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

Luisa Lambertini† Abhik Mukherjee‡

EPFL University of Cape Town

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

*Luisa Lambertini gratefully acknowledges financial support from the Swiss National Science Foundation Grant CRSI11-133058. We are grateful to Rudiger Fahlenbrach and Dianne Pierret for useful comments and discussions. We are also thankful to Pinar Uysal, Alessandro Di Nola, George Hubner, Mike Mariathasan, Steven Ongena, and seminar participants at the DEEP Macro Workshop, ASSA 2017, RBNZ, AFM 2016, EEA 2016, BRFF 2016, YSEM 2016 for useful comments.

†École Polytechnique Fédérale de Lausanne, Chair of International Finance, Station 5, Odyssea ODY 2.05, CH-1015 Lausanne, Switzerland; E-mail: luisa.lambertini@epfl.ch.

‡University of Cape Town, African Institute of Financial Markets & Risk Management, Leslie Commerce 6.26, Rondebosch 7701, South Africa; E-mail: a.mukherjee@uct.ac.za

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 an 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 is 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 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 output losses; it also lowers the likelihood of a taxpayer funded bailout.

The remainder of the paper is structured is as follows. In Section 2 we discuss the related literature and how our paper contributes to it. 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 for testing the effects on loan pricing and discusses the results; section 6 presents robustness checks. Section 7 presents the econometric model for testing the effects on loan volume and discusses the results. Section 8 concludes.

2 Literature

The aftermath of the recent financial crisis has galvanized a wave of regulatory changes towards strengthening capital requirements. Consequently, 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 Wilcox (1993, 1994). 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. They test the hypothesis that banks have an internal capital target ratio and credit growth depends on how actual capital deviates from this target. They find a reduction of about 1.4 dollars in bank credit for every dollar of capital target shortfall and a reduction of 3 dollars in bank credit for every dollar of capital shortfall from the regulatory level.

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 4 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 that 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. 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 using U.S. data. Carlson, Shan and Warusawitharana (2013) attempt to disentangle demand from supply by matching U.S. banks to a set of neighboring banks 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 1 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. We focus primarily on lending spreads using loan-level data that allows us to control for credit demand using firm-level information and we use stress test failure as an identification strategy.

A rapidly growing literature studies the relationship between capital requirements and lending volume using European data. 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 a 100 basis point increase in the policy interest rate. Gropp, Mosk, Ongena and Wix (2016) use differences in capital requirements for European banks. The European Banking Authority used a country-specific selection rule for its 2011 capital exercise that caused banks with similar size to be included or excluded from stress testing and its related capital requirements solely depending on the country of operation of the

bank. They find that higher capital requirements were achieved mainly by reducing credit supply. De Jonghe, Dewachter and Ongena (2016) investigate the effect of time-varying and bank-specific capital requirements stemming from Pillar 2 of Basel II, which was briefly implemented in Belgium between 2011 and 2014. These authors find that higher capital requirements led banks to reduce their balance sheets and to contract the supply of credit. Célérier, Kick and Ongena (2016) analyze the impact of corporate tax reform in Italy and Belgium and find that banks in these countries raised capital and increased lending to German firms.

Two papers have looked at the effects of specific capital charges activated in Switzerland in 2012 against residential mortgages. Basten and Koch (2015) find that banks with lower capital ratios charged higher mortgage rates relative to capital-rich banks and issued fewer mortgages; Auer and Ongena (2016) estimate a shift away from mortgages toward other types of loans.

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 capital requirements apply at the BHC level.[1] Third, our sample spans the post financial crisis regulatory environment. In Appendix B we estimate our benchmark specification using their capital measure and find that the impact of capital on loan spread becomes positive when the sample is extended beyond 2007.

In addition, a growing literature has used the Troubled Asset Relief Program

[1]We will document key aspects covering capital regulations under the Basel guidelines in section 3.

(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 regulatory oversight and capital requirements for U.S. BHCs. We begin by defining the capital measures under the Basel framework:

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

Tier 2 Capital (supplementary capital) includes undisclosed reserves, revaluation reserves, general provisions and general loan-loss reserves, hybrid debt capital instruments, and subordinated term debt;

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;

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 bonds with a risk weighting AA- or higher had a 0 percent risk weight while similarly rated corporates had a risk weight of 20 percent.

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

The second Basel accord, Basel II, redesigned the weighting scheme of RWAs by allowing for more risk differentiation and became effective April 1, 2008[2] for the largest BHCs.[3] In the aftermath of the financial crisis, regulatory authorities moved ahead with additional capital requirements with a phasing-in horizon. With Basel III, banks have to hold a core capital ratio of at least 6 percent, and the common equity should be at least 4.5 percent of RWA. Total capital ratio is left unchanged and it still has to be at least 8 percent. Basel III introduced two new buffers:

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

Countercyclical Buffer, which requires banks to hold an additional 2.5 percent 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 countercyclical buffer. When fully implemented, large 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 was 2016. The conservation buffer and the optional countercyclical buffer need to be phased-in by 2019. In Table 1, we

[2]https://www.gpo.gov/fdsys/pkg/FR-2007-12-07/pdf/07-5729.pdf

[3]With at least $250 billion in consolidated assets or at least $10 billion on balance sheet foreign asset holdings

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

document the increase in capital requirements for U.S. BHCs before and after 2009.

3.2 SCAP and CCAR

The SCAP program was initiated and carried out by the U.S. federal bank regulatory agencies between February and April of 2009. All U.S. 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 19 institutions, 10 were found to have a 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 subject to stress tests 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.[5] If the Federal Reserve objects

[4] www.sigtarp.gov

[5] https://www.federalreserve.gov/bankinforeg/stress-tests/CCAR/201606-comprehensive-capital-analysis-review-capital-plan-assessment-framework-and-factors.htm

Table 2: Capital Increase Required under SCAP

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

Source: www.sigtarp.gov

to a BHC's planned capital actions, the BHC may be restricted from making capital distributions and be required to resubmit its capital plan.[6] 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 FR Y-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 are listed in Table A.1 in Appendix A. We use the leading index for the United States as our macroeconomic variable. The leading index by the Federal Reserve Bank of Philadelphia and retrieved from FRED, Federal Reserve Bank of St. Louis, 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

[6]https://www.federalreserve.gov/bankinforeg/stress-tests/CCAR/201606-comprehensive-capital-analysis-review-process-and-requirements-after-ccar-2016.htm

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 FR Y-9Cdata. Lead bank identification follows Ivashina (2005).

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 0.6 percentage points, cash to asset ratio of 7 percentage points, and a debt

to asset ratio of 34 percentage points. In Figure 1, we present the distribution of firm size in our sample. It llustrates the positive skew in firm size for our matched sample. The average tranche maturity is 3 years. The variation between the 5th and 95th percentiles of firm and loan characteristics demonstrates sample heterogeneity.

Table 3: Summary Statistics for Loan and Firm Characteristics

Variable	**N**	**Mean**	**S.D.**	**P5**	**P95**
AID Spread	15794	167.00	115.84	30.00	375.00
Firm Assets (USD Million)	15794	5748.05	14577.29	143.59	24378.01
Firm Cash to Assets	15794	0.07	0.09	0.00	0.27
Firm Return on Assets	15794	0.01	0.04	-0.04	0.04
Firm Debt to Assets	15794	0.34	0.21	0.03	0.70
Loan Tranche Size (USD Million)	15794	468.07	960.41	20.00	1700.00
Maturity (years)	15794	3.09	9.93	1.00	6.95

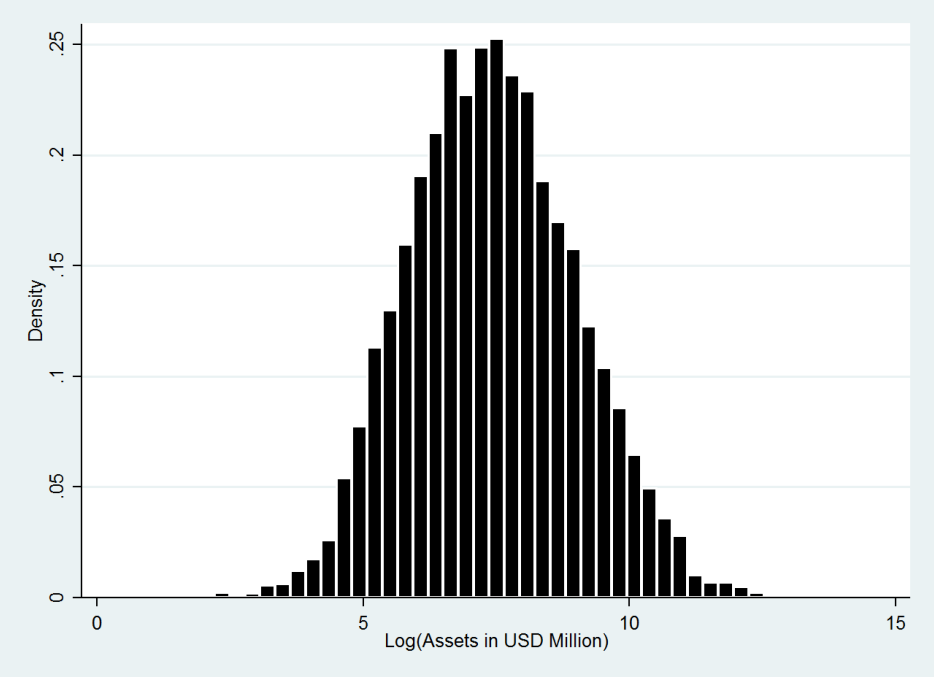

Figure 1: Firm Size Distribution

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 2. 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, with the difference being approximately 100 basis points. To better understand this increase in post-crisis spread, we explore underlying firm and loan characteristics that could potentially be a driving force.

