Breaking Banks? Monetary Policy and Bank Profitability *

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Preliminary – please do not quote

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Abstract

This paper uses a long-run perspective to study the effects of monetary policy on banking. I construct a new country level dataset on retail and central bank interest rates and bank profitability for the near-universe of industrialized countries from 1870 to 2015 and analyse the short- and medium-term effects of policy rate changes on banking spreads and bank performance. An increase in the policy rate drives the spread between lending and deposit rates up. The effect is mainly driven by a widening of the deposit-to-market spread, while the lending-to-market spread remains stable. On average, bank profitability falls after a policy rate hike – but the effect is highly state dependent. It is increasing in the share of mortgage credit in the economy and decreasing in the share of deposit finance in bank liabilities. This holds both in the long-run cross-country data and across individual banks in the United States.

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1 Introduction

Years after the start of the Great Recession banks all over the world still face serious profitability issues. Bank interest rate spreads compressed substantially during this period. Many economists and commentators hold the view that current monetary policy rates – which are in most industrialized countries still close to the so-called Zero Lower Bound – are the key drivers of the ever-decreasing spreads.[1] As a consequence, the push for a normalization of interest rates is particularly strong among commercial bankers.

This concern is not new. The narrative link between bank profitability and monetary policy reappears all over history. Still, there is surprisingly little empirical evidence on the relationship between the two that goes beyond the very recent period. Borio et al. (2015) find a positive relationship between interest rates and bank profitability for a large sample of banks between 1995 and 2012. English (2002) reports a mixed impact of interest rate changes on bank interest margins for 10 OECD countries between 1979 and 2001. Further, there is a large group of papers and policy reports that focuses on the contemporary developments in individual countries with mixed evidence (i.a. Busch and Memmel (2015), Sääskilahti (2016), and Scheiber et al. (2016)).

This paper provides new insights and facts for the debate using a long-run perspective. I construct a new dataset of retail and central bank interest rates from 1870 to 2015 for the near-universe of industrialized countries. I use this new source of data to study the effects of monetary policy on banking spreads and bank profitability (using the data by Richter and Zimmermann (2017)).

Several issues make an investigation from a historical cross-country perspective attractive. First, most of the current research relies on a limited sample and is based on the recent global boom and bust episode or individual country data. I can abstract from individual economic and country characteristics in this large long-run setting. Second, industrialized countries have experienced a downward trend in interest rates over the last 30 years. Any trend in profitability and spreads would result in a correlation between both variables, regardless of the underlying causes. A longer sample reduces the possibility of spurious correlation by providing substantial variation in interest rates, and economic and financial conditions. Third, I can use differences in the financial structure across countries and time to learn more

[1] Bank profitability and the ZLB in the news: "Miserable Year for Banks: Stocks Suffer as Rates Stay Low" (WSJ; April 10, 2016); "US banks gain from rate rises as savers suffer" (FT; April 20, 2017); "Higher interest rates point to more bank profits" (FT; March 13, 2017); and in research: Claessens et al. (2017), Sääskilahti (2016), Busch and Memmel (2015), Scheiber et al. (2016).

about the relative importance of individual channels. More specifically, I explore the role of the bank balance sheet composition for bank profitability.

This paper takes the perspective of the policy maker and focuses on the short- and medium term effects of *changes* in the policy rate.[2] I estimate the response of retail interest rates, banking spreads and bank profitability to a change in the policy interest rate using local projections (Jordà (2005)) controlling for a large set of macroeconomic control variables. I employ two procedures to guard against endogeneity problems – an instrumental variable strategy for the baseline results and micro data coupled with an exogenous shock series for the state dependent results. Jordà et al. (2017c) use interest rate variations in global financial centers as instruments for local interest rates in countries with open capital markets and fixed exchange rates. This instrument is particularly useful for my analysis due to its long-run and cross-country availability. I complement the long-run perspective with micro evidence based on US Call Report data and Romer and Romer (2004) identification of monetary policy shocks. The additional variation across banks eases the proper identification of causal state dependent outcomes. The results can be summarized by two major findings:

First, the lending spread increases if monetary policy tightens. When policy rates increase by one percentage point (ppt), spreads rise by 0.22 ppts in the first year and remain significantly elevated throughout the following years. The increase is mainly driven by a widening of the market-to-deposit spread to a change in the policy rate, while the lending-to-market spread shrinks on impact, but recovers quickly. Thus, banks are able to earn larger spreads when rates rise. However, the gross effect on bank profits still remains unclear. Policy rate increases lead to a slowdown of economic activity, losses on security investments and make credit with longer maturities less attractive.

Second, I find a negative effect of an increase in interest rates on the return on equity (RoE) and the return on assets (RoA). This is consistent with the finding by English et al. (2012), who find that bank stock prices in the United States respond negatively to an unanticipated increase in the interest rate. The profitability results are highly state dependent. When the share of mortgage credit in the economy is high, interest rate increases have a particularly negative effect on bank earnings. A higher share of deposits in bank liabilities reduces the estimated effects. These state-dependencies can also be found in US micro data. Banks with

[2]The appendix contains a section on the long-run correlations between the *level* of nominal interest rates and bank profitability. Once I control for basic macroeconomic variables, there is no correlation between interest rate levels and bank profitability. However, there is a robust and significant correlation between the lending-to-deposit spread and interest rate levels.

a high share of mortgages are hit harder when monetary policy tightens, while banks with a lot of deposits can cushion the contractionary effects.

My findings suggest the following key lesson: Risk for the banking sector lurks at both ends of the interest rate spectrum. Today, most bankers mainly worry about the low interest rate environment and its detrimental effects on bank spreads. However, raising rates too quickly exposes banks to substantial repricing and credit risks. My results show that banks are more likely to lose out from interest rate increases if they hold a lot of mortgages and finance themselves relatively little through deposits. The share of mortgage credit doubled on average since 1950 (Jordà et al. (2016b)). At the same time, the expansion of bank balance sheets was supported more and more by wholesale funding (Jordà et al. (2017b)). As a consequence, the results in this paper predict a higher sensitivity of bank profitability to monetary policy in the future.[3]

The structure of the paper is as follows. The next section reviews the theory and literature on bank profitability and monetary policy. The third section describes the data and the forth presents the empirical setting. Section five and six present the main results. I conduct a number of robustness checks in section seven. I test for the role of interest rate regulation, monetary policy tightening compared to easing, and monetary policy during booms and during recessions. Section eight concludes. The appendix contains tables with numerous other robustness checks, including time and country subsamples, checks for other relevant state dependencies, and level correlations of interest rates and bank performance.

2 Literature and Theory

The effectiveness of monetary policy hinges on a set of crucial transmission mechanisms, which are not directly controlled by central banks. Instead they are linked to economic agents' reactions and incentives after the policy change. If interest rates decrease, banks are supposed to make use of "cheaper" refinancing by lending more at lower rates. When monetary policy tightens banks are expected to cut lending and increase rates. Still, it is far from clear how banks adjust their retail interest rates as a response to policy changes (see for example Zentefis (2017), Brunnermeier and Koby (2016)) and how monetary policy affects banks more generally.

[3]Trends towards varaible rate mortgages and more sophisticated risk management might be able to counterbalance some of the increased exposure.

Most macroeconomic models carefully model households' and businesses' responses to a change in the interest rate, but there are relatively few that explicitly include a banking sector and model bank responses to monetary policy specifically. However, a one-for-one pass-through of monetary policy to borrowing and lending interest rates with no side effects on the banking system should not be taken for granted. The banking sector and its lending behavior is a keystone for the effectiveness and the transmission of monetary policy into the real economy (Bernanke and Gertler (1995), Kashyap and Stein (1994)). The channels through which monetary policy affects banks and bank performance can be grouped into three broad classes. The first class consists of the direct effects on the existing stock of assets and liabilities, the second class focuses on the indirect effects through the real economy, and a third class summarizes the endogenous responses of the bank to policy rate changes.

Work on the direct link between monetary policy and banking goes back to the founding fathers of modern economics. Samuelson (1945) describes how a simple maturity mismatch can affect bank margins and bank profitability: "[A] rise in interest rates hurts the banking system if the average time period of its inpayments exceed that of its outpayments" (Samuelson (1945)). Hence, different maturities between assets and liabilities generate a repricing risk for banks. Bank liabilities are typically considered to be of shorter maturity than bank assets. As a consequence, interest rate cuts should improve and interest rate increases should harm bank performance. The literature considers a number of additional direct mechanisms: Policy rate changes lead to a revaluation of securities on the bank balance sheet. Further, the incentive for borrowers to make use of option effects, such as early repayment clauses, is highly dependent on the interest rate level. Changes in the interest rate might also affect the yield curve and bank earnings through the term premium (see English (2002) for a detailed discussion of the individual sources of interest rate risk for banks).

