Impact of Bank Equity Capital on Bank Cost of Capital *

Saad Alnahedh†, Sanjai Bhagat‡

Abstract

Using a sample of 178 publicly traded Bank Holding Companies (BHCs) between 1994 and 2014, this paper provides evidence on the relation between a bank's equity capital ratio and the cost of capital. To address endogeneity between a bank's equity capital ratio and risk of balance sheet assets, we use an instrumental variable approach, as well as a triple differences approach. We find a 10 percentage point increase in the book equity capital ratio is associated with a 92 basis points increase in the bank's cost of capital. We also find that a 10 percentage point increase in the market equity capital ratio is associated with a 59 basis points increase in the bank's cost of capital. Restricting the analysis to large banks with book assets in excess of $50 billion, we find that a 10 percentage point increase in the book equity capital ratio is associated with a 23 basis points increase in the bank's cost of capital. Even though an increase in the equity capital ratio is associated with a private cost to the banks, the effects on bank lending is positive. We find that a 1 percentage point increase in the book (market) equity ratio is associated with a 1.69 (1.21) percentage point increase in bank-level new lending growth.

JEL classification: G21, G28, E5

Keywords: Financial Regulation; Bank Capital; Capital Requirements; Cost of Capital

*We are grateful for the comments and suggestions by Jonathan Berk, Bernard Black, Tony Cookson, Robert Dam, Giovanni Favara, David Gross, Katie Moon, Nathalie Moyen, David Scharfstein, Ed Van Wesep, and Jaime Zender. We also thank seminar participants at the University of Colorado Boulder, participants and a discussant at the 2016 Paris Financial Management Conference, participants and a discussant at the 2017 Southwestern Finance Association, participants and a discussant at the 2017 Eastern Finance Conference. Any errors are our own.

†University of Colorado Boulder - Leeds School of Business, saad.alnahedh@colorado.edu

‡University of Colorado Boulder - Leeds School of Business, sanjai.bhagat@colorado.edu (Corresponding author)

1 Introduction

The strongest form of bank capital is common equity that can absorb losses without disrupting the bank's ongoing business activities. There are three ways that bank capital can impact bank risk. First, with more bank capital, bank owners and managers will have more skin-in-the-game, hence, will focus more carefully on risk management (borrower screening and ongoing monitoring) and avoid excessive risk-taking that arises as a consequence of limited liability and taxpayer-funded bailout. This is the essence of the argument in the extant literature, notably, Holmstrom & Tirole (1997), Allen, Carletti & Marquez (2011), and Mehran & Thakor (2011). Second, greater bank capital discourages risk-shifting in a bank leading to safer bank investment and trading strategies; Smith & Warner (1979), Calomiris & Kahn (1991), Acharya, Mehran & Thakor (2016). Finally, greater bank capital increases the bank's ability to absorb negative earnings shocks and survive; Repullo (2004).

In the wake of the crisis of 2007 and 2008, policy-makers and researchers have made numerous calls for banks to hold more equity to reduce the risk of another crisis. These calls were met with resistance from banks who claim that equity is more costly than debt, and forcing higher equity capital ratios will raise their cost of capital, leading to a reduced credit supply and an increase in loan spreads.

We consider a sample of 178 Bank Holding Companies (BHCs) in the period between 1994 and 2014 to evaluate the impact of increased bank equity capital on a bank's cost of capital. First, we calculate a forward looking measure for the cost of equity using five different methods. The first two methods are derived from the asset pricing models, CAPM and Fama-French three factors (FF3). The other methods are based on the implicit value of the cost of equity deduced from the analyst consensus in earnings per share forecasts for BHCs. Specifically, we use the methods from Gebhardt, Lee & Swaminathan (2001), henceforth GLS, and Claus & Thomas (2001), henceforth CT, both as modified by Li & Mohanram (2014) to compute a forward looking implied cost of equity. The fifth method is based on a simple dividend growth model (DGM), and the sixth measure averages above five estimates (AVG). Cost of debt is measured from long-term non-convertible straight bond issues and trades for BHCs in the sample. Specifically, we look at all bond trades and issues with 7 to 15 years to maturity that are tradable, non-convertible with a market value in FISD and TRACE. The yield-to-maturity on these bonds proxies for the pre-tax cost of debt. Finally, the costs of debt and equity are combined to produce six distinct weighted average costs of capital.

We run OLS regressions to find the relationship between the book equity capital ratio and the cost of equity. Using the six measures for the cost of equity, henceforth CAPM, FF3, GLS, CT, DGM, and AVG, we find a consistent and negative relationship between the cost of equity capital and book equity capital ratio. Specifically, a 10 percentage point increase in the book equity capital ratio is associated with 87 basis points decrease in the cost of equity. The regressions control for size, book to market, performance, competition, loans performance and exposure, as well as firm level credit rating. Further, we include year-quarter and firm fixed effects to control for time-invariant and cross-sectional-invariant unobserved factors. Standard errors are heteroskedasticity robust and clustered around year-quarter and BHC levels.

Next, we investigate the relation between a bank's book equity capital ratio and its cost of debt. We find no significant relationship between the two. This either means that the market does not price book leverage through a bank's cost of debt, perhaps due to government guarantee frictions, or that the opacity in the observed book leverage causes measurement error in estimating bank risk. Given that book leverage is an endogenous choice variable that is self-reported by banks, either explanation seems plausible. Finally, we consider the relation between book equity capital ratio and bank cost of capital. We find a positive and significant relation between all six measures of cost of capital and book equity capital ratio. A 10 percentage point increase in the book equity capital ratio is associated with a 54 basis points increase in the bank's cost of capital. This result is consistent with Kashyap, Stein & Hanson (2010) and Baker & Wurgler (2015).

The relation between book equity capital ratio and bank cost of capital can be confounded by the opacity of the underlying risks in bank assets. A bank with a 10 percent equity capital ratio and safe assets could be safer than a bank with a 20 percent equity capital ratio but a very risky asset portfolio. Since bank equity capital ratio and risk of portfolio assets are simultaneously determined by the bank, they are endogenous. This calls into question the possibility of establishing causal inference. To address endogeneity concerns, we use an instrumental variable (IV) approach similar to Berger & Bouwman (2009), as well as a triple differences (DDD) approach. Our instrumental variable is the time-varying and cross-sectional exogenous variation in statutory state taxes levied on banks. The benefit of tax shield is a major friction that affects the M-M capital-structure irrelevance proposition, and motivates our instrument selection. Specifically, interest on debt is tax-deductible while dividend payments are not. Therefore, it is reasonable to expect that banks operating in states with high state tax rates to be more levered to take advantage of the tax shield. Also, the instrument satisfies the exclusion restriction in that the exogenous variation in state tax rates can only affect the bank's cost of capital through leverage. Both the IV and the DDD methodology yield qualitatively similar results; specifically, a 10 percentage point increase in the book equity capital ratio is associated with an increase in the bank's cost of capital between 60 and 92 basis points.

Using data from the largest 20 banks in the sample, we find a positive and statistically significant relationship between a bank's equity capital ratio and growth in new lending. The results indicate that a 1 percentage point increase in the market (book) equity capital ratio is associated with a 1.21 (1.69) percentage point increase in new loan lending. The fact that well capitalized banks are associated with positive growth in lending behavior is not necessarily at odds with the negative relationship between an equity capital ratio and a bank's private cost of capital. In a competitive market, an increase in a bank's private cost of capital likely translates into an increase in loan spreads, but not necessarily the amount of lending. On the one hand, banks with low capital cannot generate new loans instantly, and have to first compete for deposits or raise equity capital before being able to generate new loans. On the other hand, well capitalized banks, who have equity capital in excess of the capital requirements, possess a greater capacity to generate loans (assets) given their excess equity capital buffer. This result is consistent with the findings in Gambacorta & Shin (2016), who find that a 1 percentage point increase in the equity capital ratio is associated with a 0.6 percentage point increase in annual loan growth.

The rest of this paper proceeds as follows. Section 2 discusses the extant literature on bank capital regulation. Section 3 discusses related literature on bank equity capital and bank lending and risk-taking. Section 4 describes the data and sample collection. Section 5 describes the empirical methodology. Section 6 discusses the results. Section 7 highlights a battery of robustness checks, and Section 8 concludes with a summary.

2 Bank capital regulation

In a public testimony, the former chair of the U.S. Federal Deposit Insurance Corporation Sheila Bair summarized the relation among bank equity capital regulation, risk taking by banks, and moral hazard.

> *"There are strong reasons for believing that banks left to their own devices would maintain less capital, not more, than would be prudent. The fact is, banks do benefit from implicit and explicit government safety nets. Without proper capital regulation, banks can operate in the marketplace with little or no capital. And governments and deposit insurers end up holding the bag, bearing much of the risk and cost of failure. History shows this problem is very real. In short, regulators can't leave capital decisions totally to the banks. We wouldn't be doing our jobs or serving the public interest if we did."*[1]

[1] All remarks by Sheila Bair is available at the FDIC webpage https://www.fdic.gov/news/news/speeches/archives/2007/chairman/spjun2507.html

Diamond & Rajan (2000) argue that while deposit insurance reduces the probability of bank runs and increases liquidity, such insurance does induce moral hazard among bank managers who would invest in riskier assets and strategies than they would without deposit insurance. The difficulties in measuring the risk of a bank's assets makes it harder for regulators to enforce optimal levels of equity capital.

Large international banks' capital requirements have been globally harmonized, under the Basel accords, since 1988. Basel capital calculations take into account an asset's risk, that is, banks are required to hold more capital for riskier assets, such as corporate loans, than they are required to hold for what are considered safer assets, such as government debt. The initial accord has been revised several times, with each succeeding revision resulting in more complex calculations of risk, and layered on top of existing provisions. Under Basel I, regulators established standardized risk weights for broad categories of assets.[2] Banks were then required to hold a minimum of 8% capital against those assets. The standardized approach was amended under Basel II for the largest banks to apply a methodology by which regulators enlist banks' own more sophisticated internal risk management models to determine their risk-based capital requirements ("Internal Ratings Based" or "IRB").[3]

Bhagat (2017) recommends pegging bank capital to the ratio of tangible common equity to total assets (i.e., to total assets independent of risk) rather than the risk-weighted

[2] For example, if a bank made a loan to a business of $1 million, given the 100% risk weight for such assets, the bank would need capital in the amount of 8% x 100% x $1 million = $80,000. By contrast, if it used the same $1 million to buy a U.S. treasury bond, given the 0% risk weight for sovereign debt, it would not need to hold any capital against that asset, despite total assets remaining unchanged.

[3] IRB was intended to address regulatory arbitrage opportunities created by the arbitrary requirements of the standardized approach, such as, for instance, banks cherry-picking assets within a category to increase their yield, i.e., the riskiest assets, without incurring an increased capital charge because the standardized risk categories were insensitive to the risk of specific borrowers or assets within the class. E.g., Tarullo (2008) (discussing regulatory arbitrage opportunities afforded by Basel I).

capital approach that is at the core of Basel. [4] [5] In this he endorses the position advocated by two experienced bank regulators, Thomas Hoenig, Vice Chairman of the FDIC, and Andrew Haldane, Executive Director, Financial Stability, of the Bank of England. They have both called for abandoning Basel III's complicated risk-weighted approach in favor of straight leverage ratios.[6] Similarly, they contend that Basel III's approach to capital needs to be recalibrated to emphasize the leverage ratio (ratio of tangible common equity to total assets) over the risk-weighted minimum, which would require a ratio far higher than its present 3%, which has been set as a backstop to the risk-weighted ratio, rather than the mainstay of capital requirements.

Hoenig's and Haldane's emphasis on the leverage ratio over risk-weighted capital measurements is, in part, a reaction to Basel III's daunting complexity and obscurity. As Haldane has remarked, Basel III's multiple requirements, and definitions of capital and risk-weight computations are so exceedingly complicated that they now reach over

[4]Regulators refer to bank capital as the sum of Tier-1 capital and Tier-2 capital. Tier-1 capital includes common stock, retained earnings, capital surplus from sale of common or preferred stock above par, and disclosed capital reserves such as cash dividends not yet declared. Tier-2 capital includes loan loss provisions, preferred stock of maturity of at least 20 years, subordinated equity and debt obligations with maturity of at least 7 years, undisclosed capital reserves, and hybrid capital, such as, contingent convertible debt. Per Basel Accords, bank regulators consider Tier-1 capital or Tier-1 capital and Tier-2 capital as the numerator (in measuring bank capital). The denominator is risk-weighted total assets, which has been and continues to be under considerable controversy. The risk-weights are ad-hoc, and can be easily manipulated and gamed. For example, sovereign debt has a weight of 20% whereas corporate debt has a weight of 100%; this does not make sense when considering AAA rated corporate debt, and sovereign debt from countries like Greece and Italy.

[5]Tangible common equity includes common stock plus retained earnings (both via the income statement and unrealized value changes on cash flow hedges). Anginer & Demirguc-Kunt (2014) study the relation between different types of bank capital and its impact on systemic-risk of the banking industry. They find that Tier-1 capital, especially tangible capital, was correlated with reductions in systemic risk. On the other hand, Tier-2 capital has the opposite, destabilizing effect. Furthermore, these effects are accentuated during the crisis years and for the larger banks.

[6]Vice Chairman Hoenig voted against Basel III; citing the rule's inability to set a binding leverage ratio constraint, Statement by Thomas Hoenig, Basel III Capital Interim Final Rule and Notice of Proposed Rulemaking, FDIC (July 9, 2013), https://www.fdic.gov/about/learn/board/hoenig/statement7-9-2013.html, and has advocated that the United States take the lead and abandon Basel III in favor of the ratio of tangible equity (i.e., excluding goodwill, tax assets and other accounting entries) to tangible assets (assets less intangibles), Alan Zibel, FDIC's Hoenig: U.S. Should Reject Basel Accord, Wall Street Journal, Sept. 14, 2012, http://online.wsj.com/news/articles/SB10000872396390443524904577651551643632924. Haldane has called for simplifying Basel's capital requirements to eliminate IRB and reemphasize standardized weights for broad asset classes and for applying a stricter leverage ratio. Andrew G. Haldane, The Dog and the Frisbee (Aug. 31, 2012).

600 pages, compared to Basel I's 30 page text, and for a large bank to comply it now requires several million calculations, as opposed to Basel I's single figures (Haldane (2009)). These data suggest that it is, at present, all but impossible for any individual investor, regulator, or bank executive to get a good handle on the risk that such institutions are bearing.

As the complexity of the risk-weight calculation has increased with each regulatory permutation, it magnifies what is a behavioral constant in the financial regulatory landscape: banks will game regulatory requirements to minimize the capital they must hold. It is axiomatic that the more complicated the system, the more leeway banks will have to engage in such activity, termed "regulatory arbitrage," reconfiguring their portfolios to achieve the maximum risk with the minimum amount of capital. In turn, the more room banks have to engage in such activity, the more difficult it becomes for regulators and investors to evaluate bank capital and monitor compliance.[7]

The far simpler equity capital ratio, defined as leverage using tangible equity over book assets, would cabin banks' ability to engage in exploitation of regulatory loopholes across risk weights and asset classes to minimize their cost of capital. Importantly and relatedly, although it does not prevent gaming by increasing the risk of assets held, a straight leverage ratio requirement is easier for regulators and investors to monitor compliance, as well as to evaluate banks' relative risk, as it will increase the comparability of banks' risk and performance compared to the IRB approach. This would have a beneficial feedback effect on bank managers' incentives to take risks, as

[7] Wall Street Journal, November 13, 2012, p A20, "The FDIC's own Director Thomas Hoenig sees in Basel III the same complicated system for judging risk that failed in Basel II but with more complexity. Using theoretical models that have failed in practice, the rules assign risk-weights to different assets, divined by an almost endless series of calculations. For the largest banks with the resources to spend on regulatory arbitrage, this is an opportunity to get risky assets officially designated as safe." The Economist, September 19, 2015, "Whose model is it anyway?" "The models used to gauge the riskiness of a loan book were once provided by regulators, with fixed weightings for categories such as business credit or loans to other banks. But an update to the global regulatory guidelines, known as Basel II and adopted just before the crisis, encouraged banks to come up with their own risk models. The models are often fiendishly complicated, as well as being numerous. Repeated studies have found that putting the same pool of loans and securities through different banks' formulae lead to wildly different outcomes."

better informed investors and regulators better convey their preferences regarding risk.

Demirguc-Kunt, Detragiache & Merrouche (2013) analyze whether better capitalized banks performed better (in terms of stock returns) during the 2007-2008 crisis. They consider a sample of 381 banks in 12 countries. In the financial crisis, they found a positive relation between capital and stock returns. Additionally, this positive relation was stronger when capital was measured by leverage ratios, and not Basel risk-weighted capital, suggesting that the stock market did not view Basel risk-adjustments as informative. Finally, they document that the positive relation between capital and stock returns was mostly driven by higher quality capital, such as, common stock.

2.1 Proposals to reform bank capital requirements

The strongest form of bank capital is common equity that can absorb losses without disrupting the bank's ongoing business activities; hence, common equity can be thought of as "going concern" capital. Recently, other forms of capital, referred to as regulatory hybrid securities, that can absorb losses after conversion to equity have been proposed. We can think of these regulatory hybrid securities as "gone concern" capital since they convert to equity only when the existing amount of common stock is insufficient to cover losses. The "gone concern" capital comes in various flavors, such as, CoCo bonds, TLACs; these are discussed below.

French, Baily, Campbell, Cochrane, Diamond, Duffie, Kashyap, Mishkin, Rajan, Scharfstein & others (2010) in The Squam Lake Report propose a thoughtful solution to the current thin equity capitalization of large banks, "The government should promote a long term debt instrument that converts to equity under specific conditions. Banks would issue these bonds before a crisis and, if triggered, the automatic conversion of debt into equity would transform an undercapitalized or insolvent bank into a well-capitalized bank at no cost to taxpayers." These contingent convertible bonds are popularly known as CoCos. Subsequent to the financial crisis of 2008, European banks have issued CoCos worth about $450 billion; see Avdjiev, Bolton, Jiang, Kartasheva & Bogdanova (2015). In the U.S., banks issued a somewhat different security: senior debt whose face value could be reduced in the event of imminent bank failure; these securities are called TLACs (total-loss-absorbing-capacity).

A potential advantage of the Regulatory Hybrid Security proposal is it requires less equity capital upfront. However, several authors have raised concerns about the incentive and legal problems the triggering mechanism (that would lead to the conversion of the hybrid capital to equity) would generate; for example, see Flannery (2014), Duffie (2010) and McDonald (2013). The recent experience of Deutsche Bank, UniCredit SpA, Barclays Plc, and Royal Bank of Scotland suggests that the security-design concerns raised about CoCos are quite real.[8] The illiquidity of bond markets raises concerns about the effectiveness of TLACs.[9]

Taylor & Kapur (2015) suggest a thoughtful and innovative reform to the bankruptcy process; they refer to it as Chapter 14.[10] In essence, a specialized panel of bankruptcy judges would recapitalize the financially troubled big bank by requiring the bank's long-term unsecured debtholders to bear the losses such that the new bank would not be in bankruptcy. If the bank's long-term unsecured debtholders agree to bear the losses, the process appears to be viable. However, given the large dollar figures involved, for example, the long-term unsecured debtholders would have to agree to losses over tens of billions of dollars, making litigation a real possibility. Prior agreements can make such litigation

[8] See The Economist (February 13, 2016; "Deutsche Bank's unappetizing cocos") and Bloomberg Business (February 9, 2016).

[9] See The Economist (November 14, 2015; Buttonwood, Born to run), and The Wall Street Journal (March 3, 2016; The Perverse Effects of Crisis-Prevention Bonds).

[10] http://web.stanford.edu/~johntayl/2015_pdfs/Testimony_Senate_Banking-SCFICP-July-29-2015.pdf "Chapter 14 would operate fasterideally over a weekendand with no less precision than Chapter 11. Unlike Chapter 11, it would leave all operating subsidiaries outside of bankruptcy entirely. It would do this by moving the original financial firm's operations to a new bridge company that is not in bankruptcy. This bridge company would be recapitalized by leaving behind long-term unsecured debtcalled the "capital structure debt." The firm's long-term unsecured debt would bear the losses due to the firm's insolvency and any other costs associated with bankruptcy. If the amount of long-term debt and subordinated debt were sufficient, short-term lenders would not have an incentive to run, and the expectation of Chapter 14's use will reduce ex ante uncertainty about runs."

difficult, but not impossible. The very threat of such litigation would cause uncertainty in the minds of investors leading to potential disruption in the bank's financial market transactions.