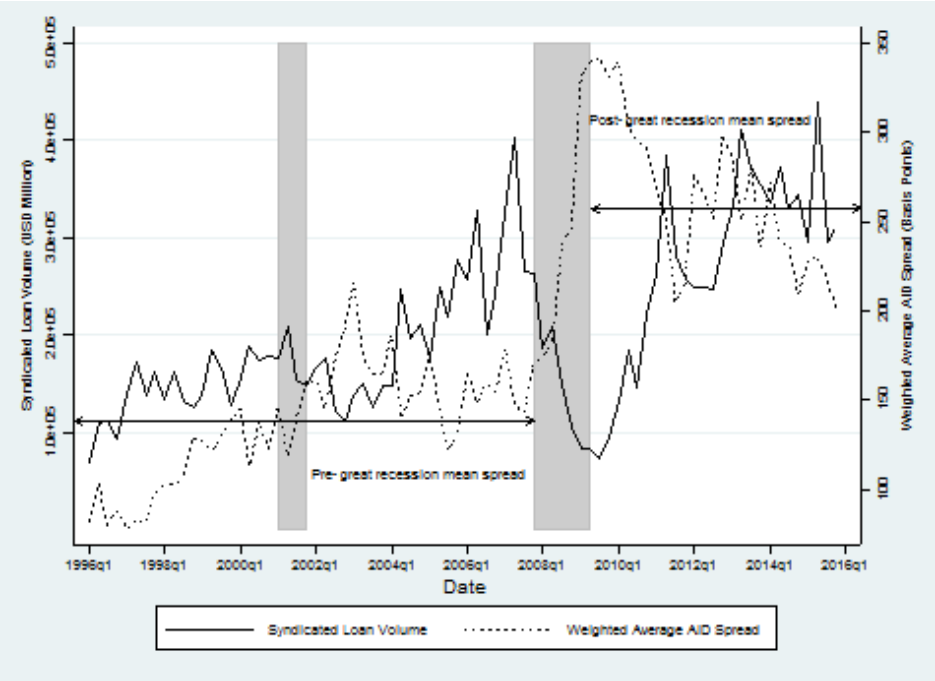

Figure 2: Quarterly Evolution of Syndicated Loans and Size-weighted AID Spread

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.[7] 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

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

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

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

Figure 3 plots, for every quarter, the fraction of firms in the final matched sample that issued a bond at least once in the previous 20 quarters. Overall, 49 percent of our firms tapped into the bond market over our sample period. The fraction of bond-issuing firms fell over the period 2000 to 2010 and it doubled in 2010Q2 when the AID Spread started climbing down from its peak. The increase in syndicated lending volume (see figure 3) and the reduction in the fraction of bond-issuing firms attests to the increased importance of the syndicated loan market before the crisis, as firms with and without previous access to the bond market tapped into this funding source. The sharp increase in the fraction of bond-issuing firms in 2010Q2 suggests that borrowing constraints were binding during the crisis; it may also have been driven by switching from bonds to syndicated loans in response to elevated post-crisis spreads in the corporate bond market. Together with low syndicated lending volume until 2012, it also indicates that firms without access to the bond market may have lost access to syndicated loans. Overall this evidence suggests that credit

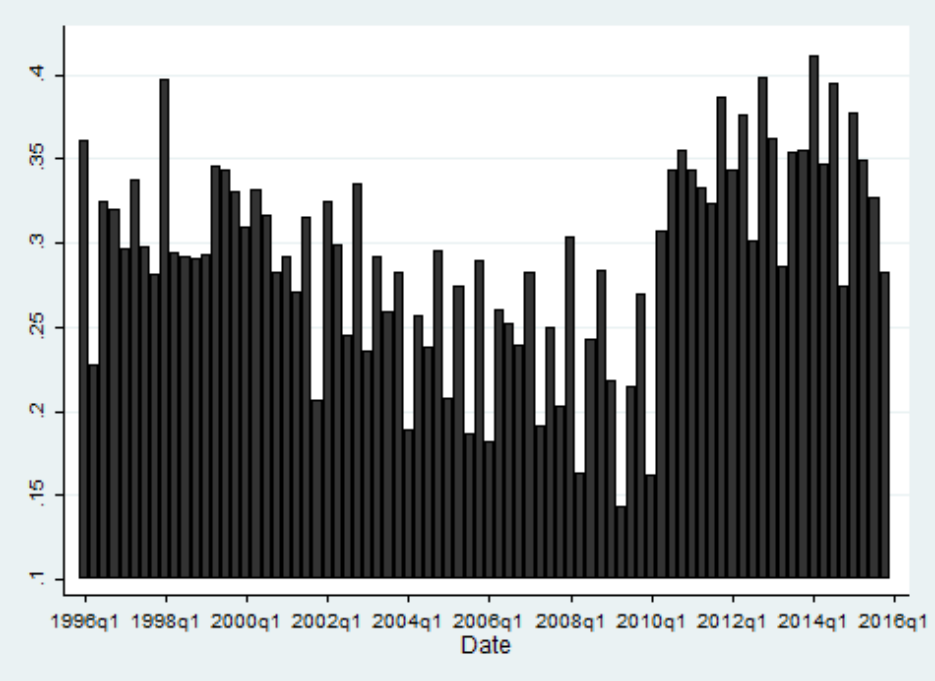

Figure 3: Fraction of Bond-issuing Firms (Previous 5 years)

conditions were tight during and after the financial crisis.

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 post-crisis. This 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.

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 by splitting our firms into 4 groups based on 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

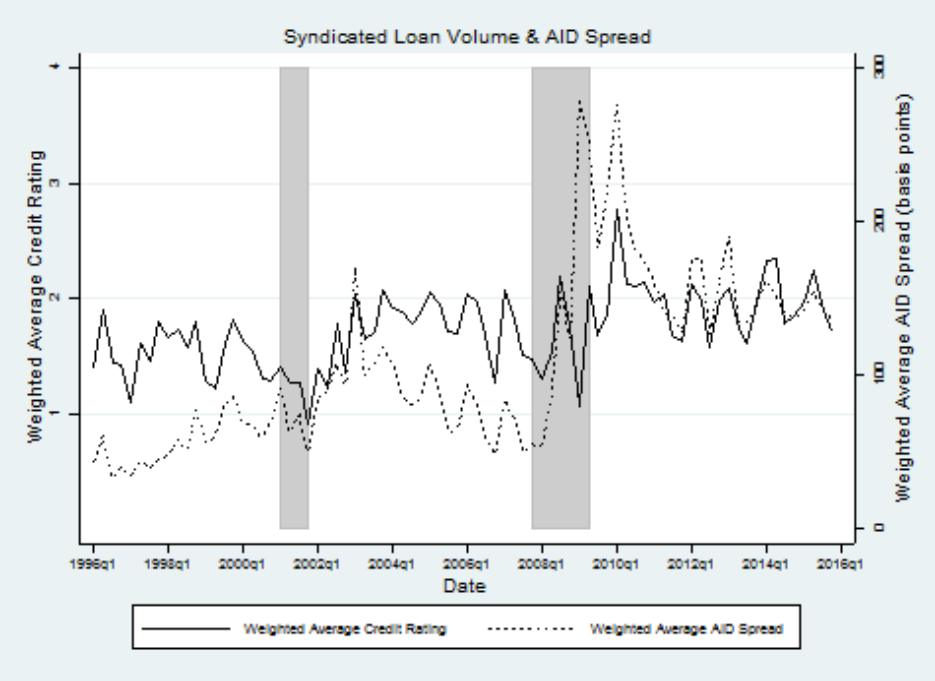

Figure 4: Weighted-average Credit Rating and AID Spread

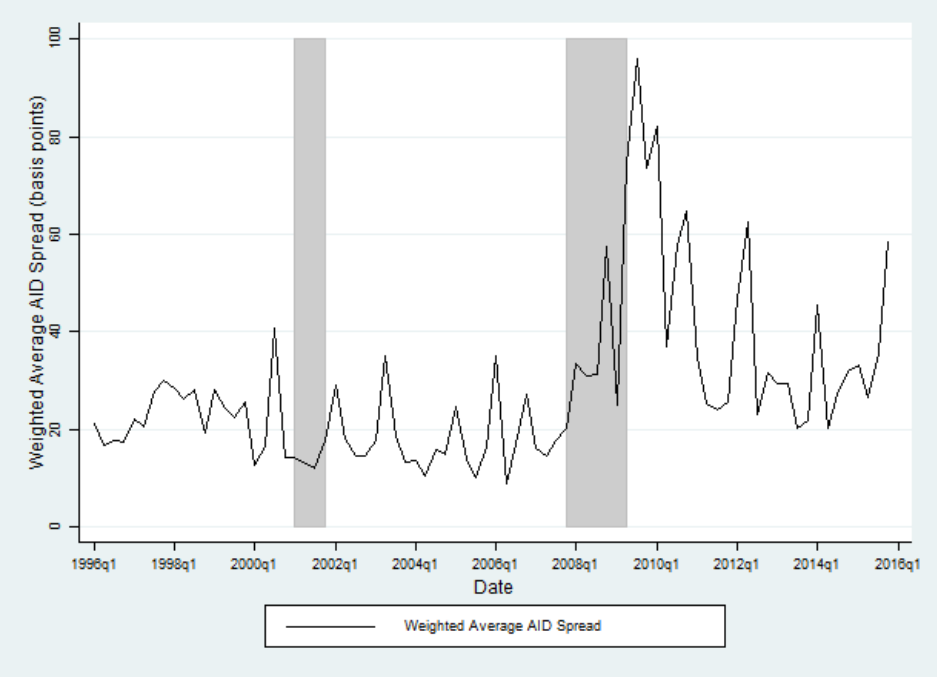

Figure 5: Weighted-average AID Spread - Unrated Firms

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

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. Therefore, the increase in spread was not restricted to firms in specific credit rating groups.