There is a consensus among economists that monetary policy tightening typically leads to an economic contraction in the short-run, while expansionary monetary policy is followed by an expansion of the real economy (Christiano et al. (1999), Romer and Romer (2004)). These real effects feed back to the banking sector. Higher interest rates reduce loan demand and loan growth in the economy. Borrowers are more likely to default at higher rates, and banks have to increase their loan loss provisions to account for these expected losses. It is likely that non-interest income also falls when the real economy contracts. The indirect effects are largely believed to have overall negative effects on bank performance (English et al. (2012), Borio et al. (2015)).

Retail interest rates are essentially choice variables of the banking sector. Limited competition between banks, or other factors generating market power, might generate an incentive for banks to adjust retail rates differentially, or not one-for-one with the policy rate to extract a higher margin from customers. In this situation, the bank might trade-off the gains from higher margins with deposit outflows (Drechsler et al. (2016) and Williams (2016)). Also, if changes in the interest rate makes some assets more attractive relative to others, a bank might choose to adjust its asset composition after interest rate changes.

Table 1: Literature on monetary policy and bank performance

Paper	Result	Unit and Period
Research on realized profits, interest margins and spreads		
Hancock (1985)	positive	18 US banks, 1973-78
Demirgüç-Kunt and Huizinga (1999)	positive	Banks, 80 countries, 1988-95
English (2002)	ambiguous	10 OECD countries, 1979-01
Borio et al. (2015)	positive	109 banks, 1995-12
Busch and Memmel (2015)	neg. SR, pos. LR	Germany, 1968-13
Alessandri and Nelson (2015)	neg. SR, pos. LR	44 UK banks, 1992-09
Sääskilahti (2016)	positive	181 Finnish banks, 2005-14
Scheiber et al. (2016)	no effect	3 countries, 2007-16
Claessens et al. (2017)	positive	3385 banks, 2005-13
Research on stock market returns		
English et al. (2012)	negative	355 US banks, 1997-2007
Aharony et al. (1986)	negative	73 US banks, event study

SR: short-run; LR: long-run

Overall, the evidence on the link between monetary policy and bank performance is mixed. Demirgüç-Kunt and Huizinga (1999) show that banking margins and profitability are positively associated with the interest rate level. Borio et al. (2015) rely on a sample of 109 large international banks between 1995 and 2012 and study the effects of monetary policy on the return on assets, interest rate income and loss provisions. They find a positive effect on interest income that dominates negative effects on loss provisions and other income.

There are also a number of studies that find no, or even negative effects. English (2002) argues that monetary policy had no significant effect on bank interest margins between 1979 and 2001 for 10 OECD countries and Busch and Memmel (2015) even find negative short run effects for Germany (similarly Alessandri and Nelson (2015)) for the UK. Papers on bank stock returns after policy announcements tend to find significant decreases of bank stock prices after rate increases (Aharony et al. (1986) and English et al. (2012))

There is no consensus in the literature on the effects of interest rates on various measures of banking income and profitability (see Table 1). One reason may be that these studies typically focus on a limited time period or only one country. These studies can only partially control for individual economic and country characteristics. In particular, they are mainly based on data from the aftermath of the global financial crisis or might be significantly influenced by the downward trend in interest rates in industrailized countries in the last 30 years. This paper solves these issues by using a long-run dataset for a large group of countries. This allows me to abstract from current economic issues and investigate if there is indeed an inherent relationship between monetary policy and bank performance.

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3 A new dataset on bank retail interest rates

The new data in this project are the result of an extensive data collection effort over the last year. They cover retail interest rates on outstanding loans and deposits of the banking sector on an annual basis from 1870 to 2015 for the near-universe of industrialized economies. The countries included are Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States, representing almost the entirety of advanced economy GDP in the sample period. This dataset consists of four new interest rate series:

Deposit interest rate: The interest rate depositors receive on their short-term deposits in the banking system. Most of the data are 3 month term deposit interest rates. In some cases I rely on average interest rates received on total deposits, sight deposit rates, term deposit

rates at slightly different maturities or deposit rates of savings banks to fill gaps or extend the data into the 19th century.

Lending interest rate: The lending rate series is mainly based on short-term business credit. The recent data is typically based on business loans with a maturity of less than one year. For some countries I use the average rate on all loans of the banking sector or a group of banks or bank overdraft rates to extend the series backwards.

Mortgage interest rate: These loans are on average of longer maturity than business loans and are heavily collateralized. Historical data sometimes comes from specific mortgage banks, dominant government sponsored enterprises in the mortgage business, or life-insurance companies providing mortgage credit to households.

Return on equity and return on assets: The new series on commercial bank profitability provides me with data on the return on equity and the return on assets of the commercial banking sector (see Richter and Zimmermann (2017) for a detailed description). The figures are calculated by dividing annual net profits by paid-in capital plus reserves or total assets respectively.

Central bank policy rate: Central banks used a number of different interest rates to conduct monetary policy or provide liquidity to the banking system throughout history. Most of the data are based on the central bank discount rate, that is the rate at which financial institutions could obtain liquidity from the central bank. Central banks typically chose to move their individual interest rates jointly. As a consequence, the choice of the appropriate policy rate should not greatly influence the results of this paper.[4]

The new data come from a broad range of sources. The more recent data are typically based on publications of central banks and statistical offices. I extend these data backwards using economic and financial history books and articles, old publications of statistical offices and central banks and archival sources at private banks. I have relied on the help of a large group of economists, economic history scholars, archivars, librarians, and central bank employees, who directed me to potential sources or shared data and historical records with me. All acknowledgments are listed in the extended documentation of the dataset. This documentation also provides the specific sources that are used in the construction of the series. The primary goal of the dataset is to archive within-country and within-series consistency of the data. As a consequence, I accept differences in the specific type, structure or maturity of deposits and loans across countries if it helps to generate more consistent series. I use growth

[4]My definition of monetary policy in this paper is restricted to changes in the policy rate. I do not consider alternative monetary policy tools (as in Monnet (2014)).

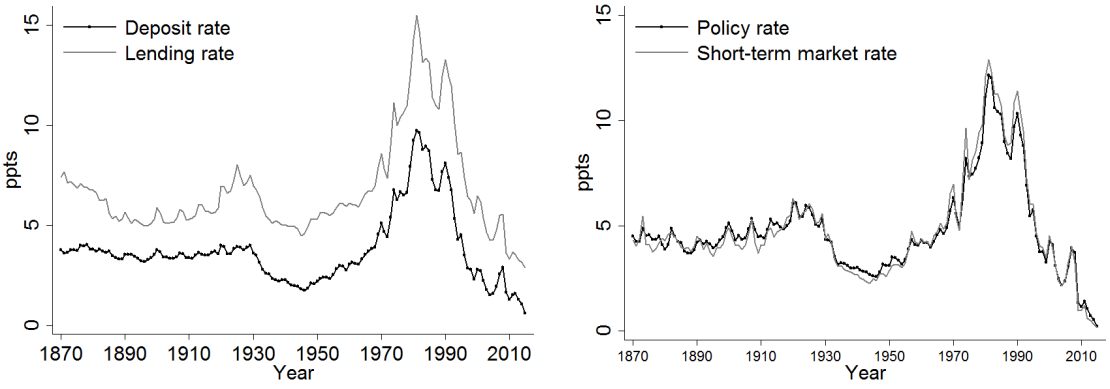
Table 2: Sample coverage of the interest rate series by country

Country	*Deposit rate*	*Lending rate*	*Mortgage rate*	*Policy Rate*	*CB Foundation*
Australia	1870–2014	1872–2015	1913–2015	1925–2014	1959 (1911)
Belgium	1870–2015	1950–2015	1870–2015	1870–2015	1850
Canada	1870–2014	1929–2014	1870–2014	1935–2014	1934
Denmark	1875–2015	1874–2015	1870–2015	1870–2015	1818
Finland	1870–2015	1870–2015	1870–2015	1870–2015	1811
France	1870–2015	1878–2015	1870–2015	1870–2015	1800
Germany	1870–2015	1888–2015	1870–2015	1870–2015	1876 (1847)
Italy	1870–2015	1870–2015	1876–2015	1893–2015	1893
Japan	1876–2014	1870–2014	1967–2015	1883–2015	1882
Netherlands	1882–2015	1884–2015	1870–2015	1870–2015	1814
Norway	1870–2015	1900–2015	1870–2015	1870–2014	1816
Portugal	1870–2015	1870–2015	1870–2015	1870–2015	1846
Spain	1922–2015	1913–2015	1877–2015	1874–2015	1874
Sweden	1870–2015	1870–2015	1870–2015	1870–2015	1668
Switzerland	1870-2015	1930–2015	1870–2015	1870–2014	1907
United Kingdom	1870–2014	1885–2014	1870–2014	1870–2014	1694
United States	1870–2014	1880–2014	1870–2014	1914–2014	1914

Note: These series show the earliest and the latest datapoint for each country. There are gaps in the data for some countries. Major gaps (mortgage rate): Finland 1936-88; Germany 1937-66; Italy 1941-1994; please contact the author for the detailed and extended documentation of the dataset. Years in brackets refer to first central-bank-like institutions. The Swiss policy rate series is extended back to 1870 using discount rates of important note-issuing banks.

rate splicing if two overlapping interest rate series differ by more than 30 basis points. This restriction preserves the original level of a majority of the data. The subsequent analysis in this paper is based on interest rate changes. Possible level errors due to insufficient splicing might increase the error terms and bias the estimated effects towards zero.

