industry banking did not consolidate significantly until the 1990s, the introduction of the Federal Reserve and the FDIC reduced the need for high capital ratio. Saunders and Wilson also note that while equity volatility has trended upward in all three countries, asset volatility has remained roughly constant, suggesting that most the rise in equity risk is primarily due to lower capital ratios as opposed to increased risk taking.

the mark-up or spread that banks charge borrowers over their cost of funds: i) the net interest margin (net interest income over earning assets); ii) the earning yield on loans (interest income on loans over gross loans) minus the rate paid on deposits (interest expense on deposits over deposits); and iii) the prime rate minus the rate on short-term Treasury bills. Our net interest margin and prime-rate spread series are available from 1920-2009, while the loan yield minus deposit rate series is only available beginning in 1927.[13] These three series are plotted individually versus commercial bank equity-assets in Figure 2. None of these measures is without problems. For instance, net interest margins will be affected by changes in the mix of loans versus securities held by banks over time. Furthermore, the prime rate has become a less meaningful indicator of the cost of customer loans over the last 15 to 20 years.

In Table 2, we regress each of these measures on the ratio of equity-to-assets.[14] In univariate regressions, there is no discernible relationship between equity-assets and any of our three mark-up measures. In fact, the univariate relationship is actually negative for the net interest margin and the loan yield minus the deposit rate. Thus the simplest analysis reveals no tendency for higher capital ratios to be associated with higher loan spreads.

In the second column in each panel, we control for other plausible determinants of mark-ups. These controls include: Treasury bill yields, the squared Treasury bill yield, the term spread (yield on long-term Treasuries minus the bill yield), a recession dummy based on NBER business cycle dates, a time trend, and the ratio of loans to earning assets. While these controls greatly enhance the fit of the regressions—the R^2 now range from 0.77 to 0.93—the coefficients on the key equity-to-assets variable remain small and statistically insignificant in the first two specifications, those involving the net interest margin and the loan yield minus the deposit rate.

By contrast, in the third specification, that involving the spread between the prime rate and T-bills, the coefficient on the equity-to-assets variable is large and statistically significant. The point estimate of 28.31 implies that a one-percentage point increase in the ratio of equity-to-assets is associated with a 28 basis point increase in the cost of loans. The magnitude of this effect is approximately *ten times* that emerging from our calibrations, and if anything, is too big

[13] Data from 1919-1933 is for Federal Reserve member banks and is from Banking and Monetary Statistics, 1919-1941. Data from 1934-2010 is for all insured commercial banks and is taken from the FDIC's Historical Statics on Banking at http://www2.fdic.gov/hsob/. Interest income on loans is not available until 1927.

[14] The dependent variables and most of the regressors are highly persistent, so we compute Newey-West (1987) standard errors allowing for serial correlation at up to 5 lags.

to make economic sense—loosely speaking, it implies that the cost of equity exceeds the cost of debt by 28 percentage points.

Overall, based on these divergent results, our reading of the historical evidence is that it is too noisy, and our proxies for bank lending spreads too crude, for us to draw any firm conclusions about whether a reliable correlation between equity ratios and lending costs *even exists*. Certainly this data does not allow us to get anywhere close to a precise quantitative estimate of the sort that we would like to have. This reinforces the notion that our theory-based calibrations, despite the caveats that they entail, are likely the best that we can do to come up with meaningful numerical estimates.

Capital ratios by bank size

Figure 3 plots capital ratios by bank size from 1976-2009. Specifically, Panel A plots the ratio of book equity to book assets from 1976-2009, while Panels B, C, and D plot total risk-based capital ratios, Tier 1 leverage ratios, and Tier 1 risk-based capital ratios from 1996 through 2009. We divide banks into five size groups based on their assets in 2008Q4 dollars: "small community" banks with assets less than $100 million, "large community" banks with assets between $100 million and $1 billion, "regional" banks with assets between $1 and $10 billion, "small super-regional" banks with assets between $10 and $100 billion, and large banks ("large super-regional" or "money-center") with assets greater than $100 billion.

Panel A shows that book equity to assets has risen for all five size groups since the late 1980s. Historically, capital ratios have been much higher for community banks with assets less than $1 billion (in 2008 dollars) than for larger banks. The smallest community banks, those with less than $100 million in assets, have had particularly elevated capital ratios historically. The largest banks, those with assets greater than $100 billion, held less Tier 1 capital than banks with assets between $1 and $100 billion. However, the differences in Total risk-based capital ratios between the largest banks and mid-sized banks were not as large because the largest banks held more Tier 2 capital in the form of subordinated debt.

In the past, regulators and counterparties were comfortable with the lower capital ratios of large banking organizations, reasoning that their greater geographic and product diversification would ensure a lower *probability of default* than a smaller bank with the same capital ratios. Recently, however, regulators have become more focused on what might be called

the *social loss given default* – the spill-over costs imposed on the broader financial system and the economy – and have either argued that large banks should hold the same amount of capital or even more capital than small banks. Over the last two years the differences in capital ratios have compressed significantly. This reflects the fact that larger banks were more likely to participate in the U.S. Treasury's Capital Purchase Program (Taliaferro 2009) as well as the surge in public equity issuance by large banks, particularly following the Supervisory Capital Assessment Program in May 2009.

Whatever their root cause, the historically large differences in capital ratios between the smallest and largest banks hint at a couple of important points. First, consistent with the results from our calibration exercise, they suggest that even several additional percentage points of capital need not imply prohibitively large effects on lending rates—for if they did, it would be hard to understand how the smaller community banks, with their much higher capital ratios, have managed over the years to provide credit to their customers on sufficiently reasonable terms as to be able to retain their lending franchises.

Second, however, it is likely that the ability of small banks to continue operating at much higher capital levels reflects something about the softer degree of competition in their core line of business. A large literature in banking argues that small banks tend to focus on informationally-intensive "relationship lending", and that the embedded soft information in these relationships creates a degree of lock-in between firms and their small-bank lenders (Rajan (1992), Petersen and Rajan (1994, 1995), Berger et al (2005)). Thus, loosely speaking, while a small bank probably cannot afford to be at a 100-basis point disadvantage in funding its loans, it may also not be at risk of losing a longstanding relationship borrower over, say, a 20-basis-point pricing differential. By contrast, to the extent that larger banks deal with larger customers where competition from other providers of finance (both other banks and potentially the bond market) is more intense, even very small cost-of-capital disadvantages are likely to prove unsustainable.