We next analyze the loan characteristics as outlined in Table 6. The average tranche amount starting 2008 is \$609.26 million, which is higher than the period prior. We also observe a slight increase in the mean maturity. These differences are statistically significant at the 1 percent level. An increase in the size of the mean tranche and maturity is indicative of an improvement in the supply of credit. Combining this with the evolution of firm credit rating presented earlier, we do not find any indications of a flight to quality in the syndicated loan market post-crisis.

Next we document and analyze the increase in capital measures for sample BHCs during and after the crisis. 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 correspond to the

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)	10,082	3.95	1.92	5610	4.34	1.34

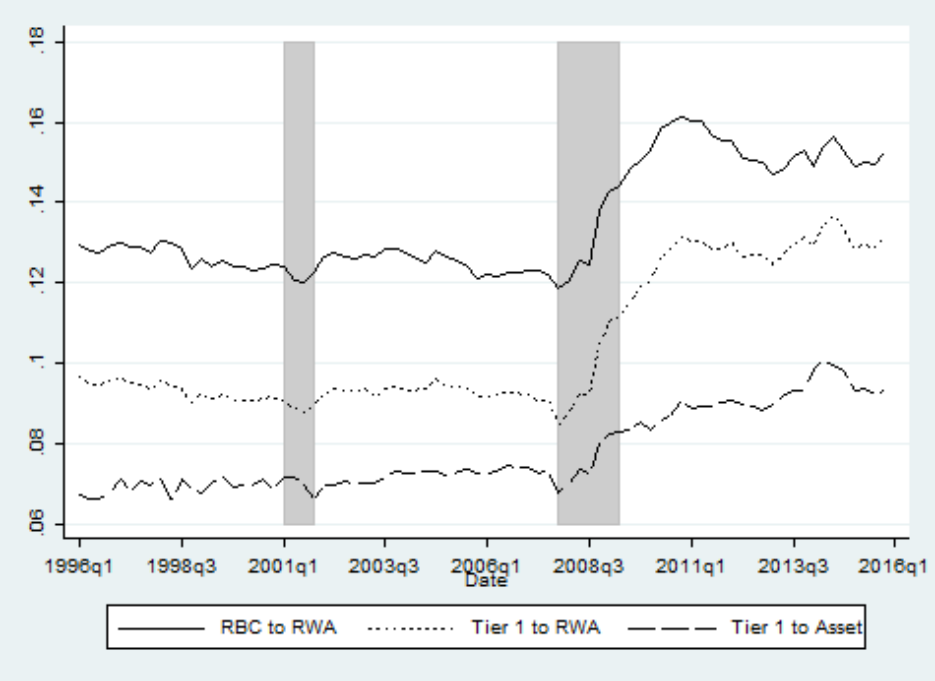

Figure 6: BHC Capital Ratios

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 $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. Therefore, 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.

Another channel via which BHCs can adjust to higher risk-based capital requirements is the denominator, i.e. RWAs. We observe the ratio of RWAs to total assets to behave procyclically for our sample BHCs as shown in Figure 8. During the sam-

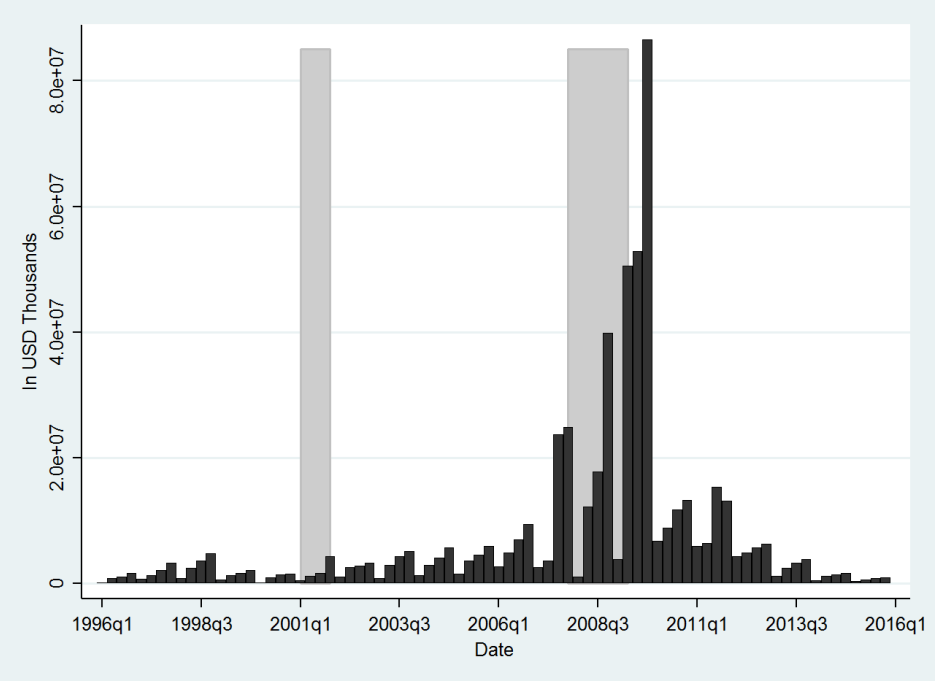

Figure 7: BHC Common Stock Issuance

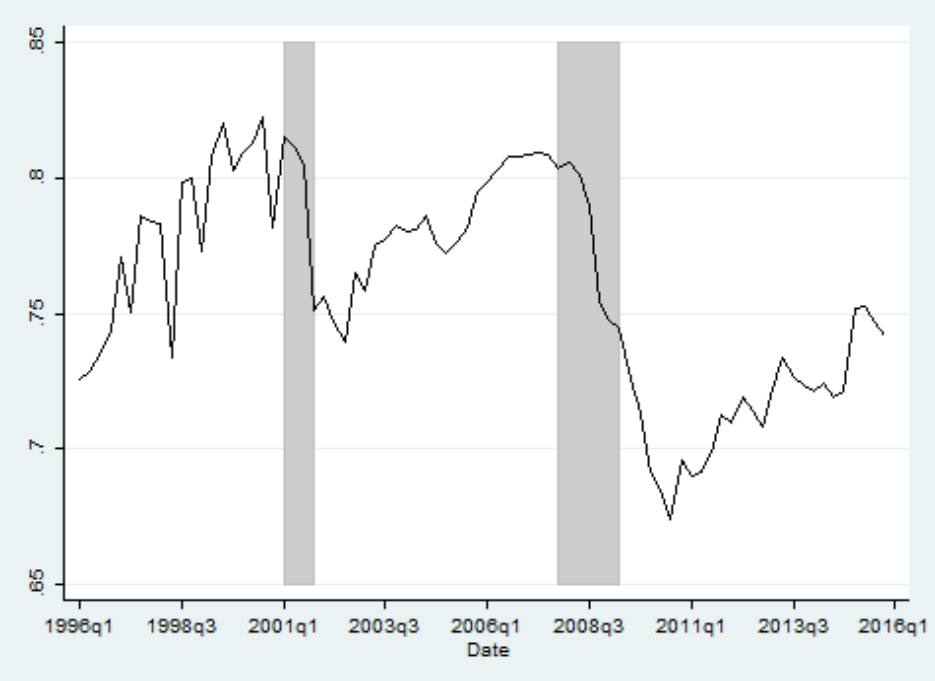

Figure 8: BHC RWA to Asset Ratio

ple 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 during the crisis. 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 evidence of higher post-crisis syndicated loan pricing. This increase in spreads does not appear to be driven by a significant shift toward riskier borrowers after the crisis or to longer-maturity loans or sample firms lacking access to corporate bond markets. On the other hand, BHCs have raised their capital and have reduced risk exposure by reducing RWAs. In the next section we test whether higher lending spreads are driven by higher capital holdings.

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:

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

$AID\ Spread_{i,j,t}$ is the loan price that firm j is charged for the loan tranche by BHC i. $CAP_{i,t-1}$ 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. $Bank_{i,t-1}$, $Firm_{j,t-1}$ are lead bank and firm characteristics, all measured at time $t-1$. $Macro_{t-1}$ are macroeconomic variables also measured at $t-1$; b_i and f_j are bank

and firm fixed effects, respectively. σ_{ijt} is the error term.

For BHC characteristics, we use measures of size, liquidity, profitability, loan portfolio provisions and losses, and funding costs.[8] *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 total BHC assets. As a measure of *Charge-Offs*, we use the ratio of net charge-offs 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 deposits) and funding expense (interest paid on trading liabilities, other borrowed money, subordinated notes and debentures scaled by total liabilities other than deposits).

