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The Countercyclical Capital Buffer and the Composition of Bank Lending

Abstract

Do macroprudential regulations on residential lending influence commercial lending behavior too? To answer this question, we identify the compositional changes in banks' supply of credit using the variation in their holdings of residential mortgages on which extra capital requirements were uniformly imposed by the countercyclical capital buffer (CCyB) introduced in Switzerland in 2012. We find that the CCyB's introduction led to higher growth in commercial lending although this was unrelated to conditions in regional housing markets. Interest rates and fees charged to the firms concurrently increased. We rationalize these findings in a model featuring both private and firm-specific collateral.

JEL-Codes: E510, E580, E600, G010, G210, G280.

Keywords: macroprudential policy, spillovers, credit, bank capital, systemic risk.

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1. Introduction

The damaging effects of financial crises have helped to forge a consensus among policymakers that financial regulation needs a macroprudential dimension. Such policies aim to boost the resilience of the financial system and to lessen the negative externalities from the financial to the real sector (eg Caruana (2010); Drehmann, Borio, Gambacorta, Jimenez and Trucharte (2010)).

Importantly, macroprudential policies are intended to complement monetary policy, which by itself cannot simultaneously ensure both monetary and financial stability. Macroprudential policies can also be directed at specific sectors (eg the real estate business) or agents (eg systemically relevant financial institutions), thereby focusing on any potential threats to the soundness of the financial system.[1]

However, the effects of even a highly focused macroprudential policy may extend beyond the targeted sectors or actors. Other parts of the economy may be affected via the impact on the supply and resulting cost of credit.[2] However, despite the potential importance of such spillover effects, neither the academic nor the policy literature has so far examined them in detail.

In this paper, we examine the compositional effects of Switzerland's countercyclical capital buffer (CCyB), a targeted macroprudential policy introduced in June 2012 into Swiss legislation.

[1] A by-now voluminous literature discusses macroprudential policies (eg Brunnermeier, Crocket, Goodhart, Persaud and Shin (2009); Hanson, Kashyap and Stein (2011); Galati and Moessner (2013)). Empirical work on the links between macroprudential policies and financial stability includes: (1) cross-country studies that consider the link between macroprudential policies and credit growth and other financial indicators (eg Cerutti, Claessens and Laeven (2017) and references therein); and (2) micro-level studies on the use of only one or a few macroprudential policies within one country (we will review most of these studies below). However none of these studies analyses the compositional effects of targeted macroprudential policies.

[2] A targeted policy may also be circumvented on the demand side. For example, small business owners who fail to qualify for a residential mortgage may instead lever up their business and take out a corporate loan. Our empirical analyses and theoretical framework will focus on changes on the supply side.

The CCyB was implemented together with a set of supporting measures aimed at addressing risks in residential mortgage markets. When activated, it requires banks to set aside capital according to a time-varying percentage on their *stock* of *risk*-weighted residential mortgages.

On 13 February 2013, Switzerland's Federal Council decided to activate the CCyB, requiring banks to hold an additional 1% equity on loans secured against domestic residential properties. The rate of 1% was applicable from 30 September 2013 onwards and was increased to 2% on 30 June 2014, where it currently remains (see also Figure 1).[3]

This had a large aggregate effect on capital requirements, although individual Swiss banks were very differently affected as their residential mortgage exposures differed substantially both in total amounts and, more importantly for our empirical strategy, in relative terms, eg as a percentage of their total assets. This is exemplified in Figure 2, which shows the CCyB's size as a percentage of total risk-weighted assets (RWAs) at the end of 2014 for 15 large Swiss-domiciled banks. At the high end of the spectrum, the CCyB accounts for 1.22% of RWAs for Migros Bank, representing around a seventh of the bank's total regulatory core equity (CET1) requirement. At the low end of the spectrum, the CCyB is almost negligible.

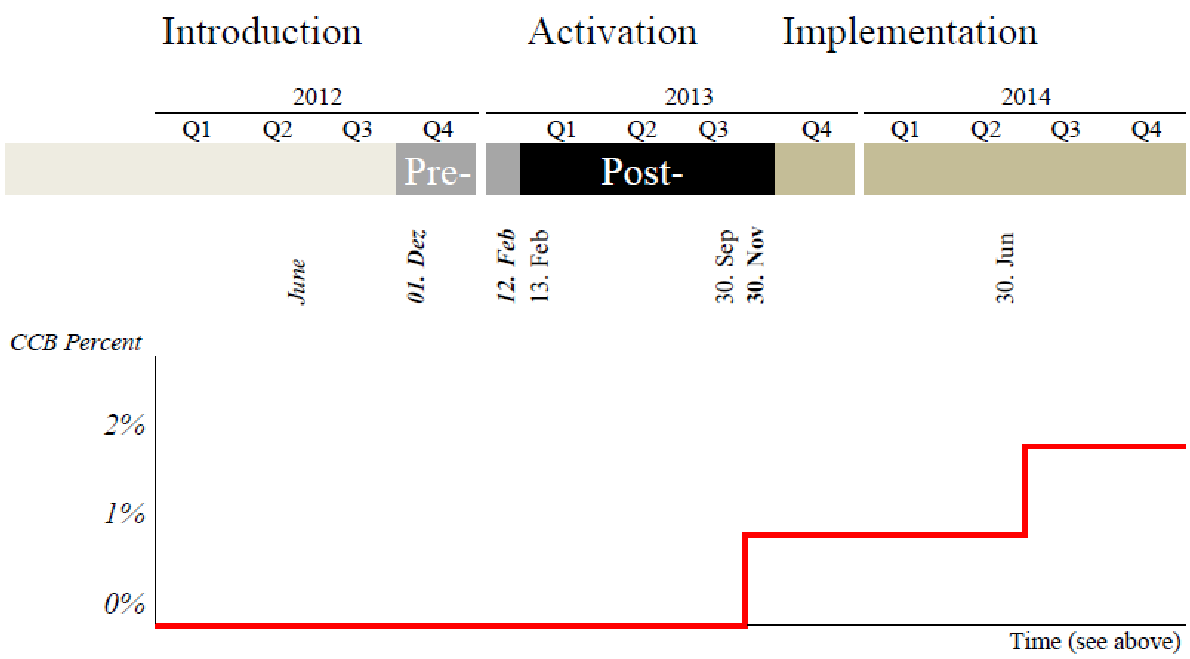
Our empirical strategy exploits the timing of the CCyB's activation and the variation across banks in the ensuing capital requirements. Upon activation, a common formula and a common rate were applied to all banks, but there were large pre-existing differences across banks in the relative importance of their residential mortgage lending (as a share of their total business). If the CCyB's activation resulted in a shift from private to commercial lending, this shift was felt relatively more by banks with a higher proportion of private lending.

[3] For details see the Swiss National Bank's press releases on 13 February 2013 entitled "Countercyclical capital buffer: proposal of the Swiss National Bank and decision of the Federal Council" and on 23 January 2014 entitled "Swiss National Bank's proposal to increase the countercyclical capital buffer." The former proposal came into effect on 30 September 2013 while the latter came into effect on 30 June 2014.

Indeed, we first document in a bank-level analysis that banks more exposed to the CCyB due to a higher importance of residential mortgage granting as a share of total business and/or more risky mortgage portfolios did in fact reduce their residential mortgage granting more strongly than other banks. However, this impact was fully offset by banks with high exposure to the CCyB strongly increasing their other loan granting. On balance, the result is that heterogeneous exposure to the CCyB is associated with a strong decline in the share of residential loan granting, but not with a decline in overall lending.

Time line of the Introduction, Activation and Implementation of the Counter Cyclical Capital Buffer in Switzerland

Figure 1



Notes: Switzerland's countercyclical capital buffer (CCyB), a targeted macroprudential policy, was introduced in June 2012 into Swiss legislation. On 13 February 2013, Switzerland's Federal Council decided to activate the CCyB, requiring banks to hold an additional 1% equity on loans secured against domestic residential properties. The rate of 1% was applicable from 30 September 2013 onwards and was increased to 2% on 30 June 2014, where it currently remains. In benchmark estimations the pre-period runs from 1 December 2012 to 12 February 2013 and the post-period from 13 February 2013 to 30 September 2013.

This first aggregate finding raises two questions. A first question pertains to causality. In particular are these patterns present in the bank-level data truly driven by the CCyB? Or is it the case that banks with higher exposures to residential mortgages are simply situated in booming real estate markets, where demand for credit was consequently higher? A second question regards the impact of the intervention on financial stability as macroprudential policies aim to boost the resilience of the financial system and to lessen the negative externalities from the financial to the real sector.

To answer the first of these questions we then move to our main empirical analysis examining a loan-level dataset of credit granting in Switzerland. Credit register data from the Swiss National Bank (SNB) allows us to account for credit demand through saturation with business-type fixed effects. In this way, we aim to identify if, and how, the CCyB's activation altered the *supply* of bank credit to the commercial loan market (which was not directly affected by the capital surcharge). The credit register data allow us, for the first time in the literature, to study the compositional effects in terms of the quantity of credit supplied. Further, they let us assess the CCyB's impact on interest rates and other loan characteristics.

Finally, our empirical investigation takes place in a stable setting where monetary policy was already fully committed to a different goal, ie the maintenance of an exchange rate to promote price stability.[4] In other countries, the authorities may have imposed countercyclical capital buffers and changed their (conventional) monetary policy setting at the same time (Aiyar, Calomiris and Wieladek (2016)), while in our case this was not possible. In this respect,

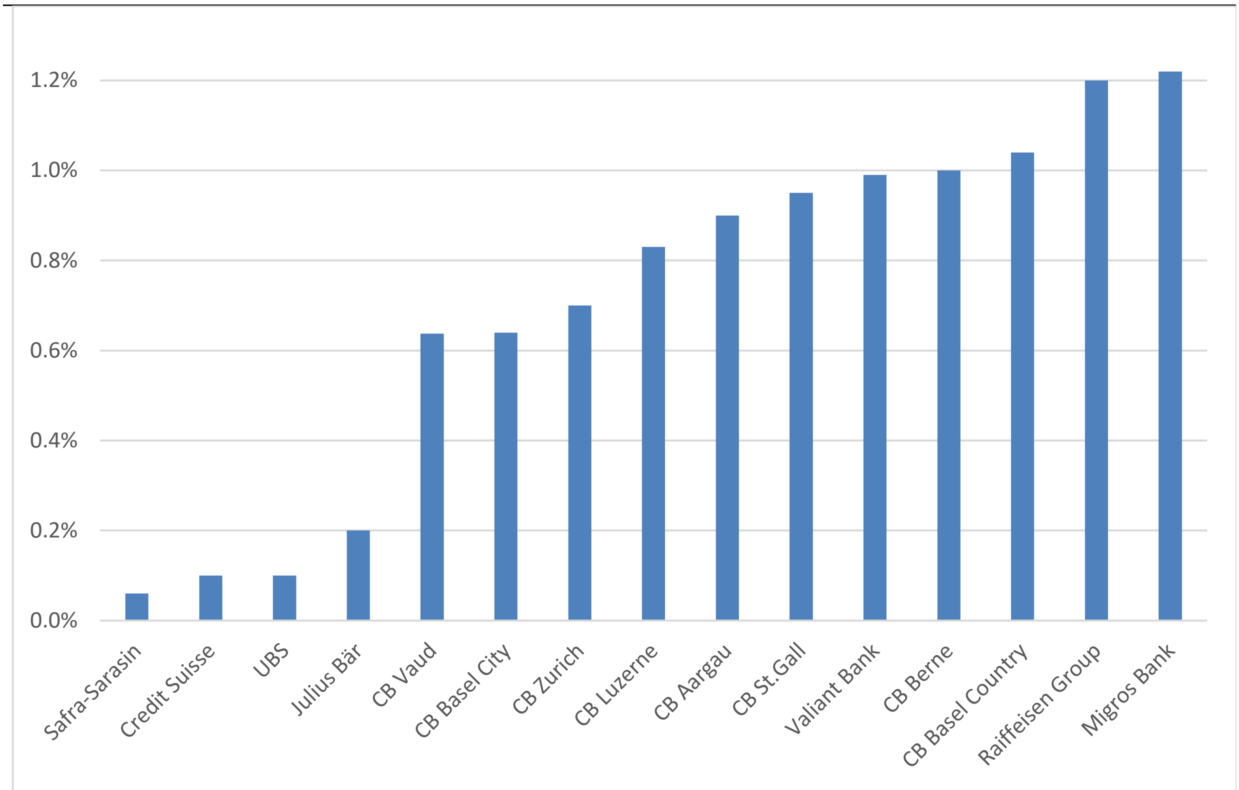
[4] The SNB in its press release of 6 September 2011 stated that "the current massive overvaluation of the Swiss franc poses an acute threat to the Swiss economy and carries the risk of a deflationary development. The SNB is therefore aiming for a substantial and sustained weakening of the Swiss franc. With immediate effect, it will no longer tolerate a EUR/CHF exchange rate below the minimum rate of CHF 1.20. The SNB will enforce this minimum rate with the utmost determination and is prepared to buy foreign currency in unlimited quantities." The SNB discontinued the minimum exchange rate on 15 January 2015.

the Swiss experience is singular and may serve as a unique opportunity to identify the national spillover effects of a targeted macroprudential policy.

Our three main findings, which are statistically significant, economically relevant and robust to many model alterations throughout, are as follows: First, we find that the CCyB's activation, which was intended to curb mortgage lending to private households, also affected lending to corporates. In particular, banks with a higher share of residential RWAs relative to total assets lent more to corporations than banks with a lower share. Second, banks increased both the interest rate and their one-time commissions on newly granted corporate loans. Third, after this announcement, banks shifted lending to riskier firms and to smaller firms, but we find no evidence that commercial loan growth was spurred in regions with booming housing markets.

The size of the Counter Cyclical Capital Buffer as percentage of total Risk Weighted Assets of 15 large Swiss-domiciled banks (end 2014)

Figure 2



Notes: The Counter Cyclical Capital Buffer as percentage of total Risk Weighted Assets is measured as of end of 2014 and is collected from the bank's Annual Reports or the additional public Basel Pillar III Disclosure Reports. "CB" stands for Cantonal Bank.

While we do find that commercial loan growth picked up following the CCyB's application to private residential mortgages, we also observe that lending rates increased substantially, as did other costs of obtaining credit.

We document our main empirical findings for a variety of horizons and subsamples, controlling for a large set of alternative mechanisms. The CCyB was not the only policy that was introduced in Switzerland during the last few years that could have affected commercial lending. Moreover, it is *a priori* unclear when a CCyB should have its maximum impact, ie when the legislative framework is enacted, or when a future CCyB rate is announced, or when a CCyB rate becomes effective.

To singularly identify the CCyB's impact, we therefore study different time horizons to determine when its impact was most felt. We document that the announcement of the 1% rate on 13 February 2013 did affect loan growth and lending rates (recall that we compare banks that have different degrees of susceptibility to the CCyB, and contrast the time period before the announcement with the period after). However, when we employ the same empirical strategy for a control period during which the CCyB legislation came into existence, we find no such effect. We thereby establish that that it is not the mere existence of the legal framework that changes banks' behavior, but rather the actual announcement and/or activation of it by the authorities.

We further show that our results are robust to the inclusion of other macroprudential policies. We include a bank-specific set of dummies for those banks that were subject to the Too-Big-To-Fail legislation. We further control for a bank-specific measure that captures the impact of a permanent increase in the risk-weighing for certain loans that occurred in January 2013 and the effect of which could be correlated with the CCyB. We find that controlling for these additional measures does not alter our conclusions with regard to the CCyB's impact.

We also examine how exposure to the CCyB interacts with bank capitalization during the period under observation. We follow Gambacorta and Mistrulli (2004) and construct the ratio of a bank's Core Equity Tier 1 (CET) compared to the bank-specific regulatory capital requirement (REQ). We then show the CCyB's impact on loan granting is less pronounced in the group of banks with a higher ratio of CET/REQ, while the impact on the interest rate is actually more pronounced in that group.

