Credit Supply and the Macroeconomy: An Empirical Analysis of Capital Regulation, Bank Lending, and Firm Behavior

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To my parents

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Abstract

The policy response to the recent financial crisis has broadly focused on two themes: 1) Increasing the banking sectors' resilience to future financial shocks: 2) Improving credit availability to households and firms via lowering both short and long-term interest rates and thereby affecting short-term output and inflation. This dissertation studies how banks and firms have responded to these policy measures. The dissertation comprises of three chapters. The first two analyze the impact of capital regulation on bank lending for two different jurisdictions - United States and Switzerland. The third evaluates the response of U.S. non-financial firms to lower interest rates.

The first chapter is joint work with Luisa Lambertini. We estimate the impact of bank capital regulation on lending spreads. We use U.S. firm-level data on 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 a 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.

The second chapter is joint work with Luisa Lambertini, Dan Wunderli and Robert Bichsel. We use confidential loan-by-loan data of Swiss banks to study the impact of higher capital requirements on lending. Our data allows us to trace the link between bank capital and new credit granted at the bank level. Additionally bank-specific variation of capital targets allows us to analyze how deviation from the regulatory capital target impacts loan pricing and volume. We find that tighter capital regulation has small but statistically significant short-term effects on loan pricing and growth. We do not find a permanent effect of higher capital ratios on loan growth.

In the third chapter, I study the behavior of U.S. non-financial corporates after the recent financial crisis. I document an increase in the real debt holdings and correspondingly the book leverage for these firms. Controlling for firm- and time- fixed effects, I find a higher long-term debt to asset ratio to be associated with lower capital expenditures and growth in fixed capital post-crisis. This is also true for financially unconstrained firms, as determined by the Whited-Wu index, vis-a-vis pre-crisis. Moreover, firms with a higher share of long-term debt after the crisis appear to have a greater likelihood of repurchasing shares and larger dollar payouts to equity holders. The evidence points to the fact that any increase in long-term debt has had an impact on firms' capital structure but no positive effect on real investment.

Key words: Bank capital; Lending; Capital Requirements; Syndicated Loans; Stress-testing; Interest Rates; Capital Structure; Corporate Investment; Share Repurchases.

Zusammenfassung

Die finanz- und geldpolitische Antwort auf die jüngste Finanzkrise hat sich vor allem auf zwei Bereiche fokussiert: 1) Verbesserung der Widerstandsfähigkeit der Banken bezüglich zukünftiger Schocks an den Finanzmärkten 2) Verbesserung der Kreditverfügbarkeit für Haushalte und Firmen durch eine Reduktion der kurz- und langfristigen Zinssätze, und dem damit verbundenen kurzfristigen Einfluss auf die Wirtschaftsleistung und Inflation. Diese Doktorarbeit analysiert wie Banken und Unternehmen auf die implementierten Massnahmen reagiert haben und beinhaltet drei Kapitel. Die ersten beiden Kapitel analysieren den Einfluss der Eigenkapitalregulierung auf die Kreditvergabe von Banken für zwei unterschiedliche Länder: Die USA und die Schweiz. Das dritte Kapitel evaluiert die Reaktion von amerikanischen Firmen auf niedrigere Zinssätze.

Das erste Kapitel ist gemeinschaftliche Arbeit mit Luisa Lambertini. We schätzen den Einfluss der Eigenkapitalregulierung für Banken auf die Zinsspanne der Kredite. Wir verwenden einen Längsschnittdatensatz, welcher Informationen zu Konsortialkrediten auf Fimenebene für amerikanische Unternehmen sowie der kreditvergebenden Banken (BHC) beinhaltet. Die Ergebnisse unserer Analyse zeigen, dass höhere Eigenkapitalanforderungen zu einer Erhöhung der Kreditpreise führt. Darüber hinaus untersuchen wir, ob das Nichtbestehen von Stresstests unter dem "Supervisory Capital Assessment Program and Comprehensive Capital Analysis and Review" zu höheren Zinsspannen der Kredite führt. Zugrunde liegt hier die überlegung, dass Finanzinstitute, welche den Stresstest nicht bestehen, gezwungen werden ihr Eigenkapital kurzfristig zu erhöhen. Mithilfe einer Difference-in-difference Methodologie dokumentieren wir folgende Ergebnisse: 1) BHCs, welche den Stresstest nicht bestanden haben, erhöhten ihre Kreditpreise 2) Die Kreditpreise sind höher für alle Banken seit der Einführung der Stresstests. Unsere Ergebnisse deuten darauf hin, dass eine grössere regulatorische Präsenz und höhere Eigenkapitalvoraussetzungen die Kosten für Konsortialkredite für Firmen erhöht haben.

Das zweite Kapitel ist gemeinschaftliche Arbeit mit Luisa Lambertini, Dan Wunderli und Robert Bichsel. Wir verwenden vertrauliche Kreditdaten über Schweizer Banken, um den Einfluss von höheren Eigenkapitalmindestanforderungen auf die Kreditvergabetätigkeit zu untersuchen. Unser Datensatz erlaubt die Herstellung einer Verbindung zwischen Bankenkapital und neu ausgegebenen Krediten auf Bankenebene. Zusätzliche bankspezifische Variation der Kapitalanforderungen ermöglicht es zu analysieren, wie die Abweichung von den regulatorisch vorgegebenen Kapitalanforderungen die Kreditpreise und das Kreditvolumen beeinflusst. Die Analyse zeigt, dass striktere Kapitalregulierung einen kleinen aber statistisch signifikanten Einfluss auf die Kreditpreise und das Kreditwachstum hat. Wir finden jedoch keinen dauerhaften Effekt von erhöhtem Eigenkapital auf das Kreditwachstum.

Im dritten Kapital untersuche ich das Verhalten von amerikanischen Firmen, welche nicht dem Finanzsektor angehören, auf die kürzliche Finanzkrise. Ich dokumentiere eine Erhöhung des realen Schuldenstands und des Verschuldungsgrads für diese Firmen. Kontrollierend für spezifische Firmen- und Zeiteffekte (fixed effects), zeigt die Analyse einen höheren Verschuldungsgrad, geringere Investmenttätigkeit sowie langsameres Wachstum in langfristigen Anlagen nach der Finanzkrise.

Dies betrifft auch solche Firmen mit solider Finanzsituation gemäss dem Whited-Wu Index. Darüber hinaus zeigen Firmen mit einem höheren Anteil von langfristigen Schulden nach der Krise eine erhöhte Neigung für Aktienrückkäufe, und in diesem Zusammenhang werden höhere Zahlungen an die veräussernden Anteilsbesitzer geleistet. Dieses Ergebnis stellt einen Hinweis dar, dass jeglicher Anstieg in den langfristigen Schulden zugleich einen Einfluss auf die Firmenkapitalstruktur hat, jedoch nicht auf die tatsächliche Investitionstätigkeit.

Schlüsselwörter: Kreditvergabe von Banken, Eigenkapitalanforderungen, Konsortialkredite, Stresstests, Zinssätze, Kapitalstruktur, Investitionstätigkeit von Unternehmen, Aktienrückkäufe.

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Introduction

The aftermath of the recent financial crisis has witnessed a wave of financial regulation and monetary policy actions. Financial regulation has aimed at making the banking sector more resilient to future financial shocks. Monetary policy measures have been focused on improving credit availability to firms and households via a lowering of short- and long-term interest rates. It is important to understand how these measures affect the real economy. This dissertation investigates: 1) The effect of higher bank capital on lending to non-financial corporates; 2) The financing and investment behavior of non-financial corporates after the crisis.

The crisis of 2007: The bursting of the housing bubble in 2007 has led to a global recession of a magnitude not witnessed since the Great Depression in the 1930s. As a direct consequence of the mortgage delinquencies, banks had to write down billions of dollars in bad loans. Huge losses incurred by the banking sector raised concerns about the banks' ability to withstand the crisis causing creditors and holders of uninsured deposits to withdraw and stop rolling over of funds. In some countries, the government had to step in to keep the banking sector solvent.

Policy Response & Challenges: The regulatory response by national authorities and the Basel Committee on Banking Supervision has centered on higher capital and liquidity requirements, improved risk management and greater transparency. The new regulations have been globally enshrined under Basel III and have been further supplemented by national regulators in their respective jurisdictions. The primary focus this far, has been on higher capital requirements (Table 1). On top of the minimum requirements listed in Table 1, national regulators can impose additional capital requirements. For example, in Switzerland, banks can be asked to hold up-to an additional 2.5% in risk-weighted capital against their exposures to the mortgage sector.

Capital is the difference between the assets and liabilities held by a bank. In effect, creditors and depositors hold the liabilities of a bank while capital is held by the shareholders.

Table 1. Basel Minimum Risk-Weighted Capital Requirements

	Basel II	Basel III
Common Equity Tier 1 to RWA	N.A.	4.5%
Tier 1 to RWA (includes CET 1)	4%	6%
Total Capital to RWA	8%	8%
Capital Conservation Buffer	N.A	2.5%

Any losses that a bank makes are first absorbed by shareholders and then by creditors and depositors. Since shareholders are the owners of the firm, a higher level of capital encourages prudent behavior by a bank thus making it less susceptible to financial shocks. This in turn should lower borrowing costs for banks. However, as being the first exposed to any losses requires that the shareholders demand a higher return for taking on this risk. This trade-off forms the basis for the debate on the benefits and costs of higher capital requirements.

In most of the advanced economies (AE), the response of monetary authorities to the crisis was to lower the policy interest rate. This policy rate has remained close to zero for almost seven years now or even turned negative. With inflation below target and economic growth underwhelming, several AE central banks have adopted unprecedented measures loosely termed as unconventional monetary policies. These policy measures have been undertaken to lower long term interest rates and ease credit conditions.

The rationale is that low real (adjusted for inflation) interest rates would encourage household spending and thereby positively impact aggregate demand. However, low interest rates may not lead to higher investment by firms if future growth expectations are low or there is uncertainty about future demand. For example, Bertrand and Morse (2013) show that the increase in consumption leading up to the recent financial crisis was driven by less affluent and younger U.S. households. Further, Mian et al. (2013) show that the fall in demand was highest in areas that experienced higher appreciation of house prices. Given this nature of differentiated demand, it is not clear that to what extent the monetary policy measures can affect aggregate consumption and investment.

Research: This dissertation comprises of three chapters. The first two analyze the impact of capital regulation on bank lending for two different jurisdictions - United States and Switzerland. The third evaluates the response of U.S. non-financial firms to lower interest rates.

The first chapter is joint work with Prof. Luisa Lambertini. We quantify the impact of increased capital requirements on the lending spread of U.S. Bank Holding Companies. We use syndicated loans, which are loans made by a group of banks to a firm, as our laboratory of study. In contrast to most of the literature, we focus on loan pricing and not on volume. 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 Bank Holding Company to its balance sheet characteristics. This allows us to interpret our results conditional on firm characteristics and a positive demand for loans. Further we use stress test failure for BHCs under the Supervisory Capital Assessment Program and Comprehensive Capital Analysis and Review 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. We find: 1) Higher bank capital ratios contribute to higher loan spreads in the syndicated loan market; 2) Loan pricing is higher for Bank Holding Companies subjected to stress-tests; 3) Bank Holding Companies that failed the stress tests increased their loan pricing vis-à-vis peers that passed.

The second chapter is joint work with Prof. Luisa Lambertini, Dr. Dan Wunderli, and Dr. Robert Bichsel. We investigate the impact of higher capital requirements on loan spreads offered to non-financial firms in Switzerland. Switzerland with a large and heterogeneous banking sector provides an excellent laboratory for this study. In addition to Swiss regulatory authorities being at the forefront of capital regulation, different groups of banks have different capital targets. This allows us to not only assess the cost of each incremental unit of capital ratio on loan spreads but also how deviation from the supervisory target affects this pricing. We use a rich new confidential dataset on new credit granted to firms in Switzerland matched with supervisory data on bank capital and capital requirements. We use the matched dataset to analyze the impact of bank capital on credit supply along two different dimensions - pricing and volume. We also test for a permanent effect of higher capital on new credit growth. We find that banks to increase the loan spread and reduce loan growth in order to attain higher capital ratios. While statistically significant, the effects are economically small. We do not find a statistically significant permanent effect of higher capital ratios on new credit growth.

The third chapter empirically investigate changes in firm behavior along the dimensions of investment, payout to equity holders and cash holdings in the aftermath of recent financial crisis. I begin the analyses by documenting an increase in the real value of debt on the balance sheet of U.S. non-financial corporates and that this increase has been driven by long-term debt. I next investigate the relationship between long-term debt and investment and whether this has changed after the crisis using fixed effects panel regressions. I find a negative correlation between investment as a share of total assets and the ratio of long-term debt to assets. In the next set of tests, I evaluate alternate uses of debt namely, payouts to equity holders and cash holdings. I find that after the crisis, a higher long-term debt to asset ratio is positively correlated with payouts and negatively with the growth in cash holdings. Additionally, the likelihood of net share repurchases increases with the share of long-term debt post-crisis.

The empirical analysis in this dissertation provides new insights on the linkages between different economic agents. Assessing how bank capital impacts lending is extremely policy relevant as national regulators continue working towards a safer banking sector. The findings on the post-crisis behavior of firms contribute to the ongoing debate on the efficacy of current and future monetary policy actions. The dissertation is organized as follows. Chapter 1 presents the first paper, Is Bank Capital Regulation Costly for Firms? – Evidence from Syndicated Loans. Chapter 2 presents Bank Capital and Firm Lending: The Case for Switzerland. Chapter 3 presents Leverage & Use of Financing: Corporate America after the Great Recession.

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

Joint work with Prof. Luisa Lambertini (EPFL)

1.1 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 5 to 7 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 1.2, we briefly discuss the literature. Section 1.3 provides a short review of bank capital regulation in the United States. Section 1.4 describes the data and presents the summary statistics. Section 1.5 presents the econometric model and discusses the results. Section 1.6 presents robustness checks. Section 1.7 concludes.

1.2 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 et al. (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 et al. (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 et al. (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 et al. (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.

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.

1.3 U.S. Bank Capital Regulation

1.3.1 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 were risk-weighted 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

[1] We will document key aspects covering capital regulations under the Basel guidelines in section 2.3.

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-Frank 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 1.1, 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 1.1. 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

1.3.2 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 1.2 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.

1.4 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 1.16 in Appendix 3.A. We use the leading index for the United States as our macroeconomic variable. The leading index is a composite index that includes non-farm payroll employment, the unemployment rate, average hours worked and wages in manufacturing, housing permits

[4] www.sigtarp.gov

Table 1.2. 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

(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 1.3 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 1.1, 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.

Table 1.3. 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

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 1.1. 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.

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 after the crisis, and a fundamental change in tranche size and maturity.

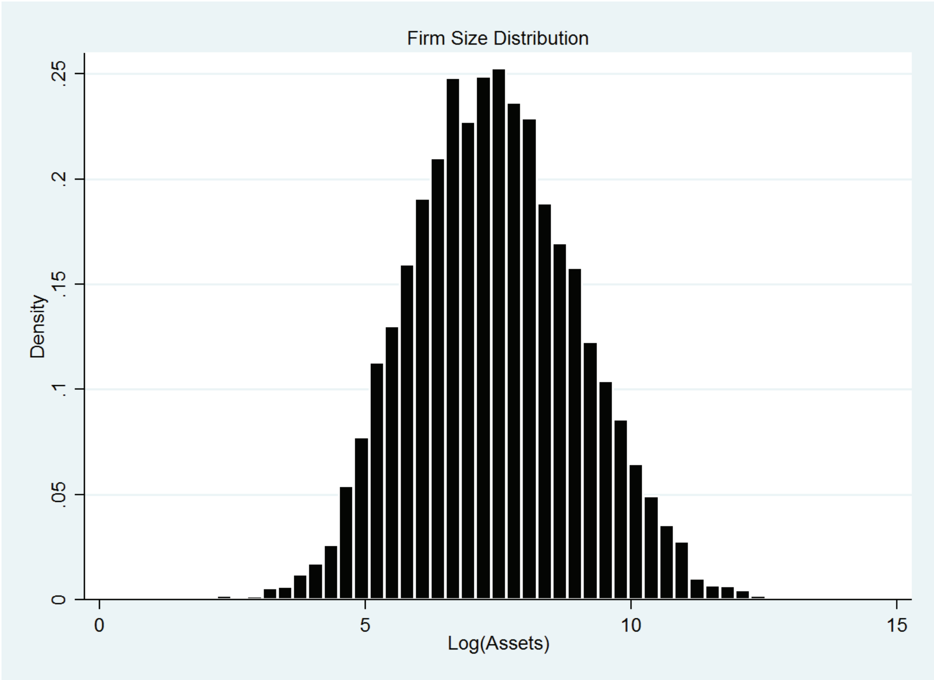

Figure 1.1. Firm Size Distribution

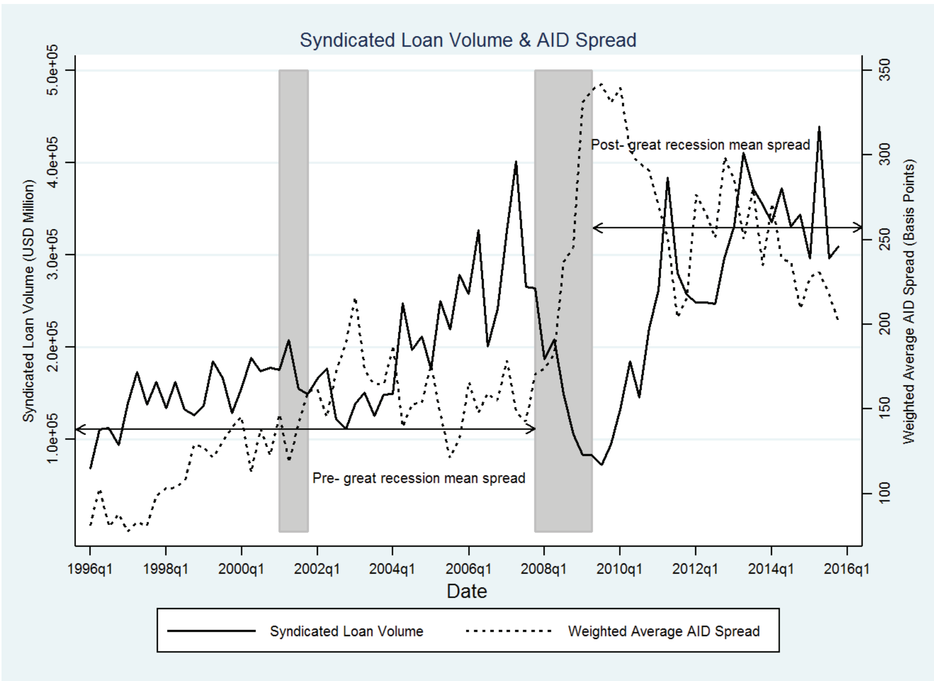

Figure 1.2. Quarterly evolution of syndicated loans and size-weighted AID spread

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.[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 1.4 show that there has been a post-crisis increase in spread both in the syndicated loan and corporate bond markets. As we 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 1.4. 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 1.3 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. Therefore firms in our sample are not reliant on bank funding alone.