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 are covenants attached to the loan and 0 otherwise. We control for the size of the syndicate and include dummies for each loan type. We also add an indicator variable, *Relationship*, if the lead bank-firm pair has appeared in our matched sample before. It is equal to 0

[8]Our choice of BHC variables reflect the balance sheet variables used by the Federal Reserve in stress testing.

the first time the pair appears and 1 thereafter. Tables A.3 in Appendix A lists the loan types. The final sample includes 27 types of loans. We use the leading index as control for macroeconomic conditions. 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 macroeconomic 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 5.02 to 8.37 basis points. The largest impact is observed for the Tier 1 leverage ratio. As outlined in section 3, the minimum increase in total risk-based capital requirements for the BHCs in our sample is 2.5 percent, from 8 to 10.5 percent including the capital conservation buffer. Assuming a linear cost of capital, our results indicate that this would lead to $5.02 \times 2.5 = 12.55$ basis point increase in the AID Spread. The increase in tier 1 capital ratio from a minimum 4 to 8.5 percent would lead to AID Spreads increasing by $5.10 \times 4.5 = 22.95$ basis points. Finally, bringing the tier 1 leverage ratio from 3 to 7 percent would cause a $8.37 \times 4 = 33.48$ basis 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. The first set of variables controls for BHC characteristics, the second for firm characteristics, the third for loan characteristics and the last for macroeconomic conditions. 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 frac-

Table 7: Impact of Regulatory Capital Ratio on AID Spread

	(1)	(2)	(3)
RBC to RWA	5.024***		
	(5.17)		
Tier 1 to RWA		5.100***	
		(5.21)	
Tier 1 to Assets BHC			8.371***
			(5.14)
BHC: Size	0.208***	0.209***	0.227***
	(5.67)	(5.61)	(6.70)
Liquidity	0.748***	0.604**	1.093***
	(3.14)	(2.48)	(4.49)
PPNR	8.888***	7.649***	5.502**
	(3.54)	(3.01)	(2.11)
Provisions	32.06***	35.39***	35.03***
	(3.50)	(3.98)	(3.83)
Charge-Offs	42.53**	43.80**	47.19***
	(2.54)	(2.63)	(2.82)
Deposit Expense	-5.691**	-4.573*	-3.895*
	(-2.53)	(-1.97)	(-1.69)
Funding Expense	-17.72***	-17.67***	-17.33***
	(-6.60)	(-6.61)	(-6.50)
Firm: Size	-0.0895***	-0.0956***	-0.0972***
	(-4.30)	(-4.63)	(-5.05)
ROA	-1.887***	-1.886***	-1.886***
	(-4.68)	(-4.67)	(-4.72)
Liquidity	0.0731	0.0687	0.0727
	(0.54)	(0.51)	(0.54)
Leverage	0.842***	0.835***	0.837***
	(9.02)	(8.97)	(8.87)
Loan: Size	-0.0841***	-0.0841***	-0.0841***
	(-7.34)	(-7.33)	(-7.31)
Maturity	0.0234	0.0248	0.0245
	(1.27)	(1.35)	(1.34)
Syndicate Size	0.0169	0.0144	0.0135
	(0.83)	(0.70)	(0.66)
Covenant Indicator	-0.174***	-0.175***	-0.173***
	(-5.31)	(-5.38)	(-5.49)
Relationship	-0.0429***	-0.0427***	-0.0443***
	(-3.86)	(-3.84)	(-3.99)
Leading Index	-0.290***	-0.292***	-0.290***
	(-13.48)	(-13.75)	(-14.21)
Firm & Bank Fixed Effects	Yes	Yes	Yes
Adj. R^2	0.671	0.672	0.671
N	14333	14333	14336

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

tions 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 in the banking sector. 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. The coefficient on *PPNR* is positive. Lambertini and Uysal (2014) show that return on assets and net interest margin are countercyclical for U.S. banks. This is driven by the stronger procyclicality of assets compared to net income. Loan spreads also tend to fall during economic expansions, as we find and comment on later, thereby commanding a positive coefficient on *PPNR*. We find a higher share of funding expenses to liabilities to be negatively correlated with the spread. This is because deposit and funding expenses are procyclical.

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 *Covenant Indicator* are significant. Loan covenants in principle increase 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 a loan, after adjusting for publicly available measures of borrower risk. We also find that banks charge a lower spread to firms that they have lent to previously. This can be attributed to a lower monitoring cost for repeated lending. Our measure of macroeconomic conditions is negatively correlated with loan spreads, as consistent with a countercyclical external finance premium for firms.

In section 4 we document a decrease in RWA density, namely the ratio of RWAs to assets, during and after the financial crisis as illustrated in Figure 8. A decrease in RWA density implies that a BHC is holding more assets with lower risk weight.

This asset portfolio choice can generate lower return on assets, at least in normal times, which in turn may lead to an increase in lending spreads if the BHC chooses to raise its profit margin on these riskier loans vis-a-vis safer assets. However, lower RWA density makes the BHC safer, which may reduce its overall borrowing cost. In this case the BHC can choose to charge lower spreads on loans to firms.

We test for the effect of RWA density on lending spreads in the syndicated loan market by adding it as an explanatory variable in our baseline specification equation (1) along with the tier 1 to asset ratio as regulated capital measure. The results are tabulated in Table 8. 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 in the syndicated market.

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 equity issuance on failing BHCs. As outlined in section 3.2, 10 out of the 19 institutions subjected to SCAP were required to raise capital. In a second specification, we extend our analysis to include subsequent stress tests, namely CCAR from 2011 to 2015. We use the following regression set-up to estimate the effects of being subjected to stress testing and failing it:

$$\begin{aligned} AID\,Spread_{i,j,t} &= \delta_1 SCAP_{i,t} + \delta_2 SCAP\ Fail_{i,t} + \beta_1 CAP_{i,t-1} + \beta_2 Bank_{i,t-1} \\ &\quad + \beta_3 Firm_{j,t-1} + \beta_4 Loan_{i,j,t} + \beta_5 Macro_{t-1} + f_j + \sigma_{ijt}. \end{aligned} \tag{2}$$

The firm, bank, loan and macroeconomic control variables are the same as in equation (1). $SCAP_{i,t}$ is a dummy that is equal to 1 starting 2009Q2 until the end of the sample

Table 8: Effect of RWA Density on AID Spread

	(1)
Tier 1 to Assets	10.12***
	(7.10)
RWA Density	-1.020***
	(-5.02)
BHC: Size	0.178***
	(4.85)
Liquidity	0.638**
	(2.60)
PPNR	8.050***
	(3.07)
Provisions	34.68***
	(3.86)
Charge-Offs	40.95**
	(2.45)
Deposit Expense	-3.372
	(-1.42)
Funding Expense	-17.82***
	(-6.58)
Firm: Size	-0.102***
	(-5.33)
ROA	-1.882***
	(-4.69)
Liquidity	0.0522
	(0.39)
Leverage	0.831***
	(8.90)
Loan: Size	-0.0840***
	(-7.29)
Loan Maturity	0.0242
	(1.32)
Syndicate Size	0.0114
	(0.55)
Covenant Indicator	-0.178***
	(-5.77)
Relationship	-0.178***
	(-5.77)
Leading Index	-0.297***
	(-14.62)
Firm & Bank FE	Yes
Adj. R^2	0.672
N	14336

$^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$

t-statistics in parentheses, standard errors clustered by date

for the 19 banks that underwent SCAP and subsequent CCARs.[9] The coefficient δ_1 captures the impact of being subjected to stress testing on the AID Spread. A positive and significant coefficient implies that stress tested BHCs charge a higher spread vis-a-vis non stress tested peers.[10] $SCAP\ Fail_{i,t}$ is a dummy equal to 1 for the period 2009Q2-2010Q4 only for BHCs that underwent and failed SCAP. The coefficient δ_2 captures the effect of failing 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 9. Our main variables of interest are the coefficients on $SCAP_{i,t}$ and $SCAP\ Fail_{i,t}$. In columns 1 to 3, we find both δ_1 and δ_2 to be greater than zero and statistically significant at the 1 percent level. The coefficient implies an increase in lending spreads between 32.03 and 37.65 basis points since the commencement of stress testing and depending on the regulatory capital definition used. Also, BHCs that failed the assessment charged 37.11 to 38.32 basis points more relative to non-failing SCAP-tested 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 is not. This finding suggests that differences in the Tier 1 to asset ratio are strongly correlated with *SCAP* and/or *SCAP Fail*. Other BHC, firm, loan and macroeconomics controls are qualitatively similar to the ones reported in Table 7. Combined with the 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. In columns (4) to (6) we report the results after accounting for bank fixed effects.

[9]SCAP was announced in February 2009 and the first details were released in April. All BHCs subjected to SCAP were also subjected to CCARs.

[10]Our results are qualitatively similar if we restrict the dummy to be equal to 1 between 2009Q2-2010Q4, i.e. to the quarter before CCAR 2011.

Table 9: Impact of Regulatory Capital Ratio on AID Spread - DID with SCAP Failure

	(1)	(2)	(3)	(4)	(5)	(6)
SCAP	32.03***	30.87***	37.65***	17.54**	15.60**	18.31***
	(5.28)	(4.72)	(6.23)	(2.59)	(2.11)	(2.88)
SCAP Fail	38.00***	38.32***	37.11***	34.16***	34.01***	31.50***
	(3.76)	(3.83)	(3.64)	(3.34)	(3.36)	(3.09)
RBC to RWA	4.198***			4.018***		
	(3.78)			(3.65)		
Tier 1 to RWA		4.009***			4.048***	
		(3.22)			(3.20)	
Tier 1 to Assets			3.714			5.577***
			(1.54)			(3.50)
BHC: Size	0.00743	0.0122	0.00379	0.136***	0.143***	0.149***
	(0.45)	(0.74)	(0.20)	(3.81)	(4.00)	(4.09)
Liquidity	1.164***	1.094***	1.520***	0.771***	0.672***	1.062***
	(6.09)	(5.67)	(7.27)	(3.34)	(2.85)	(4.45)
PPNR	2.632	1.134	-0.694	8.361***	7.369***	5.900**
	(1.28)	(0.57)	(-0.32)	(3.47)	(3.00)	(2.33)
Provisions	2.209	5.179	0.814	21.43***	25.04***	24.62***
	(0.32)	(0.72)	(0.11)	(2.92)	(3.39)	(3.22)
Charge-Offs	44.50***	46.14***	51.37***	37.16**	38.29***	41.14***
	(3.20)	(3.34)	(4.00)	(2.61)	(2.70)	(2.86)
Deposit Expense	-6.939**	-5.979**	-5.842**	-6.239***	-5.377**	-5.090**
	(-2.44)	(-2.21)	(-2.36)	(-2.85)	(-2.36)	(-2.22)
Funding Expense	-10.24**	-10.12**	-10.15**	-15.24***	-15.30***	-14.97***
	(-2.45)	(-2.45)	(-2.51)	(-5.86)	(-5.86)	(-5.67)