As noted above, a potential advantage of the Regulatory Hybrid Security proposal and the Chapter 14 proposal is it requires less equity capital upfront. If the banks had significantly more equity capital upfront, this would preclude the need for the Regulatory Hybrid Security or the Chapter 14 bankruptcy reform. A question that arises: *Why are banks not capitalized with significantly more equity capital than the current norm?*

2.2 Financing banks with significantly more equity

This section is based on Admati & Hellwig (2014) and Bhagat (2017), and discusses the flaws in the current received wisdom that large banks should be mostly financed with debt; in other words, they question the potential advantage of the Regulatory Hybrid Security and Chapter 14 proposals' requirement of less equity capital upfront.

Proponents of high bank leverage have highlighted the negative consequences on the economy if big banks were required to hold significantly more equity capital. For example, bankers argue that if they were required to hold more equity, they would be forced to curtail their lending. To the extent this lending would have been to individuals for mortgages, and corporations for plant, equipment and working capital, reduction in such lending would dampen economic growth and employment. This argument is a classic confusion between a bank's investment and financing decisions. Lending activities are a part of a bank's investment decision. Financing this lending with debt or equity is a financing decision. In general, if a bank is engaged in value-enhancing investment activities, its investment activities should not impact how the funds are obtained (through debt or equity).

A second fallacy is that debt provides a discipline on bank managers; if the bank's debt ratio decreases this discipline effect would be diluted. However, there is not a single empirical study which documents that debt provides discipline on bank managers in large publicly-held banks. Indeed, the financial collapse of the too-big-to-fail banks (that had debt ratio upwards of 95%) in 2008 is prima facie evidence inconsistent with the argument that debt provides discipline on bank managers. If debtholders in banks with 95% debt ratio could not or would not impose discipline on bank managers, when would debtholders impose such discipline?[11] Kaplan & Strömberg (2009) and Gompers, Kaplan & Mukharlyamov (2016) document the discipline effect of debt in privately-held companies (subsequent to a going-private transaction sponsored by a private equity investor). The equity ownership structure in these newly privately-held companies is significantly different from that in large publicly-held banks; specifically, subsequent to a going-private transaction, equity is extremely concentrated in the new privately-held company.

A third fallacy is that more banking activities would move to the shadow banking system if banks have to adhere to high equity capital ratio requirements. The shadow banking system consists of financial intermediaries that perform functions similar to traditional banks maturity, credit, and liquidity transformation; money market mutual funds, and special purpose vehicles (used for securitization) are examples of such intermediaries. They borrow short-term and invest in long-term illiquid assets. However, unlike the traditional banks, they did not have access to deposit insurance or central bank liquidity guarantees until 2008. Most of the shadow banks are off-balance sheet vehicles of the traditional big banks. If the traditional big banks were to bring these off-balance sheet vehicles on their balance sheet, they would need additional equity capital to meet their equity capital ratio requirements. Big bank managers, whose incentive compensation have a significant return on equity component, prefer the high

[11] Of course, if debtholders in these too-big-to-fail banks were fairly confident of being bailed out by public taxpayers, they would not have any incentive to monitor or impose discipline. The question is Do debtholders in banks smaller than the too-big-to-fail banks provide monitoring and impose discipline on bank managers, and can they do it more effectively than shareholders in these smaller banks? We are not aware of any empirical evidence that directly addresses this question.

leverage of the off-balance sheet vehicles since this would magnify the impact of these vehicles' earnings (at the time these vehicles were created and subsequently) on the return on equity of the traditional bank. While the big bank managers could benefit significantly from the off-balance sheet vehicles, it is unclear how the big bank shareholders might benefit from these off-balance sheet vehicles; shareholders care about projects/strategies that create and sustain long-term shareholder value, not return on equity. Hence, the problem of shadow banking is ultimately a problem of inappropriate incentive compensation structure for big bank managers.[12]

3 Bank capital, lending, and risk-taking

There is a growing literature focused on measuring the impact of increased bank equity capital on bank cost of capital. Since cost of debt is less than cost of equity, bank managers argue that greater financing with equity will increase the bank's cost of capital. However, per the Miller-Modigliani theorem as the bank is financed with more equity, the equity becomes less risky, hence, the cost of equity decreases. In general, the increase in equity financing by itself neither increases nor decreases the bank's cost of capital. Now to the empirical evidence on the impact of increased bank equity capital requirements on bank cost of capital. Kisin & Manela (2016) consider the impact of a 10 percentage point increase in bank equity capital and estimate an upper bound of 3 basis points in the increase in the bank's cost of capital. Kashyap et al. (2010) consider the impact of a 10 percentage point increase in bank capital and estimate a range of 25-45 basis points in the increase in the bank's cost of capital. Junge & Kugler (2012) consider a sample of Swiss banks and find that halving their leverage would increase their cost of capital by about 14 basis points. Slovik, Cournède & others (2011) and King (2010) consider a sample of OECD banks and document an increase in the cost of capital of 150 to 160 basis points

[12] Bhagat (2017) details the role of bank manager incentive compensation in the banking crisis of 2007-2008, and recommends bank manager incentive compensation reform.

for a 10 percent increase in equity capital. For a sample of 13 OECD banks, the Basel Committee on Banking Supervision (2010) computes a 130 basis points increase in the cost of capital for a 10 percent increase in equity capital. Miles, Yang & Marcheggiano (2013) estimate that even if bank equity capital was doubled, bank cost of capital would increase by 10-40 basis points.

From the viewpoint of economic policy, it is not the increase in a bank's private cost of capital per se that is important, but the impact of the increase in bank cost of capital on bank lending. What is the impact of bank lending on the growth of non-financial (both, entrepreneurial and larger, more mature) companies? Bank based financing is not a major source for funds for the vast majority of firms in the U.S. manufacturing sector. The shareholders' equity for the entire U.S. manufacturing sector in 2016 is $3,976 billion; total liabilities are $5,638 billion of which bank debt accounts for $568 billion.[13] Hence, bank debt accounts for less than 6% of the financing for the U.S. manufacturing sector. It is possible that bank debt financing might be more significant for smaller firms that have less access to public equity and public debt markets. The shareholders' equity for firms with assets under $25 million in the U.S. manufacturing sector in 2016 is $159 billion; total liabilities are $147 billion of which bank debt accounts for $43 billion. Hence, bank debt accounts for about 14% of the financing of firms with assets under $25 million in the U.S. manufacturing sector in 2016. Furthermore, Myers (1977) suggests that debt, such as borrowing from banks, is not an appropriate source of financing for high growth companies that will have the option to invest in many future projects.

An important issue to consider in this context is the relationship between capital adequacy ratio and credit supply. Peek & Rosengren (2000) use a natural experiment that isolates shocks to bank capital that are unrelated to lending opportunities. Their method involves U.S. branches of Japanese banks and they find that a 1% decline in capital ratio of bank parent company led to a 6% decline in loans growth at the U.S. branch. Houston,

[13] Please see http://census.gov/econ/qfr/mmws/current/qfr_pub.pdf

James & Marcus (1997) use a similar identification strategy in U.S. commercial banks that have a common BHC, and find a similar result in that well-capitalized banks have a lower loan growth when the parent BHC has regulatory capital below the minimum required by regulators. These and other papers such as Ediz, Michael & Perraudin (1998), Ito & Sasaki (2002), Brinkmann & Horvitz (1995) assert that capital shocks have an impact on lending rates and credit supply. As such, opponents of capital regulation argue that increasing capital requirements will lead to a credit supply shortage. However, Aliaga-Díaz & Olivero (2012) test the role of bank capital requirements in the transmission of credit shocks, and find that there is weak evidence supporting this claim. More recently, Gambacorta & Shin (2016) consider the lending behavior of major financial institutions of 14 advanced economies during 1994-2012. Their sample includes 105 consolidated banking institutions that hold over 70% of worldwide banking assets. They find that a 1 percentage point increase in a bank's equity to total assets ratio is associated with a 0.6 percentage point increase in the bank's lending growth.

The relationships among bank size, risk taking, moral hazard, and excessive leverage have been documented for U.S.-based banks in the period surrounding the financial crisis by Bhagat, Bolton & Lu (2015). Using data on the size and risk-taking of financial institutions from 2002 to 2012, they investigate whether cross-sectional variation in the size of banks is related to risk-taking. They document four important facts. First, bank size is positively correlated with risk-taking, even when controlling for endogeneity between size and risk-taking. Second, banks engage in excessive risk-taking mainly through increased leverage. They also suggest that economies of scale do not exist for banks. Regressions with volatility of stock return as the dependent variable indicate that size-related diversification benefits may not exist in the financial sector since size is positively associated with return volatility. Third, they find that the recently developed corporate governance measure (Bhagat & Bolton (2008)), calculated as median director dollar stock holding, is negatively associated with risk-taking. This has important policy implications. For example, policy-makers interested in discouraging banks from taking excessive risks should focus on bank director stock ownership and compensation structure. Finally, they document that the positive relation between bank size and risk is present in the pre-crisis period (2002-2006) and the crisis period (2007-2009), but not in the post-crisis period (2010-2012). Perhaps the scrutiny on risk-taking behavior by banks from regulators, policy-makers, and the media after the crisis may have attenuated large banks' investments in high-risk projects.

Bhagat & Bolton (2014) find that too-big-to-fail bank CEOs were able to realize a substantial gain on their common stock sales in the pre-crisis period (2000-2007), compared to the large losses the executives experienced on their equity stake during the crisis (2008). Additionally, stock sales by too-big-to-fail bank CEOs was significantly greater than stock sales by other bank CEOs in the pre-crisis period. Finally, several different bank risk-taking measures suggest that TBTF banks were significantly riskier than other banks. Their results are mostly consistent with the argument that incentives generated by executive compensation programs in the too-big-to-fail banks are positively correlated with excessive risk-taking by these banks in high-risk but value decreasing investments and trading strategies. They also find that well-capitalized banks had less stock sales by their CEOs.

3.1 Tax policy and bank capital

Recently, an IMF report to the G20 nation has significantly focused on bank taxation policy. Claessens, Keen & Pazarbasioglu (2010) highlight a range of tax policies that different countries have adopted, and how such policies have contributed to decreasing the burden of government interventions in safeguarding the financial sector. Tax shield benefits are of first order importance in determining financial institutions' capital structures, and numerous studies find empirical evidence consistent with this hypothesis.

In the non-financial corporate sector, Heider & Ljungqvist (2015) show that firms increase leverage by approximately 40 basis points for every one percentage increase in state taxes. Their results show that taxes have a first order effect on leverage. In the banking and financial corporations sector, Schandlbauer (2017) uses a difference-in-differences methodology and shows that an increase in state tax rate affects both sides of a bank's balance sheet. In particular, the author finds that banks exposed to tax increases respond by increasing non-depository debt by 5.9%. On the one hand, better capitalized banks increase debt and benefit from tax shield savings, and reduce equity financing. On the other hand, banks with constrained capital are affected on the asset side of the balance sheet. The reduction in after-tax cash flow leads such banks to constrain the expansion of customer loans. The author finds no change in loan growth for well-capitalized banks that increase their leverage post-tax increase shocks. Consistent with these results, Gambacorta, Ricotti, Sundaresan, Wang & others (2017) find that banks reduce leverage in response to tax decreases, and this stems from a decrease in non-deposit debt. The authors show this leads to a decrease in non-equity cost of funding, and an increase in lending.

Schepens (2016) finds that banks become better capitalized when tax discrimination between equity and debt funding is reduced. The author draws evidence from Belgium and neighboring countries where an exogenous shock to the tax system created a tax shield benefit for equity. The results show that following such policy, banks have increased their equity capital ratios by 1 percentage point, which corresponds to a 15% increase from prior levels. These results confirm the close link between tax policy and bank equity capital levels. Panier, Pérez-González & Villanueva (2015) use the same natural experiment and find similar results. In their analysis, the authors show that the increase in the share of equity in the capital structure was driven by an increase in equity funding, and not a reduction in liabilities. Using confidential data on regional Italian banks, Bond, Ham, Maffini, Nobili & Ricotti (2016) exploit regional exogenous variations in taxes levied on banks, and find that such changes affect leverage. They find that the effect is larger for smaller or slow-growing banks, and that capital constrained banks do not respond with a change in leverage.

However, the literature does not explore how this exogenous variation of tax affects a bank's overall cost of capital. Using a detailed analysis from large BHCs in the US, this paper fills this gap in the literature, by examining how the exogenous variation of tax shocks affects a banks cost of capital through the change in capital structure.

4 Data

We gather data on stock prices, returns, and market capitalization from CRSP to calculate asset pricing betas and the implied costs of equity for all BHCs. CAPM and FF3 equity betas are estimated from regressing a bank's trailing 24 monthly returns in excess of the riskless rate over the corresponding market value-weighted excess returns and the SMB and HML factors from Fama and French's three factor model. Balance sheet and other quarterly BHC financial information is gathered from quarterly Y-9C call reports available from the Federal Reserve Bank of Chicago. Market data from CRSP is then matched to BHC quarterly financials using the RSSD ID to PERMCO bridge available from the Federal Reserve Bank of New York. This link covers most public BHCs, but not all. To increase coverage, we perform a fuzzy matching technique to identify other RSSD to PERMCO matches based on quarter, year, bank name, state, street address, zip code, and phone number which are variables found both at CRSP and the Chicago FED for BHCs. Then, we manually inspect and hand collect all potential matches and include only the confirmed ones. This yields an initial sample of 1018 unique BHCs with quarterly data from 1986 to 2014 where cost of equity information is available from asset pricing models.

To calculate the cost of equity from analyst EPS forecasts, we use I/B/E/S consensus analyst forecasts for a bank's one and two years ahead expected EPS, as well as the reported consensus long-term growth rates. Details on the construct of the GLS, CT, and DGM estimations methods are available in Appendix A. This yields a subsample of 780 unique BHCs with quarterly cost of equity estimates from 1988 to 2014.

To calculate the cost of debt, we use bond issues data from Mergent's FISD and bond trades data from TRACE. We exclude short-term and small bond issues. We keep only long-term straight non-convertible non-zero coupon bond issues and trades maturing in 7 to 15 years. The corresponding yield to maturity, which is value-weighted on issue size across all observable outstanding bonds for a BHC, is then used to proxy for the bank-level pre-tax cost of debt. This yields a subsample of 198 unique BHCs where cost of debt information is available from 1986 to 2014. The decreased coverage for this subsample is primarily due to TRACE data availability which starts in 2002. Mergent's FISD bond issues coverage goes back far enough, though bond issues by banks are not very common. As such, we check for possible selection issues and confirm that the subsample where cost of debt is available is fairly representative of the overall sample.

Further, we collect loan-level data for the largest 20 banks in our sample from Thomson-Reuters DealScan database. This allows us to construct a variable that measures growth in new lending by the large banks. We also gather firm-level S&P long-term issuer credit ratings from Compustat. The ratings are converted into a categorical variable that takes the value of 1 for a D rating and 22 for AAA. Statutory state income taxes on banks and financial institutions used for the IV regressions are hand collected from the annual publication of *The Book of States* available from The Council of State Governments.[14] Of the entire sample, 72% of the BHCs have depository branches in only one state. In the other 28% of the BHCs, who operate in multiple states, we calculate their statutory state tax income exposure as the weighted average across the states using the proportion of the bank's deposits in each of these states as the weight. We would like to construct the weighted average statutory tax rate for these

[14]This data is available from http://knowledgecenter.csg.org/kc/category/content-type/bos-2016

multiple states BHCs by the amount of loans in the respective states; unfortunately, this information is not publicly available. Bank deposits data at the branch and state level are gathered from the FDIC's June Summary of Deposits database; these data are available from 1994 to 2014. This yields a final sample of 178 unique BHCs with 6,278 bank-year-quarter observations for the period 1994-2014 where all previous variables are available. Compared to the starting sample of the universe of 1018 BHCs, the final sample of 178 BHCs has 81.7% of the assets and 77.4% of the deposits.

All variables are winsorized at the 1st and 99th percentile levels to reduce the effects of outliers. A description of all the variables is in Table 1.

5 Empirical methodology

Do exogenous changes in equity capital requirements lead to a change in a bank's cost of capital? We first test the relationship between bank equity capital ratio and the cost of equity. We then test the relationship with the cost of debt, and then the overall cost of capital.

The CAPM and FF3 costs of equity are measured by first estimating equity betas. We regress banks' trailing 24 months excess returns over the CRSP market value weighted returns and the Fama French factors from Kenneth French's data library.[15]

Beta estimates from CAPM and FF3 are then used to calculate a forward looking cost of equity in the following way.

$$R_e^{CAPM} = R_f + \hat{\beta}_M \left[E(R_{M)} - R_f\right] \tag{1}$$

$$R_e^{FF3} = R_f + \hat{\beta}_M \left[E(R_{M)} - R_f\right] + \hat{\beta}_S\, SMB + \hat{\beta}_V\, HML \tag{2}$$

The expected market risk premium is calculated using the Gordon & Shapiro (1956) method, which determines the total market equity by discounting dividends when the

[15] Rf, Rm, SMB, and HML monthly factors are found at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

latter grow at an annual rate g. We use the I/B/E/S analyst forecasts for all available BHC earnings forecasts and their stated long term growth rates to calculate the expected market risk premium in the following way:

$$E[R_M] = \sum_{i=1}^{I} \frac{EPS_{t+1}}{P_t} + \bar{g} \tag{3}$$

The construction of the other measures for the cost of equity, namely the DGM, GLS, and CT models warrant a longer discussion and are thus discussed in detail in Appendix A. The implied cost of capital is then calculated simply as the market average weighted costs of equity and after tax cost of debt.

$$ICC = W_E\, R_E + (1 - W_E)\ (1 - T)\, R_D \tag{4}$$

Where W_E is the ratio of market value of equity to the sum of market equity and book debt, and ICC is measured six different ways (5 plus the average) depending on which R_E is input in the ICC formula.

We run three fixed effects OLS regression specifications where the dependent variables are the cost of equity, the cost of debt, and the cost of capital. The following depicts these regressions:

$$\begin{aligned} Y_{i,t} \quad = \quad & \beta_1 \frac{BE}{TA}_{i,t-1} + \beta_2\, Log(TA)_{i,t-1} + \beta_3\, Log(\frac{B}{M})_{i,t-1} + \beta_4\, Loan\, HHI_{i,t-1} \\ & + \beta_5\, Competition\, HHI_{i.t-1} + \beta_6\, NPL\, Ratio_{i,t-1} + \beta_7\, ROA_{i,t-1} \\ & + \beta_8\, Securitization\, Ratio_{i,t-1} + \beta_9\, Credit\, Rating_{i,t-1} + \gamma_i + \gamma_t + \varepsilon_{i,t} \end{aligned} \tag{5}$$

To find the relationship between new lending growth and the equity capital ratio, we also run the previous regression using $New\, Lending\, Growth$ as the dependent variable. $New\, Lending\, Growth$ is the bank-level quarterly growth (over the same quarter in the previous year) in new bank lending, as obtained from loan-level data from Thomson-Reuters DealScan database.

All explanatory variables are lagged by one period, and the standard errors are two-way robust-clustered at the bank and year-quarter dimensions. $\frac{BE}{TA}$ is the main explanatory variable of interest, and it measures the book equity capital ratio, also called inverse book leverage, of the bank. $Log(TA)$ controls for size, $Log(\frac{B}{M})$ is a proxy for inverse Q and controls for the market's perspective of growth opportunities. $Loan\,HHI$ and $Competition\,HHI$ are the Herfindahl Hirschman Indices measuring the loan and market competition concentrations separately.

$$HHI = \sum_{i=1}^{N} s_i^2 \tag{6}$$

Where s_i is the market share, proxied by state deposits share, in the case of Competition HHI. In the case of $Loan\,HHI$, it measures the loan category share and exposure against gross loans in the balance sheet of a bank. $NPL\,Ratio$ measures the percentage of non-performing loans in a bank's balance sheet, which is a common proxy for the quality of the asset pool. ROA measures bank performance. $Securitization\,Ratio$ controls for the amount of securitized assets relative to total assets, and finally $Credit\,Rating$ is a categorical variable that takes a value between 1 for D rating and 22 for AAA rating, and measures the bank-level credit risk. Table 1 provides variable constructs and description.

Since capital structure is endogenous, a challenge to causal inference is to identify exogenous shocks to bank capital. Within bank variation in leverage is closely associated with financial health, which is correlated with future financial health. Consider the situation where a bank becomes financially distressed, bad debt is charged off against equity, and this increases leverage, and likely raises the cost of capital. As such, to the extent that increased leverage simply captures the probability of distress, the OLS estimates are likely biased towards finding that increased leverage (low equity capital ratio) is associated with an increase in the cost of capital. We consider two different econometric techniques to test for a causal link between capital shocks and changes in cost of capital.