Table 2 shows the coverage of the dataset by country and interest rate. Most of the series extend well back into the 19th century or cover the entire period under consideration. The dataset includes on average 140 years of deposit rates, 118 years of lending rates, and 127 years of mortgage rates for each country. The policy rate series typically start in 1870 or right after the foundation of the central bank (see the foundation year in the last column of Table 2) and includes on average 130 years of data. Table 3 shows the summary statistics of the dataset, including the number of observations, the mean interest rate, the standard deviation and the maximum and minimum of each series. The average lending rate for the whole sample was 6.9 percent, around 3 percentage points above the average deposit rate. Mortgage rates were on average slightly lower at 6.2 percent. Interest rates fluctuated substantially over time. Therefore, Figure 1 might be a better summary of the dataset. It shows the cross-country mean evolution of the retail and policy interest rates over time. All



(a) Lending and deposit interest rate

(b) Policy and market interest rate

Figure 1: Mean interest rates by year for all countries

Table 3: Summary statistics of the long-run dataset

	Obs.	Mean	Sd. Dev.	Min.	Max.
Lending rate	2092	6.86	3.51	1.22	28.11
Mortgage rate	2158	6.20	2.87	1.06	26.88
Deposit rate	2334	3.75	2.51	0.04	28.00
Policy rate	2276	4.79	2.89	-0.74	25.00
Return on equity	2336	8.33	6.09	-113.77	35.15
Return on assets	2325	0.97	0.95	-8.57	6.98

Note: Mean, Standard Deviation, Minimum and Maximum are measured in percentage points.

interest rate series follow the same broad trends: First, interest rates were relatively stable at the beginning of the sample. After a first hump at the end of the 1920s rates declined substantially during the Great Depression and World War 2. Second, interest rates recovered in the 1950s and increased to record levels during the high inflation period of the 70s and early 80s. Lastly, interest rates declined dramatically in the last 30 years. The summary statistics and the Figure show that the 3-6 rule of banking - to borrow at three percent and lend at six percent was a good approximation of banking until the 1970.

I combine the new data on bank retail interest rates with the Macrohistory Database (Jordà et al. (2016a)) and data from Jordà et al. (2017a). The Macrohistory Database provides control variables and a low-risk, short-term market interest rate (mainly based on 3 month treasury bills). Long-term government bond yields and government bond returns come from Jordà et al. (2017a).

4 Method

The response of banking retail interest rates, spreads and profitability to policy changes is estimated with a fixed-effects panel specification using Jordà (2005) local projections:

$$\Delta y_{i;t-1,t+h} = \alpha_i + \theta_h \Delta irate_{i;t} + \Gamma_{h,1} X_{i,(t-1;t-2)} + \varepsilon_{i,t} \quad h \in \{0, ..., 4\} \tag{1}$$

Here $\Delta y_{i;t-1,t+h} = y_{i,t+h} - y_{i,t-1}$ is the cumulative forecast change of the outcome variable. The forecast is computed by 5 individual fixed-effect regressions ($h \in \{0, ..., 4\}$). α_i are country fixed effects, $\Delta irate_{i;t}$ is the change in the interest rate level and $X_{i,(t-1;t-2)}$ are control variables. The following control variables are included: (Two lags): past interest rate changes, a banking crisis dummy, the inflation rate, past GDP and credit growth, (One lag:) the GDP level, the credit to GDP ratio, the current account deficit and the interest rate level. Local projections estimate coefficients at each horizon directly. They easily accomodate state dependence (Jordà and Taylor (2016) and Owyang et al. (2013)), allow for nonlinear effects and do not require the same structural assumptions as a VAR.

There are a number of potential caveats for a causal interpretation of the main results. The baseline measure of monetary policy (the policy rate) used in this study is not exogenous to the state of the economy. As a consequence, endogeneity and reverse causality complicate the identification of the 'true' effects. I include a large number of macroeconomic and financial control variables to control for the state of the economy and reduce possible biases. However, the data are only available at annual frequency. This is particularly worrying, since even controlling for macroeconomic variables at quarterly frequency might not be enough to identify unbiased estimates of the effects on monetary policy (Romer and Romer (2004)).

I employ two procedures to address potential endogeneity concerns. First, I confirm the baseline local projection results using an instrumental variable specification. The instrumental variable is based on the *trilemma instrument* proposed by Jordà et al. (2017c). The trilemma of international finance states that is impossible to have an independent monetary policy, open capital markets and a fixed exchange rate at the same time (Obstfeld et al. (2005)). If countries are in a fixed exchange rate regime and have open capital markets, they "import" the monetary policy of the economic leader (base country). The *trilemma instrument* uses unexplained variation in the base country policy interest rate as an instrument for monetary policy in countries with open capital markets and fixed exchange rates (see section 6.2). Second, I use bank level data from the United States to confirm state dependent results.

Micro level data contains sufficient variation to identify these state dependent effects with bank and time fixed effects and guarantee instrument relevance of a seperate IV specification with Romer and Romer (2004) monetary policy shocks.

As explained in the literature and theory section, it is not clear from a theoretical standpoint if positive or negative effects on bank performance dominate in the aggregate. The relative size of these negative and positive forces is likely to differ across countries, banking structures and time. The results first present a baseline effect for the whole sample, and then investigate differences based on the balance sheet structure, the time period and country subsamples.

5 Monetary Policy and Banking Spreads

Banking differs markedly from other businesses. Banks do not only charge fees for their services, but also bill customers indirectly through an interest spread on top of their own cost of funds. Even though non-interest income is becoming more and more important in the last decades, interest income is still the most important source of income for commercial banks. Thus, falling banking spreads can reduce bank profitability, diminish bank capital positions and endanger financial stability.

Spreads between individual interest rates are driven by maturity differences, risk and bank service costs, but can also be influenced by industry structure, competition and the health of the financial system (Drechsler et al. (2016), Zentefis (2017), Brunnermeier and Koby (2016)). As a consequence, spreads might vary with the policy rate. A quick and complete transmission of policy to retail interest rates is crucial for the effectiveness of monetary policy. Any change in interest rate spreads might therefore not only be important for bank earnings, costs and profitability, but also have important implications for the effectiveness of monetary policy. This section discusses the effects of monetary policy on interest rate spreads. The focus will be on the lending-to-deposit spread (lending spread henceforth), but I will also present results on various other spread measures.

Table 4 reports the estimated response of the lending spread decomposed into the lending-to-market and market-to-deposit spread, and a number of other relevant spread responses. The lending-to-deposit spread widens when interest rates increase. A one percentage point increase in the policy rate leads to a 22 basis point increase of the spread in the first year. Lending spreads slowly normalize thereafter, but remain significantly elevated for a number of years.

Table 4: Policy rate changes and retail spreads

	Year 1	Year 2	Year 3	Year 4	Year 5
Lending spread	0.22(0.07)***	0.23(0.07)***	0.17(0.05)***	0.14(0.04)***	0.14(0.04)***
Observations	1620	1617	1604	1591	1574
Decomposition					
Loan–Market	-0.27(0.07)***	-0.05(0.06)	0.02(0.04)	-0.02(0.05)	0.00(0.05)
Observations	1605	1596	1578	1562	1543
Market–deposit	0.44(0.10)***	0.25(0.09)***	0.13(0.07)*	0.13(0.05)***	0.11(0.07)*
Observations	1670	1658	1636	1617	1597
Alternative spread measures and security prices					
Loan–Mort	0.33(0.05)***	0.27(0.07)***	0.13(0.04)***	0.08(0.05)*	0.05(0.05)
Observations	1433	1429	1416	1402	1385
Gbond–deposit	-0.15(0.07)**	-0.20(0.08)***	-0.10(0.07)	-0.08(0.07)	-0.08(0.06)
Observations	1683	1675	1658	1641	1623
Gbond price	-1.86(0.36)***	-1.58(0.36)***	-1.59(0.36)***	-1.33(0.40)***	-1.14(0.48)***
Observations	1628	1626	1610	1593	1576
Yield curve	-0.62(0.06)***	-0.43(0.08)***	-0.21(0.08)***	-0.19(0.08)***	-0.18(0.07)***
Observations	1677	1668	1645	1624	1603

Local projections with country fixed effects, macroeconomic controls and robust standard errors.