Table 9: (continued)

	(1)	(2)	(3)	(4)	(5)	(6)
Firm: Size	-0.0832***	-0.0867***	-0.0821***	-0.0940***	-0.0972***	-0.0967***
	(-4.11)	(-4.31)	(-3.93)	(-4.62)	(-4.83)	(-4.98)
ROA	-2.007***	-2.005***	-2.010***	-1.902***	-1.900***	-1.903***
	(-4.70)	(-4.69)	(-4.75)	(-4.69)	(-4.68)	(-4.73)
Liquidity	0.147	0.147	0.156	0.0595	0.0579	0.0619
	(1.16)	(1.15)	(1.23)	(0.46)	(0.44)	(0.48)
Leverage	0.841***	0.838***	0.842***	0.832***	0.829***	0.831***
	(8.65)	(8.63)	(8.68)	(8.87)	(8.85)	(8.82)
Loan: Size	-0.0832***	-0.0829***	-0.0814***	-0.0845***	-0.0844***	-0.0843***
	(-6.81)	(-6.78)	(-6.72)	(-7.46)	(-7.45)	(-7.43)
Loan Maturity	0.0160	0.0172	0.0178	0.0235	0.0246	0.0244
	(0.81)	(0.88)	(0.90)	(1.29)	(1.35)	(1.34)
Syndicate Size	0.0186	0.0164	0.0142	0.0169	0.0149	0.0148
	(0.87)	(0.76)	(0.65)	(0.83)	(0.73)	(0.73)
Covenant Indicator	-0.221***	-0.221***	-0.221***	-0.183***	-0.182***	-0.182***
	(-7.59)	(-7.51)	(-7.39)	(-6.10)	(-6.06)	(-6.07)
Relationship	-0.0499***	-0.0494***	-0.0529***	-0.0395***	-0.0394***	-0.0408***
	(-4.04)	(-4.00)	(-4.15)	(-3.41)	(-3.40)	(-3.52)
Leading Index	-0.297***	-0.295***	-0.297***	-0.285***	-0.284***	-0.286***
	(-14.42)	(-14.55)	(-14.31)	(-13.31)	(-13.40)	(-13.34)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	Yes	Yes	Yes
Adj. R^2	0.662	0.662	0.660	0.674	0.674	0.674
N	14333	14333	14336	14333	14333	14336

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

Next, we extend our analysis to incorporate the CCAR. We substitute the dummies $SCAP_{i,t}$ and $SCAP\ FAIL_{i,t}$ with $Regulatory\ Pressure_{i,t}$ and $Regulatory\ Pressure\ Fail_{i,t}$ respectively. $Regulatory\ Pressure_{i,t}$ is a dummy variable equal to 1 as soon as a BHC started being subject to stress testing until the end of our sample in 2015Q4. For example, 31 BHCs were subjected to CCAR in 2015.[11] $Regulatory\ Pressure\ Fail_{i,t}$ is a dummy variable equal to 1 for a BHC failing the stress test for the time period until the next stress testing exercise is conducted. For example, if a BHC failed 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 CCAR 2011 were not made public by the Federal Reserve; therefore, we do not have any BHCs failing the test for 2011. We present the estimation results in Table 10. 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 being subjected only to SCAP, the effect of failure is smaller once we include CCAR in our definition of stress test. We attribute this difference to the fact that SCAP failure explicitly imposed capital raising requirements as opposed to failure under CCAR. Including bank fixed effects does not affect our findings, as shown in column (4) to (6).

We find that stress testing failure leads to higher loan spreads. One could argue that the reason why a bank that fails a stress test charges higher loan rates relative to its peers is weakness in its balance sheet rather than being required to raise capital in the immediate future. Our regressions include a number of bank-specific controls that capture the direct effect of balance sheet characteristics on loan spread. Hence, *SCAP Fail* and *Regulatory Pressure Fail* estimate the consequences of stress test failure above and beyond what balance sheet variables already explain. To provide further evidence for our BHC controls being able to capture any balance sheet heterogeneity, we estimate equation (3) using a population-averaged probit model:

[11] We list BHCs subjected to SCAP and CCAR in Table A.2 of Appendix A.

Table 10: Impact of Regulatory Capital Ratio on AID Spread - DID with SCAP and CCAR Failure

	(1)	(2)	(3)	(4)	(5)	(6)
Regulatory Pressure	31.61***	30.67***	37.76***	15.13**	13.22*	15.81**
	(5.14)	(4.62)	(6.03)	(2.20)	(1.78)	(2.43)
Regulatory Pressure Fail	11.69*	11.65*	11.35*	14.13**	13.94**	13.38**
	(1.75)	(1.76)	(1.74)	(2.18)	(2.17)	(2.10)
RBC to RWA	3.894***			3.543***		
	(3.31)			(3.04)		
Tier 1 to RWA		3.674***			3.623***	
		(2.80)			(2.75)	
Tier 1 to Assets			3.282			5.398***
			(1.30)			(3.26)
BHC: Size	0.0105	0.0145	0.00565	0.152***	0.159***	0.163***
	(0.63)	(0.89)	(0.30)	(4.10)	(4.29)	(4.40)
Liquidity	1.114***	1.054***	1.432***	0.705***	0.616***	0.956***
	(5.99)	(5.60)	(6.82)	(3.17)	(2.70)	(4.06)
PPNR	1.941	0.546	-1.040	8.172***	7.301***	5.902**
	(0.91)	(0.27)	(-0.48)	(3.33)	(2.92)	(2.28)
Provisions	5.900	8.645	4.409	26.76***	29.96***	28.98***
	(0.70)	(1.00)	(0.51)	(3.05)	(3.43)	(3.25)
Charge-Offs	50.23***	51.84***	56.29***	41.48***	42.47***	44.75***
	(3.23)	(3.35)	(3.92)	(2.66)	(2.73)	(2.87)
Deposit Expense	-6.471**	-5.595**	-5.501**	-5.988***	-5.210**	-4.855**
	(-2.27)	(-2.06)	(-2.23)	(-2.71)	(-2.26)	(-2.10)
Funding Expense	-11.11**	-11.01**	-10.96***	-16.00***	-16.07***	-15.72***
	(-2.62)	(-2.63)	(-2.68)	(-6.22)	(-6.22)	(-6.06)

Table 10: (continued)

	(1)	(2)	(3)	(4)	(5)	(6)
Firm: Size	-0.0858***	-0.0888***	-0.0852***	-0.0965***	-0.0994***	-0.100***
	(-4.17)	(-4.32)	(-4.00)	(-4.75)	(-4.94)	(-5.21)
ROA	-1.998***	-1.996***	-2.003***	-1.890***	-1.889***	-1.891***
	(-4.68)	(-4.67)	(-4.73)	(-4.67)	(-4.66)	(-4.71)
Liquidity	0.169	0.168	0.176	0.0666	0.0647	0.0675
	(1.31)	(1.30)	(1.37)	(0.50)	(0.49)	(0.51)
Leverage	0.824***	0.821***	0.825***	0.819***	0.817***	0.818***
	(8.58)	(8.56)	(8.59)	(8.75)	(8.73)	(8.66)
Loan: Size	-0.0830***	-0.0827***	-0.0814***	-0.0848***	-0.0847***	-0.0847***
	(-6.77)	(-6.75)	(-6.70)	(-7.47)	(-7.46)	(-7.44)
Loan Maturity	0.0190	0.0201	0.0204	0.0258	0.0267	0.0265
	(0.96)	(1.03)	(1.03)	(1.41)	(1.46)	(1.45)
Syndicate Size	0.0185	0.0164	0.0144	0.0171	0.0153	0.0149
	(0.87)	(0.77)	(0.66)	(0.84)	(0.75)	(0.74)
Covenant Indicator	-0.231***	-0.230***	-0.230***	-0.187***	-0.186***	-0.186***
	(-7.82)	(-7.76)	(-7.68)	(-6.20)	(-6.18)	(-6.26)
Relationship	-0.0521***	-0.0517***	-0.0548***	-0.0409***	-0.0408***	-0.0420***
	(-4.22)	(-4.20)	(-4.30)	(-3.55)	(-3.54)	(-3.64)
Leading Index	-0.314***	-0.313***	-0.315***	-0.298***	-0.297***	-0.298***
	(-15.69)	(-15.84)	(-15.66)	(-13.95)	(-14.08)	(-14.15)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	Yes	Yes	Yes
Adj. R^2	0.660	0.659	0.658	0.673	0.673	0.673
N	14333	14333	14336	14333	14333	14336

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

$$Fail_{i,t} \quad = \quad \beta_0 + \beta_1 CAP_{i,t-1,t-4} + \beta_1 Bank_{i,t-1,t-4} + \beta_5 Macro_{t-1,t-4} + \sigma_{i,t}. \quad (3)$$

$Fail_{i,t}$ is a binary variable that takes a value equal to 1 for a BHC failing SCAP or CCAR in the quarter when the stress test results are announced. The vectors $CAP_{i,t-1,t-4}$ and $Bank_{i,t-1,t-4}$ comprise the lagged four quarter means of the same set of BHC capital and control variables specified in equation (1). $Macro_{i,t-1,t-4}$ is also the lagged four quarter mean of the leading index. Figure 9 plots the median predicted failure probability for the average bank of 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; they rise to almost 60 percent during SCAP and fall afterwards. This is consistent with the fact that the largest number of failures occurred under SCAP – see Table A.2. We report the marginal effect for each co-variate in Appendix A.4.

