The Pass-through of Bank Capital Requirements to Corporate Lending Spreads*

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Abstract

This paper studies the impact of higher bank capital requirements on corporate lending spreads. We conduct an empirical analysis using granular bank- and loan-level data for Switzerland. Overall, we find a positive relationship between capital ratios, actual and required, and lending spreads. The relationship is statistically significant but economically small. According to our results, a one-percentage point increase of capital ratios (risk-weighted) leads to an increase in lending spreads between 0 and 5 basis points. This figure is higher - between 5 and 20 basis points - for unweighted capital ratios (leverage ratios), partly but not only reflecting scaling effects. We find support in favor of gradual phasing-in of new requirements as banks with capital shortfalls relative to their short-run regulatory requirements charge higher spreads relative to institutions with surpluses while the effects are weaker for look-through capital shortfalls. Holding additional capital when requirements are raised is associated with lower spreads vis-à-vis peers.

JEL codes: E44, G21, G28
Keywords: bank capital requirements; lending spreads; bank regulation

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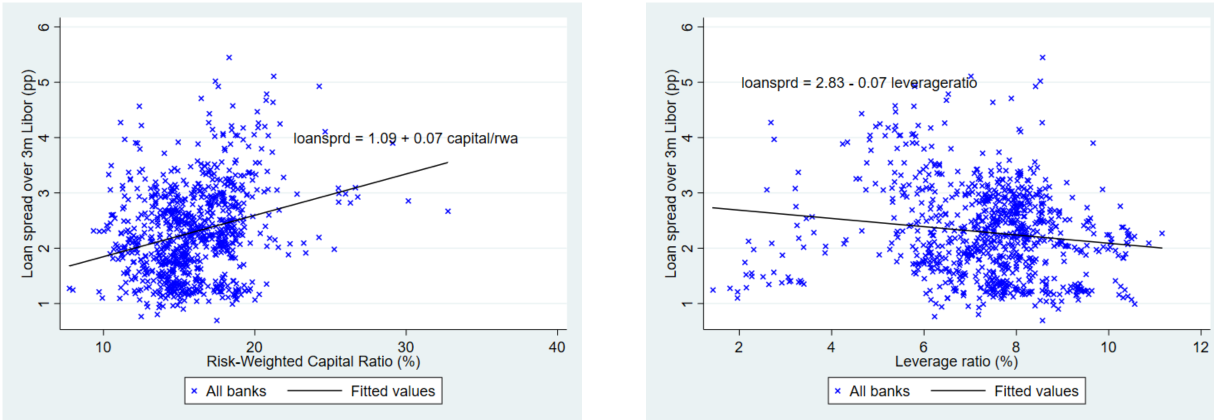
1 Introduction

This paper contributes to the ongoing debate about the cost of capital in banking. The global financial crisis and the ensuing measures to tighten up financial regulation have brought renewed interest to this old question. In particular, we ask whether higher capital ratios requirements lead to an increase in lending rates. In such a case, tighter bank capital regulation would raise borrowing costs for firms and negatively affect borrowing and the economy.

The debate on the cost of capital goes back several decades. On one hand, the celebrated Modigliani-Miller theorem (see Modigliani and Miller, 1958) argues that the capital structure is irrelevant for the value of a firm. On the other hand, banks heavily reject regulatory initiatives aimed at strengthening the financial system by increasing capital requirements, stressing the rise in costs entailed by these measures. The literature points to the fact that several conditions necessary for the irrelevance of the capital structure fail to occur in reality. For example, the preferential treatment of debt relative to equity for tax purposes and the implicit government guarantee for too-big-to-fail financial institutions make equity capital more expensive than debt. The original question on the cost of capital in banking is therefore empirical by nature. Overall, the empirical literature, which we review in detail in the next section, finds that the cost of capital is positive but small both in absolute terms and relative to the benefits in terms of increased financial stability and hence reduced frequency and depth of financial crises.

Switzerland provides an excellent laboratory to study the transmission of changes in capital requirements because: a) there is considerable heterogeneity in required and actual levels of capital across banks at any point in time; b) the largest financial institutions have bank-specific time-varying capital requirements; c) our sample period is characterized by several regulatory changes. This cross-section heterogeneity in capital requirements, given common demand conditions, and the time variation in bank-specific capital requirements make us confident that we can estimate the shift in the supply function and the pass-through to lending rates due to changes in capital levels and requirements.

We rely on a dataset with detailed information on every new loan granted to non-financial firms by a reporting group of Swiss banks that account for 80 percent of all assets in the Swiss banking sector. The dataset reports detailed characteristics of the loan (issuing bank, price, fees, size, maturity, presence of collateral and risk class) and several characteristics of the



(a) Total Capital to RWAs **(b) Leverage Ratio**

Figure 1: Lending Spreads vs. Capital Ratios

borrowing firm (size, location, industry) but not its identity. We match this data on new loans with supervisory data on bank balance sheets.

Figure 1 shows the scatter plot of the lending spread against the total capital to risk-weighted asset ratio in panel (a) and the total capital to unweighted assets (leverage ratio) in panel (b). Lending spreads are the difference between the interest rate charged on the loan and the 3-month Swiss franc Libor and they are shown in percentage points. For each quarter between 2006Q3 and 2017Q1 we calculate the average lending spread charged by each bank in our sample and each dot represents a bank-quarter observation.

As can be seen, the dispersion is wide, regarding both average lending spreads and capital ratios. However, no clear relationship between (unconditional) lending spreads and capital ratios is visible. Looking at the total capital to risk-weighted assets, the relationship appears to be slightly positive. Looking at the leverage ratio, the relationship appears slightly negative overall, but also non-monotonic. The relationship is positive for low levels of the leverage ratio (below 5 percentage points) but it becomes negative for higher levels of the leverage ratio.

Lending rates, however, depend on numerous factors such as loan and firm characteristics and other bank-specific, time-varying, observed and unobserved characteristics. In our study we carefully control for these factors thanks to granular loan-level data and time-varying bank-level capital and capital requirement information.

Our findings can be summarized as follows. We find a small positive relationship between capital ratios and lending spreads. In general this positive relationship applies to the largest banks, UBS and Credit Suisse, as well as to the smaller domestically oriented financial institutions; it holds true for the risk-weighted and the leverage ratio. A one-percentage point increase in total capital to risk-weighted assets is accompanied by an average 1.3 basis points (bps) increase in lending spreads across all banks. The estimated effect is 1.9 bps for the two largest banks and 1.5 for domestically oriented banks, although it is significantly different from zero only for the domestically oriented institutions. The estimated effect is economically small. To put these numbers into perspective: lending spreads would increase by less than 5 bps in response to activating the Basel III Countercyclical Capital Buffer, a macro-prudential tool used in particular in Switzerland, at 2.5 percentage points. The impact on lending rates of a leverage ratio increase is statistically significant and somewhat stronger, partly but not only reflecting scaling effects.[1] A one percentage point leverage ratio increase is accompanied by 6.9 bps increase in lending spreads on average; this result is primarily driven by the two largest banks that are characterized by comparatively low leverage ratios compared to the other banks in our sample.

When both capital ratios are included in the same regression, the leverage ratio emerges as the main driver of the positive relationship between capital and lending spreads if we consider all banks. This result is driven by UBS and Credit Suisse. When considering the two groups of banks separately, we find that lending spreads are affected by the leverage ratio for the two big banks, the binding regulatory constraint for these financial institutions. On the other hand, lending spreads respond to the risk-based capital ratio for the domestically oriented banks, for which the risk-weighted requirements are the only regulatory constraint. Interestingly, domestically oriented banks have been holding relatively high levels of unweighted capital even though they were not subject to leverage regulatory requirements. These findings suggest that lending spreads are affected by binding regulatory requirements.

Results based on specifications including a capital shortfall metric confirm this view. Capital requirements affect lending conditions primarily while banks face capital shortfalls relative to the regulatory target. We show that banks with risk-weighted capital positions below their short-term regulatory target charge higher lending rates relative to bank-period observations

[1] On average, the ratio between unweighted and risk-weighted assets is 0.4 in our sample. Hence, on average, a 1 percentage point increase of the leverage ratio on average corresponds to a 2.5 (1/0.4) percentage points increase of the risk-weighted capital ratio. This scaling effect will impact the magnitude of the parameter estimates.

above target. Such asymmetric response would emerge if banks with a capital shortfall temporarily raise their spreads in order to reduce lending (deleverage) or raise earnings in order to improve their capital positions or simply in response to higher funding costs; as banks return to the comfort zone, i.e. with capital levels above requirements, capital surpluses cease to explain lending spreads. An implication of our findings is that the pricing effects of heightened capital requirements are likely to be temporary.

We then analyze the behavior of lending spreads at the time of changes in capital regulation. We find that the lending spreads of financial institutions affected by heightened capital requirements are higher in the four quarters before and after the change in regulation relative to banks not affected by new requirements. We also find that holding additional capital reduces lending spreads when capital requirements are raised.

Our results are robust to excluding the financial crisis period, to considering a bank in shortfall no matter whether the negative position emerges in its risk-weighted capital or leverage ratio, and to the choice of measure of the lending spread.

Our results are consistent with the view that higher capital requirements translate into temporarily higher lending rates either in response to depressed profit margins due to higher funding costs and/or in an effort to reduce lending or raise earnings so as to improve capital positions. From a banker's perspective, this would justify opposing more prudent capital requirements. From a social planner's perspective, however, our results convey a different message. First, they show that the impact of higher capital (requirements) on lending spreads is economically small and temporary. Thereby our results confirm, but are at the lower end of, existing findings in the literature. Second, our results suggest that these effects can be mitigated by choosing sufficiently long phase-in periods, as banks appear to raise lending spreads primarily when facing short-term capital shortfalls. Third, the economic costs of higher capital requirements have to be balanced against their economic benefits stemming from less frequent (and less costly) banking crises and higher economic efficiency due to the reduced too-big-to-fail subsidy. Estimating the marginal social benefits of higher capital (requirements) is beyond the scope of this paper. However, existing results suggest that the marginal benefits of more prudent capital requirements significantly exceeds the marginal cost at the levels defined in Basel III, the international benchmark (see the literature reviewed in Basel Committee on Banking Supervision, 2016). Our findings are specific to Switzerland but they suggest that the marginal cost of higher capital requirements is possibly lower than previously estimated. For countries, such as Switzerland, that face a too-big-to-fail issue and thus have comparatively higher marginal benefits from more prudent capital requirements, our results speak in favor of capital requirements that significantly exceed international benchmarks.

The rest of paper is structured as follows. Section 2 reviews the literature. Section 3 provides a short review on capital regulation in Switzerland. Section 4 describes the data and presents descriptive evidence. Section 5 illustrates our testing strategy and presents the results. Section 6 presents a number of robustness exercises and section 7 concludes.

2 Related Literature

The empirical impact of capital shocks on bank lending has been an area of active research. The primary identification challenge is to disentangle shifts in loan supply stemming from capital shocks that are unrelated to lending and/or economic conditions. One approach to address this identification issue is to utilize a 'natural experiment' as in Peek and Rosengren (1997). They estimate the impact of a capital shock under Basel I to Japanese banks on lending by bank branches in the United States. They find that a 1 percentage point reduction in the parent banks' capital ratio led to a 6 percent decline in loans extended by the U.S. branches.

Several studies use bank-level data to investigate the impact of bank capital on loan quantities assuming identical lending opportunities. Bernanke and Lown (1991) estimate the effect of the level of the capital-to-asset ratio on loan growth; Hancock and Wilcox (1993) focus on the deviation of the capital to asset ratio from an estimated target. Both studies find relatively modest effects of their capital variable on loan growth. Berrospide and Edge (2010) use quarterly data of U.S. Bank Holding Companies (BHCs) from 1992 to 2009 and, depending on the measure of the capital ratio, find that a 1 percentage point increase corresponds to a 0.7 - 1.2 percentage point increase in loan growth. Francis and Osborne (2009) apply the Hancock-Wilcox approach to U.K. banks during the period 1996-2007 and find stronger credit growth for banks with surplus capital relative to target. These authors find that a 1 percentage point increase in capital requirements results in a 1.2 percentage point decrease in loan volume. Also employing the Hancock-Wilcox approach for U.K. banks for the period 1989 - 2013, de Ramon, Francis and Harris (2016) find that a one percentage point increase in capital requirements corresponds to an

8, 14, and 12 bps lower annual loan, asset and risk-weighted asset growth, respectively. Maurin and Toivanen (2012) develop a partial adjustment model along the lines of Francis and Osborne (2009) for euro area banks and find that a 1 percentage point capital shortfall dampens long-run loan growth by 2 - 2.3 percentage points. Labonne and Lamé (2014) rely on data from French banks between 2003 and 2011 to study the sensitivity of non-financial 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 point increase in credit growth. Mésonnier and Monks (2015) exploit the European Banking Authority's capital exercise in 2011 that required banks to build a capital buffer against sovereign debt exposures and raise Core Tier 1 (CT1), i.e. common equity plus disclosed reserves, capital ratio to 9 percent. They find that a 1 percentage point shortfall in the CT1 ratio led to a 1.2 percentage point annualized nine-month loan growth. In a vein similar to our work but using aggregate data, Bridges, Gregory, Nielsen, Pezzini, Radia and Spaltro (2014) exploit heterogeneity in individual bank capital requirements for U.K. banks between 1990 and 2011 and find that a 1 percentage point increase in capital requirements reduces loan growth to private non-financial corporations by 3.9 percentage points in the following year. Unlike these studies, we use loan-level data and we focus on lending spreads.

