Is Bank Capital Regulation Costly for Firms? - Evidence from Syndicated Loans

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Abstract

This paper estimates the impact of bank capital regulation on lending spreads. We use firm-level data on large syndicated loans matched with Bank Holding Company (BHC) data for the lending banks in our panel regressions. We find that higher bank capital leads to an increase in the loan pricing. Further, we investigate if stress test failure under the Supervisory Capital Assessment Program and Comprehensive Capital Analysis and Review leads to higher loan spreads, since financial institutions that failed were required to raise capital in the short run. Using difference-in-difference framework, we find: 1) BHCs that failed the stress tests increased their loan pricing; 2) Loan pricing is higher for all banks after the commencement of the stress tests. These findings suggest that greater regulatory oversight and higher capital requirements have made syndicated loans more costly for firms.

Keywords: Bank capital; Lending; Capital Requirements; Syndicated Loans; SCAP; CCAR
JEL Codes: E44, G01, G28, G38

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1 Introduction

The 2008 financial crisis has brought to the forefront the linkage between the capital position of the banking sector and the real economy. The primary role of banks is to intermediate funds between borrowers and savers. During an economic downturn, this channel of credit intermediation might be adversely affected by weaker credit demand, by concerns about the credit-worthiness of borrowers, or by lower credit supply due to an insufficient amount of capital and liquidity in the banking sector. Much of the post-crisis policy debate has focused on the credit supply channel. National regulatory authorities and the Basel Committee on Banking Supervision have responded to the financial crisis by requiring financial institutions to improve risk management, increase transparency, and hold additional capital and liquidity. These regulations have been enshrined under Basel III. Additionally, the Dodd-Frank Act was signed into U.S. federal law in July, 2010.

This paper aims to investigate the impact of increased capital requirements on the lending spread of U.S. Bank Holding Companies (BHCs). We use syndicated loans, which are loans made by a group of banks to a firm, as our laboratory of study. Syndicated loans have increasingly become an important source of finance for firms. The Shared National Credit program, which tracks syndicated credit of more than $20 million and shared by three or more federally supervised institutions, reported a total outstanding credit of $1.34 trillion for U.S. banks including credits to financial firms. Ivashina and Scharfstein (2010) use the H.8 statistics to estimate that syndicate loans are 26 percent of total Commercial and Industrial loans in the United States.

In contrast to most of the literature, we focus on loan pricing and not on volume. The main identification challenge arises from the endogeneity between credit demand and credit supply. For example, the new regulatory environment coincides with the post financial crisis period when credit demand was low and credit supply tight due to bank balance sheet constraints and low credit worthiness of borrowers. The majority of the literature on this topic utilizes bank level data alone and thus are able to observe only the equilibrium credit supply and demand. We match borrowing firm characteristics for each syndicated loan given out by the BHC to its balance sheet characteristics. This allows us to interpret our results conditional on firm characteristics and a positive demand for loans. Additionally, we use macroeconomic variables

to control for demand conditions.

We start by documenting the evolution of syndicated loan volume and pricing. We present evidence that there was a sharp drop in syndicated loan volume and a corresponding increase in pricing in the aftermath of the crisis. While volume has recovered to pre-crisis levels, loan pricing has remained persistently high. Next, using our matched firm-bank dataset, we show that higher regulated capital ratios contribute to an increase in loan pricing. We find a 1 percentage point increase in the regulated capital ratio to impact loan pricing by 15 to 20 basis points depending on the measure of the capital used. The results are robust to firm and bank fixed effects.

To further address endogeneity issues, we use stress test failure for BHCs under the Supervisory Capital Assessment Program (SCAP) and Comprehensive Capital Analysis and Review (CCAR) as an individual variation in lending rates that is independent of demand conditions for the cross-section of banks and a systematic difference in capital behavior. In fact, financial institutions that failed the stress tests were asked to raise additional capital in the short run or to resubmit their capital plans. To the best of our our knowledge, this is the first paper that exploits this variation. Using the difference-in-difference (DID) framework, we show that BHCs that failed the stress tests charged higher loan prices relative to BHCs that did not fail theirs.

Our analysis provides evidence on the economic cost of higher bank capital. From a policy standpoint this must be weighed against the benefits of making the banking sector safer. Higher capital reduces the probability of bank default and associated losses in economic output or the likelihood of a taxpayer funded bailout.

The remainder of the paper is structured is as follows. In Section 2, we briefly discuss the literature. Section 3 provides a short review of bank capital regulation in the United States. Section 4 describes the data and presents the summary statistics. Section 5 presents the econometric model and discusses the results. Section 6 presents robustness checks. Section 7 concludes.

2 Literature

The aftermath of the recent financial crisis has witnessed a wave of regulatory changes towards strengthening capital requirements. Thereby, an active debate on the costs and benefits of higher capital has ensued.

The Modigliani-Miller (MM, 1958) theorem is the basis of the debate on higher capital requirements. Per the MM hypothesis, the capital structure is irrelevant in a frictionless environment. This would imply that the intermediation capacity of a bank will not be constrained by equity. However, there are conditions under which the MM hypothesis breaks down and an increase in equity is perhaps costly. Aiyar, Calomiris and Wieladek (2014) list the conditions under which equity finance is costly and provide empirical evidence on the negative impact of higher capital requirements on bank lending. These cases include favorable tax treatment of debt, deposit insurance, and adverse selection costs of raising external equity.

The impact of capital requirements on bank lending has been an area of active research. Pre-Basel I implementation studies include those by Bernanke and Lown (1991) and Hancock and A. (1993). Bernanke and Lown analyze the impact of bank capital on lending during the 1990-1991 recession in the United States and find that a 1 percentage point increase in the capital to asset ratio contributed to a 2.6 percentage point increase in loan growth. Hancock and Wilcox analyze bank credit flows in 1990 using data on U.S. commercial banks with assets greater than 300 million dollars. They test the hypothesis that banks have an internal target ratio and credit growth depends on the divergence from this target. They find a reduction of about 1.4 dollars in bank credit for every dollar of capital target shortfall. Post 2008, a number of studies across different jurisdictions have estimated the impact of bank capital requirements on lending to firms. Francis and Osborne (2009) use the Hancock and Wilcox approach for U.K. banks during the period 1996-2007. They find stronger credit growth for banks which had surplus capital relative to target. They find that a 1 percentage point increase in capital requirements results in a 0.65 percentage point rise in the target capital ratio. The adjustment to the desired target takes four years and results in a 1.16 percentage point decrease in loan volume. Also for the United Kingdom, Bridges, Gregory, Nielsen, Pezzini, Radia and Spaltro (2014)study the impact of capital requirements on individual banks between 1990 and 2011. They find a 1 percentage point increase in capital requirements reduces loan growth to private non-financial corporations by 3.9 percentage points in the following year. Berrospide and Edge (2010) use data on U.S. Bank Holding Companies (BHCs) between 1992Q1 to 2009Q3 to analyze the impact of bank capital on lending. They find an increase of 0.7 - 1.2 percentage point in loan growth for a 1 percentage point increase in the capital ratio. Labonne and Lamé (2014) utilize data from French banks between 2003 and 2011 to study the sensitivity of capital ratios and

supervisory capital requirements on lending to non-financial corporations. They find that an increase of 1 percentage point in the Tier 1 capital to asset ratio corresponds to a 1 percentage increase in credit growth. Despite the richness of results provided by these studies, it is difficult to identify a causal relationship between capital and lending based on bank level regressions alone.

A number of contributors have focused on disentangling credit supply factors from credit demand. Carlson, Shan and Warusawitharana (2013) attempt to disentangle demand from supply by matching banks to a set of neighboring banks in the United States of similar size and holding a similar portfolio of assets and liabilities. They find a positive but small impact of higher capital ratios on loan growth between 2001 and 2011. They find that a 1 percentage point increase in the capital ratio corresponds to only 0.05-0.2 percentage point increase in loan growth. Their coefficient on the capital ratio is positive for the entire period but significant only during the period between 2008 and 2010. Becker and Ivashina (2014) use the choice of debt financing by non-financial firms as an identification strategy for credit demand. Using data on U.S. banks and firms between 1990 and 2010, they find a one standard deviation tightening of lending standards reduces the probability to receive a loan for a firm by 1.4 percentage points conditional on the firm's ability to raise external debt. Jimenez, Ongena, Peydro and Saurina (2012) match Commercial and Industrial loan applications with loans granted in Spain between 2002Q2 and 2008Q4 to analyze the impact of monetary and economic conditions on loan supply conditional on bank capital and liquidity. They find a negative impact on loan acceptance for weakly capitalized banks in response to 100 basis point increase in the policy interest rate.

The closest methodology to this project is the paper by Santos and Winton (2013). They construct a matched U.S. firm and bank dataset between 1987 and 2007 to test several theories of bank capital and lending. They find a small negative impact of bank capital on loan rates with a larger effect for borrowers who do not have access to the corporate bond markets. We depart from their analysis in three ways. First, we use regulatory capital ratios as defined by Basel regulations as opposed to a shareholder equity to asset ratio. Second, we use BHC data instead of Call Report data for bank characteristics. This is an important distinction as BHCs have higher capital requirements.[1] Third, our sample spans the post financial crisis regulatory environment.

[1]We will document key aspects covering capital regulations under the Basel guidelines in section 3.1.

In addition, a growing literature has used the Troubled Asset Relief Program (TARP) as an identification strategy to study bank behavior. Using Call report data on U.S. banks, Berger and Roman (2013) find that TARP recipient banks increased market shares and market power. Black and Hazelwood (2013) analyze data from the Survey of terms of bank lending from 2007 to 2010 and find that larger TARP recipient banks originated riskier loans. We use the SCAP and CCAR for further identification and not TARP.

3 U.S. Bank Capital Regulation

3.1 U.S. Bank Capital Regulation

In this section, we highlight the heightened regulatory oversight and capital requirements for U.S. BHCs. We begin by defining the capital measures under the Basel framework,

1. Tier 1 Capital (core capital) predominantly consists of voting eligible common stock, disclosed reserves, and after- tax retained earnings;

2. Tier 2 Capital (supplementary capital) is limited to 100% of Tier 1 and includes undisclosed reserves, revaluation reserves, general provisions and general loan-loss reserves, hybrid debt capital instruments, and subordinated term debt;

3. Leverage ratio is the ratio of Tier 1 capital or total regulatory capital (Tier 1 + Tier 2) to total exposures. The total exposure measure includes on-balance sheet exposures, derivative exposures, securities financing transaction exposures, and off-balance sheet items.

4. Risk Weighted Assets (RWA) are computed by weighting different asset classes and/or off-balance sheet exposures by a corresponding risk weight. For example, under Basel II, sovereign with a risk weighting AA- or higher had a 0% risk weight while similarly rated corporates had a risk weight of 20%

Basel I, implemented in 1992, required banks to hold a core capital ratio *(Tier 1 Capital-to-RWA)* of at least 4%, and a total capital ratio *((Tier 1 + Tier 2) Capital-to-RWA)* of at least 8%. The supplementary capital was also limited to 100% of core capital.