*, **, ***: Significant at 10%, 5% and 1% levels respectively. Loan–market: Lending to short-term market interest rate spread; Market–deposit: Market to deposit interest rate spread; Gbond return–deposit: Government bond yield to deposit interest rate spread; Gbond price: Government bond price; Yield curve: Government bond to short-term market interest rate;

The decomposition shows that the increase in lending spreads is driven by a substantial widening of the spread between market and deposit rates. The market-to-deposit spread increases by 44 basis points in the first year and is still 11 basis points above its original level in Year 5. The lending-to-market spread actually shrinks on impact – counterbalancing the effect on deposit spreads – but recovers afterwards. The widening of deposit-to-market spreads is consistent with the results in the empirical literature (Hannan and Berger (1991), Neumark and Sharpe (1992), Discoll and Judson (2013)), which generally finds a sluggish response of deposit rates to monetary policy. There are two main explanations for the widening of market-to-deposit spreads: imperfect competition between banks for depositors (Drechsler et al. (2016), Williams (2016)) and deposit rate regulation (see robustness section 7 for more detail). The response of these basic spreads cannot be explained by maturity differences. Both the lending and the deposit interest rate series are based on assets and liabilities with short maturities. If anything, the lending interest rate series might have longer maturities, which would work against the finding.

Banking includes a large set of activities aside from short-term deposit taking and lending. Therefore, the table also reports a selected number of additional spread measures and security price responses. Mortgage credit becomes less attractive relative to other lending when monetary policy tightens. This is not surprising, since mortgage credit typically had longer maturities than other credit and monetary policy affected long-term rates less than short-term interest rates. The yield curve result supports this explanation. I measure the slope of the yield curve using the difference of a long-term government bond yield and the short-term market interest rate (3 month treasury bill rate). The slope of the yield curve flattens when policy rates increase and ascends when policy rates decrease. The return for an investment in government bonds is also highly influenced by the policy rate. First, the spread between government bond rates and deposit rates increases and second, bond prices fall substantially. The results are broadly as expected. Policy rate increases lead to losses in the security portfolios and make credit with longer maturities less attractive.[5]

6 Monetary Policy and Bank Profitability

6.1 Baseline

This section analyses the effects of monetary policy on realized profits of the banking sector. I use accounting profit and balance sheet data to compute the return on equity and the return on assets in a given year. The previous analysis showed that that banks are able to earn larger lending spreads when rates rise. At the same time, they shift into more profitable activities, experience a deposit outflow and suffer losses in their security and long-term lending portfolios. The gross effect on bank profits still remains unclear. While banks might profit from the rate increase directly and widen their deposit margins they could also lose out due to the negative indirect effects coming from the contraction of the real economy. Falling GDP growth and stock prices, a slowdown of loan growth as well as the need for larger loan loss provisions are all likely to hurt bank performance. Thus, the net effect is far from clear.

Table 5 shows the effects of a monetary policy change on bank profitability. I find significant declines of bank profitability measured by both return on equity and return on assets in the first three years. A one percentage point increase in the interest rate decreases bank RoE significantly by 0.6 ppts over the first three years.

[5]Relative bank asset and liability compositions change as expected by these results. The share of mortgage credit in total credit falls and banks have to finance themselves more through non-deposit liabilities (results available upon request).

Table 5: Monetary policy and bank profitability

	Year 1	Year 2	Year 3	Year 4	Year 5
Return on equity	-0.29(0.21)	-0.48(0.18)***	-0.59(0.18)***	-0.52(0.18)***	-0.60(0.13)***
Observations	1638	1638	1625	1609	1593
Return on assets	-0.02(0.02)	-0.02(0.01)*	-0.03(0.01)***	-0.02(0.01)*	-0.03(0.01)***
Observations	1642	1643	1629	1611	1594

Response to a one percentage point increase in the policy rate. Effect measured in percentage points.
Local projections with country fixed effects, controls and robust standard errors.
*, **, ***: Significant at 10%, 5% and 1% levels respectively.

This result might be highly sensitive to the time period, major outliers in the profitability series (financial crises), specific countries under consideration or simply driven by endogeneity. I show in the robustness section and in additional tables in the appendix that the result becomes stronger and more significant after 1945 and is not exclusively driven by extreme observations. In section 6.2 I use the monetary policy instrument proposed by Jordà et al. (2017c) and find, if anything, even bigger effects. For simplicity the remainder of the paper focuses on the return on equity. The return on equity series has the advantage relative to the return on asset series, that it does not experience the same extreme long-run trends (Richter and Zimmermann (2017)).

6.2 IV results

Estimating the effects of monetary policy is plagued by endogeneity problems. In this section I use the trilemma instrumental variable proposed by Jordà et al. (2017c) to address these concerns. The trilemma of international economics refers to the impossibility for an economy having fixed exchange rates, independent monetary policy, and free capital flows simultaneously. An economy can have only two of these policies at one time. Thus, if countries have open capital markets and a fixed exchange rate, arbitrage and not the central bank determines interest rate fluctuations. The trilemma instrument is defined as follows:

$$z_{it} \equiv (\Delta r^*_{b(i)t} - \widehat{\Delta r^*_{b(i)t}}) * PEG_{it} * PEG_{i,t-1} * KOPEN_{it} \tag{2}$$

The instrument is based on situations when external conditions in a base country influence domestic policies – countries "import" their monetary policy. Here, $\Delta r^*_{b(i)t} - \widehat{\Delta r^*_{b(i)t}}$ are unpredictable movements in the base country interest rates, $KOPEN_{it}$ is a measure of capital openness and PEG_{it} is equal to one if the country has a fixed exchange rate. Following Jordà

et al. (2017c), I require that the country was already pegged in the previous year. I also apply the Jordà et al. (2017c) base country definition. The UK is the base country until 1919, the interwar base country is a mix of the US, the UK and France, depending on their adherence to the gold standard and the US becomes the sole base country from 1945 onwards. After 1973 Germany is defined as the base country for all EMS/Eurozone countries and the US remains the base country for the rest of the sample. A detailed description and discussion of the instrument and its validity can be found in Jordà et al. (2017c).

Table 6: IV Results

	Year 1	Year 2	Year 3	Year 4	Year 5
(a) Spread: Lending - deposit rates (Pegs only)					
BL Spec.	0.26(0.07)***	0.22(0.07)***	0.17(0.04)***	0.13(0.05)***	0.12(0.05)**
IV	0.46(0.06)***	0.56(0.18)***	0.35(0.11)***	0.23(0.09)***	0.05(0.13)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	1001	1006	1007	1003	996
(b) Return on equity (Pegs only)					
BL Spec.	-0.46(0.25)*	-0.32(0.25)	-0.53(0.23)**	-0.28(0.23)	-0.53(0.12)***
IV	-0.38(0.41)	-0.55(1.05)	-2.26(0.88)***	-1.32(0.90)	-1.52(0.77)**
Controls	Yes	Yes	Yes	Yes	Yes
Observations	1031	1029	1025	1016	1008

Local projections with country fixed effects, macroeconomic controls and robust standard errors.
*, **, ***: Significant at 10%, 5% and 1% levels respectively.

Table 6 shows the response of the two main outcome variables to policy rate changes in the baseline and the IV specification (profits and lending spread). In order to ease comparisons, the baseline specification (BL Spec.) is here restricted to pegged countries with existing values for z_{it}. The IV results are obtained by instrumenting the policy rate changes with z_{it}. The estimated effects become generally stronger when using the trilemma instrument. The reaction of the lending spread in the first year increases from 0.26 ppts to 0.46 ppts when using the instrumental variable and the initial drop of the return on equity is in the same ballpark as the baseline result, but rises substantially above the baseline estimates in the subsequent years. Jordà et al. (2017c) find similarly large attenuation bias of OLS estimates of the output reactions. The stronger initial responses are followed by a more pronounced bounce back in the later years. For example, even though the initial lending spread increase is substantially higher in the IV specification, the estimated cumulative effect drops to an insignificant 0.05 ppts in the fifth year.

Thus, on average over the whole sample and across all countries and banks the negative indirect effects prevail over the positive direct effects and the ability of the banking sector to charge wider margins at higher rates. The result is consistent with the negative responses of bank stocks to unexpected monetary policy shocks in Ampudia and Van den Heuvel (2017) and English et al. (2012). However, the result differs from the majority of other studies based on bank balance sheet and accounting information on a bank or country level (eg. Borio et al. (2015), Claessens et al. (2017), English (2002)). The results presented in the next section might provide a possible explanation for the variability of the results found in the literature. The effect on bank profitability is highly state dependent. In particular it depends on the asset and liability composition of the banking system as a whole (see section 6.3) and of individual banks (see section 6.4).