Next, we plot the evolution of the weighted average credit rating and the AID spread for our sample firms in Figure 1.4. 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 is also the case for unrated firms as seen in Figure 1.5. 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 1.4. 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

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

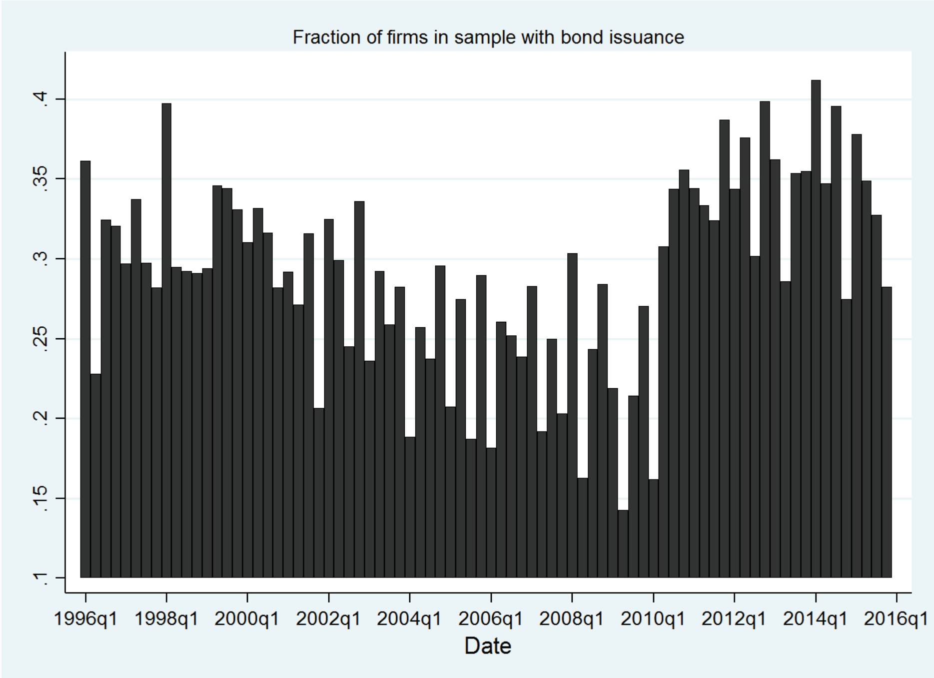

Figure 1.3. Fraction of bond issuing in-sample firms (Past 5 years)

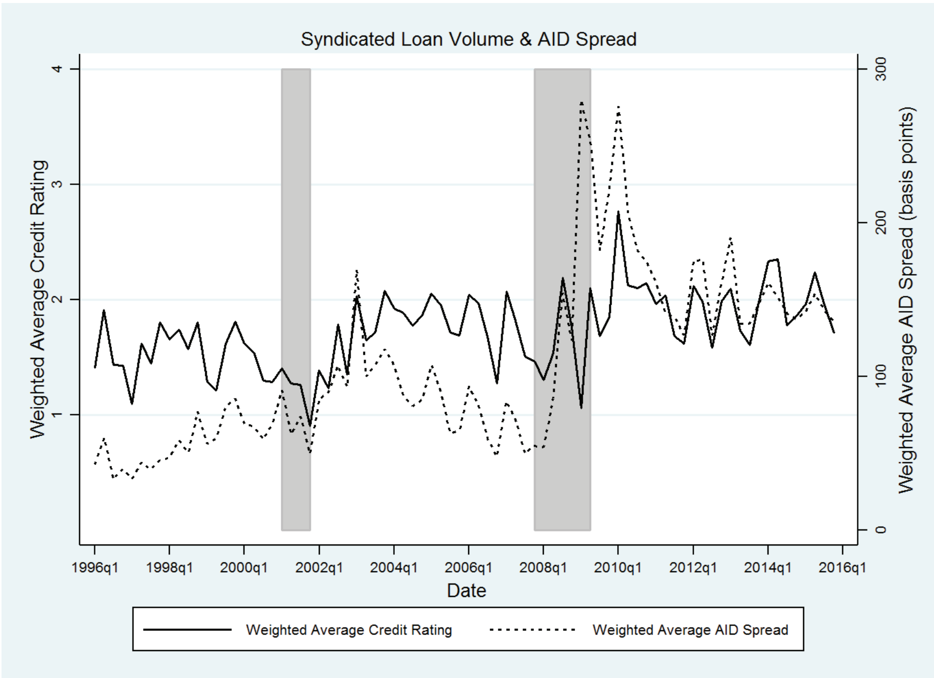

Figure 1.4. Weighted average credit rating and AID spread

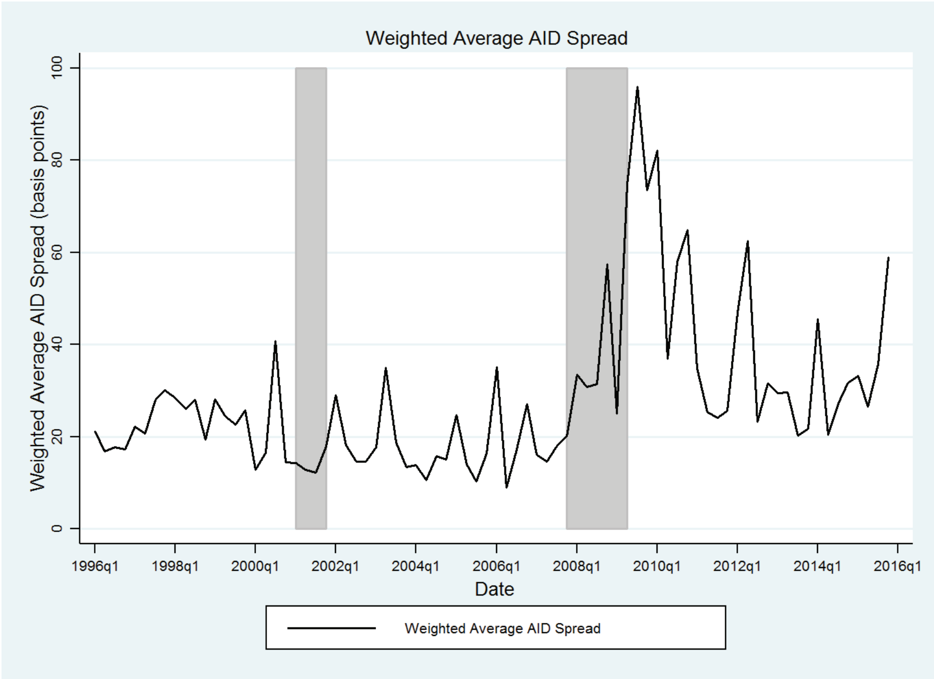

Figure 1.5. Weighted average AID spread - Unrated firms

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 1.5. We find a statistically significant difference in the mean spread pre- and post-crisis. We next analyze the loan characteristics as outlined in Table 1.6. 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 1.5. Comparison of AID Spreads by rating category

	Up to 2007Q4		2008Q1 to 2015Q4	
	Mean	S.D.	Mean	S.D.
≥ A-	39.16	39.12	95.49	60.32
≥ 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

Next we analyze the evolution of our capital measures for the BHCs in our sample. All

Table 1.6. 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

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 1.6. 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 1.7. 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 risk weighted assets to total assets to behave pro-cyclically for our sample BHCs as shown in Figure 1.8. 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.

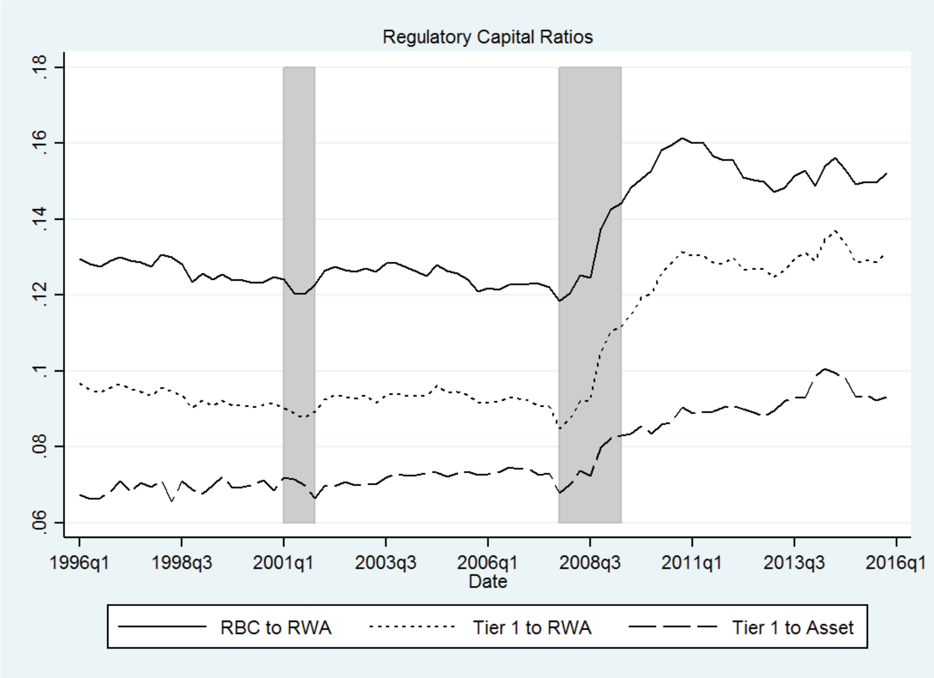

Figure 1.6. BHC capital ratios, 1996Q1 - 2013Q4

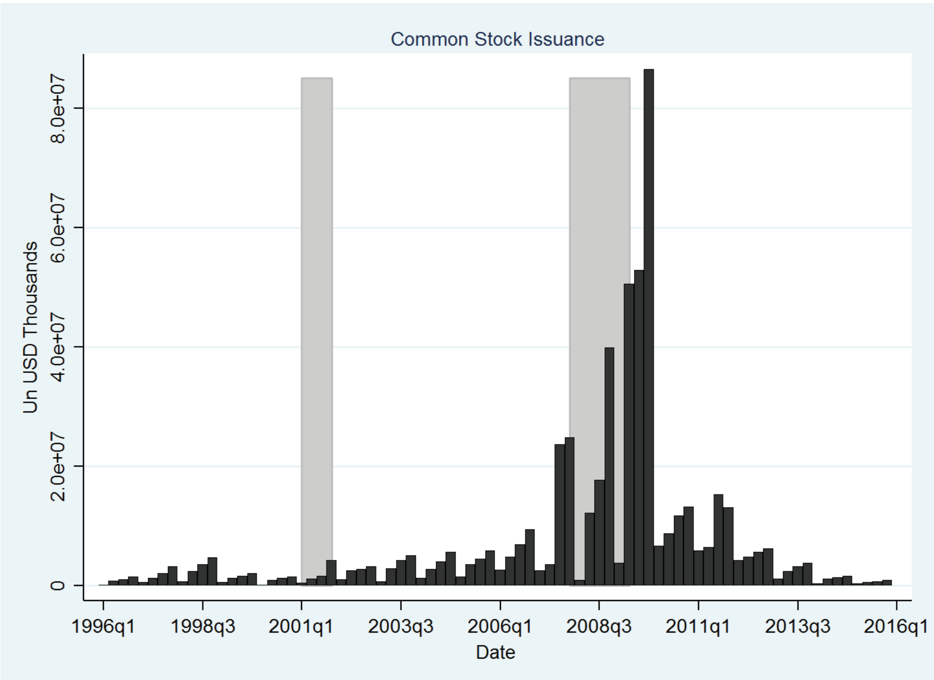

Figure 1.7. BHC Common Stock Issuance, 1996Q1 - 2013Q4

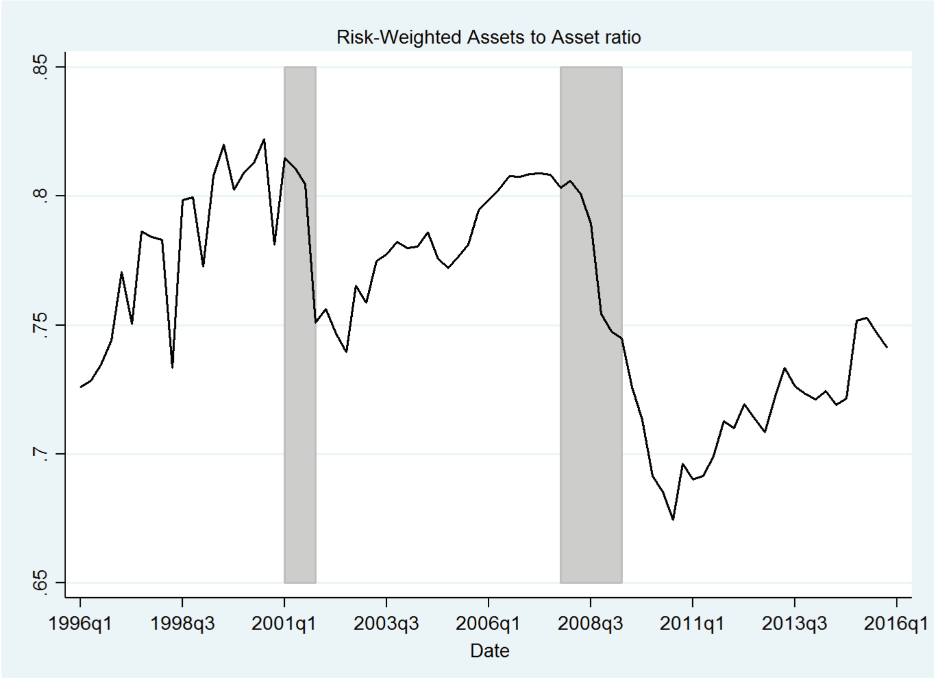

Figure 1.8. BHC RWA to Asset ratio, 1996Q1 - 2013Q4

1.5 Econometric Model and Results

1.5.1 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,

$$\begin{aligned} AIDspread_{i,j,t} &= \beta_1 CA_{i,t-1} + \beta_2 Firm_{i,j,t-1} + \beta_3 Bank_{i,t-1} + \beta_5 Loan_{i,j,t} + \\ & \quad \beta_4 Macro_{t-1} + f_j + b_i + \sigma_{ijt} \end{aligned} \tag{1.1}$$

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*

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

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 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 1.18 in Appendix 3.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 1.1 to be significantly greater than zero. Table 2.7 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

[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.

impact is observed for the Tier 1 leverage ratio. As outlined in section 2.3, 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 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 2.7. 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 BHCs 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 et al. (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.

1.5.2 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 1.3.2, 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:

$$\begin{aligned} AIDspread_{i,j,t} &= \delta_1 SCAP_{i,t} + \delta_2 SCAPFAIL_{i,t} * Fail_{i,t} + \beta_2 Firm_{i,j,t-1} \\ &\quad + \beta_3 Bank_{i,t-1} + \beta_5 Loan_{i,j,t} + \beta_4 Macro_{t-1} + f_j + \sigma_{ijt} \end{aligned} \tag{1.2}$$

The firm, bank, loan and macroeconomic control variables are the same as in equation 1.1. *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 1.8. 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

[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.

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 2.7. Combined with results reported in Table 2.7, 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 1.17 of Appendix 3.A. *Regulatory Pressure Fail* 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 1.9. 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 2.4, 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 1.3 using a population averaged probit model.

$$Fail_{i,t} = \beta_0 + \beta_1 Bank_{i,t-1} + \beta_4 Macro_{t-1} + \sigma_{i,t} \tag{1.3}$$

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 1.1. *Macro* is also the lagged four quarter mean of the leading index. Figure 1.9 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 1.19.

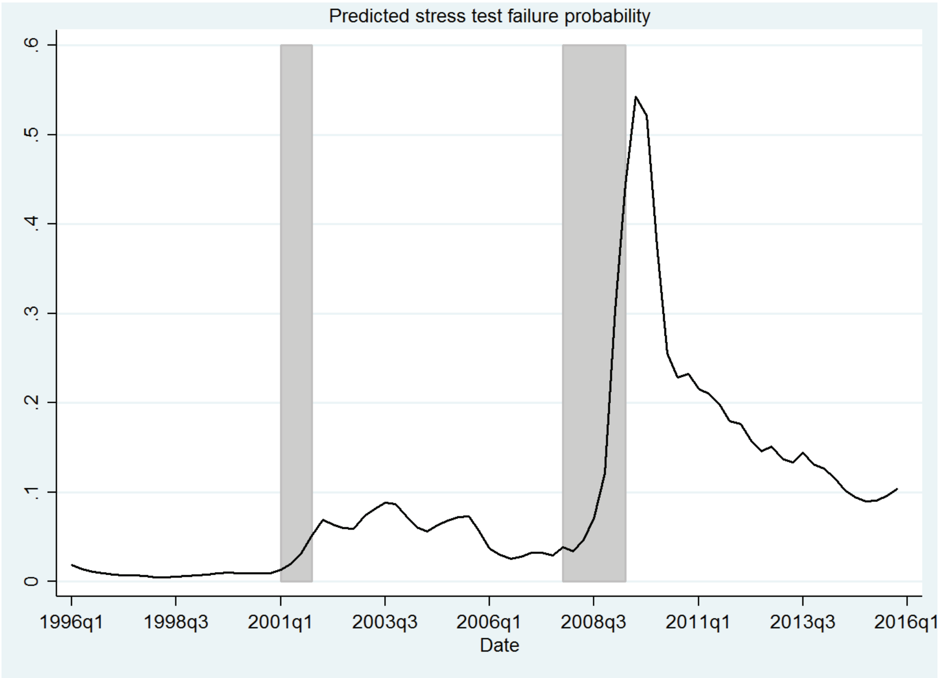

Figure 1.9. Predicted probability of stress-test failure

Table 1.7. Impact of Regulatory Capital Ratio on All In Drawn Spread

	Variable Group	(1) AID Spread	(2) AID Spread	(3) AID Spread
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 1.8. Impact of Regulatory capital Ratio - DID approach SCAP Failure

	Variable Group	(1) AID Spread	(2) AID Spread	(3) AID Spread
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	BHC	4.626***		
		(4.65)		
Tier 1 to RWA	BHC		4.270***	
			(3.81)	
Tier 1 to Asset	BHC			2.554
				(1.07)
Size	BHC	0.0149	0.0205	-0.00286
		(0.64)	(0.93)	(-0.14)
Liquidity	BHC	1.221***	1.160***	1.638***
		(6.15)	(5.64)	(8.29)
PPNR	BHC	6.271***	4.759**	4.567*
		(2.91)	(2.14)	(1.82)
Provisions	BHC	17.08***	20.78***	19.76***
		(3.80)	(4.55)	(4.01)
Charge-Offs	BHC	74.62***	75.92***	71.10***
		(3.77)	(3.81)	(3.53)
Deposit Expense	BHC	-29.17***	-27.03***	-30.07***
		(-4.24)	(-3.98)	(-4.66)
Funding Expense	BHC	-4.980	-4.409	-2.299
		(-0.70)	(-0.62)	(-0.29)
Size	Firm	-0.0873***	-0.0904***	-0.0797***
		(-4.34)	(-4.51)	(-3.89)
ROA	Firm	-2.032***	-2.031***	-2.047***
		(-4.73)	(-4.72)	(-4.79)
Liquidity	Firm	0.175	0.174	0.191
		(1.45)	(1.43)	(1.58)
Leverage	Firm	0.823***	0.821***	0.829***
		(8.83)	(8.80)	(8.91)
Loan Size	Loan	-0.0833***	-0.0830***	-0.0817***
		(-7.06)	(-7.03)	(-6.94)
Loan Maturity	Loan	0.0241	0.0254	0.0268
		(1.30)	(1.37)	(1.41)
Log(Syndicate Size)	Loan	0.0144	0.0120	0.0121
		(0.69)	(0.57)	(0.56)
Covenant Indicator	Loan	-0.217***	-0.217***	-0.216***
		(-7.39)	(-7.32)	(-7.15)
Leading Index	Macroeconomic	-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 1.9. Impact of Regulatory capital ratio - DID approach incl. CCAR

	Variable Group	(1) AID Spread	(2) AID Spread	(3) AID Spread
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	BHC	4.352***		
		(4.06)		
Tier 1 to RWA	BHC		3.892***	
			(3.25)	
Tier 1 to Assets	BHC			1.890
				(0.74)
Size	BHC	0.0163	0.0203	-0.00405
		(0.71)	(0.93)	(-0.21)
Liquidity	BHC	1.191***	1.147***	1.560***
		(6.07)	(5.60)	(7.73)
PPNR	BHC	6.628***	5.238**	5.192**
		(2.94)	(2.27)	(2.00)
Provisions	BHC	24.98***	28.53***	27.26***
		(4.58)	(5.32)	(4.80)
Charge-Offs	BHC	68.38***	69.44***	66.00***
		(3.22)	(3.24)	(3.04)
Deposit Expense	BHC	-30.21***	-28.32***	-31.15***
		(-4.39)	(-4.16)	(-4.82)
Funding Expense	BHC	-4.038	-3.454	-1.637
		(-0.58)	(-0.50)	(-0.21)
Log(Assets)	Firm	-0.109***	-0.113***	-0.105***
		(-5.07)	(-5.12)	(-4.71)
ROA	Firm	-2.117***	-2.125***	-2.137***
		(-5.04)	(-5.04)	(-5.08)
Liquidity	Firm	0.195	0.194	0.209
		(1.33)	(1.32)	(1.42)
Leverage	Firm	0.800***	0.797***	0.804***
		(8.77)	(8.73)	(8.80)
Loan Size	Loan	-0.0837***	-0.0833***	-0.0822***
		(-7.11)	(-7.08)	(-7.00)
Loan Maturity	Loan	0.0275	0.0288	0.0300
		(1.47)	(1.53)	(1.56)
Log(Syndicate Size)	Loan	0.0152	0.0130	0.0133
		(0.73)	(0.62)	(0.62)
Covenant Indicator	Loan	-0.227***	-0.227***	-0.226***
		(-7.63)	(-7.57)	(-7.46)
Leading Index	Macroeconomic	-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

1.6 Robustness Tests

In this section we conduct a series of robustness tests.