The second Basel accord, Basel II, was initially introduced in 2004 and should have become effective in 2008 for the largest BHCs.[2] Basel II redesigned the weighting scheme of RWA assets by allowing for more risk differentiation. In the United States a minimum 3% leverage ratio was also to be implemented. Due to the onset of the financial crisis, Basel II implementation was delayed or waived. BHCs with assets greater than $ 250 billion could use the internal ratings to calculate RWAs under the Basel guidelines[3]. This could have allowed large BHCs to have lower RWAs. However under U.S. regulation, the RWAs calculated under the IRB could not be below 85 % of those calculated using the standardized approach. In the aftermath of the financial crisis, regulatory authorities moved ahead with additional capital requirements with a longer phasing-in horizon. With Basel III banks have to hold a core capital ratio of at least 6%, and the common equity should be at least 4.5% of RWA. Total capital ratio is left unchanged and it still has to be at least 8%. Basel III introduced two new buffers:

1. Capital conservation buffer, which requires banks to hold an additional 2.5% of RWAs during calm times that they can draw down when losses are incurred. This is a mandatory requirement.

2. Countercyclical buffer, which requires banks to hold an additional 2.5% of RWAs if credit growth is resulting in an unacceptable build up of systematic risk as determined by national authorities.

Additionally, in response to the financial crisis, the Dodd-Franck Act was enacted, the implementation of which began in August 2010. It contains certain provisions that contribute to enhanced capital requirements. For example, phasing out of trust-preferred securities from Tier 1 capital. Dodd-Frank also requires U.S. banks to hold a counter-cyclical buffer. When fully implemented, advanced approaches BHCs would be required to meet a risk-based capital ratio of 13 percent. The implementation deadline for tier 1 and total risk-based capital ratios is 2016. The conservation buffer and the optional countercyclical buffer needs to be phased-in by 2019. In table 1, we document the increase in capital requirements for U.S. BHCs between the Basel I and II regimes and the current regulations.

[2]With at least $250 billion in consolidated assets or at least $10 billion on balance sheet foreign asset holdings.
[3]Internal Ratings Based Approach under the Basel regulation terminology.

Table 1: U.S. Capital Regulation

	(Before 2009)	(After 2009)	
		Minimum	Upper Bound
Common Equity Tier 1 to RWA	N.A.	7%*	9.5%**
Tier 1 to RWA (includes CET 1)	4%	8.5%*	10.5%**
(Tier 1 + Tier 2) to RWA	8%	10.5%*	13.0%**
Tier 1 to Assets	3%	4%	7%***

* including capital conservation buffer ** including countercyclical buffer

***Taking into account the supplementary leverage ratio

3.2 SCAP & CCAR

The SCAP program was initiated and carried out by the federal bank regulatory agencies between February and April of 2009. All domestic banking institutions with assets greater than $100 billion at year-end 2008 were required to participate. 19 institutions met this threshold guideline and these institutions collectively held two-thirds of the banking sector assets and more than half the loans.[4] SCAP was designed to estimate losses and capital requirements for 2009 and 2010 under adverse economic scenarios. Of the nineteen institutions, ten were found to have combined shortfall of $74.6 billion in capital. Table 2 lists the required amount of capital to be raised.

Building on the SCAP, in late 2010, the Federal Reserve initiated annual stress-testing (CCAR). The threshold for being subjected to the stress-test was lowered to $50 billion in consolidated assets. The key requirement under CCAR is for BHCs to submit a 24 month forward looking capital plan. The Federal Reserve has the right to qualitatively or quantitatively reject these plans. However, SCAP was the only instance where institutions were explicitly required to raise capital.

4 Data and Summary Statistics

We use multiple data sources for this analysis. The data on syndicated loans comes from Thompson Reuters SDC Platinum database. Quarterly BHC data is obtained from the FRY-9C filings. Firm level data is obtained using Compustat. Both these datasets are accessed via the Wharton Research Database Services (WRDS). The details on data series used is listed in Table A.1 in Appendix A. We use the leading index for the United States as our macroeconomic

[4] www.sigtarp.gov

Table 2: Capital required under SCAP

Institution	Required Capital ($ billion)
Bank of America	33.9
Wells Fargo	13.7
GMAC	11.5
CitiGroup	5.5
Regions	2.5
SunTrust	2.2
KeyCorp	1.8
Morgan Stanley	1.8
Fifth Third	1.1
PNC	0.6
American Express	0.0
BB&T	0.0
BNY Mellon	0.0
Capital One	0.0
Goldman Sachs	0.0
J.P. Morgan	0.0
State Street	0.0
U.S. Bancorp	0.0
MetLife	0.0

Source: www.sigtarp.gov

variable. The leading index is a composite index that includes nonfarm payroll employment, the unemployment rate, average hours worked and wages in manufacturing, housing permits (1-4 units), initial unemployment insurance claims, delivery times from the Institute for supply management manufacturing survey, and the interest rate spread between the 10-year Treasury bond and the 3-month Treasury bill. The data on stress test results is obtained from the website of the Board of Governors of the Federal Reserve System.

We begin our sample in 1996Q1 because this is the first time period for which BHCs report Tier 1 capital and RWAs. The syndicated loan sample encompasses the period between 1996Q1 and 2015Q4 for U.S. non-financial firms (excluding all U.S. borrowers with SIC codes between 6000-6999). The SDC platinum dataset provides loan information by total amount and tranche amount. We use loan tranche as the unit of analysis as different tranches of the same loan package might have different pricing and may or may not include covenants. The All in Drawn Spread (AID Spread) is the number of basis points over LIBOR including fees that a firm was charged for the loan tranche. To obtain borrower characteristics, we merge the firms that participated the syndicated loan market with corresponding firm level data from Compustat using the DealScan-Compustat link file on WRDS by Chava and Roberts (2008) and CUSIP. Loan tranche observations for which no pricing information is available are dropped from the sample. Finally, we manually match the lead bank in the lending facility to its corresponding BHC before merging with BHC data from WRDS. Lead bank identification follows Ivashina (2005). Observations with missing total bank assets are removed.

The final sample consists of 2825 firms matched to 45 BHCs. There are a total of 11215 unique loans with 15794 loan tranches. The mean number of tranches per syndicated loan is 1.8, 49.87 percent are loans with a single tranche and the maximum number of tranches is 18. Table 3 presents loan and borrower characteristics for the final sample. The mean tranche over the entire sample has an AID spread of 167 basis points. The cut-offs for the bottom and top 5 percentile of loan price are 30 and 375 basis points, respectively. The mean firm in the sample has return on assets equal to 0.64 percentage points, cash to asset ratio of 7.2 percentage points, and a long-term debt to asset ratio of 27.93 percentage points. In Figure 1, we present the distribution of firm size in our sample. The average tranche maturity is 4 years. The variation between the 5th and 95th percentiles of firm and loan characteristics indicate a reasonable degree of sample heterogeneity.

We begin our preliminary analysis by presenting the evolution of syndicated loan volume and the AID spread weighted by the tranche amount for the entire sample in Figure 1. We observe that the total volume of syndicated loans collapsed during the crisis but has since recovered to pre-crisis levels. The weighted average AID spread spiked during the financial crisis and has not returned to its pre-2008 level, the difference being approximately 100 basis points.

Table 3: Summary statistics for loan and firm characteristics

Variable	N	mean	sd	p5	p95
AID Spread	15794	167	115.84	30	375
Firm Assets (log)	15794	7.42	1.56	4.97	10.10
Firm Cash to Assets	15794	0.07	0.09	.001	0.27
Firm Return on Assets	15794	.006	0.04	-0.036	0.039
Firm Debt to Assets	15794	0.34	0.21	0.028	0.70
Loan Tranche Size (log)	15794	5.33	1.34	2.99	7.44
Maturity (years)	15794	3.09	9.93	0.997	6.95

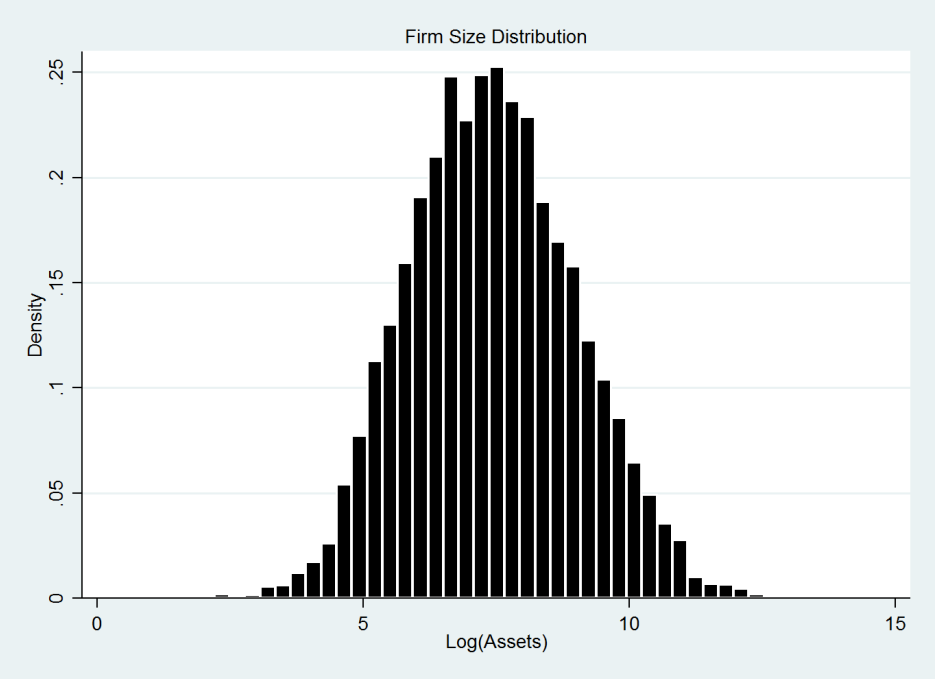

Figure 1: Firm Size Distribution

To better understand this increase in post-crisis spread, we explore underlying firm and loan characteristics that could potentially be a driving force. These could include firms switching to bond financing due to low interest rates, a shift towards riskier firms post crisis, and a fundamental change in tranche size and maturity.

