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How Banks Respond to Negative Interest Rates: Evidence from the Swiss Exemption Threshold

Abstract

We analyze the effect of negative monetary policy rates on banks, using detailed supervisory information from Switzerland. For identification, we compare changes in the behavior of banks that had different fractions of their central bank reserves exempt from negative rates. More affected banks reduce costly reserves and bond financing while maintaining non-negative deposit rates and larger deposit ratios. Higher fee and interest income successfully compensates for squeezed liability margins, but credit and interest rate risk increase. Portfolio rebalancing implies relatively more lending, also compared to an earlier rate cut within positive territory, and risk-taking reduces regulatory capital cushions and liquidity.

JEL-Codes: E430, E440, E520, E580, G200, G210.

Keywords: monetary policy transmission, negative interest rates, bank profitability, risk-taking, bank lending, Basel III.

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1. Introduction

Negative nominal interest rates have long been considered impossible.[1] As a consequence, research has focused on understanding monetary policy transmission at or above the zero lower bound (ZLB), while paying less attention to the dynamics when rates go negative. Since 2014, however, central banks in Denmark, the Euro Area, Japan, Sweden, and Switzerland have moved their policy rates into negative territory. As a result, it has become necessary and empirically possible to investigate monetary transmission and its impact on financial stability *below* the ZLB. We contribute to this investigation by studying detailed and comprehensive supervisory data from Switzerland.

In January 2015, the Swiss National Bank (SNB) lowered its deposit facility rate from zero to -75 basis points (bps), and chose to apply this rate only to the fraction of each bank's central bank reserves that exceeded twenty times its minimum reserve requirement (MRR).[2] Reserves in December 2014, less the bank-specific but unpredicted exemptions, therefore provide a direct measure of negative rate exposure that we can exploit for identification. Specifically, we gauge the causal effects on bank-level outcomes by comparing the behavior of banks with different initial exposure over time.

Our results reflect banks' reluctance to charge negative deposit rates, and reveal implied costs that are not typically observed during the transmission of positive rates: first, with incomplete pass-through to the deposit rate, negative reserve and interbank rates led to negative liability margins. Second, banks that wanted to reduce their reserves but did not want to substitute them entirely with other assets, had to shorten their balance sheets. Since deposit volumes were difficult to adjust under the self-imposed ZLB, banks reduced mostly non-deposit liabilities, and in particular (covered) bonds. This led to stronger increases in deposit and unweighted capital ratios among banks that were more heavily exposed to negative rates, despite relatively cheaper bond and interbank funding, and–in turn–raised their average funding costs. At the same time, because more exposed banks reduced their long-term bond financing *and* short-

[1] Paul Krugman, for instance, wrote in 2013 that "*the zero lower bound isn't a theory, it's a fact*" (https://krugman.blogs.nytimes.com/2013/10/15/five-on-the-floor/; accessed: September 14, 2017).

[2] With aggregate reserves equal to 24 times the sum of banks' MRR, this was presumably done to affect marginal but not total reserve costs.

term reserves more than less exposed banks, their maturity mismatch and therefore their interest rate risk also increased in comparison.

Despite non-negative deposit rates, our results also show that costs are nonetheless transmitted to customers. Banks that were more affected by negative rates increased their lending-related and overall fee income more in response to the SNB's negative interest rate policy (NIRP) than less affected banks. This effect was even stronger for banks operating in more concentrated markets, in which case they also managed to reduce their borrowing costs more. Banks, in other words, avoided negative deposit rates–presumably to not loose depositors as future customers and to protect their reputation–but achieved some pass-through if they had market power and indirectly via fees.[3]

Beyond the compensation through fees, we identify additional adjustments on the asset side of the balance sheet. More exposed banks more strongly reduced their safe reserves, implying a stronger rebalancing of their portfolios towards mortgages, uncollateralized loans and financial assets. The effect on mortgages is of particular interest in Switzerland, where the implementation of negative policy rates was accompanied by *increasing* mortgage rates (Bech & Malkhozov, 2016).[4] We find that these mortgage rate increases were more pronounced the more a bank was exposed to the SNB's NIRP, implying that we can causally attribute at least some of the aggregate changes to the negative reserve rate. The question then arises through which channels the negative rate on SNB reserves led more exposed banks to increase their mortgage rates. Our results suggest as key driver the stronger increase in more exposed banks' marginal cost of mortgages, which follow from the substitution of bond with deposit and equity financing, as well as from constrained downward flexibility of the deposit rate, and which put pressure on lending rates. We also test three prominent reasons, for why this upward pressure may have been amplified for more exposed banks: first, we test whether banks increased their mark-ups in response to squeezed liability margins; second, we investigate whether higher lending rates reflect higher risk premiums and hence reduced lending standards; and third, we

[3] Depositors provide a valuable source of stable funding during normal times, and–as mortgage borrowers and investors–often generate additional income for banks. They are therefore important for the banks in our sample and practitioners we spoke with feared they would be hard to win back once ties were cut.

[4] Similarly, Eggertson et al. (2017) report evidence of increasing mortgage margins in response to negative policy rates in Sweden.

analyze whether higher costs of using interest rate swaps under negative LIBOR rates drove up mortgage rates further. We do not find strong support for either of these factors.

With a self-imposed ZLB on deposit rates, and the consequences for banks' funding structure, the implications for risk-taking incentives under negative interest rates, are *ex-ante* ambiguous. As the balance sheet shares of common equity increase more for more affected banks, lower leverage might reduce risk-shifting. At the same time, as more affected shift some funding from uninsured interbank and bond funding to insured deposit funding, they may have been monitored less. *De facto,* we find a stronger increase in more affected banks' average risk-weights (i.e. credit risk), as well as a stronger increase in these banks' maturity mismatch (i.e. interest rate risk).

For comparison, we also investigate banks' reaction to an earlier rate cut in positive territory. We find a weaker response of loan and financial asset shares, a comparable effect on deposit ratios, and no effect on fees. This supports our conclusion that transmission works differently below the ZLB, with the difference resulting primarily from the self-imposed non-negativity of deposit rates.

Throughout, our analysis relies on detailed supervisory information about the universe of banks chartered in Switzerland. We use a Difference-in-Difference (DiD) methodology, with central bank reserves, net of exemptions, as the continuous treatment variable. Identification stems from the timing and design of the SNB's NIRP, aided–in our benchmark analysis–by a focus on domestically owned retail banks. The Swiss NIRP was first communicated on December 18, 2014 and then revised, before it was implemented on January 22, 2015. While banks may still have anticipated some form of NIRP and even a vague role for central bank reserves, it is highly unlikely that the exact exemptions were anticipated. It might have been possible to foresee that certain types of banks would be systematically more affected than others, but the same does not hold within business models, where moderate fluctuations in reserves are a common feature of day-to-day operations. Our data contain two groups of banks that are sufficiently large to study within-group differences: Wealth management (WM) banks and retail banks.[5] The former, however, hold non-negligible fractions of their assets and liabilities in foreign currency (FX). This is potentially problematic for our purposes, because the SNB removed its exchange rate peg vis-à-vis the Euro at the same time at which it began to charge a negative reserve rate. As a consequence, it is difficult to disentangle the effect of the exchange rate and the negative rate on WM banks' behavior. For our main analysis, we therefore restrict attention to domestically owned retail banks with almost no FX exposure.[6] These banks might experience exchange rate driven demand effects, but for them to affect our identification, they would need to vary systematically with banks' negative rate exposure. The same consideration applies to demand more generally, for which our setup assumes no correlation with banks' exposed reserves. As long as this holds, our DiD setup captures the effect of negative rate exposure on bank-level outcomes. The focus on retail banks in our benchmark analysis also improves external validity. Swiss WM banks are, to an important degree, a product of their legal and supervisory environment, while retail banks are more comparable to their counterparts in other developed economies.

Our results are robust to alternative treatment definitions and to controlling for time-invariant bank characteristics, as well as period-specific effects. Our ability to observe key outcome variables at monthly frequency further enables us to analyze the timing and evolution of each effect after the treatment, and to support the assumption of parallel pre-treatment trends in our dependent variables.

To the best of our knowledge, we are the first to comprehensively study the effect of negative nominal rates on retail banks. These banks are particularly relevant for households as mortgage borrowers and depositors. In addition, the Swiss policy design and our supervisory data allow us to offer a detailed anatomy of the effect on balance sheets, income, and risk-taking. Notably, it does not require us to assume a ZLB on deposits, but allows us, instead, to provide evidence of its existence.

[5] Notice that this excludes in particular the two large universal banks, of which there are too few for a meaningful statistical analysis, and cooperative banks, which face a common exemption and reallocate resources among cooperative members.
[6] For additional insight, we also report results on Wealth Management (WM) in Table 10, and discuss them in Section 5.1.

The remainder of this paper is structured as follows: Section 2 outlines how we contribute to the existing literature. Section 3 introduces the Swiss context, our data, and our identification strategy. Section 4 presents our baseline results on banks' reallocation of SNB reserves and the role of the ZLB for deposits. This includes implications for income, bank-level interest rates, and portfolio rebalancing, as well as the comparison with an earlier interest rate cut in positive territory. Section 5 provides complementary results on WM banks, an exploration of the role of capital buffers, and the effects of the NIRP on banks' foreign currency exposure. It also studies the interaction of the NIRP with liquidity regulation under Basel III and the role of banks' deposit rates prior to the NIRP. Section 6 concludes.

2. Relationship with the existing Literature

Although the related literature–both empirical and theoretical–is in many cases still preliminary, some papers nonetheless provide a valuable reference: Nucera et al. (2017) identify differential responses to negative rates across Euro Area banks with different business models, and in comparison to rate cuts in positive territory. They observe that large banks with more diversified income become less systemically risky under negative rates, while riskiness increases for smaller banks.[7] This is consistent with our findings for Switzerland, according to which the (relatively small) banks in our sample become riskier, but use fees to increase profitability. Differences across business models in the reaction of Euro Area banks also feature in Demiralp et al. (2017), who use reserves, but without an unpredicted exemption, for identification. Similar to our effect on bond funding, their paper finds that (some) banks reduce wholesale funding in response to negative rates. Heider et al. (2017) also study Euro Area banks, but focus on lead arrangers of syndicated loans. Exploiting cross-sectional heterogeneity in deposit funding, they simultaneously identify a contraction in total lending and an expansion of credit to riskier borrowers. Different from us, they observe no effect on fees or loan rates. This suggests that risk-taking in their sample is likely to be the result of reduced net worth and a shift, under limited liability, towards riskier borrowers. In our sample, instead, both (book)

[7] The analysis is extended in Lucas et al. (forthc.).

equity *and* risk-taking (in the form of credit and interest rate risk) increase more for more exposed banks.[8]

In addition to studying domestically owned retail banks, our work also differs from these papers in its focus on a non-Euro country, the coverage of our data, and the Swiss policy design. Our negative deposit facility rate is almost twice that in the Euro Area, our original sample includes all banks chartered in Switzerland, and we observe all assets and liabilities at monthly frequency.

Explicit theoretical work on the transmission of negative rates is rare: Brunnermeier & Koby (2017) study low but not explicitly negative rate environments and show how rate cuts turn contractionary for capital-constrained banks. We find evidence consistent with their predictions for mortgages, but not for uncollateralized loans. Eggertson et al. (2017) assume a lower bound on deposit rates and banks that are entirely deposit-funded, as well as a negative correlation between bank profits and intermediation costs. They predict adverse effects on profits and credit supply, while banks in our sample manage to compensate for squeezed margins by increasing their interest and fee income.

Beyond this on-going work on negative rates, we also contribute–more generally–to the literature on monetary policy transmission, and the bank lending and risk-taking channels. Existing papers typically find expansionary responses to lower rates, and often-negative correlations between interest rates and risk-taking (e.g. Maddaloni & Peydro, 2011; Altunbas et al., 2014; Dell'Ariccia et al., 2016). The effect on lending is weaker if banks are less well capitalized or liquidity constrained (Jimenez et al., 2012) and risk-taking is reflected in reduced collateral requirements (Jimenez et al., 2014). In addition, it seems to be the case that increasing credit risk is not always reflected in higher spreads and that holding liquid assets amplifies risk-taking incentives (Ioannidou et al., 2014).[9] Evidence that banks might respond differently with respect to mortgages, is provided by Landier et al. (2015), who show that monetary policy *tightening* induced the offering of riskier loans.

[8] See Eisenschmidt & Smets (2017) for a review of the literature on negative policy rates.
[9] The relevance of liquidity for monetary policy transmission is also present in Kashyap & Stein (2000), who attribute it primarily to small banks. A stronger effect for smaller and undercapitalized banks, instead, features in Kishan & Opiela (2000).

At first glance, our results are broadly consistent with this literature: a rate cut below zero induces stronger increases in loan shares and *ex-ante* portfolio risk among more exposed banks. Upon closer inspection, however, the transmission channel changes below the ZLB. Commentary (Cecchetti & Schoenholtz, 2016; Danthine, 2016) suggests that negative interest rates are special because banks' ability to adjust the cost of deposits is constrained by the return on cash. *Ceteris paribus*, negative interest rates on central bank reserves are therefore predicted to squeeze banks' net interest income. Following the reasoning of Dell'Ariccia & Marquez (2013) and Dell'Ariccia et al. (2014), a lower bound on short-term borrowing rates would then imply that the risk-taking channel is dominated by incentives for risk-shifting and the search for yield. Monetary transmission mechanisms, in other words, do not change fundamentally below zero, but they are subject to an important additional constraint: the ZLB on deposits. On the one hand, this constraint suppresses the positive effects on net worth that one would expect in positive rate environments and–in turn–amplifies risk-shifting incentives (Heider et al., 2017). On the other hand, it leads to relatively higher shares of (relatively more costly and insured) deposit funding, which impairs monitoring and generates incentives to search for yield (this paper).[10]

3. Background, Data, and Identification

3.1. The Swiss context

Prior to January 2015, monetary policy in Switzerland was conducted via open market operations. The SNB defined upper and lower bounds for the target interbank rate and injected or extracted liquidity from the market to navigate the 3-month CHF LIBOR within these bounds. By contrast, no interest was paid on central bank reserves. On December 12, 2008, the lower target bound was reduced to zero, while the upper bound was subsequently lowered from 1% to 0.75% on March 12, 2009, and to 0.25% on August 03, 2011. For comparison, the last time the lower bound was set to zero, from March 06, 2003 to September 15, 2004, the upper bound was kept between 0.75% and 1%. Unable to narrow the target range further, the SNB

[10] See Lian et al. (2017) for experimental evidence on individuals' "reach for yield" in low interest rate environments.

then moved the lower bound to -0.75% on December 18, 2014, and announced a return of -0.25% on banks' sight deposit account balances for January 22, 2015. In a subsequent communication on January 15, 2015, the rate announcement was lowered further to -0.75% and the target bounds for the LIBOR rate were moved to -1.25% and -0.25% respectively. Presumably to ensure interbank transmission while limiting the strain on the system at large, the SNB applied negative rates only to *marginal* Swiss Francs, and exempted most *infra-marginal* reserves. With system-wide liquidity worth about 24 times the sum of banks´ MRR, it exempted, more specifically, all central bank reserves below "*20 times the minimum reserve requirement for the reporting period 20 October 2014 to 19 November 2014 (static component), minus any increase/plus any decrease in the amount of cash held (dynamic component)*".[11] Importantly, for our purposes, the exemption was thus designed to manage aggregate liquidity and was not targeted towards specific banks. This policy design implied that banks could not anticipate the degree to which they were exposed to negative rates, and constitutes the core of our identification.

What further distinguishes the implementation of negative interest rates in Switzerland is that it seemed motivated by concerns to restore the interest rate differential with the Euro. That is, it was likely designed to prevent excessive CHF appreciation, rather than to stimulate domestic demand. Since 2011, the SNB had continuously acquired assets in foreign currency to moderate pressure on the Swiss Franc, and to defend an exchange rate of 1.2 CHF vis-à-vis the Euro. Despite having communicated a renewed commitment to this exchange rate on December 18, the SNB unpegged the Franc on January 15.[12] As a consequence, the move into negative rate territory was accompanied by an appreciation of the Swiss currency from 1.20 CHF/EUR in December 2014 to 1.04 CHF/EUR in April 2015 (Figure A1; Online Appendix).[13] For an economy reliant on exports, this sudden appreciation constituted an adverse shock and exports fell, although only temporarily, between 2014 Q4 and 2015 Q1. Aided by a depreciation of the Swiss Franc to the Dollar and tax-financed subsidies for temporarily reduced working hours,

[11] http://www.snb.ch/en/mmr/reference/pre_20141218/source/pre_20141218.en.pdf

[12] Some commentators have attributed this decision to concerns that a further expansion of the SNB's holdings of foreign-currency assets could at some point cause significant losses and thereby erode its equity and credibility. Others, instead, have posited that even negative equity need not be an issue for a central bank.

[13] The rate returned to 1.17 CHF/EUR by December 2017.

however, they quickly recovered and GDP growth remained largely unaffected. Effects on aggregate demand in Switzerland are further mitigated by generous unemployment benefits, which are paid for up to two years and cover 70-80% of previous earnings.

In short, the fact that monetary policy was largely exogenous to domestic credit/mortgage growth in Switzerland supports our identification, while the simultaneous unpegging of the CHF-EUR exchange rate constitute a potential concern. This concern, however, is alleviated by (a) the observation that GDP growth–as a proxy for credit demand–dropped in 2015Q1 but recovered already by the end of the same year; (b) our focus on domestically-owned retail banks; and–most importantly–(c) the quasi-random individual exposure to negative rates, under the Swiss policy regime.[14,15]

Figure 1 illustrates the evolution of the Swiss monetary policy target between July 2013 and June 2016, and the corresponding interest rates for overnight (SARON), 3- and 12-month interbank (LIBOR) loans, as well as federal government bonds with one-year maturity. All short-term rates drop to a level around -0.75% as of January 2015. The 3-month LIBOR rate and the overnight lending rate stay close to the target, while the return on one-year government bonds is more volatile and initially below target. Consistent with a standard yield curve, the return on 12-month interbank loans is on average slightly higher than the target rate. The main take-away, for our purposes, is the immediate transmission of the negative reserve rate to comparable short-term assets. The return on longer-term assets, instead, exhibits a weaker response. Government bonds, covered bonds, cantonal bonds, and bank bonds with 8-year maturity continue an almost uninterrupted downward trend that approaches -0.75% only around June 2016. A notable exception is the return on non-financial corporation (NFC) bonds with the same 8-year maturity, which does not drop further after January 2015 and subsequently approaches 1% from below. In view of the effect on banks' balance sheets, these trends suggest that relatively safe financial assets with longer maturities became relatively more attractive. In

[14] Real GDP growth (quarterly and seasonally adjusted) dropped from 0.5% in 2014Q3 to -0.39% in 2015Q1, but recovered in subsequent quarters to respectively 0.18% (Q2), 0.29% (Q3), and 0.55% (Q4) (Source: www.snb.ch).