To answer the question of precisely how much difference the CCyB made, we also examine the impact of announced and implemented CCyB rates in a monthly panel of newly granted loans. We find that changes in the announced CCyB rate had a much larger impact on the interest rate charged and other loan characteristics than the actual implementation did.

In sum, the CCyB's activation and implementation have induced banks to increase the amount and pricing of lending to corporations, especially firms that are deemed to be riskier and involved in commercial real estate activities. In other words, a targeted macroprudential policy to discourage lending in one sector may cause extra lending in another "adjacent" sector, but potentially at a higher cost. In itself, this may be neither unexpected nor suboptimal from a policymaking perspective and we would be surprised if it did not happen in a well-functioning and regulated financial market place. At the same time, the effect needs to be taken into account when designing the policy if welfare gains are to be maximized.

Given these robust estimates, the contribution of our paper on the empirical side to the literature consists in providing the first evidence of the compositional effects of a prominent macroprudential policy action. In this respect our paper is markedly different from extant work such as Igan and Kang (2011), Basten and Koch (2015), Jiménez, Ongena, Peydró and Saurina (2017) or Basten (2019), who can and/or do not study any compositional effects in sectors not directly regulated by the policy. Basten and Koch (2015) and Basten (2019), for example, examine the impact of the Swiss CCyB's activation within the affected sector, particularly the impact on mortgage pricing.[5] They use data from the *Comparis* online platform that allows them to uniquely observe multiple offers per mortgage application. They find that capital-constrained and mortgage-specialized banks raise their rates relatively more, that risk-weighting schemes do not strengthen the effect of higher capital requirements, and that both CCyB-affected banks and CCyB-exempt insurers raise mortgage rates, but that insurers raise rates by an additional 8.8 basis points on average.

Jiménez, Ongena, Peydró and Saurina (2017) study the impact of the introduction and subsequent modifications of a related macroprudential policy, ie dynamic provisioning in Spain. But their setting does not really allow them to study intra-sector compositional effects because, in each of their policy experiments, bank lending to *all* sectors was concurrently being hit with changed provisioning requirements. So, while they do provide evidence of some heterogeneity in the impact of the policy change according to banks' and firms' characteristics, these measurements reflect the resultant combined change in provisioning requirements that affected all sectors. In contrast, in our setting, we have a targeted macroprudential policy and we can cleanly examine the direct compositional effects on the non-targeted sectors.

Our paper also differs from Aiyar, Calomiris and Wieladek (2014), who find that, in response to tighter capital requirements, regulated banks (ie UK-owned banks and resident foreign subsidiaries) cut back lending, while unregulated banks (ie resident foreign branches) may even increase it. In contrast to their paper, we look at compositional effects between affected and unaffected sectors within banks using bank-firm-level data rather than studying the "leakage" between banks on the basis of bank-level data. We believe that re-allocations within banks

5 Fischer and Zachmann (2018) assess the differential impact on house prices of self- and bank-financed investment faced with the application of the CCyB. Ferrari, Pirovano and Rovira Kaltwasser (2017) study the impact of a sectoral capital requirement on mortgage spreads in Belgium.

between sectors may be an even more widespread and also a more interesting potential problem in macroprudential regulation around the world. If so, studying the effect with bank-firm-level data will be crucial as a means of identifying its impact on the supply of credit.

While both Aiyar, Calomiris and Wieladek (2014) and our paper focus on regulatory-driven re-allocation of credit within one country,[6] there is also an emerging literature on international regulatory arbitrage that manifests itself in credit flows between countries (Houston, Lin and Ma (2012)), cross-border lending and the affiliate presence of US banks abroad (Temesváry (2018)), and risk-taking by banks across locales in Central and Eastern Europe (Ongena, Popov and Udell (2013)) or the UK and Ireland (McCann and O'Toole (2018)).[7] In all these cases – and perhaps not surprisingly – banks lend more, and take on more risk, in countries where regulations are laxer.

In the final section of our paper, we go back to the second question (regarding the impact of the intervention on financial stability and as a macroprudential tool) and analyse the optimal sectoral capital requirements over the business cycle. We do this in two steps: We first derive a microfoundation that can rationalize the observed spillover patterns. We then examine whether sectoral differentiation of capital requirements is generally desirable, and further, whether such differentiation should be countercyclical.

6 Other related work investigates changes in monetary conditions on bank lending along credit risk (eg Dell'Ariccia, Laeven and Marquez (2014), Jiménez, Ongena, Peydró and Saurina (2014), Ioannidou, Ongena and Peydró (2015)), currency denomination (eg Ongena, Schindele and Vonnák (2018)), or loan type (eg Chakraborty, Goldstein and MacKinlay (2018)), the impact of bank funding shocks on credit re-allocation (eg De Jonghe, Dewachter, Mulier, Ongena and Schepens (2019)), the impact of changes in bank capital requirements on bank equity and asset composition (Gropp, Mosk, Ongena and Wix (2018), Wold and Juelsrud (2019)), lending to firms (e.g., De Jonghe, Dewachter and Ongena (2016), Bichsel, Lambertini, Mukherjee and Wunderli (2018), Mayordomo and Rodríguez-Moreno (2018)) or lending outside the regulatory perimeter (Irani, Iyer, Meisenzahl and Peydró (2018)), and the impact of the taxation of leverage (Célérier, Kick and Ongena (2019)) or a financial crisis (eg Chodorow-Reich (2014)) on bank lending and the real economy.

7 See also Buch and Goldberg (2017) and other papers in the special issue of the *International Journal of Central Banking*, for example Auer, Ganarin and Towbin (2017) for the case of Switzerland.

In the model, private and commercial loan-granting arise within the same bank-client relationship due to the structure of access to collateral: Only private loans give access to private collateral, while commercial loans have preferential access to commercial collateral. In equilibrium, the client's inability to commit to not taking out a commercial loan with a rivalling bank leads the relationship bank to grant a private and successively a commercial loan to the same client. This model is shown to rationalize the empirically uncovered spillover patterns: Higher equity requirements for private loan granting increase the equilibrium rate and volume of commercial loan granting. This effect is more pronounced for banks with initially more private loan granting.

The surprising finding of our theoretical analysis however is that in terms of optimal policy design, such spillovers do not undermine the motive for sectorally differentiated equity requirements, but in contrast, actually provide a rational for such regulatory differentiation. The crucial insight is that a regulator who differentiates bank equity requirements for private and commercial loans gains a new tool to increase the overall resilience of banks without distorting the efficient allocation of capital. Higher equity requirements for private loans are desirable precisely because spillovers imply that lower granting of private loans is compensated by higher commercial loan granting. The regulator can thus capitalize the banking system via high equity requirements for private loans, and set commercial loan capital requirements low in order to not distort the total level of invested capital. We show that due to this effect, it is generally optimal to set higher equity requirements for private loans. Further, the difference between optimal equity requirements is shown to be increasing in future perceived risk of recession, ie countercyclical.

The rest of the paper proceeds as follows. Section 2 presents the data. The next three sections combine the estimated specifications and the results. Section 3 starts with the volume of newly granted and outstanding loans and their characteristics first at the bank level then at the loan level, Section 4 deals with the heterogeneity of the effects across firms, sectors and regions, Section 5 studies how equity and capital requirements affect the impact, and Section 6 focuses on the timing of the impact. Section 7 provides an illustrative theoretical model to help us interpret the estimates and Section 8 concludes.

2. Data description

The main analysis of this paper draws on the Lending Rate Statistics dataset collected by the SNB that includes information on the volume and characteristics of all commercial loans granted by banks domiciled in Switzerland whose loans to non-financial domestic companies exceed CHF 2 billion and which includes loans that exceed CHF 50,000.[8] The frequency of the dataset is monthly, and the reporting entity is by the locational principle, ie the branches that are located in Switzerland.

The Lending Rate Statistics include information on a very broad set of loan characteristics. On loan pricing, the data include information on the initial interest rate charged, on whether the rate is fixed or variable, and on the level of extra commission fees (if any). The data include information on the loan's amount, and on its payout and payback structure. Further information is provided on the (subjective) risk rating of the individual credit and the firm as entered by the loan officer, on whether the loan was collateralized and if so what type of collateral was used, on whether the loan was insured and under what conditions. For our purposes, it is also of interest that the data include information on the purpose of the loan. In particular, we have information on whether the loan was real estate-related.

[8] Unfortunately as of the time of writing, no comparable official credit registry for loans to private households exists.

We note that, due to the confidentiality of the credit register data, the dataset does not include unique firm identifiers for all firms. However, it does include information on the characteristics of the borrower such as its industry (79 different two-digit industry codes based on NOGA 2008, the *Nomenclature Générale des Activités économiques* 2008), location by canton (ie 26 distinct categories), size in terms of employment (five different categories), (subjective) rating entered by the loan officer (five different categories), and balance sheet size (six different categories). The combination of these firm characteristics in effect spans up to 308,100 different "business" categories, into which each of the 577,847 different firms that existed in Switzerland in 2013 (of which only a fraction take out loans over 50,000 CHF) can be slotted.

Tables 1 and 2 present summary statistics of the loans that were issued during the baseline period we examine (from 2012:07:01 to 2013:11:30).

In Table 1, we present an overview of the distribution of loan characteristics, with the first four rows focusing on the initial interest rate charged. The interest rate is expressed as a percentage and is the rate charged on the date the first loan payout is made (or, in the case of a credit line, on the first date at which a loan payout could be requested). We report the mean rate and the median rate, as well as the first and the 99th percentile.[9] These statistics are reported for the entire sample, and then for those loans with a fixed rate of interest, with a variable rate with a LIBOR benchmark, and for loans that are collateralized.

The next three rows summarize the maximum loan size of all loans (most loans are at their maximum size when issued), which averages roughly CHF 1.75 million. Loans range in size is

[9] We note that due to data confidentiality reasons, we cannot report the minimum or the maximum rates.

from CHF 50,000 in the first percentile to CHF 23 million in the 99th percentile.[10] Around 81% of the loans are paid out in a lump sum, and 71% of the loans are with a fixed maturity. Whether a loan has a lump sum payout or is fixed-term does not seem to have a large effect on its amount.

For the 82,310 loans that do have a fixed maturity, the average maturity is over two years (maturity is counted in calendar days, not business days), with the 1st and the 99th percentile ranging from just under a month to 10 years. Of the fixed-term loans, 85% are paid back in a single amount at the loan maturity date ("balloon repayment"), whereas the rest are amortized over time. Last, for 17% of the loans, banks charge not only an interest rate, but also an upfront fee that averages 1.03% of the maximum size of such loans.

Data summary: Loan characteristics of all loans issued during 01.07.2012 to 30.11.2013 — Table 1

	(1) Number of Observations	(2) Mean	(3) Median	(4) 1st Percentile	(5) 99th Percentile
Initial interest rate (in percent)					
All loans	115,709	2.26	1.70	0.41	7.50
Fixed rate loans only	73,149	1.62	1.45	0.40	4.40
Variable loans with libor benchmark	13,327	1.06	1.00	0.38	2.56
For loans that are collateralized	96,027	1.96	1.51	0.40	6.50
Loan size (in 1,000 CHF)					
All loans	115,709	1,748.87	400.00	50	23,130
Loans with lump sum payouts	93,664	1,974.49	500.00	50	25,000
Fixed-term loans	82,310	2,196.36	570.00	52	26,130
Maturity (in calendar days)					
All loans with fixed maturity	82,310	781.11	182	28	3,655
Fixed maturity loans with lump sum payback	70,198	665.00	92	28	3,654
Loans with commission: rate in %	19,774	0.96	1.00	0.76	1.49

10 Note that our data only include loans that exceed CHF 50,000 at the time of granting. Because the data presented here represent monthly averages and loan amortization can start as early as the month of origination, we observe outstanding amounts that are lower than CHF 50,000.

Table 2 presents summary statistics by firm size (as measured by number of employees) and by loan type. We first examine the number of loans made during the covered sample, the average interest rate, and the average loan size for four employment size categories: small firms with fewer than 10 employees, firms with 10-49 employees, firms with 50-249 employees, and firms with 250 or more employees. We also display these characteristics for holding companies where no employee count is recorded, given that the number of employees at a parent company is often unrepresentative of the actual size of the business.

Loan characteristics by firms size and loan type of all loans issued during 01.07.2012 to 30.11.2013

Table 2

By Firm size, number of workers	<10	10-49	50-249	>249	Holdings
Number of loans	68,442	20,852	6,562	1,843	18,010
Average interest rate	2.11	2.82	2.50	1.96	2.15
Average maximum loan size (1,000 CHF)	1,686	1,483	3,083	8,515	1,117

By loan type	Current accounts	New building loans	Commercial mortgages	Other commercial loans
Number of loans	19,351	2,547	51,547	42,264
Average interest rate	5.22	2.39	1.80	1.46
Average maximum loan size (1,000 CHF)	536	2,692	880	3,307

Loan amount generally increases with the size of the firm, while the average interest rate charged tends to fall. The exceptions are loans for the smallest firms as opposed to those with 10-49 employees. The average loan size for such firms is actually larger for the smallest firms in the sample than for firms with up to 49 employees. Moreover, the smallest firms are also charged a slightly lower interest rate.

The second split of the sample we take is by loan type. The lower part of Table 2 displays the number of loans, the average interest rate, and the average loan size for current accounts, new building loans, commercial mortgages, and other commercial loans.

As expected, current accounts are the most expensive form of financing. The average maximum loan size (CHF 536,410) is surprisingly large, but this reflects the fact that these loans are mostly short-term credit guarantees which are actually only rarely used.

New building loans are granted in order to finance planned or ongoing construction (that cannot be financed via mortgages as the pledgeable real estate has not been finished). After the construction is completed, a mortgage is taken over the new property. As mortgages are secured on the completed property, they are cheaper than new building loans, and because most mortgages are split over various maturities, they are on average smaller in amount. The final category is all commercial loans for standard business activity. These loans are surprisingly inexpensive and, because they are rather large on average, they make up the bulk of lending in our data.

Table 3 presents an overview of loan characteristics for all loans issued before the CCyB's activation and afterwards. Columns (1) and (2) show the mean and media characteristics of loans issued between 2012.07.01 to 2013.02.12, and Columns (3) and (4) present the same information for the loans issued between 2013:02:13 to 2013:11:30.

We augment the Lending Rate Statistics with bank-level data containing detailed information on all balance sheet items from the SNB's monthly banking statistics, which include detailed monthly information on all balance sheet items of all individual banks domiciled in Switzerland and, further with information on the bank's equity, the equity requirements set by the regulator, risk-weighted assets (also those related to residential mortgages) from the publicly available Basel Pillar III disclosure reports that are mandatory for all Swiss banks. From the latter data, we construct our main measure of how a given increase in the CCyB variously affects different banks.

Table 3

Data summary: Loan characteristics before and after the CCyB activation

	(1)	(2)	(3)	(4)
	Before CCyB		After CCyB	
	01.07.2012 to 12.02.2013		13.02.2013 to 30.11.2013	
	Mean	Median	Mean	Median
Initial interest rate (in percent)				
All loans	2.20	1.60	2.33	1.83
Fixed rate loans only	1.61	1.41	1.66	1.51
Variable loans with libor benchmark	1.07	0.99	1.07	1.00
For loans that are collateralized	1.89	1.47	2.05	1.65
Loan size (in 1,000 CHF)				
All loans	1,807	450	1,693	385
Loans with lump sum payouts	1,996	500	1,932	498
Fixed-term loans	2,186	600	2,159	500
Maturity (in calendar days)				
All loans with fixed maturity	790	181	796	185
Fixed maturity loans with lump sum payback	667	92	687	94
Loans with commission: rate in %	0.98	1.00	0.94	1.00

The main independent variable we construct is the CCyB's bank-specific size as a fraction of its total balance sheet. For each individual bank indexed *b* we therefore calculate the Relative Residential Risk-Weighted Assets ($RRRWA_b$) as:

$$RRRWA_b \equiv \frac{RRWA_b}{Domestic\ Banksize_b}$$

where $RRWA_b$ is the bank-specific amount of Residential Risk-Weighted Assets, and $Domestic\ Banksize_b$ is equal to total Swiss assets of each bank (ie the balance sheet size of the Swiss branches of each banking company). The residential risk-weighted assets comprise mainly the mortgages granted to private households. Calculated in this way, $RRRWA$ thus measures the residential risk-weighted assets as a fraction of each bank's balance sheet.