We begin by comparing the AID spread of our syndicated loan sample with Bank of America Merrill Lynch's U.S. Corporate Option-Adjusted Spreads (OAS) for investment and non-investment grade firms pre and post crisis.[5]. If borrowing costs were significantly different in the syndicated loan and corporate bond markets, firms would have a strong incentive to switch between these financing options.The results presented in Table 4 show that there has been a post crisis increase in spread both in the syndicated loan and corporate bond markets. As we

[5]These are available at `https://research.stlouisfed.org/fred2/categories/32297`

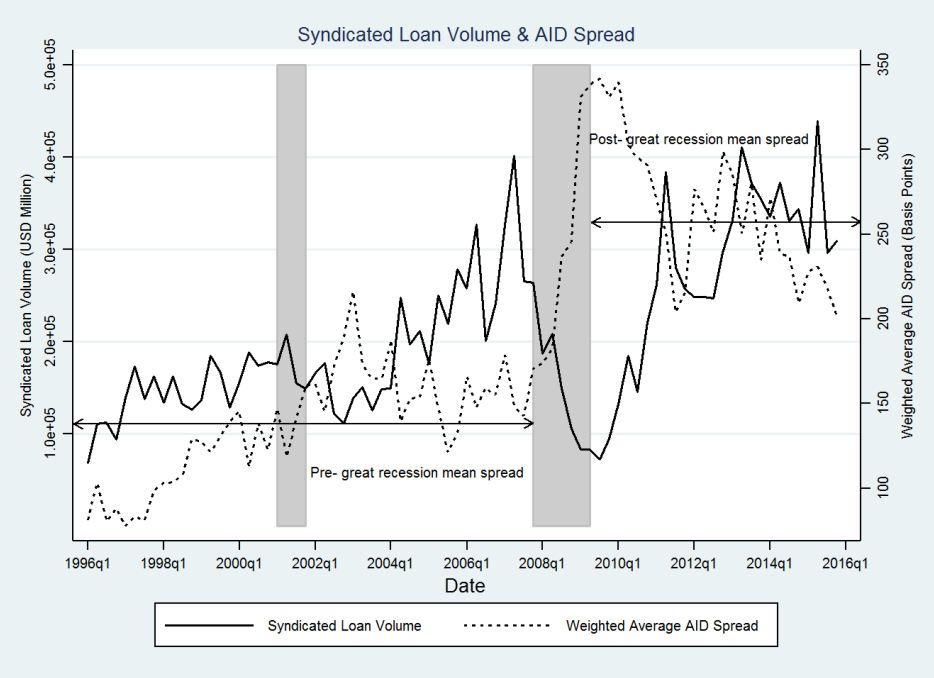

Figure 2: Quarterly evolution of syndicated loans and size-weighted AID spread

do not observe the same firms in the corporate bond option-adjusted spread data as in our sample and that the OAS spread is weighted by firm market capitalization, we refrain from discussing the observed differences in magnitude. The key takeaway is that there has been an increase in the cost of debt financing for firms post crisis. The difference in the mean spread pre and post crisis is statistically significant at the 1 percent level for both of them.

Table 4: Comparison of AID and Corporate Bond Spreads

	Up-to 2007Q4		2008Q1 to 2015Q4	
	Mean	S.D.	Mean	S.D.
AID Spread (Investment)	65.74	56.22	134.68	69.96
AID Spread (Non-investment)	190.19	103.91	271.29	133.77
Corporate Investment Grade Spread	121	44.57	215	118.28
Corporate Below Investment Grade Spread	508	215.39	679	335.23

The corporate bond spread sample starts in 1996Q4

Next, we present evidence for our sample firms' access to corporate bond markets. Figure 3 plots the fraction of firms every quarter in the final matched sample that have issued a bond at least once over the last five years. Overall, 48.67 percent of our firms have tapped the bond market over this time-span.

Next, we plot the evolution of the weighted average credit rating and the AID spread for our sample firms in Figure 4. A higher value of credit rating indicates lower firm quality. We observe the quality of firms in the sample to have fallen during the crisis and improved since. We find an increase in the weighted average AID spread of approximately 75 basis points. This

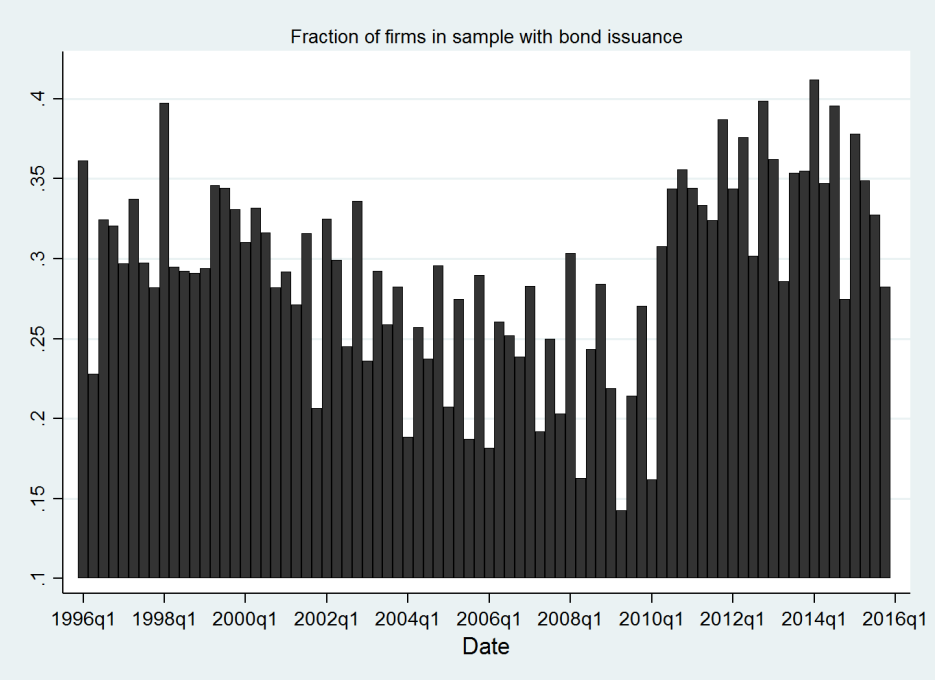

Figure 3: Fraction of bond issuing in-sample firms (Past 5 years)

is also the case for unrated firms as seen in Figure 5. We find a 4 percentage point increase in the total number of non-investment and unrated grade tranches after 2007Q4 as compared to before 2007Q4.

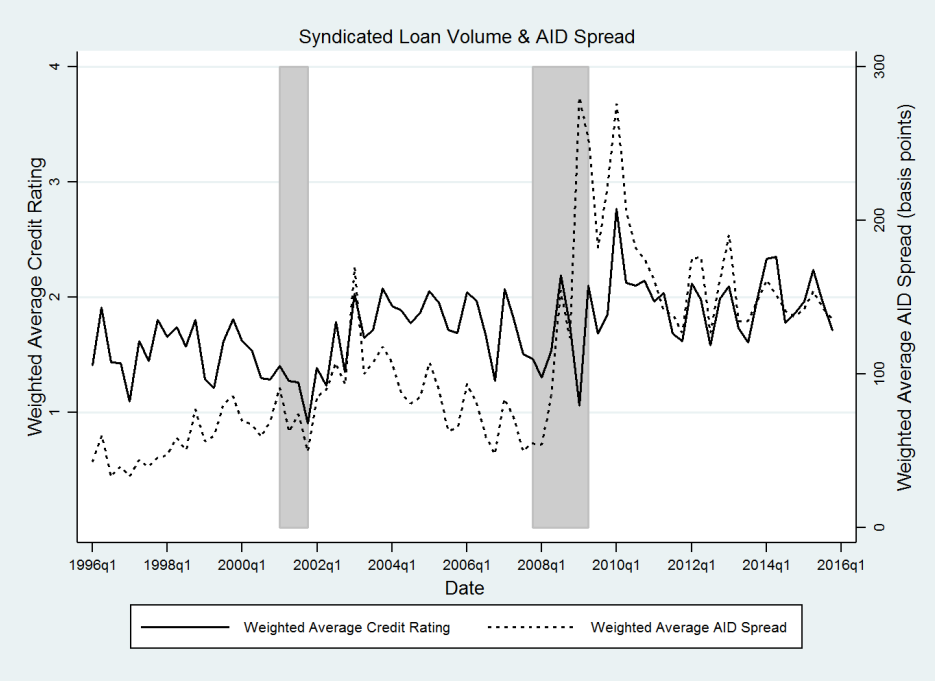

Figure 4: Weighted average credit rating and AID spread

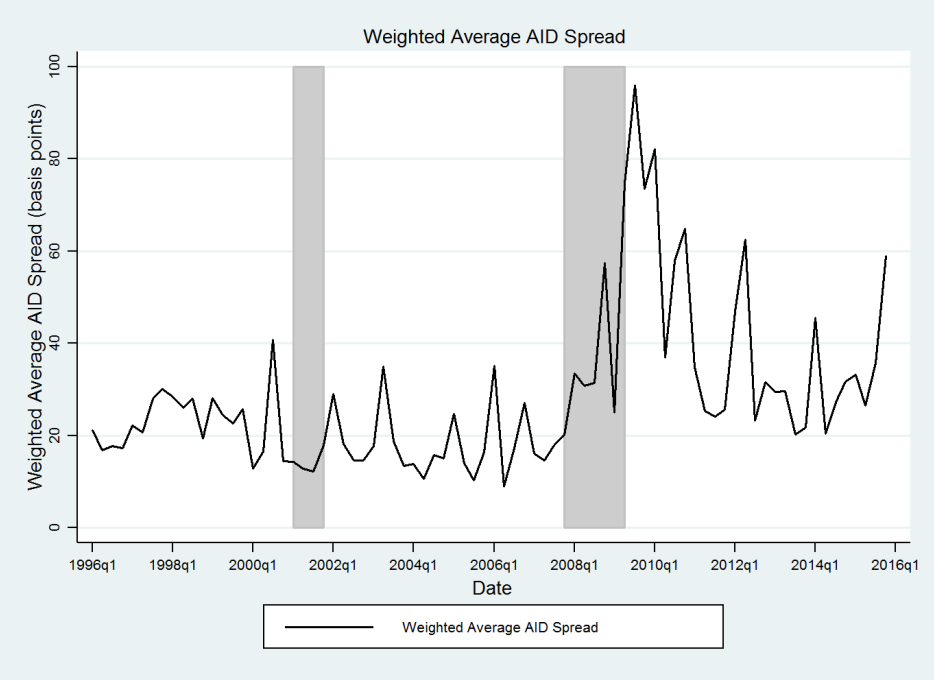

Figure 5: Weighted average AID spread - Unrated firms

We provided evidence on higher spreads for both investment and non-investment grade firms in Table 4. We take this analysis to a more granular level to convince ourselves that the observed increase in spread is not driven by a certain category of firms. We split our firms into 4 groups by Standard & Poor's (S&P) long-term credit ratings. Group 1 comprises of all firms rated A- and above; group 2 of firms with ratings below A- and down to BBB-; group 3 has ratings below BBB- and group 4 contains all firms that did not have a long term credit rating on Compustat. We summarize the pre and post crisis AID spread for these groups in Table 5. We find a statistically significant difference in the mean spread pre and post-crisis. We next analyze the loan characteristics as outlined in Table 6. The average tranche amount starting 2008 is USD 595.66 million, which is higher than the period prior. We also observe a slight increase in the mean maturity. Combining this with the evolution of firm quality presented earlier, we do not find any indications of a flight to quality in the syndicated loan market post crisis.