Thus one reason we observe larger banks operating with more leverage than small banks may be that they face more intense competition. More generally, and as argued above, the competition hypothesis allows one to reconcile two notions that otherwise might seem to be at odds with one another: i) the fact that our calibrations suggest only modest effects on loan rates from increased capital ratios; and ii) the observation that banks—especially large banks—nevertheless appear to be very resistant to reducing their leverage. In the next section, we test

this competition hypothesis explicitly, and then examine some of its implications for regulatory arbitrage and other unintended consequences of more stringent capital regulation.

V. Competition, Regulatory Arbitrage, and Unintended Consequences

A. Evidence on the Competition Hypothesis

The essence of the competition hypothesis is that banks feel more pressure to operate at high leverage—even when such leverage has only a modest effect on their overall funding costs—when the environment that they operate in is more competitive.[15] To test this hypothesis, we make use of changes in state branching regulations that plausibly alter the competitive landscape in the affected states. We investigate two basic predictions of the theory. First, we expect that a regulatory shock that increases the degree of competition in a state should lead the *average* capital ratio of banks in that state to decline. Second, we expect a *compression effect*: the decline in the capital ratio should be largest for those banks in the state that, prior to the regulatory shock, were "living the quiet life" and operating with the highest capital ratios. Or said differently, we expect the regulatory shock to reduce the cross-sectional dispersion of capital ratios of banks in the given state.

To implement our tests, we take data on the year that various state banking regulations were relaxed from Table 1 of Stiroh and Strahan (2003). We examine two different types of state-level deregulation: the relaxation of intrastate branching restrictions and the advent of interstate banking. Prior to 1970, two-thirds of states had restrictions on intrastate branching which were relaxed from 1975 to 1992. In most states, intrastate branching was first permitted via mergers and later was permitted without restriction. Following the literature, we focus on the date where branching was permitted via mergers. Turning to interstate banking restrictions, the Bank Holding Company Act of 1956 prevented BHCs from acquiring out-of-state banks unless the target state explicitly permitted this. Since no states permitted these acquisitions, interstate banking was *de facto* prohibited. Between 1982 and 1993, 48 states entered into regional or national agreements whereby out-of-state BHCs could own banks in the permitting state. Since the Reigle-Neil Act of 1994 allowed BHCs to acquire banks in other states after 1995 ("interstate

[15] This is related to the hypothesis that banks operating in a non-competitive environments will hold more equity to protect the "franchise value" associated with the future rents from operating in that environment (Keeley 1990).

banking") and permitted mergers between *banks* in different states after 1997 (effectively permitting interstate branching), we conclude our analysis in 1994.

We work with annual Call report data from 1976 to 1994. Since our source of exogenous variation is at the state-year level, we follow Jayaratne and Strahan (1998) and work with state-year level aggregates or statistics.[16] To understand how changes in competition due to deregulation impacted bank capital structures, we estimate reduced form regressions of the state-level equity-to-asset ratio on dummies ($DEREG_{s,t}$) that switch on beginning in the year that a state relaxes its regulations, along with a full set of state and year effects:

$$y_{s,t} = \alpha_s + \delta_t + \beta \cdot DEREG_{s,t} + \varepsilon_{s,t}. \tag{3}$$

The identification strategy exploits differences in the timing of deregulation across states. We use two different deregulatory dummies. $DEREG_{s,t} = INTRASTATE_{s,t}$ is based on the year that state *s* allowed intrastate branching by mergers and $DEREG_{s,t} = INTERSTATE_{s,t}$ is based on the year when the state entered a regional or national interstate banking agreement. We prefer this reduced form approach to alternative specifications that proxy for competition using measures of market structure (e.g. Hefindahl indices or *n*-firm concentration ratios) or other parametric measures of market conduct. The literature on banking competition suggests that measures of structure may be poor proxies for conduct and we worry about estimation noise in the case of parametric estimated based on bank costs or revenues. Finally, since the dependent variables are persistent at the state level, it is important to cluster standard errors by state to deal with the serial correlation of residuals.

Table 3 shows the results of these regressions where the dependent variable is alternately, the mean equity-to-asset ratio in state *s* in year *t*, the cross-sectional standard deviation of equity-to-assets, and cross-sectional quantiles of the equity-asset ratio. These are all asset-weighted measures within state-years, so, for instance, the mean state-level ratio is simply the asset-weighted average of individual bank ratios. Similarly, the 90th percentile variable is the equity-to-assets ratio such that 90% of all assets in state *s* are in banks with a lower ratio. The results in column (1) show that equity-to-assets fell by about 30 bps following intrastate branching and another 20 bps following interstate banking. Thus, equity-to-assets fell by roughly 50 bps for the

[16] Note that bank mergers are not a source of concern when working with state-level aggregates prior to 1994 since virtually all bank-level mergers were within states prior to 1994.

average state relaxing both restrictions. This decline can be compared to the typical cross-sectional standard deviation of 108 bps and is economically meaningful considering that the average equity-to-assets ratio is our sample just over 7%.

The remaining columns in Table 3 report regressions of annual state-level measures of either the dispersion or the distribution of capital ratios on the deregulatory dummies. Consistent with the notion of a compression effect, the results suggest that the dispersion of capital ratios within a state fell following deregulation and that capital ratios fell most for banks that were previously in the upper end of the capital ratio distribution. This appears to have been particularly true following the advent of intrastate banking where we see that banks in the 75th and 90th percentiles of the cross-sectional distribution of capital ratios saw their capital ratios fall by approximately 60 bps and 70 bps, respectively, versus only a 10 bps change at the 10th and 25th percentiles.

The results in Table 3 are robust to adding several obvious state-level controls. For instance, the coefficients are virtually unchanged if we control for the growth in state-level real per capital personal income. The results are also similar if we control for the average size of banking organizations in each state-year. This indicates that our results are not a mechanical consequence of post-deregulation consolidation in combination with the fact that larger banks tend to hold less capital.

In sum, the data provide clear-cut evidence in favor of the competition hypothesis: when faced with more intense competition, banks in a given market tend to be driven towards both higher and more uniform levels of leverage. On the one hand, such competitive effects—combined with our earlier calibration results—suggest one reason why stricter capital regulation of financial firms is appealing. More stringent capital regulation would seem to hold the promise of reducing competition on a dimension that creates systemic risk, while at the same time not raising loan rates by much. However, the complication is that the same competitive pressures also create powerful incentives to evade either the letter or the spirit of the rules. We turn to this issue next.