We note that $RRRWA$ changes over time as the risk-weighting of selected loans and each bank's portfolio might also change over time.[11] All the estimations below account for these

[11] In particular, the risk-weighting for the loan tranche of residential mortgages that exceeds a loan-to-value ratio of 80% was revised in early 2013.

changes of $RRRWA$, but for ease of notation, we drop the t subscripts whenever possible. Over the course of the entire sample, the median $RRRWA$ is around 20%, ie risk-weighted assets make up about a fifth of the typical bank's balance sheet size.

Further, there is substantial heterogeneity in $RRRWA$ in the cross section, with the first percentile of $RRRWA$ being equal to 1.5% and the 99th percentile equal to 32%. For easier interpretation, we standardize $RRRWA$.

3. Changes in the volume and characteristics of bank lending

In this section, we examine how the volume of loans granted and their characteristics changed with the CCyB's activation on 13 February 2013. We are particularly interested in the response of the volume and various other characteristics of the loans granted to individual borrower firms indexed by *f*. In our baseline approach, we adopt a difference-in-difference approach and examine the changes in the issuance of newly granted loans (or other dependent variables of interest). More specifically we assess how far individual banks were affected by the CCyB's activation as reflected in subsequent changes in loan issuance.

The main independent variable we construct is the CCyB's bank-specific size as a fraction of its total balance sheet. For each individual bank indexed *b* we therefore calculate the Relative Residential Risk-Weighted Assets ($RRRWA_b$) as defined above.

3.1 A first look at the main patterns in the data

To get a first sense of the salient patterns in the data, and before presenting the regression analysis that can properly account for the dynamics of loan demand, we document how overall loan characteristics evolved around the date of the CCyB's activation.

Table 4 shows that, with the announcement of a positive CCyB rate, loan origination shifted to banks that were characterized by a high $RRRWA$. Further, the interest rate charged for the loans by high-$RRRWA$ banks increased compared to the one charged by low $RRRWA$ banks.

The table presents summary statistics of how the volume of loans and the average interest rate charged differed between banks with an above-median $RRRWA$ and banks with below-median $RRRWA$ around the initial announcement of a positive CCyB rate on February 13, 2013. Columns (1A) and (1B), respectively, tabulate the share of loans that were issued by such banks before and after 13 February 2013. In Row (i) that share is calculated for five business days before or after the CCyB announcement, while in Row (ii) a three-month window is chosen. Column (2) presents the difference in the interest rates charged by high-$RRRWA$ banks and low-$RRRWA$ banks.

The picture which emerges from Table 4 is that banks that were particularly affected by the CCyB not only expanded their commercial lending, but also charged a higher interest rate for such loans. In the next section, we establish that this result is not driven by changes in the composition of borrowers and that it is robust to a variety of specifications. We also dig into the cross-section of customers to seek the correct interpretation of this finding.

But before "going down" to loan-level data, we first study the compositional effects at the bank level. We conduct our analysis by examining the response of the composition of loans on banks` balance sheets in a comprehensive sample of 279 Swiss Banks.[12] We show the impact of the CCyB is heterogeneous across banks. Following the activation of the CCyB, banks with a high exposure (ie high level of residential mortgages) reacted much stronger to the

[12] This bank-level part of our analysis uses standard balance sheet data from Bankscope. To achieve (almost) comprehensive coverage of the universe of banks we resort to using a 2015-based RRRWA because only 34 (larger) banks did so for 2012. For this set of banks, the correlation coefficient between the 2012 and 2015 measures equals 0.96. For the loan-level exercise (in the subsequent section) which relies on credit register data filed by the larger banks we can use the 2012 measure.

introduction of the CCyB and reduced the volume of outstanding residential mortgages substantially more than those banks with only little exposure.[13]

Loan Granting by High and Low- $RRRWA$ banks, before and after the CCyB Announcement

Table 4

	(1) **share of loans** issued by high $RRRWA$ Banks			(2) **difference IR in basis points** high $RRRWA$ - low $RRRWA$ Banks		
	(1A)	(1B)	**(1B)-(1A)**	(2A)	(2B)	**(2B)-(2A)**
	Before 13.2	On or after 13.02	**Difference**	Before 13.2	On or after 13.02	**Difference**
Sample is all new loans issued during:						
(i) one week before or after 13.02:	45.02%	48.05%	**3.02%**	–8.1	–1.6	**6.5**
(ii) 3 months before or after 13.02:	50.24%	51.16%	**0.91%**	–11.4	3.2	**14.6**

Notes: This table presents summary statistics of how the volume of loans and the average interest rate charged differed between banks with high $RRRWA$ and banks with low $RRRWA$ around the initial announcement of a positive CCyB rate on February 13, 2013. $RRRWA$ is as constructed in the main text and high- $RRRWA$ is defined as an above-median $RRRWA$ rate in the pre-CCyB announcement period. Columns 1A and 1B, respectively, tabulate the share of loans that was issued by such banks before and after February 13, 2013. In row (i) that share is calculated for 5 business days before or after the CCyB-announcement, while in row (ii) a 3-month window is chosen. Column (2) presents the difference in the charged interest rate by high- $RRRWA$ banks and low- $RRRWA$ banks.

To be more specific, in Column (1) of Table 5, the dependent variable is the change in the share of residential mortgages during 2013, defined as follows:

$$\Delta RMshare_{b,12-13} = 100 * ln\left(\frac{Residential\ Mortgages\ _{b,2013}}{All\ Loans\ _{b,2013}} \Big/ \frac{Residential\ Mortgages\ _{b,2012}}{All\ Loans\ _{b,2012}}\right)$$

The estimation for Column (1) is then:

$$\Delta RMshare_{b,12-13} = \alpha^{resid} + \beta^{resid} RRRWA_b + \varepsilon_b \qquad (1)$$

and the sample includes all banks in Switzerland that are covered by Bankscope in 2012 to 2015.

$\Delta RMshare_{b,12-13}$ is expressed in percent, ie the coefficient estimate -0.735 implies that a one standard deviation difference in RRRWA is associated with a 0.735 percent reduction in

[13] These bank level findings correspond to those in Behncke (2018).

the share of mortgages. The estimate is much larger in magnitude, at -1.776, in Column (2) when controlling for bank characteristics: ownership dummies, size, regulatory capital, and the lag of the dependent variable to capture trends.

At first sight, the evidence in Columns (1) and (2) documents the intended impact of the CCyB:[14] it reduced residential loan-granting more strongly for banks more strongly affected by the CCyB. However, we next document that despite the response of the share of residential mortgages, the growth rate of mortgages only reacted little, while the category of other loans actually increased, so that the total response of loan granting is at best insignificant or even positive across RRRWA.

In Columns (3) and (4), the dependent variable is the growth rate of residential mortgage granting:

$$\Delta dlnRM_{b,12-13} = 100 * ln\left(\frac{Residential\ Mortgages\ _{b,2013}}{Residential\ Mortgages\ _{b,2012}}\right).$$

The estimation for Column (3) is then:

$$\Delta dlnRM_{b,12-13} = \alpha^{resid} + \beta^{resid} RRRWA_b + \varepsilon_b \qquad (2)$$

and the sample includes all banks in Switzerland that are covered by Bankscope during 2012-2015. The coefficient is not estimated significantly and the coefficient estimate is -0.21. The point estimate is however significant and estimated to equal -1.87 when controlling for bank characteristics, ie a one standard deviation higher exposure to the countercyclical capital buffer is associated with a 1.87% lower growth rate of residential mortgages.

[14] The controls include a Raiffeisen Dummy that equals one if the bank is the Raiffeisen Bank, and zero otherwise, and a Cantonal Dummy that equals one if the bank is a cantonal bank, and zero otherwise. These banks have a different (social) objective and a different organizational structure than the other banks. This may affect their lending growth..

In Columns (5) and (6), the dependent variable is the log of the change in the level of non-residential mortgage granting, ie the growth rate of all loans that are not residential mortgages. In the estimation without controls, the coefficient is 1.91, while it is 4.77 with controls: banks more subject to the CCyB substantially increased their other loans granting following the activation of the buffer.

The impact of the CCyB on the composition of banks` balance sheets

Table 5

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variables	Change in residential mortgage share		Percentage change residential mortgages		Percentage change other loans		Percentage change all loans	
	simple	controls	simple	controls	simple	controls	simple	controls
RRRWA	-0.735***	-1.775***	-0.2104	-1.869***	1.9117**	4.7698**	0.5249***	-0.0627
	[0.2061]	[0.4303]	[0.2333]	[0.4788]	[0.9463]	[1.9821]	[0.1303]	[0.2805]
Raiffeisen Dummy		3.9133***		7.0770***		-17.656***		3.0090***
		[1.2458]		[1.3862]		[5.7705]		[0.7750]
Cantonal Dummy		-0.7030		0.6286		-6.6139		1.0990*
		[0.9483]		[1.0552]		[4.2335]		[0.5619]
Lag of size (total loans)		-0.0000*		-0.0000*		-0.0000		-0.0000
		[0.0000]		[0.0000]		[0.0000]		[0.0000]
Lag of CET1 ratio		6.0857		-9.1595		80.1831		-15.656**
		[11.8302]		[13.1629]		[53.6603]		[7.7683]
Lag of dependent variable		-0.170***		-0.1415**		-0.0953		0.0513
		[0.0573]		[0.0637]		[0.0605]		[0.0491]
Constant	-0.6668	-1.9417	3.2501***	2.5838	7.7319***	5.4584	3.9169***	4.7479***
	[0.4404]	[2.2096]	[0.4986]	[2.4585]	[2.0224]	[9.7238]	[0.2784]	[1.4940]
Observations	279	276	279	276	279	276	279	279
R-squared	0.044	0.108	0.003	0.102	0.015	0.066	0.055	0.134

Notes: This table examines how the bank-level change in residential mortgage share, and the bank level percentage changes in residential mortgages, other loans or all loans is determined by the bank's Relative Residential Risk Weighted Assets (*RRRWA*). Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

In sum, the impact of the CCyB on total loan-granting is ambiguous: in Columns (7) and (8), the dependent variable is the growth rate of total loan granting. The coefficient of

$RRRWA_{b,2012}$ is actually significant and positive in the specification without controls (in (7)), while it is estimated negatively once one allows for a richer set of controls (in (8)).

While a bank-level analysis of the impact can be insightfully comprehensive, concerns may linger about the sole attribution of the changes in bank balance sheet items to individual bank decision-making. To put differently, demand for credit for example or various pressures in financial markets may affect banks in a way that may be correlated with their residential mortgage exposures, in which case the estimates above comprise both bank supply considerations and many other elements. To cleanly disentangle, at least for corporate credit, bank credit supply from corporate credit demand we move to a (bank-firm) loan-level analysis in the next section.

3.2 Impact on the volume of outstanding loans

3.2.1 Specification

We start by estimating the impact on total loan commitments in a difference-in-differences specification in which we make a comparison of loan growth following the CCyB's introduction at banks that were strongly affected by the rate hike and those that were not. We estimate a difference-in-differences specification of the form:

$$\Delta ln\left(Total\,Commitment_{b,f}\right) = \alpha_f + \beta RRRWA_b + \gamma X_{b,f} + \varepsilon_{b,f} \tag{3}$$

where total loan commitment is, at every point in time equal to the total amount of financing (including credit lines) that is made available by bank *b* to firm *f* (hence we take into account not only new loan granting but also the entire maturity and repayment structure of existing loans). Explaining differences between the post and pre period in this way mitigates panel-related concerns of autocorrelation (Bertrand, Duflo and Mullainathan (2004)) and the unequal length of the respective periods.

Table 6 presents the estimates of this Specification (3). As a baseline case, we compare average total commitment in the months before the activation of a CCyB rate had been announced to the time including the announcement and actual implementation of the CCyB rate of 1%, ie we calculate:

$$\Delta ln\left(Total\,Commitment_{b,f}\right) = ln\left(\frac{Total\,Commitment_{b,f\,b,f,T_2}}{Total\,Commitment_{b,f\,b,f,T_1}}\right) \tag{4}$$

Where T_1 is the time from 2012:07:01-2013:02:12 and T_2 is the time from 2013:02:13-2013:11:30. Further, to make sure that our results are not driven by the response of $RRWA_b$ or $Banksize_b$ to variations in the CCyB rate, we use a pre-determined beginning-of-period values of $RRRWA_b$.

3.2.2 Main estimates

Column (1) in Table 6 presents the estimates from a basic regression of loan growth on $RRRWA$, while in Column (2) we saturate the specification with business-type fixed effects. Those are constructed on the basis of the affiliation of the firm to an industry (79 different two-digit industries), canton (26), size class (5), risk class (5), and balance sheet size class (6).[15] Their combination results in 308,100 business-type fixed effects (=79*26*5*5*6) which reasonably account for credit demand (*à la* Khwaja and Mian (2008)).[16]

In addition to the reasonable adequacy of the business-type fixed effects to capture credit demand, also notice that including individual firm fixed effects would in, the case of

15 Strict confidentiality concerns surrounding the credit register prevent access to a unique firm identifier.

16 Degryse, De Jonghe, Jakovljevic, Mulier and Schepens (2019) make a comprehensive case that the use of business or firm fixed effects in many situations will result in similar estimates.

Switzerland, lead to a substantial loss of useable observations (and corresponding selection concerns) because relatively few firms in Switzerland employ multiple banks.[17]

Admittedly, it cannot be entirely excluded that frustrated residential mortgage demand by a household could show up as corporate credit demand by a small firm at the affected bank, making credit demand bank-specific and rendering business fixed effects potentially partially impotent.[18] We therefore (go a number of steps further than most extant work and) also study credit granting to large firms (where this is less likely the case), along other bank characteristics such as proximity to regulatory bank capital (which is less likely correlated with credit demand during normal times), and across corporate sectors (to see if there is residential to corporate mortgage demand shifting). In terms of preview, it seems that in none of these cases changes in demand are the main driver of the changes in credit!

We note that in Table 6, the number of observations is 3,814, over a magnitude fewer than the number of loans granted during this period (115,709, see Table 1). The reason is that banks grant multiple credits to individual firms, which we need to aggregate in order to obtain the level of total commitment. Further, the number of observations is cut by a factor of two as we adopt a difference-in-difference specification.[19]

The estimated coefficient on $RRRWA$ in (2) equals 0.14***.[20] The positive sign on this estimated coefficient suggests that, after the CCyB's activation, banks with higher $RRRWA$

[17] See Ongena and Smith (2000), Neuberger, Räthke and Schacht (2006), Qian and Strahan (2007), and Neuberger, Pedergnana and Räthke-Döppner (2008). De Jonghe, Dewachter, Mulier, Ongena and Schepens (2019) for example employ a similar saturation strategy for Belgian small firms that, like Swiss firms, often maintain a single bank relationship.

[18] See also eg Paravisini, Rappoport and Schnabl (2014) or Altavilla, Boucinha, Holton and Ongena (2018).