5.1 Instrumental variable approach

A good instrument must satisfy the relevance and exclusion principles. Put simply, the instrument should be exogenous, has significant explanatory power over the endogenous variable, and it should affect the outcome variable only through the endogenous variable. It is easier to show relevance and argue exogeneity than to prove the "only through" condition. The instrument we use for equity capital ratio is the statutory state income tax rates levied on banks. Interest on debt is tax-deductible, which generates higher tax benefits for levered banks operating in higher tax environments. To the extent policy changes like state tax rates are exogenous, we claim that cross-sectional and time-series variation in state taxes must generate meaningful variation in bank leverage, and argue that this instrument satisfies the "only through" condition; it is difficult to find a relationship between a bank's cost of capital and state tax rates in a path other than leverage. One might argue that profitability is a potential channel through which state taxes can affect the cost of capital. While we directly control for a bank's operating performance in the analysis, it is unlikely that taxes paid explain enough variation in the cost of capital through profits in a way that undermines the first-order effect of the tax-benefit in leverage; see Berger & Bouwman (2009); Schepens (2016); Gambacorta et al. (2017); Schandlbauer (2017).

For banks operating in multiple states, we construct a BHC-level tax rate that is equal to the weighted average of state taxes where the banks operate using state share deposits, relative to total deposits, as the weights.

5.2 Difference-in-difference-in-differences

Besides using statutory state tax rates as a variable to measure leverage variation in the instrument variable (IV), we also employ a different econometric method for identification. In a multiple time period Difference-in-Differences (DD) regression, we utilize the exogenous nature of changes in state tax rates to test whether leverage, as an outcome variable, varies during episodes of state tax rate increases or decreases relative to an entropy balanced peer group of out-of-state banks that did not experience a tax shock. The following equations describes this DD regression.

$$\begin{aligned} \frac{BE}{TA}_{i,s,t+1} &= \beta_1 Tax\,Increase\,Treatment_{s,t} + \beta_2 After\,Tax\,Increase\,Shock_t \\ &+\beta_3 Tax\,Increase\,Treatment \times After\,Tax\,Increase\,Shock_{s,t} \\ &+X'_{ist}\delta + \gamma_i + \gamma_t + \varepsilon_{ist} \end{aligned} \tag{7}$$

$$\begin{aligned} \frac{BE}{TA}_{i,s,t+1} &= \beta_1 Tax\,Decrease\,Treatment_{s,t} + \beta_2 After\,Tax\,Decrease\,Shock_t \\ &+\beta_3 Tax\,Decrease\,Treatment \times After\,Tax\,Decrease\,Shock_{s,t} \\ &+X'_{ist}\delta + \gamma_i + \gamma_t + \varepsilon_{ist} \end{aligned} \tag{8}$$

In these specifications, $Tax\,Treatment$ identifies BHCs in states that have undergone a tax shock in the 4 quarters before and after the shock. $After\,Tax\,Shock$ identifies the time period after a tax increase or decrease, and is therefore absorbed by the time fixed effects. The interaction of these two variables, controlling for a host of BHC level covariates X_{ist}, therefore estimates whether BHCs in states with a tax shock adjust their capital structure differently compared to their non-treated peers of out-of-state banks.[16]

When constructing the control sample, we carefully make sure to only include banks operating in states that did not experience opposite tax shocks during the event period. While it is possible to run the two specifications in (7) and (8) in one regression, we avoid doing that because we cannot simultaneously entropy balance all covariates for opposite shocks in the same test. Covariates balance is key to shock-based causal inference, so we follow Hainmueller (2012) and use entropy weighting to balance the treatment and control covariates on the first and second moments. Therefore, it is not possible to run different weights for the same control group that simultaneously serves as a control for different

[16] As a robustness check, we repeat this analysis and exclude banks that operate in more than one state, which is approximately 20% of the BHCs in the sample, to reduce measurement error.

treatment groups unless the control sample is split, which likely reduces the power of the test. Appendix A discusses in detail and the construction of entropy balancing weights.

The previous DD test serves as the first step to establishing a direct relationship between changes in tax and capital structure. However, the relationship of interest is between capital structure and the cost of capital. To test that, we take advantage of the existing relationship between tax changes and capital structure in the DD, and run another difference with cost of capital as the outcome. In principle, the DDD differences out trends that may differentially affect treatment and control groups in the DD estimation. The following equations describe the DDD regression.

$$\begin{aligned} ICC_{i,s,t+1} = {} & \beta_1 \, Tax\,Increase\,Treatment_{s,t} + \beta_2 \, Tax\,Increase\,Treatment \\ & \times After\,Tax\,Increase\,Shock + \beta_3 \, Tax\,Increase\,Treatment \times \frac{BE}{TA}_{ist} \\ & + \beta_4 \, After\,Tax\,Increase\,Shock \times \frac{BE}{TA}_{ist} \\ & + \beta_5 \, Tax\,Increase\,Treatment_{st} \times After\,Tax\,Increase\,Shock \times \frac{BE}{TA}_{ist} \\ & + \beta_6 \frac{BE}{TA}_{ist} + X'_{ist}\delta + \gamma_i + \gamma_t + \varepsilon_{ist} \end{aligned} \tag{9}$$

$$\begin{aligned} ICC_{i,s,t+1} = {} & \beta_1 \, Tax\,Decrease\,Treatment_{s,t} + \beta_2 \, Tax\,Decrease\,Treatment \\ & \times After\,Tax\,Decrease\,Shock + \beta_3 \, Tax\,Decrease\,Treatment \times \frac{BE}{TA}_{ist} \\ & + \beta_4 \, After\,Tax\,Decrease\,Shock \times \frac{BE}{TA}_{ist} \\ & + \beta_5 \, Tax\,Decrease\,Treatment_{st} \times After\,Tax\,Decrease\,Shock \times \frac{BE}{TA}_{ist} \\ & + \beta_6 \frac{BE}{TA}_{ist} + X'_{ist}\delta + \gamma_i + \gamma_t + \varepsilon_{ist} \end{aligned} \tag{10}$$

In principle, a DD specification could be run with ICC as the outcome and no $\frac{BE}{TA}$ interactions as the third difference. However, because we are interested in testing for a causal link between leverage and cost of capital, the third interaction is needed to factor out two kinds of potentially confounding trends.

- First, changes in the cost of capital for different capital structures across states that would have nothing to do with the tax rate shock.

- Second, changes in the cost of capital for all BHCs in the treatment state, possibly due to state specific factors that affect BHCs' cost of capital.

The DDD estimate measures the mean differences in the treatment bank's cost of capital after netting out the changes in mean leverage for treated banks and the changes in mean leverage for the control banks. Observations in the DDD regressions are also weighted to reflect first and second moments covariate distribution balance using the entropy balancing approach. To deal with serial correlation of standard errors in a difference-in-difference estimation, we double cluster the standard errors by year-quarter and bank; see Bertrand, Duflo & Mullainathan (2002); Cameron & Miller (2015).

6 Results

6.1 Summary statistics

Table 2 presents summary statistics of the key variables of the 1018 unique BHCs covered in the sample. It must be noted that all variables in this table are winsorized at the 1st and 99th percentile levels to reduce the effects of extreme outliers. BHCs in the sample range in size from \$1B to \$256B in total assets with a mean of \$48.79B. These numbers underscore the size of the assets held in this part of the economy. In fact, total assets held by all BHCs by the end of 2015 is worth \$34.77 trillion US dollars, with the largest 5 banks owning half the assets, and the largest 10 owning 84% of the total assets. The FDIC estimates that 80% of all banks in the US belong to a parent BHC.

Book equity capitalization ranges from 3.74% to 18.6%, with a mean of 8.48%. Tier 1 capital ratio ranges from 3% to 17.37% with a mean of 8.28%, which is 2.28% above the Fed's definition of a well-capitalized bank. The rest of the variables span a reasonable range of variation, except for the securitization ratio. While some BHCs do not engage in securitization, others engage in securitizing assets that are worth 48 times the total assets in their balance sheets. This highlights the varying degrees of both risk taking and shifting to the economy outside of banking. Figure 1 plots the main relationship of interest: the horizontal axis collapses the BHC size-weighted average cost of capital into 5 quintiles, with 5 being the highest cost of capital bracket. The vertical axis contains the BHC size-weighted average book equity capital ratio. The positive relationship is further analyzed in the rest of this section.

6.2 OLS regressions

Tables 3 to 5 present the results from the cost of equity, debt, and capital regressions. In each model, we run a restricted specification with only equity capitalization as the independent variable and a saturated specification that includes all covariates. The results from the analysis of growth in new lending are shown in Table 6. All of the explanatory variables are lagged by one quarter and all specifications include quarter and BHC fixed effects. Standard errors are robust and double clustered at the year-quarter and BHC levels.

Table 3 looks at the cost of equity as the outcome variable of interest. The sign of the equity ratio coefficients are consistently negative where significant. Using the averaged measure for the cost of equity, the saturated model predicts a negative and statistically significant association between the equity ratio and the cost of capital. A 10 percentage point increase in the equity capital ratio is associated with 87 basis points increase in the cost of equity. This result is not surprising and it is consistent with M-M theory of risk conservation, which states that as leverage is reduced, equity becomes less risky and requires a lower return.

Table 4 focuses on the cost of debt as the dependent variable. The non-performing loans ratio, credit rating, and operating performance are significantly related to the cost of debt. Across all specifications, we find no significant relationship between cost of debt and the book equity capital ratio. One possible explanation is that market does not monitor banks' debt due to implicit government guarantees, and this finding is consistent with Bliss & Flannery (2002).

All six measures for the cost of capital are included as dependent variables in Table 5. Signs, significance and magnitudes of the book equity capital ratio (BE/TA) coefficients are consistent across most specifications, which implies a strong relationship between leverage and cost of capital. The results from the average cost of capital regression in column 12 indicates that a 10 percentage point increase in the book equity capital ratio is associated with a 54 basis points increase in the cost of capital. This result is consistent with Kashyap et al. (2010) who document a 45 basis points increase in the cost of capital for a 10 percentage point increase in the equity capital ratio, and with Baker & Wurgler (2015) who estimate 90 basis points increase in the cost of capital for a 10 percentage point increase in the tier 1 capital ratio.

Using data from the largest 20 banks, Table 6 shows the relationship between a bank's equity capital ratio and quarterly growth in new lending (growth over the same quarter in the previous year). The dependent variable in this table is growth in new lending. The specification in column (1) uses the market equity capital ratio, while column (2) uses the book equity capital ratio. The results from this table indicate that a 1 percentage point increase in the market equity capital ratio is associated with a 1.21 percentage point increase in growth in new loan lending. Using the book equity capital ratio measure, the results indicate that a 1 percentage point increase in the book equity capital ratio is associated with a 1.69 percentage point increase in growth in new loan lending. These results indicate that well-capitalized banks are associated with positive growth in lending behavior, which is not necessarily at odds with the negative relationship between the equity capital ratio and a bank's private cost of capital. In a competitive market, an increase in a bank's private cost of capital will translate into an increase in loan spreads, but not necessarily the amount or growth of lending. The amount or growth of lending is likely dictated by credit demand and supply, besides other macroeconomic factors. The main channel through which a well-capitalized bank can increase lending is the asset side of the balance sheet. On the one hand, banks with low capital (e.g., banks that operate on the margin of the regulatory equity capital requirement) cannot generate new loans instantly. Such banks have to first compete for deposits or issue costly equity or non-depository liabilities from the market before being able to generate new loans. On the other hand, well-capitalized banks, who have equity capital in excess of the capital requirements, have a greater capacity to generate loans (assets) on the spot given their excess equity capital buffer. This explains the documented positive relationship between the equity capital ratio and growth in new lending, which is consistent with the findings in Gambacorta & Shin (2016), who find that a 1 percentage point increase in the equity capital ratio is associated with a 0.6 percentage point increase in annual loan growth.

One must caution against causal interpretation of the OLS results. A potential bias in interpreting the coefficients from OLS regressions lies in the classical omitted variable bias (OVB). One obvious omitted variable in this setting is the probability of financial distress. Consider the following regression that cannot be run because the probability of financial distress is not observed.

$$ICC_{i,t+1} = \beta_1 \frac{BE}{TA}_{it} + \beta_2 Prob(Fin.Distress)_{it} + X'_{it}\delta + \gamma_i + \gamma_t + \varepsilon_{it} \tag{11}$$

The OLS regressions without the omitted variable returns a positive coefficient on β_1. The correlation between $\frac{BE}{TA}$ and $Prob(Fin.Distress)$ is likely negative, and the correlation between the cost of capital and $Prob(Fin.Distress)$ is likely positive. Hence, the OLS estimates are likely negatively biased (underestimated) due to OVB. The result from the 2SLS regressions, which is discussed next, shows a larger coefficient which confirms the negative bias in the OLS estimates.

6.3 IV regressions

To motivate the use of statutory state income taxes as a relevant instrument for leverage, we plot the asset-weighted average of book equity ratios across all banks that operate in one state against the statutory state income tax rate in Figure 2. The fitted line shows a negative slope indicating that BHCs operating in states with higher tax rates are indeed more levered than their low state tax counterparts. Figure 3 plots the variation of each state's tax rate over time. For example, the state of Arizona's state income tax rate levied on banks varied between 6.5% and 10.5% over the sample period. The fact that tax rates vary exogenously across states and over time is key to the identification strategy using the 2SLS IV regression. Table 7 shows the summary stats for the tax rates by state.

Table 8 shows the results from the 2SLS IV specification for all 6 measures of cost of capital. Under each model, the odd numbered columns display the first-stage regression where the instrument, state tax rates, along with the other explanatory variables, are regressed over the endogenous book equity capital ratio. A negative and highly significant coefficients is found for the instrument with large t-stats indicating strong relevance. The first stage F-stats are reported at the bottom of the table and range between 16.89 and 41.93, and that clears the often referred to rule of thumb hurdle level of at least 10. Further, all second stage regressions reject the null hypothesis of under-identification using the Kleibergen-Paap test statistic. The second stage results are consistent and significant except for the DGM model. The measures for the cost of capital in Table 8 indicate that a 10 percentage point increase in equity capital ratio leads to a minimum of 35 and a maximum of 92 basis point increase in the cost of capital. The results from the other covariates are qualitatively consistent with the OLS estimates.

6.4 State tax shocks regressions

Shock based causal inference requires reasonable balance between covariates in the control and treatment groups. Using entropy balancing on the first and second moments, we balance the distribution of all regression covariates using pre-shock levels. Figures 4 and 5 plot the kernel density function for the equity ratio, average cost of capital, and log of total assets before and after balancing. Clearly, a better balance between treatment and control groups is observed after applying the entropy weights. Tables 9 and 10 show the differences between the unbalanced and balanced versions in terms of means and variances across treatment and control groups.

Figures 6 and 7 collapse the entropy balanced data 4 quarters before and after the event times, which are tax increases and decreases by states. A clear wedge between treatment and control groups in both leverage and cost of capital can be seen in the figures, indicating the average effects of the treatment. Panel (A) of Figure 6 shows that during tax increase shocks, treatment BHCs increase leverage compared to their out of state control counterparts. Although less clear, Panel (B) shows the opposite happening during tax decrease shocks. It seems likely that tax decrease shocks have a smaller effect due to the inherent difficulty in de-leveraging compared to increasing leverage, which is consistent with Schandlbauer (2017). Figure 7 shows similar results for the average cost of capital. Table 11 tests the difference in means of the cost of capital and equity capital ratio between the treatment and control group of banks. All unbalanced raw differences in means for leverage and the cost of capital are significant in these univariate tests except for the CAPM and DGM models during tax increase shocks.

Table 12 shows the first difference-in-difference specification. The outcome variable is the equity capital ratio and the regression specifications test for whether tax shocks affect the equity capital ratio. Columns 1 and 2 show results for tax increase shocks and columns 3 and 4 show results for tax decrease shocks. The DD coefficient of $Treatment \times After\, Tax\, Inc.$ measures the tax increase treatment effects and is negative and significant in columns 1 and 2. This indicates that during tax increase shocks, BHCs in that state respond by decreasing their equity capital ratios. The DD coefficient of $Treatment \times After\,Tax\,Dec.$ measures the tax decrease treatment effects and is only positive and significant in the restricted specification in column 3. Not controlling for other covariates, this indicates that during tax decrease shocks, BHCs in that state respond by increasing their equity capital ratios. It seems likely that difficulty in decreasing leverage after a state tax decrease is causing the result in column 4.

Tables 13 and 14 present the results from the triple differences regressions. Here, the outcome variable is cost of capital and the main explanatory variable of interest is the DDD coefficients $\frac{BE}{TA} \times Trt \times After\,Tax\,Inc.$ in Table 13 and $\frac{BE}{TA} \times Trt \times After\,Tax\,Dec.$ in Table 14. The DDD coefficients measure the mean differences in the treatment cost of capital after netting out the changes in mean leverage for treated banks and the changes in mean leverage for the control banks. As expected, a positive and significant coefficient is present in most specifications. This indicates a consistent, directional, and causal link between leverage and the cost of capital. The sign and magnitudes of the control covariates are qualitatively consistent with both the IV and OLS estimates.

6.5 Tax shocks and bank balance sheet

There are a number of ways a bank can increase or decrease leverage. To increase leverage, a bank can either increase its liabilities via deposit or non-deposit debt claims, or reduce equity via a reduction in retained earnings or an increase in dividends. The opposite is true for a bank wanting to decrease leverage. The mechanism through which banks respond to tax shocks in this paper is consistent with Schandlbauer (2017). In response to a state tax increase, we find that banks significantly increase non-depository debt via bond issues. We find no evidence that banks changing leverage use another mechanism such as reducing equity via a reduction in retained earnings. Further, we find no evidence that capital constrained banks change leverage. These results are consistent with the literature (Gambacorta et al. (2017); Schandlbauer (2017)). On the flip side, when banks are exposed to a state tax decrease, we find mixed evidence on the mechanism driving the decrease in leverage. Some banks reduce the amount of lending (e.g., shrinking the assets in the balance sheet), while others seems to slowly build up equity through retained earnings.

7 Robustness tests

In this section, we explore the robustness of the results to alternative measures of equity capital ratio, and alternative model specifications. The results in this section are documented in Appendix A

7.1 Using market equity capital ratio

There are multiple ways to measure a bank's equity capital ratio (e.g., tiered capital and risk weighted assets). The main analysis in this paper focuses on the book equity capital ratio. We explore whether the results are consistent when using the market equity capital ratio. Table A1 repeats the same analysis in Table 5 but uses the market equity over book assets, denoted (ME/TA), instead. The results in this table, across all specifications, are consistent with the predictions found from using the book equity capital ratio. The results in this table indicate that a 10 percentage point increase in the market equity capital ratio is associated with a minimum of 13 basis points to a maximum of 33 basis points increase in the cost of capital. The results across all specifications are statistically significant. While similar in sign, these results are approximately one third of the magnitude of the results found using the book equity capital ratio. This indicates that the market equity capital ratio is less elastic compared to book equity in determining a bank's cost of capital.

We repeat the instrumental variable approach used in Table 8 but now using the market equity capital ratio. The results in Table A2 again highlight similar and consist results across all specifications. The results in this table indicate that a 10 percentage point increase in the market equity capital ratio is associated with a minimum of 10 basis points to a maximum of 59 basis points increase in the cost of capital. The results across all specifications are statistically significant. While similar in sign, these results are approximately one half of the magnitude of the results found using the book equity capital ratio. Consistent with the OLS results found before, this indicates that the market equity capital ratio is less elastic compared to book equity in determining a bank's cost of capital.

7.2 Linearity assumptions

A common specification assumption across the econometric panel data models is the relationships are linear. In particular, we assume that the equity capital ratio linearly impacts the cost of capital. To test for the possibility that the interaction between the equity capital ratio and the cost of capital is non-linear, we test two additional specifications.

The first specification takes the log transformation of the cost of capital on the left hand side, and the log transformation of the book equity capital ratio on the right hand side. This is done to normalize and smooth the distribution of these variables given their skewed nature in level form. Table A3 shows the results of this specification. The results in this table are consistent in sign and magnitude with the OLS results in Table 5 where the results are reported in levels. The results in this robustness check indicate that a 1% increase in the book equity capital ratio is associated with a minimum of 0.08% and a maximum of 0.125% increase in the cost of capital. The results across all specifications are statistically significant.

The second specification in Table A4 repeats the model in Table 5 but adds a quadratic term for the book equity capital ratio. Adding the quadratic term to the model means that the effect of equity capital ratio on the cost of capital could change for different levels of equity capital ratio. In essence, this tests the extent to which the point estimates from the OLS regressions can be extrapolated, and whether the quadratic term identifies a concave or convex relationship between the two variables. The results from this table show a negative relationship between (BE/TA) and the cost of capital, and a positive relationship between $(\text{BE/TA})^2$ and the cost of capital. This indicates a convex relationship with an inflection point in (BE/TA) where the relationship with the cost of capital changes sign. This is consistent with a bankruptcy risk hypothesis, whereby very low capital ratio are too risky and hence additions of equity decreases the cost of capital, and vice versa.Figure A1 and Figure A2 show the predictive margins plots for the linear and quadratic specifications of this regression. The predicted values in these plots come from the regression specifications of Table 5 column (12) and Table A4 respectively, where the covariates in these regressions are estimated at their means. The plots show that the infliction point occurs around 5% of book equity capital ratio, and the slope becomes more positive and convex after 15%. The increase in the average cost of capital, as these plots predict, is approximately 1% for a 10% increase of (BE/TA) if a bank were to raise its book equity capital from 5% to 15%.