Several papers have linked bank capital ratios with lending spreads using different strategies. The first strategy assumes that changes in capital requirements affect bank funding costs and correspondingly loan spreads. Under the simple assumption that debt is favored over equity due to the preferential tax treatment of debt, Kashyap, Stein and Hanson (2010) find a long-run increase in loan rates of 25-45 bps for a 10 percentage point increase in capital ratios. Baker and Wurgler (2015) show that a reduction in leverage raises the cost of bank equity. They estimate an 85 bps increase in lending spreads for a 10 percentage point increase in capital requirements.

A second strategy relies on historical data on banking crises and it projects interest rates and non-performing loan rates for different levels of capitalization. The idea is to weigh the benefits of a reduction in the probability of bank default and associated economic costs against the reduction in GDP caused by higher lending rates. BIS Macroeconomic Assessment Group (2010) estimate the unweighted median increase in lending spread to be 15 bps for a 1 percentage point increase in the tangible common equity to risk-weighted-asset ratio for 15 countries. Following the BIS methodology, a 2016 study by the Federal Reserve Bank of Minneapolis (see FRB, 2016) estimate an increase in loan rates of 60 bps if risk-weighted capital ratios were increased to 23.5 percent and a corresponding leverage ratio of 15 percent for bank holding companies with assets greater than $250 billion. These estimates are relatively modest given that the net interest margin for banks in the U.S. since 1990 has been 3.74 percent.[2] Dagher, Dell'Ariccia, Laeven, Ratnovski and Tong (2016) and Cohen (2013) 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 for banks in OECD countries.

The third strategy, as used in this paper, is using matched bank and loan-level data. Jiménez, Ongena, Peydró and Saurina (2017) utilize credit-register loan-level data and exploit the time-varying heterogeneity in dynamic provisioning by Spanish banks. They show that firms borrowing from banks holding a 1 percentage point higher dynamic provisioning funds receive a 9 percentage point higher committed credit than when borrowing from other banks during crisis periods. A number of other studies primarily focus on loan quantities (see Albertazzi and Marchetti, 2010; Carlson, Shan and Warusawitharana, 2013; Puri, Rocholl and Steffen, 2011) or a small subset of commercial lending (see Glancy and Kurtzman, 2018). In this regard, our contribution to the literature is twofold. First, we are able to estimate effects on corporate loan pricing of time-varying and institution-specific capital ratio requirements; second, we rely on pricing data for new loans,[3] which alleviates concerns over using credit stock data.

A few studies have analyzed 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. 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[4] and predict the resulting increase in loan rates for the non-financial sector to be in the range of 0.6 - 1.6 bps. Auer and Ongena (2016) estimate the change in composition in bank supply of credit and the effect on lending rates using the variation in holdings of mortgages that require

[2]https://fred.stlouisfed.org/series/USNIM

[3]This is defined as new credit or credit with significant change in conditions such as maturity or pricing

[4]Their sample includes UBS, Credit Suisse, Banque Cantonale Vaudoise, Bank Sarasin, and Valiant.

additional holding of capital following the introduction of the sectoral countercyclical capital buffer (CCyB) in Switzerland in 2012. They aggregate loans according to several characteristics and find an increase in commercial lending as well as an increase in the average interest rate. We are also interested in the effect of changes in capital requirements on lending rates but we use loan-level data.

3 Capital Measures and Capital Regulation in Switzerland

Our analysis focuses on the impact of changes in bank capital situation on their lending policy. One challenge faced in this context is how to measure bank capital situation, i.e. finding observable variables that adequately capture an inherently complex and multidimensional phenomenon. In our study we rely on the two capital ratios: (i) the ratio of total capital to risk-weighted assets; (ii) the ratio of total capital to unweighted assets, also referred to as the leverage ratio. Below we provide a brief description of the components of these capital ratios:

Total capital consists of Tier 1 capital plus potentially loss-absorbing debt instruments. Tier 1 capital has two components: Common Equity Tier 1 capital (CET1), which consists of paid-up capital, disclosed reserves and retained earnings, and Additional Tier 1 capital (AT1), which encompasses high-trigger contingent capital instruments such as contingent convertible securities. Capital requirements in Switzerland are specified in terms of CET1, AT1 and total capital. The definition of eligible Tier 1 capital underwent substantial changes over the sample period. Loss-absorbing instruments include subordinated debt, contingent capital and other hybrid instruments; their definition also underwent substantial changes over the sample period.

Risk-weighted assets (RWAs) consist of a bank's assets and off-balance-sheet exposures, weighted according to a risk measure. The risk-weighting parameters differ across banks as different risk-weighting methods co-exist in the regulation. Furthermore, the risk-weighing parameters underwent substantial changes over the sample period reflecting changes to the regulatory framework.

Unweighted assets are broadly defined as a banks' total balance sheet assets and relevant off-balance sheet positions.

We focus on total capital requirements, which are the most comprehensive.[5] Each ratio provides a metric of banks' capital situation at a given point in time. Since capital requirements display considerable variation across time and banks, the actual capital ratio does not relay reliable information about the bank's capital position relative to the requirement. This dimension, though, is important for our analysis, as the bank's capital situation is more likely to affect its lending policy if the regulation is binding. Hence, our analysis includes a distance-to-requirement variable that we label capital surplus.

Banks in Switzerland are subject to regulatory capital requirements. These requirements stipulate that a bank's capital must exceed a certain proportion of its risk-weighted and, for systematically-relevant institutions, of unweighted assets. Furthermore, banks have to report their regulatory capital ratios. These ratios play a key role for the assessment of the banks' capital adequacy and are used both by authorities and market participants. The regulatory framework in place is based on the international standards. However, Swiss specificities apply both regarding design and severity. For regulatory purposes, we identify four overlapping groups of banks: i) big banks: UBS and Credit Suisse; ii) domestically oriented banks (DOBs): all banks materially active in the domestic lending and/or deposit market except UBS and Credit Suisse; iii) Domestically Focused Systemically Important Banks (DF-SIBs): Zurich Cantonal Bank (since 2014Q4) and Raiffeisen (since 2015Q3); iv) Systemically Important Banks (SIBs): big banks plus DF-SIBs.[6] The distinction between big and domestically oriented banks is due to the difference in size and orientation between the two groups; several Swiss-specific capital requirements (see below) are based on this distinction. The two big banks, UBS and Credit Suisse, were designated as systemically important both at the global level (G-SIBS) in 2011 and in Switzerland (SIBs) in 2012 and have been subject to domestic and international too-big-to fail capital regulation since then. Zurich Cantonal Bank and Raiffeisen belong to group (ii) for the entire sample and to group (iii) since their designation as DF-SIBs.

The design and severity of the capital requirements as well as the extent to which individual

[5]The estimations using Tier 1 capital requirements are similar, both qualitatively and quantitatively, to those using total capital and we do not report them.

[6]In 2016Q3 PostFinance also became a systematically important financial group. PostFinance is excluded from our analysis since it is not active in corporate lending.

banks fulfill these requirements have been varying significantly during the time span covered by our analysis. Several changes in capital requirements are the result of the reform in the international standards developed by the Basel Committee on Banking Supervision. During the period covered by our analysis, these include the introduction of Basel II, the introduction of Basel 2.5 - a partial revised version of Basel II - and a partial introduction of Basel III. In addition, changes in the regulatory framework are Swiss-specific, such as the suppression of the preferential treatment applying to the state-owned Cantonal banks; and the introduction of additional capital requirements for systemic banks aimed at addressing the too-big-to-fail issue in Switzerland. This section briefly describes the main characteristics of the capital regulation framework in Switzerland and the major revisions that took place during the period considered in our analysis (2006Q3-2017Q1).

At the beginning of the sample period, Swiss banks had to hold capital representing 8 percent of their risk-weighted capital requirements, whereby the risk-weighting closely reflected the weighing scheme as defined in the Basel I capital standards. Furthermore, the regulator (the Swiss Federal Banking Commission that was later replaced by FINMA) expected banks to have at least 20 percent excess capital as buffer above the minimum, thereby bringing the capital requirement to 9.6 percent of risk-weighted capital. Differences regarding the severity of capital requirements across banks mainly reflected Swiss specificities and in particular reduced risk-weighted assets for a number of banks with explicit state-guarantees, i.e. Cantonal banks, which are major players in the domestic deposit and credit market representing a cumulated deposit market share of about 20 percent.

In 2007 and 2008, the regulatory framework underwent fundamental changes, as the revised international standards (Basel II) were progressively introduced in Switzerland. While the quantitative thresholds remained unchanged (minimum requirements of 8 percent of risk-weighted assets; buffer requirement of 20 percent or 1.6 percentage points), the methodology regarding the computation of the relevant risk weights underwent substantial changes. In particular, banks could opt for the internal risk-based approach to measure credit risk, which allowed banks to use their own risk weights. The two big banks, UBS and Credit Suisse, adopted such approach. Lower risk-weighted asset density mechanically translates into higher capital to risk-weighted assets ratio. This would imply a lower absolute level of capital to meet the capital requirements.

In December 2008, following the public rescue of Switzerland's biggest bank UBS in the wake of the global financial crisis, the two big banks' risk-weighted buffer requirements were increased from 20 to 100 percent, thereby rasing their total risk-weighted capital requirement to 16 percent. Furthermore, FINMA newly subjected these banks to leverage ratio requirements, namely to a minimum requirement of 3 percent applying to the ratio of capital to unweighted assets with a target of 4 percent.

The preferential treatment applying to most Cantonal banks was removed in the first quarter of 2010, leading to a substantial increase in their capital requirements. At the same time, Tier 1 capital requirements for Raiffeisen Bank, a major player on the domestic lending and deposit market, were tightened, as additional restrictions regarding capital quality were introduced.

In 2011Q1 capital requirements for the two big banks were tightened significantly, following the introduction of the revised international standards governing the capital requirements for market risks (market risk amendment, also referred to as Basel 2.5) in Switzerland. Moreover, in 2011Q3 FINMA introduced higher capital buffer requirements (target values) for domestically oriented banks (Pillar 2 regulatory change).

In 2012Q1 additional capital requirements applying to banks considered systemic from a domestic perspective were progressively introduced in Switzerland. These were part of a reform program, which we refer to as TBTF1, aimed at addressing the too-big-to fail issue in Switzerland. Initially it concerned only the two big banks. As a consequence, their quality adjusted going-concern capital requirements (capital to cover losses from current operating activities) were increased and gone-concern requirements (capital instruments to enable a restructuring or orderly resolution) were introduced. Further banks became subject to such additional requirements at a later stage (see below).

In 2013Q1, a first subset of the Basel III revised capital standards was introduced. This led to a further tightening of the capital requirements for the big banks, mainly through tighter quality requirements and an increase of risk-weighting for exposure to derivatives and counter-party risk. In February 2013 the sectoral countercyclical capital buffer (CCyB) targeting residential real estate was switched on and set at the level of 1 percent. The sectoral CCyB is a temporary capital charge applying to most banks in Switzerland, aiming at addressing cyclical risks in the domestic mortgage and real estate markets; it is therefore a form of macro-prudential policy.

In January 2014 the sectoral CCyB was increased to 2 percent. In the fourth quarter of 2014, TBTF1 specific requirements entered into force for Zurich Cantonal Bank and in 2015Q3 for Raiffeisen, as the two banks were formally designated as systemically important. This resulted in the introduction of leverage ratio requirement for these banks.

In 2016Q3 too-big-to-fail regulation underwent major modifications and resulted in the introduction of TBTF2 for systemically-relevant banks. Global systemically important banks (G-SIBs), currently UBS and Credit Suisse, faced a substantial increase in leverage ratio requirements, from 3 to 5 percent; the requirement can be higher depending on size and market shares; they also faced a slight increase, from 13 to 14.3 percent, in risk-weighted requirements. For systemically important banks (but not globally so, hence Zurich Cantonal Bank and Raiffeisen), there was an increase in leverage ratio requirement to 4.5 percent (Zurich Cantonal Bank) and 4.625 (Raiffeisen) of Tier 1 capital. In addition, there was an increase in gone-concern requirements for all systemically important banks both in terms of leverage ratio and risk-weighted capital (for domestically focused systemically important ones only at end 2018).