B. Evidence on Regulatory Arbitrage

It is widely accepted that banks already undertake some transactions and distort their organizational structure to avoid capital charges. Ironically, the very first working paper issued

by the Basel Committee, Jackson et al. (1999), "Capital Requirements and Bank Behavior: The Impact of the Basel Accord", was a survey paper that wrestled with the question of whether (p. 1) "banks have been able to take actions to reduce their [capital requirements] effectiveness, either by shifting to riskier assets within the same weighting band or through capital arbitrage." The judgment of the supervisors *in 1999* was that "the volume of regulatory arbitrage is large and growing rapidly, especially among the largest banks." Thus the race between regulated competitors and their supervisors has been underway for years.

Importantly, most banks are currently comfortably above the regulatory minimum levels of required capital, and were in 1999 too. The conventional interpretation of this observation is that regulatory requirements are not fully binding on the banks; put differently, the level of capital demanded by counterparties appears to be higher than the regulatory limit. To the extent that coming changes raise capital requirements substantially, the incentives to evade the requirements will only increase. Thus, the existing evidence on regulatory arbitrage should be thought of as a lower bound on the likely effects.

Jackson et al define capital arbitrage as actions that exploit differences between the true economic risks of a portfolio and the regulatory requirements for the portfolio. In updating their analysis, we focus on two issues. First, we review some post-1999 developments regarding arbitrage strategies that have been pursued. Second, we consider the possibility that further increases in capital requirements will cause risks to migrate out of the regulated banking system into the largely unregulated shadow banking system.

Recent capital arbitrage strategies

As of 1999 bank supervisors had identified several types of capital arbitrage. The classic among them was dubbed "cherry picking". Under Basel I banks had a strong incentive to shift their portfolios towards the riskiest assets within a given risk-weight category. Because the risk-weight buckets in Basel I were defined very broadly (e.g. almost all funded corporate exposures received a 100% risk weight), there were concerns that banks might raise both their return on equity and their riskiness by engaging in cherry picking.[17] While there is little systematic

[17] An even more egregious form of arbitrage involves changing products to exploit outright loopholes in the rules. Perhaps the best example of this type of activity concerns 364-day loan commitments. Mosebach (2000) notes that from 1987-1989, 100% of 12-month loan commitments had a 365-day legal maturity (e.g. facilities extended on 12/31/1988 expired on 12/31/1989). Basel I went into effect in the U.S. in 1990. Immediately, banks shortened

evidence about the extent of cherry picking, the more risk-sensitive approach under Basel II was intended to try to address this concern and it is discussed less frequently today.

Jackson et al also identified securitization as another channel through which banks can reduce capital charges. Remarkably, they specifically pointed to the incentives to create special purpose entities (SPEs) that were legally bankruptcy remote and into which highly rated assets could be sold! We now know that heading into the crisis many large banks had set up such vehicles to hold a variety of assets. As the crisis unfolded many of these SPEs lost access to funding as investors lost confidence in their ability to determine the value of the assets. At the height of the crisis many banks nonetheless took the assets back onto their balance sheets due to the reputational costs that would have been incurred had the banks taken advantage their legal rights to let the SPEs fail. The ensuing losses depleted bank capital and contributed to pressure on the banks to de-lever. Because of these considerations the Basel Committee on Bank Supervision (BCBS) Joint Forum Report on Special Purpose Entities (2009) argues that SPEs exacerbated the financial crisis.

A third form of regulatory arbitrage identified by Jackson et al concerned the way in which asset backed commercial paper (ABCP) programs could be structured. Acharya, Schnabl and Suarez (2009) study subsequent developments in this market. They explain that if the enhancement is structured as a "credit guarantee" where the sponsoring bank agrees to pay off maturing ABCP in all circumstances, the full exposure receives a 100% conversion factor, effectively replicating the capital requirement that would obtain if the assets were held on balance sheet. However, if the enhancement is structured as a short-term loan commitment or "liquidity guarantee" where the sponsor must pay off maturing ABCP only when the conduit collateral is not technically in "default", the sponsor had to hold no capital against this exposure prior to 2004. In practice, credit and liquidity guarantees entail virtually identical risks because technical default on collateral is a function of delinquency rates and other slow moving variables.

Acharya et al provide three different types of evidence in arguing that the desire to use these vehicles for capital arbitrage drove developments in this market. The volume of issuance is shown in Figure 4, along with the volume of other financial commercial paper to provide a

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commitment maturities by 1 day to qualify for the lower risk weighting applied to commitments shorter than 1 year: 100% of the 12-month facilities extended during 1990-1992 had 364-day maturities (e.g. facilities extended on 12/31/1990 expired on 12/30/1991).

contrast. By the late 1990s, as Jackson et al were writing, ABCP issuance was surging. Following the bankruptcy of Enron in 2001, U.S. bank regulators began a three year review of the differential treatment of credit and liquidity guarantees. While one cannot infer causation, it is interesting that the growth of ABCP slowed and partially reversed from 2001 to 2004 as this review was underway; meanwhile other financial commercial paper issuance slows during the 2001 recession, but begins rising well before ABCP issuance recovers.

In July 2004, regulators largely maintained the status quo, assigning exposures from liquidity guarantees a 10% conversion factor. In other words, banks were only required to hold one-tenth of the capital if an economically similar credit enhancement was structured as a liquidity guarantee as opposed to a credit guarantee. ABCP grew explosively following this ruling, reaching $1.2 trillion by early August 2007.

In addition to these time series patterns, Acharya et al point out two other cross-sectional patterns that suggest the importance of regulatory arbitrage for this market. First, they document that commercial banks sponsors were far more likely to use liquidity guarantees than other types of sponsoring financial institutions.[18] There does not seem to be any other intrinsic reason that these particular types of guarantees are used. Furthermore, no Spanish or Portuguese banks, which are required to hold identical capital against both credit and liquidity guarantees, sponsor ABCP conduits. The authors estimate that large international banks sponsoring conduits were able to reduce their regulatory capital requirements by $68 billion in total or 6% of their combined equity via these transactions. [19]

While this deficit is not massive, they note that that several banks suffered significant losses in connection with these exposures during the crisis. But perhaps more importantly, this

[18] Other types of financial institutions rely on "extendible" or "SIV" guarantees which are different from credit and liquidity guarantees. As in Kashyap, Rajan, and Stein (2002) and Gatev and Strahan (2006), some of this may reflect banks' comparative advantage in providing standby commitments because they are likely to benefit from deposit inflows in states where commitments are drawn.

[19] This overstates the amount of missing capital because the authors assume all ABCP conduit collateral would receive a 100% risk-weight if held on balance sheet. We can update their calculation for U.S. BHCs for 2009Q4. (BHCs only began reporting the necessary data for the calculation in 2009Q2, so this can't be done prior to the crisis.) The numbers are not directly comparable to those in Acharya et al as their sample includes international banks and is for early 2007, prior to the dramatic collapse of the ABCP market. As of 2009Q4, U.S. BHCs had extended unused commitments supporting $135 billion in conduit ABCP. If held on balance sheet, the underlying conduit collateral would correspond to $77 billion in risk-weighted assets (i.e. the average risk-weight is about 57%). However, due to the 10% conversion factor under current regulatory capital rules, this only translated into $7.7 billion in additional risk-weighted assets for BHCs or about $69 billion less than if liquidity guarantees received the same regulatory treatment as credit guarantees. Based on a 10% well-capitalized standard for the total risk-based capital ratio, this corresponds to a $6.9 billion reduction in required capital.

funding structure proved to be fragile during the crisis. Covitz, Liang and Suarez (2009) argue the collapse in ABCP between August of 2007 and December 2007 had many of the hallmarks of a run. For instance, they show that there is temporal clustering of programs which do not rollover paper that are not related to program characteristics. Also when programs initially fail to replace maturing funding they rarely are able to subsequently issue additional paper.

While there are many additional forms of regulatory arbitrage that we could point to, this brief list and description suggests three powerful lessons. First, many of these strategies were fully understood by the regulators and yet persisted for over a decade. Thus, even if regulators can spot a problem, we should not take for granted that they will be able to do anything about it. Second, these strategies contributed to the crisis. Some arrangements that looked stable or benign in normal times cracked under stress. We will never know how the crisis would have played out without the presence of so many special purpose entities, and had the asset backed commercial paper market held up, but the BCBS Joint Forum and others view these contributions as critical. Finally, the nature of the arbitrage continues to evolve. Absent frequent revisions to the rules, we should expect banks to find new ways to reduce capital charges.

Implications for the evolution of the shadow banking system

Nevertheless, it seems reasonable to hope that—informed by the lessons of the crisis—regulation going forward is likely to do a somewhat better of job of preventing banks from gaming the rules to reduce the capital charges associated with holding certain types of assets. But if this does occur, it raises the possibility that the forces of competition will drive these assets *completely outside of the banking system*. To take a hypothetical example: instead of a pool of securitized loans residing in a nominally off-balance-sheet vehicle that in fact has recourse back to a bank in a distress scenario, one can imagine this pool being acquired by a hedge fund instead, with the connection to the banking system being almost totally severed.[20] And if the hedge fund finances the pool with high levels of short-term debt—say via the repo market—and if it is one of many following the same strategy, the concern is that we will have

[20] Of course, even in a pure originate-to-distribute model, banks would still play a role in screening and monitoring borrowers and might retain some residual exposure to mitigate concerns about adverse selection and to maintain incentives for monitoring. Furthermore, even without any direct financial exposure, an originator's reputation might be damaged by subsequent losses on the pool of loans.

encouraged the development of an alternative system of credit creation that avoids the capital regulation and supervision associated with banks and bank-like institutions, and that as a result fragility and vulnerability to crises will be if anything be increased.

An illustration of these forces comes from the syndicated loan market which, prior to 2007, had become increasingly dominated by non-bank investors including mutual funds, hedge funds, insurers, and structured credit vehicles such as collateralized loan obligations (CLOs). These non-bank investors were increasingly active in the "leveraged" segment of the market which consists largely of loans to high-yield borrowers to finance LBOs, stock repurchases, and mergers. Leveraged loan originations more than tripled from 2001 to 2007, eventually overtaking investment grade originations, and institutional investors funded more than 60% of leveraged loan originations by 2007 up from just 15% in 2001 (Ivashina and Sun 2010). According to Shivdasani and Wang (2009), CLOs accounted for 60% of all institutional demand by 2006 and played a critical role at the height of the boom.[21] However, in mid-2007, demand for CLOs and other complex securitized products collapsed following losses on subprime assets. Banks responded by retaining a larger share of syndicated loans, but were unable to fill the gap due to increased liquidity and capital pressures. The overall result was a large, pro-cyclical reduction in the supply of corporate credit (Ivashina and Scharfstein 2010a, 2010b).

Even though it has yet to be implemented in the U.S., analysts have pointed to the publication of the Basel II guidelines in 2004 as an impetus for the CLO boom since most large banks adopted a Basel II-like approach to their internal economic capital management. Under the proposed Basel II guidelines, an AAA-rated CLO tranche would receive a risk weight of 7% whereas an underlying B-rated leveraged loan might receive a risk weight of 150%. For instance, Duffie (2007) notes that risk management and diversification in the presence of costly external equity may have motivated banks to engage in credit risk transfer. However, our competition hypothesis suggests a complementary interpretation: this shift may have occurred because non-banks came to enjoy a modest cost of funds advantage to banks in this market.

[21] Ivashina and Sun (2010) find that institutional demand pressure lead to tighter spreads on leveraged loans. Specifically, they argue that the number of days a loan is in syndication is a good proxy for institutional demand and show that "time-on-the-market" is positively related to loan spreads. Shivdasani and Wang (2009) argue that institutional demand for CLOs fueled the 2004-2007 LBO boom, pointing to the fact that spreads on were tightening at the same time that loan volumes were surging. Looking across syndicate managers, they find that lead banks with larger CDO underwriting businesses financed LBOs at tighter spreads and with less restrictive covenants.

For instance, Benmelech and Dlugosz (2009) report that the typical CLO consisted a 71% AAA-rated tranche, 18% mezzanine tranches rated between AA and BB, and a 11% non-rated equity tranche. If banks were required to hold 15% capital against the underlying leveraged loan (15% = 150% risk weight * 10% capital), this 4%-point difference would translate into a cost of fund advantage of up to 10-18 bps based on our previous calibrations. This minor cost advantage may have led leveraged loan activity to flow towards the shadow banking system during the boom. To be clear, this explanation is simply a conjecture and, given the minor cost advantages involved, it would be difficult to ever conclusively establish that it is correct. However, it does illustrate that the combination of tightly regulated banks and largely unregulated shadow banks might result in a fragile and overly pro-cyclical financial system. Even if they are very well capitalized, regulated banks might be unable to quickly restore the flow of credit following a collapse in non-bank credit supply.