Table 5: Comparison of AID Spreads by rating category

	Up to 2007Q4		2008Q1 to 2015Q4	
	Mean	S.D.	Mean	S.D.
$\geq$ A-	39.16	39.12	95.49	60.32
$\geq$ BBB- & <A-	83.55	58.84	151.07	67.17
<BBB-	190.22	104.46	271.85	134.75
No Rating	145.67	90.75	221.46	119.16

Table 6: Tranche Amount and Maturity

	Up to 2007Q4			2008Q1 to 2015Q4		
	N	Mean	S.D.	N	Mean	S.D.
Tranche Amount (USD Million)	10,791	378.63	773.03	5792	609.26	1186.84
Maturity (Years)	10,079	3.95	1.92	5610	4.34	1.34

Next we analyze the evolution of our capital measures for the BHCs in our sample. All BHCs file Consolidated Financial Statements using the FR Y-9C. We consider three measures of the regulated capital ratio: Tier 1 capital to RWAs; total RBC to RWAs; Tier 1 capital to Assets. We observe a sharp increase in these ratios between the end of 2007 and the end of the sample as seen in Figure 6. The spike in the capital measures between 2008Q3 and 2008Q4 corresponds to the Capital Purchase Program (CPP) carried out by the U.S. Treasury at the height of the financial crisis in October 2008. As per this program, banks could sell preferred stocks between 1 and 3 percent of RWA and not more than USD 25 billion to the U.S. Treasury. At the same time, the Treasury received warrants to purchase common stock. The capital injection counted towards Tier 1 capital. However, the terms of the program included: a) cumulative dividends of 5 percent until five years of the investment and 9 percent after that; b) restrictions on dividends and on executive compensation. Banks had a strong incentive to build up their capital ratios and repay the equity injections. We present evidence on common stock issuance by the BHCs in our sample between 1996Q1 and 2013Q4 in Figure 7. We observe a sharp increase in stock issuance starting 2008Q4.

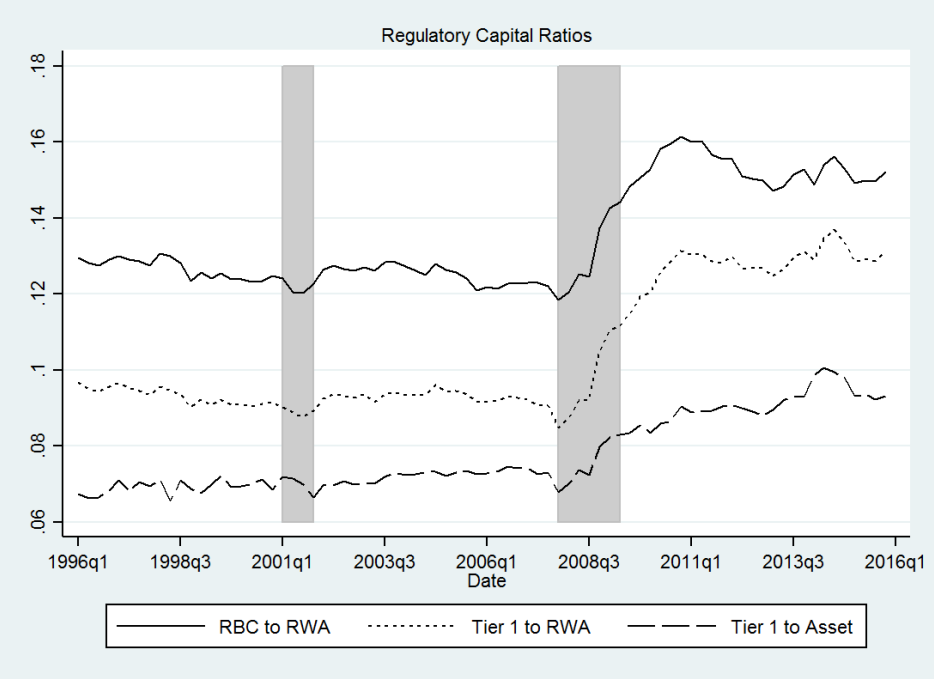

Figure 6: BHC capital ratios, 1996Q1 - 2013Q4

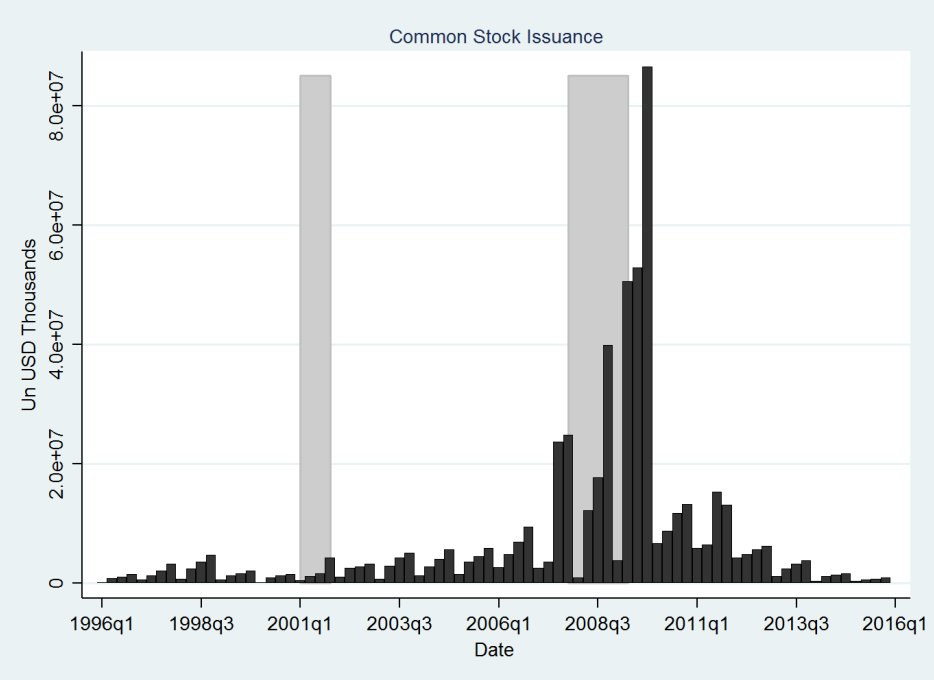

Figure 7: BHC Common Stock Issuance, 1996Q1 - 2013Q4

Another channel via which BHCs can adjust to higher risk based capital requirements is the denominator, i.e. RWAs. We observe the ratio of risk weighted assets to total assets to behave pro-cyclically for our sample BHCs as shown in Figure 8. During the sample period, it reached a peak of 84.7 percent in 2007Q2 and a trough of 66.3 percent in 2011Q2. We take this as evidence of re-balancing the asset portfolio toward safer assets. Hence, BHCs have responded to the higher capital requirements by adjusting both the numerator and denominator of the regulated capital ratios.

To summarize, we have provided aggregate evidence on higher syndicated loan pricing, common stock issuance, and an active management of BHC assets in the aftermath of the crisis. In the following section, we empirically evaluate the link between regulatory capital ratios and loan pricing.

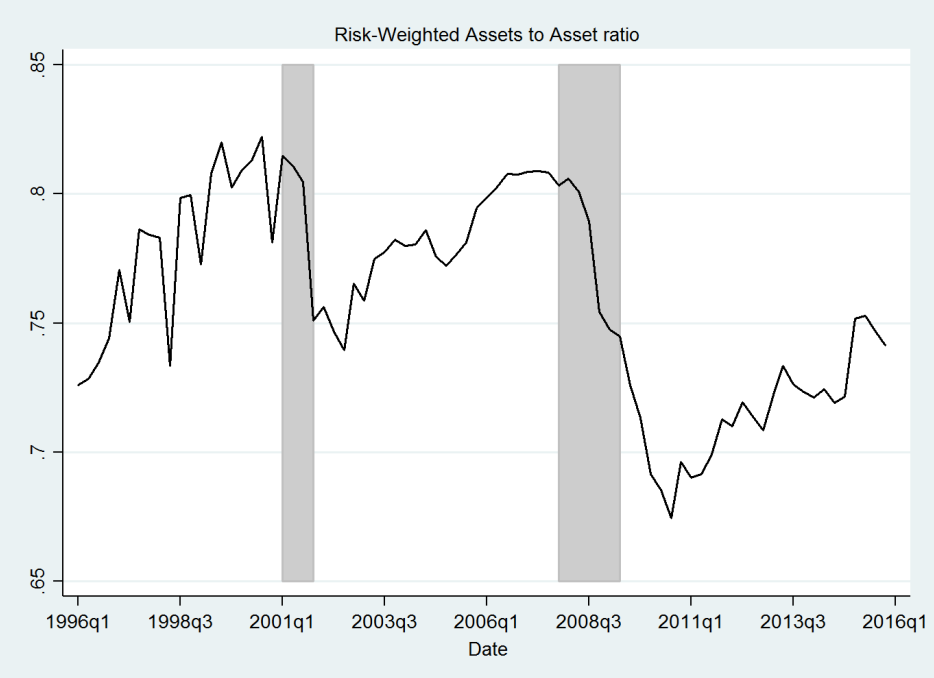

Figure 8: BHC RWA to Asset ratio, 1996Q1 - 2013Q4

5 Econometric Model and Results

5.1 Estimating the impact of regulatory capital ratios on loan pricing

To determine the impact of regulated bank capital ratios on syndicated loan pricing, we estimate the following equation,

$$\begin{aligned} AIDspread_{i,j,t} &= \beta_1 CA_{i,t-1} + \beta_2 Firm_{i,j,t-1} + \beta_3 Bank_{i,t-1} + \beta_5 Loan_{i,j,t} + \\ &\quad \beta_4 Macro_{t-1} + f_j + b_i + \sigma_{ijt} \end{aligned} \tag{1}$$

AIDspread is the loan price that firm,j, is charged for the loan tranche by BHC, i. *CA* is the regulatory capital ratio at time $t-1$. We use three different measures of the regulatory capital ratio: RBC to RWA; Tier 1 to RWA; and Tier 1 to assets. Firm and lead bank characteristics, all measured at time $t-1$ are included in the control variables. For BHC characteristics, we use measures of size, liquidity, profitability, loan portfolio losses, and funding costs.[6] *Size* is defined as the logarithm of total BHC assets. *Liquidity* is defined as the ratio of cash and balances due from depository institutions and federal funds sold and securities purchased under agreements to resell to total BHC assets. *PPNR* is the ratio of net interest and net non-interest income to total BHC assets. *Provisions* is defined as the allowance of loan and lease losses scaled by

[6]Our choice of BHC variables reflect the balance sheet variables used by the Fed in stress-testing.

total BHC assets. As a measure of *Charge-Offs*, we use the ratio of charge-offs on Commercial and Industrial loans to total BHC assets. As measures of funding costs, we use deposit expense (ratio of the sum of interest on time and other deposits to total liabilities) and funding expense (interest paid on trading liabilities, other borrowed money, subordinated notes and debentures scaled by total liabilities).

To control for firm characteristics, we use measures of size, liquidity, profitability, leverage, and credit rating. *Size* is the logarithm of total assets. *Liquidity* is the ratio of cash and short term investments to assets. *ROA* is the ratio of net income to assets. *Leverage* is the ratio of total debt to assets. We also control for the firm's credit risk using the Standard and Poor's domestic long-term issuer credit rating. Unrated firms are categorized separately.