[19] Note that a data requirement for estimating the difference-in-difference specification of Khwaja and Mian (2008), we require that the same bank- business relationship is granted a credit in both the pre- and the post-activation period. Further, due to the presence of fixed effects, only businesses with multiple banking relations are included in the sample. For our sample, these data requirements exclude only around 25% of the observations, and it further holds that the characteristics of the credits in the sample and those that are dropped are very similar within each period. This is documented in Table A1 of the Appendix.

[20] *** Significant at 1%, ** significant at 5%, and * significant at 10%. For convenience we will also indicate the significance levels of the estimates that are mentioned further in the text.

increased new lending to firms more (compared to the pre-activation period) than did banks with lower $RRRWA$. This is consistent with a compositional effect. The estimated coefficient is also economically relevant. Since we standardized $RRRWA$ prior to estimation, this coefficient suggests that *ceteris paribus* a bank in the 75th percentile of the $RRRWA$ range increased lending to firms by 18 (log) percentage points more than a bank in the 25th percentile.[21]

In sum, we find that the CCyB's activation spurred corporate lending by banks with higher $RRRWA$ more than it did at banks with lower $RRRWA$, and that such differential growth rates were not previously present, suggesting that the CCyB may have led to compositional effects.

21 The 25th to 75th percentile range equals two times 0.67, the standard deviation which by construction is set equal to 1 (= 0.14 * 2 * 0.67 * 1 = 0.18). Measured in absolute terms, the 25th percentile of relative risk-weighted assets (not standardized) is 2.3%, while the 75th percentile is equal to 24.9%. This difference of 22.6% in risk-weighted assets as a fraction of the balance sheet is associated with a 0.18 ln points difference in the growth of newly issued loans.

The impact of the activation of the countercyclical capital buffer on total loan commitment and new loan issuance

Table 6

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Model description	w/o business FE	Baseline w/ business FE	Pre-announcement effect	Windsor-ized *RRRWA*	Windsor-ized dep. var	Change in *RRRWA*	Bank size	Cantonal bank dummy	*RRRWA* incl. foreign assets	Change in newly granted loans
Dependent variable					**Δln(Total Commitment)**					**Δln(New Loan Volume)**
Difference period	*12:07:01-13:02:12 - 13:02:13-13:11:30*		*2012:H1 - 2012:H2*			*2012:07:01-2013:02:12 - 2013:02:13-2013:11:30*				
Bank Relative Residential Risk Weighted Assets (*RRRWA*)	0.03***	0.14***	–0.01	0.14***	0.09***	0.13***	0.13***	0.19***		0.22***
	[0.01]	[0.02]	[0.03]	[0.02]	[0.01]	[0.02]	[0.02]	[0.02]		[0.03]
Change in *RRRWA*						–12.40***				
						[4.36]				
Ln(Bank Balance Sheet Size)							0.21***			
							[0.03]			
Cantonal Bank y/n								0.06***		
								[0.02]		
Alternative *RRRWA* , using Domestic Size									0.15***	
									[0.02]	
Business Fixed Effects	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual Bank After Designation as TBTF y/n	No	No	No	No	No	No	No	No	No	Yes
Observations	3,814	3,814	3,033	3,809	3,594	3,814	3,814	3,814	3,814	3,159
R-squared	0.002	0.444	0.540	0.444	0.495	0.447	0.461	0.448	0.445	0.406

Notes: This table examines how the change in the volume in total commitment or of newly granted loans is determined by the bank's Relative Residential Risk Weighted Assets (*RRRWA*). In specifications (1) to (9), the dependent variable is the percentage change in the volume of total commitment (all outstanding loans-accrued repayment + credit lines) from 2012:07:01-2013:02:12 compared to 2013:02:13-2013:11:30. In (10), the dependent variable is the percentage change in the volume of newly granted loans over the same period. For the construction of *RRRWA* see the main text. The falsification exercise in (3) repeats the specification presented in (2) using the change in the half year before and after the first CCyB-announcement (2012:H1 to 2012:H2) as dependent variable. (4) excludes observations in which *RRRWA* is more than two standard deviations above or below the mean and (5) excludes observations in which the dependent variable is more than two standard deviations above or below the mean. (6) adds the change in average *RRRWA* from 2012:07:01-2013:02:12 to 2013:02:13-2013:11:30 as dependent variable. (7) adds as control the logarithm of the bank's balance sheet size, (8) adds dummies equal to 1 for cantonal banks, and (9) constructs a different measure of *RRRWA* that also takes into foreign domestic business when normalizing (see main text). All specifications except (1) absorb business fixed effects, thus limiting the variation in the data to businesses with multiple bank relations. For better comparison, also the sample in (1) is limited to this sample. Businesses are defined to belong to an industry (79 categories), canton (26), size class (5), risk class (5), and balance sheet size class (5). "Yes" indicates that the set of characteristics or fixed effects is included in the specification. "No" indicates that the set of characteristics or fixed effects is not included. Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

3.2.3 Robustness

We next examine the robustness of this first main finding. It is conceivable that our main measure of the CCyB's impact is correlated with bank-specific trends in loan growth that have little or nothing to do with the CCyB itself. Column (3) therefore contains an important falsification exercise which documents that $RRRWA$ was uncorrelated to growth in the period before the CCyB announcement.

Indeed in (3), we re-estimate Equation (3), evaluating the change in average commitment from 2012:01:01-2012:06:30 to 2012:07:01-2012:12:31, and find that the $RRRWA$ had no effect on loan growth during that period.

That our empirical strategy has no power during a time when no CCyB rate was announced constitutes an important finding in itself. The reason is that, in addition to the Federal Council's announcement of the legislation for the CCyB, FINMA announced a revision to banks' self-regulation guidelines that increased the risk-weighting for loan tranches exceeding 80% of the property's value. Fortunately, for our analysis, the latter came into effect already on 1 July 2012, i.e., over half a year before the activation of the CCyB. We find no evidence for a change in bank's loan granting around the beginning of July 2012.[22]

Thus, it is in the announcement of the CCyB's activation rather than the introduction of the legal framework that we identify the measure's impact. If we had found that our bank-specific variables – tailored to pick up the CCyB's impact but nevertheless potentially correlated with other bank characteristics that are affected by these additional measures – it would be less clear that we had identified the impact of the CCyB alone.

[22] See Danthine (2012) and FINMA (2012) for a discussion of these measures and their goals.

We next examine whether outliers in either $RRRWA$ or in loan growth could be behind our results. In Column (4), we exclude those loans issued by banks with $RRRWA$ two or more standard deviations above or below the mean of this variable, and in (5) we winsorize by the dependent variable.

Column (6) starts by controlling for changes in risk-weighted assets (RWA) during the time of observation; that is, we compare the average RWA from 2012:07:01-2013:02:12 to the average for 2013:02:13-2013:11:30. The reason we control for this change is that the underlying formulas for the calculation of RWA have been changed. This change was announced during June 2012, but actually implemented in January 2013, which is very close to the first announcement of the CCyB rate. Controlling for such changes of RWA that are induced by other legislation has no impact on the estimated coefficients.

Column (7) instead controls for bank size, measured as the natural logarithm of the bank's balance sheet. The results suggest not only a similar effect for $RRRWA$ but also a positive loading on bank size, suggesting that the CCyB may also have encouraged larger banks to lend more. Column (8) similarly controls for bank ownership by including a dummy for cantonal banks that are owned and guaranteed by the state. The estimate for $RRRWA$ remains positive, while the estimate on the dummy suggests that cantonal banks increased their supply of credit by less after the CCyB's activation than other banks did.

Column (9) presents a robustness test in which we construct an alternative measure for the $RRRWA$. In this alternative measure, we normalize $RRRWA$ by the size of the global domestic balance sheet rather than the domestic one:

$$\overline{RRRWA}_b = \frac{RRWA_b}{International\ Banksize_b} \tag{5}$$

The estimate of the coefficient on this rescaled $\overline{RRRWA_b}$ measure is most similar to the baseline estimate.

Finally, in Column (10), we examine how the change in newly granted loans is determined across banks with different $RRRWA$ by the CCyB's activation. To do so, we compute at every point in time the change in the total amount of financing (including credit lines) that is made available by bank *b* to firm *f* (hence we take into account not only new lending but also the entire maturity and repayment structure of existing loans). Then we estimate a specification of the form:

$$\Delta ln\left(NewLoanVolume_{b,f}\right) = \alpha_f + \hat{\beta} RRWA_b + \hat{\gamma} X_{b,f} + \varepsilon_{b,f} \qquad (6)$$

where:

$$\Delta ln\left(NewLoanVolume_{b,f}\right) = ln\left(\frac{NewLoanVolume_{b,f,T_2}}{NewLoanVolume_{b,f,T_1}}\right) \qquad (4`)$$

where T_1 is the time from 2012:07:01-2013:02:12 and T_2 is the time from 2013:02:13-2013:11:30. We again restrict the sample to firms that have relationships with more than one bank at both points in time. We find an estimated coefficient equal to 0.22***.

3.3 Impact on loan characteristics

3.3.1 Changes in the cost of credit

Table 7 investigates the impact of the introduction of the CCyB on loan characteristics, ie the loan interest rate and commissions (our main focus), and also the loan rating and sector.

We follow the line-up of the estimations in Equation (3), but we now feature changes in loan characteristics as the dependent variable. We commence by constructing the change in the average interest rate charged by bank *b* to firm *f*:`

$$\Delta IR_{b,f} = \overline{IR}_{b,f,T_2} - \overline{IR}_{b,f,T_1} \quad (7)$$

Specifications (1) to (6) in Table 7 use this newly constructed $\Delta IR_{b,f}$ as the dependent variable, ie we estimate:

$$\Delta IR_{b,f} = \alpha_f + \hat{\beta} RRRWA_b + \hat{\gamma} X_{b,f} + \varepsilon_{b,f} \quad (8)$$

As in Table 6, in Column (1) in Table 7 we estimate this specification first without business-type fixed effects and in Column (2) we add the business-type fixed effects. The estimated coefficient in the latter specification (again our benchmark specification) equals 0.18*** implying that, after versus before the CCyB's activation, the rate charged by banks at the 25th and the 75th percentile of $RRRWA$, respectively, diverged by 0.24% (=0.18*(0.67+0.67)). Given that the average charged interest rate in the sample is low, ie the unweighted average interest rate equals 2.4%; this difference is again economically relevant.

Next, we document that there is no such relation in the control period (see (3)) and subject our finding to a number of robustness exercises. For example, in Column (4) we again control for the change in $RRRWA$ during the period of observation to address whether the measured coefficients convolutes the CCyB's impact with that of the change in the loan-to-value ratio. We find that this is not the case.

Further, in Column (5), we add the set of bank controls featured before in Table 6, ie the bank balance sheet size, the cantonal bank dummy and the set of fixed effects for each bank after designation as TBTF. We find that the CCyB's activation had a marked positive effect on the charged interest rate also in this specification.

In Column (6) we add loan-specific controls, ie whether a loan is Libor-denominated, whether a loan is collateralized, what the quality of the collateral is, and the loan's risk class.

First and foremost, the estimated coefficient on the $RRRWA$ remains similar and equal to 0.16; hence, the differential changes in the loan rate between banks are not explained by the changing characteristics of the loans that are granted.

In Specification (7) in Table 7, we introduce a new dependent variable, which is the average change in the fraction of loans that were subject to a commission to assess whether higher interest rates were accompanied by corresponding changes in commissions. The dependent variable in (7) is thus equal to:

$$\Delta Commision_{b,f} = \overline{Commission}_{b,f,T_2} - \overline{Commission}_{b,f,T_1} \quad (9)$$

Where C_l is a dummy which is equal to one if a loan comes with a commission, and is equal to zero otherwise. We then estimate:

$$\Delta Commision_{b,f} = \alpha_f + \hat{\beta} RRWA_b + \hat{\gamma} X_{b,f} + \varepsilon_{b,f} \quad (10)$$

Since the change in the fraction of loans with commissions must lie in the interval [-1,1], we estimate a General Linear Model (GLM), assuming that the dependent variable has a Binominal distribution.[23]

The estimated coefficient on $RRRWA$ equals 0.08***, implying that around the CCyB's activation, the proportion of the loans that were charged commissions by banks at the 25th and the 75th percentile of $RRRWA$, respectively, diverged by 11 percentage points (=0.08*(0.67+0.67)). This is a very substantial economic effect, given that on average only 17% of the loans in our sample attracted additional commissions.

[23] The GLM specification with the Poisson assumption is appropriate for modeling percentage distributions, and we hence rescale the change in the fraction of loans that can take values from -1 to 1 such that the support equals [0,1] by adding one and dividing by two. We then double the resulting coefficients and standard errors, so that the interpretations of the coefficients remain intuitive. The GLM estimation does not allow us to include the set of all possible business fixed effects. We thus include fixed effects by industry, canton, and size, but not the combinations of these sets of fixed effects.

In sum, banks have not only increased the interest rate charged on the newly granted loans, but they were also much more likely to charge upfront commissions at the time of loan issuance. Below, we provide a plausible explanation for this higher commercial loan growth at a higher cost. In our illustrative theoretical framework, entrepreneurs obtain both private and commercial credit from their relationship bank. Because of the presence in the model of private benefits that accrue to entrepreneurs borrowing privately, but which are inaccessible to banks in the case of bankruptcy, private and commercial credit are perfect substitutes for entrepreneurs but not for banks. An increase in equity requirements on private lending by banks will then spur banks to lend commercially, but they will charge a higher price to do so. Moreover, and entirely consistent with our empirical estimates, both positive volume and cost effects will be stronger for banks that are granting relatively more private loans.

The impact of the activation of the countercyclical capital buffer on the characteristics of new loans from 2012:07:01-2013:02:12 compared to 2013:02:13-2013:11:30

Table 7

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Model description	w/o business FE	Baseline w/ business FE	Pre-announcement effect	Change in RRRWA	Bank Characteristics	Loan Characteristics	Extra commission	Libor rate	Loan risk class	New construction loans	Maturity
Dependent variable: %D in	**Average interest rate**						**Commission y/n**	**Libor y/n**	**Risk Class [0,1]**	**Real Estate y/n**	**Days (ln)**
Bank Relative Residential Risk Weighted Assets ($RRRWA$)	0.03	0.18***	–0.11	0.17***	0.67***	0.16***	0.08***	0.04**	0.00	0.04***	0.09**
	[0.03]	[0.04]	[0.09]	[0.05]	[0.14]	[0.04]	[0.02]	[0.02]	[0.02]	[0.01]	[0.04]
Change in $RRRWA$				–7.20							
				[14.26]							
%D Libor y/n						–0.19**					
						[0.09]					
%D Collateralized y/n						–0.68***					
						[0.15]					
D Collateral Quality						0.21***					
						[0.03]					
D Risk Class [0,1]						2.35***					
						[0.57]					
Ln(Balance Sheet Size)					–0.02						
					[0.07]						
Cantonal Bank y/n					0.59***						
					[0.14]						
Business Fixed Effects	No	Yes	Yes	Yes	Yes	Yes	Cant. & Size	Cant. & Size	Cant. & Size	Cant. & Size	Yes
Individual Bank After Designation as TBTF y/n	No	No	No	Yes	Yes	No	No	No	No	No	No
Observations	4,121	4,121	2,844	4,121	4,121	4,121	4,013	4,118	1,821	4,070	3,113
R-squared	0.000	0.474	0.571	0.474	0.480	0.497					0.565

Notes: this table examines how the respective dependent variable is affected by the bank's Relative Residential Risk Weighted Assets ($RRRWA$). In specifications (1) to (6), the dependent variable is the percentage point change from 2012:07:01-2013:02:12 to 2013:02:13-2013:11:30 in the average interest rate charged by bank b to firm f. In (7), (8), and (10), the dependent variable, respectively, is the change in the probability that a loan has a commission, is libor-denominated, is related to new construction. In (9), the dependent variable is the percentage point change in the average risk class (normalized to the range [0,1], 1=highest risk). In (11), the dependent variable is the change in the logarithm of average maturity. For the construction of $RRRWA$ see main text. (4) adds the change in the average $RRRWA$ from 2012:07:01-2013:02:12 compared to 2013:02:13-2013:11:30 as dependent variable. (5) adds the logarithm of the bank's balance sheet, a dummy equal to 1 for cantonal banks, and dummies for TBTF regulation (TBTF coefficients are not reported). (6) controls for changes in the fraction of libor-denominated loans, in the fraction of collateralized loans, in the loan risk class index, and in an index of collateral quality (if applicable). All specifications except (1) absorb business fixed effects, thus limiting the variation in the data to businesses with multiple bank relations. For better comparison, also the sample in (1) is limited to this sample. Businesses are defined to belong to an industry (79 categories), canton (26), size class (5), risk class (5), and balance sheet size class (5). "Yes" indicates that the set of characteristics or fixed effects is included. "Canton & Size" indicates that singular fixed effects for canton and size are included. "No" indicates that the set of characteristics or fixed effects is not included. Standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1.