4 Data and 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 (excluding residential mortgages) is reported at a monthly frequency by all banks whose total lending to non-financial corporations exceeds CHF 2 billion. A new loan arrangement is either a new loan granted or an old loan 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 the existing stock of loans which is commonly used in banking studies.[7] The reporting banks account for approximately 80 percent of the Swiss banking sector's assets. We match this dataset with supervisory data

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

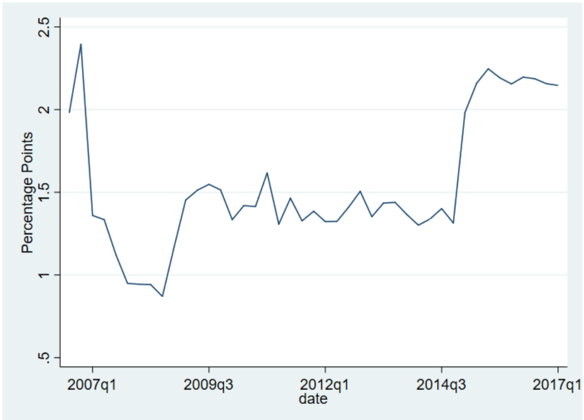
on capital requirements, capital and bank characteristics.[8] Our matched panel dataset includes data from 2006Q3 to 2017Q1. Table 1 presents the summary statistics on key loan, firm and bank characteristics.

Table 1: Summary Statistics

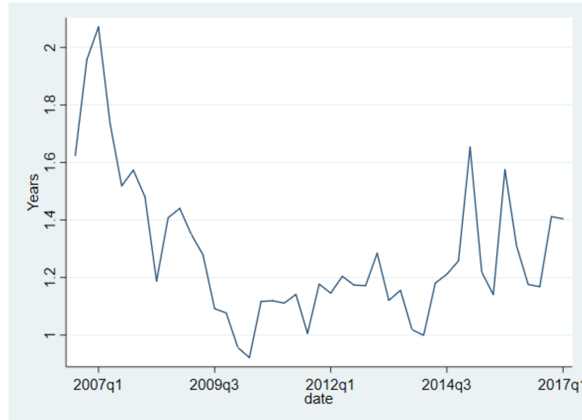
Variable	**Units**	**N**	**Mean**	**SD**	**5^{th} pct**	**Median**	**95^{th} pct**
Panel A: Loan characteristics							
Loan Spread	%	1220724	2.5	1.9	0.5	1.9	6.6
Loan Maturity	Years	762402	2.2	2.8	0.1	1.0	8.0
Loan Amount	CHF Mill	1220724	1.5	6.0	0.1	0.4	5.5
Single-Issuer Loan[1]	Dummy	1220724	0.99	0.1	1	1	1
Probability of Default	0-5[2]	1220724	3.3	1.4	0	4	5
Loan Type	Dummy	961776	See Appendix B				
Loan Collateral Type	Dummy	961776	See Appendix B				
Panel B: Firm characteristics							
Firm Size	Dummies	1220724	1.3	1.7	0	1	2
Firm Location	Dummies	1220724	26 cantons & Liechtenstein				
Firm Industry	Dummies	1220724	38 industries (NOGA 2008 codes)				
Panel C: Bank capital ratios - actual, target and surplus							
Total Capital/RWAs	%	1220724	16.9	3.8	11.3	16.7	24.2
Total Capital/Assets	%	1220724	6.5	2.0	2.7	6.9	9.6
			Phase-in target, including buffer				
Total Capital/RWAs Target	%	1220724	11.7	2.4	9.6	10.6	16.5
Total Capital/Assets Target[3]	%	1220724	0.7	1.2	0	0	3.4
Total Capital/RWAs Surplus	%	1220724	5.3	2.9	1.1	5.1	9.5
Total Capital/Assets Surplus	%	1220724	5.9	2.6	1.5	6.6	9.6
			Look-through target, including buffer				
Total Capital/RWAs Target	%	1220724	13.0	3.6	9.6	12.4	19
Total Capital/Assets Target	%	1220724	1.1	1.8	0	0	4.3
Total Capital/RWAs Surplus	%	1220724	3.9	3.3	-1.4	3.8	9.2
Total Capital/Assets Surplus	%	1220724	5.4	3.1	-0.1	7.0	9.6
Panel D: Bank characteristics							
Bank Assets	CHF Bill	1220724	447	577	14.2	155.0	1460
Cash/Assets	%	1220724	4.4	4.3	0.3	3.0	12.8
Debt[4]/Assets	%	1220724	15.6	4.9	8.8	14.9	24.6
Return on Assets	%	1220724	0.3	0.3	-0.1	0.3	0.8

[1] Dummy = 0 if syndicated loan
[2] 0: undefined, 1: low, ..., 5: high
[3] Target = 0 if the bank is not subject to requirement
[4] Excluding deposits

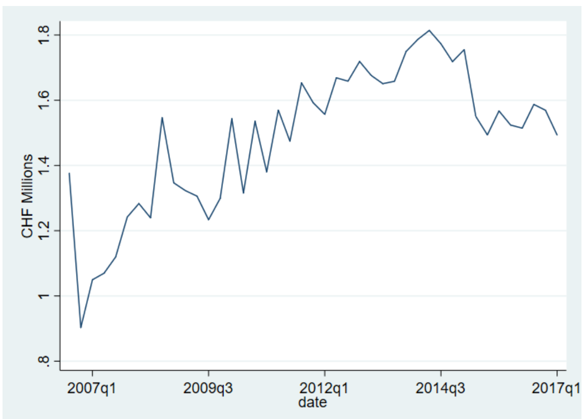
[8] Banks report at the parent level and/or at the highest level of consolidation (group). We use the highest level of consolidation for our analysis because capital requirements are imposed at the highest level of consolidation.



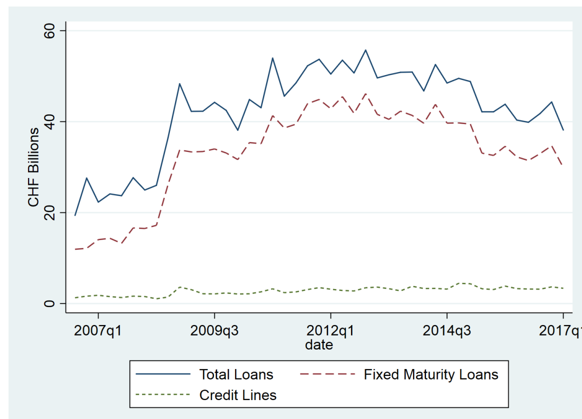
(a) Average Loan Spread[9]



(b) Average Loan Maturity



(c) Average Loan Size



(d) Loan Volume

Figure 2: Loan Characteristics

4.1 Loan Characteristics

A change in credit supply can occur along three dimensions: pricing, maturity and volume. We analyze the quarterly behavior for each of these dimensions. The loan spread is the interest rate charged on the loan over the 3-month Swiss franc (CHF henceforth) Libor. For robustness, we also measure the loan spread relative to the Swiss Confederation bond maturity-matched yield curve and report the results in Appendix D. In Figure 2a, we plot the average loan spread weighted by loan size. The average spread fell in the early part of our sample; it increased in 2008Q4, at the onset of the financial crisis, and then again in 2015Q1 as the SNB adopted negative interest rates. Since we do not observe the spread prior to 2006Q3, we cannot make an overarching argument on the trend leading up to 2008Q4. However, the period leading up to the financial crisis was characterized by a compression in spreads across asset classes globally.

Figure 2b plots the size-weighted maturity of new loan arrangements in our dataset. The average maturity over the entire sample is 2.3 years; average loan maturity fell during the financial crisis but it has regained some ground since. The average loan size in our sample is equal to CHF 1.5 Millions and its dynamics is reported in Figure 2c. The average loan size broadly increased from 2006Q3 to 2014Q2, except during the financial crisis, and it has fallen since the introduction of negative rates.

Next, we plot the quarterly volume of new loan arrangements in Figure 2d. For interpreting Figure 2d it is important to know that KREDZ reporting banks were given a deadline of year-end 2008 to satisfy the required reporting standards. The increase in loan volume in the last two quarters of 2008 primarily reflects an increase in the reporting coverage rather than a genuine increase in lending.[10] We also checked that the increase in lending volume in the last two quarters of 2008 was not driven by any single bank or group of banks or any specific type of loan.

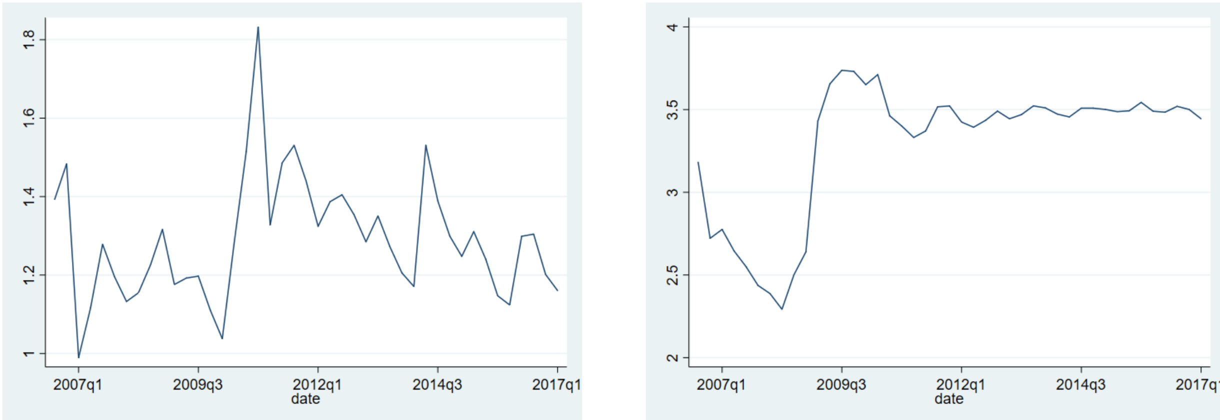
Loans can be of two types in our dataset: fixed maturity and credit lines. Fixed maturity loans represent almost 90 percent of quarterly total loan volume as reported in our dataset. Notice that the increase in loan volume in the last two quarters of 2008 is not due to a drawing down of credit lines, as documented instead by Ivashina and Scharfstein (2010) for U.S. firms. Loans can be of ten types and we report them and their frequency over the entire sample and up to 2008Q4 in Appendix B. Almost half of all new loans to firms are secured by real estate and the relative frequency of loan types did not change substantially after the financial crisis. Almost 80 percent of all loans are collateralized and/or guaranteed, as reported in Appendix B. 1 percent of all loans in our dataset are issued by a syndicate of banks.

4.2 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 category includes observations for which size was reported as *unspecified*. We assign an indicator variable taking values between 1 and 5 for the size categories and 0 for

[9]Weighted by loan size.

[10]We compare new loans with the change in the outstanding stock, which is recorded in the credit volume statistics (KRED), from 2006Q3 to 2008Q4 and indeed found that new loan issuances were underreported until the end of 2008.



(a) Average Firm Size Indicator **(b) Average Probability of Default Class**

Figure 3: Firm Characteristics

the *unspecified*, respectively. The frequency of firms in each category in our entire sample is reported in Appendix B. The majority of firms in our sample have total assets less than CHF 5 Million. In Figure 3a we report the evolution of the average value of the firm size indicator over our sample period; we do not detect any major change in the average size indicator.

Additionally, we have a composite measure of firm-loan riskiness that we label Probability of Default (PD) class. This is also categorized into five classes ranging from low (1) to high (5) and a sixth class for unspecified observations. The frequency of observations in each PD class is reported in Appendix B and we plot the average PD class over our sample period in Figure 3b. There is evidence of a change in riskiness as measured by PD class for credit granted around 2008Q4. We do not have data prior to 2006Q3 and therefore cannot say whether the evidence in Figure 3b points to an increase in riskiness post 2008Q4 or a temporary reduction in riskiness from the beginning of the sample until 2008Q3.

4.3 Bank Characteristics

We have 20 loan-granting banks in our sample, which represent over 80 percent of total assets of the Swiss banking sector. These banks are highly representative of the Swiss banking sector as they cover the bulk of Swiss banks' loans and deposits.[11] The banks in our sample are heterogenous in terms of size as measured by bank assets. Our sample includes the two big banks, which account for more than 70 percent of total assets and 51 percent of total loans to

[11] Our sample does not include foreign-controlled banks, branches of foreign banks and private banks.

non-financial corporations over our sample period. The asymmetry in bank size is confirmed by the statistics on the distribution of bank assets reported in Table 1.

Figure 4 displays total assets held by banks in our dataset over the sample period. Total assets fell sharply during the financial crisis; risk-weighted assets also decreased during the financial crisis but have regained some ground since early 2013, suggesting a gradual increase in risk exposure since the double-dip recession in Europe.[12]

We now focus on the evolution of bank capital and a number of bank balance sheet variables.[13] To assess banks' capital situation, we consider two measures: Total capital to risk-weighted assets and the leverage ratio. For each of these two capital measures, we calculate the average weighted by bank assets and we report it in Figure 5. We observe a fall in both capital ratios during the global financial crisis followed by an improvement starting in 2008Q4.