7.3 Consistency of the results using subsamples

Table A5 tests whether the results are robust to different sample periods. The table restricts the sample to the years between 2004 and 2014, and highlights the same positive relationship between the book equity capital ratio and the cost of capital that is found in Table 5. The results in this table indicate that a 10 percentage point increase in the market equity capital ratio is associated with a 35 basis points increase in the average cost of capital, which is approximately one half the magnitude found in Table 5. This indicates that the book equity capital ratio has become less elastic in the recent years compared to the 30 year sample in determining a bank's cost of capital.

Table A6 tests whether the results are robust to using only large banks. We define large banks as those with at least $50 billion in total book assets, and the table restricts the sample to such banks for all years between 1984 and 2014[17]. The results in this table highlight the same positive relationship between the book equity capital ratio and the cost of capital that is found in Table 5. The results in this table indicate that a 10 percentage point increase in the book equity capital ratio is associated with a 23 basis points increase in the average cost of capital, which is approximately one half the magnitude found in Table 5. This indicates that the book equity capital ratio for large banks is less elastic compared to smaller banks in determining a bank's cost of capital.

7.4 Consistency of the results using two period lags

Table A7 tests whether the results are robust to using two period lags for the independent variables in the regression specification instead of one period lag. This specification alleviates concerns that one period lag might possess high levels of autocorrelation with the outcome variable. The results in this table again highlight the same positive relationship between the book equity capital ratio and the cost of capital that is found in Table 5. The results in this table indicate that a 10 percentage point increase in the market equity capital ratio is associated with a 33 basis points increase in the average cost of capital.

8 Conclusion

It is hard to argue against the dire consequences of heightened systemic risks in the financial sector. Such consequences, we have seen in the recent financial crisis, have far reaching negative externalities to tax payers and the economy.

[17]Our $50 billion cutoff is motivated by a recent proposal by the treasury department to define such banks as systematically important. See https://www.wsj.com/articles/mnuchin-volcker-rule-too-big-to-fail-set-for-changes-1501187844

Proponents of higher equity capitalization argue that increasing the equity capital ratio is well-fare enhancing and not costly to the economy, at least when compared to the costs of systemic risks of bank failures. Bankers argue the opposite, claiming that a decrease in leverage causes a shortage in credit supply which will negatively affect their cost of capital and therefore lead to an increase in loan spreads.

This paper provides evidence on the relation between bank equity capital ratio and the bank cost of capital using a sample of 178 Bank Holding Companies (BHCs) for 1994-2014. We find a 10 percentage point increase in the book equity capital ratio leads to a 92 basis points increase in the bank's cost of capital. Using the market equity capital ratio, a 10 percentage point increase leads to a 59 basis points increase in the cost of capital. Restricting the analysis to large banks with $50 billion or more in assets, we find that a 10 percentage point increase in the book equity capital ratio leads to a 23 basis points increase in the cost of capital. Taken together, these results are consistent with Kashyap et al. (2010) and Baker & Wurgler (2015).

From OLS regression analysis of the largest 20 banks in the sample, we find that a 1 percentage point increase in the book (market) equity capital ratio is associated with a 1.69 (1.21) percentage point increase in new lending growth. While we have previously shown that an increase in equity capital ratio leads to an increase in the bank's private cost of capital, the effects on new lending growth is favorable. The results on lending growth is consistent with the findings in Gambacorta & Shin (2016), who find that a 1 percentage point increase in the equity capital ratio is associated with a 0.6 percentage point increase in annual loan growth. In a competitive lending environment, an increase in the bank's cost of capital is likely reflected in loan spreads, but not necessarily on lending growth. Our results indicate that well capitalized banks have increased capacity to generate new loans compared to banks with leverage ratios at the margin of the capital requirements. Taken together, these results indicate that raising the equity capital requirements is not as costly as bank's claim.

The U.S. House of Representatives debated and passed the Financial CHOICE Act in June 2017.[18] The U.S. Senate will soon be considering this Act. A principal feature of the CHOICE Act is a provision exempting well capitalized banks from many of the Dodd-Frank provisions, including the stress testing and comprehensive capital analysis and review regulations. The CHOICE Act defines a bank to be well capitalized if the bank's ratio of tangible equity to total assets is greater than 10%. The total assets are not risk-weighted, and include both on-balance sheet and off-balance sheet assets. Supporters of this feature of the CHOICE Act have applauded the off-ramp made available to well capitalized banks from many of Dodd-Frank's regulations. However, bank industry proponents have raised concerns about the negative impact on bank cost of capital and bank lending of increases in the bank equity capital ratio.

It is important for policymakers to take into account the possibility of banks circumventing capital regulations through risky financial innovation and shadow banking activities. A significant raise in the equity capital requirements, in its simple form, likely reduces the banks' ex ante incentives to take excessive risks, closely aligns bankers and policymakers incentives, and ultimately leads to less systemic risks in the financial sector.

[18] https://financialservices.house.gov/choice/

References

Acharya, V. V., Mehran, H., & Thakor, A. V. (2016). Caught between scylla and charybdis? regulating bank leverage when there is rent seeking and risk shifting. *The Review of Corporate Finance Studies*, *5*(1), 36–75.

Admati, A. & Hellwig, M. (2014). *The bankers' new clothes: What's wrong with banking and what to do about it*. Princeton University Press.

Aliaga-Díaz, R. & Olivero, M. P. (2012). Do bank capital requirements amplify business cycles? bridging the gap between theory and empirics. *Macroeconomic Dynamics*, *16*(3), 358–395.

Allen, F., Carletti, E., & Marquez, R. (2011). Credit market competition and capital regulation. *Review of Financial Studies*, *24*(4), 983–1018.

Anginer, D. & Demirguc-Kunt, A. (2014). Bank capital and systemic stability. Technical report, The World Bank.

Avdjiev, S., Bolton, P., Jiang, W., Kartasheva, A., & Bogdanova, B. (2015). Coco bond issuance and bank funding costs. *BIS and Columbia University working paper*.

Baker, M. & Wurgler, J. (2015). Do strict capital requirements raise the cost of capital? bank regulation, capital structure, and the low-risk anomaly. *The American Economic Review*, *105*(5), 315–320.

Berger, A. N. & Bouwman, C. H. (2009). Bank liquidity creation. *Review of Financial Studies*, *22*(9), 3779–3837.

Bertrand, M., Duflo, E., & Mullainathan, S. (2002). How much should we trust differences-in-differences estimates? Technical report, National Bureau of Economic Research.

Bhagat, S. (2017). *Financial Crisis, Corporate Governance, and Bank Capital*. Cambridge University Press.

Bhagat, S. & Bolton, B. (2008). Corporate governance and firm performance. *Journal of corporate finance*, *14*(3), 257–273.

Bhagat, S. & Bolton, B. (2014). Financial crisis and bank executive incentive compensation. *Journal of Corporate Finance*, *25*, 313–341.

Bhagat, S., Bolton, B., & Lu, J. (2015). Size, leverage, and risk-taking of financial institutions. *Journal of Banking & Finance*, *59*, 520–537.

Bliss, R. R. & Flannery, M. J. (2002). Market discipline in the governance of us bank holding companies: Monitoring vs. influencing. *European Finance Review*, *6*(3), 361–396.

Bond, S., Ham, K. Y., Maffini, G., Nobili, A., & Ricotti, G. (2016). Regulation, tax and capital structure: evidence from administrative data on italian banks. Technical report, Bank of Italy, Economic Research and International Relations Area.

Brinkmann, E. J. & Horvitz, P. M. (1995). Risk-based capital standards and the credit crunch. *Journal of Money, Credit and Banking*, *27*(3), 848–863.

Calomiris, C. W. & Kahn, C. M. (1991). The role of demandable debt in structuring optimal banking arrangements. *The American Economic Review*, 497–513.

Cameron, A. C. & Miller, D. L. (2015). A practitioners guide to cluster-robust inference. *Journal of Human Resources*, *50*(2), 317–372.

Claessens, S., Keen, M., & Pazarbasioglu, C. (2010). Financial sector taxation: The imfs report to the g-20 and background material. *Washington: International Monetary Fund*.

Claus, J. & Thomas, J. (2001). Equity premia as low as three percent? evidence from analysts earnings forecasts for domestic and international stock markets. *The Journal of Finance*, *56*(5), 1629–1666.

Demirguc-Kunt, A., Detragiache, E., & Merrouche, O. (2013). Bank capital: Lessons from the financial crisis. *Journal of Money, Credit and Banking*, *45*(6), 1147–1164.

Diamond, D. W. & Rajan, R. G. (2000). A theory of bank capital. *The Journal of Finance*, *55*(6), 2431–2465.

Duffie, D. (2010). *How big banks fail and what to do about it*. Princeton University Press.

Ediz, T., Michael, I., & Perraudin, W. (1998). The impact of capital requirements on uk bank behaviour. *Economic Policy Review*, *4*(3).

Flannery, M. J. (2014). Contingent capital instruments for large financial institutions: A review of the literature. *Annu. Rev. Financ. Econ.*, *6*(1), 225–240.

French, K., Baily, M., Campbell, J., Cochrane, J., Diamond, D., Duffie, D., Kashyap, A., Mishkin, F., Rajan, R., Scharfstein, D., et al. (2010). The squam lake report: fixing the financial system. *Journal of Applied Corporate Finance*, *22*(3), 8–21.

Gambacorta, L., Ricotti, G., Sundaresan, S., Wang, Z., et al. (2017). The effects of tax on bank liability structure. Technical report, Bank for International Settlements.

Gambacorta, L. & Shin, H. S. (2016). Why bank capital matters for monetary policy. *Journal of Financial Intermediation*.

Gebhardt, W. R., Lee, C., & Swaminathan, B. (2001). Toward an implied cost of capital. *Journal of accounting research*, *39*(1), 135–176.

Gompers, P., Kaplan, S. N., & Mukharlyamov, V. (2016). What do private equity firms say they do? *Journal of Financial Economics*, *121*(3), 449–476.

Gordon, M. J. & Shapiro, E. (1956). Capital equipment analysis: the required rate of profit. *Management science*, *3*(1), 102–110.

Hainmueller, J. (2012). Entropy balancing for causal effects: A multivariate reweighting method to produce balanced samples in observational studies. *Political Analysis*, *20*(1), 25–46.

Haldane, A. (2009). Why banks failed the stress test. *BIS Review*, *18*, 2009.

Heider, F. & Ljungqvist, A. (2015). As certain as debt and taxes: Estimating the tax sensitivity of leverage from state tax changes. *Journal of Financial Economics*, *118*(3), 684–712.

Holmstrom, B. & Tirole, J. (1997). Financial intermediation, loanable funds, and the real sector. *the Quarterly Journal of economics*, *112*(3), 663–691.

Houston, J., James, C., & Marcus, D. (1997). Capital market frictions and the role of internal capital markets in banking. *Journal of Financial Economics*, *46*(2), 135–164.

Ito, T. & Sasaki, Y. N. (2002). Impacts of the basle capital standard on japanese banks behavior. *Journal of the Japanese and International Economies*, *16*(3), 372–397.

Junge, G. & Kugler, P. (2012). Quantifying the impact of higher capital requirements on the swiss economy. Technical report, WWZ Discussion Paper.

Kaplan, S. N. & Strömberg, P. (2009). Leveraged buyouts and private equity. *The Journal of economic perspectives*, *23*(1), 121–146.

Kashyap, A. K., Stein, J. C., & Hanson, S. (2010). An analysis of the impact of substantially heightened capital requirements on large financial institutions. *Booth School of Business, University of Chicago, mimeo*, 2.

King, M. R. (2010). Mapping capital and liquidity requirements to bank lending spreads.

Kisin, R. & Manela, A. (2016). The shadow cost of bank capital requirements. *The Review of Financial Studies*, *29*(7), 1780–1820.

Li, K. K. & Mohanram, P. (2014). Evaluating cross-sectional forecasting models for implied cost of capital. *Review of Accounting Studies*, *19*(3), 1152–1185.

McDonald, R. L. (2013). Contingent capital with a dual price trigger. *Journal of Financial Stability*, *9*(2), 230–241.

Mehran, H. & Thakor, A. (2011). Bank capital and value in the cross-section. *The Review of Financial Studies*, *24*(4), 1019–1067.

Miles, D., Yang, J., & Marcheggiano, G. (2013). Optimal bank capital. *The Economic Journal*, *123*(567), 1–37.

Myers, S. C. (1977). Determinants of corporate borrowing. *Journal of financial economics*, *5*(2), 147–175.

Panier, F., Pérez-González, F., & Villanueva, P. (2015). Capital structure and taxes: What happens when you (also) subsidize equity?

Peek, J. & Rosengren, E. S. (2000). Collateral damage: Effects of the japanese bank crisis on real activity in the united states. *American Economic Review*, 30–45.

Repullo, R. (2004). Capital requirements, market power, and risk-taking in banking. *Journal of financial Intermediation*, *13*(2), 156–182.

Schandlbauer, A. (2017). How do financial institutions react to a tax increase? *Journal of Financial Intermediation*, *30*, 86–106.

Schepens, G. (2016). Taxes and bank capital structure. *Journal of Financial Economics*, *120*(3), 585–600.

Slovik, P., Cournède, B., et al. (2011). Macroeconomic impact of basel iii. Technical report, OECD Publishing.

Smith, C. W. & Warner, J. B. (1979). On financial contracting: An analysis of bond covenants. *Journal of financial economics*, *7*(2), 117–161.

Tarullo, D. K. (2008). *Banking on Basel: the future of international financial regulation.* Peterson Institute.

Taylor, J. & Kapur, E. (2015). How bankruptcy reform can address too big to fail,.

Figure 1: The Relationship Between Equity Capital Ratio and Average Cost of Capital

This figure shows the relationship between asset-weighted book equity capital ratio (in percent) for banks and the corresponding average cost of capital. The figure uses data from the entire sample covering the years 1986 to 2014, and cross-sectionally collapses the data using bank asset weights. I take the simple average of the resulting time series to plot this graph. The average cost of capital is grouped in five quintile bins, where quintile 1 represents banks with the lowest average costs of capital.

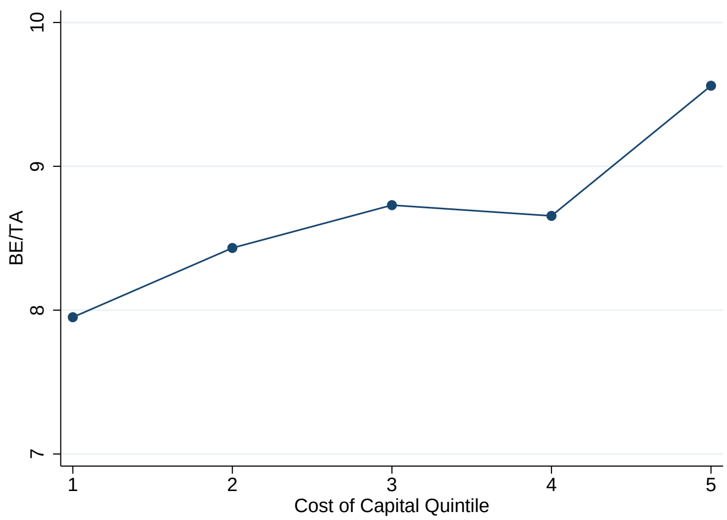


Figure 2: The Relationship Between Average Statutory State Income Taxes and BHC Equity Capital Ratio

This figure shows relationship between asset-weighted book equity capital ratio (in percent) for banks and the corresponding average statutory state tax these banks are exposed to. The figure uses data from the entire sample covering the years 1986 to 2014, and cross-sectionally collapses the data using bank asset weights. I take the simple average from the resulting time series and plot this graph for each state separately. Both axes are in percent. The fitted line is represented by the following equation:
Tax Rate = 10.69 - 0.45$\frac{BE}{TA}$

Figure 3: Variation of statutory state income tax rates over time

This figure shows the historical variation of statutory state income taxes levied on banks, using annual data from 1986 to 2014 from the annual publication of *The Book of States* available from The Council of State Governments. The figure highlights the exogenous variation of statutory state income tax rates across states and over time. For example, the state of Connecticut had historically held a state income tax rate on banks as low as 7.5 and as high as 13.8 percent across the sample years (1986-2014)

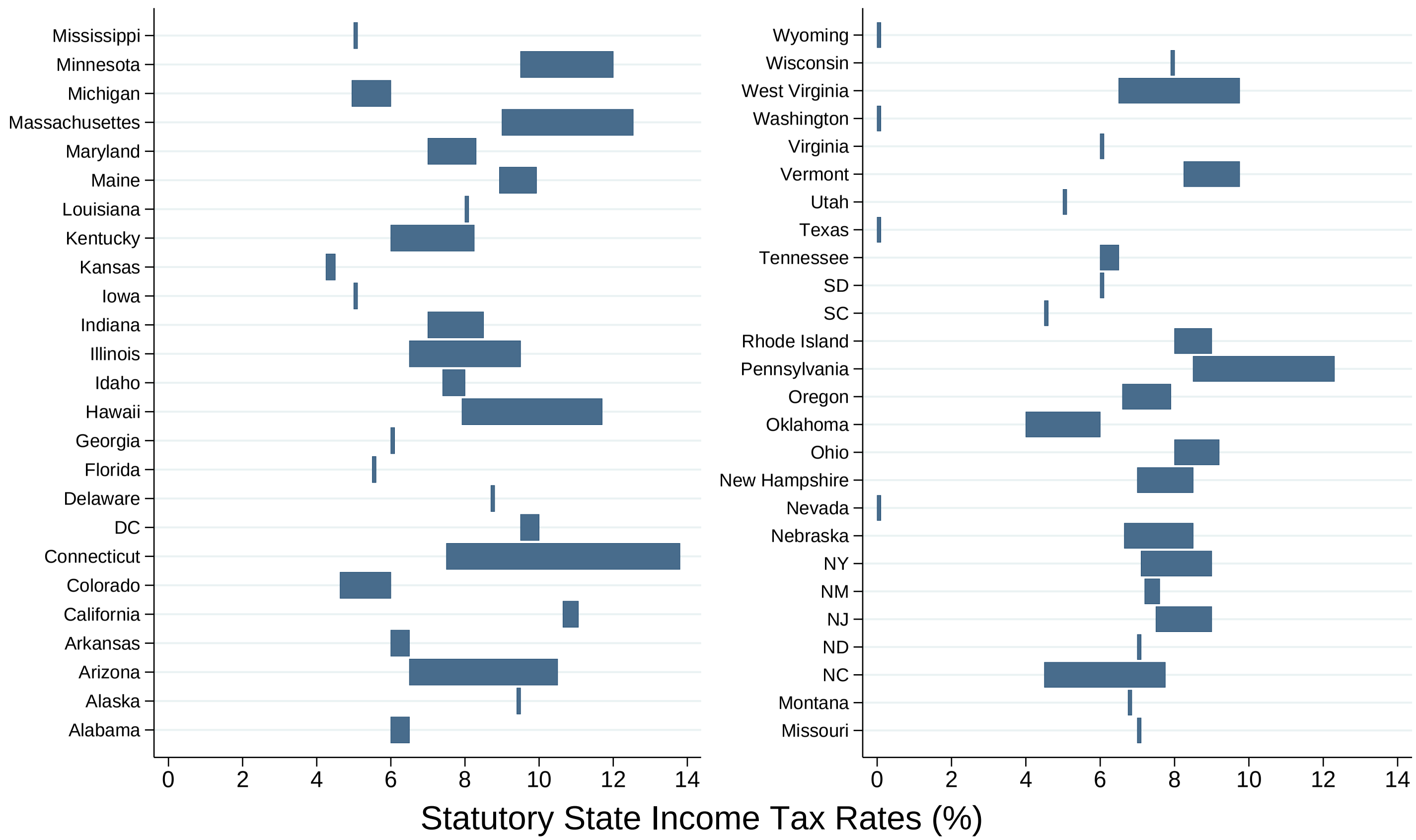


Figure 4: Kernel density plots for tax increase shocks

This figure highlights the differences between the control and treatment samples before and after applying covariate balance (e.g. entropy balancing from Hainmueller (2012)). The balanced covariates figures in the top row are balanced on the first and second moments, and uses data from the entire sample around tax increase shocks. The figures in the bottom row are unbalanced, and shows the diversion of the distribution between treatment and control samples. The control sample here includes BHCs that did not experience tax shocks, whereas the treatment sample includes BHCs that experienced tax increase shocks.