3.3.2 Changes in other loan characteristics

Tables 6 and 7 so far document that both the amount and cost of corporate lending by banks increased substantially for higher- $RRRWA$ banks following the CCyB. This is not consistent with a simple expansion of credit supply by these banks. So we next investigate how the other characteristics of the newly granted loans have evolved. In the remainder of Table 7, we examine whether the CCyB's introduction has made banks opt for floating rather than fixed rates, whether it has affected the (subjective) credit risk assessment of these newly issued loans, and whether it has shifted the composition of loans towards real estate-related activity.

For the former two loan characteristics, we follow the procedure for the construction of $\Delta Commision_{b,f}$ in Equation (9) and construct measures of the change of the fraction in Libor-denomination for use in Column (8) and the change in the risk-class for Column (9).

We find that the CCyB's activation has also made loans more likely to be tied to the Libor benchmark rather than to a fixed rate, but there is no effect on the subjective risk perception of the issued credits.[24] The former effect is also sizeable. The proportion of the loans that were Libor-benchmarked by banks at the 25th and the 75th percentile of $RRRWA$, respectively, diverged by 5.4 percentage points (=0.04*(0.67+0.67)).

In Specification (10) of Table 7, we examine a new dependent variable, the change in the fraction of loans that were related to planned and ongoing construction activity (ie so-called "Baukredit"). The estimates suggest that the CCyB has also caused a moderate shift towards real-estate related loans in the commercial sector. As the CCyB applies only to residential mortgages, it may hence incentivize banks to grant mortgages to firms. And indeed the CCyB

[24] This change in the perceived risk class must be interpreted with care in any case, as it reflects a subjective judgment by a loan officer who might simply be entering a higher loan risk class in the database in order to justify a higher interest rate. We address this concern below by classifying firms by their ex-ante risk rating (our dataset includes information on the risk class both of each loan and each firm) to assess whether those that were considered to be more risky ex-ante received more credit.

has increased the fraction of new construction loans. The ratio of the loans to construction by banks at the 25th and the 75th percentile of $RRRWA$, respectively, diverged around the CCyB's introduction by 5.4 percentage points (=0.04*(0.67+0.67).

A last loan characteristic we examine is maturity: in Specification (11), the dependent variable is the log of maturity. We find that the CCyB's introduction led to a modest increase in maturity.

In sum, banks with higher $RRRWA$ respond to the CCyB's activation by increasing the availability, price, risk and maturity of credit, and by shifting lending towards commercial real estate activities.

4. Heterogeneity of the effects

4.1 Heterogeneity of effects across firms, sectors, and regions

Since we follow Khwaja and Mian (2008) and include business-type fixed effects in every estimation that control for all variation across businesses, we can identify the CCyB's impact from the variation in the set of businesses with multiple banks. But the estimations presented hitherto are thus uninformative about the variation of the CCyB's impact across different firms.

We next estimate the above specification for different subsamples and examine whether the coefficients of interest are heterogeneous across firms. In Table 8, we examine how new loan growth (in Panel A) and loan interest rate (in Panel B) relate to bank $RRRWA$ in various subsamples.[25]

To establish whether there are differences across different types of firms, Table 8 estimates Equations (1) and (8) for various subsamples. Table A2 in the Appendix establishes the

[25] We further examine the heterogeneity of the effects with maturity as dependent variable in Table A3 in Appendix.

corresponding interaction regressions that can inform us about the statistical significance of these differences across firm groups.

The subsample in Column (1) includes all firms with fewer than 10 employees, Column (2) includes firms with 10 or more employees but not more than 49, and the subsample in Column (3) includes the remaining large firms. We find that loan growth is more strongly affected by $RRRWA$ in the sample of small firms than in the sample of large firms. However, we also find that the interest rate charged to small firms has increased more than the one charged to large firms.

The subsample in Column (4) includes only firms that are active in construction sectors (ie sectors 41, 42, 43, and 71 in the NOGA 2008 classification system), while Column (5) contains the remainder of the sample. Overall, we find that bank $RRRWA$ had a somewhat stronger effect on loan growth for firms that are active in the construction industry than for other firms. However, we do see an opposite differential effect with regards to the average interest rate and neither difference is statistically significant (see Appendix Table A2). Overall, this analysis suggests that the impact is not credit demand-related (substituting residential for company mortgage demand) but rather coming from the credit supply side where the bank re-allocates across its non-CCyB affected areas of lending.

In Column (6) we focus on a subsample of firms headquartered in a "real estate hot spot", ie the cantons of Basel City, Basel Land, Geneva, Lucerne, Vaud, Valais, Schwyz, Zug and Zurich, while in Column (7) all other cantons are included. To determine whether a canton was a real estate hot spot, we rely on the "UBS Swiss Real Estate Bubble Index," which indicates the risk of a real estate bubble forming on the Swiss housing market. We are using the 2013:Q1 issue of this index. This quarter is subsequent to our main sample period and hence we attribute foresight to loan officers that make lending decisions.

We find that $RRRWA$ had, at most, a somewhat stronger effect on loan growth in cantons with real estate hot spots as compared with cantons without hot spots. However, we again see an opposite differential effect with regard to the average interest rate and the differences are again not statistically significant (Appendix Table A2). This constitutes an important finding since it documents that no regional compositional effects can be identified.

The last two specifications split the sample by credit rating, showing that the increased lending was concentrated in the set of more risky firms, as was the increase in the interest rates charged. The sample of Column (8) includes firms whose 2012 credit ranking was either A- or higher from Standard and Poor's, or A3 or higher from Moody's. The sample of Column (9) includes firms with a lower ranking or none.

4.2 Heterogeneity across loans type: non-real estate related commercial versus other loans

What is the nature of the spillovers documented thus far? Are residential mortgages being substituted by commercial mortgages (which could spur a commercial real estate bubble as argued in eg Levitin and Wachter (2013)), or rather, is there also a response in the volume and the characteristics of the loans that are granted for purposes other than for real estate (which could involve extra risk-taking)? The ability to differentiate between the two cases would facilitate the development of an appropriate policy mix. Next, therefore, we repeat the estimations already presented above for the subsample of commercial loans that are not mortgages.

In re-estimating the analysis in the subsample of non-real estate related commercial loans, we also consider the possibility that firms take out residential mortgages (which are subject to the CCyB). Although there are no reasons to believe that the latter could have expanded after the CCyB's announcement or enactment, it is reassuring to see that the uncovered results are qualitatively identical in a sample in which this, by definition, cannot happen.

Table 8

Heterogeneous effects on new loan issuance across firms, industries and regions

		(1)	(2)	(2)	(4)	(5)	(6)	(7)	(8)	(9)
	Subsample	Small firms Emp<10	Mid size 9<Emp< 50	Large firms Emp>49	Construct -ion related	Not construct -ion related	Real estate hot spot	No real estate hot spot	High Rating (A- to AAA)	No/ Lower Rating
Panel A	**Dependent variable**	**Δln(Total Commitment)**								
	Bank Relative Residential Risk Weighted Assets ($RRRWA$)	0.24***	0.12***	0.08**	0.17***	0.14***	0.17***	0.12***	-0.05	0.15***
		[0.04]	[0.02]	[0.03]	[0.05]	[0.02]	[0.03]	[0.02]	[0.08]	[0.02]
	Business Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Observations	596	2,280	938	583	3,231	1,643	2,171	961	2,853
	R-squared	0.447	0.435	0.461	0.436	0.446	0.431	0.460	0.446	0.444
Panel B	**Dependent variable**	**Percentage point change in the average interest rate**								
	Bank Relative Residential Risk Weighted Assets ($RRRWA$)	0.24*	0.22***	0.11	0.09	0.20***	0.11	0.22***	-0.43	0.19***
		[0.13]	[0.06]	[0.08]	[0.11]	[0.05]	[0.08]	[0.05]	[0.38]	[0.05]
	Business Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Observations	449	1,955	1,717	644	3,477	1,609	2,512	379	3,742
	R-squared	0.526	0.448	0.484	0.417	0.484	0.472	0.475	0.592	0.466

Notes: This table examines whether the relation between the growth of newly granted loans (Panel A) or the change in the average asked interest rate (Panel B) and the bank's Relative Residential Risk Weighted Assets ($RRRWA$) is heterogeneous across firms. In all specifications, the dependent variable is either the percentage change in the volume of newly granted loans or the percentage change in the average interest rate from 2012:07:01-2013:02:12 and 2013:02:13-2013:11:30. All specifications absorb business fixed effects thus limiting the variation in the data to businesses with multiple bank relations present. Businesses are defined to belong to an industry (79 categories), canton (26), size class (5), risk class (5), and balance sheet size class (5). "Yes" indicates that the set of characteristics or fixed effects is included. In (1), the sample includes only firms with less than 10 employees, in (2) firms with fewer than 50 but more than 10 employees are included and in (3), firms with 50 or more employees are included. In (4), only firms that are active a construction related sector are included (sectors 41, 42, 43, and 71 in the NOGA 2008 classification system) and (5) includes the remained of the sample. (6) includes firms located in the cantons Basel City, Basel Land, Geneva, Lucerne, Vaud, Wallis, Schwyz, Zug and Zurich. (7) includes the remaining cantons. (8) includes those firms with a high credit rating in late 2011, defined as either a Standard and Poor's rating of A- and higher, or a Moody's rating of A3 of higher. (9) Includes the remaining firms (also those without a rating). Standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1.

Table 9 repeats the baseline estimations relating $RRRWA$ to the growth of new lending (see Panel A) and the percentage point change in the average interest rate charged (see Panel B) for the subsample of commercial loans that are not related to real estate. The average effect of the CCyB's activation in February 2013 on loans other than mortgages is similar to the one in the full sample of loans. Specification (1) estimates this relation, which also includes business-type fixed effects. Both the coefficient on the change in newly granted loans and the change in the charged interest rate are similar (compare to Tables 3 and 4). Also the sample sub-splits correspond to the results of Table 8 documenting that these effects are concentrated in small firms (see specifications (2), (3), and (4) respectively) and in this case also construction-related firms (see specifications (5) and (6) respectively).

For the sample including only firms headquartered in cantons with real estate hot spots versus those firms located in the rest of Switzerland, the CCyB's impact on loan growth and the interest rate charged seems to be higher in cantons without real estate hot spots.

We thus conclude that there is no large difference in the impact of the CCyB's announcement on lending for mortgage-related and non-mortgage-related loans.

No mortgage subsample - baseline and heterogeneous effects across firms, industries and regions

Table 9

		(1)	(2)	(2)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Subsample	All Firms	Small firms Emp<10	Mid size 9<Emp< 50	Large firms Emp>49	Construction related	Not construction related	Real estate hot spot	No real estate hot spot	High Rating (A- to AAA)	No/ Lower Rating
Panel A	**Dependent variable**	**Δln(Loan Volume)**									
	Bank Relative Residential Risk Weighted Assets ($RRRWA$)	0.27***	0.66***	0.26***	0.15**	0.40***	0.23***	0.17***	0.32***	0.46	-0.10
		[0.04]	[0.14]	[0.05]	[0.07]	[0.08]	[0.05]	[0.07]	[0.05]	[0.39]	[0.09]
	Business Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Observations	1,932	150	854	928	298	1,634	865	1,067	15	1,452
	R-squared	0.415	0.523	0.402	0.415	0.458	0.408	0.413	0.418	0.586	0.539
Panel B	**Dependent variable**	**Percentage point change in the average interest rate**									
	Bank Relative Residential Risk Weighted Assets ($RRRWA$)	0.15***	0.27	0.23***	-0.01	0.11	0.16***	0.01	0.24***	-0.06	0.15***
		[0.05]	[0.17]	[0.07]	[0.09]	[0.11]	[0.06]	[0.09]	[0.06]	[0.73]	[0.05]
	Business Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Observations	2,632	214	1,124	1,294	378	2,254	1,118	1,514	43	2,589
	R-squared	0.509	0.603	0.463	0.526	0.512	0.508	0.520	0.501	0.659	0.507

Notes: This table examines the relation between newly granted loans (Panel A) or the change in the average asked interest rate (Panel B) and the bank Relative Residential Risk Weighted Assets ($RRRWA$) for the no-mortgages subsample, and whether this relation is heterogeneous across firms. In all specifications, the dependent variable is either the percentage change in the volume of newly granted loans (Panel A) or the percentage change in the average interest rate (Panel B) from 2012:07:01-2013:02:12 to 2013:02:13-2013:11:30. All specifications absorb business fixed effects thus limiting the variation in the data to businesses with multiple bank relations present. Businesses are defined to belong to an industry (79 categories), canton (26), size class (5), risk class (5), and balance sheet size class (5). "Yes" indicates that the set of characteristics or fixed effects is included. In (1), the full sample is included. In (2), the sample includes only firms with less than 10 employees. In (3), firms with 10-49 employees are included, and in (4) firms with 50 or more employees are included. In (6), only firms active in construction sectors are included (sectors 41, 42, 43, and 71 in the NOGA 2008 classification system), and in (7), the remainder of the sample is included. (8) includes firms located in the cantons Basel City, Basel Land, Geneva, Lucerne, Vaud, Wallis, Schwyz, Zug and Zurich. (9) includes the remaining cantons. (10) includes those firms with a high credit rating in late 2011, defined as either a Standard and Poor's rating of A- and higher, or a Moody's rating of A3 of higher. (11) includes the remaining firms (also those without a rating). Standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1.

5. Equity, capital requirement, and $RRRWA$

What is the impact of a bank's equity compared to the level of capital that is required by the regulator on lending and the interest rate charged during the time of observation? Further, are there any interactions between the bank's equity and its exposure to the CCyB through its residential mortgage business (eg Brei and Gambacorta (2016))?

We show that the previously established results regarding the impact of $RRRWA$ on loan growth and the average interest rate charged are unaltered when also controlling for the proximity of a bank's equity to regulatory capital. Further, on its own, proximity to regulatory capital has no effect on new lending volume, but is associated with lower interest rates. That is, during the time of observation, those banks with comparatively ample equity reduced their interest rates.

Moreover, we point out an interesting interaction between $RRRWA$ and proximity to regulatory capital around the CCyB's introduction. We find that $RRRWA$ had stronger effects on loan growth, yet weaker effects on the interest rate charged for banks that had lower levels of equity compared to the regulatory requirement. A rationalization of this result is that banks with a high $RRRWA$ have a stronger incentive to grant more commercial loans when the CCyB is activated. Further, in the high $RRRWA$ group, banks with less equity have more room to increase lending where the CCyB does not "bite". We document these findings in Tables 10 and 11. In Table 10, the dependent variable is the change in total commitment around the CCyB's introduction, and the table examines how this change is affected by the bank's $RRRWA$, by the bank's Tier 1 Core Equity (CET1) compared to the required core equity ratio (REQ), and by the interaction of $RRRWA$ and CET/REQ. A large excess over regulatory requirements has no impact on loan growth. Column (1) includes a dummy labeled High CET/REQ that is equal to one if the bank's CET/REQ is above the median for all banks in the sample, and zero otherwise. Column (2) adds this dummy to our baseline specification including $RRRWA$.