One potential rebuttal to the above concerns about migration is that the shadow banking system ultimately requires access to liquidity, and regulated banks are the most, and perhaps only, reliable providers of liquidity. Under this view, provided that the banks themselves are well-regulated, the risks of the shadow banking system will be manageable—because the shadow banking system cannot exist without the support of the banks.

We find this line of reasoning unconvincing for two reasons. First, some elements of the shadow banking system were built with little direct reliance on the banks. As the BCBS Joint Forum (2009, p. 10) notes:

> some liquidity providers to SPEs are not regulated depository institutions and thus cannot generally access central bank "lender of last resort" facilities. During periods of market duress, SPEs associated with these liquidity providers are more susceptible to deleveraging and may face significant liquidity and solvency pressures if unable to refinance short-term liabilities.

Perhaps all these arrangements can be snuffed out, but there will be strong incentives to try to redevelop them if they are not also subject to similar capital requirements.

A second problem could be the new cyclical aspects of the capital rules themselves. The December 2009 consultative paper on strengthening the resilience of the banking system from the Basel Committee on Bank Supervision refers specifically (p. 7) to "the broader macroprudential goal of protecting the banking sector from periods of excess credit growth." Presumably this will involve raising capital standards for banks during credit booms.

While this time-varying approach to capital regulation may well be a desirable way to restrain the bank lending and make the banking system more stable, its interaction with the shadow banking system could be a problem. Suppose that during normal times, banks are critical providers of liquidity to unregulated entities and therefore banks typically constrain the shadow banks. The alternative to bank funding in normal circumstances is to seek liquidity from non-banks and it may be that the margins and haircuts associated with this alternative mode of financing are sufficiently high to make it unattractive most of the time. However, it is precisely during credit booms that these margins and haircuts are likely to be at their lowest. Thus, the ability of the shadow banks to find non-bank financing is likely be highest exactly when time-varying capital regulations are most tightly impinging on the banks themselves. This will undoubtedly create additional substitution incentives. So again, the concern is that credit-creation activity will migrate completely away from the banking system, with the propensity for this migration perhaps being most pronounced in boom times.

To be clear, we do not know of important cases where it can be convincingly demonstrated that capital regulation was so tough that it pushed major activities completely out of the banking system. But with substantially higher capital requirements we will be moving to an untested regime where the incentives for this sort of migration will be higher than ever before.

VI. Conclusions and Policy Implications

Our basic argument can be summarized as follows: to the extent that they are properly phased in, substantially higher capital requirements for significant financial institutions are likely to have only a modest impact on the cost of loans for households and corporations. This impact is, in and of itself, probably not sufficient to be a major cause for concern.

On the other hand, a significant change in the capital regime, even if it does not materially impact the cost of credit, raises very significant concerns relating to the reshaping of *how* credit will be provided, and the associated implications for financial stability.

What is the best way to address these concerns? In our view, the answer is not to back away from the goal of setting higher capital standards for banks. Rather, our emphasis on competition, and on the importance of non-bank providers of credit, suggests that one should not be satisfied to just focus regulatory attention on banks, or even on bank-like institutions.

To mitigate the incentives for regulatory arbitrage, a systematic effort must be made to impose similar capital standards *on a given asset class, no matter who winds up holding the asset*. This is not an easy task, but one tool that might be helpful is broad-based regulation of "haircuts" (i.e. minimum margin requirements) on asset-backed securities (ABS) that trade in the shadow-banking market.[22] For concreteness, consider the case of a consumer loan. If this loan is made by a bank, it will be subject to a capital charge. Now suppose instead that the loan is securitized by the bank, and becomes part of a consumer ABS whose tranches are distributed to various types of investors. An asset-based form of regulation would stipulate that whoever holds a tranche of the ABS, be it a hedge fund, a pension fund, or anybody else, would be required to post a minimum haircut against that tranche—with the value of the haircut depending on the seniority of the tranche, the quality of the underlying collateral, and so forth. If these haircut requirements are well-structured, they could go a long way towards achieving harmonization across organizational forms, in that there would be no obvious regulation-avoidance advantage to moving the consumer loan off the balance sheet of the bank and into the shadow-banking sector. We believe that this kind of harmonization is a critical ingredient to the ultimate success of any more high-powered regime of capital regulation.

Going further, haircut regulation could be made explicitly time-varying, as a complement to time-varying macroprudential regulation of bank capital. In other words, if it is desirable to raise capital requirements on banks during boom times, then haircuts on ABS should be raised commensurately, so as to preserve a level playing field between banks and the shadow-banking system.

Again, we recognize that this broader-based asset-oriented approach represents a significant paradigm shift for regulators, and that implementing it will raise a number of practical challenges. However, a failure to move in this direction may ultimately undercut many of the hoped-for benefits associated with more stringent capital requirements.

[22] See Geanakoplos (2010) who also focuses on asset-level as opposed to institution-level leverage and arrives at a similar policy prescription, arguing that (p. 3) "the Fed should manage system wide leverage, curtailing leverage in normal or ebullient times, and propping up leverage in anxious times."

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Figure 1: Book Equity to Book Assets for U.S. Commercial Banks, 1840-2009: Data from 1840-1896 is based on the Statistical Abstracts of the United States from the U.S. Census. Data from 1896-1919 is based on data for All Banks and is taken from the Federal Reserve's All Bank Statistics, 1896-1955. Data from 1919-1933 is based on Federal Reserve member banks and is taken from Banking and Monetary Statistics, 1919-1941. Data from 1934-2010 is for all insured commercial banks and is taken from the FDIC's Historical Statics on Banking at http://www2.fdic.gov/hsob/.

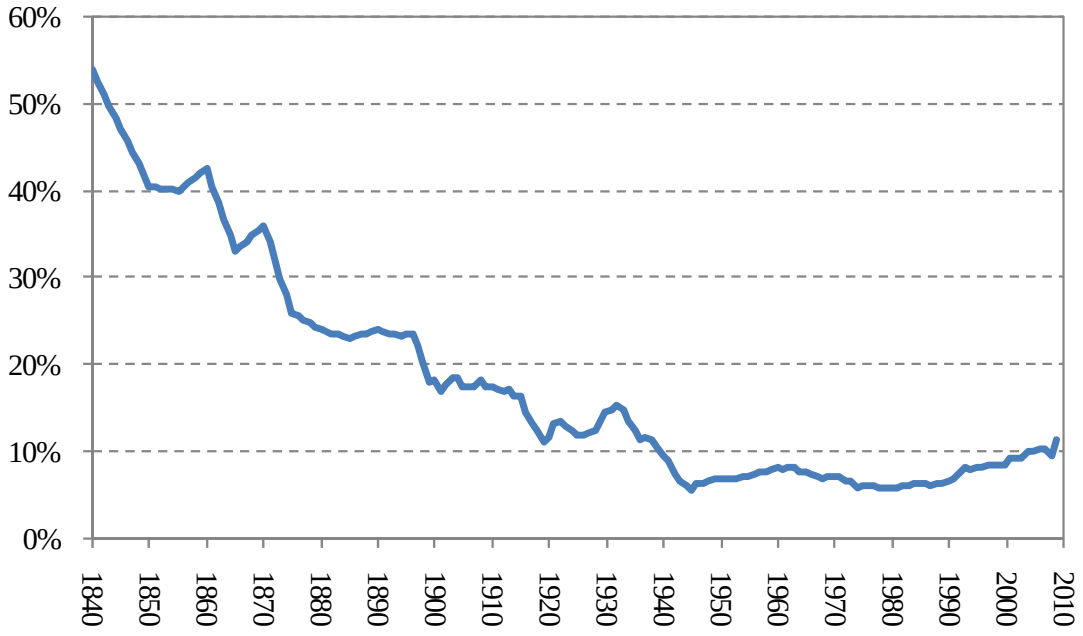
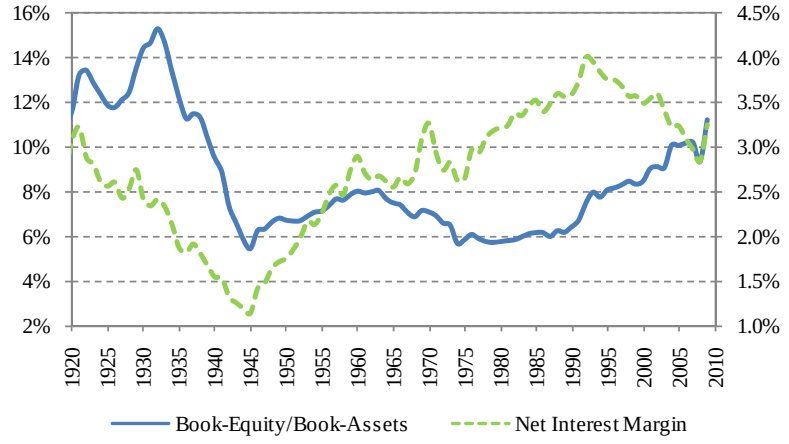
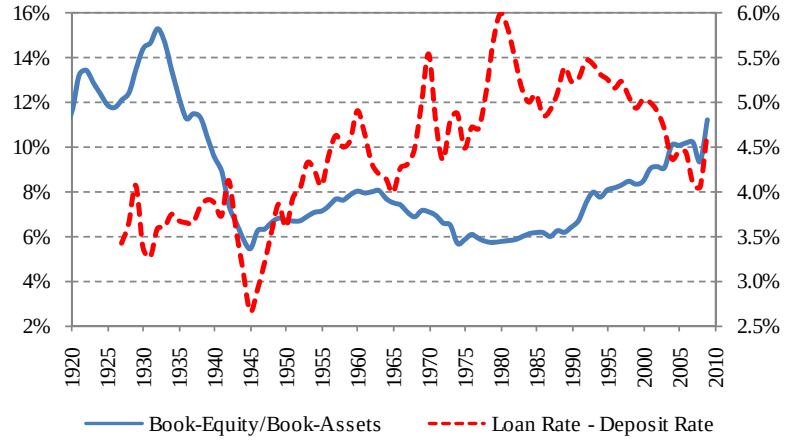


Figure 2. Bank Capital and Loan Spreads, 1920-2009: The solid line, plotted on the left axis, is the ratio of book equity to book assets for U.S. commercial banks. The dashed line, plotted on the right axis, is a measure of loan spreads or mark-ups. Panel A shows the net-interest margin. Panel B shows the loan rate minus the rate paid on deposits. Panel C shows the Prime rate minus the Treasury bill yield. The net interest margin is defined as net interest income divided by earnings assets. Earning assets are the sum of loans, securities, cash and balances due from other depositories, and other earning assets (where available). Typically, analysts would exclude cash and non-interest bearing balances from other depositories when computing earnings assets, but this is not possible using our aggregated historical data. The loan rate minus deposit rate is interest income on loans divided by loans minus interest on deposits divided by deposits. Our prime rate series is spliced version of several data series. From 1920-1940 the prime rate is the "Rate on Customer Loans, New York City"; from 1940-1949 the prime rate is the "Bank Rates on Business Loans, 19 Cities"; from 1949-onward we use the Prime Rate reported by the Federal Reserve Board. However, since the early 1990s banks have mechanically set the Prime Rate at 3.00% over the FOMC's Federal Funds target, so the Prime Rate has become less informative about bank loan spreads. The 3-month Treasury bill series is constructed as in Krishnamurthy and Vissing-Jorgensen (2010).

Panel A: Net interest margin



Panel B: Loan rate – deposit rate



Panel C: Prime rate – Treasury-bill rate

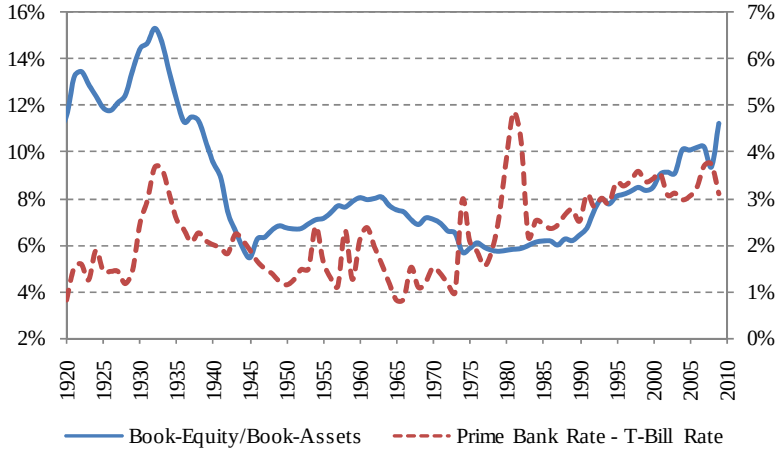
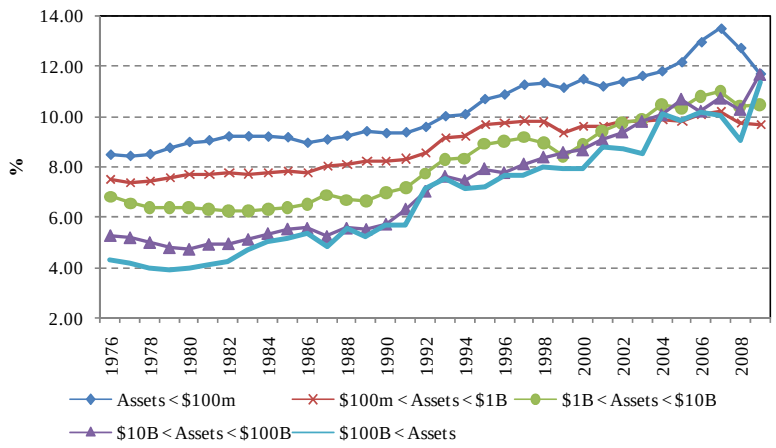
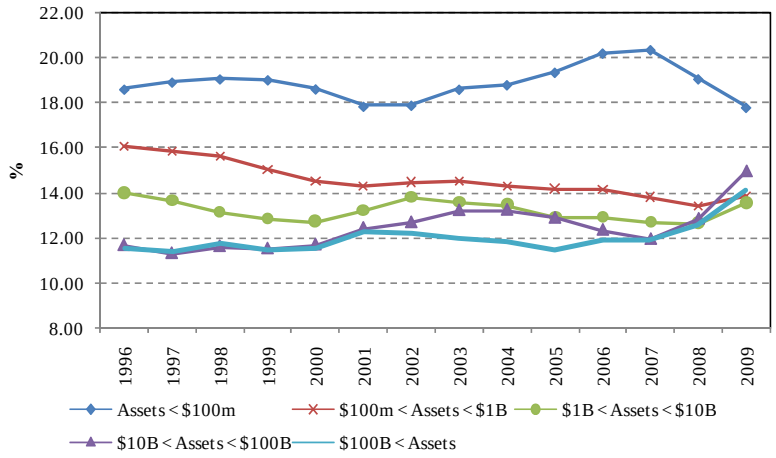


Figure 3. U.S. Bank Capital Ratios by Bank Size, 1976-2009: This figure plots capital ratios by bank size from 1976-2009. Banks are placed into size groups based on assets in 2008Q4 dollars using the CPI. Panel A plots book equity to book assets. Panel B plots total risk-based capital ratios (total regulatory capital over risk-weighted assets). Panel C plots Tier 1 leverage ratios (Tier 1 regulatory capital over adjusted average assets). Panel D plots Tier 1 capital ratios (Tier 1 regulatory capital over risk-weighted assets). All banks owned by a given Bank Holding Company or other regulatory high holders are combined into a single organization for the purposes of this size classification.

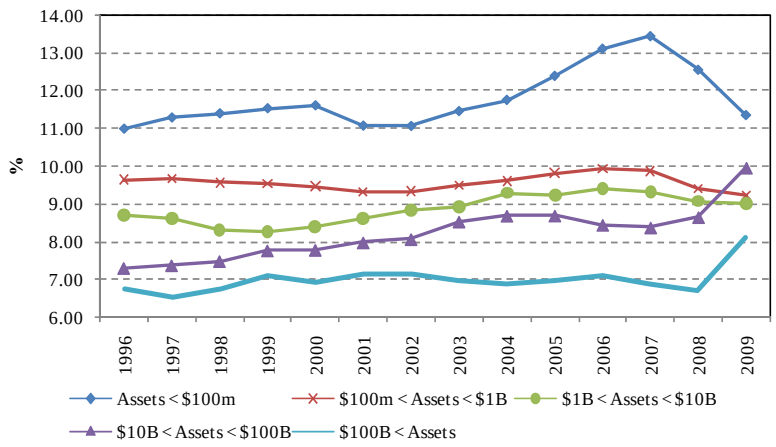
Panel A: Book equity to book assets



Panel B: Total risk-based capital ratios



Panel C: Tier 1 leverage ratio



Panel D: Tier 1 risk-based capital ratios

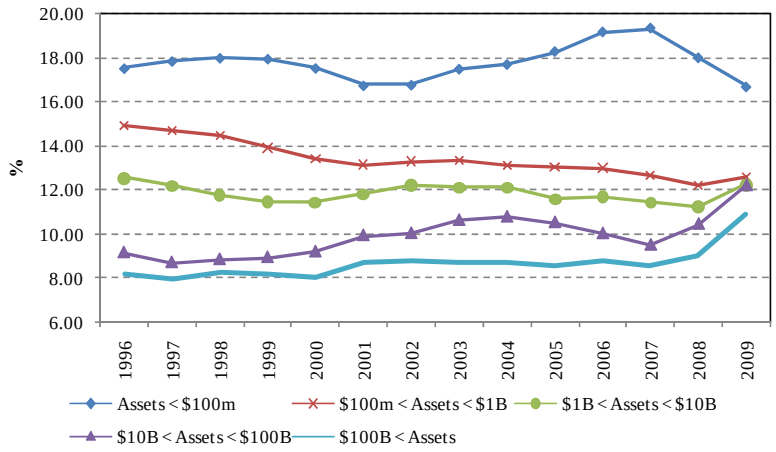


Figure 4: Commercial Paper Outstanding, 1992-2010: This figure plots the quantity of outstanding Asset Backed Commercial Paper (ABCP) and Other Financial Commercial Paper (excluding ABCP). The figure is based on monthly data published by the Federal Reserve Board.