[15] It also plays in our favor that the SNB's decision to charge negative interest on banks' reserves had no precedent in Swiss monetary policy and was implemented with relatively short notice between December 2014 and January 2015. Even if banks had anticipated negative policy rates, however, this would bias our results towards zero, implying that our estimates would constitute a lower bound on the full effect.

addition, however, Figure 1 also suggests an imperfect, albeit existing, pass-through to banks' long-term borrowing costs, with the return on bank bonds remaining positive until June 2016.

In contrast, we see no transmission of negative rates to sight and demand deposit rates. Banks apparently maintained a ZLB on these liabilities, for fear of losing customers who also provide non-deposit related business.[16] This strategy meant that the liability margin between deposit and interbank rate, which is traditionally positive, turned negative. To illustrate this, Figure 2 plots the evolution of banks' margins on sight and demand deposits. The average sight deposit rate approaches 0.01% after the policy change, while the demand deposit rate drops from 0.15% in December 2014 to 0.06% in June 2016. At the same time, banks could only earn a return close to the target policy rate of -0.75% on assets with similar maturities (SARON, 3-month LIBOR). From December 2014 to February 2015, liability margins thus drop from -0.03% [-0.17%] to -0.75% [-0.99%] for sight [demand] deposits.

Furthermore, we also observe the aforementioned response on the asset side of banks' balance sheets. Figure 3 depicts the margin between the average adjustable rate mortgage (rate resetting every 3 months based based on the 3-months CHF LIBOR; 3 year contract period) and the 3-month CHF LIBOR rate itself. While the LIBOR rate dropped to -0.75% after January 2015, banks kept the return on adjustable rate mortgages largely unchanged and even increased it for fixed rate mortgages. This implied an increase in the corresponding asset margin from 1.18% in December 2014 to 2.03% in February 2015. Similarly, the average margin on 10-year fixed-rate mortgages jumped from 1.22% in December 2014 to 1.74% in February 2015. At the same time, we also observe that swap prices adjusted quickly to the new conditions, which most likely explains why we do not find banks with swap usage to have raised their mortgage rates more than those that do not use interest rate swaps.[17] Since mortgages comprise more than 70% of assets for the average bank in our sample, higher mortgage margins compensate significantly for squeezed liability margins. Simultaneously increasing mortgage shares, as well as

[16] Some banks have reportedly discussed negative deposit rates with selected (high net worth or corporate) customers for deposits above very high thresholds. These cases do not show up in our data on regular customers however.
[17] Figure A2 in our online Appendix plots the evolution of 5, 10, and 15 year swap rates at daily frequency. Consistent with Figure 3 it shows a rapid drop in swap rates across maturities during December 2014/January 2015.

reductions in regulatory capital cushions and liquidity coverage, however, imply that the economy-wide welfare implications remain unclear.

In anticipation of our econometric analysis below, several aspects of the Swiss case matter. First, the quick succession of events and the lack of a precedent implied that banks could not foresee their exposure to negative reserve rates. Second, exemptions did not target individual banks. Third, pass-through to the interbank market remained intact. Fourth, banks maintained non-negative deposit rates.

3.2. Data

Our work uses a panel data set based on monthly balance sheet information that the Swiss Financial Market Supervisory Authority (FINMA) and the SNB jointly collect for supervisory purposes. For our baseline regressions, our sample period starts 18 months before the introduction of negative rates in Switzerland (July 2013) and ends 18 months thereafter (June 2016). This allows us to study symmetric pre- and post-treatment periods and to contrast our results with those for a similar period around an earlier rate cut in August 2011.

Data are available for all "*[b]anks whose balance sheet total and fiduciary business combined exceed CHF 150 million and whose balance sheet total amounts to at least CHF 100 million*".[18] Of the 237 banks that originally satisfy these criteria, we retain 68 banks that satisfy FINMA's definition of *retail banks*, which is used for internal peer group analysis.[19] This definition demands that banks generate at least 55% of their income from balance-sheet effective activities on average during the three years preceding June 2013.[20] The relevant income components include net interest income and fees on loans, as opposed to advisory fees and trading income. The criterion primarily eliminates WM banks, which derive most income from advisory fees. This has three important advantages: First, it helps us to address the simultaneity of the negative interest rate and exchange rate shocks. While WM banks' costs in CHF

[18] http://snb.ch/en/emi/MONAX

[19] Notice that this definition is different from the SNB's definition of *retail banks*, which takes into account banks' ownership structure. We believe that a classification based on business models is preferable for our purposes, also because it provides us with a larger sample size. We worked with the SNB's definition in an earlier version of this paper and found our results to be qualitatively robust.

[20] June 2013 is the last month before the start of our pre-treatment period. Income shares, however, are stable so that the group composition would remain unchanged if we chose a different selection date.

remained unaffected by the exchange rate, their fee income–which foreign clients typically pay in their home currencies–decreased. We would thus expect a drop in fee income for WM banks, and we would expect it to be more pronounced when the fraction of foreign clients is larger. For retail banks, instead, foreign currency assets and liabilities constitute a negligible fraction of the balance sheet (the pooled sample averages are 2.73% and 4.38%). Second, the focus on retail banks also alleviates concerns about the predictability of the exemption threshold and the plausibility of the parallel trend assumption. Since WM banks hold fewer short-term liabilities, they face systematically lower MRR and higher exposed reserves. Because it is harder to argue in this case that exposure to negative rates was unpredictable, including WM banks could challenge our identifying assumption. Third, we also believe that focusing on retail banks improves the external validity of our analysis. WM banks are a product of their institutional environment and may offer more limited insights beyond Switzerland. Retail banks, with deposit and mortgage ratios of around 70%, instead, have counterparts in many countries.[21] Besides WM banks, the income-based definition of retail banks also eliminates the universal banks, UBS and Credit Suisse, as well as other more trading-focused banks. Cooperative banks do not enter our sample either, as they hold reserves at a shared clearing bank.

We also drop from our sample banks that are foreign-owned. Of all retail banks they have the largest currency mismatch, and may thus exploit links with their foreign owners when they adjust their balance sheets, who–in turn–might adjust their behavior to the simultaneously changing exchange rate. Finally, we drop from our sample all banks that are not present throughout the 36 months of our baseline period and the 36 months of our reference period (February 2010 to January 2013). As a result, we are left with 50 banks and a perfectly balanced panel of (50*36 =) 1,800 bank-month observations. Regulatory risk measures are available at quarterly frequency, so that our risk analysis, from 2013Q1 to 2016Q2, is based on 600 bank-quarter observations. Our profitability analysis, instead, relies on semi-annual data and 300 bank-time observations (2013H2 to 2016H2).

[21] Despite these caveats, we also provide supplementary analyses of the effects on WM banks, and thereby a more comprehensive picture of the entire Swiss banking sector.

Table 1 provides pooled summary statistics. Table A1 (Online Appendix) provides statistics for the pre- and post-treatment periods, separately for banks experiencing treatment intensity below (Panel A) and at or above (Panel B) the sample median. Summary statistics are provided for different balance sheet items, as well as for income and risk-taking measures. The average bank in our sample invests 72.78% of total assets in mortgages, 8.49% in uncollateralized loans, and 4.70% in financial assets. Liquid assets amount to 8.34% and are dominated by central bank reserves (7.77% of total assets). On the liability side, deposit funding constitutes the largest fraction (67.59%), followed by bond funding (13.04%). The sample banks hold few assets in foreign currency (2.73%) and raise 95.62% of their funding in CHF. They exceed their risk-weighted capital requirement by 8.21% of risk-weighted assets on average and hold a weakly negative net position on the interbank market (-0.86% of total assets). The share of their required equity attributed to credit risk amounts to 94%, and is significantly higher than the shares attributed to market (1%) or operational risk (6%).[22] In short, we focus on simple retail banks that deal primarily with local households and small firms. They are well capitalized and their main exposure stems from traditional banking services, such as credit provision and–to a lesser extent–maturity transformation.

Next, we consider the change in *average* sample characteristics from the period before January 2015 to the period of and after that month (Table A1). We observe that the average bank held a larger share of liquid assets in the period after January 2015 and fewer claims on other banks. Banks also generated less net interest and fee income, invested in safer portfolios and more strongly exceeded their regulatory capital requirement. Because of the simultaneous exchange rate shock and because banks were differentially affected by the SNB's policy, however, these changes cannot be attributed directly to negative interest rates. To isolate the *marginal* effect of negative interest rates on banks, we need to compare banks with *different degrees of exposure*. Table A1, for banks with treatment intensity below (Panel A) and at or above (Panel B) the median, provides first insights.[23] We observe an increase in average SNB reserves in both groups, but the change is significantly stronger in Panel A (from 4.06% to 9.14%,

[22] We use those values that FINMA and SNB collect and report for regulatory purposes. Notice that required equity is calculated before deductions, so that individual fractions (or the sum of different fractions) can exceed 100%.
[23] We do not report summary statistics for groups above and below the exemption threshold to maintain equal group size. As can be seen in Figure 4, the group of banks with positive levels of exposed reserves is smaller, implying that subsample statistics would be less reliable.

compared to a change from 8.30% to 9.59%). At the same time, the net position on the interbank market changes from -0.35% to -2.75 for banks below the median, and from 0.16% to -0.51% for those above. For banks below the median, this reflects an arbitrage opportunity. Their unused exemption allows these banks to deposit more interest-exempt reserves at the central bank while charging a negative rate on loans from other banks. When exposed reserves are above the median, instead, the group consists of banks with both positive *and* negative levels of exposed reserves. It is therefore plausible that Panel B exhibits a qualitatively identical, but weaker change in ratios. Consistently, we also observe that below-median banks reduce the share of mortgages on their balance sheet from 74.81% to 72.89%, while above-median banks do not reduce it significantly. Uncollateralized loans, instead, are cut from 10.28% to 8.95% for below-median banks, while they change from 7.65% to 7.09% for those above the median.

While these observations are suggestive, they are not entirely conclusive; e.g. because the group with reserves above the sample median in December 2014 mixes banks with positive and negative levels of exposed reserves. Next, we therefore proceed with a more in-depth regression analysis.

3.3. Identification

To identify the effect of marginally higher negative rate exposure on banks' investment and funding choices and the corresponding implications for income and risk-taking, we rely on a Difference-in-Difference design. Our treatment period is characterized by a dummy variable ($Post_t$) that is equal to one from January 2015 and zero before.[24] Treatment intensity, instead, is defined as the level of SNB reserves in December 2014, minus the bank-specific exemption and relative to total assets (TA). For each bank *i*, we refer to this variable as *Exposed Reserves* (ER_i):

[24] As previously discussed we use quarterly data when we analyse the effect on risk-taking and semi-annual data when we study bank income. Treatment period dummies in these cases are equal to one for all quarters (semesters) following and including 2015Q1 (2015H1), and zero before. When we compare our results to an earlier reference period, with a rate cut in positive interest rate territory, our treatment dummy is equal to one for all months following and including August 2011.

$$ER_i = \frac{\text{SNB Reserves}_{i,12/2014} - \text{SNB Exemption}_{i,2014}}{\text{Total Assets}_{i,12/2014}}$$

We use a continuous treatment variable because banks were affected by negative rates to many different degrees (rather than in a binary fashion). An unreported robustness check with a binary treatment indicator, however, for which we compare banks with treatment intensity above and below the sample median, generates consistent results.

Denoting a generic dependent variable in period t as $Y_{i,t}$, our benchmark model is:

$$Y_{i,t} = \alpha + \beta \cdot ER_i + \gamma \cdot Post_t + \delta \cdot \left(ER_i \times Post_t\right) + \varepsilon_{i,t}. \quad (1)$$

The coefficient of interest, δ, captures the difference in the pre-post change of the dependent variable, between banks with different levels of exposed reserves, or more intuitively: the *effect* of a stronger negative rate exposure on $Y_{i,t}$. It is worth mentioning that our definition of the treatment variable assumes the same relationship between $Y_{i,t}$ and ER_i for positive and negative levels of ER_i. This is because a marginal unit of ER_i has the same (opportunity) cost for banks with $ER_i < 0$ as it has for banks with $ER_i > 0$. While the latter pay more negative interest to the SNB if ER_i is larger, additional reserves reduce the *unused exemption* for the former. This exemption, however, could be used to borrow at an interbank rate of approximately -75bps while depositing at the SNB for free.

Building on Model (1), we consider several extensions: First, for our main regression, we saturate the model with bank and time fixed effects (FE) to control for time-invariant, bank-specific heterogeneity and for period-specific factors:

$$Y_{i,t} = \hat{\alpha} + \hat{\delta} \cdot \left(ER_i \times Post_t\right) + FE_i + FE_t + u_{i,t}. \quad (2)$$

Next, to capture not only the *average* treatment effect for the post-treatment period, we also estimate month-by-month effects. To this end, we interact our treatment variable with dummy variables for 35 of the 36 sample months, using July 2013 as the reference date:

$$Y_{i,t} = \alpha' + \sum_{s=08/2013}^{06/2016} \delta'_s \cdot \left(ER_i \times FE_s\right) + FE_i + FE_t + \varepsilon_{i,t}. \quad (3)$$

The coefficients of interest (δ'_s) provide evidence of the difference in the inter-temporal change in $Y_{i,t}$ between our initial sample date and each subsequent month. Over the 17 pre-treatment months this constitutes an implicit placebo test, which should return insignificant interaction effects under the parallel trends assumption. Over the 18 post-treatment months, instead, Model (3) provides additional insights into the evolution of the negative rate effect over time. We estimate our models using ordinary least squares and cluster our standard errors at the bank level (Bertrand et al., 2004).

A central identifying assumption of our setup is that–absent negative rates–time trends in the dependent variables would be parallel for banks with different levels of exposed reserves. To support this assumption, we plot the distribution of exposed reserves as of December 2014 in Figure 4. The fact that it is reasonably smooth and symmetric around the average level of ER_i (-5.76%), suggests that neither banks nor the SNB targeted specific cut-off levels.[25] In addition, the availability of monthly data for all balance sheet items allows us to estimate and plot, in Figures 5-7, the monthly DiD coefficients from Model (3) for the 35 months following July 2013, and thereby to demonstrate the absence of significant effects prior to treatment. The evidence supports the parallel trends assumption required for the validity of our DiD design and also suggests that we do not need to condition on additional control variables. We can thus study the effects on a wide range of dependent variables and abstract from concerns related to the estimation of dynamic panels.

Another challenge to our identification arises from the removal of the exchange rate peg that occurred simultaneously with the implementation of negative interest rates in Switzerland. The unpegging came as a surprise to financial markets and led to heavy losses among currency traders betting on a depreciation of the CHF. Their losses transmitted to direct brokers, both foreign and domestic, who had financed the traders' bets with Lombard Loans.[26] This could be

[25] The sample median is -6.3% of total assets.
[26] See, for example, "Swiss central bank moves to negative deposit rate" (*Financial Times*; 18.12.2014) and "Swiss franc storm claims scalp of top FOREX broker " (*Financial Times*; 20.01.2015), where the latter is referring to a UK entity.

problematic if the losses were systematically related to exposed reserves, e.g. because direct brokers have lower deposit ratios. In response to this challenge, we do not include direct brokers in our sample and focus entirely on domestically owned retail banks. We further isolate our analysis from exchange rate exposure by excluding internationally active WM and universal banks. For retail banks themselves, the exchange rate shock could have mattered insofar as the more export-oriented of their corporate clients may have suffered from reductions in competitiveness. With hindsight, these clients have coped well, aided by tax-financed schemes to support shorter working hours and by the international price setting power of many Swiss exporters.[27] For this channel to affect our conclusions, it would, in any case, be necessary that differences in the demand from corporates are correlated with banks' exposed reserves.

A third identification challenge arises if the treatment of one bank in our sample affects the behavior of other–differently treated–banks. Since our sample covers about 27% of the Swiss mortgage market, and does not include any of the banks with significant market share, we are confident that individual treatment does not affect market conditions for other banks in the same market.

For additional robustness, we re-run Models (1) and (2) using alternative treatment definitions. First, we consider the difference between total liquid assets required of each bank in 2015 and the Swiss exemption threshold, scaled by total assets (*LCR Dist$_i$*):

$$\text{LCR Dist}_i = \frac{\text{Total Liquid Assets Required}_{i,2015} - \text{SNB Exemption}_{i,2014}}{\text{Total Assets}_{i,12/2014}}$$

Total Liquid Assets Required refers to the regulatory requirement under the liquidity coverage ratio (LCR) of Basel III. It amounted to 60% of predicted *Total Net Outflows* in 2015, and was designed to increase by 10 percentage points annually thereafter, until the conclusion of the Basel III phase-in in 2019, when liquid assets will be required to cover at least 100% of net outflows. *Total Net Outflows* are bank-specific and based on a 30-day liquidity stress scenario.

[27] To avoid bankruptcies or heavy losses of employers, as well as lay-offs in the face of temporarily lower demand for a firm's products, *short-term work* schemes had employees work only e.g. 50% of regular hours but receive 80% of their full wage, where the difference was paid by the government. For the government this was cheaper than the unemployment benefits due if the person were laid off entirely. See for example https://www.ch.ch/en/short-time-work/.

Higher predicted net outflows result in higher liquidity requirements and, since banks cover most of these with SNB reserves, provide us with a second proxy for negative rate exposure. Our results are robust to using *LCR* $Dist_i$.

We also replicate our analysis using the sum of ER_i and banks' net interbank exposure in December 2014, relative to the exemption and scaled by total assets, as treatment variable. Since central bank reserves and interbank loans are close substitutes and the 3-month LIBOR rate is, in fact, the SNB's target interest rate, the sum of both values provides an alternative–although potentially more confounded–measure of bank's total exposure to monetary policy.[28] We find all results to be qualitatively robust. An added benefit of this treatment is that it facilitates the comparison with a rate cut in positive territory. Absent any interest on reserves at the time, and hence of any exemption, we use the sum of *Excess Reserves* (reserves exceeding the MRR) and net interbank exposure in July 2011 as treatment variable for this reference period.

4. Results

Next, we proceed to discuss our main results. We begin by documenting the direct and indirect costs of negative rates, where the latter are owed primarily to the ZLB on deposits. Section 4.1 shows how banks reallocate SNB reserves, which are directly treated with negative rates, to the interbank market. Subsequently, Section 4.2 identifies a stronger reduction in long-term bond financing for relatively more exposed banks, but–due to their reluctance to levy negative rates on depositors–not in short-term deposits. This implies a stronger maturity mismatch, since long-term liabilities are reduced along with short-term reserves, and a stronger increase in average funding costs. Section 4.3 then analyzes the effect on income. We find evidence of direct and indirect costs, but–maybe surprisingly–no negative effect on the net profitability of more exposed (retail) banks. This is due to the growth in fee and net interest income. Section 4.4 further explores the effect on loan shares and thereby risk-taking. Section 4.5 compares our

[28] Figure 4 also provides the distribution of $ER_i + NIB_i$ in December 2014 across banks.

results to the effect of an earlier rate cut within positive territory. In Section 5, we discuss extensions and robustness checks.