Loan specific variables are measured at time t. We control for the size, maturity, and presence of covenants in every observation. *Loan Size* is the logarithm of the tranche amount. *Loan Maturity* is the logarithm of maturity of the loan tranche . *Covenant Indicator* is a dummy variable equal to 1 if there were covenants attached to the loan and 0 otherwise. We also control for the size of the syndicate and include dummies for each loan type. Tables A.3 in Appendix A lists the loan types. The final sample includes 27 types of loans. f_j denotes firm fixed effects; b_i, bank fixed effects; and σ_{ijt} is the error term. We use the leading index as control for macroeconomic conditions.[7] We also estimate the above equation using a set of macroeconomic variables, measured at $t-1$, that includes annual GDP growth, inflation, and an indicator of financial stress from the Cleveland Fed (CFSI). The CFSI is a composite index that takes into account stress in credit, equity, foreign-exchange, interbank, real estate, and securitization markets. Our results go through with the alternative macro-economic variables.

If higher bank capital results in higher loan pricing, we would expect to find β_1 in equation 1 to be significantly greater than zero. Table 7 reports the estimation results for our three different measures of the regulatory capital ratio. The estimates for a 1 percentage point increase in the regulatory capital ratio range from 5.1 to 7.37 basis points. The largest impact is observed for the Tier 1 leverage ratio. As outlined in section 3.1, for the BHCs in our sample, the minimum increase in total risk based capital requirements is 2.5 percent from 8 percent to 10.5 percent including the capital conservation buffer. Our results, assuming a linear cost of capital, indicate that this would lead to a 12.76 basis point increase in the AID spread. This represents a 7.6 percent increase relative to the sample average. The increase in Tier 1 capital ratio from a minimum 4 percent to 8.5 percent would lead to AID spreads increasing by 22.97 basis points. Finally, every percentage point increase in the Tier 1 leverage ratio would cause a 20.29 basis

[7]The leading index for each state predicts the six-month growth rate of the state's coincident index. In addition to the coincident index, the models include other variables that lead the economy: state-level housing permits (1 to 4 units), state initial unemployment insurance claims, delivery times from the Institute for Supply Management (ISM) manufacturing survey, and the interest rate spread between the 10-year Treasury bond and the 3-month Treasury bill.

point increase in the AID spread. The increase in loan spread could be higher if the additional requirements for countercyclical buffer and the too big to fail regulation are factored in.

Next we discuss the control variables reported in Table 7. Of the BHC variables, *provisions* and *charge-offs* come out as the strongest determinants of loan spreads quantitatively. This indicates that BHCs that have to write-down larger fractions of their loan portfolio or are expecting greater future losses demand a higher price for new loans. Larger BHCs charge a slightly higher spread. This result points towards a certain degree of monopolistic competition. Also interesting is the positive coefficient on the share of liquid assets on the BHC balance sheet. It indicates the opportunity cost of holding cash and cash-like instruments. While, one could expect a BHC with a higher share of revenue to assets to charge a lower spread, our coefficient on *PPNR* is positive. We interpret the positive coefficient to be reflective of the BHC's size, business model and macroeconomic expectations. *PPNR* is a measure of net interest margin and net non-interest income for BHCs. Banks incorporate their expectations of future losses in the interest rate charged on new loans and this raises the net interest margin in the short-run while losses appear after a few years(Borio, Gambacorta and Hofmann (2015)). Also, while a steeper yield curve should positively impact net interest income, it could lead to lower non-interest income. Finally larger BHCs have a larger share of non-interest income. We find a higher share of funding expenses to liabilities to be negatively correlated with the spread. This is because the gross interest paid on deposits and other sources of funding are positively correlated with macroeconomic conditions. Among firm controls, we find *size*, *profitability* and *leverage* to be statistically significant. Larger firms command lower spreads. A firm with higher leverage is riskier and is charged a higher spread. On the other hand, more profitable firms are offered a lower spread. For our loan characteristics, *loan size* and presence of *covenants* are significant. Loan covenants in principle increases lender protection and thus lead to a lower spread. *Loan size* is inversely related to the AID spread as consistent with earlier literature. Strahan (1999) finds evidence that banks use loan size and maturity in a complementary way to price of a loan, after adjusting for publicly available measures of borrower risk. Our measure of macroeconomic conditions is negatively correlated with loan spreads indicating a higher cost of borrowing during a downturn and vice-versa.

5.2 Regulatory pressure and loan pricing

In this section, we exploit stress testing by the Federal Reserve and subsequent failure as a shock to short-run BHC capital requirements and analyze the impact on the AID spread. We use a DID framework to ascertain any differences in the AID spread charged in the syndicated loan market by affected BHCs. We primarily focus on the SCAP as it explicitly imposed capital issuance on failing BHCs. As outlined in section 3.2, 10 out of the 19 institutions subjected to

SCAP were required to raise capital. We do extend our analysis to the subsequent stress-tests, namely CCAR. We use the following regression set-up to estimate the effects of being subjected to a stress test and failing it:

$$\begin{aligned} AIDspread_{i,j,t} &= \delta_1 SCAP_{i,t} + \delta_2 SCAP\ FAIL_{i,t} * Fail_{i,t} + \beta_2 Firm_{i,j,t-1} + \beta_3 Bank_{i,t-1} \\ &\quad + \beta_5 Loan_{i,j,t} + \beta_4 Macro_{t-1} + f_j + \sigma_{ijt} \end{aligned} \tag{2}$$

The firm, bank, loan and macroeconomic control variables are the same as in equation 1. *SCAP* is a dummy that is equal to 1 starting 2009Q2.[8] Sample BHCs that were stress-tested under SCAP have been subject to future stress-tests as well. The coefficient δ_1, therefore, captures the impact of being subjected to stress-testing on the AID spread. A positive and significant coefficient would that a stress-tested BHC charges a higher spread vis-a-vis it's peers.[9] *SCAP FAIL* is a dummy that is equal to 1 only for a BHC that failed the stress test for the period 2009Q2-2010Q4. The coefficient δ_2 captures the effect of failing the SCAP given that a BHC was subjected to it. As before, we use firm fixed effects to control for time-invariant firm characteristics.

We report the results in Table 8. Our main variables of interest are the coefficients on *SCAP* and *SCAP FAIL*. We find both δ_1 and δ_2 to be greater than zero and statistically significant at the 1 percent level. The coefficient implies a higher spread of 31.52 to 41.03 basis points after the commencement of stress testing. Also, BHCs that failed the assessment charged 46.30 to 47.22 basis points higher compared to other BHCs between 2009Q2 and 2010Q4. Next we turn to our controls; our measures of capital as a function of risk-weighted assets are statistically significant but the tier 1 leverage ratio. This is primarily driven by the low between BHC variation in the Tier 1 to asset ratio at any given point in time. Other BHC, firm, loan and macroeconomics controls are qualitatively similar to the ones reported in Table 7. Combined with results reported in Table 7, we provide evidence that increased capital regulation and greater regulatory oversight have contributed to higher loan pricing in the syndicated loan market.

Next, we extend our analysis to incorporate the CCAR. We substitute the dummies *SCAP* and *SCAP FAIL* with *Regulatory Pressure* and *Regulatory Pressure Fail* respectively. *Regulatory Pressure* is a dummy variable equal to 1 as soon as a BHC started getting stress-tested till the end of our sample in 2015Q4. For example, in 2015, 31 BHCs were subjected to stress-tests. We list BHCs subjected to SCAP and CCAR in Table A.2 of Appendix A. *Regulatory Pressure Fail*

[8]SCAP was announced in February 2009 and the first details were released in April.

[9]Our results are qualitatively similar if we restrict the dummy to be one between 2009q2-2010q4, the period prior to the next stress-test.

is now a dummy variable equal to 1 for a BHC failing the stress-test for the duration till the next stress-testing exercise is conducted. For example, if a BHC was required to raise capital under SCAP 2009 but its capital plans were accepted under CCAR 2012, the dummy would be one for the period 2009Q2 to 2010Q4. The results for SCAP 2011 were not made public by the Federal Reserve and therefore we do not have any BHCs failing the test for 2011. We present the estimation results in Table 9. The coefficients on our DID terms are again positive and statistically significant. While the impact of being subjected to a stress-test is quantitative similar to only being subjected to SCAP, the effect of failure once we include CCAR results is much smaller. We attribute this difference to the fact that SCAP failure explicitly imposed capital raising requirements as opposed to failure under CCAR.

Finally, we try to rule out alternate explanations for a higher spread. To allay concerns that a change in firm characteristics as a driver of spreads, we have included a number of firm controls. Additionally, we exposited in section 4, no changes in the riskiness of firms in the sample as determined by credit ratings. Similarly, we include a a number of controls for BHC characteristics. As further evidence for our BHC controls being able to capture any balance sheet heterogeneity, we estimate equation 3 using a population averaged probit model.

$$Fail_{i,t} \quad = \quad \beta_0 + \beta_1 Bank_{i,t-1} + \beta_4 Macro_{t-1} + \sigma_{i,t} \tag{3}$$

Fail is a binary variable that takes a value equal to 1 for a BHC failing SCAP or CCAR in the quarter where the stress-test results are announced. The vector *Bank* comprises the lagged four quarter means of the same set of BHC control variables specified in equation 1. *Macro* is also the lagged four quarter mean of the leading index. Figure 9 plots the median predicted failure probability for the average bank after our estimation. Our BHC variables are good predictors of SCAP failure and thus absorbing BHC balance sheet effects that could influence the AID spread. Predicted probabilities before the financial crisis are less than 10 percent. Predicted failure probabilities under CCAR are lower since the maximum number of failures occurred happened under SCAP and the fact that we are estimating failure probability for the average BHC. We report the marginal effect for each co-variate in appendix A.4.