However, there is some indication that the impact of $RRRWA$ is weaker for banks with a larger excess over regulatory requirements. Column (3) adds the interaction of $RRRWA$ with the large excess over regulatory requirements dummy. The latter is positive, indicating that the covariation of loan growth and $RRRWA$ is lower (in absolute value) among the group of banks with high equity.

These results are similar when we control for CET/REQ directly. In (4) we add this variable, in (5), we add it to the baseline specification including $RRRWA$ and in (6) we add the interaction of $RRRWA$ with CET/REQ.

Table 10

Equity, regulatory requirements, $RRRWA$ and new loan issuance

Model description	(1) Only high CET/REQ dummy	(2) Controlling for high CET/REQ dummy	(3) Interaction $RRRWA*$ high CET/REQ dummy	(4) Only CET/REQ	(5) Controlling for CET/REQ	(6) Interaction $RRRWA*$ CET/REQ
Dependent variable	**Δln(Total Commitment)**					
Bank Relative Residential Risk Weighted Assets ($RRRWA$)		0.14***	0.16***		0.14***	0.11***
		[0.02]	[0.02]		[0.02]	[0.02]
High Tier 1 Core Equity (CET) / Required Core Equity (REQ)	0.02	-0.02	0.02			
	[0.03]	[0.03]	[0.03]			
$RRRWA*$ High CET/REQ			-0.18***			
			[0.04]			
Tier 1 Core Equity (CET) / Required Core Equity (REQ)				0.02	0.02	-0.01
				[0.04]	[0.04]	[0.04]
$RRRWA*$ CET/REQ						-0.17**
						[0.07]
Business Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,814	3,814	3,814	3,814	3,814	3,814
R-squared	0.426	0.445	0.449	0.426	0.445	0.446

Notes: This table examines how the change in total commitment is affected by the bank's Relative Residential Risk Weighted Assets ($RRRWA$), by the bank's tier 1 core equity (CET) compared to the required core equity ratio (REQ), and by the interaction of $RRRWA$ and CET/REQ. In all specifications, the dependent variable is the percentage point change from 2012:07:01-2013:02:12 to 2013:02:13-2013:11:30 in loan growth by bank b to firm f. All specifications except (1) and (4) include $RRRWA$ as dependent variable. (1) and (2) adds a dummy equal to 1 for bank-firm relations above the median CET/REQ, and (3) further adds the interaction of this dummy with $RRRWA$. (4) includes the CET/REQ directly instead of a dummy, and (6) includes the interaction of the CET/REQ with $RRRWA$. Standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1.

In Table 11, we present the same specifications as in Table 10, but with the change in the average interest rate around the CCyB's introduction as the dependent variable. Banks with a greater excess over regulatory capital did lower their interest rates around that time (see (2) and (4)), but this does not alter our results regarding the positive impact of $RRRWA$ on the interest rate charged (see Columns (4) and (5)). Again, there is evidence that the interaction of $RRRWA$ and excess capital over regulatory requirements is positive (see Columns (3) and (6)), ie that the impact of $RRRWA$ on the interest rate charged is more pronounced in the group of banks with ample equity. In sum, Tables 10 and 11 suggest that banks with high $RRRWA$ and low equity will grow lending more and at a lower interest rate (than other banks) in areas not affected by the CCyB surcharges.

Table 11

Equity, regulatory requirements, $RRRWA$ and interest rates

	(1)	(2)	(3)	(4)	(5)	(6)
Model description	Only high CET/REQ dummy	Controlling for high CET/REQ dummy	Interaction $RRRWA*$ high CET/REQ dummy	Only CET/REQ	Controlling for CET/REQ	Interaction $RRRWA*$ CET/REQ
Dependent variable	**The percentage point change in the average interest rate**					
Bank Relative Residential Risk Weighted Assets ($RRRWA$)		0.12***	0.08		0.19***	0.22***
		[0.04]	[0.05]		[0.04]	[0.05]
High Tier 1 Core Equity (CET) / Required Core Equity (REQ)	–0.55***	–0.51***	–0.48***			
	[0.07]	[0.07]	[0.07]			
$RRRWA*$ High CET/REQ			0.11			
			[0.07]			
Tier 1 Core Equity (CET) / Required Core Equity (REQ)				–0.43***	–0.45***	–0.90***
				[0.14]	[0.14]	[0.21]
$RRRWA*$ CET/REQ						0.72***
						[0.26]
Business Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,121	4,121	4,121	4,121	4,121	4,121
R-squared	0.484	0.485	0.486	0.472	0.476	0.478

Notes: This table examines how loan growth is affected by the bank's Relative Residential Risk Weighted Assets ($RRRWA$), by the bank's tier 1 core equity (CET) compared to the required core equity ratio (REQ), and by the interaction of $RRRWA$ and CET/REQ. In all specifications, the dependent variable is the percentage point change from 2012:07:01-2013:02:12 to 2013:02:13-2013:11:30 in the average interest rate charged by bank b to firm f. All specifications except (1) and (4) include $RRRWA$ as dependent variable. (1) and (2) adds a dummy equal to 1 for bank-firm relations above the median CET/REQ, and (3) further adds the interaction of this dummy with $RRRWA$. (4) includes the CET/REQ directly instead of a dummy, and (6) includes the interaction of the CET/REQ with $RRRWA$. Standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1.

6. The timing of the impact: announcement or actual effects?

So far, we have evaluated the impact of the CCyB activation on loan growth from 2012:12-2013:02 to 2013:03-2013:11. In this section, we first examine a longer time horizon and we then go to a panel estimation in which we pick up the finer over-time variation of the announced and actually implemented CCyB rates.

For the impact on loan volume growth, we find that the CCyB's long-run impact is somewhat larger than the impact over a shorter horizon. Column (1) of Table 12 reproduces the baseline specification presented in Column (2) of Table 6, but we compare the average total commitment before the CCyB rate had been announced (as before: 2012:07:01-2013:02:12) to average total commitment from 2013:02:13-2014:09:30. We find that the change in total commitment is somewhat larger than when including only a shorter time period. This is hardly surprising given that the second period now also includes the second hike of the CCyB rate: during January of 2014, the CCyB rate had been announced to equal 2% effective of June 2014.

To more clearly distinguish the impact of the two announcement and two effective dates on the properties of charged interest rates, we next go to a different form of estimation that allows us to more finely disentangle the importance of activation and implemented effects. Instead of looking at a simple difference in difference, we can also look at the entire sample of individual loans and examine how the interest rate charged has evolved with the announced and implemented CCyB rates. We construct the variables:

$$CCB\ Actual_{b,t} = CCB\ Actual\ Rate_t * RRRWA_b \tag{11}$$

$$CCB\ Announced_{b,t} = \left(CCB\ Announced\ Rate_t - CCB\ Actual\ Rate_t\right) * RRRWA_b \tag{12}$$

Where $CCB\ Actual\ Rate_t$ is the rate that is applicable to $RRRWA$ (0, 1% or 2%) at each point in time and $CCB\ Announced\ Rate_t$ is the rate that has been announced. $CCB\ Announced_{b,t}$ is thus picking up the variation in interest rates during periods when a CCyB rate has been announced, but not yet implemented. For example, the rate of 1% was announced on 13 February 2013, but took effect only after 30 September of that year. From Specification (2) onwards, Table 12 presents estimations of the form:

$$Interest\ Rate_{b,f,l,t} = \alpha_{f,t} + \hat{\beta} CCB\ Actual_{b,t} + \hat{\beta} CCB\ Announced_{b,t} + \varepsilon_{b,f,l,t} \quad (12)$$

This specification is estimated for the sample of individual loans. To maintain the spirit of the estimations presented hitherto that follow Khwaja and Mian (2008) and utilize the variation across multiple banks serving the same customer, Columns (2) to (5) of Table 7 control for business-time fixed effects, thus also absorbing all aggregate over-time variation, and they further cluster fixed effects around businesses (business-type fixed effects are subsumed in the business-time fixed effects). Our estimations thus filter out not only all aggregate trends and fluctuations brought about by other regulatory changes during the period of observation, but even such fluctuations at the business level.

Column (2) only includes the actual rate and estimates a coefficient of 0.69** for $CCB\ Actual_{b,t}$, implying that, if the CCyB rate is increased by 1 percentage point, the interest rate charged by a bank with $RRRWA$ of 0.5 increases by 0.34 percentage points (=0.69*0.5*1).

Table 12

Timing of the effects

	(1)	(2)	(3)	(4)	(5)	(6)
Model description	Difference-in-difference	Regressions with Business * Year-Month Fixed Effects				Poisson regression
Dependent variable	**Δ New Commitment 2013:Q4**	**Loan specific interest rate**		**Ln(Maturity)**	**Libor y/n**	**Libor y/n**
Actual Bank Specific Countercyclical Capital Buffers (CCyB)	0.22***	0.69**	0.49*	2.45***	–0.44***	0.05
	[0.03]	[0.32]	[0.26]	[0.38]	[0.08]	[0.11]
Announced Bank Specific Countercyclical Capital Buffers (CCyB)			0.94**	4.40***	–0.37***	–0.52***
			[0.46]	[0.60]	[0.09]	[0.17]
Business Fixed Effects	Yes	No	No	No	No	Yes
Year:Month Fixed Effects	No	No	No	No	No	Yes
Business * Year:Month Fixed Effects	No	Yes	Yes	Yes	Yes	No
Observations	3,522	402,017	402,017	299,952	402,017	402,017
R-squared	0.463	0.610	0.610	0.625	0.377	–

Notes: Specification (1) in this table examines how the change in the volume of total commitment from 2012:07:01-2013:02:12 compared to 2013:02:13-2013:12:31 is determined by the bank Relative Residential Risk Weighted Assets ($RRRWA$). This specification includes business fixed effects and $RRRWA$ as the only independent variable. In specifications (2) to (6), the sample includes all individual loans issued from the start of 2010 to the end of the sample period, and the dependent variable is a loan characteristic, i.e., interest rate in (2) and (3), the logarithm of maturity in (4), and Libor denomination or not in (5) and (6). The variable Actual Bank Specific Countercyclical Capital Buffers (CCyB) is equal to $RRRWA$ times the applicable actual CCyB rate at each point in time. The variable Announced Bank Specific CCyB is equal to $RRRWA$ times the announced minus the applicable CCyB rate at each point in time. Specifications (2) to (5) estimate regressions that absorb business – year-month fixed effects, thus limiting the variation in the data to businesses and year-month combinations with multiple bank relations present. Businesses are defined to belong to an industry (79 categories), canton (26), size class (5), risk class (5), and balance sheet size class (5). "Yes" indicates that the set of characteristics or fixed effects is included. "No" indicates that the set of characteristics or fixed effects is not included. The reported standard errors are clustered at the level of the business. Specification (6) estimates a Poisson model that also includes year-month fixed effects (but not business * year-month fixed effects). Standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1.

We next add $CCB\ Announced_{b,t}$ to the Specification (2), documenting that the activation effect is actually stronger than the implementation effect.

In Columns (4) and (5), we also document that the announcement effect is dominant for (the log of) loan maturity and for whether a loan is Libor-denominated. We note that the absorption regression in Column (5) does not produce the correct standard errors due to the non-normality of the dependent variable, and we thus estimate a Poisson specification in Column (6). We cannot include the firm-time fixed effects in the latter specification, and we thus also report Specification (5). In sum, we find that the announcement effect is stronger than the implementation effect for all three examined loan characteristics.

7. Spillovers of a targeted regulation in a model of relationship lending

In this section, we show that the above-documented patterns actually imply that a countercyclical sectoral capital buffer is socially desirable. We first derive a microfoundation that can rationalize the observed spillover patterns. We then show that sectoral differentiation of capital requirements is generally desirable, and moreover that such optimal differentiation is countercyclical. We first document that in a model of relationship lending, changes in equity requirements for private lending by banks (such as the one brought about by the activation of the CCYB in Switzerland) spill over into the interest rates charged for and the volume of commercial loans. Higher equity requirements for private lending by banks reduce the equilibrium amount of private loan granting, thus raising the value to the entrepreneur of obtaining commercial loans, which results in more commercial loan granting at a higher interest rate. This spillover of regulation from private to commercial lending is shown to be stronger for banks that grant more private loans.

In our model banks lend to both the entrepreneurs privately and to the firms these entrepreneurs own, due to the structure of seniority in the case of bankruptcy. In case of bankruptcy of the firm, commercial lenders (ie banks granting commercial loans) have senior claims to the collateral of the firm, while only private lenders have claims to the private collateral of the entrepreneur. The private lender however only has claims to whatever is left of the liquidation value of the firm after the commercial loan has been paid back. We assume that a bank and an entrepreneur are “endowed with” a business relationship. The entrepreneur can also invest in establishing a further business relationship with another bank. Because the entrepreneur cannot commit to not applying for a commercial loan with another bank, her current bank grants her such a loan. In equilibrium, the entrepreneur thus sticks with her current banking relationship, and the relationship bank grants first a private loan and then a commercial loan.

In sum, the existence of private and firm-specific collateral and the inability of entrepreneurs to commit to applying for only one type of loan leads to the emergence of an equilibrium in which the same bank finances a project with both a private and a commercial loan.

7.1 Informal description of the game and its sequence

We develop a model in which banks can grant private and commercial loans and the ability to contract on and if necessary claim private and commercial (ie firm-specific) collateral. Entrepreneurs are endowed with the the ability to run a firm and with one bank relationship.

The entrepreneur requires funds to run their firm. The entrepreneur can open a bargaining round and approach her relationship bank asking for either a private or a commercial loan. The bank can set the volume of loans granted (including zero) and the interest rate at which the loan will be granted. The entrepreneur can then accept or decline the offer.

The entrepreneur can approach the bank several times before any investment occurs, but after each bargaining round, there is an exogenous probability χ that the bank-entrepreneur relationship goes “sour” and breaks up. If this is the case, the entrepreneur cannot obtain any more credit.

We also assume that investment happens in two stages, in the first of which the entrepreneur can choose a project with high or low private benefits. Because only the private loan enables the bank to access these private benefits in the case of bankruptcy, no bank will ever grant a commercial loan in the first investment stage (and no entrepreneur will ever ask for such a loan as this would create the risk χ of the relationship breaking up, while benefiting neither party).

Once the initial investment has happened, the project type cannot be changed and becomes public knowledge, thus opening the possibility for commercial loans.

Indeed, due to the seniority structure in case of default, once the type of the project is set, only commercial loans will be granted. The reason is that, after bargaining with their current bank, the entrepreneur also has the option to pay an infinitesimal fixed cost to obtain a new bank relationship and ask for a new commercial loan. Although this does not happen in the equilibrium, it creates an inability of the entrepreneur to seeking only private lending by banks: Any entrepreneur with only private lending by banks has incentives to ask for commercial credit at another bank, which will grant this credit as it thereby obtains senior rights to the firm-specific collateral.

Because entrepreneurs cannot commit to not obtaining commercial loans, any private loan will always be granted on the basis that the entrepreneur will later also ask for a commercial loan afterwards, thereby diluting the residual collateral value of the firm to zero.

After all credit is obtained, all funds are invested and production is realized. There is aggregate risk in the production function. In case of bankruptcy, the "commercial loan granters" have senior rights to the collateral of the firm, while private lenders have claims only to whatever is left of the firm after commercial credit has been repaid. However, private lenders can access the private benefits created by the firm (which are inaccessible to commercial lenders).