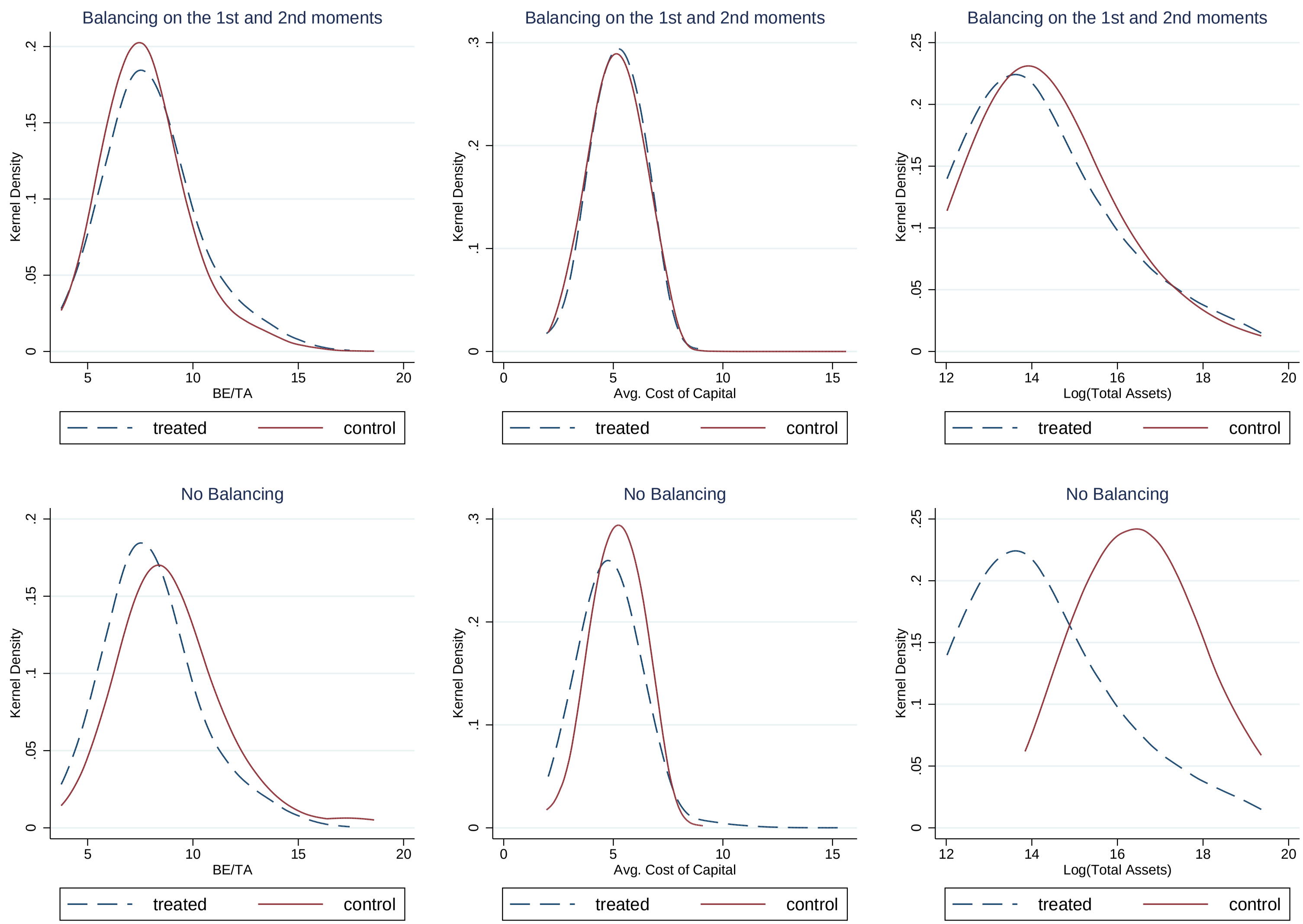


Figure 5: Kernel density plots for tax decrease shocks

This figure highlights the differences between the control and treatment samples before and after applying covariate balance (e.g. entropy balancing from Hainmueller (2012)). The balanced covariates figures in the top row are balanced on the first and second moments, and uses data from the entire sample around tax decrease shocks. The figures in the bottom row are unbalanced, and shows the diversion of the distribution between treatment and control samples. The control sample here includes BHCs that did not experience tax shocks, whereas the treatment sample includes BHCs that experienced tax decrease shocks.

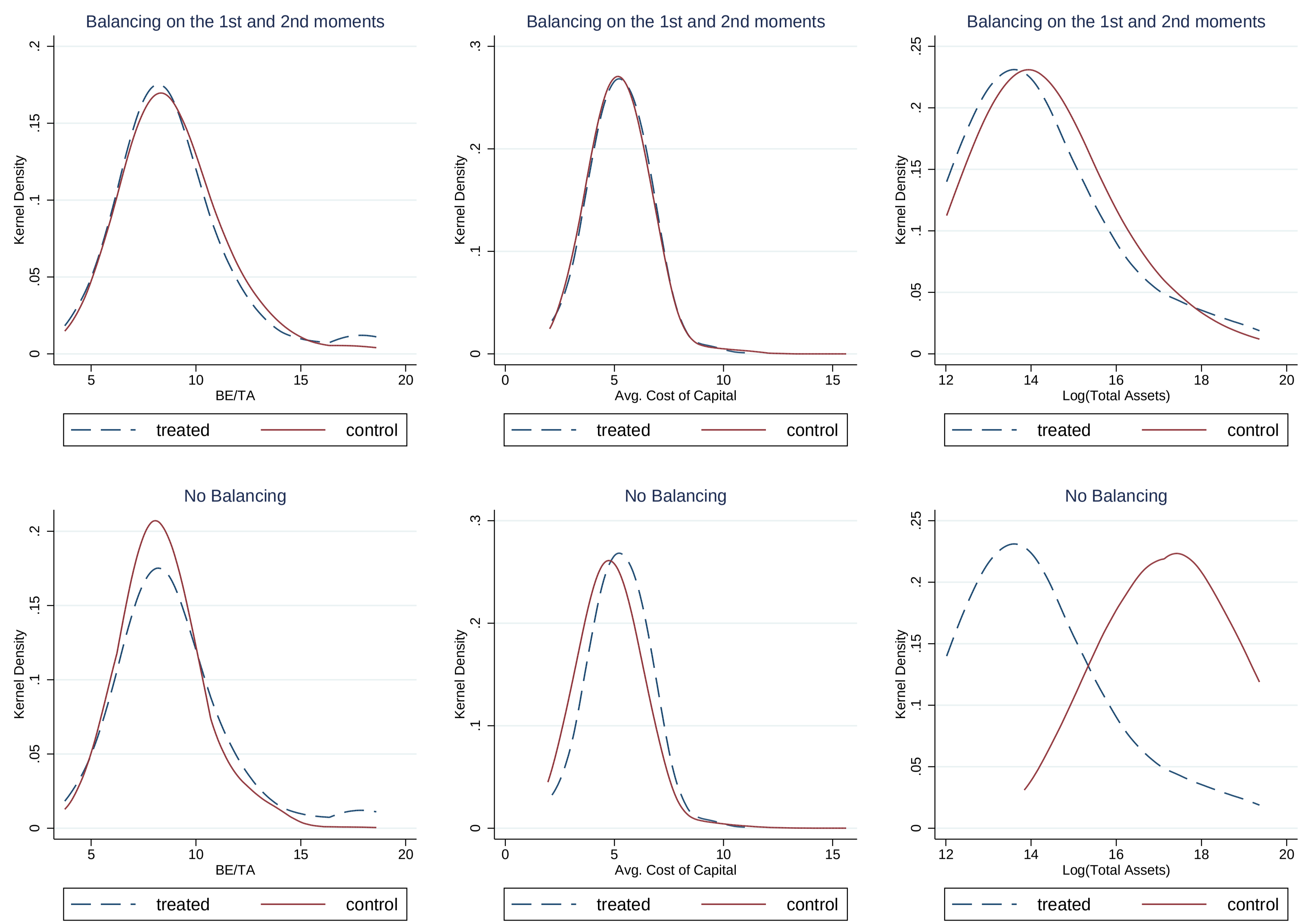
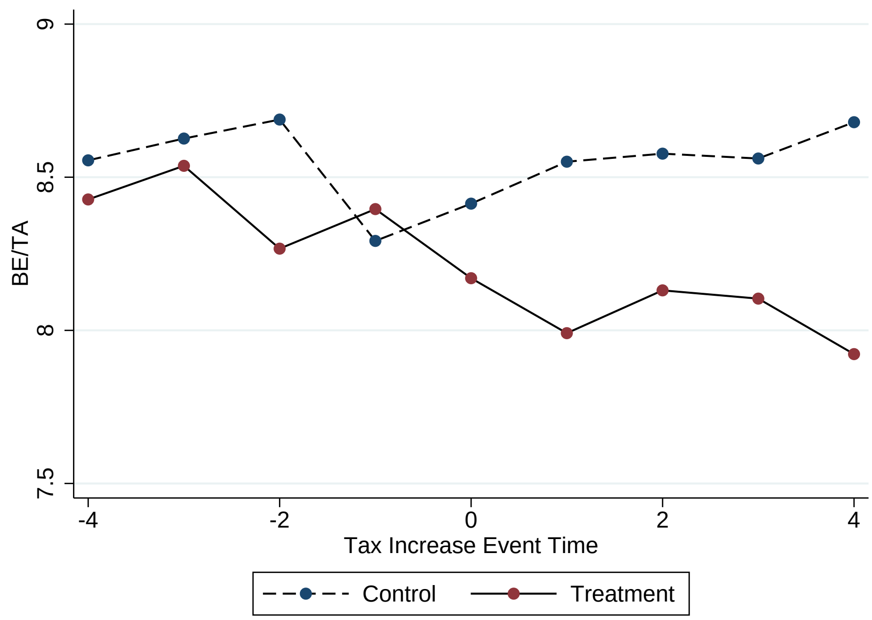
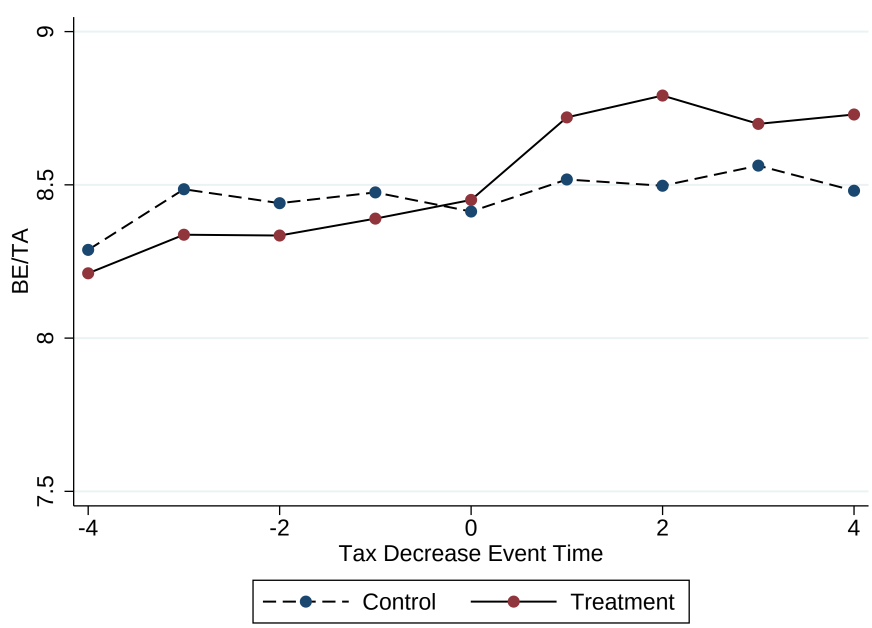


Figure 6: Tax shock effects on equity capital ratio

This figure shows the time-series evolution of the book equity capital ratio, collapsed over state tax change event time. The book equity capital ratio on the Y-axis is asset weighted across the BHCs in the sample. Panel (A) shows the plot using changes before and after tax increase shocks. Panel (B) shows the plot using changes before and after tax decrease shocks. Time unit of measurement is quarters, and the book equity capital ratio is in percent. Control refers to banks that did not experience a tax shock, and Treatment refers to banks that experienced a tax shock at the event time.



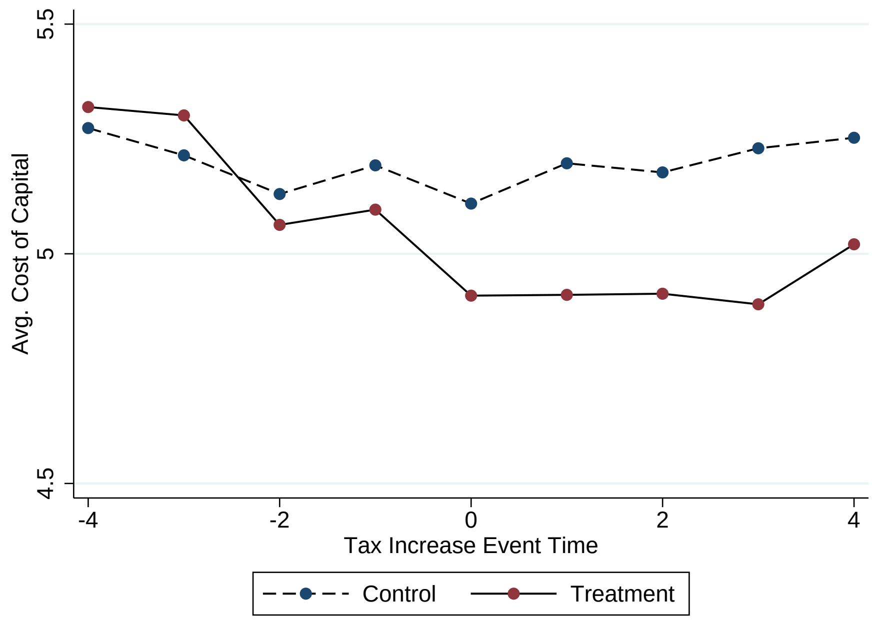
Panel (A)



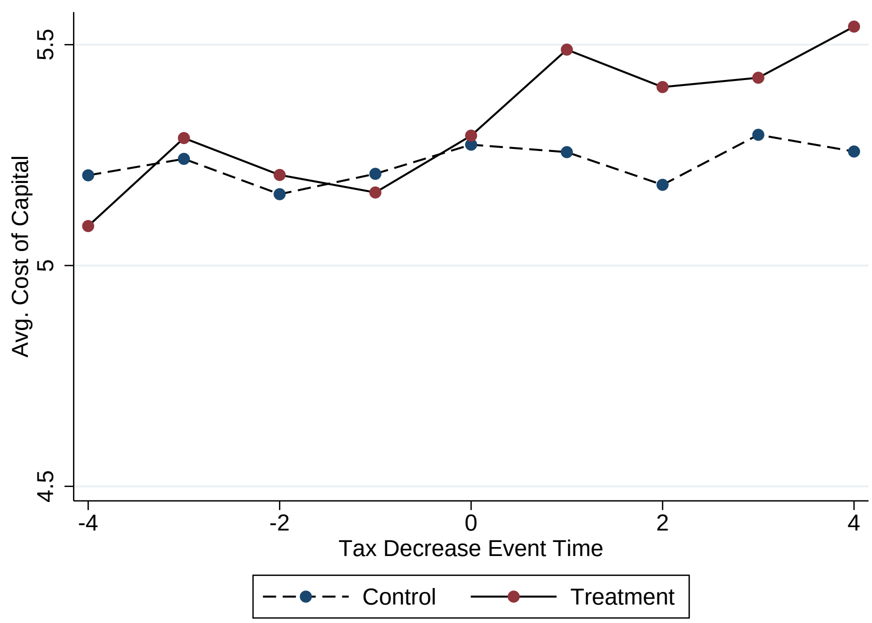
Panel (B)

Figure 7: Tax shock effects on cost of capital

This figure shows the time-series evolution of the average cost of capital, collapsed over state tax change event time. The average cost of capital on the Y-axis is asset weighted across the BHCs in the sample. Panel (A) shows the plot using changes before and after tax increase shocks. Panel (B) shows the plot using changes before and after tax decrease shocks. Time unit of measurement is quarters, and the average cost of capital is in percent. Control refers to banks that did not experience a tax shock, and Treatment refers to banks that experienced a tax shock at the event time.



Panel (A)



Panel (B)

Table 1: Variable Definitions

BHC Characteristics	Variable Description
Total Assets	The total assets held by a BHC, measured in nominal US billion dollars. Call report id BHCK2170
Log of Total Assets	The natural log of total assets
ROA	Return on assets, or net income over total assets. (BHCK4340/BHCK2170)
BE/TA	The ratio of total book equity to total book assets (BHCK3210)/(BHCK2170)
Tier1/TA	The ratio of tier1 capital to total assets. (BHCK8274)/(BHCK2170)
Book to Market	The ratio of total book common equity to market value of equity. Market value of equity is obtained from CRSP (prccm*cshoq), total book common equity has a call report id BHCK3230
Log of B/M	The natural log of book to market ratio
Loan HHI	The bank-level loan HHI, defined as the squared sum of loan category proportions at the bank level out of four loan categories: Real Estate Loans (BHCK1410), Individual Loans (BHCK1975), Corporations and Industrial Loans (BHCK1766), and all the other loans.
Competition HHI	State level banking competition index, defined as the squared sum of each BHC's total deposits in a state.
NPL Ratio	The ratio of all past due and non performing loans to gross loans. (BHCK5525+BHCK5526-BHCK3506-BHCK2122)/BHCK2122
Securitization Ratio	The ratiof all securitized assets to total assets. (BHCKb705+BHCKb706+BHCKb707+BHCKb708 +BHCKb709+BHCKb710+BHCKb711)/BHCK2170
Credit Rating	Categorical variable indicating the BHC level credit rating from S&P Rating. It takes the value of 1 for D rated firms and up to 22 for AAA rated firms.
Cost of Debt	The pre-tax firm level cost of debt as measured from yields to maturity from outstanding long-term straight bond issues and trades.

[..] Cost of Equity	The implied forward looking cost of equity, where [..] identifies the calculation method.
[..] Cost of Capital	The implied forward looking cost of capital where [..] identifies the calculation method.
New Lending Growth	Quarterly growth (over the same quarter in the previos year) of lending calculated using loan-level data from DealScan (Thomson-Reuters.

Other Variables	**Variable Description**
Statutory State Tax Rate	The state income statutory tax rate levied on banks and financial institutions.
Tax Dec. Treatment	A dummy variable identifying BHCs in states undergoing state tax decrease shocks. The variable takes the value of 1 for treatment banks during the 4 quarters before and after states decrease taxes.
Tax Inc. Treatment	A dummy variable identifying BHCs in states undergoing state tax increase shocks. The variable takes the value of 1 for treatment banks during the 4 quarters before and after states increase taxes.
After Tax Dec.	A dummy variable identifying BHCs in states undergoing state tax decrease shocks. The variable takes the value of 1 for treatment and control banks during the 4 quarters after states decrease taxes.
After Tax Inc.	A dummy variable identifying BHCs in states undergoing state tax increase shocks. The variable takes the value of 1 for treatment and control banks during the 4 quarters after states increase taxes.
Capital Regulation	This variable identifies the before and after years for the Basel 1 capital regulation shock. The dummy variables equals 1 for the years 1986, 1987, and 1988 and 0 for the years 1992,1993, and 1994.

Table 2: Summary Statistics

This table reports the summary statistics for the entire sample of BHCs, using quarterly data covering the time-period between 1986 and 2014. All variables are winsorized at the 1st and 99th percentiles to reduce the effects of outliers. Variables in this table are defined in Table 1.