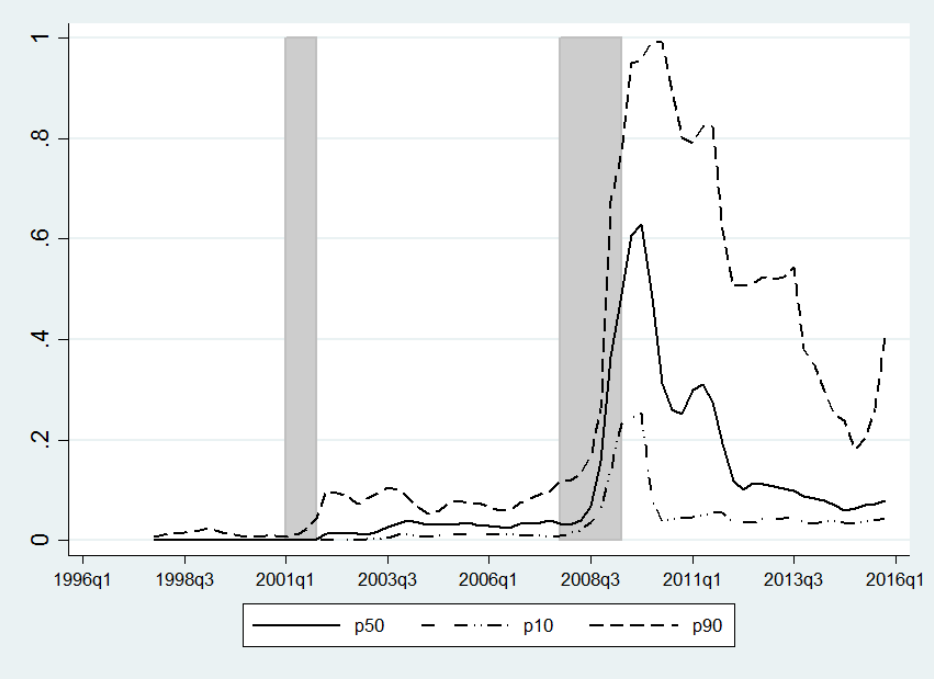

Figure 9: Predicted Probability of Stress-test Failure

6 Robustness

In this section we conduct a series of robustness tests.

6.1 Excluding Crisis Period

To test whether our results are solely 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 11. The estimates for a 1 percentage point increase in the regulatory capital ratio now range from 4.775 to 8.542 basis points, which is quantitatively similar to our estimates over the entire sample and significant at the 1 percent level. There is no qualitative change in the effect of our control variables.

6.2 Firm Quality

It is possible that 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. We include un-rated firms in the non-investment-grade sub-sample. Columns 1 to 3 of Table 12 present the results for investment-grade firms and columns 4 to 6 for non-investment-grade firms. The effects are significant for both sub-samples.

6.3 Single Tranche Loans

In our benchmark specification, we carry out the analysis at the tranche level. To allay concerns that syndicated loans with multiple tranches are priced differently compared to single-tranche loans, we repeat the analysis for loans with a single tranche. The results are reported in Table 13 and are qualitatively similar to those

Table 11: Impact of Regulatory Capital Ratio on AID Spread - Excluding Crisis Period

	(1)	(2)	(3)	(4)	(5)	(6)
	Excluding 2008Q1-2009Q4			Excluding 2008Q1-2010Q4		
RBC to RWA	4.819***			5.312***		
	(4.77)			(4.83)		
Tier 1 to RWA		4.775***			5.117***	
		(4.42)			(4.29)	
Tier 1 to Assets			8.033***			8.542***
			(5.20)			(5.96)
BHC: Size	0.214***	0.214***	0.232***	0.180***	0.179***	0.198***
	(5.52)	(5.44)	(6.44)	(5.03)	(4.92)	(6.11)
Liquidity	0.687***	0.571**	1.032***	0.713***	0.610**	1.099***
	(2.90)	(2.30)	(4.18)	(2.95)	(2.43)	(4.35)
PPNR	8.061***	6.777**	4.859*	7.083**	5.524*	3.372
	(3.06)	(2.52)	(1.78)	(2.61)	(1.96)	(1.19)
Provisions	29.44***	32.77***	32.35***	18.80***	22.74***	21.80***
	(3.04)	(3.47)	(3.32)	(3.04)	(3.75)	(3.44)
Charge-Offs	41.46**	43.06**	46.62***	42.35***	44.33***	49.69***
	(2.39)	(2.49)	(2.67)	(2.79)	(2.91)	(3.10)
Deposit Expense	-4.986**	-4.046	-3.219	-5.403*	-4.174	-3.416
	(-2.08)	(-1.62)	(-1.27)	(-1.98)	(-1.46)	(-1.19)
Funding Expense	-18.11***	-18.00***	-18.13***	-17.35***	-17.29***	-17.49***
	(-5.51)	(-5.46)	(-5.49)	(-5.03)	(-5.00)	(-5.01)
Firm: Size	-0.0878***	-0.0932***	-0.0964***	-0.0782***	-0.0834***	-0.0863***
	(-3.94)	(-4.19)	(-4.57)	(-3.68)	(-3.97)	(-4.49)
ROA	-2.136***	-2.137***	-2.139***	-2.402***	-2.399***	-2.389***
	(-4.79)	(-4.78)	(-4.82)	(-4.83)	(-4.81)	(-4.81)
Liquidity	0.127	0.125	0.132	0.0881	0.0890	0.0941
	(0.95)	(0.94)	(0.99)	(0.65)	(0.66)	(0.70)
Leverage	0.818***	0.812***	0.812***	0.809***	0.803***	0.807***
	(8.94)	(8.92)	(8.83)	(8.77)	(8.75)	(8.67)

Table 11: continued

	(1)	(2)	(3)	(4)	(5)	(6)
	Excluding 2008Q1-2009Q4			Excluding 2008Q1-2010Q4		
Loan: Size	-0.0861***	-0.0861***	-0.0860***	-0.0823***	-0.0822***	-0.0822***
	(-7.16)	(-7.14)	(-7.12)	(-6.77)	(-6.76)	(-6.74)
Loan Maturity	0.0289	0.0305*	0.0308*	0.0351*	0.0368**	0.0372**
	(1.60)	(1.70)	(1.72)	(1.94)	(2.05)	(2.08)
Syndicate Size	0.0130	0.0105	0.00890	-0.000850	-0.00337	-0.00550
	(0.61)	(0.49)	(0.41)	(-0.04)	(-0.16)	(-0.26)
Covenant Indicator	-0.181***	-0.182***	-0.182***	-0.174***	-0.175***	-0.174***
	(-5.36)	(-5.39)	(-5.52)	(-5.21)	(-5.23)	(-5.32)
Relationship	-0.0484***	-0.0481***	-0.0506***	-0.0486***	-0.0482***	-0.0513***
	(-4.11)	(-4.07)	(-4.28)	(-4.00)	(-3.96)	(-4.23)
Macroeconomic						
Leading Index	-0.283***	-0.285***	-0.291***	-0.276***	-0.278***	-0.285***
	(-10.01)	(-9.91)	(-10.24)	(-9.22)	(-9.08)	(-9.51)
Firm & Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.668	0.668	0.667	0.664	0.664	0.664
N	13384	13384	13387	12858	12858	12861

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

Table 12: Impact of Regulatory Capital Ratio on AID Spread - Firm Quality

	(1)	(2)	(3)	(4)	(5)	(6)
	Investment Grade			Non-Investment Grade & Un-rated		
RBC to RWA	4.635***			5.521***		
	(3.46)			(4.80)		
Tier 1 to RWA		5.673***			5.620***	
		(4.25)			(4.49)	
Tier 1 to Assets			9.567***			8.612***
			(5.66)			(5.16)
BHC: Size	0.209***	0.190***	0.227***	0.185***	0.190***	0.203***
	(5.02)	(4.42)	(5.84)	(3.97)	(4.02)	(4.63)
Liquidity	0.576*	0.477	0.803***	0.307	0.117	0.765**
	(1.91)	(1.60)	(2.83)	(1.02)	(0.37)	(2.51)
PPNR	6.919**	5.950*	2.901	10.09***	8.671**	6.878*
	(2.15)	(1.90)	(0.93)	(2.99)	(2.48)	(1.92)
Provisions	34.78***	35.87***	35.31***	36.22***	40.20***	40.34***
	(4.24)	(4.30)	(4.35)	(3.45)	(3.95)	(3.87)
Charge-Offs	35.68***	36.59***	42.37***	38.17**	39.38**	42.26**
	(2.85)	(3.00)	(3.46)	(2.01)	(2.09)	(2.24)
Deposit Expense	-0.466	0.333	0.491	-5.341	-3.488	-2.818
	(-0.25)	(0.17)	(0.26)	(-1.36)	(-0.87)	(-0.70)
Funding Expense	-18.49***	-18.23***	-17.53***	-17.61***	-17.85***	-17.55***
	(-5.63)	(-5.66)	(-5.72)	(-4.98)	(-5.16)	(-4.95)
Firm: Size	-0.0567*	-0.0683**	-0.0729**	-0.0737**	-0.0801***	-0.0784***
	(-1.81)	(-2.24)	(-2.44)	(-2.57)	(-2.81)	(-2.80)
ROA	-2.564***	-2.567***	-2.528***	-1.699***	-1.699***	-1.711***
	(-3.54)	(-3.52)	(-3.45)	(-3.71)	(-3.69)	(-3.78)
Liquidity	0.0125	0.0132	0.0380	-0.0777	-0.0864	-0.0871
	(0.08)	(0.08)	(0.25)	(-0.48)	(-0.53)	(-0.54)
Leverage	0.285**	0.242**	0.251**	0.866***	0.860***	0.860***
	(2.48)	(2.14)	(2.10)	(7.60)	(7.56)	(7.52)