In this game, under parameter restrictions that give rise to positive loan amounts and given the possibility of bankruptcy, there exists an equilibrium in which entrepreneurs first ask for a private loan and then a commercial loan from the same bank, and both loans are offered and then granted. The sequence of the game in this equilibrium is:

1. All endowments, ie the cost of banks' debt and equity, the banks' capabilities, the entrepreneur's capabilities and equity stake, and the entrepreneur-bank relationships are realized.
2. Private loan subgame.

a. The entrepreneur asks for private credit, the bank makes an offer.
b. The entrepreneur has the choice to accept or decline, but chooses to accept.
c. The entrepreneur chooses the size of the initial investment and whether the firm uses high- or low-productivity technology. The initial investment and the chosen production technology become known.
d. With exogenous probability χ, the game moves to stage 5.

3. Commercial loan subgame.

a. The entrepreneur asks for commercial credit, the bank makes an offer.
b. The entrepreneur accepts or declines.
c. The entrepreneur invests her funds in the firm
d. With exogenous probability χ, the game moves to stage 5.

4. Entrepreneurs can invest in a new bank relationship, but chooses not to.
5. Production realizes, payments are made, bankruptcy occurs or not.

We next lay out the formal ingredients of the model and solve the lending game and the underlying parameter restrictions by backward induction.

7.2. The loan granting game

Production technology and the entrepreneur's choice set. The entrepreneur has a potential firm that requires financing. The firm will produce output Y that depends on private effort θ, the invested capital K, and the aggregate economy. Output is equal to $\theta \ln(K)$ if there is no recession, which happens with exogenous probability $(1-\mu) \in [0,1]$. With probability μ, there is a recession, and the project only pays a fraction $\theta\kappa_C \in [0,1]$ of the invested capital K. The firm's output is thus:

$$Y(\theta, K) = \begin{cases} K\kappa_C \text{ with probability } \mu \\ \theta \ln(K) \text{ with probability } 1-\mu \end{cases}$$

The entrepreneur can choose the private effort level θ to be high (H-type, associated with θ^H) or low (L-type, associated with θ^L where $0 < \theta^L < \theta^H$). If the entrepreneur chooses low effort, she will receive additional private benefits$B^L \ln(K^I)$, where K^I is the initial investment. The initial investment K^I is different from total investment K because it does not include the investment made possible by a commercial loan. $B^L \ln(K^I)$ are funds that are available to the entrepreneur and they are not part of the liquidation value of the firm in case of bankruptcy. They are, however, accessible in case of private bankruptcy to the bank that grants a private loan. We assume that parameters are such that it is socially optimal to choose the H -type project: it holds that $B^L + (1-\mu)\theta^L < (1-\mu)\theta^H$.

Aggregate risk - i.e. recession or not - realizes after the type of the project is chosen by the entrepreneur, all loans have been granted, and all investments have been made.

The entrepreneur can take out private and commercial loans from the bank. We denote the volume and interest rate of the private loan by $\mathrm{F_P}$ and r_P that of the commercial loan by F_C and $\mathrm{r_C}$ ($\mathrm{r_P}$ and r_C include repayment of the principal).

The firm is subject to limited liability and its profit π_C^{Firm} is equal to output minus repayment for the commercial loan:

$$\pi_C^{Firm} = \max[Y - r_C F_C, 0].$$

The entrepreneur herself is risk neutral in final wealth and subject to limited liability. Her utility is thus linear in expected income, which is equal to firm profit π_C^{Firm}, private benefits, and the negative repayment of the private loan $r_P F_P$. In the worst of all cases, both the firm and the entrepreneur go bankrupt. In this case, also the private benefits ($B^L \ln(K^I)$ if there are any) are lost to the entrepreneur, who is left with zero income (due to limited liability). In the case of an H-type project, the entrepreneur's utility is

$$u = \max\left[\pi_C^{Firm} - r_P F_P, 0\right].$$

whereas in the case of an L-type project, the entrepreneur's utility is

$$u = \max\left[\pi_C^{Firm} + B^L \ln(K^I) - r_P F_P, 0\right].$$

The commercial loan. Solving the game by backward induction and anticipating that the private loan will be given such that the entrepreneur chooses the H-type project, we first examine the commercial lender's decision. If she receives a request for such a loan (which happens unless the relationship has broken up in the application process for the private loan), the commercial lender makes a take-it-or-leave-it offer to the entrepreneur after observing the amount of private credit F_P, the interest rate r_P, and the project's type.

The commercial lender anticipates that the entrepreneur will accept only if the offer is such that expected utility of accepting is at least as large as financing the project with private credit only. He accordingly sets the conditions of the loan such to extract all surplus.

The parameters are such that in the equilibrium of the game, $r_P F_P$ is larger than the value of the firm during recession, such that the entrepreneur is left with zero in the bad state, also resulting in a utility of zero (we solve for the associated parameter restrictions below). Then, the expected utility of the entrepreneur is $(1 - \mu)\left(\theta^H ln(F_P + F_C) - r_C F_C - r_P F_P\right)$ in case she accepts the commercial loan offer, and $(1-\mu)(\theta^H \ln(F_P) - r_P F_P)$ in case she declines it. This implies that the entrepreneur will accept the commercial loan offer as long as

$$r_C F_C \leq \theta^H \ln(F_P + F_C) - \theta^H \ln(F_P) \qquad (1)$$

To finance the loan, the commercial lender can rely on bank equity at marginal cost mc_e, and bank debt at marginal cost mc_d. The loan is subject to a minimum equity regulation (endogenised below) requiring that a fraction $0 \leq e_C \leq 1$ of each loan is financed via bank equity. Assuming that $mc_e > mc_d$, this constraint will always bind, resulting in the effective cost mc_C per unit of commercial loan granted

$$mc_C = e_C mc_e + (1 - e_C) mc_d \ (2)$$

The profit to the bank is $(r_C - mc_C)F_C$ in case of a good outcome and $K\kappa_C - mc_C F_C$ in case of a recssion. The profit maximization problem of the commercial lender is thus

$$\max_{r_C, F_C} \pi_C^{Bank} = (1-\mu) r_C F_C + \mu\kappa_C (F_P + F_C) - mc_C F_C$$

subject to the acceptability constraint (1). This implies

$$F_C = \frac{(1-\mu)\theta^H}{mc_C - \mu\kappa_C} - F_P \qquad (3)$$

$$r_C = \frac{\theta^H \ln\left(\frac{(1-\mu)\theta^H}{mc_C - \mu\kappa_C}\right) - \theta^H \ln(F_P)}{\frac{(1-\mu)\theta^H}{mc_C - \mu\kappa_C} - F_P} \qquad (4)$$

The private loan. Before obtaining a commercial loan, the entrepreneur asks for a private loan. To finance the loan, the private lender can rely on equity at marginal cost mc_e, and debt at marginal cost mc_d. The private loan is subject to a minimum equity regulation requiring that a fraction $0 \leq e_P \leq 1$ of each private loan is financed via bank equity. Again assuming that $c_e > mc_d$, this constraint will always bind, resulting in effective costs mc_P of

$$mc_P = e_P mc_e + (1 - e_P) mc_d \ (5)$$

The private lender grants this loan assuming that unless the loan relationship sours, there will a subsequent commercial loan that is large so that both equity and the firm-specific collateral will be exhausted in case of bankruptcy. However, the private lender can obtain the private benefits (if there are any) only in case of private default. Of course, the very aim of the private loan is to avoid that the entrepreneur chooses the L-type project. If this is true, there are no private benefits and the profit to the private lender then equals $(r_P - mc_P)F_P$ in case the project goes well, and $-mc_P F_P + \chi\kappa_C F_P$ in case of a recession. The term $\chi\kappa_C F_P \approx 0$ corresponds to the expected gains if there is no corporate loan afterwards as the lender relationship has turned sour (which happens with probability $\chi \approx 0$). The expected profit generated by the private loan is thus:

$$\max_{r_P, F_P} \pi_P^{Bank} = (1 - \mu) r_P F_P - mc_P F_P$$

The entrepreneur needs to accept the private loan and she also needs to be incentivized to choose the H-type project. The entrepreneur accepts the private loan only if it makes her weakly better off than an outside option to do nothing and obtain a utility of 0 and in this decision, she also anticipates that with likelihood $1 - \chi$ she will receive a commercial loan F_C, the size of which depends on F_P. The entrepreneur correctly anticipates that should she receive a commercial loan, the size of this commercial loan will depend one-to-one on the private loan and also the conditions will be such that to her, the commercial and the private loans are perfect substitutes.

However, in the case that she does not get the commercial loan, obtaining the private loan is important. In this case, the entrepreneur is indifferent between obtaining a private loan or not if it offers a weakly better deal than her outside option to not start the firm and receive 0. If the firm is financed, the payoff in the bad state equals zero, while it equals $\theta^H \ln(F_P) - r_P F_P$ in the good state. Thus, the entrepreneur will accept the private loan as long as

$$(1-\mu)(\theta^H \ln(F_P) - r_P F_P) \geq 0 \qquad (6)$$

Note that with the private loan, the entrepreneur will always be incentivized to choose the H-type project as she has nothing to gain from creating private benefits in the case of bankruptcy.[26]

Assuming that parameters are such that the commercial loan is large enough to consume all equity in the case of bankruptcy (we verify this parameter restriction below), the payoff for the private loan is $F_P r_P - F_P mc_P$ in the good state (probability μ), $-F_P mc_P$ in the bad state if there is a subsequent commercial loan (probability $\mu(1-\chi)$), and $-F_P mc_P + \kappa_C(F_P)$ in the bad state is there is no subsequent commercial loan (probability $\mu\chi$). Maximizing the profit of the private lender taking into account that $\chi \approx 0$ and also taking into account the acceptability constraint (6) implies that

$$F_P = \frac{(1-\mu)\theta^H}{mc_P} \qquad (7)$$

$$r_P = \frac{mc_P}{1-\mu} \ln\left(\frac{(1-\mu)\theta^H}{mc_P}\right) \quad (8)$$

Having solved the model, we are able to deliver three testable predictions.

Proposition 1 (Matching the empirically observed patterns) Assume that parameters are such that there is both private and commercial loan granting ($mc_C - \mu\kappa_C \leq mc_P$), that parameters are generally well behaved ($0 < \mu < 1$; $mc_P, mc_C, \theta^H > 0$) and that collateral in the bad state is low so that bankruptcy can occur ($\kappa_C < mc_C - \mu\kappa_C$). Then, there exists an equilibrium in which:

[26] Note that by assumption $\theta^H \ln(F_P) - r_P F_P > (B^L + \theta^L)\ln(F_P) - r_P F_P$ holds.

i.) An increase in the equity requirements for private lending by banks e_P leads to an increase in the volume of the commercial loan F_C.

ii.) An increase in the equity requirements for private lending by banks e_P leads to an increase in the interest rate of the commercial loan r_C.

iii.) The response of the amount of the commercial credit F_C and its interest rate r_C to a given increase in the equity requirement for private lending by banks e_P is stronger, if a bank's ratio of private to commercial loan F_P/F_C is larger.

Proof: see section derivations.

Intuitively, predictions i) and ii) arise because a higher equity requirement for private lending by banks e_P increases the marginal cost of such loans, thus leading to a lower volume of the private loans. This raises the marginal benefits for increasing the commercial loans in the second investment, and thus leads to more commercial loan granting and a higher commercial loan interest rate.[27]

Prediction iii) arises because the impact on the commercial loan is stronger for banks with initially more private loan granting. The reason for this is that any given change in the marginal cost of the private loan mc_P creates a proportional response in the supply of private lending by banks F_P, which in absolute terms has stronger spillover effects if private lending makes up a large proportion of the bank`s total loan supply.

[27] It is noteworthy that the conditions for the existence of the described equilibrium are mild and only require that the commercial loan, once adjusted for the firm's collateral κ_C is cheaper than the private loan, and further, that collateral κ_C is low so that bankruptcy will occur in the bad state. If $\kappa_C = 0$, the described equilibrium will arise whenever $mc_C \leq mc_P$.

7.3 The social motive for a sectoral CCYB

We next examine the desirability of a sectoral differentiation of equity requirements in general, and specifically, whether such a policy should be pro-cyclical. In order to analyse this issue, we nest the above model of private and commercial loan granting in a simple endowment economy: there is an investment stage in which residents give debt and equity to a bank and in which banks successively grant commercial and private loans. After all investments have been made, aggregate productivity realizes and all payouts are made. If banks end up being undercapitalized, this has a welfare cost proportional to the capital shortfall.

The macroeconomic environment. The economy is endowed with a population of L residents, an aggregate stock of capital $L\Pi$ and a mass of 1 of entrepreneurs each endowed with a banking relationship. As outlined below, entrepreneurs require funding for their business, which, due to agency conflicts, requires a bank. There also exists an outside technology in which that part of the aggregate stock of capital Π that is not invested into firms can be invested, yielding a gross rate of return of $1 + r$.

Banks can obtain funds from residents in the form of equity or via drawing on debt. We assume that equity is more costly than debt as a resident investing into bank equity need to monitor the bank in order to prevent it from running away with the equity, which entails a cost of m expressed at a fraction of the invested equity. In contrast, the bank cannot run away with debt (but it can default on it in case of a low aggregate productivity).

Banks lend to entrepreneurs who engage in risky investments. If there is a recession, all of the firm's collateral goes to the bank, and the bank then pays out all of this plus all the equity it holds to its debt holders. If the bank's debt obligations exceed its equity and the collateral it can recover from firms, it has to go into default, causing a welfare cost γS ($\gamma > 0$) proportional to the capital shortfall S. γ either reflects the welfare cost of bankruptcy, or, if the government steps in and bails out banks the welfare cost of taxation. We make the assumption that

Assumption 1: $\gamma\mu > m$: The expected welfare cost of bankruptcy exceeds the extra cost of equity.

Assumption 1 implies that a regulator maximizing aggregate welfare has incentives to minimize capital shortfalls.

Consumption happens after all investments are made, productivity realizes, all payments are made and have paid off and after any bailout has realized. Aggregate welfare is linear in total consumption and equal to the firm's output, the return of capital that is invested in the storage technology, and the welfare cost of bankruptcy. Denoting the amount of bank equity by E^B (which requires $(1+m)E^B$ capital) and D the amount of bank debt, it is equal to:

$$W = (\Pi - (1+m)E^B - D^B)(1+r) + Y(\theta, K) - \gamma S \qquad (9)$$

the banking sector can grant credit of in total $E^B + D^D$. Given that the price of debt is $mc_d = (1+r)$, lower than that of equity $mc_e = (1+m)(1+r)$, banks subsequently choose to minimize equity such that is marginally fulfilled the equity requirements e_P and e_C: $E^B = e_P F_P + e_C F_C$.

The capital shortfall is equal to 0 if productivity is high. If there is a recession, the shortfall is equal to the outstanding level of debt including accrued interest $D(1+r)$, minus the capital $K\kappa_C$ that the bank can recover from the firm:

$$S^{bad} = \max[D^B(1+r) - K\kappa_C, 0]$$

In this economy, the regulator (the social planer) thus trades off the higher cost of equity due to the need to monitor on the one side, and the welfare costs of bank capital shortfalls with debt on the other side. The regulator's decision problem yields the key result of our theoretical analysis:

Proposition 2 (The optimal countercyclical sectoral capital buffer).

As long as $\frac{(1+r)}{1+(1-\mu)m^{-1}} < \kappa_C$,

i) it is socially optimal to differentiate sectoral capital requirements and set $e_P > e_C$.

ii) the optimal difference in equity requirements $e_P - e_C$ is increasing in the risk of crisis μ.

Proof: if debt is so high that banks go into bankruptcy in case of a recession, expected welfare is equal to

$$\frac{E(W)}{1+r} = \frac{(1-\mu)\theta^H}{1+r}\ln(K) + \frac{\mu\kappa_C}{1+r}(1+\gamma)K + \Pi(\gamma\mu - m)(e_P - e_C)F_P + (-(1+\gamma\mu) + (\gamma\mu - m)e_C)K$$

(10)

In this case, $(1+r)(1+\gamma\mu)$ is the average cost of debt (the interest rate and a premium γμ for the expected additional cost of bankruptcy). The change in welfare for substituting debt with equity is $(1+r)(\gamma\mu - m)$, trading off the higher cost of equity m with the lower expected cost of bankruptcy γμ.

On the other side, if the banking system is sufficiently well-capitalized so that even in a recession, there is no capital shortfall, welfare is strictly decreasing in m. It holds that:

$$\frac{E(W)}{1+r} = \frac{(1-\mu)\theta^H}{1+r}\ln(K) + \frac{\mu\kappa_C}{1+r}(1+\gamma)K + \Pi - m(e_P - e_C)F_P + (-1 - me_C)K \quad (11)$$

Note that in (10), $\frac{\partial K}{\partial e_P} = \frac{\partial F_P}{\partial e_C} = 0$ i.e. the level of capital does not depend on equity requirements for private loans and the level of the private loan does not depend on equity requirements for commercial loans. Further, it holds that $\frac{\partial(e_P - e_C)F_P}{\partial e_P} = F_P\frac{1+e_C m}{1+e_P m} > 0$, i.e. there is a corner solution in which the regulator sets e_P such that there is exactly no default. This, in turn, implies that the first-order condition with respect to e_C is trivial: given that e_P is set such to take care of default, the regulator sets $e_C^* = 0$ such as to not distort the market's choice of K. As long as $\frac{(1+r)}{1+(1-\mu)m^{-1}} < \kappa_C$, this yields an optimal e_P^* of:

$$e_P^* = \frac{(1+r) - \kappa_C}{(1+r)(1-m) + (m-\mu)\kappa_C}$$

It is straightforward to show that $\frac{\partial e_P^*}{\partial \mu} > 0$ and therefore that $\frac{\partial (e_P^* - e_C^*)}{\partial \mu} > 0$. Note that since $\frac{\partial e_P^*}{\partial \kappa_C} < 0$, an interior solution requires that $\kappa_C > \frac{(1+r)}{1+(1-\mu)m^{-1}}$. No-negativity of e_P^* is implied by $\kappa_C < 1$ and $r > 0$.

8. Conclusion

We examine the compositional effects of Switzerland's countercyclical capital buffer (CCyB), a specific targeted macroprudential policy. When it was activated on 13 February 2013, banks were required to hold an extra 1% of equity on loans secured against domestic residential properties from 30 September of the same year. The CCyB rate was later increased to 2% effective on 30 June 2014. The impact of this activation was substantial, although it varied considerably across Swiss banks, reflecting the substantial difference in their mortgage exposures, both in total amounts and (more importantly for our application) in relative terms, eg as a percentage of total assets.

Our empirical strategy naturally employs the CCyB's activation, its timing and its variation across banks in terms of the resulting capital requirements, to identify the potential impact on lending behavior in other credit categories. The confidential credit register data from the Swiss National Bank (SNB) let us account for credit demand through saturation with business-time-level fixed effects In this way, we identify if and how the CCyB's activation spilled over in altering the *supply* of bank credit to sectors other than those directly affected by the capital surcharge.

We find that the CCyB's activation and implementation led to both an increase in the amount and the cost of lending to corporations (a concurrency we interpret with a theoretical model featuring both private and firm-specific collateral), but especially to small firms and somewhat (for non-mortgage credit) to those active in commercial real estate. A targeted macroprudential policy to squeeze lending in one place leads to an expansion of lending in another adjacent place. Such expansion may not be unexpected or even suboptimal from the policymaker's perspective, but it seems to be an inevitable part of designing a targeted policy. Our estimates suggest that an expansion in lending in other areas than those targeted indeed took place in Switzerland.

Therefore, in the final section of our paper, we model the optimal sectoral capital requirements over the business cycle, by deriving a microfoundation that can rationalize the observed spillover patterns, and then by examining whether sectoral differentiation of capital requirements is generally desirable, and further, whether such differentiation should be countercyclical. On the latter account, the surprising finding in terms of optimal policy design is that such spillovers do not undermine the motive for sectorally differentiated equity requirements, but in contrast, actually provide a rational for such regulatory differentiation. Indeed, a regulator who differentiates bank equity requirements for private and commercial loans gains a new tool to increase the overall resilience of banks without distorting the efficient allocation of capital. In essence, higher equity requirements for private loans are desirable precisely because spillovers imply that lower granting of private loans is compensated by higher commercial loan granting.

While our empirical identification strategy allows us to estimate the compositional effects, many questions may remain. First, our empirical estimates do not allow us to indicate how large and how lasting these compositional effects are. This is, to some extent, the price we pay for the adopted identification strategy (which relies on within-business and within-time-period variation), but for policy purposes the size and timing of targeted macroprudential policies should be assessed by future, more applied, work. Second, our current data do not allow us to indicate where precisely this effect may originate: Are the loan officers or branch managers somehow incentivized to keep on lending, or do our findings derive from changes in the pattern of loan applications? Need the funds that are raised be lent out? Are banks forced to compete for market share in those adjacent lending areas? Our work has nothing to say about these questions and we leave therefore them for future research.

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Appendix

Deriving the parameter restrictions. We have above assumed that private and commercial loans are large enough so that both the firm and the entrepreneur have to declare bankruptcy in case the project goes bad. We note that all restrictions are satisfied if κ_C is sufficiently close to 0.

i) *No-negativity of loans*. We have implicitly assumed that all loan amounts are positive. Formally, this implies

$$\frac{(1-\mu)\theta^H}{mc_C-\mu\kappa_C} > \frac{(1-\mu)\theta^H}{mc_P} > 0.$$

i.e., $mc_C - \mu\kappa_C > mc_P$, which holds under e_C^* and e_P^*.

ii) Firm default in case of recession: $\kappa_C K - r_C F_C \leq 0$. Note that the solution of e_P^* is such that $\kappa_C K - (r_C F_C + r_P F_P) = 0$, which by non-negativity of F_P and r_P implies $\kappa_C K \leq r_C F_C$.

iii) Private default during recession is always satisfied by ii) (since in equilibrium, there are no private benefits).

Proof of Proposition 1

i) "an increase in the equity requirements for private lending by banks e_P leads to an increase in the amount of commercial credit granted F_C." We want to show that $\frac{\partial F_C}{\partial mc_P} = -\frac{\partial F_P}{\partial mc_P} > 0$, which follows directly from respective derivations of Equation (7).

ii) "an increase in the equity requirements for private lending by banks e_P leads to an increase in the interest rate of the commercial credit granted r_C." We want to show that $\frac{\partial r_C}{\partial mc_P} = \frac{\partial r_C}{\partial F_P}\frac{\partial F_P}{\partial mc_P} > 0$. Since $r_c = \frac{\theta^H \ln(K) - \theta^H \ln(F_P)}{K-F_P}$, $\frac{\partial r_C}{\partial F_P} = \frac{-\frac{\theta^H}{F_P}}{K-F_P} + \frac{\theta^H \ln(K) - \theta^H \ln(F_P)}{(K-F_P)^2}$ which has the same sign as $\ln\left(\frac{K}{F_P}\right) - \left(\frac{K}{F_P} - 1\right)$. It thus holds that $\frac{\partial r_C}{\partial F_P} < 0$ by concavity of the natural logarithm and since $\frac{K}{F_P} > 1$.

iii) "The elasticity of the amount of the commercial credit F_C and its interest rate r_C to a given increase in the equity requirement for private lending by banks e_P is higher, if the bank's ratio of private to commercial loan F_P/F_C is larger." Note that because the amount of commercial and private loans are substitutable one-to-one, it hold that

$$\sigma_{F_C,mc_P} \equiv \frac{\partial F_C}{\partial mc_P}\frac{mc_P}{F_C} = -\frac{\partial F_P}{\partial mc_P}\frac{mc_P}{F_C} = \frac{F_P}{F_C}$$

which is increasing in F_P/F_C as $K = F_P + F_C$ (as long as parameters are such that $F_C, F_P > 0$). By the proof of claim ii) of Proposition 1, the result that $\frac{\partial_{F_C,mc_P}}{\partial F_P/F_C} > 0$ implies that also the interest rate is more responsive to mc_P for banks with a higher F_P/F_C ratio.

Table A1

How restrictive is the Khwaja and Mian (2008) data requirement?

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Before CCyB				After CCyB			
	All observations		Included observations		All observations		Included observations	
	Number of observations	Mean	Number of observations	Mean	Number of observations	Mean	Number of observations	Mean
Initial interest rate (in percent)								
All loans	66,655	2.20	49,071	2.20	92,972	2.33	66,638	2.31
Fixed rate loans only	46,143	1.65	32,823	1.61	58,069	1.66	40,326	1.63
Variable loans with libor benchmark	6,420	1.07	5,595	1.07	9,190	1.07	7,732	1.06
For loans that are collateralized	53,780	1.93	40,619	1.89	74,599	2.05	55,408	2.01
Loan size (in 1,000 CHF)								
All loans	66,655	1,807.75	49,071	1807.32	92,972	1,692.52	66,638	1,705.83
Loans with lump sum payouts	55,823	1,978.04	40,630	1,996.23	74,221	1,931.54	53,034	1,957.83
Fixed-term loans	50,499	2,156.37	36,548	2,185.91	64,621	2,158.98	45,762	2,204.70
Maturity (in calendar days)								
All loans with fixed maturity	50,499	807.50	36,548	789.53	64,621	796.13	45,762	774
Fixed maturity loans with lump sum payback	43,285	687.20	31,167	666.53	55,387	687.16	39,031	663.79
Loans with commission (in percent)	9,744	0.98	7,707	0.98	16,346	0.94	12,067	1

Notes: This table reports the number of observations and the means, by loan category, on the initial interest rate, the loan size, the maturity and the loan type before and after the introduction of the CCyB in 2012.

Interaction regressions testing for heterogeneous effects across firms, industries and regions

Table A2

	Interaction with	(1) Small firms	(2) Small/Mid-sized firms	(3) Construction related	(4) Real estate hot spot	(5) High Rating (A- to AAA)
Panel A	**Dependent variable**	**Δln(Total Committment)**				
	Bank Relative Residential Risk Weighted Assets ($RRRWA$)	0.11***	0.08***	0.14***	0.12***	0.15***
		[0.02]	[0.03]	[0.02]	[0.02]	[0.02]
	Interaction: $RRRWA*$ (dummy=1 for small firms)	0.13***				
		[0.04]				
	Interaction: $RRRWA*$ (dummy=1 for small and midsized firms)		0.08**			
			[0.04]			
	Interaction: $RRRWA*$ (dummy=1 for construction-related firms)			0.03		
				[0.05]		
	Interaction: $RRRWA*$ (dummy=1 for firms in boom cantons)				0.05	
					[0.03]	
	Interaction: $RRRWA*$ (dummy=1 for highly rated firms)					-0.20**
						[0.08]
	Business Fixed Effects	Yes		Yes	Yes	Yes
	Observations	3,814	3,814	3,814	3,814	3,814
	R-squared	0.447	0.446	0.445	0.445	0.446
Panel B	**Dependent variable**	**Percentage point change in the average interest rate**				
	Bank Relative Residential Risk Weighted Assets ($RRRWA$)	0.17***	0.11	0.20***	0.23***	0.19***
		[0.05]	[0.07]	[0.05]	[0.06]	[0.04]
	Interaction: $RRRWA*$ (dummy=1 for small firms)	0.06				
		[0.14]				
	Interaction: $RRRWA*$ (dummy=1 for small and midsized firms)		0.11			
			[0.09]			
	Interaction: $RRRWA*$ (dummy=1 for construction-related firms)			-0.11		
				[0.11]		
	Interaction: $RRRWA*$ (dummy=1 for firms in boom cantons)				-0.11	
					[0.09]	
	Interaction: $RRRWA*$ (dummy=1 for highly rated firms)					-0.62
						[0.56]
	Business Fixed Effects	Yes	Yes	Yes	Yes	Yes
	Observations	4,121	4,121	4,121	4,121	4,121
	R-squared	0.474	0.474	0.474	0.474	0.474

Notes: This table examines, using interaction regressions, whether the relation between the growth of newly granted loans (Panel A) or the change in the average asked interest rate (Panel B) and the bank's Relative Residential Risk Weighted Assets ($RRRWA$) is heterogeneous across firms. In all specifications, the dependent variable is either the percentage change in the volume of newly granted loans or the percentage change in the average interest rate from 2012:07:01-2013:02:12 and 2013:02:13-2013:11:30. All specifications absorb business fixed effects thus limiting the variation in the data to businesses with multiple bank relations present. Businesses are defined to belong to an industry (79 categories), canton (26), size class (5), risk class (5), and balance sheet size class (5). "Yes" indicates that the set of characteristics or fixed effects is included. In (1), the interaction of $RRRWA$ and a dummy equal to one if firm has fewer than 50 employees is included as dependent variable. In (2), the interaction of $RRRWA$ and a dummy equal to one if the firm is active in a construction-related sector (sectors 41, 42, 43, and 71 in the NOGA 2008 classification system) is included. In (3), the interaction of $RRRWA$ and a dummy equal to one if the firm is located in the cantons Basel City, Basel Land, Geneva, Lucerne, Vaud, Wallis, Schwyz, Zug and Zurich is included. In (4), the interaction of $RRRWA$ and a dummy equal to one if the firm has a high credit rating in late 2011 is included. The latter is defined as either a Standard and Poor's rating of A- and higher, or a Moody's rating of A3 of higher. In (1) to (4), the dummies are subsumed in the fixed effects. Standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1.

Table A3

Heterogeneous effects on maturity across firms, industries and regions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Subsample	Small firms	Large firms	Construction related firms	Architects and planning	Not construction related	Real estate hot spot	No real estate hot spot	High rating (A- to AAA)	Lower rating
Dependent variable					**Δln(New Loan Issuance)**				
Bank Relative Residential Risk Weighted Assets (*RRRWA*)	0.17*	0.08*	0.08	0.34*	0.09**	0.09	0.09**	-0.41	0.10**
	[0.10]	[0.04]	[0.09]	[0.17]	[0.04]	[0.06]	[0.05]	[0.332]	[0.041]
Business Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	366	2,747	497	127	2,616	1,225	1,888	150	2,963
R-squared	0.557	0.566	0.529	0.571	0.572	0.549	0.577	0.724	0.558

Notes: This table examines whether the relation between the change in the average maturity of newly granted loans and the bank Relative Residential Risk Weighted Assets (*RRRWA*) is heterogeneous across firms. In all specifications, the dependent variable is the percentage point change in the average maturity of newly granted loans from 2012:07:01-2013:02:12 and 2013:02:13-2013:11:30. All specifications absorb business fixed effects thus limiting the variation in the data to businesses with multiple bank relations present. Businesses are defined to belong to an industry (79 categories), canton (26), size class (5), risk class (5), and balance sheet size class (5). "Yes" indicates that the set of characteristics or fixed effects is included. In (1), the sample includes only firms with less than 10 employees and in (2), the remainder of the firms are included. In (3), only firms active in construction sectors are included (sectors 41, 42, 43, and 71 in the NOGA 2008 classification system). In (4), only firms that are either architects or planning bureaus are included, while (5) includes the firms included in neither the sample of (3) nor (4). (6) includes firms located in the cantons Basel City, Basel Land, Geneva, Lucerne, Vaud, Wallis, Schwyz, Zug and Zurich. (7) includes the remaining cantons. (8) includes those firm with a high credit rating in late 2011, defined as either a Standard and Poor's rating of A- and higher, or a Moody's rating of A3 of higher. (9) includes the remaining firms (also those without a rating). Standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1.