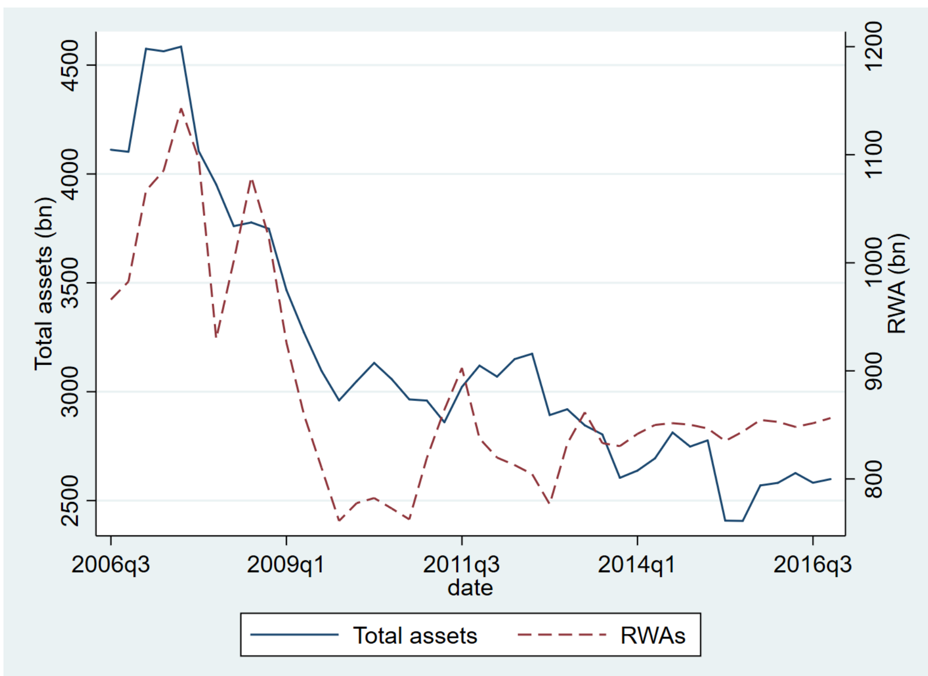


Figure 4: Total Assets and Risk-weighted Assets

Looking at aggregate capital ratios, however, hides a great deal of variation in the capital situation of Swiss banks. One of the strengths of our study is that different banks faced different capital requirements at any given date in Switzerland. This is to say that a total

[12]A re-calibration of internal risk models may also explain the increase in risk-weighted assets.

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

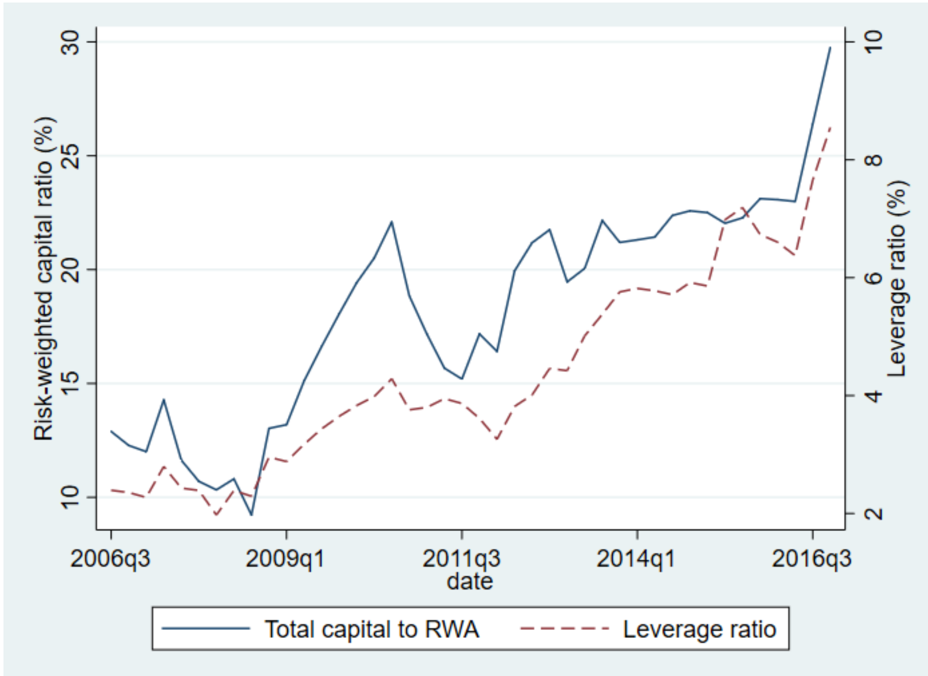
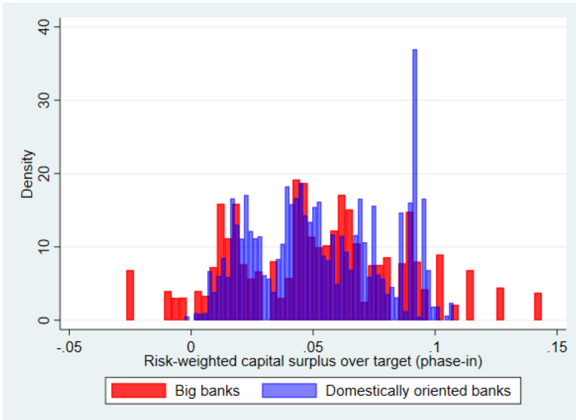


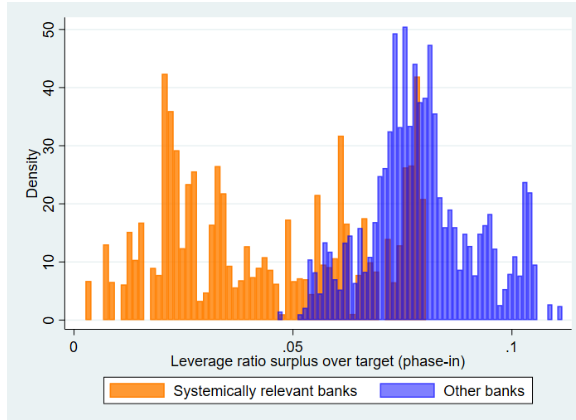
Figure 5: Capital Ratios

capital to risk-weighted assets ratio of 12 percentage points represents a capital surplus for a bank with a requirement of 10.5 percentage points but it implies a serious capital shortage for a bank with a 19 percentage points requirement. It is for this reason that our empirical analysis includes a capital surplus measure, which we calculate as the difference between actual and target capital ratio. A bank with a capital deficit needs to undertake corrective measures in order to fulfill its requirements and to avoid intervention by the supervising authority.

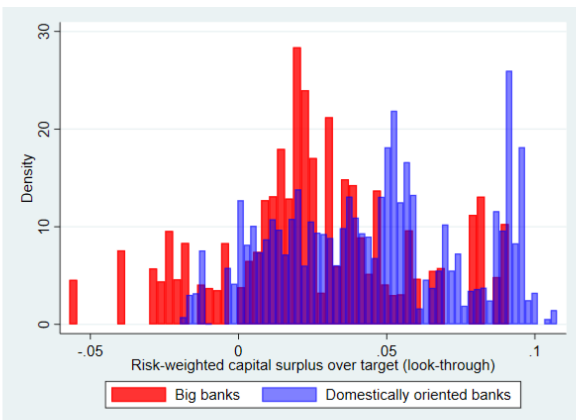
We measure capital surpluses relative to two different capital targets: phase-in and look-through. A detailed explanation of how we build these targets is given in section 5.3. Almost all banking regulation provides for a phase-in period at the end of which banks are supposed to be fully compliant. Intuitively, a phase-in capital target is the smooth path of the target between its old and new required levels, with quarterly increases calculated as the total change in the target divided by the number of quarters in the phase-in period. The look-through target is the new target level throughout the phase-in period. In Figure 6 we report the density of capital surpluses for our two capital measures; panels (a) and (b) pertain to phase-in targets whereas panels (c) and (d) pertain to look-through targets. For the risk-weighted surplus, we show separately the densities of the two big banks and of domestically oriented banks; for the leverage ratio surplus, we report separately the density of systematically relevant



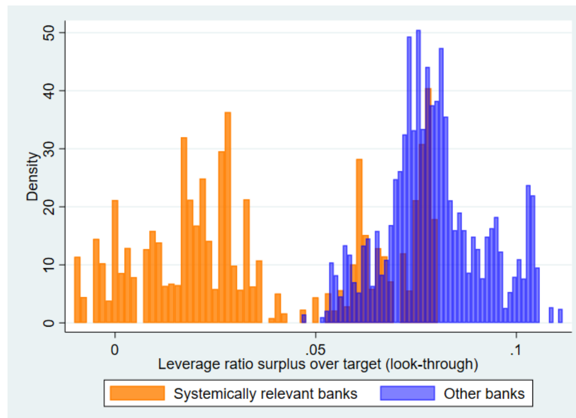
(a) Total Capital/RWAs Surplus (phase-in)



(b) Leverage Ratio Surplus (phase-in)



(c) Total Capital/RWAs Surplus (look-through)



(d) Leverage Ratio Surplus (look-through)

Figure 6: Capital Surplus Density

(SIBs) banks, which are subject to the leverage ratio requirement, and the density of all other banks.[14] For non-systemically important financial institutions, the leverage ratio surplus is calculated assuming a leverage ratio target of zero. Conditional on a capital measure, look-through surpluses are lower than their phase-in counterpart; this confirms that our sample period captures the process of adjustment undertaken by Swiss banks to their new and higher required capital ratios. The distributions of capital surpluses of large financial institutions, big and systematically relevant, have higher standard deviations than those of other banks. The leverage ratio surplus distributions, phase-in and look-through, clearly display a bimodal distribution where observations around the left mode almost entirely belong to SIBs. Notice

[14] As noted earlier, two domestically oriented banks (Zurich Cantonal Bank and Raiffeisen) were designed as SIBs in 2014Q4 and 2015Q3, respectively, and became subject to leverage ratio regulation.

that the distance between the two modes is larger than the average leverage ratio requirement for SIBs in our sample period. The distribution of look-through risk-weighted capital surpluses is also bimodal, with the lower mode belonging to the big banks. This evidence alludes to important differences in the way small and large financial institutions operate, with the latter being more leveraged and holding riskier assets but smaller capital buffers, as pointed out by Rime (2001). Negative surpluses are non-negligible and they almost entirely concern the big banks. Risk-weighted total capital shortfalls of big banks represent 1.7 and 5.6 percent of all observations for the phase-in and look-through definitions, respectively; the corresponding percentages for the leverage ratio shortfalls of systematically relevant banks are 0 and 5.1. These capital deficits speak to the effort undertaken by the large Swiss financial institutions to raise their capital ratios during our sample period.

5 Results

5.1 Benchmark Specification

To estimate the impact of bank capital on lending spreads, we start from the following benchmark specification:

$$\text{Loan Spread}_{j,i,t} = \alpha \, \text{Cap Ratio}_{i,t-1} + \gamma \, \text{Bank}_{i,t-1} + \phi \, \text{Firm-Loan}_{j,t} + \varphi \, \text{Neg Rate}_t + \mu_i + \nu_t + \epsilon_{i,j,t}. \tag{1}$$

Loan $\text{Spread}_{i,j,t}$ measures the spread between the interest rate charged for loan j by bank i at time t and the 3-month CHF Libor rate at time t. All independent variables are lagged one period to avoid simultaneity. Cap $\text{Ratio}_{i,t-1}$ denotes the measure of the bank capital ratio; $\text{Bank}_{i,t-1}$ is a vector of bank-specific characteristics, namely size (log of total assets), liquidity (cash-to-assets ratio), debt (medium term notes and bonds over assets), ROA (net income divided by assets). The vector $\text{Firm-Loan}_{j,t}$ includes controls for firm size, industry, location, loan amount, loan type, loan maturity, collateral type and PD class. To distinguish between fixed maturity loans and credit lines, we include the indicator variable Fixed $\text{Maturity}_{i,j,t}$, which takes a value equal to 1 if the loan has a fixed maturity and 0 otherwise. Neg Rate_t is a dummy variable that takes the value of 1 starting in 2015Q1, when the SNB moved the target range for its policy rate, the 3-month CHF Libor, into negative territory. Bank fixed effects, μ_i, control for any unobserved systematic heterogeneity at the bank level and time fixed effects, ν_t, control for macroeconomic conditions and/or demand effects common to all banks at a given point in time.

In equation (1), α measures the basis point change in the spread caused by a one percentage point increase in the capital ratio; $\alpha > 0$ would imply that banks charge higher loan spreads when they raise the capital ratio. We run specification (1) for our two capital measures on all banks and then separately on the big banks and on domestically oriented banks.

Table 2 presents the estimates of equation (1). The risk-weighted total capital ratio is associated with a 1.3 bps (not significant) increase in lending spreads when we consider all banks in column (1); the effect is 1.5 bps for DOBs in column (5) and 1.9 bps for the big banks in column (3). Overall these estimated effects are economically small. Considering domestically oriented banks, a one percentage-point increase in their total capital to risk-weighed assets ratio raises lending spreads on average by 1.5 bps for this group of banks. The effect is slightly larger for the big banks, even though the estimated coefficient fails to be significantly different from zero. The impact on lending spreads of an increase in the leverage ratio is statistically significant and larger. A one percentage-point increase in the leverage ratio raises on average lending spreads by 6.9 bps across all banks. The stronger effect of changes in the leverage ratio partly reflects the fact that, on average, the risk-weighted capital ratio is a multiple of the leverage ratio (2.6 across all banks and 4 for the big banks); the estimated effect of 19.4 bps for the big banks, however, suggests that loan pricing by this group of banks responds at the margin to changes in the leverage ratio. The positive effect in column (5) for domestically oriented banks confirms that the risk-based capital ratio is the binding regulatory constraint for these banks while the negative effect in column (6) suggests that lending spreads will respond negatively to an increase in their leverage ratio.