Table 12: continued

	(1)	(2)	(3)	(4)	(5)	(6)
	Investment Grade			Non-Investment Grade & Un-rated		
Loan: Size	-0.0141	-0.0140	-0.0136	-0.103***	-0.103***	-0.103***
	(-0.98)	(-0.99)	(-0.96)	(-6.62)	(-6.60)	(-6.58)
Loan Maturity	0.0257*	0.0275*	0.0263*	-0.0419	-0.0419	-0.0419
	(1.80)	(1.96)	(1.88)	(-1.31)	(-1.30)	(-1.30)
Syndicate Size	-0.0163	-0.0158	-0.0126	0.0332	0.0298	0.0276
	(-0.68)	(-0.66)	(-0.52)	(1.39)	(1.24)	(1.16)
Covenant Indicator	0.0414*	0.0361	0.0334	-0.276***	-0.278***	-0.273***
	(1.75)	(1.56)	(1.50)	(-6.40)	(-6.48)	(-6.41)
Relationship	-0.0329**	-0.0311**	-0.0332***	-0.0378**	-0.0383**	-0.0400**
	(-2.64)	(-2.50)	(-2.71)	(-2.25)	(-2.28)	(-2.40)
Leading Index	-0.270***	-0.277***	-0.275***	-0.314***	-0.315***	-0.312***
	(-7.19)	(-7.42)	(-7.81)	(-11.95)	(-11.98)	(-11.90)
Firm & Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.648	0.651	0.653	0.629	0.629	0.628
N	4075	4075	4075	10258	10258	10261

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

in our main estimation and statistically significant at the 1 percent level.

6.4 Pro-rata Loan Allocation

In our benchmark specification we match every loan to the lead bank. However, this might lead to a bias in our findings depending on the capitalization of the lead bank relative to the other banks in the syndicate. We re-estimate equation (1) after allocating equal amounts of the syndicated loan to all Tier 1 Agents.[12] The results are reported in Table 14 and are qualitatively similar to those in our main estimation and statistically significant at the 1 percent level.

6.5 Placebo Test

As common in this literature, 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 1 for the period 2001Q2-2006Q4. *Placebo Fail* is the DID variable corresponding to *SCAP Fail* in equation (2). Results are reported in Table 15. The effect of being subjected to the fictional SCAP on the AID Spread is either not significant or negative. The result implies that BHCs subjected to the fictional SCAP experiment after the dot-com bubble were actually charging a lower spread relative to their peers. This provides further support for our claim that stress testing is a source of regulatory pressure on BHCs with real costs. The coefficients on fake SCAP failure are all insignificantly different from zero.

[12]We allocate up-to 10 Tier 1 agents. This comprises 99 percent of our matched sample.

Table 13: Impact of Regulatory Capital Ratio on AID Spread - Single Tranche Loans

	(1)	(2)	(3)
RBC to RWA	5.182***		
	(4.50)		
Tier 1 to RWA		5.847***	
		(4.89)	
Tier 1 to Assets			9.357***
			(5.47)
BHC: Size	0.232***	0.220***	0.248***
	(5.43)	(5.05)	(6.05)
Liquidity	0.811***	0.685**	1.143***
	(2.81)	(2.41)	(4.00)
PPNR	13.78***	12.42***	10.02***
	(3.88)	(3.56)	(2.85)
Provisions	31.05***	33.46***	34.47***
	(3.14)	(3.50)	(3.68)
Charge-Offs	42.02***	43.06***	45.97***
	(2.68)	(2.77)	(2.94)
Deposit Expense	-9.602***	-8.009**	-7.065**
	(-3.00)	(-2.47)	(-2.14)
Funding Expense	-16.84***	-16.87***	-16.57***
	(-4.65)	(-4.73)	(-4.74)
Firm: Size	-0.126***	-0.135***	-0.136***
	(-4.37)	(-4.65)	(-4.91)
ROA	-1.787***	-1.778***	-1.775***
	(-3.69)	(-3.65)	(-3.70)
Liquidity	-0.241	-0.250	-0.225
	(-1.41)	(-1.47)	(-1.32)
Leverage	0.973***	0.961***	0.950***
	(7.61)	(7.57)	(7.38)
Loan: Size	-0.0781***	-0.0794***	-0.0785***
	(-3.73)	(-3.79)	(-3.73)
Loan Maturity	0.00857	0.0112	0.0109
	(0.36)	(0.47)	(0.47)
Syndicate Size	0.0390	0.0390	0.0403*
	(1.63)	(1.63)	(1.68)
Covenant Indicator	-0.104***	-0.108***	-0.107***
	(-3.37)	(-3.65)	(-3.92)
Relationship	-0.0124	-0.0137	-0.0140
	(-0.52)	(-0.57)	(-0.60)
Leading Index	-0.267***	-0.271***	-0.264***
	(-8.51)	(-8.87)	(-9.06)
Adj. R^2	0.672	0.673	0.673
N	7267	7267	7268

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

Table 14: Impact of Regulatory Capital Ratio on AID Spread - Pro-rata Loan Allocation

	(1)	(2)	(3)
RBC to RWA	2.651***		
	(5.46)		
Tier 1 to RWA		3.639***	
		(6.65)	
Tier 1 to Assets			9.198***
			(9.86)
BHC: Size	0.232***	0.239***	0.247***
	(8.51)	(8.52)	(10.01)
Liquidity	0.382**	0.151	0.581***
	(2.52)	(0.96)	(4.22)
PPNR	4.487***	4.470***	2.964**
	(3.27)	(3.31)	(2.17)
Provisions	39.26***	40.22***	38.21***
	(5.74)	(6.00)	(5.38)
Charge-Offs	34.81***	34.58***	35.83***
	(3.09)	(3.08)	(3.12)
Deposit Expense	-8.026***	-7.134***	-5.567***
	(-3.69)	(-3.54)	(-3.35)
Funding Expense	-11.91***	-12.27***	-11.98***
	(-4.98)	(-5.19)	(-5.37)
Firm: Size	-0.0541***	-0.0691***	-0.0866***
	(-2.88)	(-3.63)	(-4.70)
ROA	-2.794***	-2.791***	-2.773***
	(-7.35)	(-7.31)	(-7.28)
Liquidity	0.384***	0.361***	0.342**
	(2.89)	(2.71)	(2.55)
Leverage	0.685***	0.665***	0.652***
	(6.98)	(6.89)	(6.62)
Loan: Size	-0.0594***	-0.0600***	-0.0608***
	(-5.21)	(-5.27)	(-5.38)
Loan Maturity	0.0330*	0.0331*	0.0338*
	(1.68)	(1.72)	(1.77)
Syndicate Size	-0.00673	-0.0157	-0.0272
	(-0.31)	(-0.72)	(-1.25)
Covenant Indicator	-0.0970***	-0.0978***	-0.110***
	(-3.07)	(-3.19)	(-3.89)
Leading Index	-0.238***	-0.242***	-0.246***
	(-10.15)	(-10.62)	(-11.85)
Adj. R^2	0.742	0.743	0.745
N	149294	149294	149353

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

Table 15: Impact of Regulatory Capital Ratio on AID Spread - Placebo Test

	(1) RBC 1 to RWA	(2) Tier 1 to RWA	(3) Tier 1 to Asset
Panel A: Based on lead bank matching			
Placebo	0.277	1.775	2.653
	(0.07)	(0.43)	(0.66)
Placebo Fail	9.873	9.076	7.187
	(1.22)	(1.07)	(0.85)
Adj. R^2	0.672	0.672	0.671
N	14333	14333	14336
Panel B: Based on pro-rata loan allocation			
Placebo	-14.67***	-12.96***	-9.187***
	(-3.99)	(-3.46)	(-2.76)
Placebo Fail	2.959	2.062	-0.686
	(0.64)	(0.42)	(-0.14)
Adj. R^2	0.743	0.744	0.745
N	149416	149416	149475

$^{*}p < 0.1,^{**}p < 0.05,^{***}p < 0.01$

t-statistics in parentheses, standard errors clustered by date

6.6 BHCs Subject to Stress Testing

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 at least $100 billion. We restrict our sample to these BHCs and estimate the following DID specification:

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

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. We estimate equation (4) with identical firm, loan and BHC variables as before and include a full set of time dummies. *SCAP Fail * Post SCAP* is the DID term of interest because it measures the additional lending spread (in basis points) charged by BHCs that failed SCAP. The results are presented in Table 16. 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.

Table 16: Impact of Regulatory Capital Ratio on AID Spread - BHCs Subject to Stress Testing

	(1)	(2)	(3)
	Tier 1 to RWA	Tier 1 to Asset	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)
Adj. R^2	0.772	0.772	0.772
N	117467	117467	117467

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

7 Loan Growth Estimation

A contraction in credit supply typically affects both loan volume and loan pricing. We have shown thus far that an increase in regulated bank capital ratios affects loan pricing in the syndicated loan market. To test the effect on loan volume, we estimate the following loan growth regression based on Khwaja and Mian (2008) and Acharya, Eisert, Eufinger and Hirsch (2016):

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

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 each quarter, we do not have same pairs repeating every quarter. We follow Acharya et al. (2016) and aggregate loans based on industry and ratings based on the three-year median interest coverage ratio[13] of the borrowing firm by each BHC every quarter. Thus our unit of observation is the firm cluster-BHC-quarter. *Loan Growth*$_{i,j,t}$ is the change between quarter $t-1$ and t in loan volume by BHC i to firm-cluster j. We use separately a measure of capital, risk-based capital in the first specification and Tier 1 capital in the second, and RWA as regressors in order to estimate their relative contribution. 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 17.