6.3 State dependence

Table 7: State-dependent effects of monetary policy on bank profits

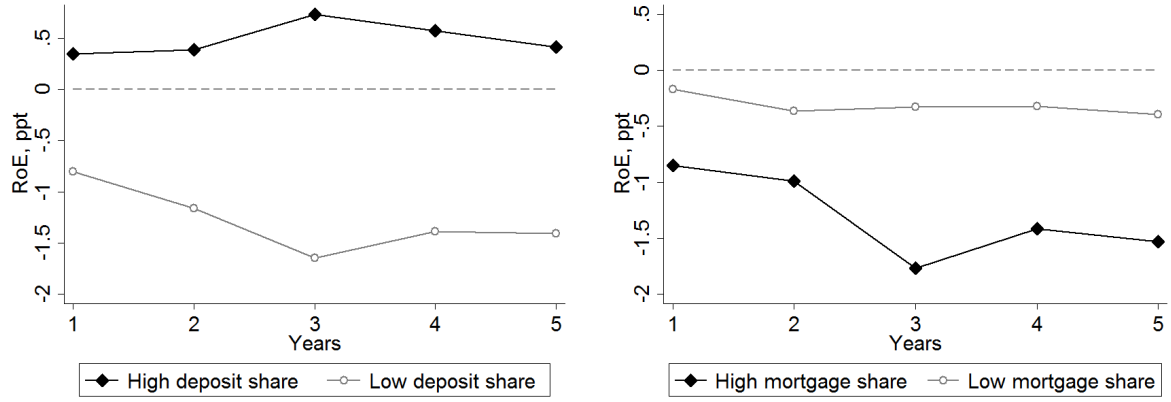
(a) Liability composition - The share of deposits in total liabilities					
	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Policy rate	-1.50**	-2.09***	-3.07***	-2.56***	-2.51***
	(0.58)	(0.46)	(0.59)	(0.63)	(0.63)
Δ Policy rate * deposit share	2.31**	3.10***	4.75***	3.91***	3.65***
	(0.84)	(0.76)	(0.94)	(1.12)	(1.08)
Observations	1625	1617	1609	1590	1571
Controls	Yes	Yes	Yes	Yes	Yes
(b) Credit Composition - The share of mortgage credit in total credit					
	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Policy rate	0.34	0.11	0.75*	0.50	0.46
	(0.32)	(0.28)	(0.36)	(0.41)	(0.33)
Δ Policy rate * mort. share	-1.71	-1.57	-3.61***	-2.74*	-2.84**
	(1.32)	(1.06)	(1.02)	(1.50)	(1.03)
Observations	1628	1620	1609	1589	1570
Controls	Yes	Yes	Yes	Yes	Yes

Local projections with country fixed effects, macroeconomic controls and robust standard errors.
*, **, ***: Significant at 10%, 5% and 1% levels respectively.

This section reconciles the profitability results with the previous results on retail spreads, by conditioning the effects on the share of mortgage credit and deposit finance in the economy.

Fortunately, previous work painstrikingly collected these two series and the authors kindly allowed me to use their data (Jordà et al. (2016b), Jordà et al. (2017b)). I add an interaction term of the policy rate and the share of deposits in total liabilities of the banking sector to the regression specification. The underlying idea is the following: Section 5 shows that deposit-to-market spreads increase when monetary policy tightens. The option for banks to profit from this mechanism depends on the overall share of deposits in the economy. The more deposit finance a banking system uses, the bigger the benefits from higher deposit-to-market spreads. Banks can use this additional income from their deposit taking business to counterbalance some of the negative effects in other business areas.

Indeed, Panel (a) of Table 7 shows that banking sectors with a smaller share of deposit liabilities show a more pronounced negative response to interest rate increases. Banks in these economies cannot rely as much on an increase of deposit spreads to counterweight the negative indirect effects of the real economy contraction. However, banks still face a trade-off. By increasing spreads in the short-run, they accept deposit outflows and lower revenue from their deposit business in the future.



(a) Liability side

(b) Asset side

Figure 2: Counterfactual profit evolution conditional on the balance sheet composition

Coefficients are based on a linear combination of the estimated cumulative coefficients. High deposit share: 80% deposits, 20% other means; Low deposit share: 30% deposits, 70% other means; High mortgage share: 70% mortgages, 30% other credit; Low mortgage share: 30% mortgages and 70% other credit

I apply the same approach to the share of mortgages in total credit. Mortgage credit can be seen as a crude proxy for longer-term credit in many countries. Further, mortgage lending becomes less attractive in the short-run when interest rates increase (section 5). Thus, the effect of a policy rate change on profitability might be substantially different for high mortgage share periods than for low mortgage share periods. The results in panel ba) confirm this view.

A larger share of mortgage credit in the banking sector leads to substantially stronger negative effects of interest rate increases on bank profitability.[6]

Figure 2 illustrates the size and relevance of the estimated state-dependent coefficients. Graph (a) shows two counterfactual responses to an 1 ppt increase in the policy rate, one for a banking sector that finances itself mainly through deposits and one that relies substantially on other means. Graph (b) performs the same function with high mortgage share and a low mortgage share counterfactuals. The counterfactual balance sheet compositions are chosen to reflect the upper and lower bound of realized values since 1950. Two findings stand out: First, banking systems with a low share of deposit finance are more exposed to risks arising from monetary policy and second, a larger share of mortgage credit increases the sensitivity of bank profitability to interest rate changes. The U.S. Savings and Loan Crisis of the 1980s can be seen as a good illustration of this finding. S&L banks typically used short-term financing on the liability side for their asset portfolio of long term mortgages. When inflation and market interest rates took off, their profitability and financing structure collapsed.

Industrialized economies have reached an all time high of the mortgage share in total credit (Jordà et al. (2016b)). At the same time the rise of money market funds and deposit outflows have increased the role of non-deposit liabilities for bank funding. All else equal, my results predict that we might see a higher sensitivity of bank profitability to monetary policy in the future. However, general trends towards variable rate mortgages, shorter fixed-rate periods or better risk management might provide a counterweight for this trend.

6.4 US Micro Evidence on State Dependence

The long-run cross country data uncovered that banking sector performance after monetary policy changes is largely determined by the balance sheet composition. The following section turns to US micro data and adds three additional important insights: First, it confirms the importance of the balance sheet structure. The balance sheet composition is not only crucial in the aggregate long-run cross-country setting, but also matters in the cross-section. It is a key determinant of the relative effects across banks. Second, it allows me to identify

[6]Table 11 in the appendix shows the results for a sample restricted to the post 1945 period. The results are in the same ballpark as the estimated coefficients in Table 7.; The mortgage share analysis has one additional potential caveat. The underlying mortgage credit and total credit data are based on all outstanding credit in the economy, no matter if it is bank credit or credit from other potential lenders. For example, historically U.S. life-insurance companies were heavily active in the mortgage business, while access for commercial banks was restricted. The amplification of the monetary policy shock by a high share of mortgage credit is therefore not necessarily directly - through the bank balance sheet - linked with lower profits. Instead, the lower profits could also be generated through stronger indirect general equilibrium effects of a monetary policy hike in an economy with a high share of mortgage credit.

the channel of the profit response. The state dependency is directly driven by the balance sheet composition and not by differential monetary policy responses of the real economy. Third, the state dependent results survive even the strongest possible robustness tests. They are still present after the inclusion of bank and time fixed effects and become larger in the IV specifications. Bank level data has sufficient variation in the balance sheet structure to identify and estimate the state dependent effects.

The analysis is based on annual bank level data for the United States. I combine data from US Call Reports from 1976 to 2011 with an exogenous monetary policy shock measure (Romer and Romer (2004), extended by Cloyne and Hürtgen (2016)) and a number of macroeconomic controls. The focus of this analysis is not on the average effect of monetary policy on bank profitability, but instead on the causal effects of policy changes conditional on the balance sheet structure in the previous period.

$$\Delta y_{i;t-1,t+h} = \alpha_i + \delta_t + \theta_h^1 \Delta irate_{i;t} + \theta_h^2 \Delta irate_{i;t} * Structure_{t-1} + \Gamma_{h,1} X_{i,(t-1)} + \varepsilon_{i,t} \quad h \in \{0, ..., 5\} \quad (3)$$

I estimate four different specifications of equation 3 (See Table 8). All of them include a bank fixed effect α_i, a number of bank specific and macroeconomic controls $X_{i,(t-1)}$ and interactions of the policy rate change and the balance sheet structure $\Delta irate_{i;t} * Structure_{t-1}$. Specifically, these interactions are the share of deposits in total liabilities and the share of mortgages in total credit (parallel to the aggregate analysis). Specification (i) and (ii) include the policy rate change itself $\Delta irate$, while specification (iii) and (iv) add time fixed effects δ_t. The data starts in 1976, however only few banks reported earnings on a quarterly frequency in the first years. I will therefore focus on annualized data and report results based on a smaller sample of quarterly data in the appendix (Table 13).