	Summary Statistics				
	mean	median	sd	min	max
CAPM Cost of Equity	7.99	7.86	4.48	0.00	34.64
CAPM Cost of Capital	4.73	4.65	1.32	1.44	17.87
FF3 Cost of Equity	9.14	8.72	6.22	0.67	37.91
FF3 Cost of Capital	4.95	4.84	1.65	0.26	21.66
GLS Cost of Equity	6.18	6.79	1.93	0.70	11.22
GLS Cost of Capital	4.52	4.60	1.10	1.45	15.39
CT Cost of Equity	10.05	9.33	4.97	3.57	35.88
CT Cost of Capital	5.03	4.85	1.41	2.31	19.08
DGM Cost of Equity	10.60	10.41	4.45	2.34	33.35
DGM Cost of Capital	5.16	5.14	1.39	1.75	15.48
Avg Cost of Equity	8.79	8.48	2.64	0.28	22.08
Avg Cost of Capital	4.88	4.87	1.20	1.95	15.62
Pretax Cost of Debt	6.55	6.44	1.83	2.33	24.59
BE/TA	8.70	8.48	2.02	3.74	18.60
Total Assets	48.79	18.47	68.91	1.03	2,572.77
Book to Market	0.67	0.57	0.44	0.01	9.48
Loan HHI	0.43	0.40	0.14	0.25	0.99
Competition HHI	0.38	0.30	0.21	0.09	1.00
NPL Ratio	0.94	0.58	1.13	0.00	9.58
ROA	0.69	0.68	0.41	-0.88	1.77
Securitization Ratio	2.03	0.00	6.67	0.00	47.94
Credit Rating	15.95	16.00	2.17	5.00	22.00

Table 3: Cost of Equity OLS Regressions

This table reports OLS regression results showing the effects of book equity capital ratio on the cost of capital. The cost of equity is measured using CAPM in columns (1)-(2), Fama French 3 Factors Model in columns (3)-(4), Gebhardt et al. (2001) model in columns (5)-(6), Claus & Thomas (2001) in columns (7)-(8), the dividend growth model (DGM) in columns (9)-(10), and the average of all previous methods in columns (11)-(12). The sample in this table cover the time-period between 1986 and 2014. The dependent variable is the cost of equity, measured using 5 different models in addition to their average. All variables are as define in Table 1. Independent variables are lagged by one period, and standard errors are double clustered at the quarter and BHC levels. T-stats are reported under the coefficients in parenthesis. * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$.

	CAPM		FF3		GLS		CT		DGM		AVG	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
BE/TA	-0.0917***	-0.0956**	-0.2164***	-0.1202**	-0.0095*	0.0052	-0.1695***	-0.1443**	-0.1544**	-0.0703*	-0.0970***	-0.0871**
	(-4.88)	(-2.37)	(-3.43)	(-2.45)	(-1.71)	(0.87)	(-3.38)	(-2.09)	(-2.32)	(-1.72)	(-2.93)	(-2.31)
Log of Total Assets		-0.3755*		-0.4511*		0.0085		-0.5608		-0.9447*		-0.1004*
		(-1.89)		(-1.77)		(0.14)		(1.28)		(-1.86)		(-1.93)
Log of B/M		0.4750*		0.6129*		-0.0253		-0.0796		0.6210*		0.1584
		(1.82)		(1.71)		(-0.77)		(-0.27)		(1.75)		(1.50)
Loan HHI		2.3539		2.5945		0.4253*		0.6472*		-0.3038		0.9265**
		(1.28)		(0.96)		(1.77)		(1.84)		(-0.10)		(2.15)
Competition HHI		0.2449*		0.0192		0.1036*		-0.7924		0.6416**		0.4333
		(1.72)		(0.02)		(1.74)		(-0.74)		(2.43)		(1.62)
NPL Ratio		0.1783		0.0921		0.0198		0.5088*		0.7520***		0.1745*
		(0.81)		(0.41)		(0.65)		(1.68)		(3.32)		(1.87)
ROA		-0.3900*		-0.2675***		0.0122		0.1049		-0.8403**		-0.2841**
		(-1.71)		(-2.82)		(0.21)		(0.24)		(-2.27)		(-2.61)
Securitization Ratio		-0.0465*		-0.0446		0.0037		-0.0274		-0.0468		-0.0255
		(-1.78)		(-1.54)		(0.82)		(-0.78)		(-0.99)		(-1.49)
Credit Rating		-0.2807**		-0.3089**		-0.0013		-0.2818**		-0.2740*		-0.1106*
		(-2.44)		(-2.34)		(-0.03)		(-2.06)		(-1.67)		(-1.76)
Obs.	33,456	6,920	33,496	6,933	20,018	5,285	22,606	5,841	22,690	5,877	18,344	5,012
R-Sq	0.474	0.510	0.385	0.529	0.928	0.912	0.748	0.789	0.615	0.366	0.589	0.612
Yearquarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4: Cost of Debt OLS Regressions

This table reports OLS regression results showing the effects of book equity capital ratio on the cost of debt. The dependent variable is the cost of debt. For each bank, the cost of debt is measured as the bank level and time varying yield to maturity for all outstanding long term bond issues and bond trades. The sample in this table cover the time-period between 1986 and 2014. All variables are as define in Table 1. Independent variables are lagged by one period, and standard errors are double clustered at the quarter and BHC levels. T-stats are reported under the coefficients in parenthesis. * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$.

	Pretax Cost of Debt			
	(1)	(2)	(3)	(4)
BE/TA	0.0116	0.0087	0.0056	0.0082
	(0.57)	(0.40)	(0.34)	(0.51)
Log of Total Assets		-0.0397*	-0.0684*	-0.0662
		(-1.71)	(-1.97)	(-0.93)
Log of B/M			0.1016**	0.0909*
			(2.38)	(1.72)
NPL Ratio			0.1373***	0.1275***
			(3.93)	(2.89)
Credit Rating			-0.2148***	-0.2076***
			(-7.74)	(-6.15)
Loan HHI				0.2289
				(1.50)
Competition HHI				0.1610
				(1.12)
ROA				-0.1572***
				(-2.74)
Securitization Ratio				0.0034
				(0.11)
Obs.	6,914	6,914	6,761	6,753
R-Sq	0.866	0.866	0.897	0.897
Yearquarter FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes

Table 5: Cost of Capital OLS Regressions

This table reports OLS regression results showing the effects of book equity capital ratio on the cost of capital. The dependent variable is the cost of capital. For each bank, the cost of capital is measured as the market equity weighted average of the after-tax cost of debt and the cost of equity, which calculated in five different methods plus their average. The sample in this table cover the time-period between 1986 and 2014. All variables are as define in Table 1. Independent variables are lagged by one period, and standard errors are double clustered at the quarter and BHC levels. T-stats are reported under the coefficients in parenthesis. * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$.

	CAPM		FF3		GLS		CT		DGM		AVG	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
BE/TA	0.0861*	0.0460**	0.1463**	0.0951***	0.0594***	0.0296**	0.0963**	0.0764**	0.1220**	0.0549	0.1021**	0.0535***
	(1.81)	(2.01)	(2.55)	(3.10)	(2.73)	(2.57)	(2.18)	(2.12)	(2.06)	(1.59)	(2.24)	(2.72)
Log of Total Assets		-0.5302**		-0.6904**		-0.2226***		-0.2915**		-0.6574***		-0.5049***
		(-2.53)		(-2.57)		(-2.69)		(-2.05)		(-4.02)		(-2.71)
Log of B/M		0.2063		0.2827*		0.0998**		0.4750***		0.3924**		0.2732**
		(1.48)		(1.70)		(2.25)		(3.56)		(2.38)		(2.21)
Loan HHI		0.8960		1.3155		0.9321**		0.3124		1.4717**		1.4801*
		(1.04)		(1.28)		(2.48)		(0.44)		(2.17)		(1.75)
Competition HHI		0.1299		0.2492		0.3333**		0.2191		0.6795***		0.4134*
		(0.61)		(0.93)		(2.25)		(0.95)		(2.64)		(1.83)
NPL Ratio		0.1252***		0.1418***		0.0656**		-0.1050		-0.0311		0.0185*
		(2.75)		(2.85)		(2.62)		(-1.27)		(-0.79)		(1.75)
ROA		-0.1352		-0.1453		-0.1021**		-0.2032		-0.0706		-0.2122***
		(-1.49)		(-1.12)		(-2.35)		(-1.27)		(-0.99)		(-3.08)
Securitization Ratio		-0.0095		-0.0117		-0.0010		-0.0176		-0.0053		-0.0069**
		(-1.41)		(-1.39)		(-0.38)		(-1.16)		(-0.83)		(-2.19)
Credit Rating		-0.1273***		-0.1222***		-0.1143***		-0.0317		-0.0673**		-0.0956***
		(-5.21)		(-4.09)		(-8.54)		(-0.60)		(-2.23)		(-3.67)
Obs.	6,592	6,437	6,599	6,443	5,105	4,983	5,593	5,463	5,610	5,479	4,861	4,741
R-Sq	0.624	0.698	0.583	0.655	0.853	0.887	0.783	0.832	0.678	0.765	0.747	0.823
Yearquarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 6: Equity Capital Ratio and New Lending Growth

This table reports OLS regression results showing the effects of book equity capital ratio on new lending growth. The dependent variable is the bank-level quarterly growth in lending (over the same quarter in the previous year). Loan-level data for the largest 20 banks in our sample is obtained from Thomson-Reuters Dealscan database. The sample in this table cover the time-period between 1986 and 2014 and includes the largest 20 banks. The specification in column (1) highlights the relationship of lending to the market equity capital ratio ME/TA, and the specification in column (2) uses the book equity capital ratio BE/TA. All variables are as define in Table 1. Independent variables are lagged by one period, and standard errors are double clustered at the quarter and BHC levels. T-stats are reported under the coefficients in parenthesis. * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$.

	Growth in New Loans	
	(1)	(2)
ME/TA	1.2066**	
	(2.17)	
BE/TA		1.6869*
		(1.89)
Log of Total Assets	-6.7614***	-8.1910**
	(-2.88)	(-2.28)
Log of B/M	32.8245**	14.1529*
	(2.60)	(1.91)
Loan HHI	-4.3979	-7.6523
	(-0.39)	(-0.68)
Competition HHI	-0.1471	-6.6122
	(-0.04)	(-1.21)
NPL Ratio	-0.6218	-1.2664
	(-0.56)	(-0.85)
ROA	4.4711	3.7045
	(1.00)	(0.89)
Securitization Ratio	0.0693	0.0892
	(0.78)	(0.95)
Credit Rating	6.0218**	5.3549**
	(2.78)	(2.37)
Obs.	1,406	1,406
R-Sq	0.311	0.226
Yearquarter FE	Yes	Yes
Firm FE	Yes	Yes

Table 7: Statutory State Taxes

This table highlights the summary statistics of the historical variation of statutory state income taxes levied on banks, using annual data from 1986 to 2014 from the annual publication of *The Book of States* available from The Council of State Governments. The figure highlights the exogenous variation of statutory state income tax rates across states and over time. For example, the state of Connecticut had historically held a state income tax rate on banks as low as 7.5 and as high as 13.8 percent across the sample years (1986-2014)

State	Mean	Min	Max	State	Mean	Min	Max
AK	9.40	9.40	9.40	MT	6.75	6.75	6.75
AL	6.27	6.00	6.50	NC	6.87	4.50	7.75
AR	6.40	6.00	6.50	ND	7.00	7.00	7.00
AZ	8.32	6.50	10.50	NE	7.33	6.65	7.81
CA	10.80	10.64	11.06	NH	7.85	7.00	8.50
CO	5.00	4.63	6.00	NJ	8.81	7.50	9.00
CT	10.08	7.50	13.80	NM	7.60	7.60	7.60
DC	9.93	9.50	10.00	NV	0.00	0.00	0.00
DE	8.70	8.70	8.70	NY	8.26	7.10	9.00
FL	5.50	5.50	5.50	OH	8.55	8.00	9.20
GA	6.00	6.00	6.00	OK	5.87	4.00	6.00
HI	8.78	7.92	11.70	OR	6.80	6.60	7.90
IA	5.00	5.00	5.00	PA	10.15	8.50	12.30
ID	7.80	7.40	8.00	RI	8.73	8.00	9.00
IL	7.47	6.50	9.50	SC	4.50	4.50	4.50
IN	8.23	7.00	8.50	SD	6.00	6.00	6.00
KS	4.38	4.25	4.50	TN	6.21	6.00	6.50
KY	7.25	6.00	8.25	TX	0.00	0.00	0.00
LA	8.00	8.00	8.00	UT	5.00	5.00	5.00
MA	11.16	9.00	12.54	VA	6.00	6.00	6.00
MD	7.28	7.00	8.30	VT	8.77	8.25	9.75
ME	8.94	8.93	9.82	WA	0.00	0.00	0.00
MI	5.04	4.95	6.00	WI	7.90	7.90	7.90
MN	9.81	9.50	12.00	WV	8.80	6.50	9.75
MO	7.00	7.00	7.00	WY	0.00	0.00	0.00
MS	5.00	5.00	5.00				

Table 8: Cost of Capital IV Regressions

This table reports 2SLS regression results showing the effects of book equity capital ratio on the cost of capital. The dependent variable is the cost of capital, measured in 5 different methods plus their average. The book equity capital ratio is endogenous, and the statutory state income tax levied on banks is used as an instrument. The odd-numbered columns show the first stage of the 2SLS IV regressions where the endogenous book equity capital ratio is regressed on the instrument statutory state tax rates. The first stage F-Stat and Kleibergen-Paap p-value for underidentification are reported in this table. The sample in this table cover the time-period between 1994 and 2014. All variables are as define in Table 1. Independent variables are lagged by one period, and standard errors are double clustered at the quarter and BHC levels. T-stats are reported under the coefficients in parenthesis. * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$.

	CAPM		FF3		GLS		CT		DGM		AVG	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Statutory State Tax Rate	-0.0621***		-0.0611***		-0.0447***		-0.0446***		-0.0456**		-0.0463***	
	(-6.48)		(-6.35)		(-4.11)		(-4.48)		(-2.56)		(-4.19)	
BE/TA		0.0836***		0.0786***		0.0689***		0.0348**		0.0871		0.0924***
		(3.37)		(4.15)		(3.24)		(2.19)		(1.61)		(4.72)
Log of Total Assets	-0.0023	-0.2420***	-0.0078	-0.2147***	-0.0564	-0.3578***	-0.0149	-0.2687***	-0.0156	-0.3931***	-0.0551	-0.3293***
	(-0.05)	(-5.06)	(-0.15)	(-5.98)	(-0.91)	(-3.78)	(-0.25)	(-6.04)	(-0.26)	(-4.83)	(-0.94)	(-5.84)
Log of B/M	-0.0999	-0.2816***	-0.0704	-0.5107***	-0.0954	-0.1205*	-0.1504	-0.3336***	-0.1503*	-0.7068***	-0.0238	-0.4026***
	(-1.05)	(-2.70)	(-0.77)	(-4.63)	(-0.94)	(-1.67)	(-1.60)	(-4.73)	(-1.66)	(-6.75)	(-0.23)	(-5.31)
Loan HHI	4.1037***	2.4627***	4.1316**	2.1283***	3.8237***	1.4234***	4.0205***	0.1238	4.0272***	2.8387***	3.6673**	1.9368
	(2.87)	(5.40)	(2.48)	(4.71)	(2.73)	(3.05)	(3.60)	(0.21)	(3.55)	(3.89)	(2.10)	(1.47)
Competition HHI	0.3263***	0.4699***	0.3160***	0.5123***	0.4424***	0.5225***	0.4185***	0.6317***	0.4145***	0.8765***	0.4367***	0.7327***
	(2.96)	(4.21)	(2.89)	(4.21)	(3.95)	(5.41)	(3.81)	(8.63)	(3.80)	(5.78)	(3.79)	(5.87)
NPL Ratio	0.6923***	0.4285***	0.6946***	0.3529***	0.7249***	0.1571	0.7346***	0.0383	0.7422***	0.3912**	0.7293***	0.2878**
	(4.91)	(3.42)	(4.95)	(3.14)	(5.09)	(1.39)	(4.87)	(0.33)	(4.93)	(2.54)	(5.43)	(2.25)
ROA	1.0305***	0.5073***	1.0481***	0.6818***	0.7873***	0.4950***	0.8621***	0.1825	0.8561***	0.7238***	0.7921***	0.5332***
	(8.12)	(2.79)	(8.03)	(3.34)	(5.79)	(3.35)	(6.48)	(1.18)	(6.48)	(3.57)	(5.92)	(3.18)
Securitization Ratio	-0.0039	-0.0256***	-0.0039	-0.0266***	-0.0086	-0.0148***	-0.0069	-0.0137***	-0.0073	-0.0175***	-0.0096	-0.0196***
	(-0.54)	(-5.28)	(-0.53)	(-5.41)	(-1.24)	(-4.38)	(-0.93)	(-6.25)	(-0.97)	(-3.77)	(-1.48)	(-5.37)
Credit Rating	-0.0036	0.0136	-0.0012**	-0.0034	0.0169	0.0119	-0.0119	-0.0320**	-0.0117**	-0.0068*	-0.0102***	-0.0114**
	(-0.12)	(0.59)	(-2.04)	(-0.14)	(0.57)	(0.73)	(-0.40)	(-2.35)	(-2.39)	(-1.71)	(-3.34)	(-2.56)
Obs.	6,278	6,278	6,282	6,282	4,885	4,885	5,367	5,367	5,378	5,378	4,650	4,650
R-Sq	0.662	0.448	0.562	0.318	0.452	0.299	0.638	0.370	0.541	0.374	0.608	0.423
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1st Stage F-stat	41.93		40.36		16.89		20.09		20.75		17.53	
K-P Under-id P-value		0.00		0.00		0.00		0.00		0.00		0.00

Table 9: Covariate Balance Before and After Tax Increase

This table highlights the first and second moments of the unbalanced and the entropy balanced covariates. The first four columns show the first and second moments of the unbalanced covariates for the treatment and control samples around state tax increase shocks. Columns (5) and (6) show the difference in means (first moment), and variances (second moment), between treatment and control. Columns (7) to (10) show the first and second moments of the entropy balanced (e.g. Hainmueller (2012)) covariates for the treatment and control samples around state tax increase shocks. Columns (11) and (12) show the difference in means (first moment), and variances (second moment), between treatment and control.

	Unbalanced Covariates						Entropy Balanced Covariates					
	μ_{control}	μ_{treat}	σ_{control}	σ_{treat}	$\Delta\mu$	$\Delta\sigma$	μ_{control}	μ_{treat}	σ_{control}	σ_{treat}	$\Delta\mu$	$\Delta\sigma$
CAPM Cost of Capital	5.19	4.88	1.67	0.95	0.32	0.72	4.98	4.98	0.93	0.93	0.00	0.00
FF3 Cost of Capital	5.38	5.08	2.59	1.06	0.29	1.53	5.16	5.16	1.10	1.10	0.00	0.00
GLS Cost of Capital	4.94	4.51	1.23	0.79	0.43	0.44	4.88	4.88	0.81	0.81	0.00	0.00
CT Cost of Capital	5.38	5.07	1.96	0.74	0.31	1.22	5.28	5.28	0.71	0.71	0.00	0.00
DGM Cost of Capital	5.46	5.22	1.97	0.89	0.23	1.08	5.36	5.36	0.88	0.88	0.00	0.00
Avg Cost of Capital	5.17	4.85	1.50	0.75	0.31	0.75	5.13	5.13	0.70	0.74	0.00	-0.04
BE/TA	8.98	8.06	6.40	4.91	0.92	1.48	7.77	7.77	3.85	3.85	0.00	0.00
Log of Total Assets	14.36	14.17	2.34	2.71	0.19	-0.37	16.53	16.53	1.51	1.51	0.00	0.00
Log of B/M	-0.30	-0.12	0.42	0.55	-0.19	-0.13	-0.36	-0.36	0.51	0.51	0.00	0.00
Credit Rating	15.81	16.12	6.46	7.05	-0.30	-0.59	16.03	16.03	3.88	3.88	0.00	0.00
Loan HHI	0.57	0.48	0.03	0.02	0.09	0.01	0.41	0.41	0.01	0.01	0.00	0.00
Competition HHI	0.36	0.31	0.04	0.02	0.05	0.02	0.30	0.30	0.02	0.02	0.00	0.00
ROA	0.51	0.45	0.31	0.37	0.06	-0.07	0.60	0.60	0.11	0.11	0.00	0.00
NPL Ratio	1.11	0.97	2.81	3.47	0.14	-0.66	0.77	0.77	1.27	1.27	0.00	0.00
Securitization Ratio	0.48	0.15	12.63	3.94	0.33	8.69	0.20	0.20	0.59	0.57	0.00	0.01

Table 10: Covariate Balance Before and After Tax Decrease

This table highlights the first and second moments of the unbalanced and the entropy balanced covariates. The first four columns show the first and second moments of the unbalanced covariates for the treatment and control samples around state tax decrease shocks. Columns (5) and (6) show the difference in means (first moment), and variances (second moment), between treatment and control. Columns (7) to (10) show the first and second moments of the entropy balanced (e.g. Hainmueller (2012)) covariates for the treatment and control samples around state tax increase shocks. Columns (11) and (12) show the difference in means (first moment), and variances (second moment), between treatment and control.