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. A 1 percentage point increase in risk-based capital growth reduces loan growth by almost 4 percent; the effect is stronger for a 1 percentage point increase in Tier 1 capital growth. A 1 percentage point reduction in RWA growth lowers loan growth by slightly less than 3 percent. The negative impact of higher bank capital ratios on U.S. syndicated lending we document in Table 17 is in line with a number of recent studies that use lending application data from Spain (Jimenez et al., 2012), syndicated loan data in Europe (Gropp et al., 2016), and loan-level data from Germany using as treatment corporate tax reforms in Italy and Belgium (Célérier et al., 2016).

[13]Less than half of our sample firms has a credit rating in Compustat. The interest coverage ratio is equal to earnings before interest and taxes divided by the interest expenses for the same period. We assign ratings based on categories provided by Standard & Poor's (2006).

Table 17: 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
Adj. R^2	0.626	0.626
N	5522	5522

$^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$; t-statistics in parentheses; errors clustered by bank

8 Conclusions

We find 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 Y-9C 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 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 lead 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. These reforms 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.

References

Acharya, Viral V., Tim Eisert, Christian Eufinger, and Christian W. Hirsch, "Real Effects of the Sovereign Debt Crisis in Europe: Evidence from Syndicated Loans," *CEPR Discussion Paper*, 2016, (10108).

Aiyar, Shekhar, Charles W. Calomiris, and Tomasz Wieladek, "Does Macro-Prudential Regulation Leak? Evidence from a UK Policy Experiment," *Journal of Money, Credit and Banking*, 2014, *46* (s1), 181–214.

Auer, Raphael and Steven Ongena, "The Countercyclical Capital Buffer and the Composition of Bank Lending," *BIS Working Paper*, December 2016, (593).

Basten, Christoph and Catherine Koch, "Higher Bank Capital Requirements and Mortgage Pricing: Evidence from the Counter-Cyclical Capital Buffer," *BIS Working Paper*, 2015, (511).

Becker, Bo and Victoria Ivashina, "Cyclicality of Credit Supply: Firm Level Evidence," *Journal of Monetary Economics*, 2014, *62* (C), 76–93.

Berger, Allen N. and Raluca A. Roman, "Did TARP Banks Get Competitive Advantages?," *Journal of Financial and Quantitative Analysis (JFQA), Forthcoming*, 2013.

Bernanke, Ben S. and Cara S. Lown, "The Credit Crunch," *Brookings Papers on Economic Activity*, 1991, *22* (2), 205–248.

Berrospide, Jose M. and Rochelle M. Edge, "The Effects of Bank Capital on Lending: What Do We Know, and What Does It Mean?," *International Journal of Central Banking*, 2010, *6* (34), 1–50.

Black, Lamont K. and Lieu N. Hazelwood, "The Effect of TARP on Bank Risk-taking," *Journal of Financial Stability*, 2013, *9* (4), 790–803.

Bridges, Jonathan, David Gregory, Mette Nielsen, Silvia Pezzini, Amar Radia, and Marco Spaltro, "The Impact of Capital Requirements on Bank Lending," Bank of England working paper 486, Bank of England January 2014.

Carlson, Mark, Hui Shan, and Missaka Warusawitharana, "Capital Ratios and Bank Lending: A Matched Bank Approach," *Journal of Financial Intermediation*, 2013, *22* (4), 663–687.

Célérier, Claire, Thomas ans Kick, and Steven Ongena, "Does the Cost of Equity Affect Bank Lending?," *Mimeo*, June 2016.

Chava, Sudheer and Michael R. Roberts, "How Does Financing Impact Investment? The Role of Debt Covenants," *Journal of Finance*, October 2008, *63* (5), 2085–2121.

Francis, William and Matthew Osborne, "Bank Regulation, Capital and Credit Supply: Measuring the Impact of Prudential Standards," Occasional Paper 36, Financial Services Authority September 2009.

Gropp, Reint, Thomas C. Mosk, Steven Ongena, and Carlo Wix, "Bank Response to Higher Capital Requirements: Evidence from a Quasi-Natural Experiment," *SAFE Working Paper*, 2016, (156).

Hancock, Diana and James A. Wilcox, "Has There Been a Capital Crunch in Banking? The Effects on Bank Lending of Real Estate Market Conditions and Bank Capital Shortfalls," *Journal of Housing Economics*, December 1993, *3* (1), 31–50.

_ **and** _ , "Bank Capital and the Credit Crunch: The Roles of Risk-Weighted and Unweighted Capital Regulations," *Real Estate Economics*, 1994, *22* (1), 59–94.

Ivashina, Victoria, "Structure and Pricing of Syndicated Loans," New York City Area Conference on Financial Intermediation 2005.

_ **and David Scharfstein**, "Bank Lending during the Financial Crisis of 2008," *Journal of Financial Economics*, September 2010, *97* (3), 319–338.

Jimenez, Gabriel, Steven Ongena, Jose-Luis Peydro, and Jesus Saurina, "Credit Supply and Monetary Policy: Identifying the Bank Balance-Sheet Channel with Loan Applications," *American Economic Review*, August 2012, *102* (5), 2301–26.

Jonghe, Olivier De, Hans Dewachter, and Steven Ongena, "Bank Capital (Requirements) and Credit Supply: Evidence from Pillar 2 Decisions," *NBB Working Paper Research*, October 2016, (303).

Khwaja, Asim Ijaz and Atif Mian, "Tracing the Impact of Bank Liquidity Shocks: Evidence from an Emerging Market," *The American Economic Review*, 2008, *98* (4), 1413–1442.

Labonne, Claire and Gildas Lamé, "Credit Growth and Bank Capital Requirements: Binding or Not?," Working paper 481, Banque de France March 2014.

Lambertini, Luisa and Pinar Uysal, "Macroeconomic Implications of Bank Capital Requirements," *Ecole Polytechnique Fédérale de Lausanne, mimeo*, 2014.

Modigliani, Franco and Merton H. Miller, "The Cost of Capital, Corporation Finance and the Theory of Investment," *The American Economic Review*, 1958, *48* (3), 261–297.

Santos, Joao A. C. and Andrew Winton, "Bank Capital, Borrower Power, and Loan Rates," AFA 2010 Atlanta Meetings Paper 2013.

Standard & Poor's, "Corporate Ratings Criteria," *The McGraw-Hill Companies, Inc. New York*, 2006.

Strahan, Philip E., "Borrower Risk and the Price and Nonprice Terms of Bank Loans," *FRB of New York Staff Report*, 1999, (90).

A Appendix: Data

Table A.1: Variable Definitions

Variable	FR Y-9C/ Compustat	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	Federal Funds sold and securities purchased under agreements to sell
Pre-Provison Net Revenue	BHCK4074 +	Net Interest Income
	BHCK4079 -	Total noninterest income
	BHCK4093	Total noninterest expense
Provisons	BHCK3123	Allowance for loan and lease losses
Net Charge-offs	BHCK4635 -	Charge-offs on loans and leases
	BHCK4605	Recoveries on loans and leases
Deposit Interest	BHCKA517 +	Time deposits of $100,000 or more
	BHCKA518 +	Time deposits of less than $100,000
	BHCK6761	Other deposits
Funding Interest	BHCK4185	Interest on trading liabilities and other borrowed money
	BHCK4397	Interest on subordinated notes and debentures and on mandatory convertible securities
Deposits	BHDM6631 +	Noninterest-bearing deposits
	BHDM6636	Interest-bearing deposits
Liabilities	BHCK2948	Total Liabilities
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: BHCs subjected to SCAP and CCAR

BHC	SCAP 2009	CCAR 2012	CCAR 2013	CCAR 2014	CCAR 2015
Ally Financial Inc.		Y	Y	Y	Y
American Express Company	Y	Y	Y	Y	Y
Bank of America	Y	Y	Y	Y	Y
BB&T	Y	Y	Y	Y	Y
BBVA Compass Bancshares, Inc				Y	Y
BMO Financial Corp				Y	Y
BNY Mellon	Y	Y	Y	Y	Y
Capital One	Y	Y	Y	Y	Y
CitiGroup	Y	Y	Y	Y	Y
Comerica				Y	Y
Deutsche Bank Trust Corporation					Y
Discover Financial Services				Y	Y
Fifth Third	Y	Y	Y	Y	Y
Goldman Sachs	Y	Y	Y	Y	Y
HSBC North America Holdings Inc				Y	Y
Huntington Bancshares Inc				Y	Y
JP Morgan	Y	Y	Y	Y	Y
KeyCorp	Y	Y	Y	Y	Y
M&T Bank Corporation				Y	Y
Morgan Stanley	Y	Y	Y	Y	Y
Northern Trust Corporation				Y	Y
PNC	Y	Y	Y	Y	Y
RBS Citizens Financial Group Inc				Y	Y
Regions	Y	Y	Y	Y	Y
Santander Holdings USA, Inc				Y	Y
State Street	Y	Y	Y	Y	Y
SunTrust	Y	Y	Y	Y	Y
U.S. Bancorp	Y	Y	Y	Y	Y
UnionBanCal Corporation*				Y	Y
Wells Fargo	Y	Y	Y	Y	Y
Zions Bancorporation				Y	Y

Y=Yes; *: same identifier as MUFG Americas Holdings Corporation for CCAR 2015

Table A.3: 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 Co-variates 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

Santos and Winton (2013) estimate how bank capital affects lending rates. These authors use Call report for bank-level variables and stockholder equity over asset as measure of capital. They find a small but negative effect of the capital ratio on lending spreads.

We re-estimate equation (1) using total equity capital to asset as capital measure and restricting our sample period to 2007Q2, per Santos and Winton. We too find a small negative impact of capital on loan spreads with the sample ending in 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 2007Q3 to 2015Q4, we find a positive significant effect, larger than the effect reported in column 2. On the other hand, our risk-based capital measures 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 recent 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 Assets 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)
Adj. R^2	0.647	0.660	0.680
N	9355	15210	5855

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