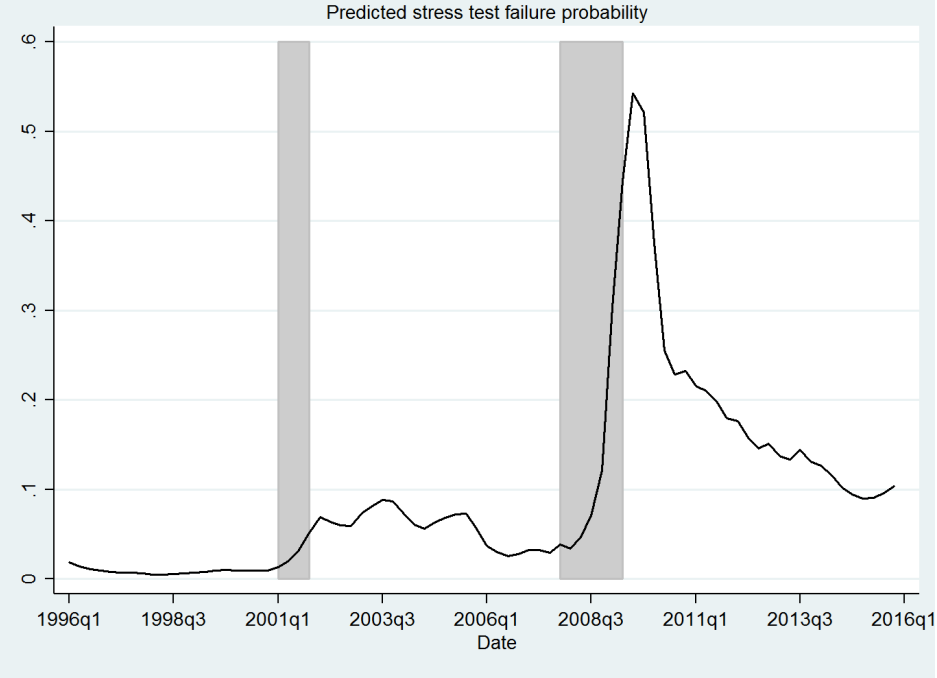

Figure 9: Predicted probability of stress-test failure

Table 7: Impact of Regulatory Capital Ratio on All In Drawn Spread

	Variable Group	(1) avgaids	(2) avgaids	(3) avgaids
RBC to RWA	BHC	5.102***		
		(5.51)		
Tier1 to RWA	BHC		5.104***	
			(5.21)	
Tier1 to Assets	BHC			7.369***
				(5.14)
Size	BHC	0.242***	0.246***	0.264***
		(6.49)	(6.60)	(7.63)
Liquidity	BHC	0.711***	0.558**	1.081***
		(2.98)	(2.26)	(4.47)
PPNR	BHC	11.29***	10.14***	8.896***
		(4.12)	(3.65)	(3.27)
Provisions	BHC	48.56***	52.56***	54.89***
		(7.90)	(8.96)	(9.41)
Loan Losses	BHC	75.46***	75.93***	72.94***
		(3.61)	(3.64)	(3.56)
Deposit Expense	BHC	-18.65***	-16.13**	-16.02**
		(-2.84)	(-2.42)	(-2.33)
Funding Expense	BHC	-23.56***	-23.30***	-21.66***
		(-5.19)	(-5.23)	(-4.63)
Size	Firm	-0.0916***	-0.0975***	-0.0945***
		(-4.41)	(-4.73)	(-4.90)
ROA	Firm	-1.908***	-1.908***	-1.911***
		(-4.65)	(-4.63)	(-4.68)
Liquidity	Firm	0.0820	0.0772	0.0871
		(0.61)	(0.58)	(0.66)
Leverage	Firm	0.822***	0.815***	0.823***
		(9.17)	(9.13)	(9.07)
Loan Size	Loan	-0.0860***	-0.0861***	-0.0862***
		(-7.66)	(-7.66)	(-7.64)
Loan Maturity	Loan	0.0286	0.0297	0.0293
		(1.56)	(1.62)	(1.60)
Log(Syndicate Size)	Loan	0.0180	0.0156	0.0159
		(0.89)	(0.77)	(0.78)
Covenant indicator	Loan	-0.172***	-0.173***	-0.170***
		(-5.31)	(-5.38)	(-5.36)
Leading Index	Macroeconomic	-0.276***	-0.278***	-0.276***
		(-11.71)	(-11.96)	(-12.20)
Firm & Bank Fixed Effects		Yes	Yes	Yes
Adj. R^2		0.665	0.663	0.661
N		14333	14333	14336

$^{*}p < 0.1,^{**}\ p < 0.05,^{***}\ p < 0.01$ t statistics in parentheses

Table 8: Impact of Regulatory capital Ratio - DID approach SCAP Failure

Variable Group	(1) avgaids	(2) avgaids	(3) avgaids
SCAP	32.27***	31.52***	41.03***
	(5.36)	(4.87)	(6.78)
SCAP Fail	46.53***	47.22***	46.30***
	(5.75)	(5.94)	(5.72)
RBC to RWA	4.626***		
	(4.65)		
Tier 1 to RWA		4.270***	
		(3.81)	
Tier 1 to Asset			2.554
			(1.07)
Size	0.0149	0.0205	-0.00286
	(0.64)	(0.93)	(-0.14)
Liquidity	1.221***	1.160***	1.638***
	(6.15)	(5.64)	(8.29)
PPNR	6.271***	4.759**	4.567*
	(2.91)	(2.14)	(1.82)
Provisions	17.08***	20.78***	19.76***
	(3.80)	(4.55)	(4.01)
Charge-Offs	74.62***	75.92***	71.10***
	(3.77)	(3.81)	(3.53)
Deposit Expense	-29.17***	-27.03***	-30.07***
	(-4.24)	(-3.98)	(-4.66)
Funding Expense	-4.980	-4.409	-2.299
	(-0.70)	(-0.62)	(-0.29)
Size	-0.0873***	-0.0904***	-0.0797***
	(-4.34)	(-4.51)	(-3.89)
ROA	-2.032***	-2.031***	-2.047***
	(-4.73)	(-4.72)	(-4.79)
Liquidity	0.175	0.174	0.191
	(1.45)	(1.43)	(1.58)
Leverage	0.823***	0.821***	0.829***
	(8.83)	(8.80)	(8.91)
Loan Size	-0.0833***	-0.0830***	-0.0817***
	(-7.06)	(-7.03)	(-6.94)
Loan Maturity	0.0241	0.0254	0.0268
	(1.30)	(1.37)	(1.41)
Log(Syndicate Size)	0.0144	0.0120	0.0121
	(0.69)	(0.57)	(0.56)
Covenant Indicator	-0.217***	-0.217***	-0.216***
	(-7.39)	(-7.32)	(-7.15)
Leading Index	-0.273***	-0.272***	-0.277***
	(-11.21)	(-11.27)	(-10.89)
Firm Fixed Effects	Yes	Yes	Yes
Adj. R^2	0.661	0.660	0.658
N	14333	14333	14336

$^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$ t statistics in parentheses

Table 9: Impact of Regulatory capital ratio - DID approach incl. CCAR

Variable Group	(1) avgaids	(2) avgaids	(3) avgaids
Regulatory Pressure	32.10***	31.87***	41.94***
	(5.34)	(4.91)	(6.63)
Regulatory Pressure Fail	14.78**	14.81**	14.82**
	(2.51)	(2.53)	(2.56)
RBC to RWA	4.352***		
	(4.06)		
Tier 1 to RWA		3.892***	
		(3.25)	
Tier 1 to Assets			1.890
			(0.74)
Size	0.0163	0.0203	-0.00405
	(0.71)	(0.93)	(-0.21)
Liquidity	1.191***	1.147***	1.560***
	(6.07)	(5.60)	(7.73)
PPNR	6.628***	5.238**	5.192**
	(2.94)	(2.27)	(2.00)
Provisions	24.98***	28.53***	27.26***
	(4.58)	(5.32)	(4.80)
Charge-Offs	68.38***	69.44***	66.00***
	(3.22)	(3.24)	(3.04)
Deposit Expense	-30.21***	-28.32***	-31.15***
	(-4.39)	(-4.16)	(-4.82)
Funding Expense	-4.038	-3.454	-1.637
	(-0.58)	(-0.50)	(-0.21)
Log(Assets)	-0.109***	-0.113***	-0.105***
	(-5.07)	(-5.12)	(-4.71)
ROA	-2.117***	-2.125***	-2.137***
	(-5.04)	(-5.04)	(-5.08)
Liquidity	0.195	0.194	0.209
	(1.33)	(1.32)	(1.42)
Leverage	0.800***	0.797***	0.804***
	(8.77)	(8.73)	(8.80)
Loan Size	-0.0837***	-0.0833***	-0.0822***
	(-7.11)	(-7.08)	(-7.00)
Loan Maturity	0.0275	0.0288	0.0300
	(1.47)	(1.53)	(1.56)
Log(Syndicate Size)	0.0152	0.0130	0.0133
	(0.73)	(0.62)	(0.62)
Covenant Indicator	-0.227***	-0.227***	-0.226***
	(-7.63)	(-7.57)	(-7.46)
Leading Index	-0.297***	-0.297***	-0.301***
	(-11.62)	(-11.67)	(-11.25)
Firm Fixed Effects	Yes	Yes	Yes
Adj. R^2	0.657	0.657	0.655
N	14333	14333	14336

$^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$ t statistics in parentheses

6 Robustness Test

In this section we conduct a series of robustness tests.

6.1 Excluding crisis period

To test whether our results are solely being driven by the crisis period, we re-estimate our regression for sub-samples that exclude the periods 2008Q1-2009Q4 or 2008Q1-2010Q4. We present the results in Table 10. The estimates for a 1 percentage point increase in the regulatory capital ratio now range from 4.78 to 7.23 basis points, which is quantitative similar to our estimates over the entire sample and significant at the 1 percent level. There is no qualitative change in our control variables.

6.2 Did firm quality drive our findings?

Even though the firms in our sample are in Compustat[10] and we control for the credit rating, our results may be driven by non-investment grade firms (defined as firms with a credit rating lower than BBB-). To address this concern we estimate our model for the sub-samples of investment and non-investment grade firms. Firms rated above BBB- are classified as investment grade. W include un-rated firms in the non-investment grade sub-sample. Columns 1 to 6 of Table 11 present the results for non-investment and investment grade firms, respectively. The effects are significant for both sub-samples.

6.3 Pro-rata loan Allocation

In our main results, we match every loan to a lead bank. However, this might lead to a bias in our findings depending on the capitalization of the lead bank. Therefore we re-estimate equation 1 after allocating equal amounts of the syndicated loan to all Tier1 Agents.[11] We find qualitatively similar to our main estimation and statistically significant at the 1% level. The results are reported in Table 12.

6.4 Placebo Tests

Following Berger and Roman (2013), we conduct a placebo test to mitigate concerns that unobserved effects might be driving the results of our DID approach. We assume that the stress tests conducted by the Federal Reserve were carried out in the aftermath of the dot-com bubble. The dummy *Placebo* is now equal to one for the period 2001Q2-2006Q4. *Placebo Fail* is

[10]Data coverage includes all active and inactive firms that have traded on a U.S. stock exchange.
[11]We allocate up-to 10 tier1 agents. This comprises 99 percent of our matched sample.

the DID variable corresponding to *SCAP Fail* in equation (2). Results are reported in Table 13. The effect of being subjected to the fictional SCAP on the AID spread is negative and in some cases significant with different measures of the capital ratio as a control variable. The result implies that BHCs subjected to SCAP were actually charging a lower spread compared to their peers prior to the financial crisis. This provides further support for our claim of stress-testing being a source of regulatory pressure on BHCs with real costs. The coefficients on fake SCAP failure are all insignificantly different from zero.

6.5 Program Evaluation style DID estimator

We provide further evidence for BHCs charging a higher spread as a consequence of SCAP failure. The threshold for being subjected to SCAP was 2008 year-end assets of $100 billion. We restrict our sample to these BHCs and estimate the following DID specification:

$$\begin{aligned} AIDspread_{i,j,t} &= \delta_1 SCAP\ Fail_i + \delta_2 SCAP\ Fail_i * Post\ SCAP_t + \beta_2 Firm_{i,j,t-1} + \beta_3 Bank_{i,t-1} \\ &\quad + \beta_5 Loan_{i,j,t} + \beta_4 Time_t + f_j + \sigma_{ijt} \end{aligned} \tag{4}$$

SCAP Fail is a dummy variable equal to 1 if the BHC failed SCAP and required to raise capital. *Post SCAP* is a dummy equal to 1 for the period between SCAP and CCAR 2011, namely, 2009Q2-2010Q4. *SCAP Fail * Post SCAP* is the DID term of interest. We estimate equation4 with identical firm, loan and BHC variables as before and include a full set of time dummies. The results are presented in Table14. The positive coefficient on the DID term indicates that BHCs failing the SCAP charged a higher spread compared to their stress-tested peers between 2009Q2-2010Q4.