To control for bank specific characteristics I include bank size and bank size squared, bank leverage, the share of deposits in liabilities and mortgages in total credit as controls. I also add previous changes in the return on equity and the level of the return on equity to abstract from pre-existing profitability trends. The macroeconomic controls are the inflation rate, the level of the federal funds rate, lagged changes of the federal funds rate, and the four quarter and one-quarter growth rates of GDP, credit, house prices and stock prices.

Table 8: US micro data: Balance sheet dependent effects on bank profits

	Year 1	Year 2	Year 3	Year 4	Year 5
(a) Liability composition - The share of deposits in total liabilities					
Δ I-rate	-0.76(0.12)***	-1.12(0.14)***	-1.01(0.16)***	-1.44(0.18)***	-0.23(0.20)
Δ I-rate * D. Share	1.10(0.14)***	1.06(0.16)***	0.54(0.18)***	0.55(0.21)***	0.07(0.23)
Year FE	NO	NO	NO	NO	NO
IV	-2.77(0.24)***	-3.91(0.25)***	-4.84(0.36)***	-0.56(0.34)*	-0.51(0.35)
IV * D. Share	2.25(0.27)***	3.03(0.28)***	3.33(0.40)***	-0.73(0.40)*	-0.08(0.41)
Year FE	NO	NO	NO	NO	NO
Δ I-rate * D. Share	0.64(0.14)***	0.77(0.16)***	0.79(0.19)***	0.69(0.21)***	0.08(0.24)
Year FE	YES	YES	YES	YES	YES
IV * D. Share	1.27(0.28)***	1.36(0.28)***	1.81(0.38)***	0.70(0.41)*	-0.19(0.42)
Year FE	YES	YES	YES	YES	YES
(b) Credit Composition - The share of mortgage credit in total credit					
Δ I-rate	0.61(0.03)***	0.53(0.03)***	0.12(0.03)***	-0.28(0.04)***	0.35(0.05)***
Δ I-rate * M. Share	-0.93(0.04)***	-1.66(0.05)***	-1.53(0.05)***	-1.44(0.06)***	-1.00(0.07)***
Year FE	NO	NO	NO	NO	NO
IV	1.07(0.11)***	1.59(0.11)***	0.95(0.12)***	-0.27(0.09)***	0.15(0.09)*
IV * M. Share	-2.29(0.10)***	-3.45(0.09)***	-3.81(0.13)***	-1.60(0.15)***	-1.27(0.14)***
Year FE	NO	NO	NO	NO	NO
Δ I-rate * M. Share	-0.93(0.05)***	-1.66(0.05)***	-1.65(0.05)***	-1.56(0.06)***	-0.97(0.07)***
Year FE	YES	YES	YES	YES	YES
IV * M. Share	-1.70(0.12)***	-2.72(0.10)***	-3.37(0.13)***	-2.11(0.14)***	-1.17(0.14)***
Year FE	YES	YES	YES	YES	YES

Local projections with bank fixed effects, controls and robust standard errors.

*, **, ***: Significant at 10%, 5% and 1% levels respectively.

Table 8 shows the estimated cumulative response of bank profitability. It displays the coefficients of all four major specifications ((i)-(iv) in this order). All four specifications tell the same story: The interaction term between the monetary policy change and the deposit share of bank liabilities is significantly positive on impact and remains at the same level for a number of years. Year fixed effects and IV identification only change the size of the effect, but leave the basic insight unchanged. Banks with high deposit ratios profit relative to other banks when policy tightens. They earn more from larger market-to-deposit spreads and can use this money to counterbalance other losses. Ampudia and Van den Heuvel (2017) find the same state-dependency of bank stock prices to monetary policy surprises. High deposit ratios make banks less sensitive to monetary policy. The opposite holds true for banks with a lot of mortgage credit. The interaction terms are significantly negative.

The effect of monetary policy on banks is not set in stone. It depends crucially on the balance sheet composition of the individual bank. Banks are actively managing their balance sheet composition. Thus, banks are essentially choosing their interest rate sensitivity. This is consistent with the finding of Drechsler et al. (2017) that on average banks are able to reduce a large fraction of their interest rate risk by matching the interest rate sensitivty of their asset and liability side. However, even though banks engage in sensitivity matching the results in Table 8 clearly show that the balance sheet provides substantial additional information to understand the effects of monetary policy on banks.

7 Robustness

Interest rate regulation

Even though most countries nowadays only have a low level of interest rate regulation – typically preventing only the most extreme forms of usury – almost all countries in my sample went through a period of strong interest rate regulation in the last 150 years. The majority of countries introduced interest rate regulations after the Great Depression or the Second World War. Governments had two objectives in introducing these measures. First, they wanted to influence interest rates directly. In particular, several countries enacted policies to keep interest rates for businesses, households and the government at a low level. Typical regulatory measures to reach this goal were ceilings on lending interest rates or specified average lending rates.[7] Second, policy makers tried to improve banking sector stability through rate regulation. There was a widespread belief among policy makers that an unconstrained financial sector tends to engage in ruinous competition, which destabilizes the system and has negative spillovers to the rest of the economy. Typical measures to limit excessive competition in the financial sector included maximum deposit and time deposit rates, a minimum lending rate, or the toleration of interest rate cartels in the banking system.

Interest rate regulations can affect the results of this paper in various ways. The findings on spreads from section 5 might be affected if some of the retail rates were regulated, while others could move freely. For example, Regulation Q in the US prohibited interest rates on demand deposits and imposed ceilings on savings and time deposits. These ceilings were only adjusted every few years and did not mirror a market interest rate for deposits. At the same time, interest rates on lending were allowed to fluctuate freely. It is straightforward

[7] These measures can be seen as part of the "financial repression" policy apparatus after 1945. (Reinhart and Sbrancia (2011))

to see that policy rate increases would lead to initial spread increases in this regulatory setting. Second, regulated rates might adjust – by law – one-for-one with the policy interest rate. As a consequence, there might be a full transmission of policy rates to retail rates during the regulated period and lower pass-through of policy rate changes to retail rates after deregulation.

I construct a new long-run interest rate regulation index and investigate the effects when excluding regulation periods. The index is based on the work by economic and financial historians on the structure, regulation and history of the banking systems in the individual countries. In several countries interest rates were not directly set by the government, but instead by cartels, which often had the support and backing of the governments. I code these cases as regulated in the index. Futher, several countries enacted wartime interest rate freezes or controls. I code 1914–1919 and 1939–1945 for all countries as periods with interest rate regulation.

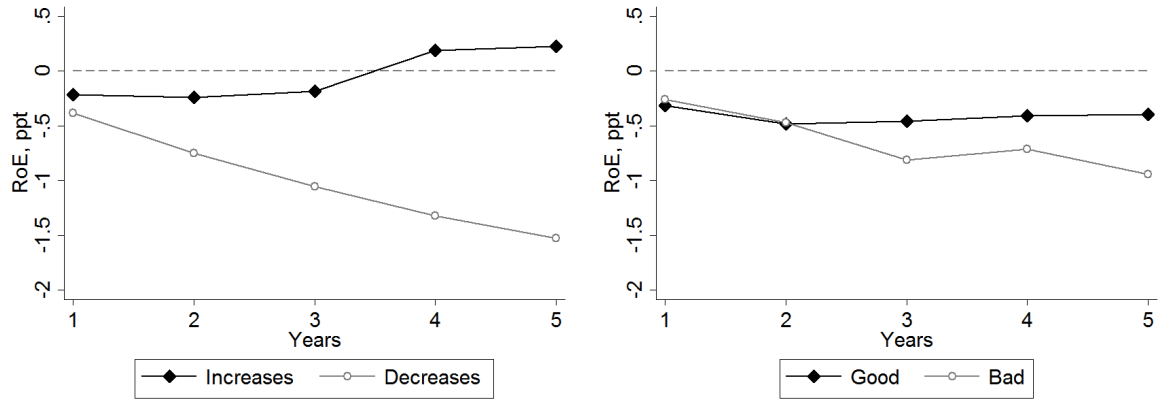
This new index uses a broad zero-one classification, compared to more detailed on financial sector regulations in the recent past (see Barth et al. (2004), Barth et al. (2013)). This is not a problem for this robustness check. I simply use the new index to exclude regulated periods from the baseline sample and confirm the results for a sample without interest rate regulation.

Table 14 in the appendix shows the effect of removing all regulated periods from the baseline sample. It also excludes all observations without reliable sources and information on interest rate regulation. The number of observations drops by roughly one third. Still, the results are basically unchanged. The positive effect on lending spreads and the negative effect on bank profitability are in the same ballpark as the baseline results. This does not imply that interest rate regulation had no effects. It is still likely that some countries had effective regulations on their interest rates with significant consequences for the banking system and the real economy. However, either these effects are washed out on the average, or complete pass-through regulations equilibrate the effect in the baseline result[8].