	Unbalanced Covariates						Entropy Balanced Covariates					
	μ_{control}	μ_{treat}	σ_{control}	σ_{treat}	$\Delta\mu$	$\Delta\sigma$	μ_{control}	μ_{treat}	σ_{control}	σ_{treat}	$\Delta\mu$	$\Delta\sigma$
CAPM Cost of Capital	4.85	5.29	1.64	1.31	-0.44	0.33	5.10	5.10	1.44	1.44	0.00	0.00
FF3 Cost of Capital	5.04	5.63	2.42	2.81	-0.59	-0.38	5.46	5.46	3.25	3.25	0.00	0.00
GLS Cost of Capital	4.50	4.83	1.21	1.17	-0.33	0.04	4.80	4.80	1.16	1.16	0.00	0.00
CT Cost of Capital	5.07	5.30	2.00	0.95	-0.24	1.05	5.21	5.21	0.94	0.94	0.00	0.00
DGM Cost of Capital	5.20	5.59	1.92	1.73	-0.40	0.19	5.52	5.52	1.73	1.73	0.00	0.00
Avg Cost of Capital	4.83	5.22	1.47	1.26	-0.39	0.21	5.22	5.22	1.26	1.24	0.00	0.02
BE/TA	8.92	8.94	6.15	8.00	-0.02	-1.85	8.36	8.36	3.54	3.54	0.00	0.00
Log of Total Assets	14.37	14.19	2.30	2.87	0.18	-0.57	17.25	17.25	1.86	1.86	0.00	0.00
Log of B/M	-0.29	-0.29	0.44	0.37	0.00	0.07	-0.62	-0.62	0.54	0.54	0.00	0.00
Credit Rating	15.79	16.19	6.66	5.04	-0.40	1.62	16.44	16.44	4.36	4.36	0.00	0.00
Loan HHI	0.56	0.57	0.03	0.04	-0.01	-0.01	0.44	0.44	0.03	0.03	0.00	0.00
Competition HHI	0.36	0.32	0.04	0.03	0.04	0.01	0.31	0.31	0.03	0.03	0.00	0.00
ROA	0.50	0.56	0.32	0.26	-0.05	0.06	0.70	0.70	0.16	0.16	0.00	0.00
NPL Ratio	1.14	0.77	2.98	1.68	0.37	1.30	0.78	0.78	0.86	0.86	0.00	0.00
Securitization Ratio	0.50	0.19	13.18	3.52	0.30	9.65	1.66	1.66	30.27	30.27	0.00	0.00

Table 11: Difference in Group Means After State Tax Shocks

This table highlights summary and test statistics for the book equity capital ratio and different measures for the cost of capital. The table compares the means of each variable between treatment and control groups. The treatment group under $AfterTaxIncrease$ include banks that experienced tax increase shocks. The treatment group under $AfterTaxDecrease$ include banks that experienced tax decrease shocks. The control group is banks that did not experience a tax shock. T-stats and P-values are reported for each tax shock.

	After Tax Increase					After Tax Decrease				
	μ_{control}	μ_{treat}	$\Delta\mu$	T-Stat	P-Value	μ_{control}	μ_{treat}	$\Delta\mu$	T-Stat	P-Value
BE/TA	8.95	8.12	0.83	12.95	0.00	8.91	9.37	-0.46	-3.59	0.00
CAPM Cost of Capital	5.02	4.90	0.12	1.54	0.12	4.87	4.97	-0.10	-5.83	0.00
FF3 Cost of Capital	5.29	5.10	0.19	1.88	0.06	5.07	5.31	-0.24	-7.51	0.00
GLS Cost of Capital	4.80	4.52	0.28	3.34	0.00	4.51	4.66	-0.15	-4.23	0.00
CT Cost of Capital	5.28	5.08	0.20	1.93	0.05	5.08	5.22	-0.14	-1.94	0.05
DGM Cost of Capital	5.32	5.24	0.08	0.80	0.42	5.22	5.47	-0.24	-3.43	0.00
Avg Cost of Capital	5.03	4.81	0.12	1.82	0.08	4.85	5.07	-0.22	-4.27	0.00

Table 12: Equity Capital Requirement Difference-in-Differences

This table reports OLS regression results showing the effects of tax increase and decrease shocks on the book equity capital ratio. The dependent variable in this table is the book equity capital requirement. The regression specification is a multiple-period difference-in-differences where shocks are identified when states exogenously change their statutory state tax rates. Columns 1 and 2 restrict the analysis to instances when states increase the tax rate on banks and financial firms, while columns 3 and 4 refers to instances with state tax decrease. Banks in the control group are formed at each shock period from states where there has been no tax intervention during the year before and after the event period. Covariates are entropy balanced pre-treatment at the 1st and 2nd momemnts. The sample in this table cover the time-period between 1994 and 2014. All variables are as define in Table 1. Independent variables are lagged by one period, and standard errors are double clustered at the quarter and BHC levels. T-stats are reported under the coefficients in parenthesis. * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$.

	BE/TA			
	(1)	(2)	(3)	(4)
Tax Dec. Treatment			-0.1027	-0.0565
			(-0.42)	(-0.36)
Treatment x After Tax Dec.			0.0139*	0.1540
			(1.78)	(1.52)
Tax Inc. Trteatment	0.2406	0.4568		
	(0.93)	(1.60)		
Treatment x After Tax Inc.	-0.0792***	-0.0660**		
	(-3.29)	(-2.17)		
Log of Total Assets		-0.5897***		-1.1050***
		(-2.87)		(-5.96)
Log of B/M		0.2879*		0.8433***
		(1.82)		(4.66)
Loan HHI		-0.7863		0.9670
		(-0.33)		(1.04)
Competition HHI		3.2472***		3.8996***
		(3.35)		(4.74)
NPL Ratio		0.2480***		-0.0547
		(3.25)		(-0.55)
ROA		0.6671***		0.2836
		(3.47)		(1.35)
Securitization Ratio		0.1776**		-0.0632***
		(2.52)		(-3.89)
Credit Rating		0.1020*		0.0876
		(1.75)		(1.37)
Obs.	4,277	4,277	4,492	4,492
R-Sq	0.846	0.867	0.766	0.819
Yearquarter FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes

Table 13: Cost of Capital Difference-in-Difference-in-Differences Tax Increase Regressions

This table reports OLS regression results showing the effects of tax increase shocks on the cost of capital through the book equity capital ratio. The dependent variable in this table is the cost of capital. The regression specification is a multiple-period difference-in-difference-in-differences where shocks are identified when states exogenously change their statutory state tax rates. This table restricts the analysis to instances when states increase the tax rate on banks. Banks in the control group are formed at each shock period from states where there has been no tax intervention during the year before and after the event period. Covariates are entropy balanced pre-treatment at the 1st and 2nd momemnts. The sample in this table cover the time-period between 1994 and 2014. All variables are as define in Table 1. Independent variables are lagged by one period, and standard errors are double clustered at the quarter and BHC levels. T-stats are reported under the coefficients in parenthesis. * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$.

	CAPM		FF3		GLS		CT		DGM		AVG	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
BE/TA	0.0291*	-0.0045	0.0609*	0.0786*	0.0500***	0.0373***	0.0606**	0.0668***	0.0833**	0.0738***	0.0568**	0.0602***
	(1.79)	(-1.13)	(1.73)	(1.82)	(3.09)	(3.44)	(2.20)	(3.36)	(2.18)	(2.89)	(2.04)	(2.69)
Tax Inc. Trteatment	0.7568**	0.5651*	1.4771***	1.2152***	0.2263	0.0914	0.4552	0.1740	0.1258	-0.1020	0.6082**	0.3887*
	(2.23)	(1.91)	(4.30)	(3.89)	(1.19)	(0.57)	(1.19)	(0.51)	(0.33)	(-0.29)	(2.22)	(1.69)
Treatment x After Tax Inc.	-0.5585	-0.1725	-0.9053**	-0.4446	-0.2247	0.0655	-0.0545	0.5220*	0.4263	0.8154*	-0.2633	0.1571
	(-1.19)	(-0.51)	(-2.23)	(-1.38)	(-0.84)	(0.31)	(-0.16)	(1.70)	(1.12)	(1.91)	(-0.84)	(0.60)
BE/TA x Tax Inc. Trt	0.1188**	0.0851*	0.2247***	0.1862***	-0.0375	-0.0118	-0.0660	0.0239	0.0293	0.0026	0.0953**	0.0609*
	(2.35)	(1.96)	(4.15)	(3.84)	(-1.39)	(-0.55)	(-1.30)	(0.56)	(0.54)	(0.05)	(2.43)	(1.92)
BE/TA x After Tax Inc.	0.0529	0.0422	0.0367	0.0264	0.0295	0.0215	0.0432	0.0287	0.0720*	0.0631**	0.0469	0.0364
	(1.26)	(1.24)	(0.98)	(0.85)	(1.04)	(1.14)	(1.27)	(1.30)	(1.85)	(2.07)	(1.42)	(1.61)
BE/TA x Trt x After Tax Inc.	0.0873*	0.0328	0.1385**	0.0776*	0.0278	-0.0124	0.0029	0.0718**	0.0601*	0.1044*	0.0393*	0.0156**
	(1.76)	(0.71)	(2.43)	(1.71)	(0.80)	(-0.47)	(0.06)	(2.66)	(1.93)	(1.74)	(1.92)	(2.46)
Log of Total Assets		-0.0977***		-0.1372***		-0.0219*		-0.0523		-0.0023		-0.0526**
		(-3.90)		(-4.98)		(-1.74)		(-1.35)		(-0.06)		(-2.48)
Log of B/M		0.0755		0.1456*		0.0296		0.1929**		0.2603**		0.1408**
		(1.20)		(1.74)		(0.94)		(2.34)		(2.61)		(2.29)
Credit Rating		-0.1286***		-0.1357***		-0.1050***		-0.1213***		-0.1027***		-0.1186***
		(-7.51)		(-7.95)		(-7.50)		(-5.73)		(-5.14)		(-8.03)
Loan HHI		-0.3118		0.3064		-0.0865		0.4976		0.2858		0.1383
		(-0.85)		(0.68)		(-0.64)		(1.58)		(0.78)		(0.63)
Competition HHI		0.0409		0.1260		-0.0013		0.1119		0.0621		0.0679
		(0.18)		(0.69)		(-0.01)		(0.64)		(0.30)		(0.45)
ROA		-0.1856		-0.1687		-0.1577***		-0.2958**		-0.2524***		-0.2121***
		(-1.56)		(-1.06)		(-2.97)		(-2.15)		(-2.74)		(-2.69)
NPL Ratio		0.0700		0.0372		0.0154		0.0452*		-0.0357		0.0264*
		(1.46)		(0.95)		(0.65)		(1.80)		(-1.11)		(1.89)
Securitization Ratio		-0.0346		-0.0184		-0.0158		-0.0199		-0.0228		-0.0223
		(-1.43)		(-0.66)		(-1.42)		(-0.82)		(-0.57)		(-1.37)
Obs.	4,282	4,282	4,282	4,282	4,282	4,282	4,282	4,282	4,282	4,282	4,282	4,282
R-Sq	0.692	0.739	0.626	0.671	0.856	0.905	0.641	0.722	0.611	0.677	0.762	0.821
Yearquarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 14: Cost of Capital Difference-in-Difference-in-Differences Tax Decrease Regressions

This table reports OLS regression results showing the effects of tax decrease shocks on the cost of capital through the book equity capital ratio. The dependent variable in this table is the cost of capital. The regression specification is a multiple-period difference-in-difference-in-differences where shocks are identified when states exogenously change their statutory state tax rates. This table restricts the analysis to instances when states decrease the tax rate on banks. Banks in the control group are formed at each shock period from states where there has been no tax intervention during the year before and after the event period. Covariates are entropy balanced pre-treatment at the 1st and 2nd momemnts. The sample in this table cover the time-period between 1994 and 2014. All variables are as define in Table 1. Independent variables are lagged by one period, and standard errors are double clustered at the quarter and BHC levels. T-stats are reported under the coefficients in parenthesis. * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$.

	CAPM		FF3		GLS		CT		DGM		AVG	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
BE/TA	0.0994**	0.0923***	0.2069***	0.1829***	0.0381**	0.0226	0.0379	0.0213	0.1615**	0.1139***	0.1087***	0.0866***
	(2.00)	(3.54)	(3.33)	(4.57)	(2.10)	(1.56)	(1.16)	(1.03)	(2.47)	(3.43)	(2.80)	(5.17)
Tax Dec. Treatment	0.2914	0.2073	1.5542**	1.3709**	-0.1112	0.0967	-0.1239	0.1297	0.2449	0.5302	0.3711	0.4670*
	(0.49)	(0.55)	(2.43)	(2.62)	(-0.38)	(0.46)	(-0.28)	(0.32)	(0.32)	(1.22)	(0.81)	(1.87)
Treatment x After Tax Dec.	0.5178	0.5131	-0.5898	-0.5758	0.1068	-0.2420	0.2917	-0.2184	0.1907	-0.3380	0.1034	-0.1722
	(0.88)	(1.38)	(-0.60)	(-0.70)	(0.28)	(-1.00)	(0.70)	(-0.67)	(0.27)	(-0.72)	(0.19)	(-0.54)
BE/TA x Tax Dec. Trt	0.0183	0.0025	0.1704*	0.1345*	0.0084	-0.0108	0.0156	0.0076	0.0364	0.0604	0.0402	0.0422
	(0.22)	(0.05)	(1.77)	(1.89)	(0.21)	(-0.39)	(0.26)	(0.15)	(0.34)	(1.05)	(0.60)	(1.25)
BE/TA x After Tax Dec.	0.0383	0.0032	0.0551	0.0075	0.0819***	0.0213	0.0472*	0.0151	0.0952**	0.0260	0.0635**	0.0073
	(1.37)	(0.16)	(0.64)	(0.08)	(3.87)	(1.38)	(1.83)	(0.76)	(2.41)	(0.76)	(2.23)	(0.27)
BE/TA x Trt x After Tax Dec.	0.0845	0.0951**	0.0368	0.0207	0.0233*	0.0124	0.0444*	0.0102	0.0366**	0.0141*	0.0304*	0.0075
	(1.23)	(2.11)	(0.30)	(0.19)	(1.69)	(1.44)	(1.84)	(1.24)	(2.30)	(1.74)	(1.68)	(0.20)
Log of Total Assets		-0.0361		-0.1032		-0.0774***		-0.0271		-0.1113*		-0.0153**
		(-0.71)		(-1.08)		(-2.81)		(-0.83)		(-1.87)		(-2.34)
Log of B/M		0.5739***		0.9581***		0.2492***		0.3737***		0.8568***		0.6023***
		(4.04)		(3.82)		(4.04)		(4.98)		(6.66)		(5.00)
Credit Rating		-0.0934***		-0.1288***		-0.1060***		-0.1493***		-0.0912***		-0.1137***
		(-3.69)		(-3.12)		(-7.25)		(-6.53)		(-3.18)		(-5.17)
Loan HHI		0.5240*		0.8993*		0.0180		-0.4011*		0.7042*		0.3489
		(1.71)		(1.82)		(0.15)		(-1.79)		(1.68)		(1.49)
Competition HHI		0.5557***		0.6954**		0.1569		0.2165*		0.6554***		0.4560***
		(2.78)		(2.35)		(1.39)		(1.67)		(2.63)		(2.80)
ROA		-0.3208*		-0.1529		-0.1077		-0.0434		0.1611		-0.0927
		(-1.96)		(-0.62)		(-1.43)		(-0.46)		(0.81)		(-0.79)
NPL Ratio		0.2211***		0.2267***		0.0310		0.0401		0.0614		0.1161***
		(2.94)		(2.66)		(1.09)		(1.00)		(0.97)		(2.66)
Securitization Ratio		-0.0035		0.0002		-0.0041		0.0032		0.0187*		0.0029
		(-0.39)		(0.02)		(-0.86)		(0.66)		(1.87)		(0.48)
Obs.	4,497	4,497	4,497	4,497	4,497	4,497	4,497	4,497	4,497	4,497	4,497	4,497
R-Sq	0.544	0.648	0.498	0.607	0.800	0.878	0.592	0.720	0.468	0.707	0.618	0.763
Yearquarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

A Appendix

Cost of equity estimation methods

Gebhardt, Lee & Swaminathan (2001) use a variant of the residual income valuation model to calculate the implied cost of equity capital. The authors use estimates for EPS from consensus analyst forecasts for the next two years, the expected dividends payouts from historical data, and derive book value and ROE forecasts. Their model assumes that ROE starts to revert to the by year 12. ROE is defined as the ratio of net income before extraordinary items (Compustat: IB) to lagged total common shareholders' equity (Compustat: CEQ). The cost of equity is numerically computed by solving the following formula for the present value of future residual earnings:

$$P_0 = B_0 + \sum_{t=1}^{12} \frac{(EPS_t - R_e\, B_{t-1})}{(1+R_e)^t} + \frac{(EPS_{12} - R_e\, B_{11})}{R_e(1+R_e)^{12}}$$

EPS is the forecasted earnings per share obtained from analyst consensus estimates in I/B/E/S or inferred from expected ROE and lagged book value. P_0 is the current price per share, B_0 is the current book value per share, B_1 to B_{11} are the expected future book values calculated using a clean surplus relation where future payout ratio is equal to current payout ratio. Payout ratio is dividends divided by net income before extraordinary items. I follow Li & Mohanram (2014) and exclude banks with negative net income. In these instances, 6% of total assets is used as the denominator. Further, model forecasts are used explicitly for the years 1 through 5, and ROE convergence is applied from years 5 to 12.

Claus & Thomas (2001) use a similar approach based on the residual income model. They calculate the implied cost of equity by assuming that earnings grow at the long-term growth rates available from the analyst forecasts. The earnings grow at this rate until year 5 and then at the rate of inflation thereafter. The cost of equity is numerically computed by solving the following formula for the present value of future residual earnings:

$$P_0 = B_0 + \sum_{t=1}^{5} \frac{(EPS_t - R_e\, B_{t-1})}{(1+R_e)^t} + \frac{(EPS_5 - R_e\, B_4)\,(1+g)}{(R_e - g)\,(1+R_e)^5}$$

I follow CT (2001) and set g to $R_f - 3\%$

Entropy balancing estimation method

Hainmueller (2012) proposes a weighting scheme to establish covariate balance between the control and treatment groups when using matching methods. Simple matching methods typically estimate the average treatment effects on the treated by measuring the mean outcomes. The mean difference in outcomes between the control group and the treatment is found by:

$$E[Y(1)||D = 1] - E[Y(0)|D = 1]$$

However, causal inference hinges heavily on having covariate balance between the treatment and control groups. As such, Hainmuller proposes the following to correct for out-of-balance covariates:

$$E[\widehat{Y(0)}|D = 1] = \frac{\sum_{i|D=0} Y_i\, w_i}{\sum_{i|D=0} w_i}$$

where w_i is a weight assigned for each covariate to preserve an n^{th} order of balance in moment distribution. The reweighing scheme used to determine the weights is thus a function of the moment order, which is 2 in this paper (mean and variance). The following minimization function depicts this process.

$$\min_{w_i} H(w) = \sum_{i|D=0} h(w_i)$$

subject to the following set of constraints

$$\begin{aligned} \sum w_i c_{ri}(X_i) &= m_r \\ r \in 1, \ldots, R & \\ \sum_{1|D=0} w_i = 1 & \\ w_i \geq 0 & \end{aligned}$$

h() is a maximum distance deviation constraint assigned by the researched and is equal to $h(w_i) = w_i \log(\frac{w_i}{q_i})$ and m_r represents the n^{th} order of balance in moment distribution assigned.

Figure A1: Predictive Margins Plot - Linear (BE/TA)

This figure shows the margins predictive relationship between the book equity capital ratio and the change in average cost of capital using a linear term for (BE/TA). The predicted values in this plot come from the regression specification in Table 5 column (12). All covariates in that specification are estimated at their means. The X and Y-axis in this plot are in percent.

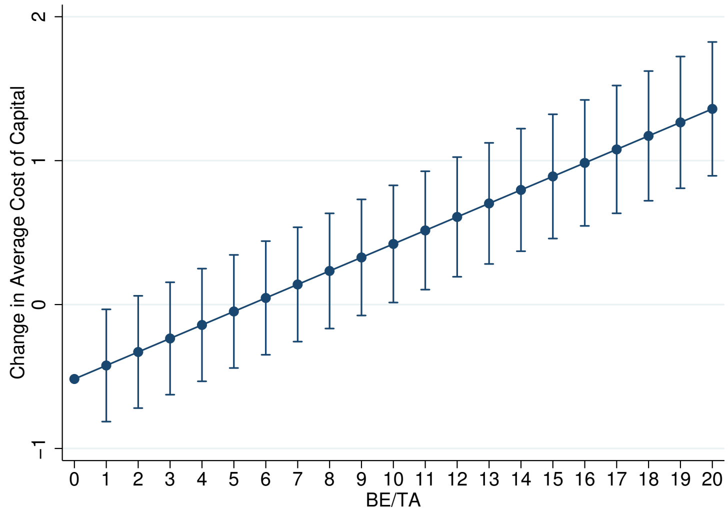


Figure A2: Predictive Margins Plot - Quadratic (BE/TA)

This figure shows the margins predictive relationship between the book equity capital ratio and the change in average cost of capital using a quadratic and linear terms for (BE/TA). The predicted values in this plot come from the regression specification in Table A4 column (6). All covariates in that specification are estimated at their means. The X and Y-axis in this plot are in percent.