6.6 Loan growth estimation

The two main dimensions along which a contraction in credit supply can manifest itself are loan volume and loan pricing. We have shown thus far that an increase in regulated bank capital ratios affect loan spreads in the syndicated loan market. To test the importance of loan volume, we estimate the following loan growth regression based on Khwaja and Mian (2008) & Acharya, Eisert, Eufinger and Hirsch (2016).

$$\begin{aligned} Loan\ growth_{i,j,t} &= \beta_1 \Delta Capital_{i,t-1} + \beta_2 \Delta RWA_{i,t-1} + \beta_3 Bank_{i,t-1} \\ &\quad + Firm\ cluster * Quarter_{j,t} + Firm\ cluster * BHC_{j,i} + \sigma_{ijt} \end{aligned} \tag{5}$$

The starting point for this estimation is our matched dataset with pro-rata loan allocation

across tier 1 agents. While our dataset has a large number of firm-bank pairs, we do not have same pairs repeating every quarter. Therefore, following Acharya et al. (2016), we aggregate loans based on industry and credit ratings by each BHC every quarter. We calculate the three year median interest coverage ratio and assign ratings based on categories provided by Poor's (2006).[12] Thus our unit of observation is the firm cluster-BHC-quarter. *Loan growth* is the quarterly change in loan volume by BHC, i to firm-cluster,j. To control for demand over time and any common characteristics shared by firms in the cluster, we introduce firm-cluster times quarter fixed effects. To control for BHC heterogeneity and any relationships between firm-cluster and BHC, we interact firm-cluster and BHC fixed effects. Our regression also includes the same BHC controls as before. We present our results in Table 15. Consistent with the narrative of a contraction in credit supply, we find the coefficient on total risk-based capital growth and tier 1 capital growth to be negative.

[12]Only about half of our sample firms have a credit rating assigned in Compustat.

Table 10: Impact of Regulatory Capital Ratio - Excluding crisis period

		(1)	(2)	(3)	(4)	(5)	(6)
	Variable Group		Excluding 2008Q1-2009Q4			Excluding 2008Q1-2010Q4	
RBC to RWA	BHC	4.941***			5.579***		
		(5.16)			(5.31)		
Tier1 to RWA	BHC		4.777***			5.285***	
			(4.72)			(4.67)	
Tier1 to Assets	BHC			6.625***			7.226***
				(4.35)			(4.88)
Log(Assets)	BHC	0.248***	0.252***	0.269***	0.208***	0.212***	0.232***
		(6.34)	(6.43)	(7.40)	(5.92)	(6.01)	(7.38)
PPNR	BHC	9.653***	8.494***	7.611***	8.259***	6.885**	5.978**
		(3.41)	(2.95)	(2.70)	(3.14)	(2.52)	(2.20)
Liquidity	BHC	0.580**	0.466*	0.969***	0.599**	0.483*	1.040***
		(2.48)	(1.88)	(3.97)	(2.48)	(1.90)	(4.18)
Provisions		44.09***	48.38***	50.97***	30.95***	36.01***	39.27***
		(6.67)	(7.74)	(8.19)	(6.04)	(7.37)	(7.71)
Charge-Offs	BHC	84.02***	84.43***	79.60***	81.29***	81.76***	76.56***
		(3.72)	(3.74)	(3.59)	(4.25)	(4.27)	(4.00)
Deposit Expense	BHC	-16.80**	-14.50**	-14.49**	-16.05**	-13.42**	-13.45*
		(-2.46)	(-2.10)	(-2.01)	(-2.48)	(-2.03)	(-1.94)
Funding Expense	BHC	-24.46***	-24.11***	-23.04***	-24.12***	-23.73***	-22.61***
		(-4.78)	(-4.75)	(-4.29)	(-4.46)	(-4.41)	(-3.97)
Log (Assets)	Firm	-0.0902***	-0.0949***	-0.0918***	-0.0804***	-0.0854***	-0.0810***
		(-4.02)	(-4.27)	(-4.36)	(-3.79)	(-4.06)	(-4.18)
ROA	Firm	-2.155***	-2.156***	-2.161***	-2.435***	-2.434***	-2.431***
		(-4.76)	(-4.74)	(-4.79)	(-4.84)	(-4.82)	(-4.82)
Liquidity	Firm	0.136	0.134	0.146	0.0999	0.101	0.113
		(1.02)	(1.01)	(1.10)	(0.74)	(0.74)	(0.84)
Leverage	Firm	0.805***	0.799***	0.806***	0.796***	0.789***	0.799***
		(9.10)	(9.08)	(9.04)	(8.79)	(8.78)	(8.74)
Log (Tranche Amount)	Loan	-0.0881***	-0.0881***	-0.0881***	-0.0842***	-0.0842***	-0.0844***
		(-7.50)	(-7.50)	(-7.48)	(-7.14)	(-7.14)	(-7.13)
Log (Maturity)	Loan	0.0319*	0.0334*	0.0337*	0.0382**	0.0397**	0.0401**
		(1.80)	(1.89)	(1.90)	(2.15)	(2.26)	(2.26)
Log (Syndicate Size)	Loan	0.0168	0.0146	0.0142	0.00183	-0.000642	-0.00109
		(0.81)	(0.70)	(0.68)	(0.09)	(-0.03)	(-0.05)
Covenant Indicator	Loan	-0.180***	-0.180***	-0.176***	-0.173***	-0.173***	-0.169***
		(-5.41)	(-5.43)	(-5.37)	(-5.27)	(-5.29)	(-5.18)
Leading Index	Macroeconomic	-0.243***	-0.246***	-0.253***	-0.235***	-0.238***	-0.246***
		(-8.09)	(-7.99)	(-8.20)	(-7.37)	(-7.22)	(-7.50)
Firm & Bank Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2		0.662	0.660	0.658	0.663	0.663	0.661
N		13384	13384	13387	12858	12858	12861

$^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$ t statistics in parentheses

Table 11: Robustness Tests - Firm Quality

	(Investment Grade)			(Non-Investment Grade & Un-rated)		
	avgaids	avgaids	avgaids	avgaids	avgaids	avgaids
RBC to RWA	4.600***			5.274***		
	(3.50)			(4.95)		
Tier 1 to RWA		5.821***			5.193***	
		(4.03)			(4.70)	
Tier 1 to Assets			9.008***			7.016***
			(4.64)			(4.34)
BHC Size	0.220***	0.202***	0.238***	0.225***	0.233***	0.246***
	(4.68)	(4.25)	(5.43)	(4.94)	(5.12)	(5.69)
BHC Liquidity	0.567	0.448	0.856**	0.477*	0.298	0.909***
	(1.59)	(1.28)	(2.58)	(1.74)	(1.01)	(3.23)
BHC PPNR	10.51***	9.358***	7.275**	12.08***	10.92***	10.07***
	(3.22)	(2.96)	(2.33)	(3.64)	(3.22)	(2.99)
BHC Provisions	50.18***	51.48***	54.89***	49.46***	53.85***	56.20***
	(7.50)	(7.69)	(8.73)	(7.38)	(8.34)	(8.59)
BHC Charge-Offs	21.88	19.62	21.29	86.58***	87.46***	83.30***
	(0.93)	(0.84)	(0.92)	(3.87)	(3.93)	(3.82)
BHC Deposit Expense	-6.342	-3.086	-4.511	-22.22***	-19.72**	-19.48**
	(-0.84)	(-0.41)	(-0.60)	(-2.81)	(-2.47)	(-2.38)
BHC Funding Expense	-21.98***	-21.23***	-18.20***	-22.46***	-22.25***	-21.16***
	(-5.28)	(-5.30)	(-4.52)	(-3.72)	(-3.72)	(-3.31)
Firm Size	-0.0531	-0.0652*	-0.0659**	-0.0897***	-0.0955***	-0.0899***
	(-1.60)	(-1.97)	(-2.02)	(-3.33)	(-3.56)	(-3.47)
Firm ROA	-2.387***	-2.351***	-2.317***	-1.893***	-1.895***	-1.902***
	(-2.97)	(-2.96)	(-2.96)	(-3.95)	(-3.94)	(-4.00)
Firm Liquidity	0.0810	0.0883	0.120	-0.0559	-0.0662	-0.0628
	(0.51)	(0.56)	(0.79)	(-0.34)	(-0.40)	(-0.38)
Firm Leverage	0.392***	0.347***	0.364***	0.819***	0.814***	0.818***
	(3.12)	(2.77)	(2.75)	(7.58)	(7.56)	(7.53)
Log(Syndicate Size)	0.00303	0.00542	0.00897	0.0283	0.0249	0.0246
	(0.12)	(0.22)	(0.36)	(1.24)	(1.09)	(1.08)
Loan Size	-0.00870	-0.00950	-0.00825	-0.105***	-0.105***	-0.105***
	(-0.67)	(-0.74)	(-0.63)	(-6.99)	(-6.96)	(-6.93)
Loan Maturity	0.0378***	0.0385***	0.0377***	-0.00939	-0.00922	-0.00984
	(2.80)	(2.92)	(2.83)	(-0.32)	(-0.31)	(-0.33)
Covenant Indicator	0.0622**	0.0555**	0.0529**	-0.272***	-0.272***	-0.266***
	(2.54)	(2.35)	(2.23)	(-6.53)	(-6.56)	(-6.45)
Leading Index	-0.293***	-0.300***	-0.296***	-0.285***	-0.286***	-0.284***
	(-7.88)	(-8.20)	(-8.49)	(-10.97)	(-11.03)	(-10.97)
Firm & Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
N	3643	3643	3643	10690	10690	10693
Adj. R^2	0.670	0.673	0.673	0.626	0.627	0.625

$^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$ t statistics in parentheses, standard errors clustered by date

Table 12: Robustness Tests - Pro-rata loan allocation

	(1) avgaids	(2) avgaids	(3) avgaids
RBC to RWA	2.718***		
	(5.53)		
Tier 1 to RWA		3.677***	
		(6.72)	
Tier 1 to Assets			9.002***
			(9.71)
BHC Size	0.240***	0.250***	0.257***
	(8.30)	(8.42)	(9.81)
BHC Liquidity	0.480***	0.238	0.684***
	(3.10)	(1.45)	(4.71)
BHC PPNR	8.281***	7.860***	6.635***
	(5.51)	(5.12)	(4.56)
BHC Provisions	54.71***	55.32***	54.78***
	(10.71)	(11.44)	(11.78)
BHC Charge-Offs	36.86**	40.30***	33.32**
	(2.48)	(2.72)	(2.34)
BHC Deposit Expense	-23.83***	-21.65***	-19.80***
	(-6.39)	(-5.73)	(-5.02)
BHC Funding Expense	-15.68***	-16.13***	-13.69***
	(-4.77)	(-4.91)	(-4.29)
Firm Size	-0.0527***	-0.0681***	-0.0851***
	(-2.78)	(-3.53)	(-4.52)
Firm ROA	-2.806***	-2.801***	-2.785***
	(-7.28)	(-7.25)	(-7.23)
Firm Liquidity	0.425***	0.401***	0.380***
	(3.14)	(2.95)	(2.78)
Firm Leverage	0.672***	0.652***	0.643***
	(6.99)	(6.89)	(6.65)
Loan Size	-0.0585***	-0.0591***	-0.0600***
	(-5.12)	(-5.18)	(-5.28)
Loan Maturity	0.0369*	0.0368*	0.0367*
	(1.90)	(1.92)	(1.94)
Log(Syndicate Size)	-0.00521	-0.0145	-0.0257
	(-0.24)	(-0.67)	(-1.20)
Covenant Indicator	-0.105***	-0.105***	-0.115***
	(-3.33)	(-3.45)	(-4.06)
Leading Index	-0.241***	-0.244***	-0.247***
	(-9.97)	(-10.26)	(-11.33)
N	149416	149416	149475
Adj. R^2	0.739	0.741	0.742