Subsamples

I examine the impact of monetary policy on the banking system for a number of subsamples (see Table 10 and Table 15 in the appendix). More specifically, I test if the results are driven by individual country groups or banking crisis observations. I run separate regressions without Anglo-American and Scandinavian countries and drop all observations directly preceding and

[8] A number of countries regulated retail interest rates to move directly one-to-one with the policy rate or chose to adjust all interest rates simultaneously with the policy rate.



(a) Increases and decreases

(b) Good and bad times

Figure 3: Counterfactual profits for increases and decreases

following an banking crisis from the regression. The results are in the same ballpark as the baseline coefficients (see Table 15). Table 10 splits the dataset into a pre-1945 and a post 1945 sample and estimates the effects for both subsamples separately. Again, the results are similar, but the post 1945 coefficients generally have lower error bands and are more significant.

Increases and Decreases

I check whether interest rate increases and decreases have different effects on bank profitability. If competition is imperfect, Banks might choose to react differentially to positive and negative policy changes to increase profits. A number of empirical studies have found support for this argument and show that deposit rates are downwards-flexible and upwards-sticky (Discoll and Judson (2013) and Hannan and Berger (1991)). Not only bank responses, but also the effect on the aggregate economy is not symmetric. Angrist et al. (2016) find that a monetary policy tightening tends to have larger effects on economic activity than a monetary policy loosening. Panel (a) of Figure 3 displays the profitability responses to increases and decreases of the policy rate separately. Profits react stronger to policy rate decreases than to policy rate increases. However, this does not mean that policy rate increases have no impact on bank profitability. For both, increases and decreases, the response of bank profitability is largely driven by the balance sheet composition of the banking sector (see Figure 5 in the appendix).

State of the economy

Existing research shows that monetary policy tends to have larger effects in booms than in recessions (Jordà et al. (2017c)). I investigate if similar state dependencies can also be found

for bank profitability. To examine this nonlinearity, I split the dataset into boom and bust observations based on the Bry and Boschan (1971) algorithm. I find that the boom and bust coefficients track each other closely (see Panel (b) of Figure 3).[9] The effect on bank profitability does not exhibit the same non-linearities as the output response.

8 Conclusion

This paper presents the first cross-country evidence on the impact of monetary policy on the banking sector over the long-run. This novel focus reveals an important fact: the effect of monetary policy on bank profitability is highly state dependent. The sensitivity of bank profits to monetary policy depends significantly on the share of deposits in bank liabilities and the share of mortgages in total credit. It decreases in the share of deposit liabilities and increases in the share of mortgages. A larger share of mortgage credit, which is typically fixed for longer periods than non-mortgage credit, exposes banks to additional interest rate risk. The spread between deposit and market interest rates increases with the policy rate. Banks with a large deposit ratio can use the additional revenue to sustain bank profitability.

Rising shares of mortgages in total credit (Jordà et al. (2016b)) and a replacement of traditional deposits with more market-based liabilities (Jordà et al. (2017b)) are thus likely to make bank profitability particularly sensitive to interest rate changes. Demands for a quick normalization of interest rates should therefore be met with the appropriate caution. There are a number of factors that might counter these general trends. The repricing risk of the stock of outstanding mortgages is likely to fall due to strong trends towards variable rate mortgages in a number of industrialized economies. Also, new systems for the management and hedging of individual risks are likely to improve risk sharing and reduce the exposure of the system by allocating inversely correlated risks better across market participants.

[9] A sample split based on the cyclical component of HP-filtered data (one-sided) leads to similar results

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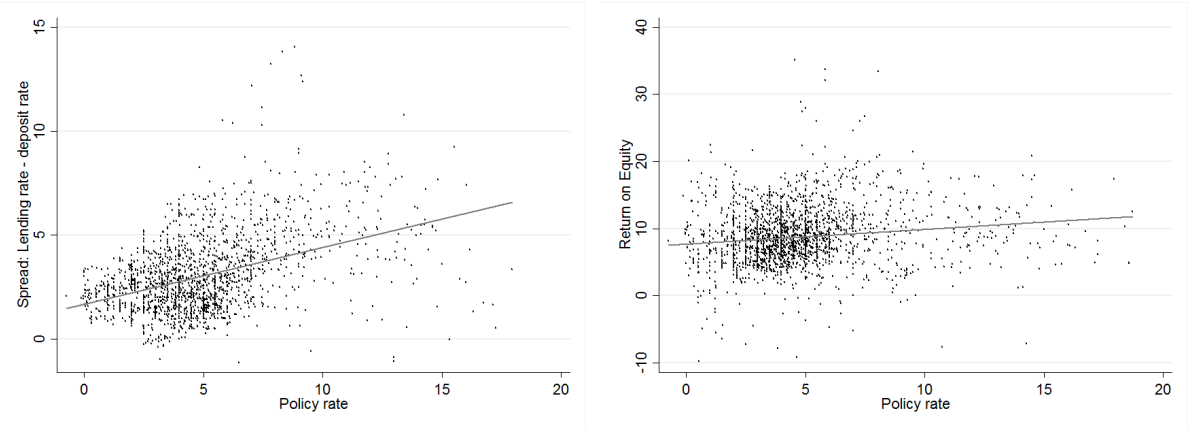
A Banking income and the interest rate level

The main part of the paper focuses on the relationship between monetary policy changes and bank performance. This section takes a different approach and investigates the level relationships. There is a widespread belief among bankers and economists that low interest rate levels are bad for banking spreads and profitability. This section provides evidence against a clear cut view on this issue. Even though interest rates and bank spreads are positively correlated, there is no robust correlation between bank return on equity and the interest rate level.



(a) Lending spread

(b) Return on equity

Figure 4: Level correlations

I omit extreme observations of the return on equity and the interest rate series (return on equity > -10, interest rates < 20) for graphical purposes

Figure 4 shows basic scatter-plots of bank profitability, lending spreads and the interest rate level. Figure 4(a) plots lending spreads and the policy rate and Figure 4(b) the return on equity and the policy rate. Both plots include a fitted regression line of the pooled dataset. There is a strong correlation of the lending spread and the interest rate level in the pooled data. Return on equity is also positively correlated with the interest rate level, but the connection is considerably weaker.

Table 9: Banking income and the interest rate level

	Lending spread	Lending spread	Return on equity	Return on equity
Policy rate	0.26***	0.20***	0.14	-0.06
	(0.07)	(0.06)	(0.11)	(0.10)
Controls	No	Yes	No	Yes
Observations	1946	1629	2163	1649

Interest rate levels, bank profitability and lending spreads are all likely to be highly influenced by the state of the economy. Standard regression control techniques are therefore a natural second step for a more robust investigation of the level relationships. Table 9 shows the results of a country fixed effects panel regression with and without controls. I condition a large number of macroeconomic controls to capture the state of the economy. As expected, past GDP growth rates, inflation and a number of other macroeconomic variables are highly correlated with spreads and the return on equity. Even after controlling for all these macroeconomic variables, there is still a positive correlation between the lending spread and the level of the policy interest rate. However, the weak positive correlation between the interest rate level and the return on equity disappears.

B Additional robustness tables

B.1 Results by period

Table 10: Effects before and after 1945

	Year 1	Year 2	Year 3	Year 4	Year 5
(a) Before 1945					
Lending spread	0.14(0.15)	0.14(0.12)	-0.04(0.07)	-0.02(0.06)	-0.04(0.05)
Observations	491	494	497	500	500
Return on equity	-1.59(2.05)	0.20(0.23)	-0.29(0.44)	-0.53(0.82)	-0.65(0.61)
Observations	526	526	525	525	526
(a) After 1945					
Lending spread	0.23(0.07)***	0.23(0.07)***	0.18(0.05)***	0.14(0.04)***	0.15(0.04)***
Observations	1129	1123	1107	1091	1074
Return on equity	-0.20(0.11)*	-0.60(0.22)***	-0.73(0.19)***	-0.57(0.19)***	-0.60(0.13)***
Observations	1112	1112	1100	1084	1067

Local projections with country fixed effects, macroeconomic controls and robust standard errors.

% Pass-through: cumulative rate change relative to the cumulative policy rate change;

*, **, ***: Significant at 10%, 5% and 1% levels respectively.