4.1. The Reallocation of SNB Reserves

We first document the reallocation of SNB reserves through the interbank market. Under the Swiss NIRP, banks with $ER_i > 0$ were charged negative interest, while those with $ER_i < 0$ could still deposit reserves at the SNB for free. Because changes in banks' cash position were also charged negative interest, reallocation of liquidity via the interbank market was an expected outcome and presumably intended to ensure transmission of the negative rate to the interbank market.

Table 2 provides the corresponding results. It shows that for banks with one standard deviation larger ER_i in December 2014, the balance sheet share of SNB reserves is reduced by (0.55*4.3% =) 2.37 percentage points (pp) more on average over the subsequent 18 months. Over the same period, the share of TA invested in net interbank loans for such banks is increased by an additional 1.12pp. When we consider year-on-year growth rates of our dependent variables, we also find more strongly reduced growth of liquid assets and more accelerated growth of interbank lending among relatively more exposed banks.[29]

Beyond the average effect for the post-treatment period, Figure 5 plots coefficients and confidence intervals for the interaction terms (ER_i*month dummy*) in Model 3. For all 17 months preceding the policy change, the change relative to the levels of July 2013 does not depend on ER_i, which supports our parallel trends assumption. By contrast, a significantly negative (positive) coefficient after the policy change means that banks with relatively higher ER_i reduced their SNB reserves (increased their net interbank exposure) more, as a share of total assets. We observe that the differences occur already during the initial months after the introduction of negative deposit facility rates, but persist afterwards.

[29] Our model has limited explanatory power for year-on-year growth rates, as these are generally noisier than balance sheet shares. To indicate whether the nominator or denominator of the balance sheet shares drive our findings, we report them nonetheless, but allocate less weight to them in our interpretations than to the effects on scaled balance sheet positions.

Since Swiss retail banks tend to have high deposit ratios and low levels of reserves, most banks in our benchmark sample held SNB reserves below their exemptions in December 2014 (Figure 4). They could therefore increase their net borrowing on the interbank market at up to -75bps and freely deposit the additional liquidity at the SNB until their own exemption was exhausted. Just as a negative deposit facility rate would constitute a negative income shock for banks with positive ER_i, it can thus be thought of as a positive income shock for most banks in our sample. To be able to identify the *marginal* effect of negative interest exposure, however, it is only required that the impact of more exposed reserves is independent of the sign of ER_i. This is confirmed by qualitatively similar results for WM banks with–on average–positive exposed reserves (Section 5.1).

That we expect to observe effects beyond the reallocation of liquidity from exposed to exempt SNB accounts has two reasons: First, the sum of all exemptions was–by design–not large enough to absorb all excess liquidity. Second, the overnight and 3-month interbank rates adjusted quickly to the negative rate and even the 12-month interbank rate turned and remained negative (Figure 1). Since changes in cash holdings were also charged negative interest under the SNB's NIRP, banks were thus forced to respond in one of two ways: by allocating the remaining excess liquidity somewhere more profitable and more risky, or by incurring negative rates while finding ways to compensate for the higher costs. Next, we therefore investigate the effect of negative rate exposure on other balance sheet items.

4.2. Balance Sheet Shortening, Funding Choices and the Zero Lower Bound

Table 3 studies banks' response to negative rate exposure on the liability side of the balance sheet. To start with, Columns (1) and (7) show for regressions first without and then with bank and month fixed effects that banks with higher initial ER_i did not reallocate all money withdrawn from the SNB into other assets, but also shrank their balance sheets faster. If exposed reserves were one standard deviation higher in December 2014, banks reduced the growth rate of total assets (TA) by 1.03pp more over the 18 post-treatment months. For our results on different balance sheet items, for which we typically consider ratios relative to total assets, it follows that we estimate negative effects conservatively. At the same time, negative asset growth potentially inflates positive coefficients.

With this in mind, Table 3 then illustrates how banks' reluctance to charge negative deposit rates causes them to reduce their size not only by the reduction in net interbank funding (Table 2), but also by deleveraging via non-deposit liabilities, such as longer-term bonds. Specifically, banks with one sd lower ER_i reduced the growth rate of bond funding by an additional 2.24pp, on average over the period until July 2016; as a share of total assets, they cut bond funding by an additional 0.60pp. Notably, this deleveraging via bonds–and not deposits–occurs although pass-through to the bond market remained largely intact, so that bond financing was in fact a cheaper source of funding.[30]

In contrast, we find the pre- to post-treatment changes in banks' cash bond, deposit and common equity shares to be more positive the more exposed banks are to negative rates. Since we find no statistically significant evidence that more affected banks adjusted the growth rates of these liabilities differently than less affected banks, the impact on balance sheet shares appears to be driven primarily by the reduction in bond financing and thus in total assets. Reducing in particular the deposit intake accordingly, by charging a negative deposit rate, appears to have been prohibitively unattractive; even if a larger deposit share implied higher average funding costs and, as we will show below, increases in maturity mismatch and resulting interest rate risk. Conversations with practitioners suggest that this is due to depositors being particularly sensitive to negative interest and–at the same time–perceived as potential mortgage borrowers, investors, and as providers of stable funding who might be difficult to win back once lost.[31]

Figure 6 plots coefficients from Model 3 and illustrates that the response of the deposit ratio to negative rate exposure is immediate, mirroring the quick response of interbank funding (Figure

[30] For most banks in our sample, bond funding consists mainly of covered bonds, which are formally guaranteed by the bank (and implicitly secured by its borrowers and their collateral) and which are issued by "Pfandbriefzentrale" for cantonal banks and by "Pfandbriefbank" for other banks,. From 2015 onward, these bonds paid nominal rates down to 0 for maturities of 5 years and were typically issued at prices larger than 100%, implying an effectively negative annual return (see, for example, the Annual Reports for 2015 and 2016 at www.pfandbriefbank.ch). Figure 1 also illustrates the evolution of interest rates on covered and bank bonds with longer, 8-year maturity, and shows even these longer maturity bonds crossing into negative territory in late 2015 and 2016.

[31] That banks use excess liquidity to retire their liabilities resembles a result in Demiralp et al. (2017), according to which investment banks cut back wholesale funding under negative rates.

5). The share of bond financing, instead, reacts more sluggishly. We return to the analysis of banks' funding choices in Section 4.3, when we consider bank-level evidence on income and interest rates. Yet, we can already conclude that negative rate exposure induces banks to more strongly reduce funding by publicly traded, long-term bonds.

4.3. Interest and Fee Income, and an Explanation for higher Mortgage Rates

Interest Income. In Table 4, we study semi-annual income statements and find overall interest payments to drop less for more exposed banks: ER_i that are one sd larger in December 2014 cause the year-on-year growth of interest paid to drop 2.92pp less in response to negative policy rates. Similarly, interest expenses in % of TA drop 0.09pp less in response to an additional sd of exposed reserves. Beyond the negative rates on exposed SNB reserves and in the interbank market, this can be explained by the reorganization of banks' liability structure, i.e. the lower share of bond funding and the implied increase in the fraction of–relatively more expensive–deposit funding.

Likely in response to these higher funding costs, we also find that interest earned was cut less for more exposed banks, both in terms of year-on-year growth and relative to total assets. Since the growth rate of *net* interest income (NII) does not change significantly more or less for more exposed banks, while profitability (NII/TA) actually increases more, the additional income apparently suffices to compensate for higher average funding costs.

Next, we turn to analyzing *how* more affected banks managed to have their interest income decrease by less than the more weakly affected banks. As reported, for example in Bech and Malkhozov (2016), Swiss banks on average increased their mortgage rates after the introduction of the NIRP. To understand the drivers of this development better, we investigate whether interest rates increased differently for banks that are differentially exposed to negative rates, i.e. whether we can establish a causal link between the SNB's NIRP and the increase in mortgage rates. More specifically, we analyze bank-level *reference rates*, which are drawn from reports submitted to the SNB and reflect offered rates. For liabilities these rates typically coincide with actual rates.[32] For loans and mortgages, instead, the reported rates represent averages, and *de facto* rates may vary with borrowers' risk characteristics. Indeed, we find that interest rates for fixed rate mortgages have been raised relatively more by more exposed banks.

So far, we have established that relatively higher interest income plays an important role in banks' compensation of the relatively larger interest expenses implied by negative policy rates. We have also established that at least part of this compensation can be attributed to more exposed banks reducing their mortgage rates less than more weakly affected banks (as opposed to a stronger expansion in loan volumes). Next, we explore the factors that contributed to these higher mortgage rates in more detail. The key driver seems to be the relatively higher cost of funding mortgages. Although the interbank and swap rates that are usually used to compute mortgage margins dropped by almost the same margin as the reserve rate, banks' average funding costs dropped significantly less, as banks did not dare to cut deposit rates into the negative. This effect is further reinforced for more affected banks as they (a) also increased the share of deposit funding more than less affected banks, and (b) cut their sight deposit, time deposit and cash bond rates less (Table 5). We attribute the last effect to the fact that more affected banks tend to be banks with a historically lower dependence on deposit funding, and thus with lower minimum reserve requirements, lower NIRP exemptions, and higher ER_i. Hence these banks started out with deposit rates already closer to zero, implying that they had less leeway to lower them before hitting the ZLB.[33]

Offering an additional rationale for higher funding costs, and thus for incentives to raise mortgage rates, some banks have suggested an increase in the costs of hedging interest rate risk through swaps.[34] In such deals, a bank would typically agree to pay its counter-party the fixed long-term rate, which it receives from its mortgage borrowers, in return for a short-term rate, typically the CHF LIBOR. Once interbank rates go negative however, so would the received

[32] Only a few very large customers may sometimes get individual deals.
[33] Figures 5-7, and analogous Figures for further outcomes available on demand, show that this intuitive correlation of ER_i with initial deposit funding and initial deposit rates did not disturb the parallel trends assumption in our baseline sample of only domestically owned retail banks. Through bank fixed effects, we further control for differences in initial conditions in all of our regressions. While this supports our claim that we are capturing the causal impact of negative rate exposure, the concern remains that the channel through which this treatment manifests, consists of both the direct cost on reserves and interbank exposure and the differences in initial deposit rates. Robustness checks in Table A8 (Online Appendix) therefore display a "horse race" between treatment intensities measured by ER_i and by initial deposit rates. While both channels seem to be relevant, the results confirm that ER_i appears to matter more.
[34] https://www.nzz.ch/finanzen/das-raetsel-der-gestiegenen-hypothekarsaetze-1.18481102; accessed: January 26, 2018

short-term rate, implying that the bank would end up paying on both legs of the swap deal. To test if this mechanism indeed contributes to higher mortgage rates, we exploit supervisory data that inform us, in a binary fashion, which bank used interest rate swaps in December 2014.[35] Our results in Table 6 do not find that interest rate swap use leads to smaller drops in banks' mortgage rates. If anything we observe that banks using interest rate swaps respond to negative reserve rates with *larger* mortgage rate drops. A possible explanation is that the differential funding adjustments reported above have increased the importance of interest rate risk, which we also analyze below, an issue banks already using interest rate swaps could better deal with than those not using any interest rate swaps.

A second potential contributor to higher mortgage rates could be the use of market power, which might allow banks to respond to a given increase in funding costs with a more significant expansion of their interest income. In Table A3 (Online Appendix) we therefore test whether banks with more market power indeed manage to generate additional interest income. To this end, we use that many banks are only active in some of the 26 Swiss cantons, so that we can treat each canton as a separate mortgage market.[36] For each market, we then compute the Herfindahl-Hirschmann Index (HHI) and assign to each bank a weighted average, with weights equal to the bank's allocation of mortgages across cantons.[37] We find some evidence that banks operating in more concentrated markets, i.e. with higher average HHI, decrease their NII less in response to the Swiss NIRP. We observe this on average, but also, in particular, for banks that are relatively more exposed. The effect, however, disappears when we add bank and time fixed effects. Focusing on this more complete specification, we observe that operating in more concentrated markets mitigates the effects of negative rate exposure: more affected banks cut interest paid and earned less than less affected banks, but more if their weighted HHI is higher. Similarly, market power also appears to help more exposed banks to increase their net fee income more. Rather than allowing banks to raise interest rates more, it therefore appears that banks with more market power manage to cut their funding costs more and raise more fee income, and–consequently–need not raise their interest income as much. To us, this suggests

[35] Results are robust to measuring who used interest rate swaps in September 2014 rather than in December 2014.
[36] Treating cantons as separate mortgage markets is common practice among practitioners in Switzerland.
[37] See Table A3 (Online Appendix) for more detail.

that higher funding costs are indeed an important determinant of the increase in mortgage rates: the better banks are able to mitigate the impact on funding costs, the less do they need to raise their lending rates.

A third possible explanation for higher mortgage rates is that more affected banks chose to incur more credit risk in their mortgage lending and hence charged higher risk premiums. While our section on risk-taking below finds evidence of increases in bank risk-taking in multiple dimensions, we find no clear evidence specifically of more credit risk in mortgage lending. This is, in part because only higher loan-to-value ratios, but not higher payment-to-income ratios or other risk indicators, are reflected in regulatory risk-weights under the standardized approach in Switzerland. In addition, we also only observe the average risk-weight across all asset categories, but not the risk-weights specifically for banks' mortgage portfolio.

Finally, it has also been suggested that longer-term rates were driven up by increasing demand from consumers who tried to lock in low mortgage rates.[38] While this may explain why banks raised mortgage rates relatively more for longer maturities, it cannot account for *relatively* larger increases among more exposed banks, and across all maturities.

Fee Income. The second important observation in Table 4 is that relatively more affected banks manage to increase their fee income more. ER_i that are one sd larger lead to a growth rate of net fee income that is 2.80pp higher, and to a pre- to post-treatment change in the ratio of net fee income over total business volume that is 0.73pp larger. Fees are not only levied on depositors but also accrue from lending-related services. As with our results on interest expenditure, Table A4 (Online Appendix) suggests that it is easier for banks operating in more concentrated markets to pass on their costs to depositors: net fee income increases more for these banks, while there is no differential effect on loan-related fees.

Overall, our results suggest that retail banks have been able to compensate for the cost of relatively higher exposed reserves through higher interest and fee income. This is different

[38] https://ftalphaville.ft.com/2016/03/07/2155458/the-swiss-banking-response-to-nirp-increase-interest-rates/; accessed: November 05, 2017

from the response of the lead arrangers in Heider et al. (2017) that seem to adjust neither lending rates nor fees.

4.4. Lending and Risk-Taking

Ex-ante, our results on the restructuring of banks' liabilities yield ambiguous predictions about banks' risk-taking incentives: on the one hand, a stronger increase in the balance sheet share of equity funding suggests a more strongly reduced risk appetite for more exposed banks (e.g. due to reduced incentives for risk-shifting). On the other hand, a stronger increase in the balance sheet share of *insured* deposit funding, implies steeper growth in average funding costs, as well as more strongly reduced monitoring. To identify the net effect on risk-taking, we focus on the asset side of banks' balance sheets in Table 7, and investigate the effects of negative rate exposure on credit and interest rate risk in Table 8.

We find that for banks whose ER_i were one sd larger in December 2014, the balance sheet shares of uncollateralized loans increased by an extra 0.60pp, the share of mortgages increased by additional 0.69pp, and the share of financial assets increased by an extra 0.26pp. From also studying the effects on year-on-year growth rates, we conclude that this portfolio rebalancing is largely the result of banks reducing the share of safe and liquid assets, i.e. of those assets on which they are charged negative rates. Since central bank deposits are risk free and receive a regulatory risk weight of zero, we show in Table 8 that these changes lead to an increase in the ratio of risk-weighted over total assets. The corresponding coefficients for the year-on-year growth of risk-weighted assets are positive as well, but not significant at conventional levels. As a result, our bank-level data are inconclusive as to whether risk-weighted assets indeed increase more for more exposed banks, or if this is only true in proportion to banks' total assets. This makes it difficult to know, whether banks expand lending to riskier borrowers (as in Heider et al., 2017), or whether the changes in balance sheet shares are driven by reductions in safe/liquid assets (Table 2). More specifically, Panel B states that a higher ER_i in December 2014 (by one sd) would lead to an increase in the ratio of risk-weighted over total assets that is 1.51pp higher over the post-treatment period. Since this increase in average risk-weights must ultimately be the main driver behind the erosion of regulatory capital buffers (i.e. the difference between CET1/RWA and the supervisory intervention threshold) in Table 3, we can infer that risk-weights grow relatively more for more affected banks, which would suggest that–at least part of–the increase in the risk-weight density is due to riskier loans. Independent of being fully able to disentangle the two channels, however, our results show that more exposed banks did not cut risky lending in proportion with their safe asset holdings, so that they allowed average portfolio risk to increase more strongly than less exposed banks.

Next, we observe that shares of required capital attributed to market and operational risk increase more for more exposed banks. While operational risk is negligible for the banks in our sample, the effect on capital requirements due to market risk reflects primarily the increase in the relative importance of financial assets and uncollateralized loans. It does not reflect the increase in interest rate risk since higher interest rate risk did not lead to higher Pillar I capital requirements in Switzerland throughout our sample period.

At the same time, however, Table 8 also shows a stronger increase in interest rate risk for more affected banks. This increase reflects that more affected banks have partly replaced highly liquid SNB reserves with longer-maturity mortgages, whereas on the liability side they have partly replaced funding through longer-maturity covered bonds with funding through shorter-maturity deposits. Columns (6) to (9) document the effect on changes in bank value, relative to equity, which FINMA predicts in response to increasing market rates. The different measures are calculated using detailed information on the maturity of banks' assets and liabilities. For those balance sheet items with unspecified maturities (e.g. deposits), however, assumptions need to be made: in columns (6) and (7) banks' own assumptions on effective maturity are used for positions in CHF and foreign currency respectively; column (8) uses the average assumption across all banks in a given quarter, and column (9) uses a time- and bank-invariant assumption of two years.

The only measure of interest rate risk for which we identify a stronger decrease among more exposed banks concerns the interest rate risk in foreign currency. This follows from banks substituting some of their CHF liquidity with liquidity in other currencies, which incurs less or no negative rates. As a result, the average maturity of their FX assets and hence the maturity mismatch decreases within the foreign currency part of their balance sheet. All other measures, however, confirm that interest rate risk increases more for more exposed banks.

4.5. Positive Interest Rate Environment

To compare the transmission of monetary policy under positive and negative rates, we analyze banks' response to a rate cut within positive territory in August 2011. Since there was no interest on reserves and no exemption at the time, we use the sum of reserves and net interbank lending in July 2011 as alternative treatment variable. To facilitate the comparison across rate cuts, we then adjust our treatment variable for the negative rate period by adding net interbank exposure in December 2014 to ER_i. While this makes identification more difficult because exposure to interbank rates is more easily predictable, this setup helps us to shed light on the peculiarities of negative rate transmission.

Unlike in our benchmark analysis, the results in Table 9 show no differential effect on asset growth in the positive rate regime. They even suggest that more exposed banks may have *increased* their liquid asset holdings, including their central bank reserves, more. This could be because no interest was paid on reserves at the time, so that they became relatively more attractive due to substitutes becoming more expensive. Loan, mortgage and financial asset shares were not differentially affected either, while the deposit ratio increased relatively more for more affected banks. The effect on changes in the bond ratio, instead, is negative, but notably not significant. Portfolio risk increased more for more exposed banks, although without a differential effect on the regulatory cushion, while net fee income seemed to have increased less. The results indicate that the nature of monetary policy transmission changes below the ZLB and confirm that these differences are likely driven by motives to reallocate costly liquidity and to compensate for squeezed interest margins, as well as by the constraint imposed by non-negative deposit rates.

5. Extensions and Robustness

5.1. Wealth Management (WM) Banks

The results in Section 4.3 and work by Nucera et al. (2017), Lucas et al. (forthc.) and Demiralp et al. (2017) suggest that the transmission of negative policy rates is not homogeneous across banks' business models. To characterize transmission in Switzerland further, we therefore study WM banks, which FINMA defines as banks earning at least 55% of their income through fees.

We excluded WM banks from our baseline results described above because of their systematically higher exposure to both the negative reserve rate and the exchange rate. The average WM bank has 52% of liabilities and 42% of assets denominated in foreign currencies, and likely exhibits a comparable–but to us unobservable–currency mismatch between income and costs.[39] This threatens the parallel trends assumption and suggests a potential confounding of the negative rate effect by exchange rate movements. As an additional argument for focusing on retail banks, we also believe that results for this group are more relevant than those for WM banks for many other countries.

The high levels of ER_i among WM banks have two reasons: first, high shares of funding with maturities longer than three months, which do not contribute to the MRR and thus the negative rate exemption.[40] Second, large central bank deposits that WM banks hold as part of their conservative investment strategy. WM banks also differ from retail banks in that they typically have no active mortgage business. They lend to wealth management clients or employees, but rarely in the open market. This eliminates returns from (risky) mortgage lending as compensation under the negative rate regime. Although these factors make causal identification more difficult, we nonetheless provide a descriptive comparison of the inter-temporal changes for WM banks.

[39] The corresponding values for retail banks are 4.38% and 2.73%.
[40] Money in fiduciary accounts does not enter the balance sheet.

In Table 10 we present results based on Model 2. The setup is identical to our benchmark, but uses information on 46 WM banks.[41] Consistent with our main findings, relatively more exposed WM banks withdraw more SNB reserves and reallocate the liquidity towards a stronger increase in the balance sheet share of uncollateralized loans. The coefficient on the share of financial assets is positive but not significant, while it is effectively zero for mortgages, which are usually not part of WM banks' business model. Although the coefficient is not statistically significant at conventional levels, it appears that more exposed WM banks–like retail banks–raise their fee income more. Unlike retail banks, however, they also seem to be able to reduce their deposit ratio more. This is plausible if one considers the closer relationship between WM banks and their customers, and the larger set of securities and off-balance sheet vehicles, i.e. of alternative investment opportunities, that they can offer. We also find evidence that more affected WM banks increase portfolio risk more from the pre- to the post-treatment period, and that they increase their interest rate risk exposure more–specifically with respect to foreign currency items (column 10/ Panel B). Both effects, however, are economically negligible.

Notably, our results confirm the patterns of retail banks' response to negative rates (e.g., the allocation of reserves towards larger loan shares and riskier portfolios). This gives us confidence that our key insights do not hinge on the negative ER_i's in our retail bank sample.

To explore the differences vis-à-vis retail banks further, we also directly compare the two bank types. Underlying Table A4 (Online Appendix) is the combined sample, and a setup where the more exposed WM banks form the treatment, and retail banks the control group. The results reveal that the average WM bank reduced (increased) the balance sheet share of SNB reserves (loans) more than the average retail bank. Consistent with our previous explanation, it also reduced its deposit ratio and increased its portfolio risk more. Reflecting the stronger international outlook, WM banks substituted more CHF assets and liabilities with foreign currency equivalents, which may contribute to the SNB's presumed intention of moderating

[41] Summary statistics are provided in Table A2 (Online Appendix).

further CHF appreciation with its NIRP. Gross profits and NII developed more negatively, albeit insignificantly, suggesting that WM banks bore an overall larger burden.

5.2. The role of banks' capital buffers

In Section 4.4 we showed that the negative rate motivated more exposed banks to increase their mortgage and loan shares more than less exposed banks. This suggests that the *reversal rate* (Brunnermeier & Koby, 2017), defined as the rate below which rate cuts become contractionary, was either not crossed by the average bank in our sample, or that forces outside the underlying theory were at play. This theory argues that a rate cut may reduce banks' profitability and equity, and thereby impair the ability to lend due to binding capital requirements. It is also conceivable, however, that weakly capitalized banks, even if they are not at their regulatory constraint, are under more pressure to generate additional income, i.e. to compensate via higher interest or fee income.

To study the role of capital, we interact our DiD coefficient with banks' *capital cushion* (= CET1 in % of risk-weighted assets, minus the supervisory intervention threshold), prior to treatment. We find throughout that the interaction term has the opposite sign as our DiD effect, implying that a larger capital cushion *mitigates* the benchmark effects (Table A5). The interaction coefficients in our version with bank and month fixed effects are not statistically significant for mortgages, but are significant at the 10% level for loans and financial assets. For the former, they suggest that banks with smaller capital cushions increase loan shares more. Although we focus on balance sheet shares, i.e. on lending as a percentage of total assets, because the growth rate of lending per se is too noisy, our results point towards a motive for the expansion of bank lending (e.g. the search for yield), rather than towards banks hitting their capital constraints and having to restrict lending. The reason may plausibly be that throughout our sample banks start out with relatively comfortable capital cushions.

Finally, Brunnermeier & Koby also argue that banks starting out with larger reserve shares (as opposed to risky loans) should have higher reversal rates. For such banks, the rate cut should thus be less expansionary. The paper mentions savings and investment banks, but the same reasoning implies a larger expansionary response of lending for retail banks compared to WM banks. Yet, our results in Table A4, for what they are worth, imply the opposite.

5.3. Foreign Currency Exposure

To supplement our study of banks' balance sheets, we also explore the effect of negative rate exposure on banks' foreign currency assets and liabilities. In Table A6, the most robust and economically most significant effect is a relative expansion of foreign currency liquid assets. Higher exposed reserves (by one sd) imply an expansion of FX liquid assets that is 2.15pp larger. With domestic currency liquid assets becoming more expensive, banks invest more heavily in FX cash and central bank reserves. Our interpretation that this effect is primarily a response to the interest rate and not the exchange rate is supported by the relatively weaker effect on total FX assets. Instead, we find no significant effect on the shares of total FX deposits and liabilities. Overall, we interpret the evidence as supportive of our assumption that retail banks are largely isolated from exposure to the SNB's surprise unpegging of the exchange rate. Their main response reflects a substitution from domestic to FX liquid assets.

5.4. Liquidity Regulation

Next we proceed to analyze the interaction between monetary policy and Basel III liquidity regulation. On the one hand, this serves as a robustness check to our main results (in the form of an alternative treatment). On the other hand, it provides insights into the conflicts between financial stability objectives and monetary policy. SNB deposits, and similarly liquid assets with fast pass-through of the negative rate, account for the majority of liquid assets currently held by banks under the Liquidity Coverage Ratio (LCR) regulation of Basel III.[42] This means the regulatory requirement to hold sufficient liquidity also increased banks' exposure to the SNB's NIRP.

[42] Under this regulation, banks must simulate a 30-day liquidity stress scenario to predict expected outflows, and then fully cover these outflows with "High Quality Liquid Assets" (HQLA), i.e. achieve coverage of liquid assets over net outflows of no less than 100%. This regulation entered into force in Switzerland with the adoption of Basel III in 2013, but is being phased in gradually until 2019; the requirement for 2015 was equal to 60% in Switzerland.

Table A7 uses *LCR* $Dist_i$ as alternative treatment variable and investigates its impact on liquid assets (Panel A), lending and investment (Panel B), and funding (Panel C).[43] Panel A shows that banks with higher LCR requirements responded to the negative rates with stronger reductions in liquid assets and SNB reserves, and thus also in their LCR. At the same time we observe for these banks an increase in the net interbank position that absorbs about half of the liquidity withdrawn from the SNB. For the other half, Panel B shows that the same banks have also responded with significantly stronger increases in loan, mortgage and financial asset shares. Finally, Panel C shows that more heavily treated banks have responded with relatively larger decreases in their bond and interbank funding ratios. Conversely and mechanically, the balance sheet shares funded with deposits and cash bonds have increased more, with cash bonds serving essentially as a longer-maturity version of deposits.

By and large, the results thus corroborate our main analysis. That negative rates, applicable to the most important component of *High Quality Liquid Assets* (HQLA) also have induced banks to reduce HQLA levels is not surprising. In the present case this has arguably not been problematic since Swiss banks had high HQLA levels to start with. Nonetheless it should be borne in mind that negative-rate-induced reductions in reserve holdings could become problematic if they occur when liquidity is scarce; in particular if banks' reluctance to charge negative deposit rates also causes the balance sheet share of short-term liabilities to increase– as we have previously documented.

5.5. Deposit rates in December 2014

Adding to our robustness checks, we also provide evidence on deposit rates in December 2014 as a measure of how burdensome the ZLB is for banks: the higher the initial rate, the greater banks' ability to lower it before meeting the ZLB. We use the reference rates investigated in Section 4.3 for demand and sight deposits, and interact their pre-treatment values with our benchmark treatment. A higher deposit rate in December 2014 can then have two effects: on the one hand, it allows banks to lower it more and hence moderates the pressure on their liability margins. In this case we would expect banks with higher initial deposit rates to respond

[43] We use total LCR requirements, as the negative rate was quickly transmitted also to HQLA1 other than SNB reserves, and HQLA2 are down-weighted in computing LCR compliance.

less strongly along other dimensions. On the other hand, the fact that the bank could not set lower deposit rates before might signal limited market power or greater long-term dependence on deposits, a constraint that may remain in place also after the drop in interbank rates. In this case we would expect a stronger response to the NIRP.

Focusing on the stronger results in Panel B, where we use both bank and month fixed effects, we find that our baseline measure of treatment intensity, $ER_{i,}$, matters more for the large majority of outcomes. The double and triple interactions with the initial demand deposit rate, instead, are in most cases not statistically significant. We interpret this as supportive evidence for our use of ER_i, even if—as explained above—it may be correlated with initial deposit rates. Some exceptions to this result, however, are worth discussing in more detail. To start with, we find that banks with higher initial deposit rates reduce their SNB reserves less. This is consistent with the notion that these banks saw their liability margins squeezed less, as they were able to lower their deposit rates relatively more, before hitting the ZLB. In the same vein, we find the expansion of loans as a percentage of total assets to be less pronounced for these banks, and the expansion of the cash bond share to be stronger. These results confirm our hypothesis that the initial deposit rate can act as an additional measure of treatment intensity but also suggest that the direct measure via exposed reserves remains significant, even after controlling for initial rates.

6. Conclusion

This paper investigates the effects of negative rate exposure on banks' behavior. We conduct a DiD analysis and exploit that negative deposit facility rates in Switzerland were only imposed on SNB reserves exceeding 20 times banks' MRR. Access to detailed supervisory information on the universe of banks in Switzerland enables us to provide a complete anatomy of their reaction. For identification and to maximize external validity, our baseline estimates focus on domestically owned retail banks. For completeness, we also study WM banks, which are more specific to the Swiss context, and ensure robustness with respect to alternative treatment measures. In addition to the effects on banks' balance sheets, our findings cover implications for profitability, bank-level interest rates and risk-taking.

We demonstrate how banks moved liquidity away from costly central bank accounts and towards the interbank market as well as towards riskier asset classes, such as uncollateralized loans, mortgages and financial assets. Since attractive alternative assets were apparently not available for all of the excess liquidity, banks also decided to shorten their balance sheets. This was seemingly unattractive to accomplish via reduced deposit funding, as banks feared that a full pass-through to depositors might excessively damage their reputation towards current and future customers. More NIRP-exposed banks instead chose to reduce their balance sheets by retiring their long-term (and largely covered) bond funding, despite negative bond rates making these a cheaper source of funding than deposits. The funding cost implications of the self-imposed ZLB on deposit rates are further aggravated by more exposed banks increasing their deposit ratios more and by the fact that more exposed banks also had less leeway to lower their deposit rates.

The partial substitution of central bank reserves, which carry a risk-weight of zero, with mortgages, loans and financial assets significantly increased the average risk-weight on banks' assets, a key indicator of credit risk. While average risk-weights increased primarily due to portfolio rebalancing, increasing risk-weights ultimately lowered banks' capital cushions relative to regulatory requirements. At the same time, the combination of shifting assets towards longer and liabilities towards shorter maturities led to a significant increase in banks' maturity mismatch and thus to interest rate risk. Finally, the negative interest rate on central bank reserves, as the most important category of High-Quality Liquid Assets under Basel III's LCR, triggered a reduction in precisely those HQLA and hence in their regulatory LCR. Overall, we conclude that the self-imposed ZLB on deposit rates implied a stronger increase in overall risk-taking for more exposed banks.

Different from positive rate environments and from the transmission of negative rates by European lead arrangers (Heider et al., 2017), we also find that Swiss retail banks have so far managed to maintain–or even increase–their profitability. That this was achieved despite the constraint on deposit rates is the result of higher fees on loan- and deposit-related services, as well as–less expectedly–of differential increases in mortgage rates. Higher mortgage rates, when LIBOR and swap rates as usual measures of refinancing costs had fallen, are potentially counterintuitive. We show, however, that the ZLB on deposit rates caused larger increases of average funding costs for more NIRP-exposed banks and that these larger increases in marginal costs can account for relatively weaker decreases in the mortgage rates of more affected banks. By contrast, we do not find empirical evidence that larger mortgage rate increases were caused by higher costs of swap usage, by an expansion towards riskier mortgages, or by higher mark-ups in cantonal mortgage markets.

The Swiss NIRP seems to have hurt WM banks more than retail banks, as the former tend to hold more reserves and benefit less from exemptions (due to fewer short-term liabilities). This could indicate more moderate consequences for aggregate risk-taking, since WM banks are not primarily engaged in lending, but may affect the sector via the interbank market.

Overall, we conclude that monetary policy transmission remained essentially intact and that it contributed to the restoring of the interest rate differential between EUR and CHF. At the same time, it is clear that the ZLB on household deposits constituted a real constraint, which amplified risk-taking with respect to both portfolio composition and maturity mismatch. The corresponding side effects, such as the adverse implications for regulatory capital and liquidity ratios, need to be considered carefully when contemplating the use of negative interest rates in the future. Our results therefore reiterate the importance of financial stability considerations in the context of monetary policy design.

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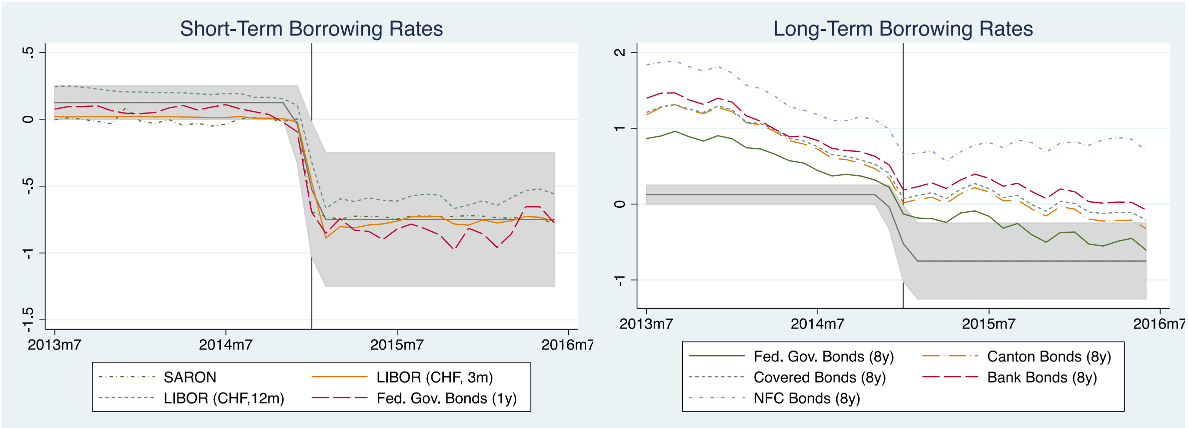
Appendix

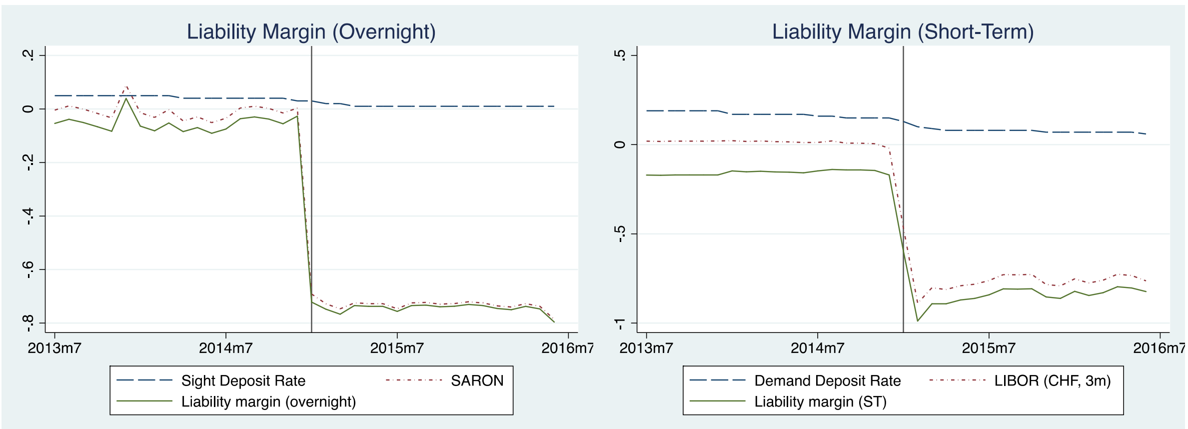
Figures

Figure 1. Borrowing Rates



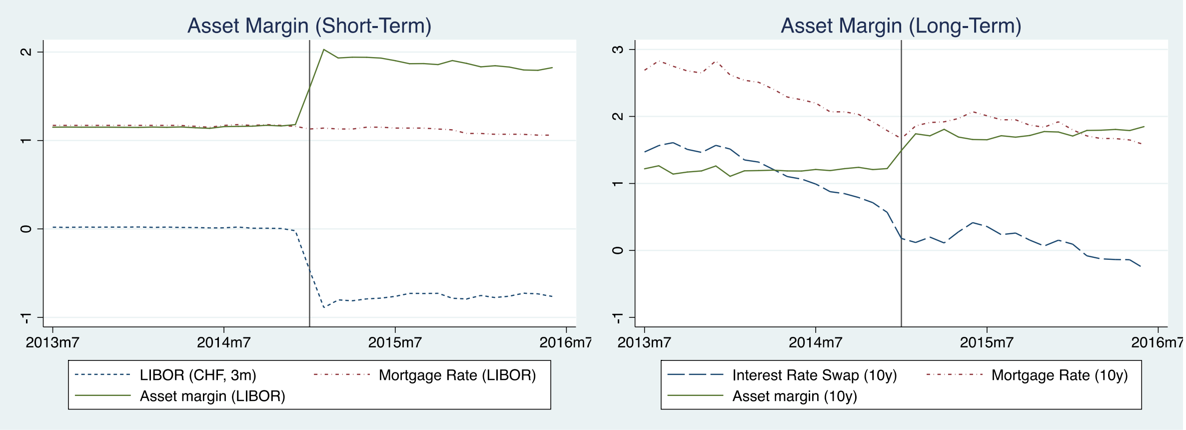
Notes: LEFT PANEL: The Figure illustrates the evolution of short-term interest rates and the Swiss National Bank's (SNB's) policy target between July 2013 and June 2016. *SARON* is the average Swiss overnight lending rate; *LIBOR (CHF, 3m)* and *LIBOR (CHF, 12m)* are the three and twelve month LIBOR rates; *Fed. Gov. Bonds (1y)* is the return on Swiss Government Bonds with a one-year maturity. RIGHT PANEL: The Figure illustrates the evolution of long-term interest rates and the SNB's policy target between July 2013 and June 2016. *Fed. Gov. Bonds (8y)* is the return on Swiss Government Bonds with an eight-year maturity; *Canton Bonds (8y)* and *Covered Bonds (8y)* are the average return on Swiss Canton Bonds and Covered Bonds with an eight-year maturity. *Bank Bonds (8y)* and *NFC Bonds (8y)* are the average return on the bonds of commercial banks and non-financial corporations respectively. The shaded area is the region between the SNB's upper and lower bound for 3-month LIBOR rate, and the grey line is the mean of the upper and lower bound. The vertical line identifies the beginning of the treatment period (01/2015). **Source:** www.snb.ch

Figure 2. Liability Margins



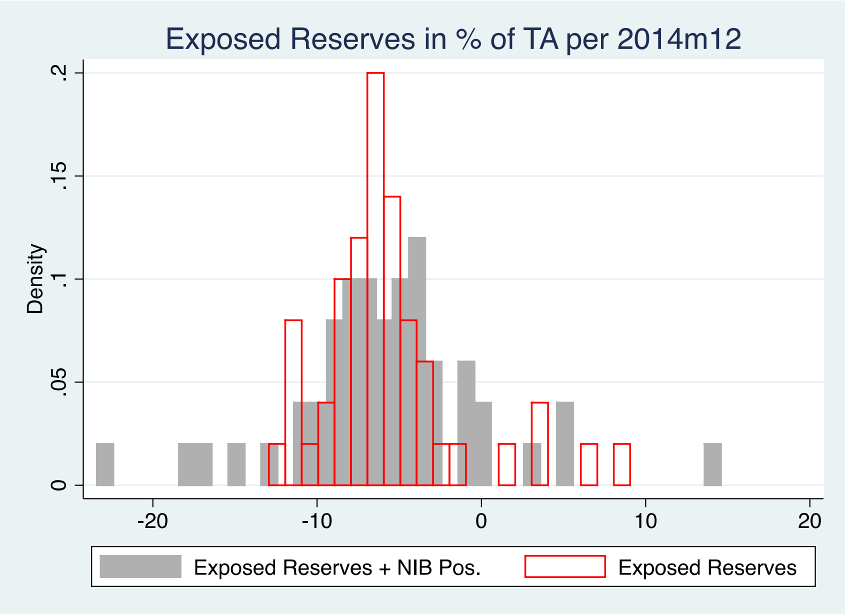
Notes: LEFT PANEL: The Figure illustrates the evolution of banks' overnight liability margin between July 2013 and June 2016. *Sight Deposit Rate* is the average cost of deposit funding; *SARON* is the average Swiss overnight lending rate. *Liability Margin (overnight)* is the difference between *SARON* and *Sight Deposit Rate*. RIGHT PANEL: The Figure illustrates the evolution of banks' short-term liability margin between January 2010 and June 2016. *Demand Deposit Rate* is the average return on demand deposits; *LIBOR (CHF, 3m)* is the three-month LIBOR rate. *Liability Margin (ST)* is the difference between *LIBOR (CHF, 3m)* and *Demand Deposit Rate*. The vertical line identifies the beginning of the treatment period (01/2015). **Source:** www.snb.ch

Figure 3. Asset Margins



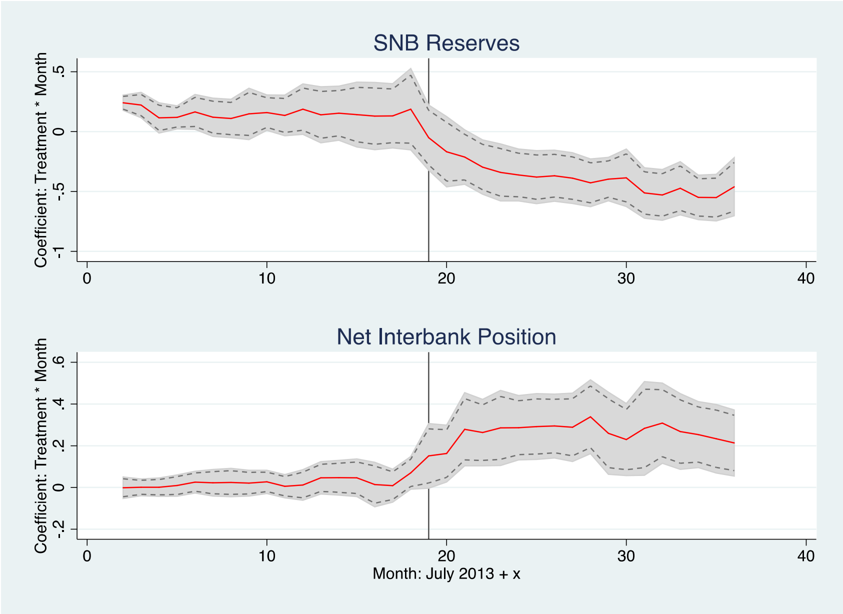
Notes: LEFT PANEL: The Figure illustrates the evolution of banks' short-term asset margin between July 2013 and June 2016. *LIBOR (CHF, 3m)* is the three month LIBOR rate; *Mortgage Rate (3y, LIBOR)* is the average 3-year, adjustable mortgage rate, indexed to the 3-month LIBOR rate. *Asset Margin (LIBOR)* is the difference between *Mortgage Rate (LIBOR)*, i.e. an average adjustable rate mortgage (with rate resetting based on the 3-months CHF LIBOR every 3 months and 3 year maturity), and *LIBOR (CHF, 3m)*. RIGHT PANEL: The Figure illustrates the evolution of banks' long-term asset margin between July 2013 and June 2016. *Interest Rate Swap (10y)* is the swap rate on ten year fixed-rate mortgages; *Mortgage Rate (10y)* is the average 10-year, fixed-rate mortgage rate. *Asset Margin (10y)* is the difference between *Mortgage Rate (10y)* and *Interest Rate Swap (10y)*. The vertical line identifies the beginning of the treatment period (01/2015). **Source:** www.snb.ch

Figure 4. Histogram: Exposed Reserves (Retail Banks)



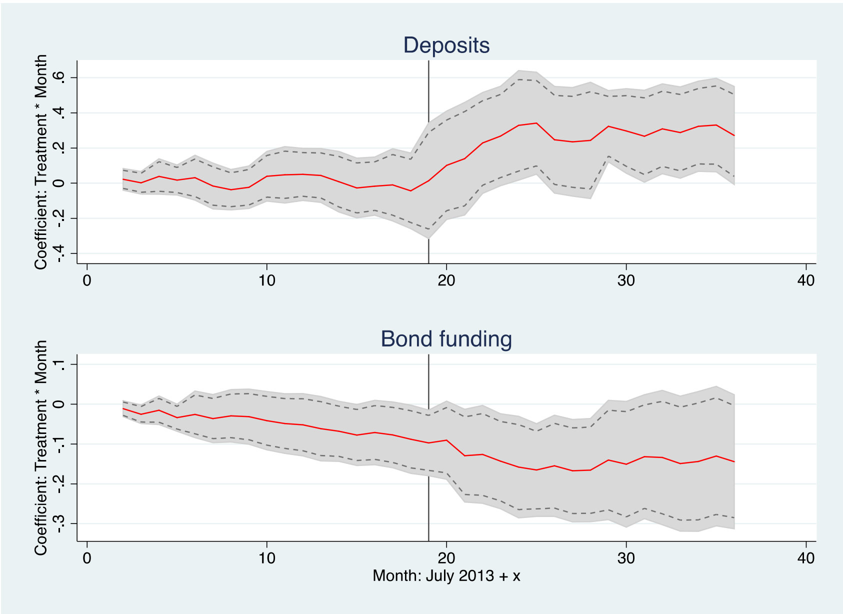
Notes: The Figure depicts the distribution of all 50 retail banks, across exposed reserves and exposed reserves + net interbank position in 2014m12. The mean of exposed reserves in our benchmark sample is -5.76%, the median is -6.3% of total assets.

Figure 5. Reallocating Liquidity (by month)



Notes: The Figure illustrates the evolution of banks' SNB reserves (upper panel) and net interbank position (lower panel), both as a fraction of total assets, between July 2013 and July 2016, as predicted by our monthly regression coefficients (Model 3). The regression coefficients are obtained after controlling for the main/baseline effect each month has had on banks with no exposed reserves. The dotted lines and shaded area show the 95% and 90% confidence interval respectively, based on standard errors clustered by bank. The vertical line identifies the beginning of the treatment period (01/2015).

Figure 6. Deleveraging (by month)



Notes: The Figure illustrates the evolution of banks' deposit funding and bond funding (lower panel), both as a fraction of total assets, between July 2013 and July 2016, as predicted by our monthly regression coefficients. The regression coefficients are obtained after controlling for the main/baseline effect each month has had on banks with no exposed reserves. The dotted lines and shaded area show the 95% and 90% confidence interval respectively, based on standard errors clustered by bank. The vertical line identifies the beginning of the treatment period (01/2015).

Figure 7. Lending (by month)

Notes: The Figure illustrates the evolution of banks' mortgages and other loans (lower panel), both as a fraction of total assets, between July 2013 and July 2016, as predicted by our monthly regression coefficients. The regression coefficients are obtained after controlling for the main/baseline effect each month has had on banks with no exposed reserves. The dotted lines and shaded area show the 95% and 90% confidence interval respectively, based on standard errors clustered by bank. The vertical line identifies the beginning of the treatment period (01/2015).

Tables

Table 1. Pooled Summary Statistics

Variable	Obs	Banks	Periods	Mean	SD	Min	Max
Exposed SNB Reserves/TA	1800	50		-5.76	4.30	-12.94	8.75
(Exposed SNB Res + Net IB Pos) / TA	1800	50		-5.92	5.91	-23.41	13.67
Deposits / TA	1800	50		47.60	10.86	24.94	69.61
2015 LCR Req. - Neg. Rate Exemption	1764	49		-0.06	0.03	-0.15	0.00
TA (yoy growth)	1800	50	36	5.12	4.35	-27.01	23.44
All SNB Reserves: % of TA	1800	50	36	7.77	4.17	0.04	27.51
Liquid Assets: % of TA	1800	50	36	8.34	4.09	0.12	28.06
Claims on Banks: % of TA	1800	50	36	2.94	2.41	0.09	14.48
Net Interbank Pos: % of TA	1800	50	36	-0.86	4.39	-16.92	10.07
Loan Assets: % of TA	1800	50	36	8.49	4.23	1.58	22.29
Mortgage Assets: % of TA	1800	50	36	72.78	9.72	32.39	88.69
Fin. Assets: % of TA	1800	50	36	4.70	2.71	0.56	18.42
Deposit Funding: % of TA	1800	50	36	67.59	7.58	39.11	95.99
Bond Funding: % of TA	1800	50	36	13.04	5.58	0.00	25.58
Dues to Banks: % of TA	1764	49	36	3.92	5.04	0.00	24.37
Cash Bond Funding: % of TA	1800	50	36	3.71	3.89	0.00	16.00
FX Share Total Assets	1800	50	36	2.73	3.33	0.01	17.57
FX Share Total Liabilities	1800	50	36	4.38	5.31	0.00	27.75
RWA Density	600	50	12	0.46	0.12	0.02	1.13
Credit Risk Share of Req. Equity	600	50	12	0.94	0.21	0.65	2.56
Market Risk Share of Req. Equity	600	50	12	0.01	0.03	0.00	0.23
OpRisk Share of Req. Equity	600	50	12	0.06	0.02	0.04	0.20
IRR: Bank Ass CHF	600	50	12	-0.06	0.04	-0.19	0.08
IRR: Bank Ass FX	600	50	12	0.06	0.03	0.00	0.20
IRR: Avg. Ass	600	50	12	-0.05	0.04	-0.12	0.11
IRR: 2y Ass	600	50	12	-0.10	0.04	-0.20	0.04
CET1 / TA	600	50	12	7.69	1.58	4.02	12.33
CET1 / RWA	600	50	12	15.66	3.01	8.37	23.72
CET1/RWA - B3 Requirement	600	50	12	8.21	3.04	0.57	16.32
Int Earned on Loans, % of TA	300	50	6	1.56	0.26	0.84	2.38
Int Earned, % of TA	300	50	6	1.65	0.27	0.89	2.47
Int Paid, % of TA	300	50	6	0.51	0.17	0.06	0.98
Net Int Inc, % of TA	300	50	6	1.13	0.18	0.61	1.78
Loan Fees, bps(1/100%) of TA	300	50	6	1.62	2.48	0.03	17.61
All Fees, bps(1/100%) of BusVol	300	50	6	19.70	9.05	0.00	59.24
Net Fee Inc, bps(1/100%) of BusVol	300	50	6	16.52	7.91	-1.57	46.92
Gross Profit, % of BusVol	300	50	6	0.43	0.24	0.00	0.97

Notes: The Table shows summary statistics for our pooled sample, covering the 50 domestically owned retail banks that feature in our baseline sample over respectively 36 months (balance sheet positions), 6 semesters (income) and 12 quarters (capitalization and risk-taking measures). For more details on the sample construction, see Section 3.2, and Table A1 in the Online Appendix.

Table 2. Reallocating Liquidity

The sample covers 50 domestically owned Swiss retail banks over the period July 2013 to June 2016 (36 months). The dependent variable is equal to respectively the balance sheet shares of liquid assets (columns 1 and 6), all (exposed and non-exposed) SNB reserves (columns 2 and 7), interbank loans (columns 3 and 6) and funding (columns 4 and 9), as well as the difference between the latter two (columns 5 and 10). In columns (1) to (5) we estimate Model (1), in columns (4) to (6) we add bank and month fixed effects. In columns (11) to (15) we express dependent variables in year-on-year growth rates. *Post* is equal to one from January 2015 and zero otherwise. The continuous treatment variable (*T*) is equal to exposed reserves (*ER*), i.e. to the difference between total SNB reserves and the regulatory exemption threshold, scaled by total assets, in December 2014. Standard errors are clustered by bank.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	Liquid Assets (% of TA)	All SNB Reserves (% of TA)	Claims on Banks (% of TA)	Interbank Funding (% of TA)	NIB Position (% of TA)	Liquid Assets (% of TA)	All SNB Reserves (% of TA)	Claims on Banks (% of TA)	Interbank Funding (% of TA)	NIB Position (% of TA)	Liquid Assets (yoy growth)	All SNB Reserves (yoy growth)	Claims on Banks (yoy growth)	Interbank Funding (yoy growth)	NIB Position (yoy growth)
Post*T	-0.53***	-0.54***	0.20*	-0.15	0.24***	-0.53***	-0.55***	0.14***	-0.16***	0.26***	-5.16***	-0.45	3.68***	32.45	-7.44
	(0.07)	(0.07)	(0.10)	(0.09)	(0.07)	(0.04)	(0.04)	(0.03)	(0.05)	(0.04)	(1.58)	(4.58)	(0.88)	(88.80)	(23.54)
Post	0.06	0.08	0.53	0.08	-0.15										
	(0.40)	(0.40)	(0.71)	(0.52)	(0.47)										
T	0.74***	0.77***	0.06	0.20	-0.03										
	(0.10)	(0.10)	(0.10)	(0.28)	(0.11)										
T	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER
Time FE	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	1,800	1,800	1,800	1,764	1,800	1,800	1,800	1,800	1,764	1,800	1,800	1,800	1,800	1,764	1,764
R2	0.47	0.49	0.13	0.02	0.05	0.56	0.57	0.16	0.13	0.25	0.02	0.00	0.03	0.00	0.00

Standard errors clustered by bank. *** p<0.01, ** p<0.05, * p<0.1

Table 3. Funding Choices and the Zero Lower Bound

The sample covers 50 domestically owned Swiss retail banks over the period July 2013 to June 2016 (36 months). The dependent variable is equal to respectively the year-on-year growth rate of total assets (columns 1 and 7), the balance sheet shares of deposit funding (columns 2 and 8), total bond funding (columns 3 and 9), cash bond funding (columns 4 and 10), CET1 (columns 5 and 11), and the regulatory capital cushion, i.e. the distance between CET1/RWA and each bank's regulatory capital requirement (columns 6 and 12). In columns (1) to (6) we estimate Model (1), in columns (7) to (12) we add bank and month fixed effects. In columns (13) to (16) we express dependent variables in year-on-year growth rates. *Post* is equal to one from January 2015 and zero otherwise. The continuous treatment variable (*T*) is equal to exposed reserves (*ER*), i.e. the difference between total SNB reserves and the exemption threshold, scaled by total assets, in December 2014. Standard errors are clustered by bank.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	TA (yoy growth)	Deposit Funding (% of TA)	Bond Funding (% of TA)	Cash Bond Funding (% of TA)	CET1 (% of TA)	Reg. capital cushion	TA (yoy growth)	Deposit Funding (% of TA)	Bond Funding (% of TA)	Cash Bond Funding (% of TA)	CET1 (% of TA)	Reg. capital cushion	Deposit Funding (yoy growth)	Bond Funding (yoy growth)	Cash Bond Funding (yoy growth)	CET1 (yoy growth)
Post*T	-0.39***	0.25***	-0.10**	0.03*	0.06***	0.03	-0.24***	0.22***	-0.14***	0.08***	0.01*	-0.07***	0.12	-0.51**	-0.18	-0.00
	(0.09)	(0.09)	(0.04)	(0.02)	(0.01)	(0.02)	(0.07)	(0.06)	(0.03)	(0.02)	(0.01)	(0.02)	(0.08)	(0.25)	(0.30)	(0.08)
Post	-1.33**	0.26	0.36	-0.39***	0.38***	0.87***										
	(0.52)	(0.55)	(0.27)	(0.12)	(0.11)	(0.20)										
T	0.03	0.08	-0.47**	0.12	-0.08	-0.09										
	(0.11)	(0.45)	(0.19)	(0.19)	(0.05)	(0.09)										
T	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER
Time FE	No	No	No	No	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	No	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	1,800	1,800	1,800	1,800	600	600	1,800	1,800	1,800	1,800	600	600	1,800	1,729	1,728	600
R2	0.07	0.02	0.16	0.03	0.02	0.03	0.05	0.15	0.19	0.23	-	-	0.02	0.03	0.00	-

Standard errors clustered by bank. *** p<0.01, ** p<0.05, * p<0.1

Table 4. Profitability and Income

The sample covers 50 domestically owned Swiss retail banks over the period 2013H2 to 2016H1. The dependent variable is equal to respectively the difference between interest earned and interest paid, scaled by total assets (columns 1 and 7), interest earned over total assets (columns 2 and 8), interest paid over total assets (columns 3 and 9), loan related fees over total assets, expressed in basis points (columns 3 and 10), net fee income over total business volume (total assets plus assets under management and fiduciary assets (columns 5 and 11), and gross profits over total business volume (columns 6 and 12). In columns (1) to (6) we estimate Model (1), in columns (7) to (12) we add bank and month fixed effects. In columns (13) to (18) we express dependent variables in year-on-year growth rates. *Post* is equal to one from 2015H1 and zero otherwise. The continuous treatment variable (*T*) is equal to exposed reserves (*ER*), i.e. the difference between total SNB reserves and the exemption threshold, scaled by total assets, in December 2014. Standard errors are clustered by bank.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
	NII (% of TA)	Interest Earned (% of TA)	Interest Paid (% of TA)	Loan Fees (‰ of TA)	Net Fee Income (‰ of Business Volume)	Gross Profits (% of Business Volume)	NII (% of TA)	Interest Earned (% of TA)	Interest Paid (% of TA)	Loan Fees (‰ of TA)	Net Fee Income (‰ of Business Volume)	Gross Profits (% of Business Volume)	NII (yoy growth)	Interest Earned (yoy growth)	Interest Paid (yoy growth)	Loan Fees (yoy growth)	Net Fee Income (yoy growth)	Gross Profits (yoy growth)
Post*T	0.01***	0.01**	0.00	0.06	0.14	0.01**	0.01***	0.03***	0.02***	0.04*	0.17***	0.02***	-0.07	0.10*	0.68**	2.04*	0.65**	3.93***
	(0.00)	(0.00)	(0.00)	(0.04)	(0.11)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.05)	(0.00)	(0.08)	(0.05)	(0.27)	(1.18)	(0.31)	(0.57)
Post	-0.02	-0.16***	-0.14***	0.13	-0.29	-0.17***												
	(0.02)	(0.03)	(0.02)	(0.16)	(0.75)	(0.02)												
T	-0.01	-0.01	-0.01	-0.04	-0.71**	-0.01***												
	(0.01)	(0.01)	(0.01)	(0.13)	(0.29)	(0.00)												
T	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER
Time FE	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	294	300
R2	0.04	0.19	0.24	0.00	0.13	0.21	0.40	0.60	0.52	0.10	0.13	0.18	0.00	0.02	0.08	0.04	0.01	0.12

Standard errors clustered by bank. *** p<0.01, ** p<0.05, * p<0.1

Table 5. Lending Rates and Funding Costs

Banks report the rates as offered on their website to the SNB. Actual lending rates may vary from customer to customer with a customer's characteristics. The sample covers all "banks whose total Swiss-franc denominated amounts due in respect of customer deposits and cash bonds in Switzerland exceed CHF 500 million (excluding private bankers who do not actively seek deposits from the public)". For the original form and further details, see https://snb.ch/en/emi/ZISAX. Unfortunately not all banks report rates for all products in all periods, thus we focus on the products for which rates are reported most frequently and hence are most representative. Columns (1) to (4) show lending rates for variable rate mortgages (column 1), and for fixed term mortgages with maturities between 5 and 15 years. Columns (5) to (9) show borrowing rates for demand, sight and time deposits, and for cash bonds at 2- and 8-year maturity. *Post* is equal to one from January 2015 and zero otherwise. The continuous treatment variable (*T*) is equal to exposed reserves (*ER*), i.e. the difference between total SNB reserves and the exemption threshold, scaled by total assets, in December 2014. Standard errors are clustered by bank.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A	Mortg. Libor C3 F3	Mortg. 5 yrs	Mortg. 10 yrs	Mortg. 15 yrs	Demand Deposits	Sight Deposits	Time Dep. 3m	Cash Bonds 2y	Cash Bonds 8y
Post*T	-0.01	-0.00	0.00	0.05*	0.00	0.00	-0.01	0.01	0.01
	(0.01)	(0.00)	(0.00)	(0.02)	(0.01)	(0.01)	(0.04)	(0.01)	(0.01)
Post	-0.16	-0.35***	-0.55***	-0.15	0.10	-0.24***	-0.28	-0.04	-0.55***
	(0.11)	(0.03)	(0.03)	(0.16)	(0.08)	(0.07)	(0.35)	(0.06)	(0.07)
T	0.01	-0.00	-0.01	-0.00	-0.00	-0.01	-0.00	-0.00	-0.01
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
T	ER	ER	ER	ER	ER	ER	ER	ER	ER
Time FE	No	No	No	No	No	No	No	No	No
Bank FE	No	No	No	No	No	No	No	No	No
Obs.	512	1,280	1,190	171	1,360	1,360	982	1,062	1,253
R2	0.06	0.42	0.50	0.44	0.10	0.36	0.12	0.11	0.73

Panel B	Mortg. Libor C3 F3	Mortg. 5 yrs	Mortg. 10 yrs	Mortg. 15 yrs	Demand Deposits	Sight Deposits	Time Dep. 3m	Cash Bonds 2y	Cash Bonds 8y
Post*T	0.00	0.04***	0.07***	0.06***	-0.01**	0.03***	0.02***	0.01***	0.08***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	512	1,280	1,190	171	1,360	1,360	982	1,062	1,253

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 6. Interest Rates and Swap Use

Banks report to FINMA whether or not they use interest rate swaps to hedge their interest rate risk. We investigate how our baseline treatment interacts with interest rate swap use in affecting mortgage rates. Rates themselves are reported to FINMA and SNB, but not all banks report all rates as in Table 5. We focus on the products for which rates are reported most frequently and where results are most representative. Columns (1) and (2) show lending rates for fixed term mortgages with maturities of 5 and 10 years. Columns (3) to (6) show borrowing rates for demand, sight and time deposits, and for cash bonds at 8-year maturity. *Post* is a dummy variable equal to one if a bank reports Swap use in December 2014, and zero otherwise (results are robust to conditioning on Swap use in September 2014). *Post* is equal to one from January 2015 and zero otherwise. The continuous treatment variable (*T*) is equal to exposed reserves (*ER*), i.e. the difference between total SNB reserves and the exemption threshold, scaled by total assets, in December 2014. Standard errors are clustered by bank.

	(1)	(2)	(3)	(4)	(5)	(6)
	Mortgages 5 yrs	Mortgages 10 yrs	Demand Deposits	Sight Deposits	Time Dep. 3m	Cash Bonds 8y
Post*T*Swap	-0.05***	-0.08***	-0.00	-0.05***	-0.01	-0.05***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.04)	(0.01)
Post*T	0.05***	0.08***	0.00	0.05***	0.01	0.07***
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)
Post*Swap	-0.36***	-0.55***	0.11	-0.24***	-0.27	-0.56***
	(0.03)	(0.03)	(0.08)	(0.07)	(0.32)	(0.07)
T	ER	ER	ER	ER	ER	ER
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	1,280	1,190	1,360	1,360	982	1,062
R2	0.48	0.53	0.16	0.49	0.18	0.26

Standard errors clustered by bank. *** p<0.01, ** p<0.05, * p<0.1

Table 7. Lending and Investing

The sample covers 50 domestically owned Swiss retail banks over the period July 2013 to June 2016 (36 months). The dependent variable is equal to the balance sheet shares of uncollateralized loans (columns 1 and 4), mortgage loans (columns 2 and 5), and the book value of a bank's financial assets (columns 3 and 6). In columns (1) to (3) we estimate Model (1), in columns (4) to (6) we add bank and month fixed effects. In columns (7) to (9) we express dependent variables in year-on-year growth rates. *Post* is equal to one from January 2015 and zero otherwise. The continuous treatment variable (*ER*) is equal to exposed reserves, i.e. the difference between total SNB reserves and the exemption threshold, scaled by total assets, in December 2014. Standard errors are clustered by bank.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Loan Assets (% of TA)	Mortgage Assets (% of TA)	Financial Assets (% of TA)	Loan Assets (% of TA)	Mortgage Assets (% of TA)	Financial Assets (% of TA)	Loan Assets (yoy growth)	Mortgage Assets (yoy growth)	Financial Assets (yoy growth)
Post*T	0.09***	0.13**	0.03	0.14***	0.16***	0.06***	1.01	0.07	0.07
	(0.03)	(0.07)	(0.03)	(0.02)	(0.05)	(0.02)	(0.64)	(0.05)	(0.42)
Post	-0.42*	-0.28	-0.34**						
	(0.23)	(0.34)	(0.15)						
T	-0.23	-0.88**	0.01						
	(0.14)	(0.40)	(0.15)						
T	ER	ER	ER	ER	ER	ER	ER	ER	ER
Time FE	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800
R2	0.05	0.13	0.01	0.29	0.13	0.11	0.02	0.02	0.00

Standard errors clustered by bank. *** p<0.01, ** p<0.05, * p<0.1

Table 8. Risk-Taking

The sample covers 50 domestically owned Swiss retail banks over the period 2013Q3 to 2016Q2 (12 quarterly risk reports). The dependent variable is equal to respectively the balance sheet share and growth rate of risk-weighted assets (column 1 and 2), the shares of banks' capital requirement due to respectively *Credit Risk* (column 3), *Market Risk* (column 4) and *Operational Risk* (column 5). In columns (6) to (9) the dependent variables capture banks' interest rate risk, quantified by the losses incurred in case of a 100bp increase in market rates in % of bank equity. This risk measure is routinely calculated by FINMA based on how banks' assets and liabilities are distributed across different maturity brackets. For assets and liabilities with unspecified maturities, such as sight deposits, columns (6) and (7) use each bank's own assumption, for positions in CHF (column 6) and foreign currency (column 7), respectively. Column (8) uses the average assumption across banks within each quarter, and column (9) uses a bank- and time-invariant assumption of 2 years. In Panel A we estimate Model (1), in Panel B we add bank and month fixed effects. *Post* is equal to one from 2015Q1 and zero otherwise, the continuous treatment variable (*ER*) is given by exposed reserves, i.e. the difference between total SNB reserves and the exemption threshold, scaled by total assets, in December 2014. Standard errors are clustered by bank.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A	RWA (% of TA)	RWA (yoy growth)	CapReq Share, Credit Risk	CapReq Share, Market Risk	CapReq Share, Op. Risk	IRR: CHF, Bank Ass.	IRR: FX, Bank Ass	IRR: CHF, Avg. Ass.	IRR: CHF, 2y Ass.
Post*T	0.23	-0.04	-0.32	-0.01	-0.02	-0.00	-0.02	-0.07	-0.04
	(0.22)	(0.23)	(0.48)	(0.04)	(0.03)	(0.06)	(0.06)	(0.07)	(0.06)
Post	-1.16	-0.39	-2.93	-0.29	-0.43	-0.92**	0.63	-0.40	-1.91***
	(1.73)	(1.68)	(3.64)	(0.30)	(0.28)	(0.42)	(0.38)	(0.51)	(0.44)
T	0.02	0.16	0.08	0.25*	0.03	-0.02	0.03	0.17	0.13
	(0.28)	(0.19)	(0.28)	(0.14)	(0.04)	(0.14)	(0.09)	(0.16)	(0.17)
T	ER	ER	ER	ER	ER	ER	ER	ER	ER
Time FE	No	No	No	No	No	No	No	No	No
Bank FE	No	No	No	No	No	No	No	No	No
R2	0.01	0.02	0.00	0.13	0.01	0.01	0.01	0.02	0.05

Panel B	RWA (% of TA)	RWA (yoy growth)	CapReq Share, Credit Risk	CapReq Share, Market Risk	CapReq Share, Op. Risk	IRR: CHF, Bank Ass.	IRR: FX, Bank Ass	IRR: CHF, Avg. Ass.	IRR: CHF, 2y Ass.
Post*T	0.35***	0.01	-0.03	0.02***	0.03*	0.10***	-0.09**	-0.02	0.18***
	(0.11)	(0.09)	(0.22)	(0.01)	(0.02)	(0.04)	(0.04)	(0.04)	(0.04)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	600	600	600	600	600	600	600	600	600

Standard errors clustered by bank. *** p<0.01, ** p<0.05, * p<0.1

Table 9. Interest Rate Cut in Positive Territory (August 2011)

The sample covers 50 domestically owned Swiss retail banks over the period of February 2010 to January 2013 (Panel A) and July 2013 to June 2016 (Panel B). Throughout, we estimate Model (1) saturated with bank and time fixed effects. *Post* is equal to one from August 2011, or from January 2015, and zero otherwise. The continuous treatment variable (*ExcessR + NIB*) is equal to the sum of banks' NIB position and excess reserves, i.e. the difference between total SNB reserves and the minimum reserve requirement, scaled by total assets, in July 2011 (Panel A), or the sum of exposed reserves and banks' NIB position in December 2014 (Panel B). Standard errors are clustered by bank.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Panel A	TA (yoy growth)	Liquid Assets (% of TA)	All SNB Reserves (% of TA)	NIB Position (% of TA)	Loan Assets (% of TA)	Mortgage Assets (% of TA)	Financial Assets (% of TA)	Deposit Funding (% of TA)	Bond Funding (% of TA)	CET1 (% of TA)	NII (% of TA)	Net Fee Income (‰ of Business Volume)	RWA (% of TA)	Reg. capital cushion
Post*T	0.39	0.22***	0.22**	0.01	-0.04	-0.03	-0.08	0.21**	-0.04	-0.01	-0.00***	-0.07**	36.76**	-0.04
	(0.33)	(0.08)	(0.08)	(0.05)	(0.03)	(0.06)	(0.06)	(0.09)	(0.05)	(0.01)	(0.00)	(0.03)	(16.22)	(0.04)
T	ExcessR	ExcessR	ExcessR	ExcessR	ExcessR	ExcessR	ExcessR	ExcessR	ExcessR	ExcessR	ExcessR	ExcessR	ExcessR	ExcessR
Period	Aug 2011	Aug 2011	Aug 2011	Aug 2011	Aug 2011	Aug 2011	Aug 2011	Aug 2011	Aug 2011	Aug 2011	Aug 2011	Aug 2011	Aug 2011	Aug 2011
Obs.	1,250	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	600	1,800	1,800	600	600
R2	0.01	0.07	0.07	0.00	0.01	0.00	0.02	0.01	0.01		0.00	0.00		

Panel B	TA (yoy growth)	Liquid Assets (% of TA)	All SNB Reserves (% of TA)	NIB Position (% of TA)	Loan Assets (% of TA)	Mortgage Assets (% of TA)	Financial Assets (% of TA)	Deposit Funding (% of TA)	Bond Funding (% of TA)	CET1 (% of TA)	NII (% of TA)	Net Fee Income (‰ of Business Volume)	RWA (% of TA)	Reg. capital cushion
Post*T	-0.24***	-0.44***	-0.45***	0.18***	0.11***	0.17***	0.06***	0.23***	-0.12***	0.01**	0.00***	0.03***	29.60***	-0.05***
	(0.05)	(0.03)	(0.04)	(0.04)	(0.02)	(0.03)	(0.02)	(0.05)	(0.03)	(0.01)	(0.00)	(0.01)	(9.80)	(0.01)
T	ER + NIB	ER + NIB	ER + NIB	ER + NIB	ER + NIB	ER + NIB	ER + NIB	ER + NIB	ER + NIB	ER + NIB	ER + NIB	ER + NIB	ER + NIB	ER + NIB
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period	Jan 2015	Jan 2015	Jan 2015	Jan 2015	Jan 2015	Jan 2015	Jan 2015	Jan 2015	Jan 2015	Jan 2015	Jan 2015	Jan 2015	Jan 2015	Jan 2015
Obs.	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	600	1,800	1,800	600	600
R2	0.08	0.50	0.51	0.17	0.26	0.18	0.13	0.22	0.19		0.00	0.00		

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 10. Wealth Management Banks

The sample covers 46 wealth management (WM) banks over the period July 2013 to June 2016 (36 months), for which summary statistics are provided in Table A2 of the Online Appendix. Throughout, we estimate Model (2) and include bank and time fixed effects. The continuous treatment variables is equal to exposed reserves (*ER*), i.e. the difference between total SNB reserves and the exemption threshold, for which the pooled sample average is 19.55% among WM banks. Standard errors are clustered by bank.

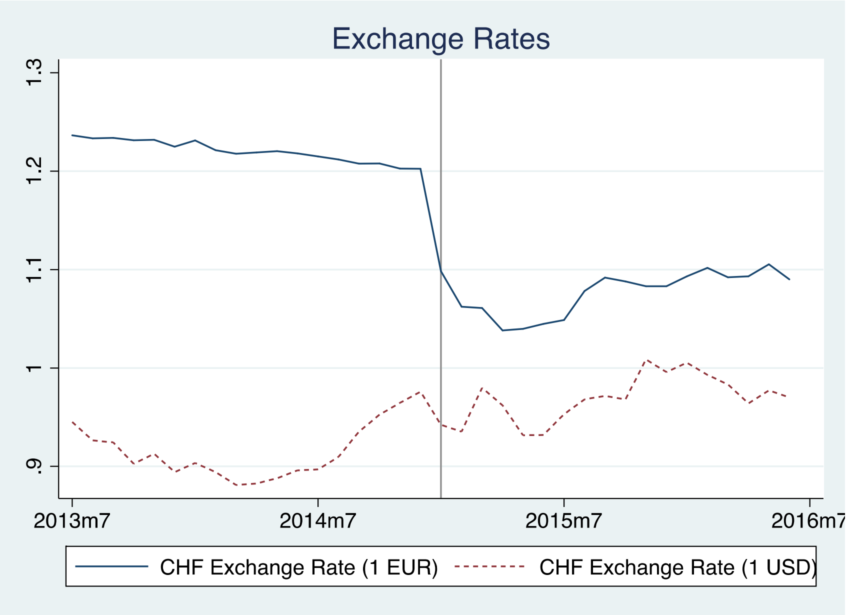
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A	Liquid Assets (% of TA)	All SNB Reserves (% of TA)	Claims on Banks (% of TA)	Interbank Funding (% of TA)	NIB Position (% of TA)	Loan Assets (% of TA)	Mortgage Assets (% of TA)	Financial Assets (% of TA)	Deposit Funding (% of TA)	Bond Funding (% of TA)
Post*T	-0.32***	-0.37***	-0.02	0.00	-0.06	0.05**	-0.00	0.09	-0.20**	0.00
	(0.08)	(0.08)	(0.03)	(0.01)	(0.04)	(0.02)	(0.01)	(0.06)	(0.08)	(0.00)
T	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER
Obs.	1,656	1,656	1,596	1,564	1,656	1,656	1,656	1,656	1,656	1,656
R2	0.16	0.21	0.00	0.00	0.01	0.02	0.00	0.04	0.03	0.00

Panel B	NII (% of TA)	Net Fee Income (‰ of Business Volume)	Gross Profits (% of Business Volume)	IRR: CHF, Avg. Ass.	RWA (% of TA)	CapReq Share, Credit Risk	CapReq Share, Market Risk	CapReq Share, Op. Risk	IRR: CHF, Bank Ass.	IRR: FX, Bank Ass
Post*T	-0.00	1.52	0.00	0.00	0.00**	-0.00	-0.00	0.00	-0.00*	0.00**
	(0.00)	(1.52)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	265	265	265	537	512	512	512	512	537	537
R2	0.00	0.02	0.00	0.03	0.02	0.00	0.02	0.00	0.08	0.08

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

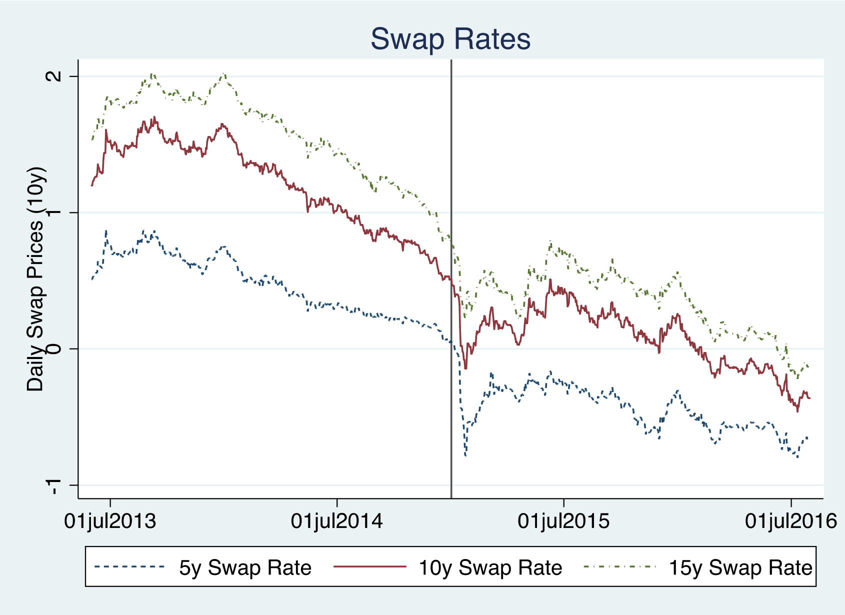
Online Appendix

Figure A1. Exchange Rates



Notes: The Figure illustrates the evolution of the exchange rates between the Swiss Franc (CHF) and the Euro (EUR) (*CHF Exchange Rate (1 EUR)*) and between CHF and the US dollar (USD) (*CHF Exchange Rate (1 USD)*) between July 2013 and June 2016. The vertical line identifies the beginning of the treatment period (01/2015). **Source:** www.snb.ch

Figure A2. Swap Rates



Notes: The Figure illustrates the evolution of daily swap rates between June 01, 2013 and July 31, 2016. The vertical line identifies the beginning of the treatment period (January 01, 2015). **Source:** Bloomberg

Table A1. Summary Statistics by Binary Treatment Group and Treatment Period

Panel A: ER < Median	July 2013 - December 2014							January 2015 - June 2016							Diff	
	Obs	**Banks**	**Periods**	**Mean**	**sd**	**Min**	**Max**	**Obs**	**Banks**	**Periods**	**Mean**	**SD**	**Min**	**Max**	**Post-Pre**	**Pval**
Exposed SNB Reserves/TA	25	25	1	-8.64	1.83	-12.94	-6.34									
(Exposed SNB Res + Net IB Pos) / TA	25	25	1	-9.03	4.74	-23.41	-1.06									
Deposits / TA	25	25	1	44.91	8.29	28.91	61.72									
2015 LCR Req. - Neg. Rate Exemption	25	24	1	-0.07	0.03	-0.15	-0.01									
All SNB Reserves: % of TA	450	25	18	4.06	1.90	0.05	10.79	450	25	18	9.14	3.12	0.75	16.32	5.09	0.00
Liquid Assets: % of TA	450	25	18	4.74	1.86	0.38	11.24	450	25	18	9.67	3.06	1.62	17.12	4.93	0.00
Claims on Banks: % of TA	450	25	18	3.19	2.22	0.15	9.62	450	25	18	2.23	1.60	0.09	13.96	-0.96	0.00
Net Interbank Pos: % of TA	450	25	18	-0.35	4.41	-13.53	8.64	450	25	18	-2.75	4.80	-16.92	10.07	-2.39	0.00
Loan Assets: % of TA	450	25	18	10.28	4.32	2.75	22.29	450	25	18	8.95	3.65	2.58	18.40	-1.33	0.00
Mortgage Assets: % of TA	450	25	18	74.81	7.37	53.24	88.69	450	25	18	72.89	8.03	47.76	87.70	-1.92	0.00
Fin. Assets: % of TA	450	25	18	5.05	1.89	1.34	11.72	450	25	18	4.51	2.08	0.56	11.46	-0.54	0.00
Deposit Funding: % of TA	450	25	18	67.20	5.15	56.84	83.21	450	25	18	64.75	6.28	51.46	85.84	-2.45	0.00
Bond Funding: % of TA	450	25	18	14.22	4.75	0.00	21.63	450	25	18	15.67	5.03	0.00	25.58	1.45	0.00
Dues to Banks: % of TA	450	25	18	3.55	3.98	0.00	13.76	450	25	18	5.14	5.32	0.00	24.37	1.59	0.00
Cash Bond Funding: % of TA	450	25	18	3.51	3.18	0.07	12.64	450	25	18	2.89	2.89	0.03	11.72	-0.62	0.00
FX Share Total Assets	450	25	18	3.05	3.28	0.10	16.82	450	25	18	2.32	2.81	0.07	16.66	-0.73	0.00
FX Share Total Liabilities	450	25	18	4.03	3.36	0.03	16.78	450	25	18	4.44	4.61	0.04	24.45	0.40	0.13
RWA Density	150	25	6	0.47	0.12	0.06	0.97	150	25	6	0.45	0.14	0.02	0.96	-0.03	0.10
Credit Risk Share of Req. Equity	150	25	6	0.96	0.20	0.86	1.88	150	25	6	0.97	0.21	0.86	1.89	0.01	0.73
Market Risk Share of Req. Equity	150	25	6	0.00	0.00	0.00	0.03	150	25	6	0.00	0.01	0.00	0.03	0.00	0.15
OpRisk Share of Req. Equity	150	25	6	0.06	0.02	0.04	0.14	150	25	6	0.06	0.02	0.04	0.13	0.00	0.28
IRR: Bank Ass CHF	150	25	6	-0.05	0.04	-0.16	0.08	150	25	6	-0.06	0.05	-0.19	0.05	-0.01	0.16
IRR: Bank Ass FX	150	25	6	0.06	0.03	0.00	0.17	150	25	6	0.06	0.04	0.01	0.20	0.01	0.11
IRR: Avg. Ass	150	25	6	-0.05	0.03	-0.10	0.05	150	25	6	-0.04	0.04	-0.10	0.06	0.00	0.27
IRR: 2y Ass	150	25	6	-0.09	0.03	-0.16	0.01	150	25	6	-0.10	0.04	-0.16	-0.02	-0.01	0.00
CET1 / TA	150	25	6	8.01	1.87	4.60	12.33	150	25	6	7.87	1.78	4.68	12.29	-0.14	0.50
CET1 / RWA	150	25	6	15.77	3.38	9.28	23.72	150	25	6	16.36	3.14	10.07	23.29	0.59	0.12
CET1/RWA - B3 Requirement	150	25	6	8.31	3.39	2.28	16.32	150	25	6	8.89	3.15	3.07	16.00	0.59	0.12
Int Earned on Loans, % of TA	75	25	3	1.70	0.19	1.37	2.05	75	25	3	1.46	0.22	1.03	1.93	-0.24	0.00
Int Earned, % of TA	75	25	3	1.79	0.20	1.44	2.20	75	25	3	1.53	0.24	1.04	2.13	-0.26	0.00
Int Paid, % of TA	75	25	3	0.61	0.15	0.33	0.98	75	25	3	0.43	0.16	0.06	0.75	-0.18	0.00
Net Int Inc, % of TA	75	25	3	1.19	0.17	0.90	1.62	75	25	3	1.10	0.16	0.89	1.56	-0.08	0.00
Loan Fees, bps(1/100%) of TA	75	25	3	1.79	3.16	0.15	17.61	75	25	3	1.41	2.28	0.04	13.13	-0.38	0.41
All Fees, bps(1/100%) of BusVol	75	25	3	21.59	8.86	9.01	49.94	75	25	3	19.56	7.90	8.07	41.97	-2.02	0.14
Net Fee Inc, bps(1/100%) of BusVol	75	25	3	19.26	8.81	6.02	46.92	75	25	3	17.48	7.85	6.19	39.83	-1.78	0.19
Gross Profit, % of BusVol	75	25	3	0.58	0.15	0.28	0.93	75	25	3	0.36	0.27	0.00	0.83	-0.22	0.00

Panel B: ER >= Median	July 2013 - December 2014							January 2015 - June 2016							Diff	
	Obs	**Banks**	**Periods**	**Mean**	**sd**	**Min**	**Max**	**Obs**	**Banks**	**Periods**	**Mean**	**SD**	**Min**	**Max**	**Post-Pre**	**Pval**
Exposed SNB Reserves/TA	25	25	1	-2.88	4.14	-6.26	8.75									
(Exposed SNB Res + Net IB Pos) / TA	25	25	1	-2.80	5.29	-12.89	13.67									
Deposits / TA	25	25	1	50.29	12.38	24.94	69.61									
2015 LCR Req. - Neg. Rate Exemption	25	25	1	-0.06	0.03	-0.12	0.00									
All SNB Reserves: % of TA	450	25	18	8.30	4.76	0.04	27.51	450	25	18	9.59	3.79	2.27	22.06	1.29	0.00
Liquid Assets: % of TA	450	25	18	8.86	4.70	0.12	28.06	450	25	18	10.11	3.71	2.33	22.50	1.25	0.00
Claims on Banks: % of TA	450	25	18	3.29	2.66	0.30	11.52	450	25	18	3.06	2.84	0.13	14.48	-0.23	0.21
Net Interbank Pos: % of TA	450	25	18	0.16	3.74	-9.44	10.03	450	25	18	-0.51	3.94	-11.86	6.73	-0.67	0.01
Loan Assets: % of TA	450	25	18	7.65	4.11	1.58	20.70	450	25	18	7.09	4.08	2.14	19.66	-0.56	0.04
Mortgage Assets: % of TA	450	25	18	71.80	11.19	36.52	86.31	450	25	18	71.63	11.32	32.39	85.90	-0.17	0.82
Fin. Assets: % of TA	450	25	18	4.84	3.41	1.05	18.42	450	25	18	4.41	3.11	0.63	16.88	-0.43	0.05
Deposit Funding: % of TA	450	25	18	69.13	8.29	43.76	92.31	450	25	18	69.27	9.04	39.11	95.99	0.14	0.81
Bond Funding: % of TA	450	25	18	10.94	5.48	0.00	21.19	450	25	18	11.31	5.58	0.00	22.85	0.37	0.31
Dues to Banks: % of TA	432	24	18	3.32	5.10	0.00	20.42	432	24	18	3.65	5.47	0.00	22.78	0.32	0.37
Cash Bond Funding: % of TA	450	25	18	4.49	4.68	0.00	15.94	450	25	18	3.96	4.37	0.00	16.00	-0.54	0.08
FX Share Total Assets	450	25	18	2.94	3.79	0.01	17.57	450	25	18	2.61	3.34	0.03	17.01	-0.33	0.17
FX Share Total Liabilities	450	25	18	4.44	6.15	0.00	24.42	450	25	18	4.60	6.52	0.00	27.75	0.17	0.69
RWA Density	150	25	6	0.47	0.12	0.34	1.05	150	25	6	0.45	0.09	0.37	1.13	-0.02	0.05
Credit Risk Share of Req. Equity	150	25	6	0.94	0.22	0.71	1.85	150	25	6	0.91	0.20	0.65	2.56	-0.03	0.22
Market Risk Share of Req. Equity	150	25	6	0.02	0.04	0.00	0.23	150	25	6	0.02	0.04	0.00	0.21	0.00	0.44
OpRisk Share of Req. Equity	150	25	6	0.06	0.02	0.04	0.20	150	25	6	0.06	0.02	0.04	0.18	0.00	0.08
IRR: Bank Ass CHF	150	25	6	-0.05	0.04	-0.14	0.05	150	25	6	-0.06	0.04	-0.15	0.04	-0.01	0.02
IRR: Bank Ass FX	150	25	6	0.06	0.03	0.00	0.15	150	25	6	0.07	0.04	0.00	0.15	0.01	0.04
IRR: Avg. Ass	150	25	6	-0.05	0.04	-0.12	0.10	150	25	6	-0.05	0.05	-0.11	0.11	0.00	0.34
IRR: 2y Ass	150	25	6	-0.10	0.05	-0.18	0.04	150	25	6	-0.12	0.05	-0.20	0.03	-0.02	0.00
CET1 / TA	150	25	6	7.32	1.22	4.02	9.27	150	25	6	7.56	1.28	4.53	11.67	0.24	0.09
CET1 / RWA	150	25	6	14.85	2.52	8.37	19.20	150	25	6	15.64	2.75	9.35	21.20	0.79	0.01
CET1/RWA - B3 Requirement	150	25	6	7.43	2.58	0.57	12.11	150	25	6	8.22	2.80	1.95	14.20	0.79	0.01
Int Earned on Loans, % of TA	75	25	3	1.63	0.27	0.86	2.25	75	25	3	1.47	0.28	0.84	2.38	-0.16	0.00
Int Earned, % of TA	75	25	3	1.73	0.27	0.97	2.31	75	25	3	1.54	0.28	0.89	2.47	-0.19	0.00
Int Paid, % of TA	75	25	3	0.58	0.15	0.29	0.86	75	25	3	0.43	0.15	0.06	0.76	-0.15	0.00
Net Int Inc, % of TA	75	25	3	1.15	0.18	0.68	1.56	75	25	3	1.10	0.19	0.61	1.78	-0.04	0.15
Loan Fees, bps(1/100%) of TA	75	25	3	1.64	2.25	0.03	11.73	75	25	3	1.63	2.12	0.03	10.87	-0.01	0.98
All Fees, bps(1/100%) of BusVol	75	25	3	19.31	10.39	6.16	59.24	75	25	3	18.32	8.75	0.00	45.67	-0.99	0.53
Net Fee Inc, bps(1/100%) of BusVol	75	25	3	14.87	7.20	0.00	34.14	75	25	3	14.46	6.80	-1.57	27.98	-0.40	0.72
Gross Profit, % of BusVol	75	25	3	0.48	0.16	0.16	0.97	75	25	3	0.31	0.25	0.00	0.83	-0.18	0.00

Table A2. Pooled Summary Statistics (Wealth Management Banks)

	Obs	Mean	SD	Min	Max
Exposed SNB Reserves/TA	46	19.55	17.45	-11.24	69.10
Liquid Assets: % of TA	1,656	33.43	21.82	0.00	85.39
All SNB Reserves: % of TA	1,656	31.29	21.91	0.00	85.36
Claims on Banks: % of TA	1,596	27.81	17.99	1.59	87.26
Net Interbank Pos: % of TA	1,656	18.48	20.51	-36.56	87.18
Loan Assets: % of TA	1,656	13.35	10.88	0.00	67.92
Mortgage Assets: % of TA	1,656	3.25	8.07	0.00	46.39
Fin. Assets: % of TA	1,656	11.15	13.08	0.00	85.36
Deposit Funding: % of TA	1,656	74.58	19.91	0.00	133.04
Bond Funding: % of TA	1,656	0.99	4.01	0.00	30.17
Dues to Banks: % of TA	1,564	7.57	9.79	0.00	97.64
FX Share, Total Assets	1,596	42.60	21.76	1.11	87.27
FX Share, Total Liabilities	1,596	52.08	23.03	1.10	88.50
NII /TA, bps	265	0.39	0.32	-0.48	2.06
Net Fee Inc / BusVol, bps	265	56.81	143.94	-64.56	2313.46
Gross Profit, % of BusVol	265	0.18	0.35	-1.43	4.40
IRR: Avg. Ass	537	0.03	0.05	-0.10	0.36
IRR: 2y Ass	537	-0.02	0.03	-0.14	0.11

Notes: The Table shows summary statistics for our pooled sample of 46 domestically owned wealth management (WM) banks, covered over respectively 36 months (balance sheet positions), 6 semesters (income) and 12 quarters (capitalization and risk-taking measures). WM banks are defined as those earning 55% or more of their income in fees. For more details on the sample construction, see Section 3.2.

Table A3. Profitability and Market Power

The sample covers 50 domestically owned Swiss retail banks over the period 2013H2 to 2016H1. The dependent variable is equal to respectively the difference between interest earned and interest paid, scaled by total assets (columns 1 and 7), interest earned over total assets (columns 2 and 8), interest paid over total assets (columns 3 and 9), loan related fees over total assets, expressed in basis points (columns 3 and 10), net fee income over total business volume (total assets plus assets under management and fiduciary assets (columns 5 and 11), and gross profits over total business volume (columns 6 and 12). In columns (1) to (6) we estimate Model (1), but add interactions with HHI, the Herfindahl-Hirschmann index for concentration in the mortgage market (see below). Note that we had to compute market shares based on the levels of mortgages on the balance sheets of each bank in each canton, as we do not have the corresponding numbers for new lending. In columns (7) to (12) we add bank and time FEs. *Post* is equal to one from 2015H1 and zero otherwise. The continuous treatment variable (*T*) is equal to exposed reserves (*ER*), i.e. the difference between total SNB reserves and the regulatory exemption threshold, scaled by total assets, in December 2014. Standard errors are clustered by bank.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	NII (% of TA)	Interest Earned (% of TA)	Interest Paid (% of TA)	Loan Fees (‰ of TA)	Net Fee Income (‰ of Business Volume)	Gross Profits (% of Business Volume)	NII (% of TA)	Interest Earned (% of TA)	Interest Paid (% of TA)	Loan Fees (‰ of TA)	Net Fee Income (‰ of Business Volume)	Gross Profits (% of Business Volume)
Post*T	-0.02	-0.03	-0.01	0.08	-0.26	-0.02	0.00***	0.01***	0.00***	0.00	-0.05***	0.01***
	(0.01)	(0.02)	(0.02)	(0.10)	(0.47)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)
Post	-0.23**	-0.43***	-0.20*	0.45	0.23	-0.35**						
	(0.10)	(0.16)	(0.11)	(0.75)	(3.32)	(0.14)						
T	0.01	-0.01	-0.02	-0.06	-0.22	-0.04						
	(0.05)	(0.07)	(0.04)	(0.40)	(1.79)	(0.04)						
Post*T*HHI	0.16*	0.22*	0.06	-0.14	2.01	0.13	-0.00	-0.02***	-0.01***	0.03	0.36***	-0.02***
	(0.08)	(0.13)	(0.10)	(0.68)	(2.81)	(0.11)	(0.00)	(0.01)	(0.00)	(0.03)	(0.13)	(0.01)
Post*HHI	1.16**	1.47*	0.31	-1.78	-2.99	0.99	-0.02	-0.14***	-0.12***	0.11	-0.29	-0.15***
	(0.57)	(0.85)	(0.59)	(4.71)	(20.07)	(0.73)	(0.02)	(0.03)	(0.02)	(0.15)	(0.69)	(0.02)
T*HHI	-0.07	0.01	0.08	0.14	-2.42	0.13						
	(0.30)	(0.42)	(0.24)	(2.58)	(9.76)	(0.22)						
HHI	-1.21	-0.42	0.80	1.26	4.66	0.60						
	(2.02)	(2.88)	(1.65)	(18.00)	(65.02)	(1.39)						
T	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER
Time FE	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	300	300	300	300	300	300	1,800	1,800	1,800	1,800	1,800	1,800
R2	0.09	0.20	0.25	0.00	0.14	0.22	0.00	0.00	0.00	0.00	0.00	0.01

Standard errors clustered by bank. *** p<0.01, ** p<0.05, * p<0.1

Herfindahl-Hirschmann-Index (*HHI*). To construct a measure of banks' market power in the mortgage market, we exploit the fact that the 26 Swiss cantons/ states can be considered as separate markets. Many cantonal as well as regional and savings banks operate only in specific cantons, leading to different numbers of competitors in each canton. We use annual data on mortgages on bank balance sheets by bank and canton to compute for each canton the market share of each bank. Then we calculate the HHI as the sum of squared market shares.[44] Hypothetically, this measure would reach a value of unity in the case of a perfect monopoly and approach zero under perfect competition. In our data based on 2014 balance sheets, the minimum value across all 26 cantons is 0.12 in Berne and the maximum value obtained for Appenzell Innerrhoden is as high as 0.49. We then map these 26 HHI values to banks by assigning to each bank the weighted average over these 26 values, using as weights the distribution of the bank's existing mortgage volume across the 26 cantons.[45] Then we interact our baseline negative rate treatment measure with the bank-specific measure of concentration of the average mortgage market the bank operates in.

[44] Note that for data reasons we compute this only based on the distribution of mortgage volumes already on banks' balance sheets, as opposed to the distribution of new lending, and therefore obtain a measure that is slightly backward-looking, reflecting new lending accumulated over the past few years. The resulting table of market concentration by canton is available on request.

[45] Notice that our original sample includes all banks chartered in Switzerland, so that we are in a position to calculate market shares for the entire market, not just for the subsample of retail banks that we focus on in our analysis.

Table A4. Wealth Management vs. Retail Banks

The sample covers 50 domestically owned retail and 46 domestically owned wealth management banks over the period July 2013 to June 2016 (36 months). The dependent variable in columns (1) to (12) is equal to the balance sheet shares of SNB reserves, the net interbank position, uncollateralized loans, mortgages, deposit funding, bond funding, the ratio of net interest income over total assets, net fee income over business volume (total assets plus assets under management), gross profits over business volume, risk-weighted assets over total assets, non-CHF assets over total assets, and non-CHF liabilities over total liabilities Rather than with Exposed Reserves, we interact the Post dummy with a dummy for the 46 Wealth Management banks, whose average treatment value was 20.6% of total assets, compared to -3.81% for retail banks. Standard errors are clustered by bank.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	All SNB Reserves (% of TA)	NIB Position (% of TA)	Loan Assets (% of TA)	Mortgage Assets (% of TA)	Deposit Funding (% of TA)	Bond Funding (% of TA)	NII (% of TA)	Net Fee Income (‰ of Business Volume)	Gross Profits (% of Business Volume)	RWA (% of TA)	Total Assets (FX Share)	Total Liabilities (FX Share)
Post*T	-7.34***	-2.73	1.72**	-0.18	-4.09*	0.25	-0.01	23.04	-0.06	0.02**	2.01*	3.75***
	(1.74)	(1.65)	(0.65)	(0.44)	(2.17)	(0.18)	(0.02)	(21.08)	(0.04)	(0.01)	(1.08)	(0.79)
T	WM	WM	WM	WM	WM	WM	WM	WM	WM	WM	WM	WM
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	3,456	3,456	3,456	3,456	3,456	3,456	565	565	565	1,112	3,396	3,396
R2	0.11	0.02	0.03	0.00	0.02	0.01	0.00	0.01	0.01	0.01	0.03	0.15

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table A5. Interaction with Banks' Capital Cushions

The sample covers 50 domestically owned Swiss retail banks over the period July 2013 to June 2016 (36 months). The dependent variable is equal to respectively the ratio of uncollateralized loans to total assets (columns 1 and 6), the ratio of mortgage loans to total assets (columns 2 and 7), the book value of a bank's financial assets, scaled by total assets (columns 3 and 8), as well as the ratios of deposit (columns 4 and 9) and bond funding (columns 5 and 10) over total assets. We estimate Model (1) interacted with the regulatory capital cushion in columns (1) to (5), and add bank and time fixed effects in columns (6) to (10). *RegCapCushion* is equal to the bank's actual risk-weighted capital ratio minus the supervisor's intervention threshold for the same measure in December 2014. *Post* is equal to one from January 2015 and zero otherwise. The continuous treatment variable is equal to exposed reserves (*ER*), i.e. the difference between total SNB reserves and the exemption threshold, scaled by total assets, in December 2014. Standard errors are clustered by bank.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Loan Assets (% of TA)	Mortgage Assets (% of TA)	Financial Assets (% of TA)	Deposit Funding (% of TA)	Bond Funding (% of TA)	Loan Assets (% of TA)	Mortgage Assets (% of TA)	Financial Assets (% of TA)	Deposit Funding (% of TA)	Bond Funding (% of TA)
Post*T*RegCapCushion	-0.53	-9.32	3.78	-1.52	-1.56	-1.53*	7.20	3.28*	7.93*	5.37**
	(1.42)	(6.12)	(2.67)	(5.70)	(5.47)	(0.81)	(5.28)	(1.91)	(4.27)	(2.55)
Post*RegCapCushion	-1.01	-90.67	7.29	-51.46	-22.60	-10.22**	61.64*	2.70	35.71*	23.43**
	(14.53)	(55.16)	(13.29)	(44.28)	(24.38)	(5.07)	(35.21)	(4.56)	(20.27)	(11.25)
T*RegCapCushion	-4.46	-135.30	-0.73	-106.74	-37.16					
	(24.58)	(137.98)	(10.56)	(153.19)	(44.03)					
RegCapCushion	-111.05	-1,214.22	1.88	-1,065.65	-343.25					
	(192.29)	(1,167.31)	(82.57)	(1,292.49)	(322.52)					
Post*T	1.00	80.01	-28.29	9.14	6.70	8.82	-49.33	-24.39**	-64.88**	-56.56**
	(11.06)	(70.11)	(17.31)	(46.89)	(51.28)	(5.44)	(30.29)	(11.83)	(27.12)	(24.57)
Post	-74.90	1,239.37**	-37.34	709.26*	403.41*					
	(111.67)	(596.06)	(89.82)	(399.35)	(213.74)					
T	146.08	1,591.05	33.38	1,586.50	479.68					
	(270.57)	(1,546.80)	(94.27)	(1,742.38)	(498.85)					
T	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER
Time FE	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Obs.	1,800	1,800	1,800	1,800	1,746	1,800	1,800	1,800	1,800	1,746
R2	0.08	0.08	0.02	0.09	0.12	0.01	0.25	0.09	0.09	0.25

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A6. Foreign Currency Exposure

The sample covers 50 domestically owned Swiss retail banks over the period July 2013 to June 2016 (36 months). The dependent variable is equal respectively to the ratio of non-CHF liquid assets to total liquid assets (columns 1 and 5), the ratio of total non-CHF assets to total assets (columns 2 and 6), the ratio of non-CHF deposits to total deposits (columns 3 and 7), and the ratio of non-CHF liabilities to total liabilities (columns 4 and 8). In columns (1) to (4) we estimate Model (1), in columns (5) to (8) we add bank and month fixed effects. *Post* is equal to one from January 2015 and zero otherwise. The continuous treatment variable (*T*) is equal to exposed reserves (*ER*), i.e. the difference between total SNB reserves and the regulatory exemption threshold, scaled by total assets, in December 2014. Standard errors are clustered by bank.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Liq Assets	Total Assets	Deposits	Total Liabilities	Liq Assets	Total Assets	Deposits	Total Liabilities
Post*T	1.38***	0.09**	0.12	0.03	0.50***	0.08***	0.02	-0.04
	(0.51)	(0.04)	(0.10)	(0.06)	(0.16)	(0.02)	(0.01)	(0.04)
Post	-6.80***	-0.39***	-0.18*	0.01				
	(1.10)	(0.12)	(0.10)	(0.18)				
T	-1.81***	-0.75***	-0.31**	-0.91***				
	(0.52)	(0.28)	(0.12)	(0.31)				
T	ER	ER	ER	ER	ER	ER	ER	ER
Time FE	No	No	No	No	Yes	Yes	Yes	Yes
Bank FE	No	No	No	No	Yes	Yes	Yes	Yes
Obs.	1,800	1,800	1,800	1,800	1,800	1,800	1,400	1,800
R2	0.10	0.08	0.07	0.09	0.16	0.12	0.04	0.03

Percentage share of the respective position held in foreign currency. Standard errors clustered by bank.
*** p<0.01, ** p<0.05, * p<0.1

Table A7. Liquidity Regulation under Basel III

The sample covers 50 domestically owned Swiss retail banks over the period July 2013 to June 2016 (36 months). In Panel A, the dependent variable is equal to the balance sheet shares of liquid assets (columns 1 and 6), SNB reserves (columns 2 and 7), claims on other banks (columns 3 and 8), the difference between a bank's interbank lending and borrowing (columns 4 and 9), and banks' Liquidity Coverage Ratio (column 5). In Panel B, the dependent variable is equal to respectively year-on-year growth in total assets (column 1), the ratio of uncollateralized loans to total assets (columns 2 and 7), the ratio of mortgage loans to total assets (columns 3 and 8), and the book value of a bank's financial assets, scaled by total assets (columns 4 and 9). In Panel C, the dependent variable is equal to the balance sheet share of deposit funding (columns 1 and 6), bond funding (columns 2 and 7), interbank funding (columns 3 and 8), cash bond funding (columns 4 and 9), and CET1 (columns 5 and 10). Throughout, we estimate Model (1) in columns (1) to (5), and add bank and month fixed effects in columns (6) to (10). *Post* is equal to one from January 2015 and zero otherwise. The continuous treatment variable (*T*) is equal to the difference between total liquid assets required of each bank in 2015 and the negative interest rate exemption over total assets (*LCR Dist.*).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A	Liquid Assets (% of TA)	All SNB Reserves (% of TA)	Claims on Banks (% of TA)	NIB Position (% of TA)	LCR	Liquid Assets (% of TA)	All SNB Reserves (% of TA)	Claims on Banks (% of TA)	NIB Position (% of TA)	
Post*T	5.41	2.88	-11.78	2.56	-8.00*	-39.58***	-41.25***	6.08	19.62***	
	(18.70)	(19.04)	(11.16)	(10.24)	(4.73)	(8.27)	(8.37)	(4.55)	(4.65)	
Post	3.32***	3.26***	-1.32**	-1.26*	-0.25					
	(1.09)	(1.10)	(0.63)	(0.73)	(0.22)					
T	5.40	11.74	6.72	-32.08**	-5.90					
	(29.77)	(30.18)	(15.92)	(15.53)	(4.69)					
T	LCR Dist.	LCR Dist.	LCR Dist.	LCR Dist.	LCR Dist.	LCR Dist.	LCR Dist.	LCR Dist.	LCR Dist.	
Obs.	1,764	1,764	1,764	1,764	1,078	1,764	1,764	1,764	1,764	
R2	0.14	0.14	0.02	0.06	0.09	0.28	0.30	0.03	0.14	

Panel B	TA (yoy growth)	Loan Assets (% of TA)	Mortgage Assets (% of TA)	Financial Assets (% of TA)			Loan Assets (% of TA)	Mortgage Assets (% of TA)	Financial Assets (% of TA)	
Post*T	6.01	7.47	-12.41	3.28			13.74***	11.41**	6.83***	
	(20.77)	(5.24)	(12.88)	(3.82)			(1.99)	(5.54)	(1.90)	
Post	1.12	-0.46	-1.76**	-0.26						
	(1.30)	(0.36)	(0.74)	(0.24)						
T	-13.02	-1.21	-74.75	24.16*						
	(11.40)	(25.42)	(61.75)	(13.84)						
T	LCR Dist.	LCR Dist.	LCR Dist.	LCR Dist.			LCR Dist.	LCR Dist.	LCR Dist.	
Obs.	1,764	1,764	1,764	1,764			1,764	1,764	1,764	
R2	0.01	0.01	0.05	0.07			0.26	0.06	0.12	

Panel C	Deposit Funding (% of TA)	Bond Funding (% of TA)	Interbank Funding (% of TA)	Cash Bond Funding (% of TA)	CET1 (% of TA)	Deposit Funding (% of TA)	Bond Funding (% of TA)	Interbank Funding (% of TA)	Cash Bond Funding (% of TA)	CET1 (% of TA)
Post*T	-7.11	1.42	-2.51	6.43	-0.11	13.10*	-12.23***	-12.25***	9.02***	-0.92
	(15.42)	(8.43)	(10.38)	(4.63)	(2.38)	(6.87)	(3.28)	(4.30)	(1.77)	(1.02)
Post	-1.49	1.01*	0.71	-0.19	0.06					
	(0.93)	(0.58)	(0.70)	(0.26)	(0.17)					
T	-104.51***	46.84	53.69*	-20.49	7.82					
	(36.07)	(31.88)	(27.43)	(19.41)	(8.03)					
T	LCR Dist.	LCR Dist.	LCR Dist.	LCR Dist.	LCR Dist.	LCR Dist.	LCR Dist.	LCR Dist.	LCR Dist.	LCR Dist.
Time FE	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Obs.	1,764	1,764	1,728	1,764	588	1,764	1,764	1,728	1,764	588
R2	0.15	0.06	0.09	0.02	0.02	0.05	0.13	0.08	0.28	

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table A8. The Role of Banks' Initial Deposit Rates

The sample covers 50 domestically owned Swiss retail banks over the period July 2013 to June 2016 (36 months). The dependent variable is equal to respectively the ratio SNB reserves to total assets (column 1), the net interbank position over total assets (column 2), uncollateralized loans over total assets (column 3), mortgage loans over total assets (column 4), the book value of a bank's financial assets, scaled by total assets (column 5), deposit funding over total assets (column 6), bond funding over total assets (column 7), cash bond funding over total assets (column 8), CET1 capital over total assets (column 9), the bank-level reference rates banks pay on demand (column 10) and sight deposits (column 11). Throughout, we estimate Model (2) and include bank and time fixed effects. The continuous treatment variables are equal to respectively exposed reserves (*ER*), i.e. the difference between total SNB reserves and the exemption threshold, the interest rate banks paid on demand deposits in December 2014 (*DDR*) and the interest rate banks paid on sight deposits in December 2014 (*SDR*). Standard errors are clustered by bank.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Panel A	All SNB Reserves (% of TA)	NIB Position (% of TA)	Loan Assets (% of TA)	Mortgage Assets (% of TA)	Financial Assets (% of TA)	Deposit Funding (% of TA)	Bond Funding (% of TA)	Cash Bond Funding (% of TA)	CET1 (% of TA)	Demand Deposits	Sight Deposits
Post*T*DDR	-0.19	0.18	-0.14	0.44**	0.10	0.58	0.85***	-0.24***	0.07	0.08**	-0.11***
	(0.18)	(0.31)	(0.23)	(0.19)	(0.37)	(0.49)	(0.21)	(0.06)	(0.09)	(0.04)	(0.03)
Post*T	-0.58***	0.23***	0.15***	0.17***	0.04	0.18*	-0.25***	0.09***	0.02	-0.02***	0.04***
	(0.04)	(0.07)	(0.03)	(0.06)	(0.04)	(0.10)	(0.05)	(0.02)	(0.01)	(0.01)	(0.01)
Post*DDR	0.58	-1.84	-1.53	0.82	-0.45	-0.51	2.98	-1.11**	0.62	0.22	-0.68*
	(1.59)	(2.92)	(1.21)	(1.34)	(1.52)	(3.18)	(2.33)	(0.46)	(0.85)	(0.25)	(0.34)
T	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER	ER
Obs.	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	444	1,332	1,332
R2	0.68	0.31	0.39	0.29	0.15	0.28	0.29	0.33		0.18	0.45

Panel B	All SNB Reserves (% of TA)	NIB Position (% of TA)	Loan Assets (% of TA)	Mortgage Assets (% of TA)	Financial Assets (% of TA)	Deposit Funding (% of TA)	Bond Funding (% of TA)	Cash Bond Funding (% of TA)	CET1 (% of TA)	Demand Deposits	Sight Deposits
Post*T*SDR	0.57**	-0.47	-0.27*	-0.39	-0.03	-0.54	-0.19	-0.15*	0.04	0.03	-0.04
	(0.22)	(0.31)	(0.14)	(0.23)	(0.16)	(0.42)	(0.18)	(0.09)	(0.05)	(0.03)	(0.03)
Post*T	-0.75***	0.42***	0.19***	0.38***	0.07	0.45***	-0.04	0.09**	0.02**	-0.01	0.02**
	(0.03)	(0.10)	(0.06)	(0.06)	(0.07)	(0.14)	(0.07)	(0.04)	(0.01)	(0.01)	(0.01)
Post*SDR	1.93	-1.18	-1.54***	0.24	-0.22	-0.80	1.26*	-0.62***	0.52	0.28	-0.63***
	(1.38)	(1.18)	(0.41)	(1.06)	(0.47)	(1.66)	(0.72)	(0.21)	(0.32)	(0.18)	(0.15)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	444	1,332	1,332
R2	0.69	0.31	0.41	0.30	0.14	0.27	0.25	0.32		0.15	0.50

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1