$^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$ t statistics in parentheses

Table 13: Robustness Tests - Placebo test

	(1) Tier 1 to RWA	(2) Tier 1 to Asset	(3) RBC to RWA
Panel A: Based on lead bank matching			
Placebo	-0.0559	-0.0466	-0.0799*
	(-1.30)	(-1.08)	(-1.82)
Placebo Fail	-0.00148	-0.00780	0.0203
	(-0.02)	(-0.09)	(0.25)
N	14333	14333	14336
adj. R^2	0.653	0.652	0.648
Panel B: Based on pro-rata loan allocation			
Placebo	-0.184***	-0.174***	-0.181***
	(-4.89)	(-4.53)	(-4.88)
Placebo Fail	0.0165	0.00719	0.0197
	(0.34)	(0.14)	(0.39)
N	149416	149416	149475
Adj. R^2	0.725	0.726	0.724

$^{*}p < 0.1,^{**}\, p < 0.05,^{***}\, p < 0.01$ t statistics in parentheses, standard errors clustered by date

Table 14: Robustness Tests - Program evaluation DID estimator

	(1) Tier 1 to RWA	(2) Tier 1 to Asset	(3) RBC to RWA
SCAP Fail	0.159	-0.005	0.349
	(0.24)	(-0.01)	(0.46)
SCAP Fail*Post SCAP	5.966**	5.686**	5.726**
	(2.72)	(2.63)	(2.60)
N	117467	117467	117467
Adj. R^2	0.772	0.772	0.772

$^{*}p < 0.1,^{**}\, p < 0.05,^{***}\, p < 0.01$ t statistics in parentheses. clustered rssd

Table 15: Robustness Tests - Loan Growth

	(1) Loan Growth	(2) Loan Growth
Risk-based Capital Growth	-3.916*	
	(-1.77)	
Tier 1 Capital Growth		-4.110**
		(-2.35)
RWA Growth	2.866*	2.940**
	(2.03)	(2.04)
BHC Controls	Yes	Yes
Firm Cluster*Quarter FE	Yes	Yes
Firm Cluster* Bank FE	Yes	Yes
N	5522	5522
Adj. R^2	0.626	0.626

$^{*}p < 0.1$,** $p < 0.05$,*** $p < 0.01$, t statistics in parentheses, Errors clustered at the bank level

7 Conclusions

This paper shows that higher bank capital has a statistically significant impact on lending rates charged by BHCs. By matching syndicated loan information with firm data from Compustat and lending bank characteristics from the FR-Y9C reports for BHCs, we are able to condition loan pricing on demand. Since syndicated loans are large loans made by a group of lenders, our results in a way serve as a lower bound for the observed contraction in credit supply. We expect the effects to be larger for smaller, unlisted firms solely reliant on bank funding. We further find that heightened regulatory oversight and stress test failure leads to higher loan pricing.

Our results contribute to the recent policy debate on real economy effects of bank capital regulation and provide quantitative insights for macro-prudential policy design. Our paper focuses on the effects on lending spreads and credit provision, but higher bank capital requirements and regulatory oversight have other important effects. These reforms were introduced in response to the financial crisis with the goal of improving the banking sector's capacity to withstand shocks and strengthening supervision and they are likely to have made the financial system more stable and to have reduced the probability of another financial crisis. These are outcomes we do not analyze in this paper and whose quantitative assessment is left for future research.

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A Appendix

Table A.1: Variable Definitions

Variable	FR Y-9C/Compustat Data Item	Explanation
Bank Assets	BHCK2170	Total assets
Bank Liquidity	(BHCK0081 +	Cash and Balances due from depository institutions
	BHCK0395 +	Interest bearing balances in U.S. Offices
	BHCK0397 +	Interest bearing balances in foreign offices
	BHCKC225) / BHCK2170	Federal Funds sold and securities purchased under agreements to sell
Net Income	BHCK4340	Net Income
Loan Portfolio Losses	BHCK4645/BHCK2170	Charge-offs on Commercial and Industrial loans to U.S. addresses
Tier 1	BHCK8274	Tier 1 capital allowable under the risk-based capital guidelines
Tier 2	BHCK8275	Tier 2 capital allowable under the risk-based capital guidelines
Risk based capital	BHCK3792	Total qualifying capital allowable under the risk-based capital guidelines
RWA	BHCKA223	Risk-weighted assets (net of allowances and other deductions)
Firm Size	atq	Total Assets
Firm Liquidity	cheq/atq	Cash and Short-term Investments/Total Assets
Firm Profitability	niq/atq	Net Income(Loss)/Total Assets
Firm Leverage	dlttq/atq	Debt in Long-Term Liabilities/Total Assets
Credit rating	ltermcr	Standard and Poor's Long term Issuer Credit Rating

Table A.2: Sample BHCs subjected to SCAP and CCAR

SCAP 2009	CCAR 2012	CCAR 2013
BNY Mellon	BNY Mellon	BNY Mellon
Bank of America	Bank of America	Bank of America
CitiGroup	**CitiGroup**	CitiGroup
Fifth Third	Fifth Third	Fifth Third
Goldman Sachs	Goldman Sachs	**Goldman Sachs**
J.P. Morgan	J.P. Morgan	**J.P. Morgan**
KeyCorp	KeyCorp	KeyCorp
Morgan Stanley	Morgan Stanley	Morgan Stanley
PNC	PNC	PNC
State Street	State Street	State Street
SunTrust	**SunTrust**	SunTrust
US Bancorp	US Bancorp	US Bancorp
Wells Fargo	Wells Fargo	Wells Fargo
Banks that failed stress tests are in boldface		

Table A.3: Loan Types

Loan Types
364d Revolver
Acquisition Financing
Bridge Loan
Delayed Draw Term Loan
First-Lien Term Loan
Letter of Credit
Revolving Credit/Term Loan A
Revolving Credit/Term Loan
Revolving Credit Facility
Second-Lien term Loan
Synthetic Lease
Term Loan
Term Loan A
Term Loan B
Term Loan C
Term Loan D
Term Loan E
Third-Lien term Loan

Table A.4: Marginal effects of each co-variate on failure probability

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Liquidity	-0.313						
	(0.202)						
PPNR		-5.379					
		(8.220)					
Provisions			9.072				
			(6.305)				
Charge-Offs				127.9*			
				(76.71)			
Deposit Expense					31.04*		
					(17.91)		
Funding Expense						28.18	
						(18.84)	
Leading Index							-0.0838***
							(0.0234)
N	104	104	104	104	104	104	104

$^{*}p < 0.1,^{**}p < 0.05,^{***}p < 0.01$,Standard errors calculated using delta method in parentheses

B Appendix: Risk-based vs. non-risk-based capital measures

We mentioned in section 2 that our methodology is closest to Santos and Winton (2013), who estimate a similar equation using Call report data om stockholder equity over asset and find a small but negative effect of the capital ratio on lending spreads . We re-estimate equation 1 using total equity capital to asset ratio[13] as the capital measure and restricting our sample period to 2007Q2. We too find a small negative impact of capital on loan spreads up-to 2007Q2 as reported in column 1 of Table B.1. In column 2, we extend the sample to 2015Q4 and find a positive and statistically significant effect. Finally, for the sample between 2007Q3 and 2015Q4, we find a positive significant effect. On the other hand, our risk-based capital measure are positive and significant in all three subsamples. We interpret this result as suggesting that regulation on risk-weights contributed to higher lending spreads since its inception while higher capital has contributed since the increase in capital requirements. Our results, therefore, add a new dimension to Santon and Winston's findings from a policy perspective.

Table B.1: Impact of Non-Risk-Based Equity to Asset on AID Spread

	(1)	(2)	(3)
	Up-to 2007Q2	Up to 2015Q4	2007Q3 - 2015Q4
Non-risk-based equity to Assets	-3.86***	3.04***	4.96**
	(-2.74)	(2.78)	(2.65)
N	9355	15210	5855
Adj. R^2	0.647	0.660	0.680

$^{*}p < 0.1,^{**}p < 0.05,^{***}p < 0.01$ t statistics in parentheses

[13]Santos and Winton(2013) define their capital measure as shareholder equity to assets

C Appendix: Effect of Risk-Weighted Asset Density

We documented a decrease in the ratio of RWAs to asset during and after the financial crisis (Figure 8). A decrease in the RWA density implies that a BHC is holding more assets with a lower risk-weight. This asset portfolio choice can lead to an increase in cost of loans to firms if BHCs choose to pass on the cost of higher capital required against these loans vis-a-vis safer assets. Alternatively, if a lowering in the RWA density makes a BHC safer and lowers the overall borrowing cost, it can choose to charge lower rates on loans to firms. We test for the effect of RWA density by adding it as an explanatory variable in our baseline specification outlined in equation 1 along with the Tier1 to asset ratio as the main explanatory variable. The results tabulated in Table C.1. We find the effect of RWA density to be negative and significant. This indicates that banks with a lower RWA density charge a higher spread for lending to firms.

Table C.1: Effect of RWA density on AID Spread

	Variable Group	(1) AID Spread
Tier1 to Assets	BHC	8.631***
		(5.92)
RWA Density	BHC	-1.120***
		(-4.71)
Size	BHC	0.213***
		(5.83)
Liquidity	BHC	0.602**
		(2.30)
PPNR	BHC	9.794***
		(3.47)
Provisions	BHC	50.24***
		(8.51)
Loan Losses	BHC	70.72***
		(3.45)
Deposit Expense	BHC	-11.67*
		(-1.78)
Funding Expense	BHC	-24.87***
		(-5.70)
Size	Firm	-0.102***
		(-5.26)
ROA	firm	-1.904***
		(-4.64)
Liquidity	Firm	0.0676
		(0.51)
Leverage	Firm	0.819***
		(9.17)
Loan Size	Loan	-0.0855***
		(-7.56)
Loan Maturity	Loan	0.0295
		(1.60)
Log (Syndicate Size)	Loan	0.0117
		(0.57)
Covenant Indicator	Loan	-0.176***
		(-5.65)
Leading Index	Macroeconomic	-0.280***
		(-12.14)
Firm & Bank FE		Yes
N		14333
adj. R^2		0.670

$^{*}p < 0.1,^{**}p < 0.05,^{***}p < 0.01$ t statistics in parentheses