Table 11: State-dependent effects after 1945

(a) Liability composition - The share of deposits in total liabilities					
	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Policy rate	-0.93**	-1.89***	-2.97***	-2.03***	-1.91***
	(0.37)	(0.45)	(0.58)	(0.54)	(0.58)
Δ Policy rate * deposit share	1.44**	2.52***	4.42***	2.89**	2.57**
	(0.62)	(0.73)	(0.90)	(1.02)	(1.08)
Observations	1099	1094	1087	1070	1053
Controls	Yes	Yes	Yes	Yes	Yes
(b) Credit Composition - The share of mortgage credit in total credit					
	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Policy rate	-0.04	-0.11	0.57	0.06	0.02
	(0.22)	(0.32)	(0.35)	(0.34)	(0.30)
Δ Policy rate * mort. share	-0.41	-1.31	-3.45***	-1.67	-1.64*
	(0.62)	(1.14)	(1.04)	(1.28)	(0.86)
Observations	1103	1098	1088	1070	1053
Controls	Yes	Yes	Yes	Yes	Yes

Local projections with country fixed effects, macroeconomic controls and robust standard errors.
*, **, ***: Significant at 10%, 5% and 1% levels respectively.

B.2 IV effects

Table 12: State-dependent IV effects

(a) Liability composition - The share of deposits in total liabilities					
	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Policy rate	-1.60	-5.11***	-6.48***	-5.76**	-6.12***
	(1.49)	(1.87)	(2.40)	(2.64)	(2.06)
Δ Policy rate * dep. share	2.77	9.78***	8.99**	9.64**	9.45***
	(3.50)	(3.62)	(3.85)	(4.37)	(3.45)
Observations	1076	1070	1063	1054	1045
Controls	Yes	Yes	Yes	Yes	Yes
(b) Credit Composition - The share of mortgage credit in total credit					
	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Policy rate	-1.45	-4.28	-0.25	-6.71	-4.56
	(2.25)	(3.57)	(3.62)	(6.39)	(4.49)
Δ Policy rate * mort. share	2.37	7.63	-4.88	11.44	5.97
	(4.81)	(8.39)	(7.52)	(12.90)	(8.88)
Observations	1050	1044	1037	1028	1019
Controls	Yes	Yes	Yes	Yes	Yes

Local projections with country fixed effects, macroeconomic controls and robust standard errors.
*, **, ***: Significant at 10%, 5% and 1% levels respectively.

B.3 Micro Evidence

Table 13: US micro evidence: Quarterly data

	Year 1	Year 2	Year 3	Year 4	Year 5
(a) Liability composition - The share of deposits in total liabilities					
Δ I-rate	-0.94(0.19)***	0.43(0.24)*	1.08(0.24)***	0.37(0.21)***	1.62(0.23)***
Δ I-rate * D. Share	1.29(0.24)***	-0.46(0.28)	-1.39(0.28)***	-0.46(0.25)***	-1.62(0.27)***
Year FE	NO	NO	NO	NO	NO
IV	-1.52(0.27)***	-1.65(0.32)***	-0.48(0.34)***	0.85(0.31)***	1.83(0.32)***
IV * D. Share	1.65(0.33)***	1.93(0.39)***	0.58(0.42)***	-1.10(0.38)***	-2.21(0.39)***
Year FE	NO	NO	NO	NO	NO
Δ I-rate * D. Share	1.17(0.26)***	0.22(0.32)	0.04(0.31)***	0.13(0.28)***	-1.36(0.30)***
Year FE	YES	YES	YES	YES	YES
IV * D. Share	2.88(0.36)***	2.78(0.43)***	1.06(0.47)***	0.25(0.43)***	-1.37(0.43)***
Year FE	YES	YES	YES	YES	YES
(b) Credit Composition The share of mortgage credit in total credit					
Δ I-rate	0.30(0.04)***	0.35(0.05)***	-0.01(0.04)***	-0.02(0.04)***	0.33(0.04)***
Δ I-rate * M. Share	-0.36(0.09)***	-0.69(0.10)***	-0.19(0.10)***	0.02(0.09)***	-0.16(0.10)***
Year FE	NO	NO	NO	NO	NO
IV	0.34(0.06)***	0.35(0.06)***	0.12(0.06)***	0.03(0.06)***	0.24(0.06)***
IV * M. Share	-1.02(0.11)***	-0.85(0.12)***	-0.26(0.14)***	-0.22(0.13)***	-0.59(0.14)***
Year FE	NO	NO	NO	NO	NO
Δ I-rate * M. Share	-0.47(0.11)***	-0.77(0.11)***	-0.64(0.11)***	-0.27(0.10)***	0.17(0.10)***
Year FE	YES	YES	YES	YES	YES
IV * M. Share	-1.21(0.13)***	-1.26(0.15)***	-0.81(0.17)***	-0.56(0.16)***	0.01(0.16)***
Year FE	YES	YES	YES	YES	YES

Local projections with bank fixed effects and robust standard errors.

*, **, ***: Significant at 10%, 5% and 1% levels respectively.

B.4 Other considerations

Table 14: Periods without interest rate regulation

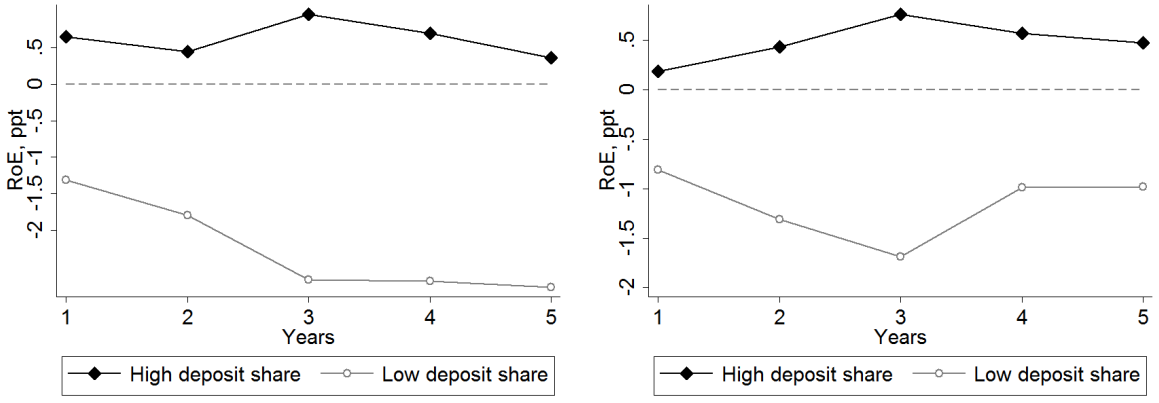
	Year 1	Year 2	Year 3	Year 4	Year 5
Lending spread	0.20(0.07)***	0.19(0.07)***	0.15(0.04)***	0.09(0.04)***	0.06(0.06)
Observations	1015	1014	1003	992	977
Return on equity	-0.13(0.14)	-0.40(0.28)	-0.52(0.27)*	-0.26(0.24)	-0.39(0.15)***
Observations	1036	1034	1018	1001	985

Local projections with country fixed effects, macroeconomic controls and robust standard errors.
*, **, ***: Significant at 10%, 5% and 1% levels respectively.

Table 15: Subsample robustness of the bank profitability results

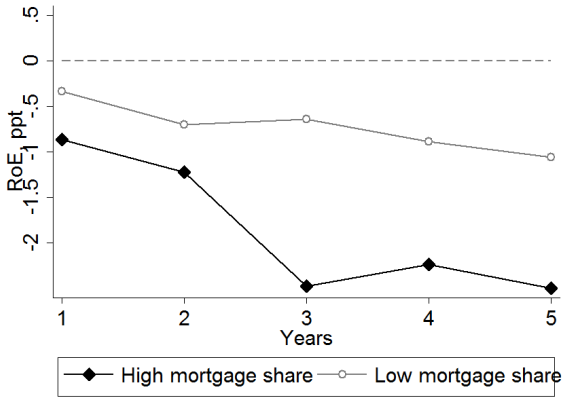
	Year 1	Year 2	Year 3	Year 4	Year 5
(a) Exclude financial crisis window					
Return on equity	-0.15(0.08)*	-0.28(0.11)***	-0.52(0.14)***	-0.32(0.17)*	-0.47(0.09)***
Observations	1262	1264	1254	1248	1244
(b) Exclude Scandinavian countries					
Return on equity	-0.36(0.24)	-0.46(0.14)***	-0.62(0.16)***	-0.62(0.13)***	-0.54(0.09)***
Observations	1153	1153	1143	1131	1119
(c) Exclude Anglo-American countries					
Return on equity	-0.38(0.27)	-0.50(0.21)***	-0.57(0.22)***	-0.52(0.23)**	-0.67(0.17)***
Observations	1330	1330	1319	1306	1293
(d) Baseline results					
Return on equity	-0.29(0.21)	-0.48(0.18)***	-0.59(0.18)***	-0.52(0.18)***	-0.60(0.13)***
Observations	1638	1638	1625	1609	1593

Local projections with country fixed effects, macroeconomic controls and robust standard errors.
*, **, ***: Significant at 10%, 5% and 1% levels respectively.



(a) Decreases

(b) Increases



(c) Decreases

(d) Increases

Figure 5: Counterfactual profits for increases and decreases