Our estimated effects are on the lower side of the range of values (between 5 and 19 bp) reported by Basel Committee on Banking Supervision (2016) and Dagher et al. (2016). We are aware of one study that focuses on the effect of increasing the ratio of total capital to unweighted assets using loan-level data, Santos and Winton (2013), and our point estimate of the effect of the leverage ratio on lending spreads is in line with theirs when we consider all banks but larger when we restrict attention to the big banks. This suggests that, in our sample,

Table 2: Benchmark Specification

	(1) All	(2) All	(3) Big	(4) Big	(5) DOBs	(6) DOBs
Total Capital/RWAs	1.256		1.871		1.463**	
	(1.68)		(0.86)		(2.48)	
Leverage Ratio		6.919***		19.38***		-2.429*
		(4.08)		(3.53)		(-1.90)
Negative Rate	1.214***	1.143***	0.945**	0.452	1.323***	1.398***
	(7.44)	(7.29)	(2.28)	(1.63)	(7.74)	(8.25)
10Y-3M Yield	0.663**	0.662**	0.612**	0.609**	0.664**	0.669**
	(2.22)	(2.22)	(2.46)	(2.46)	(2.08)	(2.11)
Bank Variables						
Log (Assets)	0.340**	0.501***	1.722***	1.927***	0.133	-0.0448
	(2.49)	(3.58)	(6.71)	(6.52)	(1.16)	(-0.33)
Cash to Assets	-0.993***	-0.788**	9.278***	7.277***	-1.495***	-1.186**
	(-2.71)	(-2.38)	(4.64)	(4.07)	(-3.15)	(-2.52)
Bank Debt to Assets	0.902**	0.736*	2.777*	0.988	1.378***	1.114***
	(2.23)	(1.86)	(1.99)	(1.07)	(3.55)	(2.87)
Return on Assets	0.728	3.732	39.68**	21.13	10.53	5.188
	(0.14)	(0.67)	(2.16)	(1.24)	(1.24)	(0.61)
Firm-Loan Variables						
Log (Loan Amount)	-0.164***	-0.164***	-0.188***	-0.187***	-0.142***	-0.143***
	(-65.99)	(-67.19)	(-50.16)	(-50.25)	(-49.97)	(-49.22)
Fixed Maturity	-0.625***	-0.628***	-0.0759	-0.0861*	-0.812***	-0.813***
	(-10.16)	(-10.31)	(-1.67)	(-1.92)	(-10.13)	(-10.11)
Syndicated Loan	0.0978***	0.102***	-0.220***	-0.228***	0.0381	0.0453
	(3.19)	(3.31)	(-5.03)	(-5.21)	(1.04)	(1.23)
Firm Size 1	-0.268***	-0.268***	-0.215***	-0.182***	-0.0584**	-0.0848**
	(-6.67)	(-7.29)	(-6.39)	(-5.93)	(-2.12)	(-2.68)
Firm Size 2	-0.232***	-0.233***	-0.219**	-0.154*	0.0475*	0.0216
	(-4.79)	(-5.25)	(-2.15)	(-1.72)	(1.80)	(0.71)
Firm Size 3	-0.169***	-0.176***	-0.145*	-0.0844	0.0571**	0.0352
	(-3.79)	(-4.26)	(-1.69)	(-1.10)	-2.25	(1.23)
Firm Size 4	-0.226***	-0.231***	-0.145**	-0.0878	-0.0268	-0.0489*
	(-5.80)	(-6.43)	(-2.18)	(-1.52)	(-1.11)	(-1.85)
Firm Size 5	-0.254***	-0.258***	-0.148***	-0.0999**	-0.0869***	-0.108***
	(-7.34)	(-8.35)	(-2.76)	(-2.02)	(-4.28)	(-4.78)
PD Unspecified	-0.323***	-0.318***	-0.804***	-0.809***	-0.271***	-0.267***
	(-12.76)	(-12.34)	(-7.08)	(-6.99)	(-9.52)	(-10.38)
PD Class 1	-0.612***	-0.607***	-1.021***	-1.021***	-0.483***	-0.486***
	(-41.85)	(-41.50)	(-37.09)	(-37.63)	(-27.28)	(-27.57)
PD Class 2	-0.565***	-0.560***	-0.886***	-0.887***	-0.493***	-0.496***
	(-38.54)	(-39.22)	(-35.01)	(-35.99)	(-37.67)	(-38.01)

Table 2: cont.

PD Class 3	-0.528***	-0.524***	-0.882***	-0.883***	-0.410***	-0.416***
	(-45.55)	(-46.15)	(-41.07)	(-42.37)	(-42.40)	(-43.09)
PD Class 4	-0.300***	-0.299***	-0.616***	-0.616***	-0.204***	-0.204***
	(-30.49)	(-31.09)	(-27.47)	(-28.00)	(-24.52)	(-24.01)
Overdraft Facility	1.571***	1.577***	2.527***	2.540***	1.662***	1.631***
	-30.45	-30.3	-32.03	-32.47	-15.67	(14.72)
Construction Loans	-0.465***	-0.460***	-0.436***	-0.422***	-0.107	-0.136
	(-9.41)	(-9.23)	(-5.42)	(-5.31)	(-1.04)	(-1.28)
Fixed Advance (Investment Loan)	-1.286***	-1.282***	-1.369***	-1.351***	-0.789***	-0.818***
	(-32.14)	(-31.60)	(-23.79)	(-23.61)	(-7.14)	(-6.97)
Loan (Investment Loan)	-0.297***	-0.284***	1.382***	1.405***	0.221**	0.186*
	(-4.88)	(-4.56)	-15.64	-16.19	-2.09	(1.70)
Mortgage to Firm	-1.079***	-1.073***	-1.486***	-1.475***	-0.500***	-0.530***
	(-23.29)	(-22.72)	(-22.91)	(-22.64)	(-5.09)	(-5.05)
Seasonal Loan	2.658***	2.650***	0	0	3.185***	3.160***
	-24.44	-24.51	(.)	(.)	-21.33	(20.09)
Rollover Loan	-1.872***	-1.874***	-1.665***	-1.660***	-1.176***	-1.190***
	(-21.42)	(-21.51)	(-31.38)	(-30.92)	(-8.33)	(-8.45)
Loans / Fixed advance (Investment Loan)	-0.921***	-0.919***	-2.942***	-2.923***	-0.383***	-0.410***
	(-17.05)	(-16.72)	(-36.66)	(-35.64)	(-3.49)	(-3.56)
Miscellaneous Loan	-1.720***	-1.664***	-1.427***	-1.349***	-1.224***	-1.263***
	(-33.46)	(-29.06)	(-22.53)	(-20.53)	(-10.04)	(-10.15)
No Collateral	0.0145	0.0201	0.0741***	0.0770***	0.0957***	0.0968***
	-0.88	-1.2	-4.13	-4.26	-3.45	(3.55)
Real Estate or Land	-0.502***	-0.497***	-0.373***	-0.370***	-0.409***	-0.408***
	(-33.01)	(-32.74)	(-15.81)	(-15.84)	(-16.04)	(-16.37)
Securities	-0.567***	-0.563***	-0.472***	-0.472***	-0.653***	-0.650***
	(-28.50)	(-27.88)	(-27.97)	(-28.33)	(-20.64)	(-20.94)
Cession	-0.150***	-0.142***	-0.0976**	-0.109**	-0.055	-0.0548
	(-5.41)	(-4.98)	(-2.16)	(-2.44)	(-1.54)	(-1.54)
Guarantees	-0.332***	-0.327***	-0.111***	-0.107***	-0.360***	-0.359***
	(-15.03)	(-14.90)	(-7.48)	(-7.23)	(-11.74)	(-12.14)
Pledge or Register on Goods	-0.322***	-0.320***	-0.000568	-0.00141	-0.692***	-0.687***
	(-4.57)	(-4.41)	(-0.01)	(-0.03)	(-7.05)	(-7.16)
Observations	1220724	1220724	391541	391541	829183	829183
Bank & Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.775	0.775	0.85	0.851	0.747	0.747

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

marginal changes in the leverage ratio have stronger effects on lending spreads for large financial institutions, which are typically more leveraged.

The negative interest rate dummy takes the value of 1 over the period when the SNB set its official policy rate, the 3-month CHF Libor, in negative territory; this period starts on January 15, 2015 and it lasts until the end of our sample period. Figure 2a shows that the average lending spread relative to 3-month CHF Libor increased in the first quarter of 2015 and it has remained elevated since. We estimate an average increase in lending spreads between 100 and 130 bps during the negative rates period depending on the specification; since the lower limit of the 3-month CHF Libor range was reduced by 100 bps, out estimates provide no evidence of an actual increase in the average lending rate during this period.

Looking at bank controls, we find that the log of lagged bank assets enters positively, thereby indicating that Swiss banks behave as monopolistically competitive to some extent in the corporate loan sector. We also find that more indebted banks have higher lending spreads; the cash-to-assets ratio has strong positive effect on lending spreads for the big banks but a negative effect for domestically oriented ones; the overall effect is negative when considering all banks. This result offers further evidence that big and small banks in our sample have different business models; one interpretation is that big banks pass the cost of holding more liquid assets (in the form of foregone returns) to borrowers via higher lending rates while smaller banks reduce lending rates likely in response to a reduction in funding costs. Return on assets is strongly significant only for the two large financial institutions in the regressions that include the risk-weighted capital ratios, thereby suggesting that loan pricing and/or funding costs of these banks is strongly correlated to their unweighted profit margin and capital ratio. We include a full set of bank-fixed effects that we do not report for brevity.

With regard to loan and firm controls, fixed-maturity loans are characterized by lower interest rates relative to credit lines; larger loans are also cheaper. Un-collateralized loans are charged higher interest rates; among the different types of collateral, loans backed by real estate or land are priced at a premium. As expected, riskier loans, i.e. belonging to higher PD classes, have higher spreads. Syndicated loans represent only 1 percent of our loans and they are cheaper than single-issuer loan when considering the universe of banks in our sample; they are however more expensive than single-issuer loans when we restrict our attention to big banks only, suggesting that syndication with small banks tend to lower lending spreads. We include in our regressions a full set of cantonal and sectoral dummies that capture the location and industry of the borrowing firm, which we do not report for brevity.

The slope of the yield curve as proxied by the difference between the 10-year and 3-month yields on Swiss Confederation bonds positively affects lending spreads in all specifications. Given the maturity transformation activity performed by banks, this positive estimate reflects the increasing cost of hedging the interest rate exposure when the yield curve becomes steeper.

5.2 Race Among Capital Ratios

In this section we study whether lending spreads respond primarily to the risk-weighted total capital ratio or to the leverage ratio. To this end we regress lending spreads on both capital measures, the total capital to risk-weighted assets and the leverage ratio, and the standard controls listed in equation (1). The goal is to let the data speak as to which capital ratio matters most and how for each group of banks. To this end, we run the following regression:

$$\begin{aligned} \text{Loan Spread}_{j,i,t} \;=\;& \alpha\,\text{Total Capital/RWAs}_{i,t-1} + \beta\,\text{Leverage Ratio}_{i,t-1} + \gamma\,\text{Bank}_{i,t-1} + \\ & \phi\,\text{Firm-Loan}_{j,t} + \varphi\,\text{Neg Rate}_t + \mu_i + \nu_t + \epsilon_{i,j,t}. \end{aligned} \tag{2}$$

Since the capital ratios are correlated, the interpretation of the estimated coefficients requires some care. The results of the estimation are reported in Table 3.

When we consider all banks, the leverage ratio stands out as the capital measure that positively and significantly influences lending spreads with an impact of 6.75 bps. Looking at columns (2) and (3) of Table 3, we find interesting differences between big and domestically oriented banks. The lending spreads of big banks respond positively to the leverage ratio but negatively to the risk-weighted ratio; the opposite is true for domestically oriented banks. This suggests that changes in the leverage ratio transmit positively to lending spreads for the big banks; however, there appears to be some slack in terms of risk-weighted capital ratios in the sense that an increase in capital per unit of risk-weighted asset is accompanied by a reduction in lending spreads for this group of banks. For domestically oriented banks the situation is reversed as the risk-weighted capital ratio emerges as the binding measure for loans pricing.

The evidence of Table 3 and Figure 6 lends support to regulation that sets leverage ratio limits

Table 3: Race Among Capital Ratios

	(1) All	(2) Big	(3) DOBs
Total Capital / RWAs	0.112	-4.383**	2.949***
	(0.15)	(-2.02)	(4.19)
Leverage Ratio	6.750***	27.93***	-6.715***
	(3.84)	(4.19)	(-5.12)
Negative Rate	1.140***	0.744**	1.311***
	(6.93)	(2.24)	(7.67)
Fixed Maturity	-0.628***	-0.0904*	-0.813***
	(-10.30)	(-2.01)	(-10.13)
Log (Assets)	0.506***	1.892***	0.0534
	(3.49)	(6.32)	(0.47)
Cash to Assets	-0.810**	7.624***	-1.608***
	(-2.45)	(4.41)	(-3.23)
Bank Debt to Assets	0.755*	-1.813	1.297***
	(1.95)	(-1.14)	(3.63)
Return on Assets	3.596	7.026	9.589
	(0.68)	(0.41)	(1.08)
Log (Loan Amount)	-0.164***	-0.187***	-0.141***
	(-67.01)	(-50.22)	(-48.18)
Syndicated Loan	0.101***	-0.229***	0.0242
	(3.30)	(-5.33)	(0.67)
10Y-3M Yield	0.662**	0.613**	0.667**
	(2.22)	(2.48)	(2.08)
Observations	1220724	391541	829183
Bank & Time FE	Yes	Yes	Yes
adj. R^2	0.775	0.851	0.748

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

for systematically important banks, whose leverage ratios tend to be lower than domestically oriented financial institutions; it also suggests that the 3 percent leverage ratio requirement extended to all banks in Switzerland starting January 2018 is unlikely to bind for the vast majority of domestically oriented banks and therefore unlikely to cause an increase in lending spreads.

5.3 Capital Surplus

Our main hypothesis is that bank's loan pricing is affected by its capital surplus, which we define as the difference between actual and required capital ratio. Intuitively, a bank with a capital surplus does not need to take any immediate capital action from the regulatory standpoint; on the other hand, a bank with a capital deficit needs to improve its capital position. Pressure to improve the capital position may come from the market or to avoid intervention by the supervising authority FINMA.[15] Funding costs may also increase for banks with capital deficits. In this section we test the hypothesis that capital surplus matters for lending spreads.

Two features of the Swiss banking sector are particularly useful for our study. The first is that several regulatory changes occurred in our sample period; the second is that capital requirements display substantial variation across banks and over time. For example, each systematically relevant bank in Switzerland is assigned individual targets for its capital ratios that comprise fixed minimum requirements, capital buffers and a variable component that is linked to the group's overall size and market share in domestic credit and deposit markets. These individual targets are subject to yearly revisions. Such rich variation in regulatory requirements, both cross-section and through time, allows us to test how banks respond to capital gaps from regulatory capital. Notice that variation in capital surplus may come from a change in capital (due to losses, for example) or from a change in capital requirement. Here we estimate the effect of changes in capital surplus on lending spreads irrespective of the source; in the next section we will account explicitly for regulatory changes.

We create the dummy $\text{Surplus}_{i,t-1}$ that takes a value of 1 if there is a capital surplus, namely if bank i's actual capital ratio is greater than the supervisory target in period $t-1$, and 0 otherwise and we estimate the following specification:

$$\begin{aligned}\text{Loan Spread}_{j,i,t} \;=\;& \alpha\,\text{CapRatio}_{i,t-1} + \beta\,\text{Surplus}_{i,t-1} + \gamma\,\text{Bank}_{i,t-1} + \phi\,\text{Firm-Loan}_{j,t} + \\ & \varphi\,\text{NegRate}_t + \mu_i + \nu_t + \epsilon_{i,j,t}. \qquad (3)\end{aligned}$$

[15] These interventions include "the suspension of dividend payments, share buy-backs and discretionary remuneration components or to carry out a capital increase or a request to reduce RWAs or sell specific assets or withdraw from specific areas of business." Quote from FINMA Circular 2011/2.

β measures the bps difference in loan spread charged by banks with a capital surplus relative to banks with a capital shortfall. An estimate of $\beta < 0$ suggests that banks with capital shortfalls charge higher spread than banks with capital surpluses. The surplus dummy is lagged by one period in our regressions to avoid endogeneity and to capture the bank's response in terms of its loan pricing to last period capital surplus. When the difference between the actual and the required capital level is negative, we say that the bank has a capital shortfall and the dummy $\text{Surplus}_{i,t}$ is set to zero.

We measures required capital in two ways: phase-in and look-through. Most banking regulation in Switzerland and elsewhere specifies a phase-in period, namely a period at the end of which banks are expected to be fully compliant. Suppose that, in period t new regulation raises the required capital ratio from 8 to 12 percentage points with a phase-in period of 8 quarters. The look-through capital requirement is equal to 0.12 starting from period t; the phase-in capital requirement starts at 8 percent in period t and it increases by 0.5 percent every following quarter until it reaches 12 percent in $t + 8$. The look-through surplus is the difference between the actual capital ratio and the look-through capital requirement while the phase-in surplus is the distance between the actual capital ratio and phase-in requirement. For both capital ratios we use bank- and time-specific capital requirements published by FINMA. We calculate the leverage ratio surplus only for the financial institutions subject to a leverage ratio requirement, namely UBS, Credit Suisse, Zurich Cantonal Bank starting 2014Q4 and Raiffeisen starting 2015Q3. Non-systematically relevant banks have no leverage regulation during our sample period, so we do not calculate a leverage ratio surplus dummy for them.

Table 4 reports the estimation of (3) for the phase-in risk-weighted capital surplus for all, big and domestically oriented banks; the results for the leverage ratio are not reported because there are no observations characterized by a shortfall in phase-in terms – see Figure 6b. The coefficient of the phase-in surplus is negative and significant while the coefficient of the capital ratio itself remains positive, significant and similar to the value estimated in Table 1. Firm-loan specific estimated coefficients are by far and large unchanged relative to Table 1 and they are not displayed for conciseness.

Banks with capital surpluses in terms of their risk-weighted requirements charge lower spreads relative to banks with capital shortfalls. Two distinct mechanisms are consistent with this finding. The first is that banks with capital deficits experience an increase in funding costs as

Table 4: Phase-in Capital Surplus

	(1) All	(2) Big	(3) DOBs
Total Capital/RWAs	2.161***	4.652**	1.503**
	(3.54)	(2.20)	(2.51)
TC/RWAs Surplus	-0.503**	-0.440***	-0.227***
	(-2.52)	(-2.95)	(-7.49)
Negative Rate	1.167***	0.761*	1.327***
	(7.02)	(1.88)	(7.78)
Fixed Maturity	-0.630***	-0.0808*	-0.812***
	(-10.28)	(-1.80)	(-10.13)
Log (Assets)	0.352**	1.778***	0.123
	(2.42)	(6.80)	(1.08)
Cash to Assets	-1.135***	6.884***	-1.509***
	(-3.01)	(3.78)	(-3.18)
Bank Debt to Assets	0.707*	3.110**	1.371***
	(1.86)	(2.50)	(3.53)
Return on Assets	5.487	46.23***	10.77
	(1.40)	(3.30)	(1.27)
Log (Loan Amount)	-0.163***	-0.187***	-0.142***
	(-64.86)	(-50.67)	(-49.91)
Syndicated Loan	0.0889***	-0.222***	0.0375
	(3.02)	(-5.00)	(1.02)
10Y-3M Yield	0.668**	0.631**	0.664**
	(2.20)	(2.53)	(2.08)
Observations	1220724	391541	829183
Bank & Time FE	Yes	Yes	Yes
adj. R^2	0.776	0.851	0.747

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

they are perceived as riskier and more likely to default. In a monopolistic competitive setting, an increase in the marginal cost may lead to an increase in price. The second mechanism is that banks with capital shortfalls temporarily increase their intermediation margin to boost retained earnings and close their capital gaps. It is well known that banks resist raising equity when their capital buffers are low because this is when equity prices are low. In fact, the empirical evidence suggests that banks mainly raise capital by increasing retained earnings. This interpretation is also consistent with the analysis of a capital quality shock in Gerali, Neri, Sessa and Signoretti (2010). Another mechanism may stem from risk-taking: undercapitalized banks have less skin in the game and may accordingly lend to riskier firms in an effort to gamble for resurrection. In this case higher spreads simply reflect higher risk. We control for loan characteristics including riskiness, which should capture the effect of increased risk-taking on lending spreads. In fact, the coefficients on PD classes (not shown) are highly significant in all six specifications.

The estimate of regression (3) for the look-through surplus dummy is reported in Table 5; column (1) to (3) pertain to the total capital to risk-weighted assets ratio while column (4) and (5) to the leverage ratio. The risk-weighted look-through surplus is negative significant only for the big banks and the estimated coefficient is smaller, in absolute value, than the coefficient for the phase-in surplus estimated in table 4 for the same group of banks – -0.3 versus -0.4 – suggesting a stronger response to phase-in shortfalls relative to look-through ones. In Table 4 we saw that domestically oriented financial institutions with phase-in capital shortfalls have higher lending spreads relative to their counterparts; we find no response to look-through capital deficits of DOBs in Table 5.

Column (4) reports the results for the leverage ratio look-through surplus when we restrict the sample to the big banks; in column (5) the sample is extended to all Swiss financial institutions subject to leverage ratio regulation, thereby including observation for Zurich Cantonal Bank and Raiffeisen since their designation as systematically relevant. We do not find evidence that lending spreads respond to long-term leverage shortfalls, as the look-through surplus for the leverage ratio is insignificant in both regressions.

To sum up, we find evidence that lending spreads respond to phase-in risk-weighted capital shortfalls; we are unable to predict the response to phase-in leverage ratio shortfalls since no financial institution in our sample displayed such position. The response to look-through risk-weighted capital deficits is significant only for big banks and weaker than the response to phase-in shortfalls. Overall this evidence suggests that Swiss banks raise their lending rates relative to peers in response to a short-term capital gap; the evidence for long-term gaps is weaker and limited to the two big banks.

Table 5: Look-through Capital Surplus

	(1) All	(2) Big	(3) DOBs	(4) Big	(5) SIBs
Total Capital/RWAs	1.466**	4.667*	1.518**		
	(2.05)	(1.99)	(2.40)		
TC/RWAs Surplus	-0.0305	-0.260**	-0.0113		
	(-0.60)	(-2.35)	(-0.44)		
Leverage Ratio				19.20***	19.21***
				(3.27)	(3.58)
Leverage Ratio Surplus				0.0949	0.183
				(0.85)	(1.65)
Negative Rate	1.199***	0.584	1.316***	0.558*	0.603**
	(7.35)	(1.41)	(7.59)	(1.71)	(2.07)
Fixed Maturity	-0.626***	-0.0798*	-0.812***	-0.0888*	-0.529***
	(-10.16)	(-1.76)	(-10.13)	(-1.99)	(-6.19)
Log (Assets)	0.351**	1.915***	0.141	1.891***	1.444***
	(2.60)	(7.04)	(1.20)	(6.36)	(5.22)
Cash to Assets	-1.007***	9.103***	-1.485***	6.182***	3.342*
	(-2.74)	(4.39)	(-3.14)	(2.72)	(1.87)
Bank Debt to Assets	0.866**	3.311**	1.357***	0.882	0.923
	(2.12)	(2.69)	(3.51)	(0.92)	(1.21)
Return on Assets	0.791	51.80***	10.66	17.31	6.853
	(0.15)	(3.30)	(1.25)	(0.99)	(0.42)
Log (Loan Amount)	-0.164***	-0.187***	-0.142***	-0.187***	-0.180***
	(-66.39)	(-51.07)	(-49.73)	(-50.62)	(-46.68)
Syndicated Loan	0.0967***	-0.223***	0.0380	-0.230***	-0.128**
	(3.23)	(-5.17)	(1.03)	(-5.25)	(-2.57)
10Y-3M Yield	0.664**	0.617**	0.664**	0.610**	0.583**
	(2.22)	(2.47)	(2.08)	(2.46)	(2.30)
Observations	1220724	391541	829183	391541	475219
Bank & Time FE	Yes	Yes	Yes	Yes	Yes
adj. R^2	0.775	0.851	0.747	0.851	0.830

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

5.4 Regulatory Changes

We argued earlier that loan pricing depends on the bank capital position relative to its regulatory target. Such position, however, is affected by variation in the bank's capital as well as changes in regulation. Changes in bank's capital may be a consequence of aggregate economic conditions; changes in capital regulation, on the other hand, are caused neither by the specific bank's capital situation nor by current economic conditions and therefore arguably exogenous to lending opportunities. Our strategy is to use changes in bank capital requirements as exogenous shocks to the capital position of the bank and measure their impact on loan pricing. Since most countries lack the necessary variation of capital requirements across banks and over time, previous research has not relied on this source of identification. An exception is Francis and Osborne (2009), who exploit bank-specific capital requirements set by regulatory institutions in the United Kingdom, but lack firm- and loan-level data and focus on lending volume. Another exception is De Jonghe, Dewachter and Ongena (2016), who use bank-specific capital requirements in Belgium matched with corporate credit register data that conveys information on the total quantity of credit granted to every firm. Unlike De Jonghe et al. (2016), we have loan-level data and we focus on loan pricing rather than volume.

We estimate the following specification:

$$\begin{aligned}\text{Loan Spread}_{j,i,t} = \quad & \alpha\,\text{CapRatio}_{i,t-1} + \delta\,\text{RegDum}_{i,t} + \lambda\,\text{RegDum}_{i,t} \times \text{CapRatio}_{i,t-1} + \\ & \beta\,\text{Surplus}_{i,t-1} + \gamma\,\text{Bank}_{i,t-1} + \phi\,\text{Firm-Loan}_{j,t} + \varphi\,\text{NegRate}_t + \mu_i + \nu_t + \epsilon_{i,j,t},\end{aligned} \tag{4}$$

where $\text{RegDum}_{i,t}$ is a set of dummy variables for regulatory changes and δ is a vector of parameters. In specification (5) the impact on lending spreads of having a capital surplus in phase-in terms is captured by β and the impact of the regulatory change is captured by δ, which measures the bps difference in loan spread charged by banks subject to the regulatory change relative to non-affected banks. With the exception of Basel II for big banks, all regulatory changes considered here led to higher capital requirements. Hence, a positive estimate of δ means that higher capital requirements cause higher lending spreads. To capture the role, if any, of bank capital in the response to capital requirement changes, we interact the regulatory dummy with the lagged bank capital ratio. λ measures the marginal effect on lending spread of a one percentage point higher lagged capital ratio during a regulatory change. A negative value of λ would imply that, among financial institutions subjected to the increase in requirements, better capitalized banks charge lower spreads.

Since many overlapping regulatory changes occurred in our sample period, some of them affecting all banks but most being relevant for a specific group of banks, our analysis will consider five non-bank-specific regulatory events:

1. Basel II
2. End of the Cantonal bank rebate[16]
3. Pillar 2
4. Basel III
5. TBTF1

These policies have been discussed in section 3; we do not consider TBTF2 because it occurs at the end of our sample. Since all these regulatory changes were announced in advance of their introduction and anticipated, we set the event dummy equal to 1 for the 4 quarters before and the 4 quarters after the regulatory change. For example, Basel III officially started in 2013Q1; the dummy variable Basel III takes value of 1 from 2012Q1 until 2014Q1. Figure 7 displays the quarters during which our five regulatory dummies are switched on and the banks for which these regulatory changes apply.[17] Notice that each regulatory dummy is equal to zero in all periods for the banks for which the requirement is not relevant.

Table 6 summarizes our findings on the effects of changes in capital regulation. For the total capital to risk-weighted assets ratio we report the regressions that include the phase-in surplus measure; the regressions with the look-through surplus are similar and available upon request. For the leverage ratio, we run our regression only on the banks subjected to such requirement and we report results separately for the big and for all the systematically relevant banks; we include only TBTF1 regulation, which is the only regulation that affected leverage ratio requirements.

[16]This rebate also applied to Raiffeisen.

[17]Bank names are reported in Appendix A.

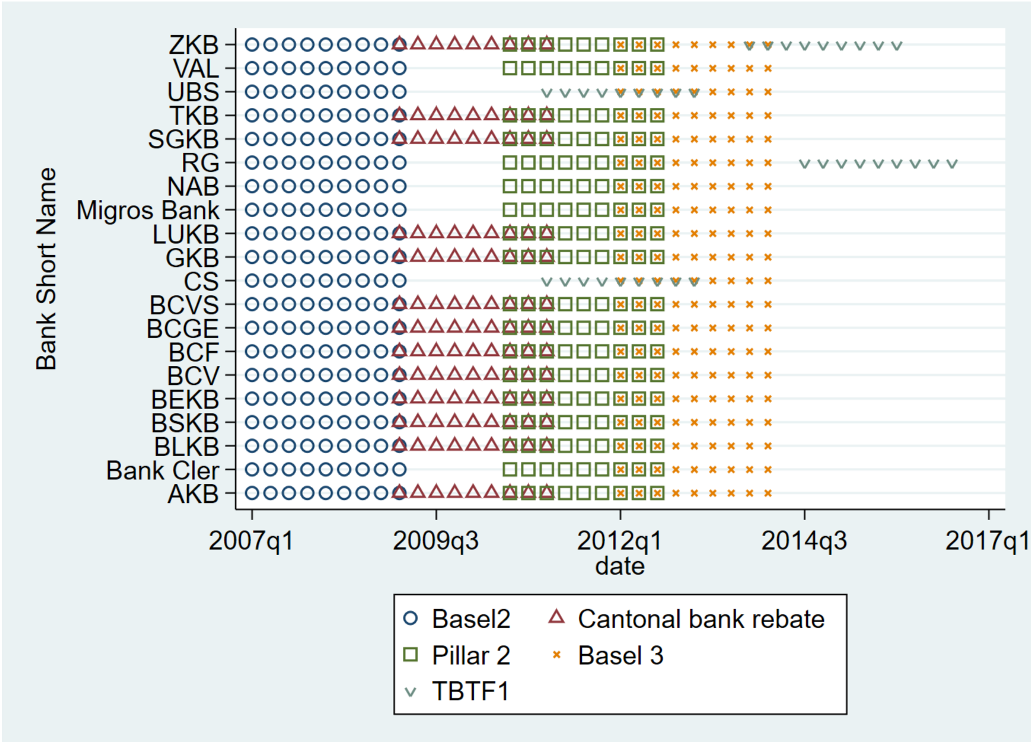


Figure 7: Regulatory Changes

The size and sign of the coefficients on the capital ratio and the phase-in surplus are largely unchanged. The non-interacted regulatory dummies are by far and large positive. Basel III is strongly significant for all banks; Pillar 2 and the end of the Cantonal banks rebate changed capital requirements only for domestically oriented banks and it is indeed significant for this group and therefore for all banks. TBTF1 regulation is positive and significant for big as well as all SIBs in column (4) and (5), which report the regressions that use the leverage ratio. As argued in section 3, the Swiss implementation of Basel II changed only slightly capital requirement for domestically oriented banks as lower requirements under the Swiss standardized approach to credit risk were compensated by higher requirements for operational risk; if anything, big banks experienced a reduction in capital requirements due to the possibility to use the internal ratings based approach for risk-weighting calculations. We find that the Basel II dummy is indeed significant only for domestically oriented banks. The positive sign of the regulation dummies tells us that the regulation is associated to an increase in lending spreads by the financial institutions subject to the regulation relative to other periods and relative to financial institutions not affected by the regulation. For Basel II, which affected all banks, the increase in lending spread is relative to the rest of sample period.

Table 6: Phase-in Capital Surplus and Regulatory Changes

	(1) All	(2) Big	(3) DOBs	(4) Big	(5) SIBs
Total Capital/RWAs	3.757***	9.145***	2.108***		
	(5.85)	(4.06)	(2.70)		
Phase-in TC/RWAs Surplus	-0.388***	-0.426***	-0.218***		
	(-2.89)	(-2.78)	(-4.55)		
Negative Rate	0.971***	-0.00886	1.313***	0.365	0.348
	(6.25)	(-0.02)	(8.08)	(1.30)	(1.32)
Basel II	0.522***	-0.0745	0.487**		
	(3.02)	(-0.12)	(2.14)		
Cantonal Bank Rebate	0.646***	0	0.311*		
	(4.76)	(.)	(1.98)		
Pillar 2	0.220	0	0.356*		
	(1.48)	(.)	(1.99)		
Basel III	0.538***	2.554***	0.345***		
	(4.83)	(3.89)	(3.64)		
TBTF1	0.0813	0.843		0.665***	0.514**
	(0.34)	(1.65)		(4.25)	(2.20)
Capital × Basel II	-4.553***	-0.973	-2.953***		
	(-3.62)	(-0.23)	(-3.46)		
Capital × Cantonal Rebate	-4.041***	0	-2.481***		
	(-4.74)	(.)	(-2.91)		
Capital × Basel III	-2.201***	-12.59***	0.226		
	(-3.67)	(-3.84)	(0.48)		
Capital × Pillar 2	-0.0790	0	0.309		
	(-0.10)	(.)	(0.53)		
Capital × TBTF1	-0.631	-7.175**			
	(-0.45)	(-2.63)			
Leverage Ratio				19.93***	20.41***
				(3.59)	(3.82)
Levrage Ratio × TBTF1				-10.39***	-8.298**
				(-2.78)	(-2.39)
Observations	1220724	391541	829183	391541	475219
Bank & Time FE	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.777	0.851	0.748	0.851	0.830

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

Passing to the interaction between our regulatory dummies and the lagged level of capital of the bank, we see that the coefficients are negative significant or, in some cases, not significant. The negative interaction with risk-weighted capital ratio emerges clearly for Basel II and the end of the Cantonal rebate for domestically oriented banks; it also emerges for Basel III and TBTF1 for the big banks. As argued earlier, Basel II did not raise risk-weighted capital requirements for the big banks, so that the lack of significance of the interaction term for this regulation is not surprising. The interaction between TBTF1 and the lagged leverage ratio is strongly significant and negative for both big banks and all SIBs. Our estimation indicates that, among banks affected by a specific regulation, financial institutions with higher (lagged) capital ratios charge significantly lower lending spreads. Capital surpluses remain associated with lower lending spreads once we control for regulatory changes. Irrespective of whether a bank faces a change in its capital requirements, financial institutions with capital shortfalls charge on average higher lending spreads relative to bank-quarter combinations with capital surpluses. Notice that the interaction between the capital ratio and the regulation dummies is significant even in the presence of the capital surplus dummy, thereby indicating that the two variables capture separate effects. It is also interesting to compare the results in Table 7 with the findings in Table 2, which estimates an unconditional positive relationship between lending spreads and lagged capital ratios. The latter captures that equity has a cost for banks, which is passed-through to corporate borrowers; nevertheless, the scarcity of bank capital relative to its required level and at times of heightened capital requirements raises lending rates.

6 Robustness

In this section we carry out a number of robustness exercises. The global financial crisis is part of our sample period and it strongly affected the two largest Swiss banks, UBS and Credit Suisse, due to their global nature. In particular, in October 2008 UBS received a capital injection of CHF 6 billion from the Swiss Confederation and it transferred USD 38.7 billion worth of illiquid assets to a stabilization fund mostly owned by the SNB. Both UBS and Credit Suisse suffered large losses and raised capital during this period. To ensure that our results are not uniquely driven by the global financial crisis, we run two specifications. We create a dummy for the global financial crisis that takes the value of 1 for the period 2008Q1 to 2009Q2 and re-estimate our specifications (1) through (5) introducing the crisis dummy by itself; in the second specification we introduce the crisis dummy by itself and interacted it with the lagged bank capital ratio. The results are reported in Table 7; for brevity, we report the regressions on all banks only.

Introducing the crisis dummy does not affect any of our earlier results. Column (1) and (2) show that the effect of bank capital ratios on lending spreads is unchanged relative to Table 2; in fact the crisis dummy is not significant. The interaction of the crisis dummy with the lagged level of capital is added in column (3) and (4) and it is negative and significant, thereby suggesting that banks with higher level of capital during the crisis charged lower lending rates. Notice that the point estimate of the lagged capital level by itself remains significant. In the last two columns we add the phase-in risk-weighted capital surplus dummy, which remains negative significant and of similar size as estimated in Table 4. The interaction between the crisis dummy and the lagged level of total capital to risk-weighted assets is also negative and significant; the point estimate of -4.1 suggests that a 1 percent higher level of risk-weighted capital during the global financial crisis was accompanied by a 4.1 bps reduction in lending spreads. Table 12 in Appendix C shows that the effect of regulation remains unchanged when the crisis dummy is added to the regulatory dummies.

As typical in the literature, we measure the lending spread as the difference between the interest rate charged on the loan and the 3-month CHF Libor, which captures the 3-month borrowing cost in CHF on the interbank market. This spread is proxy for the difference between the active and passive margin of Swiss financial institutions. There are, however, two disadvantages of using the spread relative to the Libor. First, the 3-month CHF Libor is the interest rate targeted by the SNB for monetary policy, which renders the Libor-OIS spread a less accurate indicator of credit conditions than in other countries. Second, the 3-month Libor does not measure appropriately long-term funding costs, which we aim to capture by including the loan maturity among the regressors. For these reasons, we calculate the lending spread as the difference between the interest rate charged on the loan and the Swiss Confederation bonds maturity-matched spot rates.[18] We refer to this variable as the maturity-matched lend-

[18]The SNB calculates spot rates on maturities from one to thirty years using the extended Nelson-Siegel-Svensson model; these spot rates should be interpreted as yields on synthetic zero-coupon bonds. The spot rates are publicly available on the SNB data portal.