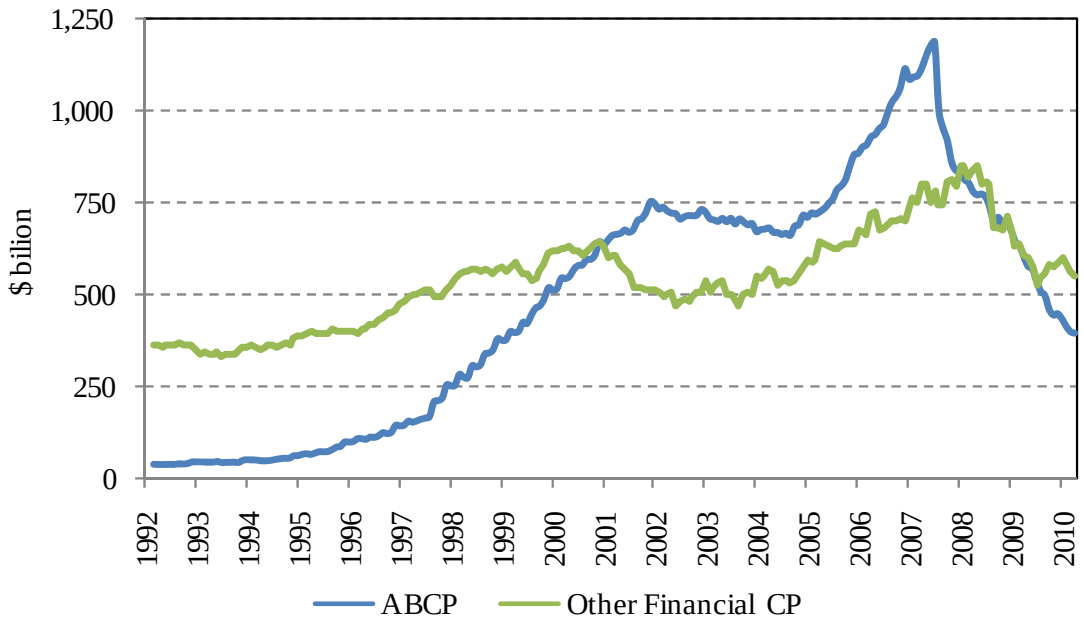


Table 1. Bank leverage, β, and σ, 1976-2008: Regressions of banks' β and σ on equity-to-assets, controlling for size and book-to-market. All specifications include year fixed effects. The sample is composed of large banks, defined as those with greater than $10 billion of assets in 2008Q4 dollars. Banks are firms with valid observations in CRSP and Compustat with 4 digit SIC codes between 6011 and 6059 or between 6120 and 6129. Standard errors are robust to clustering at both the year and firm level as in Thompson (2010).

	β		σ	
	(1)	(2)	(3)	(4)
$BE_{i,t-1} / BA_{i,t-1}$	-0.0453	-0.0372	-0.0048	-0.0039
	[2.91]	[2.18]	[3.65]	[3.62]
$\ln(BA_{i,t-1})$		0.0316		-0.0041
		[1.05]		[3.04]
$\ln(BE_{i,t-1} / ME_{i,t-1})$		0.1486		0.0375
		[2.37]		[4.77]
Constant	1.2555	1.1218	0.1094	0.1266
	[11.44]	[5.52]	[11.37]	[11.17]
Year-effects	Yes	Yes	Yes	Yes
Observations	1,226	1,226	1,226	1,226
R-squared	0.36	0.37	0.44	0.59

Table 2: OLS Regressions of Loan Spreads on Ratio of Equity-to-Assets. Regressions of the mark-up charged by banks over their cost of funds on the ratio of equity capital to assets, controlling for Treasury bill yields, the squared Treasury bill yield, the term spread (yield on long-term Treasuries minus the bill yield), a time trend, a recession dummy based on NBER business cycle dates, and the ratio of loans to earning assets. The dependent variable is alternately: i) the net interest margin (net interest income over earning assets): ii) the yield on loans minus the rate paid on deposits (interest income on loans over gross loans minus interest expense on deposits over deposits); and iii) the prime rate minus the rate on short-term Treasury bills. Equity-to-assets is the ratio of book equity capital to book assets for U.S. commercial banks. The long-term Treasury yield and Treasury bill yield are constructed as in Krishnamurthy and Vissing-Jorgensen (2010). *t*-statistics, in brackets, are based on Newey-West (1987) standard errors allowing for five years of lags.

	Net interest margin		Loan yield – deposit rate		Prime rate – T-bill yield	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Equity/Assets	-2.91	2.05	-12.72	-1.07	2.62	28.31
	[0.59]	[0.72]	[2.66]	[0.20]	[0.40]	[4.90]
T-bill yield		15.61		17.40		0.25
		[2.23]		[1.73]		[0.02]
(T-bill yield)2		-0.71		-0.21		1.96
		[1.67]		[0.38]		[2.06]
Term spread		14.35		9.06		20.39
		[2.79]		[1.20]		[3.13]
Trend		0.52		1.03		3.42
		[1.46]		[1.32]		[5.95]
Recession		0.49		4.44		20.21
		[0.09]		[0.41]		[1.98]
Loans/Assets		2.87		0.15		-3.50
		[4.23]		[0.10]		[2.10]
Constant	297.13	23.40	548.27	319.13	201.57	-78.94
	[5.56]	[1.09]	[10.49]	[6.65]	[3.39]	[2.23]
Observations	90	90	83	83	90	90
R-squared	0.01	0.93	0.18	0.77	0.01	0.79

Table 3: Impact of Deregulation on Distribution of Equity-to-Assets within States: Regressions of equity-to-assets on dummies for deregulation using an annual state-level panel from 1976-1994. The deregulation dummies are based on the data in Table 1 of Stiroh and Strahan (2003). The *INTRASTATE* dummies switch on beginning in the year when the state first permitted intrastate branching via mergers. Similarly, the *INTERSTATE* dummies switch on beginning in the year when the state entered a regional or national interstate banking agreement. The dependent variables are alternately the asset-weighted average, standard-deviation, and quantiles of the equity-to-assets ratio within each state-year. The table reports coefficients from 21 separate regressions (7 dependent variables each with 3 specifications). All regressions include a full set of state and year effects and have 969 observations (= 51 states x 19 years). *t*-statistics, in brackets, are based on standard errors that are robust to clustering (i.e. serial correlation of residuals) at the state level.

	Dependent Variable						
	Mean	**Standard Deviation**	**10th %tile**	**25th %tile**	**50th %tile**	**75th %tile**	**90th %tile**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Regression 1:							
INTRASTATE	-0.288	-0.274	-0.099	-0.106	-0.193	-0.626	-0.682
	[-2.10]	[-2.75]	[-0.70]	[-0.81]	[-1.49]	[-2.47]	[-2.40]
Regression 2:							
INTERSTATE	-0.217	-0.133	0.037	-0.182	-0.278	-0.290	-0.349
	[-2.25]	[-0.68]	[0.31]	[-1.46]	[-2.68]	[-1.96]	[-1.73]
Regression 3:							
INTRASTATE	-0.281	-0.270	-0.100	-0.100	-0.183	-0.617	-0.671
	[-2.05]	[-2.68]	[-0.71]	[-0.78]	[-1.41]	[-2.44]	[-2.33]
INTERSTATE	-0.203	-0.120	0.042	-0.177	-0.269	-0.261	-0.317
	[-2.05]	[-0.62]	[0.34]	[-1.43]	[-2.62]	[-1.69]	[-1.47]