1.6.1 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 1.10. 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.

1.6.2 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 1.11 present the results for non-investment and investment grade firms, respectively. The effects are significant for both sub-samples.

1.6.3 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 1.1 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 1.12.

[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.

Table 1.10. 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

1.6.4 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 the DID variable corresponding to *SCAP Fail* in equation (1.2). Results are reported in Table 1.13. 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.

1.6.5 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:

$$\begin{aligned} AIDspread_{i,j,t} &= \delta_1 SCAP\,Fail_i + \delta_2 SCAP\,Fail_i * Post\,SCAP_t + \beta_2 Firm_{i,j,t-1} \\ &\quad + \beta_3 Bank_{i,t-1} + \beta_5 Loan_{i,j,t} + \beta_4 Time_t + f_j + \sigma_{ijt} \end{aligned} \tag{1.4}$$

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 equation1.4 with identical firm, loan and BHC variables as before and include a full set of time dummies. The results are presented in Table1.14. 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.

1.6.6 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 et al. (2016).

$$
\begin{aligned}
Loan\,growth_{i,j,t} \quad = \quad & \beta_1 \Delta Capital_{i,t-1} + \beta_2 \Delta RWA_{i,t-1} + \beta_3 Bank_{i,t-1} \\
& + Firm\,cluster * Quarter_{j,t} + Firm\,cluster * BHC_{j,i} \\
& + \sigma_{ijt} \qquad (1.5)
\end{aligned}
$$

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 1.15. 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 1.11. Robustness Tests - Firm Quality

	(Investment Grade)			(Non-Investment Grade & Un-rated)		
	AID Spread	AID Spread	AID Spread	AID Spread	AID Spread	AID Spread
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 1.12. Robustness Tests - Pro-rata loan allocation

	(1) AID Spread	(2) AID Spread	(3) AID Spread
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 1.13. 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 1.14. 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 1.15. 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

1.7 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. The results contribute to the recent policy debate on real economy effects of bank capital regulation and provide quantitative insights for macro-prudential policy design. However, higher capital reduces the probability of banking crises and associated losses in economic output. The benefits, therefore, need to be assessed vis-a-vis costs for improved policy design.

1.A Appendix: Variable Definitions

Table 1.16. 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

1.B Appendix: Sample BHCs subjected to stress-tests

Table 1.17. 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

1.C Appendix: Syndicated Loan Types

Table 1.18. 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

1.D Appendix: Probit Regression Results

Table 1.19. 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

1.E Appendix: Risk-based vs. non-risk-based capital measures

We mentioned in section 1.2 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 1.1 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 1.20. 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 1.20. Impact of Non-Risk-Based Equity to Asset on AID Spread

	(1) Up-to 2007Q2	(2) Up to 2015Q4	(3) 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

1.F 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 1.8). 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 2.1 along with the Tier1 to asset ratio as the main explanatory variable. The results tabulated in Table 1.21. 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 1.21. 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

2 Bank Capital and Firm Lending: The Case for Switzerland [1]

Joint work with Prof. Luisa Lambertini (EPFL), Dr. Dan Wunderli (SNB), and Dr. Robert Bichsel (SNB)

2.1 Introduction

In response to the recent financial crisis, the Basel Committee on Banking Supervision and national regulatory authorities have undertaken a number of reforms to enhance the ability of banks and the banking system to weather a future crisis. These have primarily focused on raising the quantity and quality of capital held by banks. Higher capital requirements aim to make banks less susceptible to financial shocks and thereby mitigate a credit crunch in adverse scenarios. However, if higher capital raises the cost of financing for banks, this may translate into lower financial intermediation and higher borrowing costs for firms and households. Therefore, it is important from a policy standpoint to analyze the effect of higher capital requirements on bank lending.

This paper investigates the impact of higher capital requirements on loan spreads offered to non-financial firms in Switzerland. A number of other studies have looked at loan quantity or pricing and whether they have been affected by higher capital. However, national regulators usually have identical capital requirements for all banks. Therefore, it is difficult to differentiate between the effect of capital and other demand conditions common to all banks. Switzerland with a large and heterogeneous banking sector provides an excellent laboratory for this study. In addition to Swiss regulatory authorities being at the forefront of capital

[1] The views expressed in this paper are those of the author(s) and do not necessarily represent those of the Swiss National Bank.

regulation, different groups of banks have had time varying capital targets. This allows us to not only assess the cost of each incremental unit of capital ratio on loan spreads but also how deviation from the supervisory target affects this pricing.

We use a rich new confidential dataset on new credit granted to firms in Switzerland. We match this with supervisory data on bank capital and capital requirements. We use the matched dataset to analyze the impact of bank capital on credit supply along two different dimensions - pricing and volume. We also test for a permanent effect of higher capital on new credit growth. We find that banks to increase the loan spread and reduce loan growth in order to attain higher capital ratios. While statistically significant, the effects are economically small. We do not find a statistically significant permanent effect of higher capital ratios on new credit growth.

The rest of paper is structured as follows. Section 2.2 reviews the literature. Section 2.3 provides a short review on capital regulation in Switzerland. Section 2.4 describes the data and presents descriptive evidence. Section 2.5 explains our empirical methodology. Section presents our results. Section 2.7 presents robustness checks. Section 2.8 concludes.

2.2 Related 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 (Modigliani and Miller (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 maybe costly. Aiyar et al. (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.

After the financial crisis in 2008, a number of studies across different jurisdictions have estimated the impact of bank capital requirements on lending to firms. Francis and Osborne (2009) estimate an internal capital target for U.K. banks during the period 1996-2007 and quantify how deviation form this target affects loan supply. 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 et al. (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 quarterly data on U.S. Bank Holding Companies (BHCs) between 1992 to 2009 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 corporate lending to capital ratios and supervisory capital requirements. 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. Dagher et al. (2016) review some of the extant literature and report the impact of a 1 percentage point increase in capital requirements on lending spreads to be in the range of 2 to 20 basis points. Cohen (2013) and Cecchetti (2014) corroborate this consensus in empirical findings in the context of Basel III.

A small number of studies analyze the capital behavior of banks in Switzerland and the impact of capital regulation on the Swiss economy. Rime (2001) uses a simultaneous equation model with capital and risk for the period 1989-1995 and finds that swiss banks increase their capital ratios by increasing capital and not by reducing Risk-Weighted Assets (RWAs). Using bank balance sheet data, Junge and Kugler (2013) estimate the increase in weighted average cost of capital as result of higher common equity tier 1 capital (CET1) requirement for Swiss banks and predict the resulting increase in loan rates for the non-financial sector to be in the range of 0.6 - 1.6 basis points. Our study contributes to this literature by using the novel loan-level data set matched with supervisory data on bank balance sheets and capital requirements.

2.3 Capital Regulation in Switzerland

We begin by defining the capital measures used in our study,

1. CET1 Capital (core capital) predominantly consists of paid-in, disclosed reserves, after-tax retained earnings;
2. Additional Tier 1 (AT1) Capital primarily includes paid-in capital not eligible as CET1 , and perpetual capital contingent instruments;
3. Tier 2 (T2) Capital (supplementary capital) primarily includes fixed maturity capital contingent instruments and subordinated term debt;
4. Leverage ratio is the ratio of Tier 1 capital to total assets.
5. Risk Weighted Assets (RWA) are computed by weighting different asset classes and/or off-balance sheet exposures by a corresponding risk-weight.

At the beginning of our sample period (2006), every bank in Switzerland needed to fulfill the minimum Basel capital requirements of 8% capital to RWAs plus an additional 20% ("Swiss Finish"), resulting in a total capital-to-RWA requirement of 9.6%. From there onwards, capital requirements were increased piece-meal for different bank groups. In 2007, the requirement for the two big banks, Union Bank of Switzerland (UBS) and Credit Suisse (CS), was increased from 9.6% to 10.4%. In 2009, the requirement for these two banks was increased from 9.6% to 18% to be phased-in by 2013. In 2011, Pillar 2 requirements [2] for all banks were introduced in Switzerland. Five groups of banks are determined using the following four variables: Size of bank's balance sheet, assets under management, priviliged deposits, amount of total minimum capital requirements (as the level, not as RWA). From 2011 onwards, regulatory targets in Switzerland were not only formulated in terms of total capital, but also in terms of CET1 , Tier 1 (T1), AT1 and T2 capital. We tabulate these requirements for each bank category in Table2.1. Capital requirements for UBS and CS (Category 1 banks) are being determined annually starting 2012.

[2] *"Pillar 2 covers the supervisory review process which ensures that banks have sufficient capital to back all risks and also requires appropriate management of these risks."* - Swiss Financial Market Supervisory Authority, FINMA

Table 2.1. Capital Requirements for Swiss Banks starting 2011

Bank Group	Total Capital Requirements (%)	CET 1(%)	AT1 (%)	T2 (%)
Category 2	13.6-14.4	8.7-9.2	2.1-2.2	2.8-3.0
Category 3	12	7.8	1.8	2.4
Category 4	11.2	7.4	1.6	2.2
Category 5	10.5	7	1.5	2

Source: FINMA circular 2011/2

Additionally, from 2012 onwards, the too-big-to-fail (TBTF) regulation[3] took effect. In Switzerland, the Swiss National Bank (SNB), designates institutions that are TBTF. The Swiss Financial Markets Regulatory Authority (FINMA) then elaborates in an institution-specific decree what this means for the TBTF-bank in terms of regulatory targets on capital, liquidity, and large exposures. As a result of this process, there have been instituion-specific capital targets for UBS and Credit Suisse (CS) starting 2012, and for the cantonal bank of Zurich (ZKB) from 2014 onwards. The more recent designation of two more banks as systemically important (Raiffeisen-Group (Switzerland) and PostFinance) is outside our sample period.

2.4 Data & Descriptive Evidence

For our analysis, we utilize multiple confidential datasets of the Swiss National Bank (SNB). The loan level data is obtained from the lending rate statistics (KREDZ). Every new loan arrangement is reported at a monthly frequency, starting 2006Q3, by all banks whose total lending to non-financial corporations exceeds CHF 2 billion. A new loan arrangement is defined as new credit granted or an old credit to which significant changes have been made (e.g. change in maturity or pricing). Loan characteristics in KREDZ includes the price, size, maturity, type, and type of collateral (if any). It includes firm location (canton), the industry in which the firm operates, an identifier for firm size, and a combined firm and loan risk indicator. However it does not include an unique firm identifier. This new dataset is one of the strengths of our study as it allows us to use new credit granted as opposed to loan stocks which have been commonly used in banking studies.[4] The reporting banks account for approximately 80 percent of the Swiss banking sector assets. We match this dataset with

[3] https://www.finma.ch/en/ /media/finma/dokumente/dokumentencenter/myfinma/faktenblaetter/faktenblatt-schweizer-too-big-to-fail-regime-tbtf.pdf?la=en

[4] A few of the shortcomings in using loan stocks for analysis are that it can be influenced by write-offs, changes in reporting, exchange-rate effects etc.

supervisory data on capital requirements, capital and bank characteristics.[5] Our matched panel dataset includes data from 2006Q3 until 2014Q4. Table 2.2 presents the summary statistics on key loan characteristics and bank capital. Loan spread is the interest rate charged on the loan over the 3-month CHF LIBOR.

Loan Characteristics:
There are three main dimensions along which a change in credit supply can occur; pricing, volume, and maturity. We analyze quarterly behavior for each of these. In Figure 2.1, we plot the loan spread weighted by the loan size. There is a decrease in the spread from the starting point of our sample until 2008Q3. This decrease was driven by an increase in the 3 month CHF LIBOR during that period. This is consistent with the compression in spreads across asset classes globally in the lead up to the GFC (Walutowy and IMF (2007)). In 2008Q4, there is a spike in the spread and it has remained at that level till the end of our sample period in 2014Q4. The increase in spread in 2008Q4 can be attributed to the onset of the global financial crisis (GFC). Next, we plot the quarterly issuance of loan arrangements in Figure 2.2. The sharp increase in 2008Q3 and 2008Q4 is not related to a crisis phenomena but rather to the fact that banks were given a deadline of year-end 2008 to match the required reporting standards. Broadly we have two kinds of credit in our dataset, fixed maturity loans and credit lines. While the relative volume of fixed maturity loans and credit lines reported was comparable prior to 2008Q3, they now comprise less than 10 percent of quarterly loan arrangements as reported in our dataset. Therefore the increase in loan volume is not due to a drawing down on credit lines as reported by Ivashina and Scharfstein (2010) for U.S. firms. Further, the increase was not driven by a specific type of loan within the fixed maturity category. We report the frequency of loan categories over the entire sample and up-to 2008Q4 in Appendix 3.A.[6] Last, Figure 2.3 plots the size-weighted loan maturity. It shows that the size weighted maturity of new loan arrangements during our sample period is approximately one year. The figure does not reveal any sharp shortening or lengthening in maturity. Overall, characteristics of new loan arrangements indicate an increase in spread at the onset the GFC but no discernible change in the aggregate volume or maturity. If anything, the volume shows an increase.

Firm Characteristics:
The next part of the analysis deals with sample firm characteristics. Firms in our sample are classified into 6 size categories based on total assets. The cutoffs are CHF 1 Million, CHF 5 Million, CHF 25 Million, CHF 100 Million and greater than CHF 100 Million. The remaining

[5] Banks report at the individual level and/or at the highest level of consolidation. Where applicable, we use the highest level of consolidation for our analysis.

[6] Additionally, this increase in loans was not driven by any single or group of banks. We cannot report individual bank data due to data confidentiality.

category is when size was reported as 'unspecified' by the bank. We assign an indicator variable taking values between 1 and 5 for the size categories and 0 for the unspecified. Figure 2.4 indicates that the majority of firms in our sample have total assets less than CHF 5 Million.[7] Additionally, we have composite measure of firm and loan riskiness which we label probability of default (PD) class. This is also categorized into 5 classes ranging from low to high and a sixth class for unspecified observations. We attach an indicator variable like we did for firm size categories.[8] Figure 2.5 indicates that there was an increase in riskiness as measured by PD class for credit granted starting 2008Q4. While the firm size measure does not reveal a substantial time-series variation, there is some evidence for an increase in the riskiness of for our combined measure of loan and firm risk.

Bank Capital Characteristics:[9]

The last part of our aggregate analysis presents the evolution of bank capital measures. We use three measures of the regulated capital ratio: Total Risk-based capital to RWAs, Tier 1 capital to RWAs, and Tier 1 Capital to Assets (Tier 1 leverage ratio). We observe a gradual increase in these measures starting 2008Q4 as shown in Figure 2.6. The sharper increase in the Tier 1 to RWA ratio compared to the Tier 1 leverage ratio indicates that part of the increase can be attributed to a reduction in RWAs. We further breakdown capital, assets, and RWAs in Figures 2.7 and 2.8. We observe a sharp increase in tier 1 capital and a corresponding increase in total capital between 2008Q3 and 2008Q4 and a gradual increase thereafter (Figure 2.7). At the same time, both assets and RWAs fell as illustrated in panel A of Figure 2.8. Finally, panel B of Figure 2.8 shows that the ratio of RWAs to total assets of the Swiss banking sector has fallen from nearly 56% to 47% during our sample period. Aggregate evidence suggests that Swiss banks have adjusted to higher required capital ratios by both increasing capital and reducing RWAs.

[7] We report the frequency of firms in each category of firm size in Appendix 2.B.

[8] We report the frequency of firms in each category of PD class in Appendix 2.C.

[9] Bank balance sheet variables are reported monthly. However income statement variables and capital is reported semi-annually. Retained earnings are reported annually. To construct our capital measures, we allocate retained earnings based on half-yearly profits. Further, after adjusting for retained earnings, we interpolate capital for quarters 1 and 3.

Table 2.2. **Summary Statistics**

Variable	**Units**	**N**	**Mean**	**SD**	**p5**	**p95**
Loan Spread	Percent	961776	2.431034	1.872321	.4536909	6.452577
Log Loan Amount	Log	961776	6.012401	1.426385	3.912023	8.594154
Loan Maturity	Years	582855	2.206638	2.739894	.0821355	7.997262
Total Capital to RWA	Ratio	961776	.163869	.0341088	.1132485	.220021
Tier 1 Capital to RWA	Ratio	961776	.1406153	.0322714	.0809856	.1924206
Tier 1 Capital to Assets	Ratio	961776	.0623182	.0196076	.032893	.1018963
Log Bank Assets	Log	961776	18.55921	1.589015	16.43554	20.61067

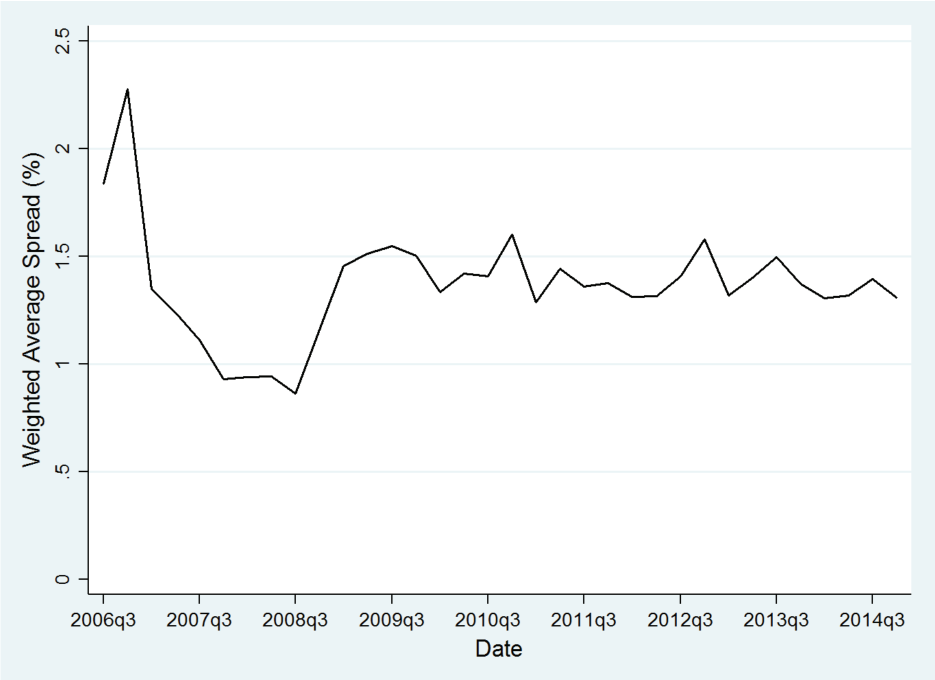

Figure 2.1. Weighted Average Loan Spread

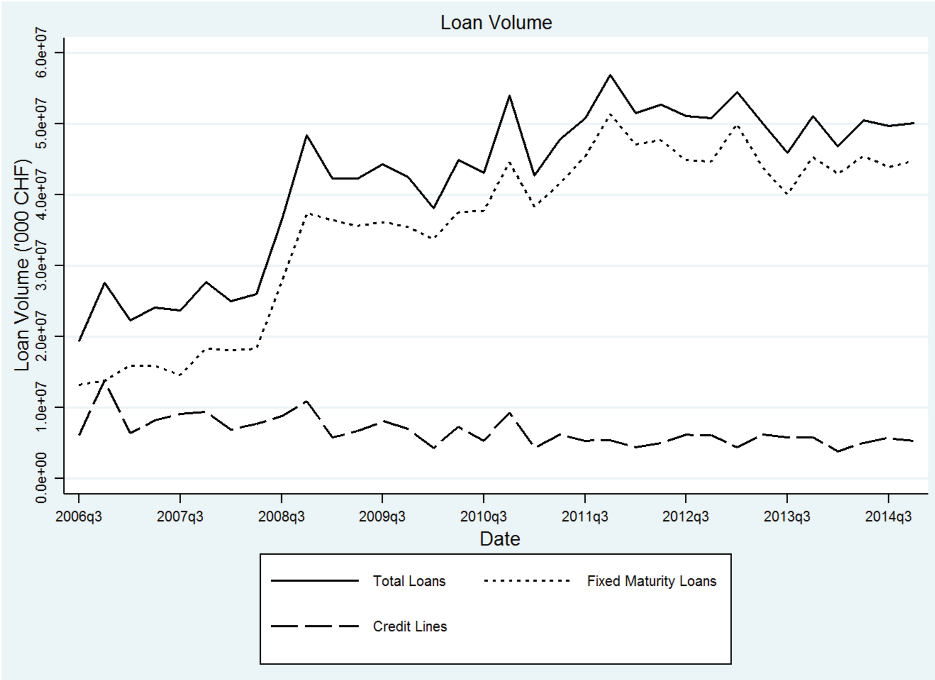

Figure 2.2. Total Volume of New Loan Arrangements

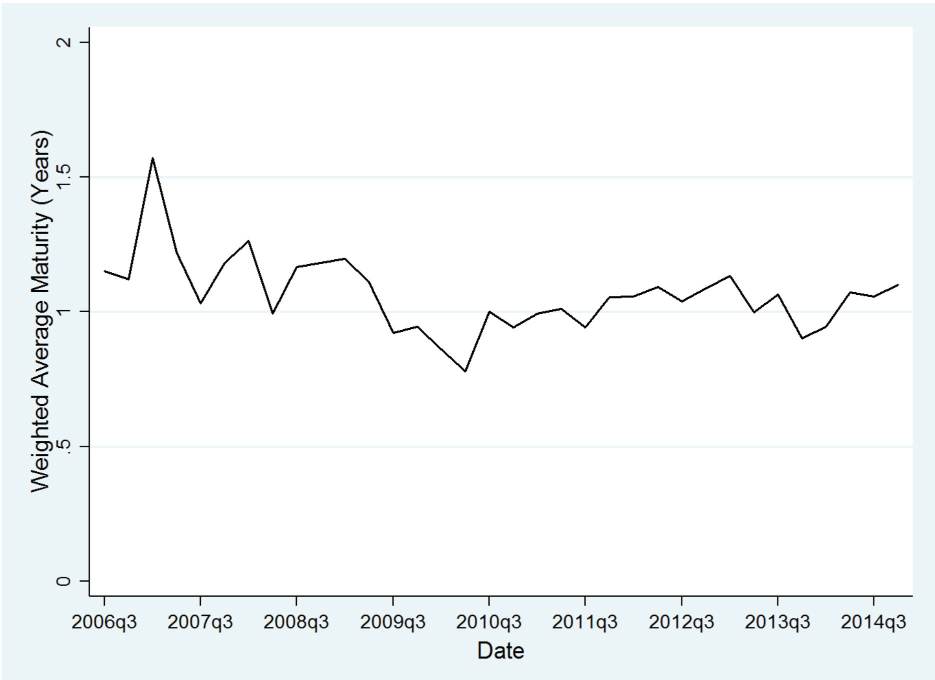

Figure 2.3. Weighted Average Loan Maturity

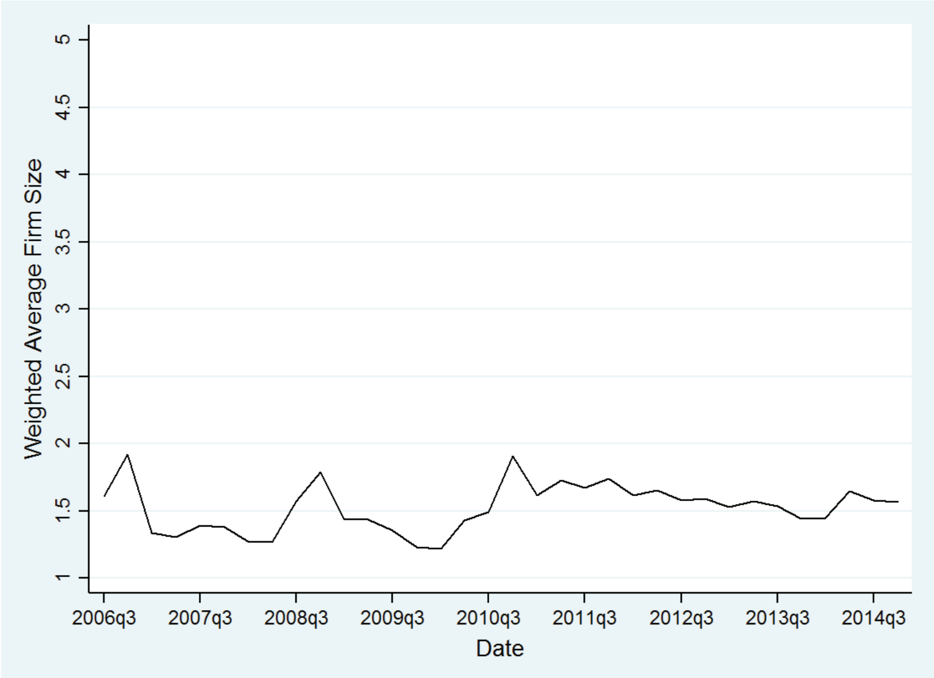

Figure 2.4. Weighted Average Firm Size

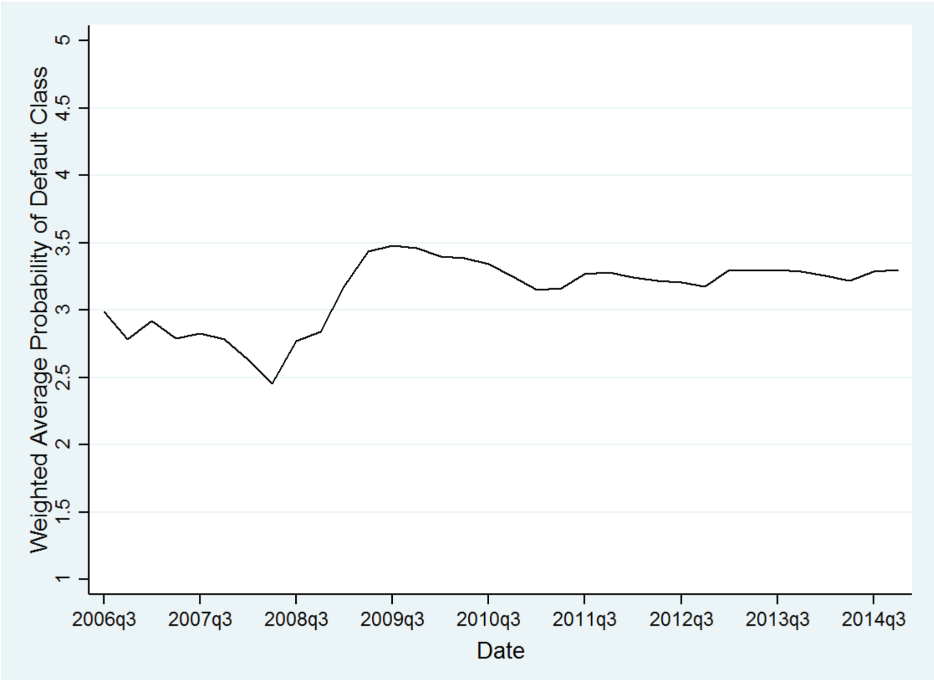

Figure 2.5. Weighted Average Probability of Default Class

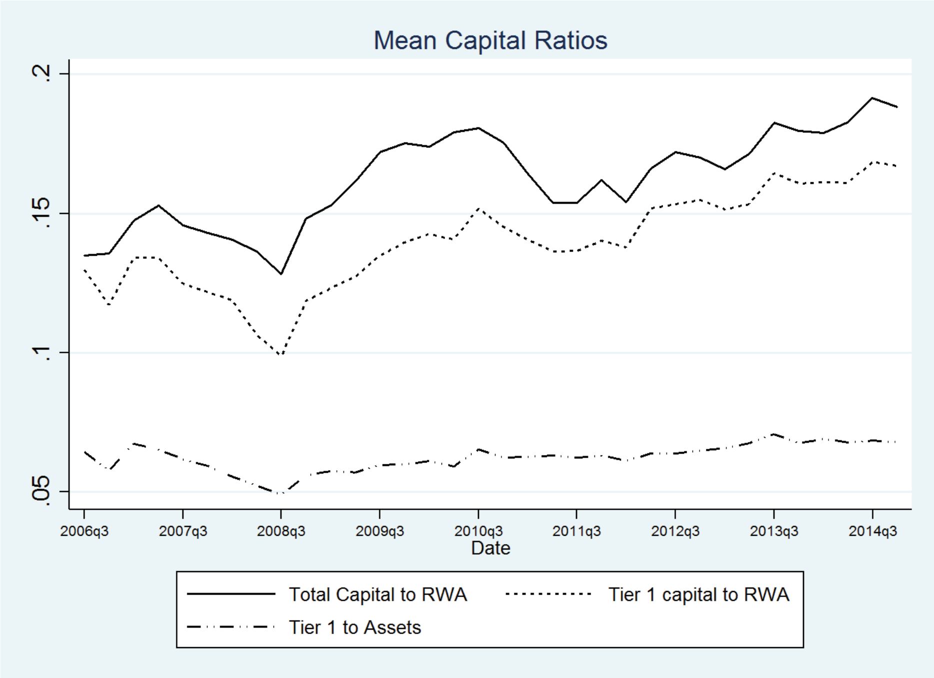

Figure 2.6. Mean Capital Ratios

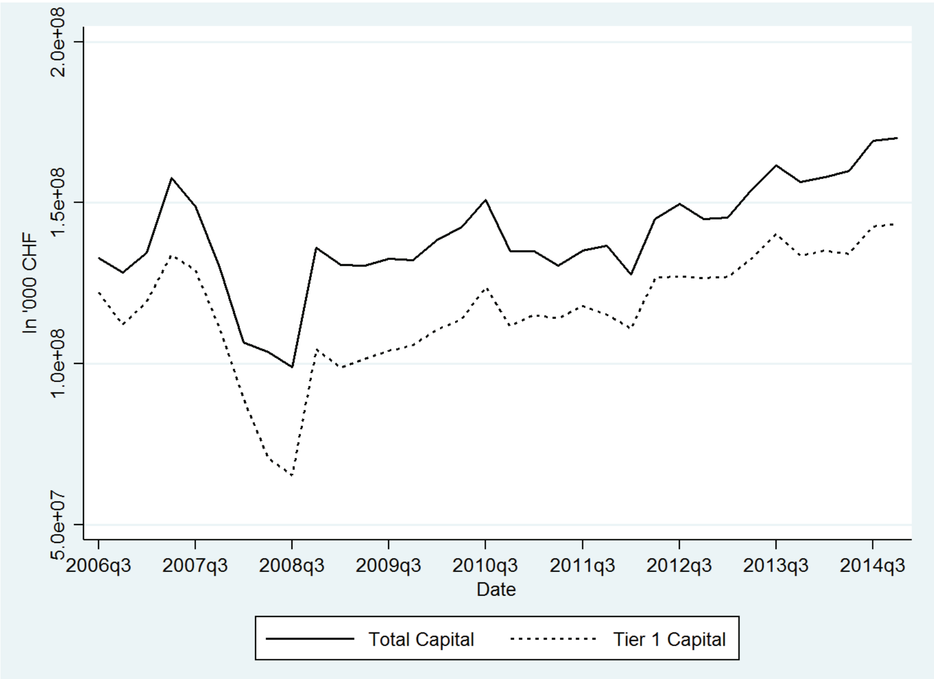

Figure 2.7. Total and Tier 1 Capital

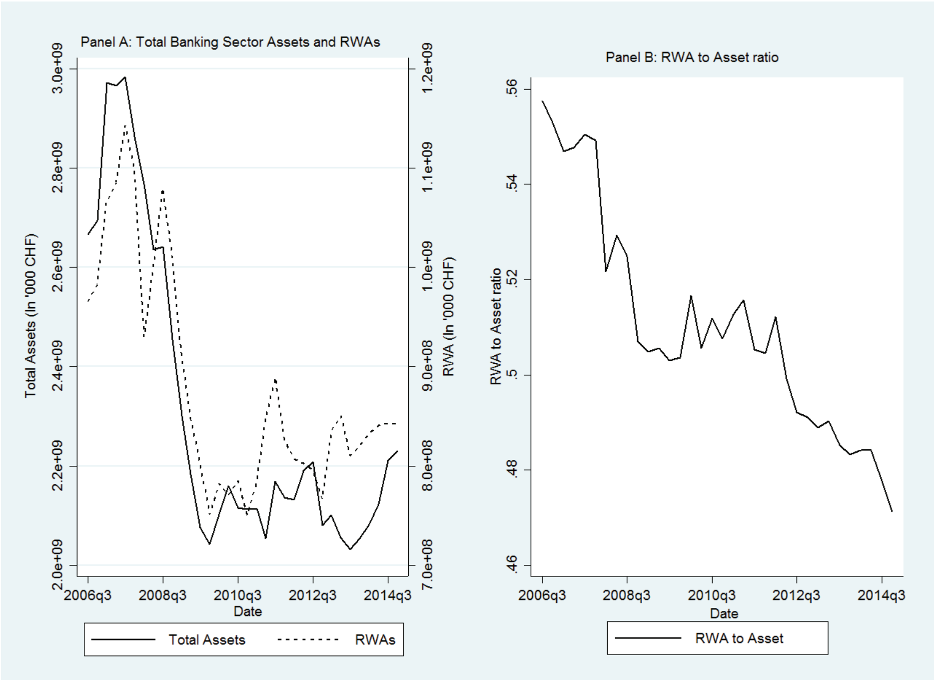

Figure 2.8. Total Assets and Risk-Weighted Assets (RWAs)

2.5 Empirical Model

2.5.1 Loan Spread Base Specification

To estimate the impact of regulated capital ratios on loan spreads, we estimate the following equation:

$$\begin{aligned} r_{i,j,t} \quad = \quad & \beta_1 K_{i,t-1} + \beta_2 Dev_{i,t-1} + \beta_3 \text{Bank}_{i,t-1} + \beta_4 (\text{Firm \& Loan})_{j,t} + \\ & Bank\ Fixed\ Effects + Time\ Fixed\ Effects + \epsilon_{i,j,t} \end{aligned} \tag{2.1}$$

$r_{i,j,t}$ measures the spread between the interest rate and 3-month CHF libor for each new loan arrangement. All independent variables are lagged one period to avoid simultaneity. $K_{i,t-1}$ denotes the measure of the capital ratio. To account for asymmetry introduced due to supervisory capital requirements, we include the dummy, $Dev_{i,t-1}$. The dummy takes a value of 1 if the actual capital ratio is greater than the supervisory target and 0 otherwise. $Bank_{i,t-1}$ is a vector of bank-specific characteristics, namely Size (log of total assets), Liquidity (cash to assets), Debt (medium term notes and bonds to assets), ROA (net income to assets). The vector $Firm$ & $Loan$ includes controls for firm size, industry, loan amount, loan type, and collateral type. To distinguish between fixed maturity loans and credit lines, we include the indicator variable, $Credit\ Line\ Dummy$. It take a value equal to 1 if the loan has a fixed maturity, 0 otherwise. Further we estimate equation 2.1 separately for these two types of loans. Bank fixed effects control for any unobserved systematic heterogeneity at the bank level. Time fixed effects control for macroeconomic conditions and any demand effects common to all banks at a given point in time. In equation 2.1, β_1 greater than 0 would imply that a higher level of bank capital ratio causes an increase in loan spreads.

2.5.2 Asymmetric Effects

We attempt to further delineate the impact of any asymmetry introduced by supervisory capital requirements. From a regulatory standpoint, for a bank i, the important question is how far its capital $K_{i,t}$ is below or above the supervisory requirement, $K^*_{i,t}$. In the first case, that is if $K_{i,t} - K^*_{i,t} < 0$, the bank is short of capital. As a result, the bank needs to build up capital K, e.g. by higher retained earnings or by issuing capital instruments. As an alternative, the bank may decrease its RWA if the bank is short of capital in the risk-weighted dimension only. In the second case, that is if $K_{i,t} - K^*_{i,t} > 0$, the bank is capitalized well enough and there are no immediate reasons as to why the bank should charge a higher spread. In addition to this asymmetry, the distance of K from $K^*_{i,t}$ will determine how a bank reacts. If a bank's capital $K_{i,t}$ is far above its target $K^*_{i,t}$, it will face fewer restrictions than if $K_{i,t}$ is only marginally above $K^*_{i,t}$. We account for this asymmetry in $K_{i,t} - K^*_{i,t}$ by creating dummy variables $I_{[a,b)}$ for different buckets of size two percentage points for $K_{i,t} - K^*_{i,t}$. E.g., if $-4\% < K_{i,t} - K^*_{i,t} < -2\%$, the dummy $I_{(-4,-2]} = 1$. If $0\% < K_{i,t} - K^*_{i,t} < 2\%$, the dummy $I_{(0,2]} = 1$. The coefficients, β_2 to β_6, measure extent to which under-capitalized or well-capitalized banks react in terms of loan spreads. We augment our baseline specification and estimate equation 2.2[10].

$$\begin{aligned} r_{i,j,t} \quad = \quad & \beta_1 K_{i,t-1} + \beta_2 I_{(-2,0]} + \beta_3 I_{(0,2]} + \ldots \beta_6 I_{(8,+\infty)} + \beta_7 \text{Firm}_{j,t-1} + \beta_8 \text{Bank}_{i,t-1} \\ & + Bank\ Fixed\ Effects + Time\ Fixed\ Effects + \epsilon_{i,j,t} \end{aligned} \tag{2.2}$$

2.5.3 Loan Growth Baseline Regression

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 for non-financial firms. To test the importance of loan volume, we use an estimator based on Khwaja and Mian (2008) & Acharya et al. (2016). Unlike Khwaja and Mian (2008), we cannot track firm-bank relationships over time as our dataset does not include an unique firm identifier. Following Acharya et al. (2016), we aggregate loans based on industry and probability of default class by each bank every quarter. The underlying assumption in using this criterion is that firms in Switzerland in a specific industry and risk category (firm-cluster) share common characteristics and were likely exposed to a common macroeconomic environment during the sample period. Therefore our unit of observation is bank-quarter-(firm-cluster). 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 bank heterogeneity and any relationships between firm-cluster and bank, we interact firm-cluster and bank fixed effects. Loan growth is the quarterly change in loan volume by bank, i to firm-cluster, k. Our regression also includes the same bank controls as before.

[10] We only estimate the effect of total capital to risk-weighted asset ratio and its deviation as an explicit Tier 1 capital ratio requirement came into force in 2011Q3.

Specifically, we estimate the following regression:

$$\begin{aligned}\Delta L_{i,k,t} &= \beta_1 K_{i,t-1} + \beta_2 Dev_{i,t-1} + \beta_3 \text{Bank}_{i,t-1} + \\ &(Firm\ Cluster)_k * Time\ Fixed\ Effects + \\ &(Firm\ Cluster)_k * Bank\ Fixed\ Effects + \epsilon_{i,j,t} \end{aligned} \tag{2.3}$$

2.5.4 Permanent versus temporary effect

This far our empirical specifications have estimated the short-term impact on loan spreads and loan volume. However, it is possible that short-run effects of higher capital ratios are different from long-run effects. For example, Bridges et al. (2014) find a lower long-term impact of an increase in capital requirements compared to the short-term for U.K. banks. We do so by introducing the quarterly lagged loan growth as an explanatory variable. We estimate the dynamic panel model in equation 2.4 using the dynamic Generalized Method of Moments estimator developed by Arellano and Bond (1991).[11] In this specification, we aggregate loans at the bank level. This enables us to have a balanced panel. The long-run effect of capital ratio on loan growth is captured by $\beta_1/(1-\gamma_1)$. Given our panel structure (N=21, T=32), we also estimate the equation in a fixed-effects framework. The presence of a lagged variable introduces a downward bias in the estimate of γ (Nickell bias,Nickell (1981)). However, for T>30, simulation studies have shown that this bias becomes negligible (Bruno et al. (2005), Judson and Owen (1999)). We present results using both estimation techniques to show that our findings are not biased by choice of estimator.

$$\begin{aligned}\Delta L_{i,t} &= \gamma_1 \Delta L_{i,t-1} + \beta_1 K_{i,t-1} + \beta_2 \text{Dev}_{i,t-1} + \beta_3 \text{Bank}_{i,t-1} + \\ &(Firm\ Cluster)_k * Time\ Fixed\ Effects \\ &+ (Firm\ Cluster)_k * Bank\ Fixed\ Effects + \epsilon_{i,j,t} \end{aligned} \tag{2.4}$$

2.6 Results

This section presents the results on how bank capital affects loan spread and volume. Tables 2.7 and 2.4 present the estimates for the impact of different measures of the regulated capital ratio on loan spreads. Results from the loan growth regression are presented in Table 2.5 while

[11] We use difference GMM.

Table 2.6 reports the long-run effect of higher capital to asset ratios.

2.6.1 Impact of capital ratios on loan spreads

Table 2.7 presents the estimates obtained from equation 2.1. We find a 1 percentage point increase in the total capital to RWA ratio is observed along with an increase in the loan spread of 2.5 basis points. The point estimate for the tier 1 capital to RWA is slightly lower at 2.1 basis points. While the coefficient on the Tier 1 leverage ratio is higher, it is not statistically significant. A 1 standard deviation (SD) increase in the total capital to risk-weighted ratio, therefore, would cause a 0.07 basis point increase in loan spread which is 0.03 % of the average loan spread in our sample. Similarly, for the Tier 1 to RWA ratio, a 1 SD increase would also correspond to a 0.03% increase in loan spread. These estimates indicate the economic significance of higher capital ratio to be extremely low, if any. We find evidence for an asymmetric response in bank behavior with respect to whether it is below or above the supervisory capital requirement for both the total capital and tier 1 capital ratios. The negative sign on the dummies, $Capital\ Deviation$ and $Tier\ 1\ Deviation$ indicates the banks with capital ratios above the supervisory requirement charge a lower spread vis-a-vis a bank that is below the required capital target. Our loan controls reveal three facts about the loan market for non-financial corporations in Switzerland: (i) fixed maturity loans are cheaper that credit lines; (ii) riskier firms and loans, as defined by the probability of default class, are charged a higher spread; (iii) loan spreads are positively correlated with the slope of the yield curve. Since banks borrow at the short end and lend at the longer end of the yield curve, this correlation indicates the cost of hedging the interest rate exposure. We also find that larger loans are charged a lower spread. This could be driven by the fact that larger loans are given to larger firms which could be less risk, more profitable and with an overall stronger balance sheet. Even though we control for broad firm characteristics, our dataset does not allow us to include specific firm level controls. Among our bank-level controls, only bank size as measured by the log of assets is statistically significant. The positive coefficient is indicative of Swiss banks behaving as monopolistically competitive in the corporate loan sector.

2.6.2 Asymmetric effects of capital requirements

In Table 2.4, we extend our baseline model to further account for the deviation between the observed total capital ratio and the supervisory requirement. We find that relative to a bank which has a total capital to RWA asset ratio less than 2 percent below the supervisory target, banks charge lower spreads as they move closer to the target and the reduction is larger if they are above. While column 1 of Table 2.4 reports the estimates for our entire sample, in columns 2 and 3, we separately report the estimates for fixed maturity loans and credit lines respectively. We find a quantitatively larger effect of higher capital ratio on the loan spreads for credit lines than fixed maturity loans. However, credit lines comprise only 10 percent of the total loan volume over our sample period. Interestingly, we do not find bank size to have any statistically significant impact on loan spreads for credit lines. This indicates that it is the fixed maturity loan segment where banks exhibit monopolistically competitive behavior. There are two additional facts about the fixed maturity loan segment that our estimation indicates: (i) longer maturity loans are charged a higher spread; (ii) syndicated loans are charged a lower spread which could be due to the positive impact of risk sharing. The effect of the other control variables is qualitatively similar to that in Table 2.7.

2.6.3 Impact of bank capital on loan growth

In Table 2.5, we report the estimates based on the modified Khwaja and Mian (2008) estimator. Consistent with the narrative of higher capital causing a contraction in credit supply, we find the coefficient on capital ratios to be negative. However, now the total capital to RWA is not statistically significant. A 1 percentage point increase in total capital and tier 1 capital to RWA negatively affects loan growth by 1.6 percent and 4.6 percent respectively. We also find the effect of having a capital ratio greater than the supervisory target to be positive on loan growth. We also find a statistically significant impact of the tier 1 to asset ratio on loan growth. The tier to asset ratio expunges any effects arising from a switching between assets in the same risk category.[12] Therefore the higher point estimate reflects a more encompassing effect of tier 1 capital. The point estimate in our baseline loan spread regression is also higher and very close to statistical significance at the 10% level. The fact that our sample ends in 2014Q4 and that an explicit tier 1 to asset ratio requirement was introduced only in 2011Q3 is probably why our estimate lacks power.

2.6.4 Long-run effects of higher capital ratios

Table 2.6 we present the results for the long-run effects of higher capital ratios on loan growth. For the rest of the independent variables, the point estimates are reported. Results obtained by The GMM and fixed estimators are reported in columns 1-3 and columns 4-6 respectively. We do not find a statistically significant long-run effect of higher capital ratios. Our finding is

[12] For example, if the risk-weights on German and Greek government debt are the same, a bank might increase its holdings of Greek debt in anticipation of higher returns. However, this would not change its risk-based capital requirement.

consistent with the literature.

Table 2.3. Impact of Regulatory Capital Ratios on Loan Spread

	(1) Loan Spread	(2) Loan Spread	(3) Loan Spread
Capital/RWA	2.508**		
	(2.77)		
Tier 1 /RWA		2.096*	
		(1.87)	
Tier 1/ Assets			3.093
			(1.33)
Deviation Capital	-0.355***		
	(-3.72)		
Deviation Tier 1		-0.395**	
		(-2.22)	
Credit Line Dummy	-0.548**	-0.548**	-0.548**
	(-2.44)	(-2.44)	(-2.44)
Log Assets	0.815***	0.740***	0.748***
	(4.42)	(4.29)	(3.94)
Cash/Assets	-0.460	0.100	0.0930
	(-0.87)	(0.14)	(0.12)
Debt/Assets	0.165	0.197	0.314
	(0.35)	(0.43)	(0.78)
Net Income/Assets	5.103	4.588	1.441
	(1.12)	(0.95)	(0.32)
Log Loan Amount	-0.166***	-0.167***	-0.167***
	(-17.26)	(-16.84)	(-17.17)
Syndicated Loan Dummy	0.143	0.151	0.154
	(1.45)	(1.51)	(1.53)
Spread (10Y-3M)	0.696***	0.700***	0.712***
	(6.81)	(6.95)	(6.96)
PD Unknown	-0.289***	-0.273***	-0.276***
	(-3.29)	(-3.26)	(-3.27)
PD Low	-0.603***	-0.601***	-0.599***
	(-4.03)	(-4.00)	(-4.00)
PD Medium-Low	-0.555***	-0.556***	-0.555***
	(-3.98)	(-3.98)	(-4.00)
PD Medium	-0.523***	-0.526***	-0.525***
	(-4.31)	(-4.35)	(-4.35)
PD Medium-High	-0.298***	-0.297***	-0.296***
	(-3.14)	(-3.15)	(-3.16)
Time & Bank Fixed Effects	Yes	Yes	Yes
N	956999	956999	956999

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

Table 2.4. Asymmetric Effects of Regulatory Capital Ratios on Loan Spread

	(Entire Sample) Loan Spread	(Fixed Maturity) Loan Spread	(Credit Lines) Loan Spread
Capital/RWA	5.529***	3.510***	6.905***
	(5.06)	(3.40)	(3.51)
$I_{(-2,0]}$	-0.410***	-0.257***	-0.938***
	(-6.67)	(-5.03)	(-4.08)
$I_{(0,2]}$	-0.787***	-0.400***	-1.389***
	(-12.27)	(-4.16)	(-5.05)
$I_{(2,4]}$	-0.725***	-0.433***	-1.232***
	(-10.29)	(-4.49)	(-4.41)
$I_{(4,8]}$	-0.841***	-0.493***	-1.417***
	(-8.64)	(-4.30)	(-4.37)
$I_{(8,\infty]}$	-0.979***	-0.587***	-1.544***
	(-8.13)	(-4.41)	(-4.37)
Credit Line Dummy	-0.551**		
	(-2.45)		
Log Maturity		0.243***	
		(18.45)	
Log Assets	0.890***	0.266**	0.851
	(5.21)	(2.80)	(1.43)
Cash/Assets	-0.646	-0.526*	1.099
	(-1.65)	(-1.75)	(1.48)
Debt/Assets	0.122	-0.0965	-0.0591
	(0.29)	(-0.47)	(-0.21)
Net Income/Assets	4.700	4.197***	0.0819
	(1.05)	(3.17)	(0.04)
Log Loan Amount	-0.165***	-0.118***	-0.190***
	(-17.43)	(-8.11)	(-9.85)
Syndicated Loan Dummy	0.131	-0.192***	0.932
	(1.36)	(-2.86)	(1.34)
Spread(10Y-3M)	0.708***	0.401***	0.995***
	(6.76)	(6.63)	(8.67)
PD Unknown	-0.296***	-0.313*	-0.127
	(-3.45)	(-1.97)	(-1.03)
PD Low	-0.600***	-0.688***	-0.537***
	(-4.01)	(-3.92)	(-3.43)
PD Medium-Low	-0.555***	-0.643***	-0.467***
	(-4.01)	(-3.86)	(-3.31)
PD Medium	-0.525***	-0.564***	-0.482***
	(-4.34)	(-3.73)	(-3.77)
PD Medium-High	-0.299***	-0.320**	-0.293***
	(-3.15)	(-2.58)	(-3.11)
Time & Bank Fixed Effects	Yes	Yes	Yes
N	956999	579577	376822

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

Table 2.5. Impact of Regulatory Capital Ratio on Loan Growth

	(1) Loan Growth	(2) Loan Growth	(3) Loan Growth
Capital/RWA	-1.622		
	(-1.44)		
Tier 1/RWA		-4.558***	
		(-3.56)	
Tier 1/Assets			-13.01*
			(-1.93)
Deviation Capital	0.0525		
	(0.19)		
Deviation Tier 1		0.606***	
		(3.36)	
Log Assets	0.0152	-0.0740	-0.262
	(0.07)	(-0.31)	(-0.91)
Cash/Assets	0.165	-0.101	-0.403
	(0.12)	(-0.07)	(-0.26)
Debt/Assets	-0.739	-0.615	-0.850
	(-0.83)	(-0.70)	(-0.94)
Net Income/Assets	5.198	5.075	10.61
	(0.64)	(0.58)	(1.30)
Firm Cluster*Time Fixed Effects	Yes	Yes	Yes
Firm Cluster*Bank Fixed Effects	Yes	Yes	Yes
N	42448	42448	42448

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ t statistics in parentheses. Winsor

Table 2.6. Impact of Regulatory Capital Ratio on All In Drawn Spread

	(GMM - Arellano Bond)			(Fixed Effects)		
	Loan Growth	Loan Growth	Loan Growth	Loan Growth	Loan Growth	Loan Growth
Lagged Loan Growth	-0.0495***	-0.0488***	-0.0504***	-0.0367	-0.0365	-0.0363
	(-6.06)	(-6.18)	(-6.28)	(-0.88)	(-0.88)	(-0.88)
Long-run coefficients, $\beta/(1-\gamma)$						
Capital/RWA	-4.465			-3.669		
	(-1.21)			(-1.43)		
Tier 1/RWA		-5.148			-4.775	
		(-1.28)			(-1.50)	
Tier1/Assets			-15.014			-6.360
			(-1.04)			(-1.00)
Deviation - Total Capital	0.312			0.234		
	(1.18)			(1.24)		
Deviation - Tier 1		0.769**			0.533*	
		(2.04)			(1.74)	
Log Assets	-0.841	-0.802	-0.944	-0.383	-0.369	-0.264
	(-1.27)	(-1.44)	(-1.29)	(-1.16)	(-1.17)	(-1.02)
Cash/Assets	1.064	0.614	0.206	0.249	0.0324	-0.145
	(0.84)	(0.53)	(0.27)	(0.27)	(0.04)	(-0.17)
Debt/Assets	-0.787	-0.751	-0.982	-0.679	-0.686	-0.777
	(-0.90)	(-0.88)	(-1.06)	(-1.04)	(-1.04)	(-1.15)
Net Income/Assets	-11.58	-11.47	-9.660	-1.940	-0.976	0.426
	(-0.45)	(-0.46)	(-0.37)	(-0.17)	(-0.09)	(0.04)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects		Not Applicable*		Yes	Yes	Yes
N	613	613	613	634	634	634

$* p < 0.1, ** p < 0.05, *** p < 0.01$ t statistics in parentheses
Difference GMM

2.7 Robustness Tests

2.7.1 Effect of Risk-Weighted Asset Density

RWAs decreased during our sample period as shown in Figure 2.8. A decrease in the RWA density implies that a bank 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 banks 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 bank 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 2.1 along with the Tier1 to asset ratio as the main explanatory variable. The results tabulated in Table **??**. 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.

2.7.2 Annual data

It is possible that decisions regarding loan portfolios and capital plans are made by a bank at a frequency lower than the quarterly level. Also, some of our bank variables are reported bi-annually. Therefore, we re-estimate equation 2.7 to test for the impact of capital ratios on loan spreads using annual data. The results are reported in Table 2.8. The estimates are qualitatively similar to those reported in Table 2.7. Quantitatively, our point estimates for the regulatory capital ratios are larger. In Beutler and Wunderli (2016 forthcoming)), results from the Swiss Bank Lending Survey suggest that the operational implementation of credit granting reacts fairly quickly (quarter-on-quarter), while the guidelines from the strategic level of the bank react somewhat lagged (year-on-year). Additionally, they find that banks reacts most strongly after about three to four quarters, while the reaction on a quarter-by-quarter level is less strong. Therefore, we believe this to be a structural feature of the Swiss banking industry and it lends credence to our hypothesis of lower frequency optimization of capital and loan portfolio.

2.7.3 Capital growth on loan growth

In section 2.6.3, we presented results on how the level of the capital ratios impact loan growth. This was a slight departure from the empirical model in Khwaja and Mian (2008) which uses growth in the dependent variable as a regressor. We modify our empirical specification to

Table 2.7. Effect of Risk-Weighted Asset Density on Loan Spread

	(1) Loan Spread
Tier 1/ Assets	3.915
	(1.59)
RWA/Assets	-0.730**
	(0.34)
Credit Line Dummy	-0.549**
	(-2.44)
Log Assets	0.712***
	(3.90)
Cash/Assets	-0.174
	(-0.24)
Debt/Assets	0.328
	(0.38)
Net Income/Assets	-0.336
	(-0.08)
Log Loan Amount	-0.166***
	(-16.89)
Syndicated Loan Dummy	0.143
	(1.42)
Spread (10Y-3M)	0.713***
	(6.90)
PD Unknown	-0.283***
	(-3.27)
PD Low	-0.600***
	(-4.04)
PD Medium-Low	-0.555***
	(-4.01)
PD Medium	-0.525***
	(-4.36)
PD Medium-High	-0.296***
	(-3.14)
Time & Bank Fixed Effects	Yes
N	956999

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

estimate the impact of capital growth on loan growth in equation 2.5. ΔK_{t-1} and ΔRWA_{t-1} are the quarterly growth in capital and risk-weighted assets respectively. The results tabulated in Table 2.9. Even though the point estimates have the expected signs, we do not find a statistically significant impact of the growth in capital on loan growth.

$$\Delta L_{i,k,t} = \beta_1 \Delta K_{i,t-1} + \beta_2 \Delta RWA_{i,t-1} + \beta_3 \text{Bank}_{i,t-1} + Bank_i + Time_t + \epsilon_{i,j,t} \quad (2.5)$$

2.7.4 Loan Growth - 2009Q1 onwards

In section 2.4, we show an increase in new credit granted between 2008Q3 and 2008Q4. To alleviate concerns that out loan growth regression results presented in Table 2.5 are driven by this, we re-estimate equation 2.3 for our sample starting 2009Q1. The results are presented in Table 2.10. As before, we find the coefficient on capital ratios to be negative. Only the Tier 1 to risk-weighted asset ratio is now statistically significant. We do not have a dummy for the deviation in Tier 1 capital to RWA ratio as there are only positive deviations starting 2009Q1.

Table 2.8. Impact of Regulatory Capital Ratios on Loan Spread - Annual

	(1) Loan Spread	(2) Loan Spread	(3) Loan Spread
Capital/RWA	4.119***		
	(4.05)		
Tier 1/RWA		3.898**	
		(2.39)	
Tier 1/Assets			15.53
			(1.67)
Deviation Capital	-0.138**		
	(-2.43)		
Deviation Tier 1		-0.124***	
		(-4.86)	
Credit Line Dummy	-0.587**	-0.585**	-0.581**
	(-2.52)	(-2.50)	(-2.46)
Log Assets	1.081***	1.057***	1.213***
	(4.66)	(4.18)	(3.02)
Cash/Assets	0.537	1.081	1.809
	(0.56)	(0.98)	(1.25)
Debt/Assets	1.280	1.471*	1.581*
	(1.51)	(1.77)	(2.09)
Net Income/Assets	5.098	3.704	5.754
	(0.64)	(0.53)	(0.76)
Log Loan Amount	-0.163***	-0.163***	-0.164***
	(-16.23)	(-15.94)	(-15.97)
Syndicated Loan Dummy	0.0934	0.109	0.123
	(1.07)	(1.21)	(1.35)
Spread(10Y-3M)	1.592***	1.581***	1.499**
	(4.89)	(3.84)	(2.78)
PD Unknown	-0.270***	-0.257***	-0.232***
	(-3.39)	(-3.27)	(-3.09)
PD Low	-0.586***	-0.591***	-0.580***
	(-3.95)	(-3.97)	(-3.83)
PD Medium-Low	-0.543***	-0.545***	-0.541***
	(-3.93)	(-3.91)	(-3.91)
PD Medium	-0.510***	-0.514***	-0.511***
	(-4.26)	(-4.29)	(-4.27)
PD Medium-High	-0.290***	-0.291***	-0.292***
	(-3.15)	(-3.14)	(-3.17)
Time & Bank Fixed Effects	Yes	Yes	Yes
N	917980	917980	917980

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

Table 2.9. Impact of capital growth on loan growth

	(1) Loan Growth	(2) Loan Growth
Capital Growth	-0.0778	
	(-0.25)	
Tier 1 Growth		-0.154
		(-0.54)
RWA Growth	0.877	0.973
	(1.01)	(1.17)
Deviation Capital	-1.270	
	(-1.07)	
Deviation Tier 1		0.460**
		(2.21)
Log Assets	0.0533	0.154
	(0.24)	(0.63)
Cash/Assets	0.409	0.243
	(0.32)	(0.18)
Debt/Assets	-0.913	-0.856
	(-0.95)	(-0.93)
Net Income / Assets	3.938	-7.473
	(0.43)	(-0.58)
Firm-Cluster*Time Fixed Effects	Yes	Yes
Firm-Cluster*Bank Fixed Effects	Yes	Yes
N	42448	42448

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

Table 2.10. Impact of Regulatory Capital Ratio on Loan Growth - 2009Q1 onwards

	(1) Loan Growth	(2) Loan Growth	(3) Loan Growth
Capital/RWA	-1.450		
	(-0.78)		
Tier 1/RWA		-3.300*	
		(-1.94)	
Tier 1/Assets			-11.198
			(-1.25)
Deviation Capital	-0.447		
	(-0.81)		
Log Assets	-0.521	-0.619	-0.784
	(-1.20)	(-1.58)	(-1.71)
Cash/Assets	0.921	1.018	0.532
	(0.66)	(0.71)	(0.35)
Debt/Assets	-1.352*	-1.189**	-1.176**
	(-2.85)	(-2.16)	(-2.18)
Net Income/Assets	5.198	8.292	10.01
	(0.64)	(0.36)	(0.43)
Firm Cluster*Time Fixed Effects	Yes	Yes	Yes
Firm Cluster*Bank Fixed Effects	Yes	Yes	Yes
N	30958	30958	30958

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ t statistics in parentheses. Winsor

2.8 Conclusions

In this paper, we estimated the impact of higher capital ratios for banks in Switzerland on pricing and volume of loans to non-financial corporations. Using a confidential dataset on new credit granted matched with supervisory data on bank balance sheets, we find a small but statistically significant impact of higher capital ratios on both pricing and volume (in the usual sense of everything else being equal). Additionally, our analysis indicates that banks' response varies by size and deviation from the supervisory target. Our estimate of the statistically insignificant long-run effect supports the Basel Committee's recommendation on longer phase-in periods for banks to attain higher capital ratio targets.

2.A Appendix: Sample Loan Types

Table 2.11. Loan Type

Variable	N entire sample	Frequency entire sample	Cumulative	Frequency Up-to 2008q4
Mortgages to Firms	448,414	46.86	46.69	47.08
Investment Credit	264,552	27.64	74.46	19.06
Overdraft Facility	200,758	20.98	95.45	29.04
Construction Loans	21,353	2.23	97.67	3.23
Fixed Advance	9,338	0.98	98.67	0.59
Investment Loans	4,926	0.51	99.19	0.73
Miscellaneous Loans	4,269	0.45	99.63	0.04
Rollover Credit	1,753	0.18	99.83	0.10
Baufesthypothek	847	0.09	99.92	0.01
Seasonal Credit	789	0.08	100	0.12

2.B Appendix: Sample Firm Size Distribution

Table 2.12. Firm Size Distribution

Firm Size CHF Million	**N entire sample**
<1	487,115
1-5	155,497
6-25	131,936
26-100	85,750
>100	33,166
Unspecified	98,072

2.C Appendix: Sample PD Class Distribution

Table 2.13. Probability of Default Class Distribution

Firm Size CHF Million	**N entire sample**
1	28,045
2	48,788
3	214,536
4	440,483
5	148,391
Unspecified	111,293

3 Leverage & Use of Financing: Corporate America after the Great Recession

3.1 Introduction

After the onset of the financial crisis, central banks around the world have pursued both standard and unconventional monetary policy actions in an attempt to stimulate economic activity. While the interactions between monetary policy and real outcomes have been widely researched, there is relatively less evidence on the impact of post-crisis monetary policy measures on firm level outcomes. Given the scale of measures undertaken, it is important to understand the impact on firm behavior.

In this paper, I empirically investigate changes in firm behavior along the dimensions of investment, payout to equity holders and cash holdings in the aftermath of the great recession. With the short-term nominal rate constrained by the zero lower bound, the Federal Reserve (Fed) implemented a number of asset purchase programs with the stated objective of lowering long-term interest rates and yields across different asset classes.[1] A number of empirical studies show that the Fed was successful in this objective.[2]

I begin the analyses by documenting an increase in the real value of debt on the balance sheet of U.S. non-financial corporates and that this increase has been driven by long-term debt. I next investigate the relationship between long-term debt and investment and whether this has changed after the crisis using fixed effects panel regressions. Further, I use the Whited-Wu index (Whited and Wu (2006)) as a measure of financial constraints to test for changes

[1] http://www.federalreserve.gov/newsevents/speech/bernanke20120831a.htm

[2] See Krishnamurthy and Vissing-Jorgensen (2011), Swanson (2011), Meaning and Zhu (2011)

in the investment behavior of constrained vis-a-vis unconstrained firms post-crisis. I find a negative correlation between investment as a share of total assets and the ratio of long-term debt to assets. This effect is stronger quantitatively and statistically significant post-crisis. Interestingly, I also find that an unconstrained firm, as defined by the Whited-Wu index, has lower investment post-crisis vis-a-vis pre-crisis. In the next set of tests, I evaluate alternate uses of debt namely, payouts to equity holders and cash holdings. I find that after the crisis, a higher long-term debt to asset ratio is positively correlated with payouts and negatively with the growth in cash holdings. Additionally, the likelihood of net share repurchases increases with the share of long-term debt post-crisis.

The analysis provides new evidence on firm behavior post-crisis. To the best of my knowledge, this is the first paper to analyze post-crisis firm behavior over an extended time period. It also adds to the debate on the effects of monetary policy actions pursued in the wake of the recent financial crisis. There have been concerns that these policies would have negligible real effects and might even lead to excessive risk taking and distort investment decisions.[3,4]

The paper proceeds as follows. Section 3.2 discusses related literature. Section 3.3 describes the data. Section 3.4 provides descriptive evidence and the basic hypotheses. Section 3.5 presents the econometric model and results. Section 3.6 concludes.

3.2 Related Literature

There are a few studies that evaluate the impact on firm outcomes in the wake of the recent crisis. Duchin et al. (2010) use the financial crisis as a negative shock to financing constraints and find a significant decline in firm investment with larger effects for firms with low cash holdings or high short-term debt. Using a survey based measure of financial constraints, Campello et al. (2010) find that Chief Financial Officers of constrained firms drew down on lines of credit, postponed profitable projects, and reduced investment and employment. Bliss et al. (2015) argue for the financial crisis to be a shock to the net supply of credit and show that firms reduced payouts to maintain cash levels and fund investment. Using debt maturity as an identification strategy, Almeida et al. (2009) show that firms with long-term debt maturing just after 2007Q3 cut investment more than similar firms with debt maturing after 2008. These studies, however, provide evidence on firm behavior using the crisis as a negative shock to credit supply. Foley-Fisher et al. (2016) find that the maturity extension

[3] https://www.federalreserve.gov/newsevents/speech/stein20130207a.htm
[4] http://www.bis.org/events/agm2013/sp130623.htm

program (MEP[5]) helped relax financing constraints for firms with a higher historical long-term debt dependence (Long-term debt/total debt). Further they show that these firms had a higher growth of property, plant and equipment (PP&E) and employees in 2012, the year of MEP. I find the opposite effect on PP&E growth using quarterly data.

This study is related to the classical corporate finance research thread on the impact of financial constraints and supply of capital on investment (Fazzari et al. (1988) & Kaplan and Zingales (1997)). This work is also related to studies that expostulate the relationship between corporate financing and macroeconomic conditions. Broadly, these can be divided into two groups. The first focuses on the demand for capital as a function of firm characteristics. If agency problems and asymmetric information are the main determinants for the demand of capital, improved macroeconomic conditions should be positively correlated with equity issuances while periods of economic contractions should induce a shift towards less information sensitive sources of financing. Choe et al. (1993) and Bolton and Freixas (2000) exposit these demand based models. However, Baker (2009) points out, the time series of capital structure decisions, payout policy, and investment are not very well explained by the demand based theories. A supply driven mechanism is postulated by Holmstrom and Tirole (1997) where a financial crisis leads to a tightening in credit supply for firms. Poor macroeconomic conditions can also lead to episodes of 'flight to quality' where investors have a preference for high quality information insensitive securities. Empirically, Kashyap et al. (1993) show that firms, in response to higher interest rates, switch to commercial paper from bank loans. Erel et al. (2012) provide evidence for macroeconomic conditions influencing both choice of capital structure and a firms' ability to raise capital subject to firm quality.

Additionally, this work is related to the theories of capital structure. There are three that are broadly prevalent.[6] The first is the trade-off theory, according to which managers weigh the benefits of debt against the costs of bankruptcy. The key idea is that since debt requires repayment, it mitigates the agency problem of free cash flows (Jensen (1986)). Additionally, a firm following the trade-off theory targets a debt-to-value ratio with continual adjustments(Myers (1984)). The second is the pecking order theory. Based on the problem of adverse selection, it orders a firms' sources of funding as retained earnings, debt, and equity (Myers and Majluf (1984)). The third is the market timing theory. As per this, managers choose between debt and equity finance based on market conditions. They issue equity when equity prices are high and issue debt when yields are low. Baker and Wurgler (2002) argue that cumulative effect of past

[5]Also known as Operation Twist. Under this program, the Fed used the proceeds from selling or redeeming $667 billion of shorter-term Treasury securities to buy longer-term Treasury securities.

[6]For a review on the theories of capital structure, see Frank and Goyal (2011)

market timing is the best determinant of capital structure. Also, Graham and Harvey (2001), in a survey of 392 Chief Financial Officers find evidence in support of this hypothesis. The descriptive evidence in this paper is indicative of the market timing theory.

3.3 Data

I use quarterly data from CRSP/Compustat Merged (CCM) Fundamentals for 1990Q1-2015Q4.[7] Since the study focuses on U.S. firms, all firms with a foreign incorporation code are excluded. The sample excludes financial firms and utilities (Standard Industrial Classification(SIC) 4900-4949 and 6000-6999). All observations with missing assets are dropped. Variable definitions are provided in Appendix 3.A. Data on the federal funds rate (FFR), corporate bond yields, and gross domestic product (GDP) is obtained from the FRED database made available by the Federal Reserve Bank of St. Louis.

3.4 Descriptive Evidence & Basic hypotheses

In response to the recent financial crisis, by december 2008, the Federal Reserve lowered it's target short term interest rate to 0-25 basis points. The FFR is the primary interest rate in the U.S. financial market. It impacts interest rates on savings, loans, and mortgages. With GDP growth and employment numbers weak, the Fed embarked on a series of Quantitative Easing (QE) programs. QE was aimed at lowering long-term borrowing costs and improve credit availability for households and firms. Krishnamurthy and Vissing-Jorgensen (2011) evaluate the impact of Federal Reserve's QE1 and QE2 on interest rates and find a significant impact for Treasuries, Agency bonds , and highly-rated corporate bonds. Swanson (2011) also finds a lowering of treasury and corporate bond yield as a consequence of QE2. While theses studies evaluate the immediate impact, Cahill et al. (2013) show a longer-term effect of the various asset purchase programs on treasury yields. Figure 3.1 plots the effective FFR and yields for corporate bonds rated AAA and Baa. It is evident from the figure that corporate bond yields are below the levels observed prior to the recent financial crisis. Barry et al. (2008) present evidence that firms have a higher debt issuance when the level of interest rate is lower compared to historical values. Graham and Harvey (2001) provide survey based evidence that chief financial officers attempt to time the market by issuing debt when interest rates are low. In Figure 3.2, I document the evolution of real balance sheet debt and the ratio of balance sheet debt to GDP for U.S. corporates excluding financials and utilities. The figure reveals an

[7] Following the adoption of the statement of Financial Accounting Standard 95, 1989 was the first year for the standardized statement of cash flows.

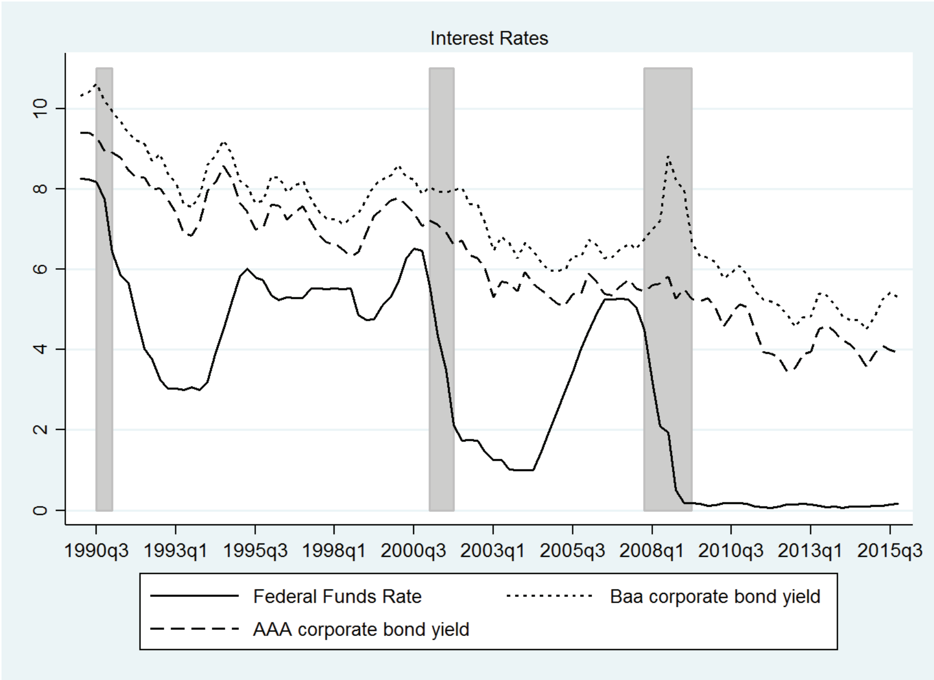

Figure 3.1. Effective Federal Funds Rate and Baa-AAA Corporate bond spread

increase in debt leading up to 2001 recession followed by a modest decline. However between 2010Q2 and 2015Q4, it has increased by 51 percent from USD 2.47 trillion to USD 3.73 trillion. While the debt to GDP ratio of non-financial corporates declined after the 2001 recession, it has sharply increased since 2010. The increase in balance sheet debt is mirrored in the increase in book leverage (Figure 3.3), defined as total book value of debt divided by the book value of assets, which has increased from a post-crisis low of 25 percent to 33 percent. The spike in leverage during the financial crisis is mostly due to a fall in assets. It is possible that the observed increase in aggregate leverage is driven by larger firms. The trade-off theory of capital structure, according to which firms weigh the cost of default against the tax benefits of debt, predicts larger firms to have higher leverage. In Figure 3.4, I split the sample into six size groups by percentiles based on total assets. While firms in the larger percentiles have higher leverage, there has been an increase in leverage for each size group. Next, in Figure 3.5, I document that the net issuance of long-term debt has closely tracked total debt issuance. Given that firms have increased their debt holdings, it is important to understand how these funds are being put to use. If higher debt issuance was to finance new projects, one would expect to observe an increase in capital investment. Panel A of Figure 3.6 plots the ratio of new capital expenditures as a share of assets and panel B, the growth in property, plant, and

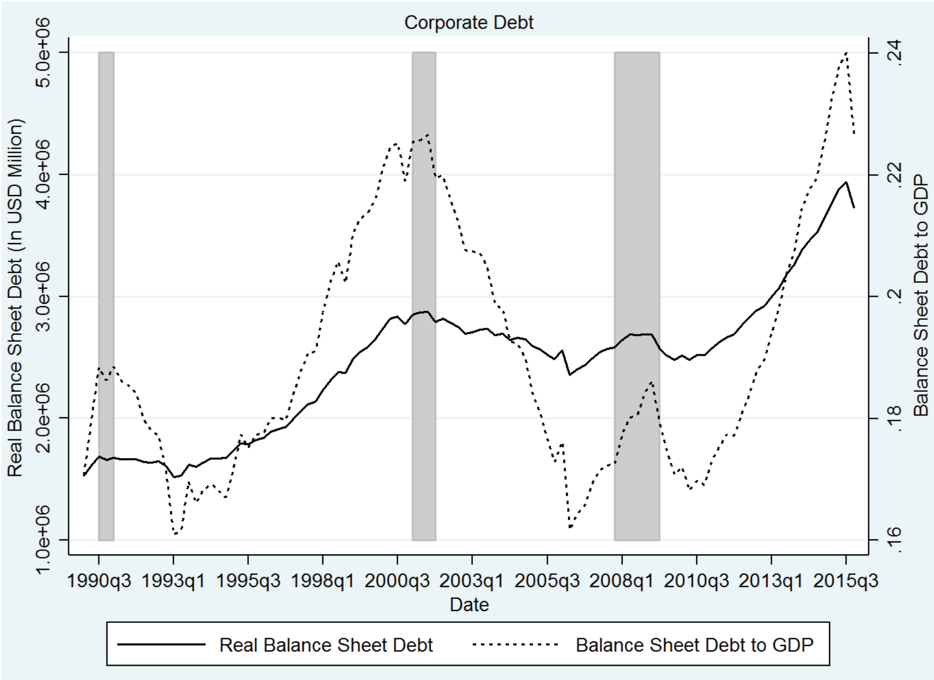

Figure 3.2. Real Balance Sheet Debt

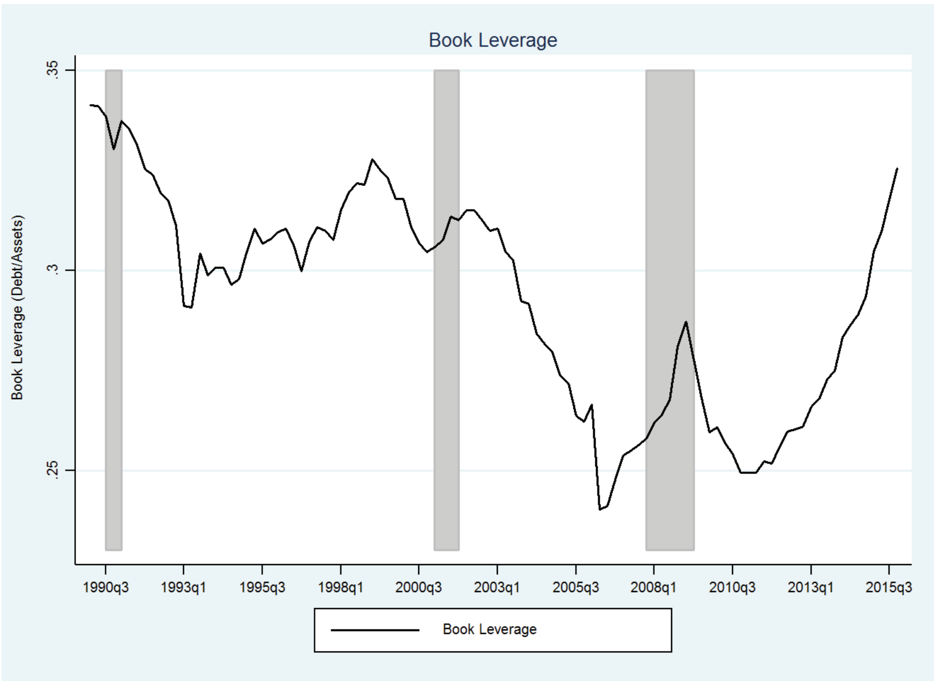

Figure 3.3. Book Leverage

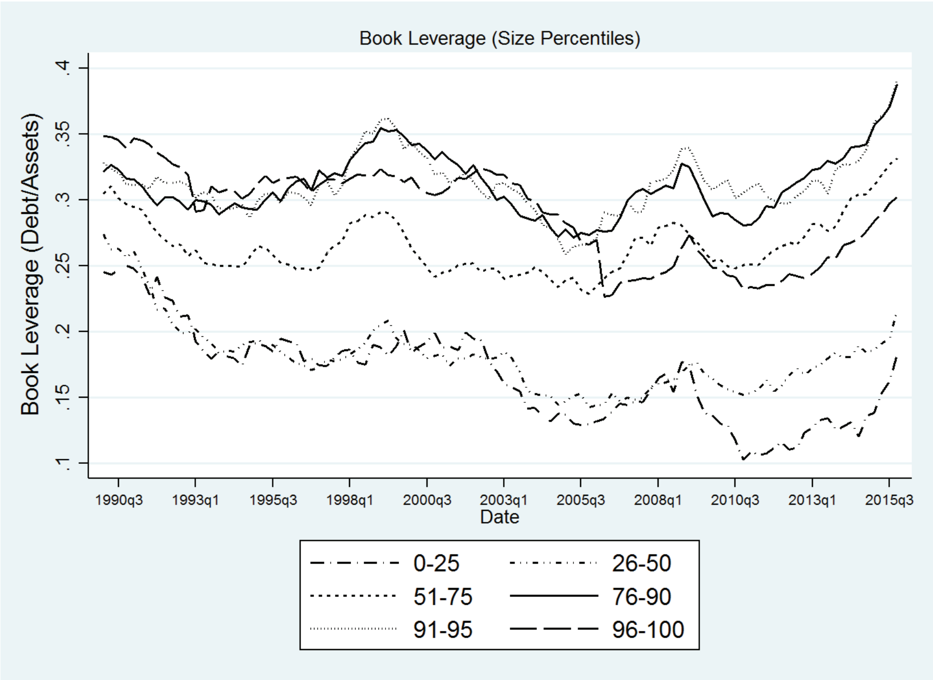

Figure 3.4. Book Leverage (Size Percentiles)

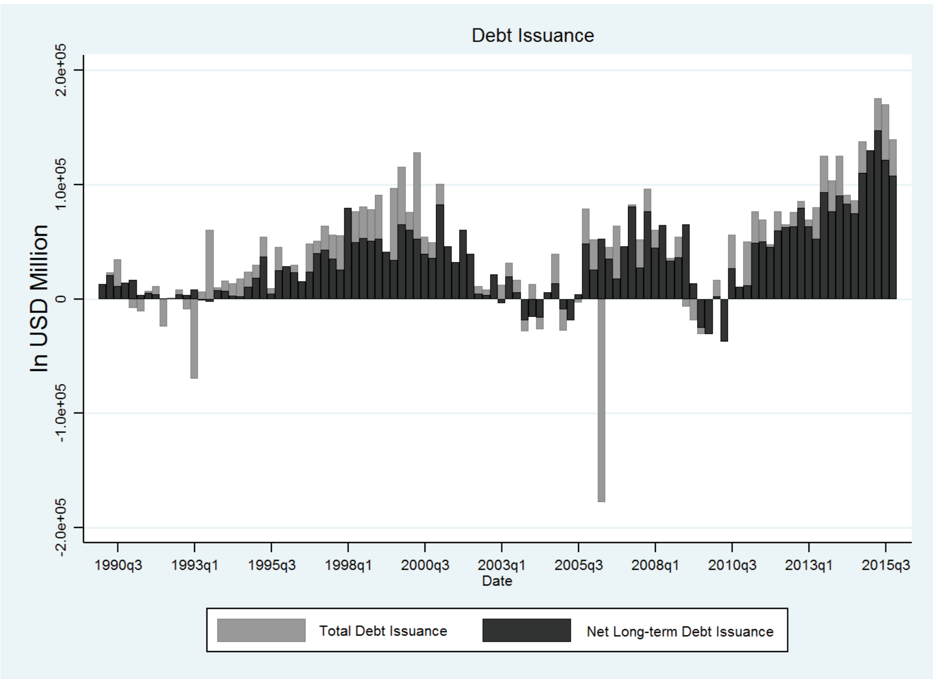

Figure 3.5. Net Debt Issuance: Total and Long-term

equipment (PP&E)[8]. After a sharp fall during the recent financial crisis, aggregate evidence indicates that both measures have recovered to pre-crisis levels. In the empirical specification, I test for the impact of a higher long-term debt to asset ratio on these two measures of capital spending. Further, if low corporate bond yields improved the ability of firms to issue debt, it can be thought of as a relaxation in the external financing constraint. In the cross-section, unconstrained firms should invest more vis-a-vis constrained firms. I use the Whited-Wu index to separate firms into two groups - constrained and unconstrained and test if this hypothesis holds true post-crisis.

Alternatively, it is possible that firms could have put the borrowed funds to alternate use. This

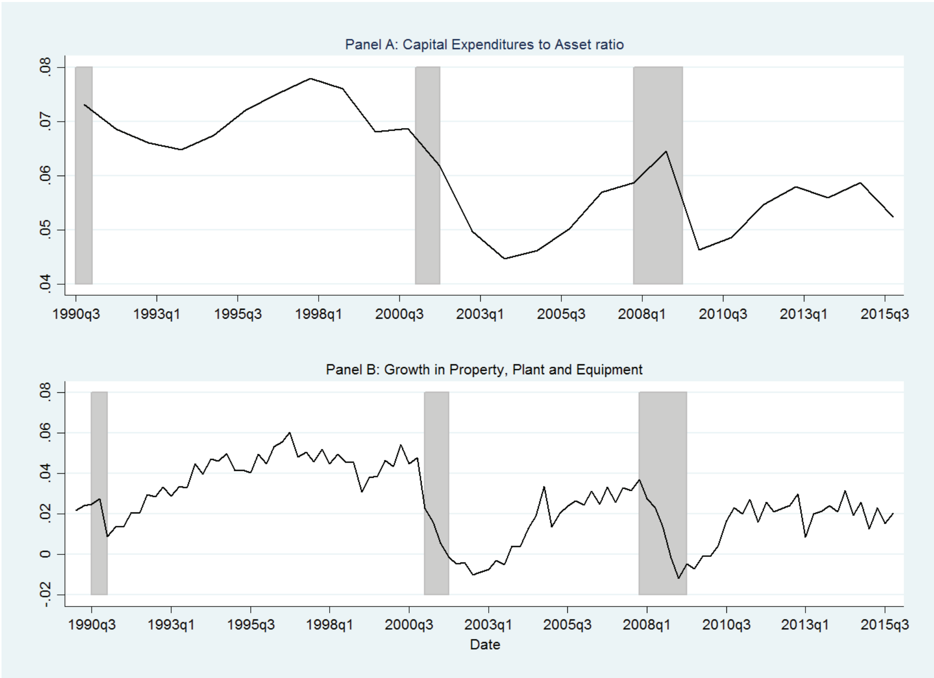

Figure 3.6. Capital Expenditures and Growth in PP&E

could be the case if the post-crisis recovery was sluggish or there was continued macroeconomic uncertainty. I explore two different uses of financing in this paper; (1) Payouts to equity holders and (2) Increase in cash holdings. While it is beyond the scope of this paper to take a stand on the post-crisis recovery and macroeconomic environment, the extant literature has explored reasons for firms wanting to increase cash holdings and/or postpone investment. Bates et al. (2009) provide evidence of an increase in cash holdings for firms with riskier cash flows. Firms have an incentive to buyback their stock if it is optimal to postpone capital

[8] Since the quarterly capital expenditure series is extremely volatile, for the purpose of exposition, the figure plots annual capital expenditures. PP&E growth is plotted quarter on quarter.

expenditures as in the presence of uncertainty Bloom (2009). Panel A of Figure 3.7 presents the evolution of cash and short-term investments as a share of total assets in the aggregate. The sharpest increase is observed after the dot-com bubble when this share increased from 7 percent to about 11.5 percent. While this ratio did go up during the great recession, it has remained relatively stable at the same level since. In panel B, I document a steady increase in payout to equity holders in the form of dividends and equity repurchases leading up to the great recession. It collapses during the crisis but has now surpassed it's pre-crisis peak. I further break down payouts into dividend payments and equity repurchases in Figure 3.8. Payouts in the form of dividends and equity repurchases sharply increase between 2004 and 2008. During the crisis, however, equity repurchases show a sharp decrease while dividends remain stable. Post-crisis, we again observe a sharp increase in both. Table 3.1 further documents the increase in the percentage of firms paying dividends and repurchasing shares after the financial crisis. In 2007, 25.57% and 25.56% of sample firms paid out dividends and re-purchased shares respectively. This share increased to 32.3% and 34.6% respectively in 2015. Additionally, net share repurchases have closely tracked net long-term debt issuance by U.S. non-financial corporates after the financial crisis (Figure 3.9). This last stylized fact has also been documented by Van (2015). It is important to distinguish between the two payout policies as it might influence real outcomes. Almeida et al. (2016) show that repurchases motivated by earnings per share (EPS) are associated with reductions in investment and employment. On the other hand, Brav et al. (2005) report that dividend payments are sticky and a sustainable increase in earnings or demand from institutional investors are the main reasons for initiating or increasing dividend payments. Therefore dividend payouts are less likely to funded by debt issuance than share repurchases. The final empirical test estimates the relationship between the long-term debt to asset ratio and the likelihood of net share repurchases and dividend payments.

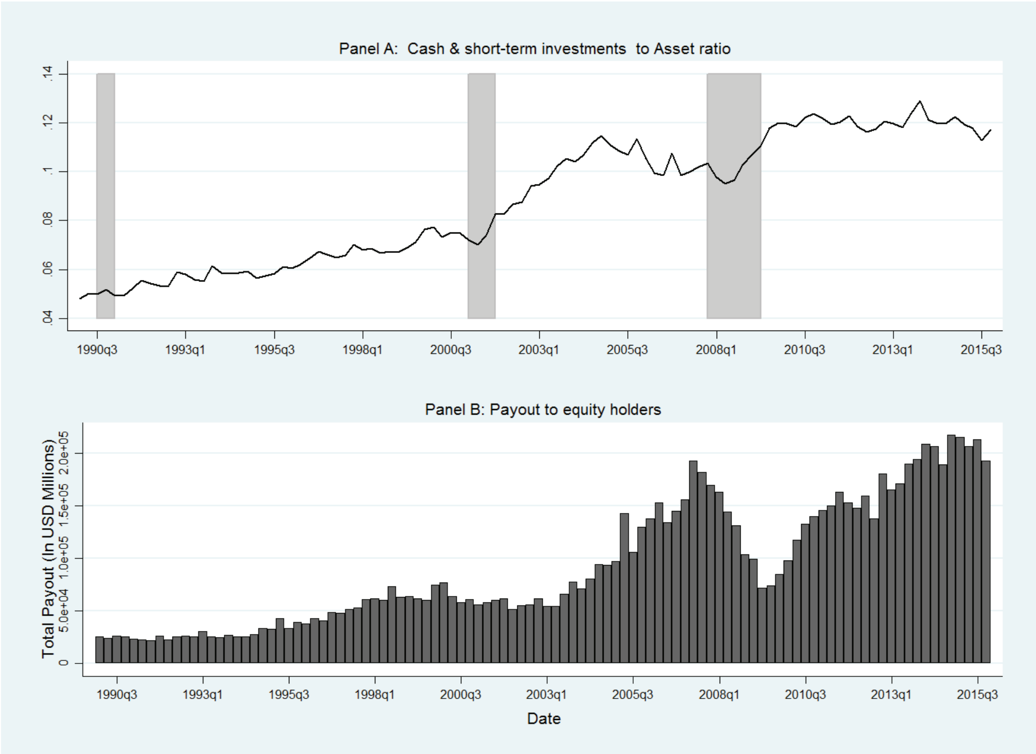

Figure 3.7. Aggregate time-series of cash & short-term investments to asset ratio and the payout to equity holders.

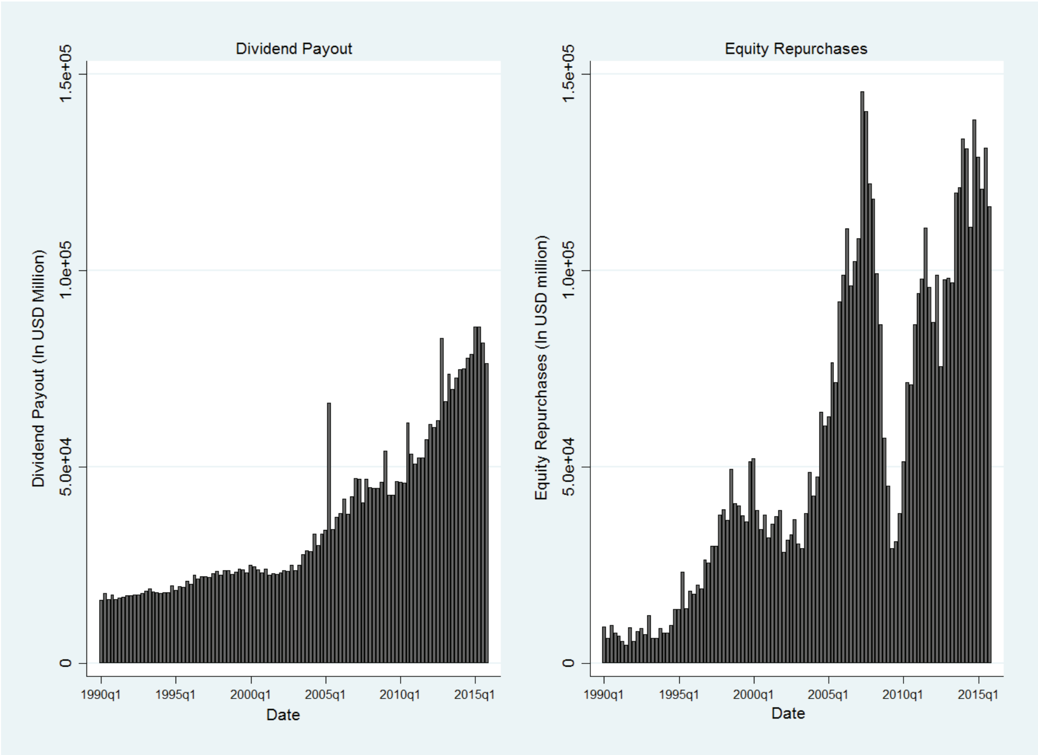

Figure 3.8. Aggregate time-series behavior of dividend payments and share repurchases.

Table 3.1. Percentage of Firms paying dividends and repurchasing shares

Year	Dividend Payers(%)	Share Repurchasers(%)
1990	28.65	26.73
1991	27.06	16.49
1992	26.48	16.68
1993	25.27	16.60
1994	23.64	17.42
1995	23.18	18.14
1996	21.47	20.17
1997	19.99	20.25
1998	19.52	24.64
1999	19.28	27.14
2000	17.68	25.56
2001	17.33	21.08
2002	17.87	20.66
2003	20.50	18.87
2004	23.18	18.65
2005	24.84	21.56
2006	25.53	23.79
2007	25.57	26.56
2008	25.60	30.00
2009	24.24	21.45
2010	25.68	24.43
2011	28.02	30.72
2012	31.26	30.91
2013	31.76	30.44
2014	32.50	32.87
2015	32.30	34.60

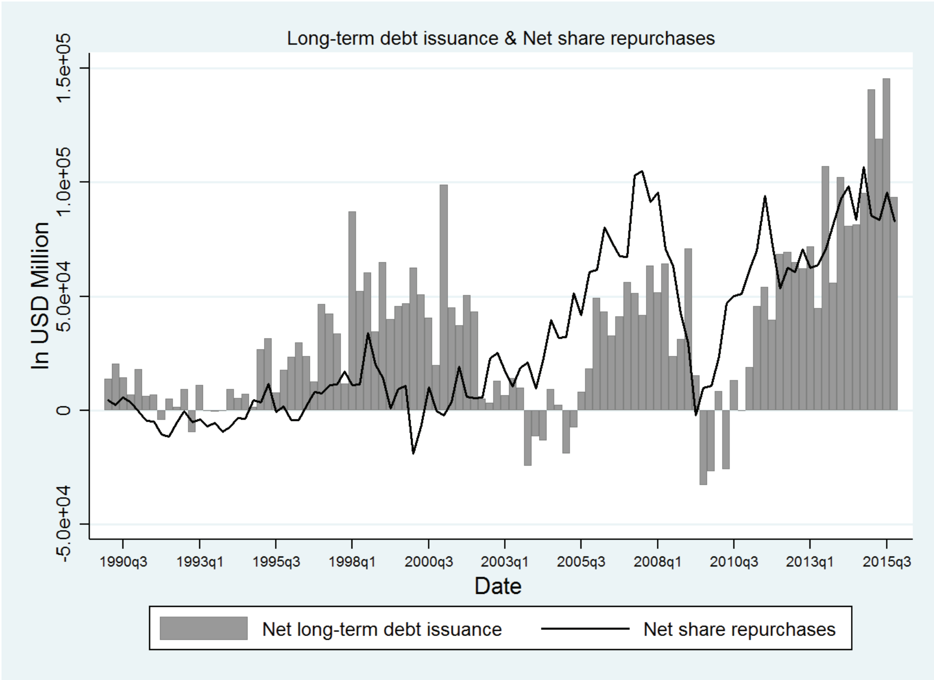

Figure 3.9. Net long-term debt issuance and Net share repurchases

3.5 Econometric Model and Results

3.5.1 Impact of Long term debt on corporate investment

I estimate the following equation using the fixed effects framework to determine the impact on investment. The specification is based on Covas and Den Haan (2011). In equation 3.1, I evaluate the impact of long-term debt to asset ratio on investment. Investment is capital expenditures at time, *t* scaled by total firm assets (TA) at time, *t-1* or the growth in PP&E between *t* and *t-1*. Post-crisis is a dummy variable that takes a value equal to one starting 2009Q1.[9]

$$\begin{aligned} Investment_{i,t} = {} & \beta_0 + \beta_1(LTD_{i,t-1}/\ TA_{i,t-2}) + \beta_2(Cash_{i,t-1}/\ TA_{i,t-2}) + \\ & \beta_3(Sales_{i,t-1}/\ TA_{i,t-2}) + \beta_4(Tobin's\,q)_{i,t-1} + \\ & \beta_5(Net\,Income_{i,t-1}/\ TA_{i,t-2}) + \beta_6(Market\,Leverage)_{i,t-1} + \\ & \beta_7(Log\,TA)_{i,t-2} + \beta_8 Post\,Crisis * (LTD_{i,t-1}/\ TA_{i,t-2}) + \\ & \beta_9 Post\,Crisis * (Cash_{i,t-1}/\ TA_{i,t-2}) + \\ & \beta_{10} Post\,Crisis * (Sales_{i,t-1}/\ TA_{i,t-2}) + \\ & \beta_{11} Post\,Crisis * (Tobin's\,q)_{i,t-1}/ + \\ & \beta_{12} Post\,Crisis * (Net\,Income_{i,t-1}/\ TA_{i,t-2}) + \\ & \beta_{13} Post\,Crisis * (Market\,Leverage)_{i,t-1} + \\ & Firm\,Fixed\,Effects + Time\,Fixed\,Effects + \sigma_{ijt} \end{aligned} \tag{3.1}$$

Columns 1 and 2 of Table 3.2 report the results. The primary coefficients of interest are the ones on ratio of long-term debt to assets and the interaction with the post-crisis dummy, *PC*. Both the coefficient on the long-term debt ratio and the interaction term are negative. In the previous section, I documented the increase in long-term debt holdings of non-financial firms post-crisis. The results indicate that a higher share of long-term debt has a negative impact on both capital expenditures and PP&E growth and that this relationship has been reinforced post-crisis. A one standard deviation higher long-tern debt to asset ratio is associated with a 0.02% and 0.07% lower capital expenditures as a share of assets and PP&E growth respectively. The additional effects post crisis are 0.03% and 0.3% respectively. This negative impact of the long-term debt ratio on investment is consistent with the past literature on leverage and

[9] Results are qualitatively and statistically similar if I chose a later date for switching on the post crisis dummy, for e.g. 2010Q2

capital investment(Lang et al. (1996) and Ahn et al. (2006)). In addition, I find a statistically significant difference in how firm characteristics influence investment behavior after the crisis. I expect firms with higher liquidity (cash to asset ratio), investment opportunities (Tobin's Q) and profitability (Net Income to Assets) to invest more. Importantly, I find the effects to be opposite or insignificant post-crisis. The findings suggest a significant post-crisis departure from established firm behavior. The ratio of cash to total assets is statistically insignificant for capital expenditures. In the cross-section, it is positively correlated with PP&E growth. However, the post-crisis effect is negative. The positive coefficient is in line with Riddick and Whited (2009) who argue that firms with higher cash ratios invest more. A possible explanation for the change in sign is that cash flows after the financial crisis have become riskier leading to an increase in cash ratios and lower investment which would corroborate findings in Bates et al. (2009). Also of interest is the reversal in the relationship between Tobin's Q and investment. This could potentially indicate a divergence between investors' and a firms' own perception of growth opportunities. This would be true if the post-crisis increase in market value of firms has been driven by investors searching for higher returns in a low yield environment as opposed to higher expected firm growth. The sign on market leverage follows the same logic as that of Tobin's Q. A higher market value lowers market leverage and vice-versa. The observed change in sign post-crisis for most of the control variables could be driven by the fact that investment can be thought of as a proxy for growth opportunities. If firms expect lower or uncertain future demand then it is optimal for firms to postpone investment as modeled by Bloom (2009).

The analysis documents lower yields and an increase in long-term debt and book leverage but does not provide an insight into whether or not the higher debt issuance helped relax firm financing constraints. If financial constraints were indeed relaxed, one would expect unconstrained firms to invest more that their constrained counterparts. To test this, I use the Whited-Wu index [10] as a measure of financial constraints. $Unconstrained$ is an indicator variable equal to one if the firm is less constrained than the median firm for that quarter. Additionally, I interact it with the post-crisis dummy, *PC*. The results are reported in columns 3 and 4 of Table 3.2. While an unconstrained firm has higher capital expenditure and growth in PP&E in the cross-section, the effects are reversed post-crisis. The control variables exhibit the same behavior as in columns 1 and 2. Overall, the results outlined in Table 3.2 do not indicate any positive effects post-crisis on investment due to an increase in long-term debt. In the following section, I analyze alternate uses of funds by firms.

[10] $-0.091CF_{i,t} - 0.062DIVPOS_{i,t} + 0.021TLTD_{i,t} - 0.044LNTA_{i,t} + 0.102ISG_{i,t} - 0.035SG_{i,t}$

Table 3.2. Long-term debt and Firm investment

	(1) Capital Expenditures	(2) PP&E Growth	(3) Capital Expenditures	(4) PP&E Growth
LTD/TA	-0.00119**	-0.00595**	-0.00157***	-0.0120***
	(-2.23)	(-1.99)	(-3.11)	(-4.29)
PC*LTD/TA	-0.00162*	-0.0257***		
	(-1.83)	(-5.80)		
Unconstrained			0.00145***	0.0174***
			(8.18)	(14.79)
PC*Unconstrained			-0.000971***	-0.00425***
			(-3.43)	(-2.82)
Cash/TA	0.0000707	0.118***	0.0000816	0.117***
	(0.16)	(33.06)	(0.18)	(32.63)
Sales/TA	0.00682***	0.0309***	0.00679***	0.0304***
	(11.61)	(8.20)	(11.54)	(8.07)
Tobin's Q	0.00181***	0.0145***	0.00179***	0.0143***
	(30.16)	(33.65)	(29.93)	(33.16)
Net Income/TA	0.0116***	0.208***	0.0113***	0.206***
	(11.45)	(24.69)	(11.13)	(24.45)
Market Leverage	-0.00141***	-0.00868***	-0.00139***	-0.00831***
	(-27.97)	(-30.24)	(-27.97)	(-29.40)
Log Assets	-0.0000997	0.00414***	-0.000291**	0.00149*
	(-0.77)	(5.45)	(-2.23)	(1.92)
PC*Cash/TA	-0.000184	-0.0314***	-0.000386	-0.0278***
	(-0.30)	(-6.04)	(-0.61)	(-5.37)
PC*Sales/TA	-0.00131	-0.0122***	-0.00120	-0.00792*
	(-1.59)	(-2.87)	(-1.44)	(-1.89)
PC*Tobin's Q	-0.000632***	-0.000628	-0.000620***	-0.000882
	(-5.94)	(-0.77)	(-5.82)	(-1.07)
PC*Net Income/TA	-0.00436**	-0.0198	-0.00267	-0.0141
	(-2.27)	(-1.19)	(-1.40)	(-0.84)
PC*Market Leverage	0.000248***	0.00255***	0.000209**	0.00154***
	(2.59)	(5.28)	(2.28)	(3.43)
Firm & Time Fixed Effects	Yes	Yes	Yes	Yes
N	345779	344792	345779	344792
adj. R^2	0.464	0.148	0.464	0.149

This table reports fixed effect regressions for the period 1990Q1-2015Q4. Variables are winsorized at 1 and 99 percent. Errors are clustered by firm.

* Statistical significance at the 10% level

** Statistical significance at the 5% level

*** Statistical significance at the 1% level

3.5.2 Use of financing

To examine the relationship between long-term debt and payout to equity holders or the growth in cash holdings, I estimate equation 3.2. Use of financing at time, *t*, is the logarithm of the real total payout to equity holders or the growth in cash holdings between *t* and *t-1*.

$$\begin{aligned} Use of\,financing_{i,t} &= \beta_0 + \beta_1 (LTD/\,TA)_{i,t-1} + +\beta_2 (Sales/\,TA_{i,t-1}) + \\ &\quad \beta_3 (Tobin's\,q)_{i,t-1} + \beta_4 (Net\,Income/\,TA)_{i,t-1} + \\ &\quad \beta_5 (Market\,Leverage)_{i,t-1} + \beta_6 (Log\,Assets)_{i,t-1} + \\ &\quad \beta_7 Post\,Crisis * (LTD/\,TA)_{i,t-1} + \\ &\quad \beta_8 Post\,Crisis * (Sales/\,TA)_{i,t-1} + \\ &\quad \beta_9 Post\,Crisis * (Tobin's\,q)_{i,t-1} + \\ &\quad \beta_{10} Post\,Crisis * (Net\,Income/\,TA)_{i,t-1} + \\ &\quad \beta_{11} Post\,Crisis * (Market\,Leverage)_{i,t-1} + \\ &\quad Firm\,Fixed\,Effects + Time\,Fixed\,Effects + \sigma_{ijt} \end{aligned} \tag{3.2}$$

Table 3.3 reports the estimates from the specification outlined above. Column 1 shows that the relationship between long-term debt to asset ratio and payouts has reversed post-crisis. Firm life-cycle theory(DeAngelo et al. (2006)) suggests that payouts should be financed via excess free cash flow. Therefore, a positive correlation between the long-term debt ratio and payouts is not explicitly supported by a theoretical framework. One likely explanation for a debt-financed payout is the managerial desire to meet earnings per share forecasts. Hribar et al. (2006) show that a majority of share repurchases between 1988 and 2001 were carried out by firms that would have missed analyst EPS forecasts. In the next section, I separate dividend payments and net share repurchases and test whether a higher share of long-term debt has a differing impact on the probability of the two forms of payout.

The increase in cash holdings by U.S. non-financial corporates for the pre-crisis sample period has been well documented elsewhere (Dittmar (2008) and Bates et al. (2009)). This is reflected in the positive cross-sectional correlation between the growth in cash holdings and the long-term debt ratio. However, the negative sign on the post-crisis interaction term indicates that the firms have lowered their cash growth even as they increased the long-term debt ratio after the recent financial crisis. Taken together, the results indicate that firms have utilized new borrowings to manage their capital structure as opposed to investment or increasing cash holdings.

Table 3.3. Use of financing - payouts vs. cash

	(1) Log(Real Payout)	(2) Cash Growth
LTD/TA	-1.263***	0.167***
	(-14.28)	(6.91)
PC*LTD/TA	0.459***	-0.134***
	(3.42)	(-4.19)
Sales/TA	0.0435	0.542***
	(0.47)	(15.97)
Tobin's Q	0.119***	0.0437***
	(9.72)	(18.07)
Net income/TA	1.510***	-0.367***
	(6.05)	(-6.39)
Market Leverage	-0.192***	0.00989***
	(-14.82)	(3.78)
Log Assets	0.913***	-0.0514***
	(41.21)	(-11.89)
PC*Sales/TA	-0.0118	-0.139***
	(-0.09)	(-4.15)
PC*Tobin's Q	0.140***	0.0105***
	(6.83)	(2.68)
PC*Net Income/TA	1.903***	-0.0155
	(3.82)	(-0.16)
PC*Market Leverage	-0.105***	-0.00655
	(-3.67)	(-1.45)
Firm & Time Fixed Effects	Yes	Yes
N	138671	353530
adj. R^2	0.764	0.033

This table reports fixed effect regressions for the period 1990Q1-2015Q4. Variables are winsorized at 1 and 99 percent. Errors are clustered by firm.
* Statistical significance at the 10% level
** Statistical significance at the 5% level
*** Statistical significance at the 1% level

3.5.3 Long-term debt and the likelihood of payouts

In the following estimation, I separately examine the relationship between the long-term debt to asset ratio and the likelihood of dividend payments or share repurchases. The empirical specification is similar to equation 3.2. The dependent variable, however, is now a dummy variable that takes a value of one if a firm has a positive dollar amount of dividend payments or net share repurchases . Because, a firm with a positive dividend payment in one quarter shows a high propensity towards a positive dividend payment in the next[11], I estimate the model with both random and fixed effects.[12] Both the Lagrangian Multiplier[13] and the Hausman specification tests[14] reject the null of individual effects being insignificant at the 1% level. The results are reported in Table 3.4. The results in columns 1 and 3 show the relationship between a higher long-term debt to asset ratio and the likelihood of dividend payouts to be negative. This holds post-crisis. However, as columns 2 and 4 show, a higher long-term debt to asset ratio after the crisis implies a positive likelihood of net share repurchases. This provides evidence for debt financed share repurchases after the recent financial crisis. The other interesting coefficient is the one on Tobin's Q. The change in sign of the coefficient post-crisis implies that firms with more growth opportunities are the ones diverting more resources to dividend payments and share repurchases. This result provides additional justification for the view expressed earlier that firm market valuations are likely being driven by investors seeking higher returns.

[11] Appendix 3.B presents the probability of sample firms to continue a payout policy form one quarter to the next

[12] Given some of the statistical concerns with linear probability models, in appendix 3.C, I report the marginal effects using a fixed effects logit estimation. However, in the fixed effect logit only firms which switch between states are included in the estimation.

[13] Breusch and Pagan, 1980

[14] Hausman, 1978

Table 3.4. Share repurchases or dividends

	Random Effects		Fixed Effects	
	Dividends	Net share repurchase	Dividends	Net share repurchase
Mean of dependent variable	0.238 (1)	0.230 (2)	0.238 (3)	0.230 (4)
LTD/TA	-0.0752***	-0.178***	-0.0803***	-0.207***
	(-20.06)	(-30.05)	(-21.10)	(-31.43)
PC*LTD/TA	-0.0248***	0.0650***	-0.0327***	0.0499***
	(-3.62)	(5.77)	(-4.75)	(4.18)
Sales/TA	0.0398***	-0.00456	0.0166***	-0.0364***
	(9.97)	(-0.81)	(3.97)	(-5.03)
Tobin's Q	-0.000222	-0.0148***	0.000126	-0.0157***
	(-0.64)	(-26.21)	(0.36)	(-25.62)
Net Income/TA	-0.0374***	0.0934***	-0.0416***	0.0882***
	(-4.58)	(7.06)	(-5.05)	(6.17)
Market Leverage	-0.0248***	-0.0170***	-0.0242***	-0.0177***
	(-40.03)	(-17.00)	(-38.56)	(-16.33)
Log Assets	0.0557***	0.0406***	0.0468***	0.0415***
	(87.01)	(55.41)	(65.95)	(33.72)
PC*Sales/TA	0.0346***	0.0552***	0.0242***	0.0249**
	(5.80)	(5.63)	(4.03)	(2.39)
PC*Tobin's Q	0.00700***	0.00727***	0.00879***	0.0121***
	(8.81)	(5.64)	(10.93)	(8.70)
PC*Net Income/TA	0.300***	0.296***	0.307***	0.215***
	(17.29)	(10.43)	(17.56)	(7.10)
PC*Market Leverage	-0.0274***	-0.0109***	-0.0274***	-0.00684***
	(-19.41)	(-4.60)	(-19.30)	(-2.78)
LM test($Chi^2(1)$)	6.1e+06***	2.5e+05***		
Hausman test ($Chi^2(113)$)			1358.96***	943.42***
Firm & Time Fixed Effects	Yes	Yes	Yes	Yes
N	366842	366842	366842	366842

This table reports random and fixed effect regressions for the period 1990Q1-2015Q4. Variables are winsorized at 1 and 99 percent. Errors are clustered by firm.

* Statistical significance at the 10% level

** Statistical significance at the 5% level

*** Statistical significance at the 1% level

3.6 Conclusions

In this paper, I have analyzed the behavior of U.S. non-financial corporates after the great recession. The literature has explored the impact of monetary policy in response to the financial crisis and it's aftermath on asset prices and on financing constraints of the real sector. However there is little evidence on how firms have reacted to the post-crisis environment. This paper aims to fill this gap and evaluates how firms have used the increase in financing. I first provide evidence on the increase in real value of balance sheet debt post-crisis and correspondingly firm leverage.

Next, I show that this increase in debt has not translated into higher capital expenditures or growth in PP&E. I provide evidence that firms have rather opted to modify their capital structure via payouts to equity holders. I also find a negative correlation between growth in cash holdings and the long-term debt to asset ratio post-crisis. Finally, the likelihood of a positive net share repurchase is higher for firms with a larger share of long-term debt on their balance sheet after the crisis. Also, firms with higher growth opportunities have chosen larger payouts. This has been primarily driven by net share repurchases post-crisis.

Overall, the results indicate a significant shift in firm behavior after the great recession. An increase in leverage not mirrored by an increase in investment but rather an increase in payouts raises concerns about future earnings and firm solvency in the event of monetary policy tightening. I leave this question of interest rate risk on corporate balance sheets as a result of the increase in long-term debt to future research.

3.A Appendix: Variable Definitions

Compustat item names are in parentheses. For variables that are reported year-to-date, quarterly values are determined by subtracting the past quarter from the current value[15] except for the first quarter.
Total Assets: Book value of assets (atq).
Long-term Debt: Comprises of bonds, mortgages, loans, long-term leases and any obligations that require interest payments due more than one year from the firms' balance sheet date(dlttq)
Total Debt: Long-term debt(dlttq) = Debt in current liabilities (dlcq)
Cash: Cash and short-term investments and comprises of cash and all readily transferable securities to cash (cheq).
Sales: Gross amount of sales less any cash discounts, trade discounts, returned sales and credit allowance to customers (saleq).
Net Income: Net fiscal period gain or loss after accounting for discontinued operations, extraordinary items, minority interest and income taxes (niq).
Market value of assets: Liabilities (ltq) + market capitalization (cshoq*prccq).
Tobin's Q: Market value of assets(ltq + cshoq*prccq)/Book value of assets(atq).
Market leverage: Market value of assets (ltq + cshoq*prccq)/Market capitalization (cshoq*prccq).
Investment: Two measures are used to define investment,
1. Capital expenditures: Includes expenditures on PP&E, capital leases, construction, lease-back transactions or reclassification of inventory to PP&E (capxy).
2. Property, Plant and Equipment: Net tangible fixed property used in revenue production excluding accumulated depreciation (ppentq).
Payout to equity holders: Dividend payments (dvpsxq*cshoq) + purchase of common and preferred stock (prstkcy) - any reduction in the value of redeemable preferred stocks outstanding (pstkrq).
Net share repurchases: Purchase of common and preferred stock(prstkcy)- Sale of common and preferred stock (sstky).

[15] For year to date variables, the fiscal quarter definition is used to convert to quarterly frequency.

3.B Appendix: Payout Transition Probabilities

Table 3.5 resent the transition probabilities for firms switching in and out of dividend payments and positive net share repurchases from one quarter to the next. The transition probabilities support the hypothesis that there is a persistence in dividend paying firms while share repurchases constitute a more flexible payout policy.

Table 3.5. Transition Probabilities (percentage)

	(1) Positive Payout = Yes	(2) Positive Payout = No
Dividend Payment		
Positive Payout = Yes	93.87	6.13
Positive Payout = No	97.90	2.10
Net Share Repurchases		
Positive Payout = Yes	55.65	44.35
Positive Payout = No	88.41	11.59

3.C Appendix: Payout Likelihood - Logit Regression

Table 3.6 reports the marginal effects from a fixed effects logit estimation. The effects are consistent with our finding that a higher long-term debt to asset ratio post-crisis increases the likelihood of share repurchases.

Table 3.6. Fixed Effects logit regression

	(1) Dividends	(2) Net Share Repurchases
LTD/TA	-0.006***	-0.344***
	(-0.001)	(0.016)
PC*LTD/TA	-0.001**	0.089***
	(0.006)	(0.018)
Sales/TA	0.0003	-0.053***
	(0.000)	(0.012)
Tobin's Q	-0.0002***	-0.032***
	(0.000)	(0.002)
Net income/TA	0.018***	0.319***
	(0.003)	(0.030)
Market Leverage	-0.002***	-0.034***
	(0.000)	(0.002)
Log Assets	0.004***	0.069***
	(0.001)	(0.002)
PC*Sales/TA	-0.008*	0.026*
	(0.000)	(0.015)
PC*Tobin's Q	0.001***	0.019***
	(0.000)	(0.002)
PC*Net Income/TA	0.011***	0.153***
	(0.003)	(0.057)
PC*Market Leverage	-0.002***	-0.006
	(0.000)	(0.004)
Firm & Time Fixed Effects	Yes	Yes
N	138671	334669

This table reports the marginal effects for the fixed effects logit estimation for the period 1990Q1-2015Q4. Standard errors calculated using the delta method. Variables are winsorized at 1 and 99 percent. Errors are clustered by firm.

* Statistical significance at the 10% level

** Statistical significance at the 5% level

*** Statistical significance at the 1% level

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Swiss Bank Capital Regulation & Lending Behavior
(with Luisa Lambertini, Dan Wunderli, and Robert Bichsel)
Using a confidential dataset of Swiss banks, this paper estimates the impact of time varying capital requirements on loan volumes and pricing for firms. We find an economically small but statistically significant impact of higher capital on borrowing rates for Swiss firms.

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OTHER EMPLOYMENT

Frost & Sullivan, Chennai, India
Analyst, Chemicals, Materials & Food, September 2010 – August 2011

- Consulting assignments involving market entry, acquisition, new product development for clients in the oleo-chemicals, biotechnology, medical device, and health ingredients industry.

Amgen Inc., Longmont, Colorado
Validation Engineer (Contract), September 2007 – August 2008

- Design and execution of lab and pilot scale cleanability and validation studies to implement Quality by design approach (QBD) resulting in significant time and cost savings compared to the traditional validation approach.
- Writing validation and feasibility reports for U.S. Food & Drug Administration approval.

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