Table 7: Global Financial Crisis

	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	All	All	All	All
Total Capital/RWAs	1.256		2.611***		2.161***	2.979***
	(1.68)		(4.03)		(3.54)	(4.38)
Crisis	-0.179	-0.172	0.667*	0.0566	-0.183	0.454
	(-0.67)	(-0.64)	(1.91)	(0.20)	(-0.69)	(1.41)
Leverage Ratio		6.919***		7.243***		
		(4.08)		(4.20)		
Total Capital/RWAs × Crisis			-5.486***			-4.126***
			(-4.12)			(-3.27)
Leverage Ratio × Crisis				-3.381*		
				(-1.87)		
Phase-in Surplus					-0.503**	-0.391**
					(-2.52)	(-2.19)
Negative Rate	1.214***	1.143***	1.094***	1.131***	1.167***	1.087***
	(7.44)	(7.29)	(7.57)	(7.42)	(7.02)	(7.05)
Fixed Maturity	-0.625***	-0.628***	-0.623***	-0.628***	-0.630***	-0.627***
	(-10.16)	(-10.31)	(-10.11)	(-10.32)	(-10.28)	(-10.21)
Log (Assets)	0.340**	0.501***	0.423***	0.484***	0.352**	0.412***
	(2.49)	(3.58)	(2.93)	(3.31)	(2.42)	(2.71)
Cash to Assets	-0.993***	-0.788**	-0.986**	-0.727**	-1.135***	-1.099***
	(-2.71)	(-2.38)	(-2.60)	(-2.18)	(-3.01)	(-2.89)
Bank Debt to Assets	0.902**	0.736*	1.145***	0.851**	0.707*	0.933**
	(2.23)	(1.86)	(2.83)	(2.10)	(1.86)	(2.38)
Return on Assets	0.728	3.732	8.150**	9.538*	5.487	10.01***
	(0.14)	(0.67)	(2.02)	(1.77)	(1.40)	(2.92)
Log (Loan Amount)	-0.164***	-0.164***	-0.164***	-0.164***	-0.163***	-0.163***
	(-65.99)	(-67.19)	(-66.73)	(-66.71)	(-64.86)	(-65.41)
Syndicated Loan	0.0978***	0.102***	0.0924***	0.105***	0.0889***	0.0868***
	(3.19)	(3.31)	(3.17)	(3.47)	(3.02)	(3.04)
10Y-3M Yield	0.663**	0.662**	0.660**	0.659**	0.668**	0.665**
	(2.22)	(2.22)	(2.23)	(2.22)	(2.20)	(2.21)
Observations	1220724	1220724	1220724	1220724	1220724	1220724
Bank & Time FE	Yes	Yes	Yes	Yes	Yes	Yes
adj. R^2	0.775	0.775	0.775	0.775	0.776	0.776

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

ing spread. Relative to the 3-month CHF Libor spread, the maturity-matched spread better captures the funding cost of loans with maturity above 3 months; however, it does not reflect credit risk, as Swiss Confederation bonds are regarded by the market as extremely safe. For this reason, we also include the 3-month CHF Libor in our regressions to capture credit risk. We have re-estimated all our specifications using the maturity-matched lending spread and found that our results remain unchanged. Appendix D reports specification (2) and (3) using the maturity-matched lending spread; the other specifications are available upon request.

7 Conclusions

In this paper, we estimated the impact of capital ratios and their requirements for banks in Switzerland on pricing 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, actual and required, on loan pricing. Our analysis indicates that banks' response varies by deviation from the supervisory target. We contribute to the literature by documenting that banks with a capital shortfall with respect to the regulatory target charge higher spreads for their loans. Lending rates of financial institutions subject to new and higher capital requirements are higher in the four quarters before and after the introduction of the regulation relative to banks not affected by new requirements. This increase in spreads is strongest (weakest) for banks below (above) the regulatory target. In addition, banks with higher capital charge lower lending rates relative to those with lower capital when new and higher capital requirements are introduced. Our results, therefore, speak strongly to the importance of phase-in periods, as banks raise lending rates when their capital falls below their phase-in targets.

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Appendix

A Banks names

AKB:	Aargau Cantonal Bank (Aargauische Kantonalbank)
BCF:	Fribourg Cantonal Bank (Banque Cantonale de Fribourg)
Bank Cler:	Bank Cler (Bank Coop before 2017Q2)
BCGE:	Geneva Cantonal Bank (Banque Cantonale de Geneve)
BCVS:	Valais Cantonal Bank (Banque Cantonale du Valais)
BCV:	Vaud Cantonal Bank (Banque Cantonale Vaudoise)
BLKB:	Basel-Landschaft Cantonal Bank (Basellandschaftliche Kantonalbank)
BSKB:	Basel-Stadt Cantonal Bank (Basler Kantonalbank)
BEKB:	Bern Cantonal Bank (Berner Kantonalbank)
CS:	Credit Suisse
GKB:	Grisons Cantonal Bank (Graubündner Kantonalbank)
LUKB:	Lucerne Cantonal Bank (Luzerner Kantonalbank)
Migros Bank:	Migros Bank
NAB:	New Aargau Bank (Neue Argaauer Bank)
RG:	Raiffeisen Group Switzerland (Raiffeisen Gruppe (Schweiz))
SGKB:	St. Gallen Cantonal Bank (St. Galler Kantonalbank)
TKB:	Thurgau Cantonal Bank (Thurgauer Kantonalbank)
UBS:	UBS
VAL:	Valiant Bank
ZKB:	Zurich Cantonal Bank (Zuercher Kantonalbank)

B Loan and firm characteristics

Table 8: Loan Type

Variable	**N**	**Frequency**	**Frequency $\leq$ 2008q4**	**% of Total Loan Value**
Mortgage to Firm[a]	561,586	46.00	46.57	23.1
Fixed Advance (Investment Loan)	348,101	28.52	19.4	63.5
Overdraft Facility	250,750	20.54	29.62	7.1
Construction Loan	25,608	2.10	3.2	3.2
Loan / Fixed advance (Investment Loan)	12,704	1.04	0.6	1.4
Miscellaneous Loans	8,212	0.67	0.04	0.4
Rollover Loan	5,889	0.48	0.09	1.0
Loan (Investment Loan)	5,741	0.47	0.73	0.2
Fixed-rate Construction Mortgage	1,221	0.10	0.01	0.2
Seasonal Loan	913	0.07	0.06	0.12

[a]: Secured by real estate

Table 9: Collateral Type

Variable	N	Frequency	Cumulative
Real estate or land	877,137	71.85	71.85
No collateral	222,420	18.22	90.07
Securities	46,862	3.84	93.91
Guarantee	37,524	3.07	96.99
Other collateral	28,817	2.36	99.35
Cession	5,128	0.42	99.77
Pledge on register or goods	2,836	0.23	100.00

Table 10: Firm Size Distribution

Firm Size	Dummy	N	Frequency	Cumulative
<1	1	606,035	49.65	49.65
1-5	2	205,326	16.82	66.47
6-25	3	143,767	11.78	78.24
26-100	4	97,227	7.96	86.21
>100	5	38,444	3.15	89.36
Unspecified	6	129,926	10.64	100.00

in CHF Millions

Table 11: Probability of Default Class Distribution

PD class	N	Frequency	Cumulative
Unspecified	124,105	10.17	10.17
1	36,866	3.02	13.19
2	60,721	4.97	18.16
3	270,669	22.17	40.33
4	542,619	44.45	84.78
5	185,745	15.22	100.00

C Crisis and Regulatory Changes

Table 12: Crisis and Regulatory Changes

	(1) All	(2) Big	(3) DOBs	(4) Big	(5) SIBs
Total Capital/RWAs	3.943***	9.076***	2.422***		
	(5.95)	(4.01)	(3.15)		
Phase-in Surplus	-0.360**	-0.406***	-0.216***		
	(-2.67)	(-2.72)	(-4.55)		
Leverage Ratio				20.53***	21.25***
				(4.23)	(4.24)
Total Capital/RWAs × Crisis	-2.354	-5.651	-2.468***		
	(-1.47)	(-0.36)	(-4.02)		
Leverage Ratio × Crisis				-2.310	-4.518
				(-0.28)	(-0.47)
Negative Rate	0.952***	-0.00753	1.287***	0.341	0.319
	(6.18)	(-0.02)	(8.04)	(1.29)	(1.21)
Basel II	0.266	-0.940	0.328*		
	(0.98)	(-0.55)	(1.95)		
Crisis	0.201	0.962	0.306	-0.285	-0.227
	(0.56)	(0.51)	(1.03)	(-0.77)	(-0.56)
Cantonal Bank Rebate	0.613***	0	0.283*		
	(4.59)	(.)	(1.86)		
Pillar 2	0.248*	0	0.408**		
	(1.70)	(.)	(2.34)		
Basel III	0.532***	2.527***	0.343***		
	(4.74)	(3.84)	(3.61)		
TBTF1	0.138	0.878*		0.687***	0.551**
	(0.61)	(1.82)		(4.39)	(2.30)
Capital × Basel II	-3.035	3.911	-1.488		
	(-1.65)	(0.27)	(-1.59)		
Capital × Cantonal Rebate	-3.831***	0	-2.305***		
	(-4.47)	(.)	(-2.73)		
Capital × Basel III	-2.225***	-12.47***	0.121		
	(-3.66)	(-3.76)	(0.25)		
Capital × Pillar 2	-0.256	0	0.0300		
	(-0.34)	(.)	(0.05)		
Capital × TBTF1	-0.978	-7.320***			
	(-0.74)	(-2.85)			
Leverage Ratio × TBTF1				-10.81***	-9.135**
				(-2.93)	(-2.62)
Observations	1220724	391541	829183	391541	475219
Bank & Time FE	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.777	0.851	0.748	0.851	0.830

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

D Maturity-matched Lending Spread

Table 13: Race Among Capital Ratios

	(1) All Maturity-matched Spread	(2) Big Maturity-matched Spread	(3) DOBs Maturity-matched Spread
Total Capital/RWAs	-0.0508	-5.590**	3.591***
	(-0.06)	(-2.37)	(4.65)
Leverage Ratio	7.757***	29.56***	-5.996***
	(4.41)	(4.21)	(-4.19)
Negative Rate	1.730***	1.491***	1.941***
	(18.58)	(4.63)	(21.79)
Fixed Maturity	-0.903***	-0.334***	-1.109***
	(-11.03)	(-3.90)	(-12.56)
Log (Assets)	0.641***	2.048***	0.194
	(4.86)	(6.13)	(1.55)
Cash to Assets	-0.711*	8.464***	-1.849***
	(-2.01)	(4.78)	(-3.77)
Bank Debt to Assets	1.230***	-1.869	1.730***
	(3.03)	(-1.13)	(4.89)
Return on Assets	-2.452	3.880	6.224
	(-0.46)	(0.23)	(0.66)
Log (Loan Amount)	-0.164***	-0.184***	-0.144***
	(-73.78)	(-48.82)	(-57.34)
Syndicated Loan	0.0455	-0.132***	-0.0593*
	(1.45)	(-2.76)	(-1.87)
3-Month CHF Libor	0.343***	0.374***	0.344***
	(19.16)	(14.96)	(22.76)
Observations	1220724	391541	829183
Bank & Time FE	Yes	Yes	Yes
adj. R^2	0.789	0.857	0.768

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 14: Phase-in Capital Surplus

	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	Big	Big	DOBs	DOBs
	Maturity-matched Spread	Maturity-matched Spread	Maturity-matched Spread	Maturity-matched Spread	Maturity-matched Spread	Maturity-matched Spread
Total Capital/RWAs	2.217***		4.235**		2.288***	
	(3.37)		(2.07)		(3.55)	
Phase-in Surplus	-0.529**		-0.507***		-0.139***	
	(-2.52)		(-3.17)		(-3.64)	
Leverage Ratio		7.680***		18.65***		-0.773
		(4.64)		(3.22)		(-0.54)
Negative Rate	1.739***	1.729***	1.435***	1.126***	1.963***	2.053***
	(19.38)	(21.19)	(3.67)	(4.28)	(20.49)	(19.07)
Fixed Maturity	-0.905***	-0.903***	-0.324***	-0.328***	-1.108***	-1.108***
	(-10.98)	(-11.02)	(-3.78)	(-3.81)	(-12.56)	(-12.51)
Log (Assets)	0.463***	0.643***	1.934***	2.092***	0.259*	0.0747
	(3.31)	(5.11)	(6.59)	(6.30)	(1.95)	(0.45)
Cash to Assets	-1.071***	-0.721**	7.460***	8.021***	-1.756***	-1.334***
	(-2.77)	(-2.08)	(3.97)	(4.26)	(-3.78)	(-2.88)
Bank Debt to Assets	1.194***	1.239***	3.377**	1.704	1.797***	1.507***
	(3.09)	(2.99)	(2.63)	(1.63)	(4.72)	(3.74)
Return on Assets	-0.735	-2.514	46.00***	21.86	7.209	0.875
	(-0.17)	(-0.45)	(3.19)	(1.22)	(0.80)	(0.09)
Log (Loan Amount)	-0.164***	-0.164***	-0.184***	-0.184***	-0.145***	-0.146***
	(-70.18)	(-73.75)	(-49.43)	(-49.13)	(-59.16)	(-58.92)
Syndicated Loan	0.0321	0.0452	-0.125**	-0.131**	-0.0472	-0.0336
	(1.06)	(1.44)	(-2.51)	(-2.68)	(-1.43)	(-1.02)
3-Month CHF Libor	0.333***	0.343***	0.354***	0.376***	0.348***	0.348***
	(19.13)	(19.25)	(12.84)	(15.01)	(22.90)	(22.79)
Observations	1220724	1220724	391541	391541	829183	829183
Bank & Time FE	Yes	Yes	Yes	Yes	Yes	Yes
adj. R^2	0.789	0.789	0.857	0.857	0.767	0.767

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01