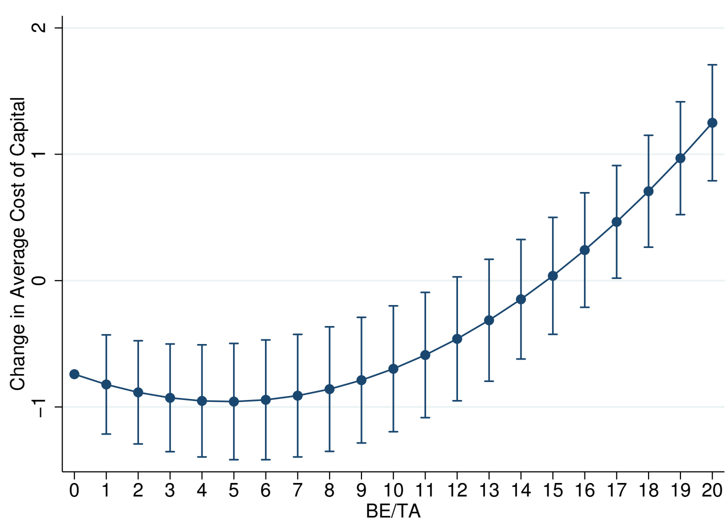


Table A1: Cost of Capital OLS Regressions - Using ME/TA

This table reports OLS regression results showing the effects of the market equity capital ratio (i.e. market Equity over book assets) on the cost of capital. The dependent variable is the cost of capital. For each bank, the cost of capital is measured as the market equity weighted average of the after-tax cost of debt and the cost of equity, which calculated in five different methods plus their average. The sample in this table cover the time-period between 1986 and 2014. All variables are as define in Table 1. Independent variables are lagged by one period, and standard errors are double clustered at the quarter and BHC levels. T-stats are reported under the coefficients in parenthesis. * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$.

	CAPM	FF3	GLS	CT	DGM	AVG
	(1)	(2)	(3)	(4)	(5)	(6)
ME/TA	0.0328***	0.0140**	0.0127***	0.0322***	0.0271**	0.0155***
	(3.71)	(2.24)	(3.94)	(3.24)	(2.52)	(4.08)
Log of Total Assets	0.1128***	-0.6881***	-0.0553***	-0.1986	-0.5500**	-0.4633***
	(2.64)	(-6.14)	(-2.82)	(-1.41)	(-2.62)	(-6.24)
Log of B/M	-0.0533	-0.0442	-0.0261	0.0151	-0.0149	-0.0309
	(-0.25)	(-0.56)	(-0.32)	(0.15)	(-0.12)	(-0.56)
Loan HHI	0.7565*	1.2424***	0.2091	0.2437	1.3872*	1.4723***
	(1.77)	(4.26)	(1.60)	(0.34)	(1.95)	(5.32)
Competition HHI	0.1899	0.2945	0.1568**	0.1450	0.5944**	0.4196**
	(1.64)	(1.53)	(2.40)	(0.62)	(2.31)	(2.36)
NPL Ratio	0.1392***	0.1625***	0.1107***	-0.0932	-0.0201	0.0283*
	(4.29)	(6.38)	(3.68)	(-1.17)	(-0.51)	(1.72)
ROA	-0.0842	-0.0736	-0.0591	-0.1376	-0.0216	-0.1701***
	(-0.49)	(-1.01)	(-1.00)	(-0.90)	(-0.31)	(-3.03)
Securitization Ratio	-0.0064	-0.0127***	-0.0018	-0.0182	-0.0056	-0.0076***
	(-1.52)	(-4.84)	(-0.85)	(-1.29)	(-0.87)	(-3.89)
Credit Rating	-0.1244***	-0.1143***	-0.1109***	-0.0342	-0.0718**	-0.0983***
	(-5.64)	(-6.67)	(-8.84)	(-0.73)	(-2.24)	(-8.05)
Obs.	6,445	6,443	4,987	5,463	5,479	4,741
R-Sq	0.602	0.653	0.859	0.837	0.769	0.823
Yearquarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Table A2: Cost of Capital IV Regressions - Using ME/TA

This table reports 2SLS regression results showing the effects of the market equity capital ratio (i.e. market equity over book assets) on the cost of capital. The dependent variable is the cost of capital, measured in 5 different methods plus their average. The book equity capital ratio is endogenous, and the statutory state income tax levied on banks is used as an instrument. The first stage F-Stat and Kleibergen-Paap p-value for underidentification are reported in this table. The sample in this table cover the time-period between 1994 and 2014. All variables are as define in Table 1. Independent variables are lagged by one period, and standard errors are double clustered at the quarter and BHC levels. T-stats are reported under the coefficients in parenthesis. * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$.

	CAPM	FF3	GLS	CT	DGM	AVG
	(1)	(2)	(3)	(4)	(5)	(6)
ME/TA	0.0414*	0.0260*	0.0329**	0.0146*	0.0094***	0.0593**
	(1.73)	(1.79)	(2.17)	(1.75)	(3.69)	(2.33)
Log of Total Assets	0.4244**	0.3344***	-0.0367**	-0.1549***	0.0187	0.0584*
	(2.26)	(2.75)	(-2.31)	(-2.74)	(0.70)	(1.92)
Log of B/M	5.7393	3.2487	0.3381	2.1785	0.7077	0.3765
	(1.56)	(1.46)	(1.26)	(1.53)	(1.63)	(0.83)
Loan HHI	-1.6650	-0.4098	-0.0112	-2.4471***	0.5349**	0.4545**
	(-1.05)	(-0.42)	(-0.10)	(-3.26)	(2.29)	(2.15)
Competition HHI	-0.1653	0.0698	0.1276***	0.2488	0.3361***	0.2725***
	(-0.57)	(0.43)	(3.89)	(1.57)	(5.51)	(4.19)
NPL Ratio	-0.3523	-0.1526	-0.0111	-0.4205***	-0.0541*	0.0189
	(-1.25)	(-0.89)	(-0.41)	(-2.93)	(-1.73)	(0.45)
ROA	-0.4939*	-0.1629	-0.1139**	-0.2687**	-0.0382	-0.0984*
	(-1.91)	(-0.90)	(-2.41)	(-2.13)	(-0.62)	(-1.74)
Securitization Ratio	0.0085	0.0034	-0.0008	-0.0058	0.0033*	-0.0020
	(0.77)	(0.52)	(-0.85)	(-0.97)	(1.78)	(-1.19)
Credit Rating	-0.1675***	-0.1539***	-0.1134***	-0.0546**	-0.1194***	-0.1276***
	(-4.46)	(-5.73)	(-10.41)	(-2.49)	(-9.02)	(-8.23)
Obs.	6,278	6,282	4,885	5,367	5,378	4,650
R-Sq	0.762	0.901	0.819	0.852	0.635	0.699
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
1st Stage F-stat	39.15	35.48	18.22	20.61	31.72	27.90
K-P Under-id P-value	0.09	0.07	0.00	0.00	0.00	0.00

Table A3: Cost of Capital OLS Regressions - Log Transformation

This table reports OLS regression results showing the effects of Log(book equity capital ratio) on the Log(cost of capital). The dependent variable is the cost of capital, and the main independent variable is the log transformed book equity capital ratio. For each bank, the cost of capital is measured as the market equity weighted average of the after-tax cost of debt and the cost of equity, which calculated in five different methods plus their average. The sample in this table cover the time-period between 1986 and 2014. All variables are as define in Table 1. Independent variables are lagged by one period, and standard errors are double clustered at the quarter and BHC levels. T-stats are reported under the coefficients in parenthesis. * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$.

	CAPM	FF3	GLS	CT	DGM	AVG
	(1)	(2)	(3)	(4)	(5)	(6)
Log(BE/TA)	0.1241***	0.1225***	0.0840***	0.0914*	0.1043**	0.0814***
	(3.33)	(5.65)	(3.84)	(1.83)	(2.60)	(4.94)
Log of Total Assets	0.0230***	-0.0922***	-0.0147***	-0.0405	-0.0869***	-0.0771***
	(2.81)	(-6.60)	(-2.89)	(-1.64)	(-3.40)	(-7.38)
Log of B/M	-0.0844***	-0.0141	-0.0403***	-0.0703***	-0.0595**	-0.0384***
	(-2.71)	(-1.17)	(-2.85)	(-3.59)	(-2.25)	(-4.37)
Loan HHI	0.1678**	0.1529***	0.0749**	0.1177	0.1864	0.2255***
	(2.06)	(3.84)	(2.23)	(1.04)	(1.55)	(5.37)
Competition HHI	0.0498*	0.0748**	0.0421**	0.0588	0.1133**	0.1002***
	(1.98)	(2.29)	(2.13)	(1.58)	(2.28)	(3.46)
NPL Ratio	0.0342***	0.0306***	0.0371***	-0.0037	0.0003	0.0096***
	(4.98)	(6.84)	(4.08)	(-0.44)	(0.03)	(3.19)
ROA	-0.0294	-0.0237*	-0.0130	-0.0144	-0.0103	-0.0323***
	(-1.09)	(-1.90)	(-1.02)	(-0.86)	(-0.84)	(-3.45)
Securitization Ratio	-0.0017*	-0.0021***	-0.0009	-0.0020	-0.0010	-0.0015***
	(-1.66)	(-3.85)	(-1.19)	(-1.27)	(-0.73)	(-3.40)
Credit Rating	-0.0264***	-0.0263***	-0.0253***	-0.0159**	-0.0170***	-0.0252***
	(-6.73)	(-8.51)	(-8.37)	(-2.46)	(-3.08)	(-11.22)
Obs.	6,445	6,443	4,987	5,463	5,479	4,741
R-Sq	0.648	0.673	0.889	0.867	0.784	0.864
Yearquarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Table A4: Cost of Capital OLS Regressions - Quadratic BE/TA

This table reports OLS regression results showing the linear and quadratic effects of book equity capital ratio on the cost of capital. The dependent variable is the cost of capital, and the main independent variable is the linear and quadratic book equity capital ratio. For each bank, the cost of capital is measured as the market equity weighted average of the after-tax cost of debt and the cost of equity, which calculated in five different methods plus their average. The sample in this table cover the time-period between 1986 and 2014. All variables are as define in Table 1. Independent variables are lagged by one period, and standard errors are double clustered at the quarter and BHC levels. T-stats are reported under the coefficients in parenthesis. * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$.

	CAPM	FF3	GLS	CT	DGM	AVG
	(1)	(2)	(3)	(4)	(5)	(6)
BE/TA	-0.0979**	-0.1298***	-0.0343	-0.0326	-0.0388	-0.0910***
	(-2.23)	(-2.64)	(-1.35)	(-0.61)	(-0.85)	(-2.66)
$(BE/TA)^2$	0.0102***	0.0145***	0.0039***	0.0055**	0.0077***	0.0095***
	(3.89)	(5.11)	(2.89)	(2.00)	(3.21)	(5.10)
Log of Total Assets	0.1086***	0.1501***	-0.0573***	0.0141	-0.0400***	0.0251**
	(6.10)	(7.22)	(-7.97)	(1.11)	(-2.65)	(2.02)
Log of B/M	-0.6164***	-0.8142***	-0.2471***	-0.7853***	-0.8878***	-0.7320***
	(-8.68)	(-8.16)	(-7.49)	(-11.93)	(-11.49)	(-10.91)
Loan HHI	0.7565***	0.9279***	0.1829***	0.1278	0.9887***	0.7023***
	(6.55)	(7.31)	(4.13)	(1.12)	(7.74)	(8.09)
Competition HHI	0.2048***	0.2429***	0.1613***	0.2778***	0.4610***	0.3138***
	(4.22)	(3.87)	(5.62)	(6.02)	(8.14)	(6.88)
NPL Ratio	0.1549***	0.1712***	0.1144***	0.2330***	0.1074***	0.1659***
	(9.63)	(8.28)	(10.46)	(7.81)	(7.02)	(10.48)
ROA	-0.1755***	-0.1923**	-0.0892**	-0.4430***	-0.0001	-0.2042***
	(-2.87)	(-2.06)	(-2.29)	(-6.58)	(-0.00)	(-3.77)
Securitization Ratio	-0.0057***	-0.0039**	-0.0015	-0.0081***	0.0019	-0.0033**
	(-3.17)	(-2.03)	(-1.30)	(-4.19)	(1.13)	(-2.42)
Credit Rating	-0.1273***	-0.1313***	-0.1098***	-0.1387***	-0.1072***	-0.1189***
	(-11.91)	(-10.30)	(-13.01)	(-14.97)	(-10.95)	(-11.31)
Obs.	6,445	6,450	4,987	5,470	5,487	4,746
R-Sq	0.590	0.551	0.859	0.486	0.663	0.722
Yearquarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Table A5: Cost of Capital OLS Regressions - 2004 to 2014

This table reports OLS regression results showing the effects of the book equity capital ratio on the cost of capital, where the analysis is restricted for the years 2004-2014. The dependent variable is the cost of capital. For each bank, the cost of capital is measured as the market equity weighted average of the after-tax cost of debt and the cost of equity, which calculated in five different methods plus their average. All variables are as define in Table 1. Independent variables are lagged by one period, and standard errors are double clustered at the quarter and BHC levels. T-stats are reported under the coefficients in parenthesis. * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$.

	CAPM	FF3	GLS	CT	DGM	AVG
	(1)	(2)	(3)	(4)	(5)	(6)
BE/TA	0.1493**	0.0693**	0.0571***	0.0532***	0.0306	0.0355*
	(2.17)	(2.29)	(2.79)	(3.38)	(1.55)	(1.70)
Log of Total Assets	-0.0033	-2.0323***	-0.0528*	-0.5337***	-1.2660***	-1.1821***
	(-0.06)	(-8.85)	(-1.73)	(-6.26)	(-13.26)	(-10.54)
Log of B/M	-1.2190**	-0.0081	-0.4133**	-0.5580***	-0.2827***	-0.2165*
	(-2.38)	(-0.06)	(-2.69)	(-4.45)	(-2.92)	(-1.96)
Loan HHI	0.4943	3.0092***	0.2066	0.4340	0.6443	1.6391***
	(1.20)	(5.81)	(1.23)	(1.20)	(1.33)	(4.14)
Competition HHI	0.1310	1.7594***	0.2560**	0.5319***	0.8769***	1.1041***
	(0.69)	(6.12)	(2.59)	(3.11)	(3.81)	(6.00)
NPL Ratio	0.1728***	0.0732**	0.1233***	-0.0638	-0.0096	0.0065
	(2.78)	(2.31)	(3.58)	(-1.23)	(-0.32)	(0.15)
ROA	-0.6006**	-0.3183**	-0.2158*	-0.2349*	-0.2653***	-0.3484***
	(-2.10)	(-2.33)	(-1.85)	(-1.86)	(-3.24)	(-2.76)
Securitization Ratio	-0.0013	-0.0030	-0.0005	-0.0328***	-0.0200***	-0.0127***
	(-0.25)	(-0.70)	(-0.22)	(-8.06)	(-4.07)	(-4.08)
Credit Rating	-0.1693***	-0.0021	-0.1499***	0.0804***	-0.0528**	-0.0300*
	(-4.11)	(-0.07)	(-6.51)	(3.25)	(-2.37)	(-1.70)
Obs.	1,992	1,992	1,810	1,826	1,835	1,754
R-Sq	0.489	0.669	0.770	0.792	0.675	0.771
Yearquarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Table A6: Cost of Capital OLS Regressions - BHCs with $50B or more in Assets

This table reports OLS regression results showing the effects of the book equity capital ratio on the cost of capital, where the analysis is restricted for large BHCs with assets equal to or greater than $50 billions. The dependent variable is the cost of capital. For each bank, the cost of capital is measured as the market equity weighted average of the after-tax cost of debt and the cost of equity, which calculated in five different methods plus their average. The sample in this table cover the time-period between 1986 and 2014. All variables are as define in Table 1. Independent variables are lagged by one period, and standard errors are double clustered at the quarter and BHC levels. T-stats are reported under the coefficients in parenthesis. * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$.

	CAPM	FF3	GLS	CT	DGM	AVG
	(1)	(2)	(3)	(4)	(5)	(6)
BE/TA	0.0532***	0.0439*	0.0402***	0.0182**	0.0722**	0.0225*
	(2.91)	(1.81)	(2.86)	(2.07)	(2.26)	(1.83)
Log of Total Assets	-0.8030***	-0.7920***	-0.0489	-0.4795***	-0.7453***	-0.4803***
	(-10.00)	(-7.91)	(-1.09)	(-10.40)	(-3.56)	(-8.77)
Log of B/M	0.0343	0.1313*	-0.0001	0.0073	-0.1484	0.0504*
	(0.67)	(1.93)	(-0.00)	(0.23)	(-1.23)	(1.73)
Loan HHI	-0.9525***	-0.6203	0.0511	1.1598***	0.7764	0.0796
	(-2.94)	(-1.30)	(0.44)	(4.67)	(0.95)	(0.31)
Competition HHI	0.9278***	1.0554***	0.2092**	0.8290***	0.7076*	0.7111***
	(4.58)	(4.04)	(2.29)	(6.84)	(1.79)	(5.33)
NPL Ratio	0.0544***	0.0826***	0.0120	-0.0366*	-0.0416	-0.0404**
	(2.69)	(2.91)	(0.42)	(-1.82)	(-0.89)	(-2.56)
ROA	-0.1671**	-0.0816	-0.0205	0.0815	-0.0802	-0.1280**
	(-2.04)	(-0.78)	(-0.28)	(1.01)	(-0.80)	(-2.19)
Securitization Ratio	-0.0110***	-0.0060	0.0020	0.0069***	0.0086**	-0.0026
	(-3.73)	(-1.62)	(0.95)	(4.53)	(2.61)	(-1.59)
Credit Rating	-0.1004***	-0.1057***	-0.1037***	-0.0691***	-0.0857*	-0.1222***
	(-5.09)	(-4.64)	(-4.72)	(-5.95)	(-2.02)	(-9.00)
Obs.	1,591	1,588	1,269	1,293	1,295	1,219
R-Sq	0.833	0.822	0.938	0.896	0.795	0.923
Yearquarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Table A7: Cost of Capital OLS Regressions - 2 Period Lags

This table reports OLS regression results showing the effects of book equity capital ratio on the cost of capital. The dependent variable is the cost of capital. For each bank, the cost of capital is measured as the market equity weighted average of the after-tax cost of debt and the cost of equity, which calculated in five different methods plus their average. The sample in this table cover the time-period between 1986 and 2014. All variables are as define in Table 1. Independent variables are lagged by two periods, and standard errors are double clustered at the quarter and BHC levels. T-stats are reported under the coefficients in parenthesis. * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$.

	CAPM	FF3	GLS	CT	DGM	AVG
	(1)	(2)	(3)	(4)	(5)	(6)
BE/TA	0.0901***	0.0677***	0.0374***	0.0724***	0.0379**	0.0332***
	(3.62)	(4.14)	(3.71)	(6.20)	(2.57)	(3.03)
Log of Total Assets	0.1203**	-0.7339***	-0.0538***	-0.2938***	-0.6706***	-0.5196***
	(2.50)	(-7.94)	(-2.82)	(-5.67)	(-9.85)	(-8.57)
Log of B/M	-0.5672***	-0.1868***	-0.2207***	-0.4136***	-0.2971***	-0.1898***
	(-2.72)	(-2.83)	(-3.27)	(-7.22)	(-4.57)	(-4.54)
Loan HHI	1.0262*	1.4284***	0.2663**	0.4331*	1.5978***	1.5935***
	(1.89)	(4.92)	(2.06)	(1.88)	(4.70)	(5.65)
Competition HHI	0.2226	0.3404	0.1649**	0.2642***	0.7084***	0.5274***
	(1.65)	(1.64)	(2.29)	(2.77)	(4.16)	(2.79)
NPL Ratio	0.1489***	0.1143***	0.1061***	-0.1368***	-0.0442*	0.0086
	(4.29)	(5.07)	(3.12)	(-3.88)	(-1.70)	(0.57)
ROA	-0.2132	-0.1818***	-0.0623	-0.1991***	-0.0757	-0.1947***
	(-1.13)	(-2.86)	(-1.26)	(-4.27)	(-1.28)	(-5.72)
Securitization Ratio	-0.0056	-0.0116***	-0.0012	-0.0156***	-0.0020	-0.0061***
	(-1.24)	(-5.20)	(-0.59)	(-5.68)	(-0.50)	(-3.63)
Credit Rating	-0.1249***	-0.1142***	-0.1082***	-0.0349**	-0.0609***	-0.0848***
	(-5.06)	(-6.88)	(-8.58)	(-2.25)	(-4.01)	(-7.34)
Obs.	6,289	6,289	4,946	5,339	5,356	4,702
R-Sq	0.577	0.649	0.851	0.828	0.756	0.814
Yearquarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes