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**Monetary Policy and Bank Equity Values in a Time of Low and  
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# Monetary Policy and Bank Equity Values in a Time of Low and Negative Interest Rates<sup>1</sup>

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## Abstract

Does banks' exposure to interest rate risk change when interest rates are very low or even negative? Using a high-frequency event study methodology and intraday data, we find that the effect of surprise interest rate cuts announced by the ECB on European bank equity values – an effect that is normally positive – has become negative since interest rates in the euro area reached zero and below. Since then, a further unexpected cut of 25 basis points in the short-term policy rate lowered banks' stock prices by about 2% on average, compared to a 1% increase in normal times. In the cross section, this 'reversal' was far more pronounced for banks with a more traditional, deposit-intensive funding mix. We argue that the reversal as well as its cross-sectional pattern can be explained by the zero lower bound on interest rates on retail deposits.

**JEL-codes:** G21, E52, E58

**Keywords:** negative interest rates, monetary policy, bank profitability, ECB

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## 1. Introduction

In July 2012 the ECB lowered its deposit facility rate to 0%. A series of further cuts pushed the deposit facility rate into negative territory, reaching -0.4% in March 2016. These cuts were intended to provide more monetary accommodation amid low inflation and weak economic conditions. At the same time, some have blamed the low and negative rate environment for damaging banks' profitability by reducing their income from interest-earning assets and even for endangering their viability in the medium term.<sup>4</sup> Lower bank profitability would be of significant concern, as it could impair banks' ability to lend, which would be a drag on economic activity. Moreover, it could also reduce banks' resilience to economic shocks, creating a potential risk to financial stability.

Our results suggest that there are grounds for such concerns. We find that the effect of interest rate cuts on bank equity values – normally positive – has become negative since rates in the euro area reached zero and below. Moreover, this 'reversal' was more pronounced for banks with a more traditional, deposit-intensive funding mix, a result that we argue indicates a specific causal mechanism.

As a theoretical matter, reductions in interest rates generally reduce banks' interest income over time, as assets reprice at lower rates. However, banks also benefit from rate cuts, which reduce funding costs, generate capital gains on existing long-term assets, and can stimulate the broader economy, thereby boosting the demand for banks' products and improving the evolution of their non-performing loans. More crucially, however, the question is why these effects of rate cuts would be *different* when interest rates are near or below zero?

A key fact in this regard is that banks are very reluctant to charge negative interest rates to depositors. In part, this reflects the existence of cash –an alternative to bank deposits which by definition has a zero nominal yield– and in part it reflects a desire to maintain relations

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<sup>4</sup> The banking industry has been especially vocal about this. For example, Francisco González, BBVA's CEO, claimed that "de facto negative rates currently prevailing in the euro area are killing the banks" (Institute of International Finance Spring Membership Meeting, Madrid, May 24, 2016), and the German private banks' association BdB has demanded that the ECB introduce thresholds that exempt a portion of banks' excess reserves from negative interest rates. Central bankers are also aware of the potential negative consequences of negative rates, as expressed by the European Central Bank's Executive Board member Benoît Cœuré: "Central bankers should however be mindful of a potential "economic lower bound," at which the detrimental effects of low rates on the banking sector outweigh their benefits, and further rate cuts risk reversing the expansionary monetary policy stance" (Yale University, 28 July 2016, <https://www.ecb.europa.eu/press/key/date/2016/html/sp160728.en.html>).

with customers, who might find negative rates unacceptable.<sup>5</sup> As a result, banks that rely on retail deposits as a significant part of their funding will see much smaller declines in their funding costs when market interest rates drop into negative territory, compared to a situation where rates drop a similar amount but from normal or high levels. Because rate cuts will still reduce interest income over time in the usual way, net interest margins of deposit-intensive banks can get squeezed by sub-zero or very low market interest rates. Unless these banks can compensate, say, by shifting to higher-earning assets or by finding new sources of income, the reduction in net interest margins will hurt their overall profitability.<sup>6</sup>

Motivated by this backdrop, this paper aims to make two main contributions: First, we employ a high-frequency event study methodology to quantify the effect of surprise interest rate changes induced by conventional monetary policy actions on bank equity values in the euro area. Bank equity values are used as a convenient summary measure of current and future bank profitability. They are also available at the high frequency needed for our identification strategy, which is similar to Kuttner (2001), Gürkaynak et al. (2005), Bernanke and Kuttner (2005), and others; although we adapt our strategy to the institutional features of the euro area, using intraday (tick-by-tick) data on interest rate swaps, sovereign bond yields and individual bank stock prices. Our second main contribution is then to assess if, how, and why the observed effect of interest rate surprises on bank equity values has changed in the current period of low and even negative interest rates.

Our main findings are as follows. First, on average, an unexpected decrease of 25 basis points in the short-term interest rate boosts euro area banks' stock prices by 0.97%. We also find effects with a negative sign from long-term rate surprises, but they are not always statistically significant. Second, these effects vary over time. They were stronger during the crisis and, most strikingly, reverse during the recent period with low and even negative interest rates. During that period, further interest rate cuts harmed banks' equity values, with a 25 basis point surprise cut *decreasing* bank stock prices by 2.0%. This finding is consistent with the notion of a "reversal rate" of monetary policy (Brunnermeier and Koby, 2019).

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<sup>5</sup> Even if rates would have to be negative enough to overcome the opportunity costs of holding cash, only two banks are "remunerating" deposits at negative rates (and only for deposits above a certain threshold).

<sup>6</sup> Heider, Saidi, and Schepens (2018) find evidence consistent with changes in asset risk as well as volumes in the low rate environment. In particular, focusing on syndicated loans, they find that that high-deposit banks take on more risk and lend less than low-deposit ones when rates become negative.

Our third main finding supports the role of a zero lower bound on deposit rates as a driver of the ‘reversal’ in the observed impact of conventional monetary policy on bank equity values in the period of low and negative interest rates. Specifically, we find that banks that rely more on deposit funding experience a much larger reversal in the effect of short-term interest rate surprises on their equity values once rates are low or negative. We argue that this is exactly what one should expect if the reversal phenomenon under near- or sub-zero rates is, at least in part, due to a “zero lower bound” on interest rates on deposits. As mentioned, banks’ reluctance to charge negative rates to depositors implies that declines in short-term market rates are likely to squeeze deposit-intensive banks’ net interest margins when short-term rates are already low: interest earnings drop with market rates but funding costs do not fully adjust, hurting their profitability. In effect, we are able to test whether this mechanism can explain the reversal by sorting banks on their reliance on deposits as a funding source, and we find that it does. This result is corroborated by additional evidence: net interest margins of deposit-intensive banks declined markedly in the recent period of low and negative interest rates, whereas as margins of low-deposit banks remained more or less constant (figure 4). Moreover, during that period, stock prices of deposit-intensive banks underperformed relative to low-deposit banks (figure 5).

Although this evidence is consistent with the notion that negative rates are, at the margin, a drag on bank profitability, it is important to add that accommodative monetary policy *per se* does not have to be detrimental to bank profitability. In fact, we also find that policy-induced reductions in long-term rates have positive, economically large, and statistically significant effects on bank equity values in the low/negative interest rate period. Although the focus of this paper is on *conventional* monetary policy, the heightened importance of long-term rate surprises likely reflects the positive impact of announcements by the ECB regarding asset purchases and forward guidance during this period. These unconventional policies created capital gains and a more favorable financing environment for banks, tending to boost their share prices. Overall, our results thus suggest that, for a given degree of monetary accommodation, the precise mix of monetary policy measures matters a great deal for bank profitability.

Finally, we also find evidence that banks’ maturity mismatch, captured by loan fixation terms, influences their exposure to interest rate risk, and document sizeable differences in the reaction of bank stocks to monetary policy surprises across countries in the euro area.

The rest of this paper is organized as follows. The next section places the paper in the context of related literature. Section 3 describes the construction of our interest rate surprises. Section 4 presents the average effects of monetary policy surprises on bank equity values, and documents how these effects have varied over time. The following section then examines cross-sectional (and cross-country) differences in the response of bank stocks, with a focus on the role of deposit funding, maturity transformation, and differences in competition at the country-level. Finally, section 6 compares our results to non-bank sectors, and the last section concludes.

## **2. Related literature**

Understanding banks' exposure to interest rate risk has been an area of active research for some time. Going back to seminal work by Flannery and James (1984), several studies have examined the reaction of bank stock prices to interest rate changes, generally finding that bank equity values decline when rates rise, and that this reaction is influenced by measures of the degree to which banks engage in maturity transformation.<sup>7</sup> However, until recently, these studies generally did not consider the reasons why interest rates might change and did not fully control for the economic news that might be driving those changes, giving rise to difficult issues of endogeneity and simultaneity.

To circumvent the problems associated with using raw interest rate changes, English, Van den Heuvel, and Zakrajsek (2018) examine the reaction of bank equity values to surprise interest rate changes associated with monetary policy actions, an approach that we also follow in this paper. This approach employs a high frequency event study methodology, first developed by Kuttner (2001), to identify interest rate surprises around monetary policy announcements. As emphasized by Bernanke and Kuttner (2005) and Gürkaynak, Sack, and Swanson (2005), these high-frequency shocks are unlikely to be correlated with other economic news that might independently affect asset prices.

Using this method, English et al. find that stock prices of U.S. banks decline substantially following an unanticipated increase in the level of interest rates or a steepening of the yield curve. The decline is larger for banks with a greater reliance on core deposits, but smaller for

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<sup>7</sup> See English et al. (2018) for a discussion and further references.

banks with a greater maturity mismatch, consistent with conventional notion of banks “riding the yield curve.” Begenau, Piazzesi, and Schneider (2015) use a factor model to document significant exposure of banks to interest rate risk and isolate the effects of banks’ derivatives usage on their interest rate risk exposure, a topic that is also examined by Rampini, Viswanathan, and Vuillemeys (2017).

The low rate environment prevalent in most advanced economies in the wake of the global financial crisis spurred a new line of empirical research focused on evaluating the effect of this new environment on bank profitability. The evidence provided by these studies generally supports the idea that low interest rates have a negative effect on banks’ net interest margins, a key component of bank profitability. Analyzing a sample of large international banks, Borio, Gambacorta, and Hofmann (2015) and Claessens, Coleman, and Donnelly (2018) both find a positive relationship between the level and the slope of the yield curve on the one hand, and banks’ net interest margins on the other hand. Further, they find that these effects are stronger at lower levels of interest rates, concluding that unusually low rates erode bank profitability over time.<sup>8</sup>

Evidence on banks’ interest rate risk in the euro area is much scarcer. Kerbl and Sigmund (2016) confirm the negative impact of low rates and a flatter curve on net interest margins for a sample of Austrian banks. Using detailed supervisory data on balance sheets and derivatives positions, Hoffmann et al. (forthcoming), provide evidence of large cross-sectional heterogeneity in the maturity mismatches of European banks and link this to cross-country differences in prevailing mortgage contracts. Heider, Saidi, and Schepens (2018) document that interest rates on retail deposits in the euro area almost universally adhere to a zero lower bound, with increased mass at or near zero after the introduction of negative monetary policy rates. Focusing on the impact in the syndicated loan market, they

find that high-deposit banks take on more risk and lend less than low-deposit banks after rates become negative. A similar finding is obtained for Swedish banks by Eggertsson, Juelsrud, Summers, and Wold (2019). Altavilla, Boucinha, and Peydró (2017) examine the

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<sup>8</sup> More broadly, recognition that banks’ net interest margins can improve with higher interest rates dates back at least to Samuelson (1945), who argued that this is likely to happen as banks finance interest-earning assets in part with deposits that pay low and sticky interest rates (see Hannan and Berger, 1991, and Neumark and Sharpe, 1992, for evidence on the behavior of deposit interest rates). Focusing on U.S. banks, Drechsel, Savov, and Schnabl (2018) provide empirical evidence of a positive effect of higher rates on banks’ deposit franchise values, even when rates are not unusually low. They argue that banks’ maturity transformation provides a natural hedge for this effect.

impact of interest rates on the profitability of European banks. Using accounting data, they find evidence that low rates do not systematically harm banks' reported return on assets, except during the recent period of prolonged and unusually low rates, a result that is broadly consistent with and complementary to ours. They also examine the reaction of bank stock prices to announcements of non-standard monetary policy measures (OMT, TLTRO, APP, etc.) and find a generally positive effect of such announcements. Our own results on unconventional monetary policy are more indirect but are in line with these findings, as discussed in section 4.2.

Our main focus, however, is on the relationship between *conventional* monetary policy and bank equity values, a topic that is, to the best of our knowledge, unexplored for the euro area. In addition, we address the question whether this relationship changes during a period of low/negative rates. Throughout, we use intraday data to more cleanly identify interest rate surprises associated with monetary policy actions.

### **3. Data and Interest Rate Surprises**

We examine the effects on bank stock returns of surprise changes in interest rates following monetary policy announcements by the ECB after each Governing Council meeting. We use a high-frequency event study methodology, developed by Kuttner (2001) and Bernanke and Kuttner (2005), to ensure that these interest rate surprises are driven only by monetary policy actions and thus uncorrelated with other economic news that could have an independent impact on bank stock prices. We adapt this methodology to the European context by using intraday tick-by-tick data on swap contracts of different maturities in order to construct two interest rate surprises.

Tick-by-tick data on swap contracts, bond yields, and individual bank stock prices are from Thompson Reuters Tick History. We retrieve information for all days between January 7<sup>th</sup>, 1999 and January 19<sup>th</sup>, 2017 when a policy meeting (or a decision without a meeting) took place. Information on policy meeting dates and policy decisions has been manually collected from the publicly available contents on the website of the European Central Bank (<https://www.ecb.europa.eu/press/html/index.en.html>). Bank balance sheet information is taken from the Bankscope database. In a few instances, we will also use daily data on banks' stock prices, which are obtained from Datastream.



Monetary policy decisions in the euro area are announced through a press statement (typically at released by the ECB at 1:45 pm), followed by a press conference (which typically starts at 2:30 pm). The press statement lists all monetary policy decisions. For most statements, it simply states all decisions regarding the official policy interest rates, although in recent years, the statements have in some instances also included announcements regarding unconventional monetary policy actions, programs such as LTRO, TLTRO and APP (quantitative easing), as well as forward guidance. Unlike FOMC statements, the ECB press statements do not ordinarily state the reasons for these decisions or comment on economic conditions. Instead, this is communicated by the President of the ECB through the press conference.

For each press statement and each press conference, we construct a *short-term interest rate surprise* as the change in the price of the Euro OverNight Index Average (EONIA) swap contract with a maturity of 1 month in a narrow window around each event. At any point in time, the EONIA swap rate represents the market's expectation of the average EONIA rate over a 30 day period starting in two days.<sup>9</sup> For press statements, we construct an event window that extends from 10 minutes before the release until 20 minutes after it. For press conferences, the window goes from 10 minutes before the start of the press conference until 20 minutes after its end (see Appendix I for a detailed explanation of the procedure). The change in the EONIA swap rate between the start and the end of the window represents the unexpected change in the level of the ECB's policy interest rate. For most of our sample, the rate on main refinancing operations (MRO) is the most relevant official rate, although the deposit facility rate (DFR) becomes more relevant after the crisis.<sup>10</sup> Throughout, the Eonia rate remains the relevant interbank market rate, similar to the effective federal funds rate in the U.S.

On top of this, market participants may also be surprised or by announcements of unconventional monetary policy – quantitative easing or forward guidance – or by other indications regarding the future path of interest rates during the press conference. This type

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<sup>9</sup> Specifically, through an EONIA swap contract, the two parties agree to exchange at maturity, on the agreed notional amount, the difference between interest accrued at the agreed fixed rate and interest accrued through geometric averaging of the EONIA rate prevailing for 30 days starting 2 days after the day the contract is agreed.

<sup>10</sup> The ECB's official policy rates are the MRO, the DFR and the marginal lending facility rate. These typically move in tandem in a corridor system, though the width of the corridor has been adjusted on a few occasions. Even with changes in the width of the corridor or in which of the three rates is the most relevant official policy rate, the Eonia rate continues to be the relevant interbank market rate.

of information has an immediate effect on longer-term interest rates. Thus, we use the 2-year EONIA swap rate to construct our second interest rate surprise: The *long-term rate surprise* is calculated as the change in the 2-year EONIA swap rate in the same narrow windows around each press statement and press conference as used for the short-term interest rate surprise.<sup>11</sup>

Figure 1 illustrates the construction of the surprises and our identification strategy. Specifically, it shows the level of the 1-month EONIA swap rate over two particular days. . On each day policy rates were changed by 25 basis points. As can be seen, on July 7<sup>th</sup>, 2011 the rate change was completely anticipated by the market and the price of the 1- month EONIA swap contract barely moved during the day. On the contrary, on July 5<sup>th</sup>, 2012, the price of the 1- month EONIA swap contract dropped right after the policy rate change was announced in the press statement, indicating that the market was not fully expecting the decision. On each day, the short-term interest rate surprise is calculated as the change in the 1-month swap rate over the press statement (or conference) window, depicted by the green (or red) lines.

Figure 2 depicts the two interest rate surprises for the press statement over our entire sample period: from January 7<sup>th</sup>, 1999 until January 19<sup>th</sup>, 2019. Positive values represent unexpected rates increases and negative values stand for unexpected rate decreases. Monetary policy surprises are generally small in terms of absolute value (the average of the absolute value of the short-term rate surprises during the press statement is 1.87 basis points), indicating that the ECB's decisions are usually anticipated by the market. As expected, decisions taking outside regularly schedule meetings (shown in red in the graph) represent bigger surprises to the market.

Finally, using intraday data on stock prices for all listed Euro area banks, we construct simple returns over the same narrow windows as used for the interest rate shocks. Our sample is an unbalanced panel with 56 banks and 245 policy dates.

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<sup>11</sup> It is also common in the literature to use only the component of the long-term rate surprise that is uncorrelated with the short-term interest rate surprise. We have opted to use the raw long-term rate shocks mainly for interpretative reasons, since we believe this way it is easier to gauge the effects of particular changes in the level or the slope of the yield curve. For instance, the effect of a 100 basis points policy-induced steepening of the yield curve, holding the short rate constant, is simply  $\beta_2$ . That said, all our main results continue to hold when we use the orthogonal component of the long-term rate surprise instead of the raw surprise.

## 4. Average effects of monetary policy surprises

In this section, we examine the *average* effects of our interest rate surprises on the equity values of the banks in our sample. We first establish some baseline results that consider the entire sample period, and then examine whether there is evidence that the effects differed over time, in particular during the crisis and recent period of low rates. Subsequently, section 5 will look for differences across banks.

### 4.1. Baseline results

Our baseline specification is the following:

$$R_{it} = \alpha + \beta_1 \Delta Swap_t^{1m} + \beta_2 \Delta Swap_t^{2y} + \sum_k \delta_k LTRO_{kt} + \varepsilon_{it}$$

where  $R_{it}$  is bank's  $i$  simple (intraday) return over the window of policy date  $t$ ,  $\Delta Swap_t^{1m}$  is the short-term rate surprise,  $\Delta Swap_t^{2y}$  is the long-term rate surprise (both measured over the same window for each policy date) and  $LTRO_{kt}$  represents a full set of dummies, one for each LTRO and TLTRO announcement.

Table 1 shows the estimated effects of unexpected changes in short-term interest rates and long-term rates on bank stock prices, based on all policy dates in our sample. These effects are estimated using OLS, but reported standard errors are robust to heteroscedasticity and to arbitrary forms of cross-sectional dependence, using Driscoll-Kraay corrections.<sup>12</sup> We report separately the effects of surprises that occurred at the time of the press statement release and surprises that occurred during the press conference.

Expansionary monetary policy announcements made in the press statement, in the form of surprise rate cuts, had a positive effect on bank stocks' prices. A decrease in short-term rates of 100 basis points increases bank stock prices by around 3.9% on average. The long-term rate surprise has an effect that is about half as large, though it is imprecisely estimated and not statistically significant.

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<sup>12</sup> Clustering by time leads to virtually identical standard errors, reflecting the fact the two corrections differ only in finite samples.

While all rate decisions taken are contained in the press statement, information given during the press conference and the following Q&A might contain extra information regarding the future path of interest rates. Despite this possibility, we find no evidence that changes in short- or long-term rates during the press conference were associated with significant movements. The fact that there is no statistically significant effect of short-term rate surprises associated with the press conferences is as expected. It simply reflects the lack of sizable changes in the EONIA swap rate during the press conferences, which, relative to the preceding press statement, convey no additional information regarding decisions about current policy interest rates. The lack of an impact of longer-term rates is more surprising, although it is in line with the result for the press statement. Excluding the short-term interest rate surprise from the press conference regression does not materially alter this result.

A potential concern regarding our results for the press conference is that they could be contaminated by the release of the Initial Jobless Claim report which takes place every Thursday at 8:30 ET (14:30 Frankfurt time, the start of the press conference). As a check, we included as a control variable in our regression a measure of unexpected information contained in each Initial Jobless Claim report. We did this in two different ways: first, using the actual data minus the median forecast, and second, using the Bloomberg surprise measure.<sup>13</sup> Results, which are available upon request, barely change. In light of the lack of statistically significant effects from the press conference surprises, we will focus our analysis solely on the press statements after this subsection.

In order to corroborate that our findings are not spurious, we conduct a placebo test by running the same regression on non-policy dates. Specifically, in this placebo test, we use dates corresponding to one week after each policy meeting. These are days where no Government Council meeting was expected to take place or took place. As one would expect in the absence of monetary policy announcements, our short-term interest rate surprises over the narrow windows on those placebo days are tiny. (To the extent that there is any variation at all it is most likely caused by liquidity considerations in the swap market.) Accordingly, and as expected, there is no statistically significant relationship between stock returns and 'monetary policy shocks' in the placebo test and the R-squared is minuscule (see Table 1a), indicating that the results in table 1 are not spurious.

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<sup>13</sup> Bloomberg Finance LP.

There is not a unique instrument that captures which reflects long-term rates. Within the Eurozone each country issues sovereign bonds. Thus, as a robustness check, we use 2-year bonds from several euro area countries in order to construct the long-term interest rate surprise. To address concerns regarding the maturity of the instrument used we also repeat the analysis using German bonds with 5 and 10 years maturity (in addition to the 2-year Bund). As shown in table 1b, our baseline result is robust to the use of any of these alternative instruments to construct the long-term rate surprise. That said, it is worth noting that, when using the Italian or Spanish sovereign bond yields, there is a statistically significant effect of the long-rate rate surprise during the press conference. These two countries experienced severe tensions in their sovereign bond markets, tensions that also impacted the credit spreads and equity values of banks in those countries (the so-called ‘doom loop’). It is plausible that signals given during the press conference of accommodative monetary policy or other policies that might alleviate the sovereign debt crisis would have had a more pronounced effect on the Italian and Spanish sovereign spreads, and therefore their banking sectors, compared to Germany, France, or the Netherlands.

#### **4.2 The effects of monetary policy surprises over time**

Our sample period, 1999-2016, encompasses very different macroeconomic and monetary policy episodes, including the turmoil of the global financial crisis and the period of very low and even negative interest rates in its aftermath. It is plausible that the effect of monetary policy on banks profitability was not constant as conditions varied so much. The crisis entailed almost unprecedented financial turmoil, as well as extraordinary government support to the financial system, while, as argued, the ultra-low and negative rate environment posed unique challenges to banks’ business models, not to speak of the challenges for central banks of conducting monetary policy at or near its effective lower bound.

In order to allow for differences across these periods, we divide our sample into three intervals according to two main events: the failure of Lehman Brothers as the start of (the most intense phase of) the crisis and the setting of the ECB’s deposit facility rate to 0% as the beginning of the low/negative rates period. Thus, the periods we consider are as follows:

- i) Pre-crisis: beginning of the sample until October 1<sup>st</sup>, 2008;
- ii) Crisis: October 2<sup>nd</sup>, 2008 to July 4<sup>th</sup>, 2012; and
- iii) Low/negative rates: July 5<sup>th</sup>, 2012 until the end of the sample.

Table 2 shows results for our baseline analysis broken down by these three periods. Before the start of the crisis, expansionary monetary policy had a positive effect on banks' equity values, an effect that is similar, though somewhat attenuated, compared to the one obtained for the entire sample period. Once the crisis started, but before the period of low/negative rates, the effects of monetary policy on bank stock prices became more pronounced. In the pre-crisis period, a 25 basis points surprise rate cut resulted in an increase of 0.76 percent in bank stocks' prices, while in the crisis a surprise cut of the same magnitude boosted bank equity values by 1.3 percent. Admittedly, during the crisis period the press releases may have contained some information about the likelihood of support by the Eurosystem to the financial system, which could have its own impact on bank stock prices, alongside any impact of interest rate changes. On the other hand, the amplified effects during the crisis could also reflect a greater exposure of banks at the time to very tumultuous economic developments, which monetary policy was seeking to improve.

Remarkably, these positive effects dramatically reversed as the effective lower bound was approached. As can be seen in the right-most column of the table, in the period of low/negative rates, further policy-induced cuts in interest rates turned out to be detrimental for banks' equity values. Although the effect is not as precisely estimated as in the previous periods (likely reflecting the shorter sample in the low rate period), the positive coefficient on the short-term interest rate surprise is both statistically and economically significant: a 25 basis points surprise rate cut is found to lower bank equity values by 2.0 percent during this period.<sup>14</sup> As noted, this 'reversal' in the impact of short-term rate surprises in the low/negative rate environment is consistent with Brunnermeier and Koby's (2019) reversal rate. In the next section, we discuss this further and investigate what might be behind this phenomenon in the euro area.

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<sup>14</sup> Not surprisingly, the *difference* with the effect in the normal rate period is also statistically significant, as shown in table 3, which reports the results of a single regression in which dummies for the three periods are interacted with the short- and long-term interest rate surprises.

Moreover, for the low/negative rate period, we also find economically large and statistically significant effects of policy-induced surprise changes in long-term rates on bank equity values. These effects, however, operate in the conventional direction, the same direction as in normal times (as indicated by the negative coefficient). Holding fixed the short rate, a 25 basis point reduction in the long rate prompted by monetary policy increases bank stock prices by about 3 percent. The low/negative rate period encompasses the time that the Governing Council of the ECB embarked for the first time on the use of asset purchases and explicit forward guidance, both of which work importantly through reductions in long-term interest rates.<sup>15</sup> Thus, the significant impact of long-term rates may reflect the effectiveness of these unconventional monetary policy measures and thus should not be viewed as especially surprising,<sup>16</sup> nor as inconsistent with the result regarding short-term rates, because asset purchase programs (APP) and forward guidance have different effects on bank profits than conventional monetary policy.<sup>17</sup>

Further evidence regarding the differential effect of monetary policy under low rates is provided in Figure 3. The chart shows the value of the coefficient on the short-term rate

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<sup>15</sup> Rogers, Scotti and Wright (2014) examine the effects of unconventional monetary policy announcements by the Bank of England, the Bank of Japan, the ECB and the Fed on bond yields, stock prices and exchange rates. They find that the positive effects of unconventional monetary policy worked largely by reducing yields on longer-term government bonds and that these reductions largely reflected declines in term premia (rather than expectations of future short rates).

<sup>16</sup> Altavilla et al. (2017) provide further evidence regarding the impact of unconventional monetary policy on bank profitability. Overall, they find that such measures had a positive impact on profitability and stock prices, consistent with our results.

<sup>17</sup> The various channels (mentioned in the introduction) through which monetary policy can affect bank profitability do not necessarily have the same strength when APP or forward guidance is used as when conventional monetary policy is used. For example, many banks have large holdings of long-term, fixed-rate assets, and capital gains on such assets depend primarily on long-term rates. Thus, such banks should benefit much more from the recapitalization channel when term premiums and long-term yields fall due to APP or forward guidance, than when conventional monetary policy reduces short-term rates without lowering long-term yields. Recall that our regression controls for both short-term and long-term rate surprises, and so the estimated coefficient on the short rate surprise should be interpreted as measuring the marginal effect of a surprise change in short-term rates, holding fixed long-term rates. With respect to forward guidance, this was initially communicated through the press conferences, rather than the statements which we analyze here. That said, more recent ECB press statements have also contained some forward guidance. It is true that, overall, the ECB's forward guidance may have lengthened the expected duration of low or negative rates, which should, according to our results, weigh on bank equity values. However, forward guidance also likely helped to push down expectations of future rates at longer horizons from levels closer to the historical norm, an effect that our results regarding short rates suggest should be beneficial for bank equity values. For example, the instantaneous forward rate for a 5 year maturity triple AAA government bond went down from around 2.3% at the start of the low/negative rate period to slightly above zero at the end of our sample, and from 3.5% to slightly above 1% for the 10 year maturity; all levels that correspond to 'normal rate territory.' Moreover, forward guidance also works by reducing uncertainty about future interest rates, which, like APP, tends to reduce term premiums and lower long-term yields regardless of expected short rates.

surprise as in our baseline specification for different subsamples created based on the level of the MRO. Each subsample contains the set of observations when –at the start of the policy meeting– the MRO is in a bin of 100 basis points centered on the value shown on the horizontal axis. The coefficient is negative for all subsamples with the MRO above 1% and it turns positive when running the regression for the periods where the MRO rate was between 0 and 1% and the deposit facility rate entered negative territory.

## **5. The impact of monetary policy surprises across banks**

In this section, we examine how the sensitivity of bank stock prices to policy-induced interest rate surprises varies depending on key bank characteristics. We start with the extent on which banks rely on retail deposits to fund their assets, because the special nature of deposit financing is a candidate explanation for the reversal of the effects of short-term rate cuts in the recent period of low/negative rates.

### **5.1 Deposit funding: A possible driver of the reversal?**

The striking ‘sign switch’ in the impact of changes in the policy rate is consistent with the notion of a “reversal rate” of monetary policy, a concept defined by Brunnermeier and Koby (2019) as “the rate at which accommodative monetary policy ‘reverses’ its effect and becomes contractionary.” This scenario may seem puzzling, but it arises from the fact that monetary policy affects banks’ profitability through various channels, including through net interest margins, capital gains and losses, changes to the demand for loans and deposits, asset quality, and off balance sheet positions. Not all of these channels go in the same direction. In addition, while many of these channels have similar effects on banks’ profits whether rates are high or low, some do not. In particular, the effect of monetary policy on net interest margins is likely to change in a low rate environment. Brunnermeier and Koby focus on imperfect competition in the markets for bank deposits and loans as the driver of this change. A related and complementary reason, and one that we focus on, is the fact that banks are very reluctant to ‘pay’ negative rates to customers.

Deposits are normally a lucrative source of funding for banks, as interest rates on deposits are typically below market rates, or even zero (Hannan and Berger, 1991, and Neumark and



Sharpe, 1992). But this boost to net interest income is diminished when market rates are reduced below zero, since banks avoid charging negative interest rates on retail deposits, as argued. Their reluctance to charge negative rates means that, when short-term rates are already close to zero, further declines in short-term rates are likely to squeeze the net interest margins of deposit-intensive banks, as their borrowing costs do not fully adjust downward along with market rates, potentially hurting their profitability.

A decline in banks' profitability can in turn constrain their lending due to binding capital requirements. Finally, according to the mechanism put forth by Brunnermeier and Koby, the reduced supply of bank credit dampens economic activity, producing the contractionary effect from a rate cut that would normally be accommodative.

As mentioned, we will seek to assess empirically whether the 'zero lower bound' on deposit interest rates can help account for the reversal in the effect of conventional monetary policy on bank equity values in the recent period of low and negative interest rates. Before developing and formally testing a hypothesis, we start with some initial evidence on role of deposits and bank profitability in the low/negative rate period.

Figure 4 shows net interest margins of banks in the highest and lowest deposit quartiles over our sample period. The deposit ratio is calculated as customers' deposits (households and non-financial corporations) over total liabilities, based on annual data from Bankscope. Not surprisingly in light of the fact that banks often pay below-market rates on retail deposits, banks with high deposit ratios tend to have higher net interest margins (and higher non-interest expense, not shown). That said, net interest margins of deposit-intensive banks declined markedly in the recent period of low and negative interest rates, whereas those of low-deposit banks remained more or less constant, and the two groups exhibited broadly similar movements in net interest margins in the years before. The latter is especially apparent when we control for their usual co-movement with interest rates (bottom panel).<sup>18</sup> This pattern is precisely what one would expect if a zero lower bound on deposit interest rates is squeezing the net interest margins of deposit-intensive banks when market interest rates become very low or even negative.

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<sup>18</sup> The bottom panel shows, for each of the two groups of banks, the residuals of a regression of group-aggregated net interest margins on the 1-month Eonia swap rate and the 5 year Bund yield using the 2000-2011 period; the 2012-2015 residuals are thus out-of-sample.

Furthermore, the decline in net interest margins of high deposit banks in the low/negative rate period is reflected in their stock prices, as shown in figure 5. Deposit-intensive banks underperformed relative to low-deposit banks over the period in which short term rates dropped to zero and below. Again, this happened despite very similar performance in the period leading up to the bifurcation.

### ***5.1.1. A simple model of bank profits with a zero lower bound on depository interest rates***

To draw out the implications of the ‘zero lower bound’ on deposit rates for banks’ exposure to interest rate risk more explicitly and to derive some testable hypotheses, we present a very simple, illustrative model of bank profits and their reaction to interest rate changes. The model is deliberately simple in that it focuses only on net interest margins and capital gains as channels through which interest rate changes influence bank profits. While other channels are clearly important in reality, these two are enough to illustrate how a lower bound of deposit rates can, when binding, change the impact of monetary policy on bank profits.<sup>19</sup> Specifically, this stylized model shows, first, how a floor on deposit rates can give rise to a reversal rate and, second, that the intensity of the reversal in the effect of interest rates on bank profits depends on the importance of deposits as a funding source.

The key assumptions of the model can be summarized as follows (a full presentation of the model and derivations can be found in Appendix II.) First, the bank holds some long-term, fixed-rate assets – loans or bonds – with a predetermined yield, in addition to other assets and liabilities whose interest income or expense vary with market interest rates. Second, retail depositors are paid the short-term market interest rate ( $R^M$ , set by the central bank) minus a margin,  $m^D$ , which could reflect the bank’s market power in deposit markets or non-interest costs of servicing deposits. Crucially, however, the bank does not let this rate fall below zero, so

$$R^D = \max(R^M - m^D, 0)$$

where  $R^D$  is the interest rate paid to depositors. Third, to isolate the net interest margin and capital gains channels, we hold fixed the size and composition of the balance sheet, as well as

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<sup>19</sup> See Eggertsson et al. (2019) for a full-fledged DSGE model with a zero lower bound on deposit rates. Calibrated to Swedish data, the model implies that negative rates reduce bank profits, lending, and output.

any margins.<sup>20</sup>

The main prediction of the model describes the relation between profits and the short-term interest rate set by the central bank:

$$\frac{dProfits}{dR^M} = \begin{cases} -B & \text{if } R^M > m^D \\ D - B & \text{if } R^M < m^D \end{cases}$$

where  $B$  denotes the long-term, fixed-rate assets of the bank, and  $D$  are retail deposits.

The term  $-B$  represents capital losses on existing long-term assets when rates rise.<sup>21</sup> When rates are high (above the margin on deposits), this is the only effect in this simple model. In that situation, bank profits rise unambiguously when the central bank cuts the policy rate. However, when rates are low (below the margin on deposits), there is another effect because the zero lower bound on the interest rate on deposits ( $R^D$ ) is reached. Once that happens, further reductions in the policy rate do not reduce the interest cost of deposit funding, even as the interest earnings on short-term/flexible rate assets continue to decline. The result is a squeeze of net interest margins. This effect scales with the degree of deposit funding,  $D$ .

This result highlights three key implications of the zero lower bound on deposit rates:

1. A reversal rate – in the sense of a sign switch in the effect of the policy rate on bank profits when rates fall below a threshold level – arises due to the zero lower bound if retail deposits exceed existing long-term, fixed-rate assets ( $D > B$ ).
2. The intensity of the reversal is increasing in the degree to which the bank relies on deposit funding,  $D$ .
3. The level of the reversal rate is equal to the margin on deposits,  $m^D$ .

Put simply, the first implication means that, for a deposit-intensive bank, a rate cut helps in normal times, but hurts once the zero lower bound for retail deposits is reached (again, abstracting from effects through volumes and asset quality). Thus, the zero lower bound on deposit rates is a candidate explanation for the observed sign switch in the reaction of bank

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<sup>20</sup> Brunnermeier and Koby (2019) provide an extensive theoretical analysis of how deposit and lending margins adjust in an imperfectly competitive setting. It is not our goal to add anything new to their analysis of imperfect competition, and we focus instead on the effects of the lower bound on deposit rates.

<sup>21</sup> For loans, these capital losses are usually not recognized in accounting conventions, but instead show up over time as a reduction in net interest margins as their interest earnings do not rise, but interest costs on short liabilities do adjust upward when rates rise.

profits to policy rate surprises in the period of low/negative rates. The second implication will be examined empirically in the next sub-section. The third implication means that the level of the reversal rate is not necessarily zero and could be heterogeneous across banks, since margins on deposit rates tend to differ somewhat across banks. For the banking sector as a whole this would suggest that any reversal is likely to be more gradual than at the individual bank level.

### **5.1.2. Empirical Results: A triple difference approach**

The model's first and second implications are testable with our data. Indeed, we have already found evidence in favor of the first implication – the possibility of a reversal rate – in section 4.2, in the form of the ‘sign switch’ in the effect of interest rate surprises on bank equity values once rates are low/negative. The second implication suggests that, as rates approach zero or enter negative territory, profits and equity values of banks with a high reliance on deposits should decline relative to the equity values of banks with little deposit funding. We have already seen some evidence in favor of this implication in the behavior of net interest margins and stock prices (figures 4 and 5).

To further investigate whether the deposit channel is behind our results, we test this second prediction using the following interactive, triple-difference specification:

$$\begin{aligned}
 R_{it} = & \beta_0 + \beta_1 \Delta Swap_t^{1m} + \beta_2 \Delta Swap_t^{2y} + \sum_k \delta_k LTRO_{kt} \\
 & + \{\gamma_0 + \gamma_1 \Delta Swap_t^{1m} + \gamma_2 \Delta Swap_t^{2y}\} DR_{it} \\
 & + \{\psi_0 + \psi_1 \Delta Swap_t^{1m} + \psi_2 \Delta Swap_t^{2y}\} LowRates_t \\
 & + \{\theta_0 + \theta_1 \Delta Swap_t^{1m} + \theta_2 \Delta Swap_t^{2y}\} DR_{it} LowRates_t + \lambda X_{it} + \varepsilon_{it}
 \end{aligned}$$

where  $DR$  is the ratio of deposits to total assets and  $LowRates$  is a dummy variable that equals one during the low/negative rate period. We also add as extra controls in the regression bank size (defined as the log of total assets and included in the same way as the deposit ratio) and a crisis period dummy (included in the same way as the low rate dummy). To ensure that our results are not driven by trends in bank size, we use the deviation of bank size from its time-specific mean, thus keeping only cross-sectional variation. For symmetry, we apply the same transformation to the deposit ratio.

The key prediction of the model that we set out to test is that the triple difference captured by the coefficient on  $\Delta Swap_t^{1m} \times DR_{it} \times LowRates_t$  is positive:  $\theta_1 > 0$ .<sup>22</sup> A positive  $\theta_1$  would mean that the sign switch from a negative to a positive effect of short-term rate surprises on banks' profits occurring in the low rate period is more pronounced for banks with a higher share of deposit funding. Put differently, a positive triple difference would indicate that the reversal in the impact of monetary policy is more pronounced for deposit-intensive banks. As an additional test of the model's first implication, we also expect that  $\psi_1 > 0$ , which would confirm the presence of the sign switch in this specification.

We use individual bank balance sheet data provided by Bankscope. The deposit ratio is calculated as customers' deposits (households and non-financial corporations) over total liabilities. The banks in our sample show very different funding structures, with banks which rely heavily on deposits for their funding and others which make scarce use of these liabilities (see Figure 6). Bank size is measured by the log of total assets.

Table 4 and figure 7 present the results of this interactive specification. For ease of interpretation, the table shows the marginal effect of unexpected policy-induced changes in both short-term rates and long-term rates (for a 100 basis points change) for a bank with a deposit ratio in the 10th percentile of the distribution (low), the 50th percentile of the distribution (medium) and the 90th percentile of the distribution (high). The last two rows also include the interaction terms of interest from the specification above. In particular, the cell in the swap×period row and the low/negative rates column is the coefficient  $\psi_1$ , and the cell in the swap×deposit ratio×period row and the low/negative rates column is the coefficient  $\theta_1$ .

In normal times, rate cuts benefit all banks in a similar way irrespective of their funding structure. A 100 basis points surprise change in the policy rate moves stock prices of banks by about 2 to 2.5 percent. The reaction of deposit-intensive banks is somewhat more pronounced than for the average bank, in line with English et al. (2018). However, the differences across funding structures is not statistically significant in this period of 'normal rates,' a finding that is consistent with our simple model.

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<sup>22</sup> We recognize that we use the term triple difference somewhat loosely as two out of the three differences are continuous variables (rather than binary ones as in a standard diff-in-diff-in-diff).

In line with the results presented before, during the crisis period before hitting the zero lower bound, the effects of monetary policy strengthen for all types of banks. Again, there are some differences across the deposit ratio distribution. Again, however, this cross-sectional difference is not statistically significant.

In the period of low/negative rates, the effects are reversed, as we already saw: Rate cuts are now, at the margin, detrimental for banks' stock market valuation. This 'sign switch' is both economically large and statistically significant at the 1 percent level (relative to the pre-crisis period), as indicated by the coefficient on Swap×LowRates ( $\psi_1$ ) in the second-to-last row of the table. This re-confirms the model's first implication ( $\psi_1 > 0$ ).

Moreover, the *differential* effects across bank types are now substantially more pronounced than in previous periods. Specifically, deposit-intensive banks exhibit much larger declines in their equity values upon surprise policy rate cuts in the low/negative rate period, compared to banks that rely less on deposit funding. The decline for a "high-deposit bank" (12% for a 100 basis points change) is almost 8 percentage points higher than for a "low-deposit bank" (4%). Since the cross-sectional differences along this dimension were muted in the other periods, this means that banks that rely more on deposit funding experienced a much larger reversal in the effect of interest rate surprises on their stock prices once rates became low or negative. This triple difference is statistically significant at the 5 percent level, as indicated by the coefficient on Swap×deposit ratio×LowRates ( $\theta_1$ ), shown in the last row of the table. We thus also find evidence in favour of the model's second implication ( $\theta_1 > 0$ ).

Figure 7 illustrates the point graphically by showing the estimated impact of a short-term rate surprise as a function of the bank's deposit ratio (over its observed range), both under the normal period and the low rate period.

In sum, the evidence appears to support the hypothesis that the reversal in the impact of monetary policy on bank equity values in the period of low and negative rates is due, at least in part, to a reluctance of banks to charge negative rates on retail deposits. Banks that rely substantially on this funding source do not benefit from a full pass-through of reductions in market rates to their funding costs in a low rate environment, reducing their net interest margins and their stock prices, as documented earlier. This can help account for both the 'sign switch' in the effect of interest rate surprises on bank equity values, and for the fact that the sign switch is more pronounced for banks with a high deposit ratio.

As noted previously, changes in long-term rates have larger effects on bank equity values during the low/negative interest rate period, likely reflecting the positive impact of asset purchases by the Eurosystem and forward guidance. The point estimates also suggest that banks' deposit ratios matter somewhat for the impact of long-term rate surprises; however, this effect – that is, the interaction between the deposit ratio and the long-term rate surprise – is not statistically significant in any of the periods.

## 5.2. Maturity transformation

Next, we turn to the role of maturity transformation, which is, as explained, one the main reasons banks are exposed to interest rate risk. Traditionally, banks make loans with long maturities and fund themselves with short-term deposits. Of course, banks' exposure to interest rate risk from maturity transformation depends not only on the maturities of assets and liabilities, but also on their fixation terms (or repricing times). For example, a loan may have a long maturity but feature an adjustable interest rate with a short fixation period. The interest income from such a loan will adjust rapidly to changes in market rates. Thus, such a loan is similar to a short-term asset from the perspective of the lender's exposure to interest rate risk and the transmission of the policy rates to loan rates. Holding everything else constant, we should expect that a bank with a higher amount of adjustable rate loans is less adversely affected by a rise in short-term interest rates.

Unfortunately, our bank-level data do not include detailed information on the maturities and fixation terms of assets and liabilities. We do, however, have country-level information on average fixation terms (repricing times) of bank loans (ECB, 2009). Fixation terms are a major determinant of differences in the exposure to interest rate risk from maturity transformation, and there are marked differences across countries on the fixation term of loans. In some countries such as Germany and France, fixed term loans are prevalent, while in others such as Portugal, the big majority of loans are extended under adjustable rate contracts.

Table 5 reproduces the results of our baseline regressions for two groups of countries, those where adjustable rate loans are more prevalent and those where fixed rate loans are more prevalent.<sup>23</sup> The effect of a surprise increase in the short-term rate is negative and significant

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<sup>23</sup> Adjustable rate countries are: Austria, Cyprus, Finland, Greece, Ireland, Italy, Luxembourg, Slovenia, Spain and Portugal. Fixed rate countries are: Belgium, France, Germany and the Netherlands. Source is ECB (2009).

in both cases. However, as expected, the magnitude of the effect is substantially bigger for the countries in the second group. A 25 basis points rise in short-term rates reduces banks' stock prices by 0.8% on average in countries in the adjustable rate group, and by 1.3% in countries in the fixed rate group, or by about 60 percent more. Despite the data limitations, we view this as suggestive evidence supporting the role of maturity transformation in influencing banks' exposure to interest rate risk.

As before, the impact of long-term rate surprises is negative but not statistically significant for the entire sample period. That said, the smaller negative impact from an increase in the slope of the yield curve on banks in the fixed-rate group are consistent with English et al. (2018) and provide a partial support for the conventional notion of such banks 'riding the yield curve' (partial, because the overall effect is still negative).

### **5.3. Cross-country comparison and competition.**

More broadly, there are considerable differences across countries in the reactions of bank equity values to surprise interest rate changes. To illustrate this, the upper panel of figure 8 shows the average reaction of bank equity values by country to rate surprises during the period of low/negative interest rates. The average effect of the short-term interest rate surprise is positive for all countries (except for Belgium, although its coefficient is not statistically significant), indicating that decreases in interest rates are detrimental for banks' stock prices during this period, in line with the previous results. Austrian and German banks are the ones which exhibit the largest effects.

Interestingly, the cross-country differences in banks' observed exposure to interest rate risk appear to be associated with differences in the degree of competition in national banking markets. Existing evidence indicates that the pass-through of falling market rates to loan rates is weaker and slower in banking sectors where the degree of competition is low (van Leuvensteijn et al., 2011). Banks operating in those markets may thus be better able to limit the compression of net interest margins in an environment of low and falling rates. Indeed, this is exactly what we find. As shown in the bottom panel of figure 8, there is a negative relation at the country level between the estimated coefficient on the short-term rate surprise in the low/negative rate environment and the Herfindahl index of the banking sector in each country, as a measure of market concentration. This suggests that banks operating in less



competitive sectors appear to be less affected by changes in interest rates when those rates are low to start with. Given the small sample (i.e., the 7 countries for which we find a significant effect of monetary policy on bank equity values in the low/negative rate period), we present this result as only suggestive evidence that imperfect competition moderates the net interest margin channel during the time of low and negative rates.

## 6. Comparison to non-bank sectors.

So far we have identified and quantified the effects that monetary policy has on banks' stock prices. While there is clear evidence of significant effects, it is also interesting to know to what extent these reactions are in some sense 'special' to banks, or whether effects are also taking place on the broader stock market. After all, Bernanke and Kuttner (2005) have documented that the aggregate stock market tends to drop in response to surprise interest rate increases associated with monetary policy actions. Moreover, the reversal rate concept is defined for the whole economy, even if the initial transmission goes through the banking sector and its eroded profitability due to margin compressions (see Brunnermeier and Koby, 2019, and Eggertsson et al., 2019).

We estimate the following relation for each of the Eurostoxx sectoral indices:

$$R_t^I = \alpha + \beta_1^I \Delta Swap_t^{1m} + \beta_2^I \Delta Swap_t^{2y} + \sum_k \delta_k^I LTR O_{kt} + \varepsilon_t^I$$

where  $R_t^I$  stands for the return of the sectoral index  $I$  over our usual window around the policy event (press statements) on date  $t$ . Note that, unlike in our baseline specification, we now have only one return per day and thus the subscript  $i$  does not appear in the equation above.

Figure 9 shows the coefficients and 95% confidence intervals for the short term rate surprise both in the pre-crisis period and the low/negative rate period. In the pre-crisis period (shown in green), expansive monetary policy boosted equities in every sector. That said, the effect appears to be strongest for the banking sector. We caution against making too much of the latter result, however, since, as a theoretical matter, it is not clear what one should expect from this comparison. As argued at the start of this paper, changes in interest rates can have a range of arguably 'special' effects on the financial strength of banks, not all acting in the same direction. Moreover, other firms are clearly also affected by interest rate changes that

are brought about by monetary tightening or loosening, whether directly or indirectly through the effects of monetary policy on the broader economy.

The point estimates for the low/negative rate period (shown in red) suggest that the reversal phenomenon may be operative to varying degrees not just for banks, but in all sectors. However, the sign switch across the two periods is statistically significant only for one of the seven non-bank sectors. Moreover, by far the largest reversal (in an economic as well as a statistical sense) is observed for the banking sector, as the detrimental effect of rate cuts on stock prices in the low/negative rate period is the largest for banks. This last finding could be explained by the particular business model of banks, which see their net interest margins squeezed because of their reliance in deposit funding. Companies in other sectors would be affected only in an indirect way if they have their access to credit curtailed, or if the broader economy slows down in response to the deteriorating financial strength of banks, as suggested by Brunnermeier and Koby (2019). Although these sectoral results are suggestive, further research would be needed to more fully understand these patterns, and how they relate to the monetary transmission mechanism. As argued, our main results concern the effects of conventional monetary policy on bank equity values, across time and across funding models of banks.

## **7. Conclusions**

We have conducted an empirical study on the effects of conventional monetary policy on the equity values of publicly-traded banks in the Eurozone. Monetary policy affects banks profitability through a variety of channels and thus it is not straightforward to determine what the overall effect will be. On the one hand, because they engage in maturity transformation, their interest margins tend to benefit from a steep yield curve. However, changes in interest rates will also affect bank profits through capital gains or losses on their outstanding fixed-income portfolio and derivatives positions, as well as, crucially, through their effect on the general economy. Because these multiple channels are in place, we measure the effects of monetary policy on stock prices, considering these as a summary measure that captures the overall effect.

Focusing on banks stock prices also allows us to use a high-frequency event-study methodology to more cleanly identify interest rate movements prompted by monetary policy

actions. Specifically, we identify monetary policy shocks to interest rates with changes in the EONIA 1 month swap contract (short-term rate surprise) and the 2 year swap contract (long-term rate surprise) during narrow windows around the press statements and press conferences announcing monetary policy actions taken by the ECB's Governing Council, and complement these shocks with intraday data on bank stock prices around the same announcements.

We find that an unexpected increase of 25 basis points on the short-term interest rate decreases banks' stock prices by about 1% on average. Importantly, however, this effect varied over time; in particular, they were stronger during the crisis, and reversed dramatically during the recent period with low and even negative interest rates, when further cuts to short-term interest rates reduced banks' equity values. We also find evidence that surprise reductions in longer-term interest rates were highly beneficial for bank equity values during the low/negative rate period, a result that likely reflects the positive effects of forward guidance and asset purchases announced during this period.

The composition of banks' balance sheets is important in order to understand the non-standard effect of conventional monetary policy during the recent period. Banks with high deposit ratios are more sensitive to changes in interest rates when rates are low, and these banks experience a larger reversal. We argue that this pattern is consistent with a reluctance of banks to pay negative interest rates on retail deposits. We also find evidence that banks' maturity mismatch, captured by loan fixation terms, influences their exposure to interest rate risk.

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## Appendix I: Construction of intraday interest rate surprises and stock returns

There are two events on each policy day, the press statement shock and the press conference. We construct interest rate surprises and individual bank stock returns for each event. For the interest rate surprises, the swap rates are computed from quotes in the EONIA market. For each day, we discard quotes that are below the first percentile or above the 99<sup>th</sup> percentile. To compute the swap rate for a particular point in time, we use the 5 most recent observations from that time and then take the highest bid price of the 5 and the lowest ask price of the 5, and then we compute the swap rate as the average of these two numbers. Beyond that, the procedure is the following:

For the press statement:

- The window starts 10 minutes before the release of the statement, and ends 20 minutes after the release.
- Taking as an example a press statement that is released at 13:45, each interest rate surprise is calculated as  $S_{14:05} - S_{13:34}$ , where  $S$  stands for the (1-month or 2-year) EONIA swap rate.
- Taking the same example, a stock return is calculated as  $P_{14:05}/P_{13:34} - 1$  where  $P_t$  stands for the mean price over minute  $t$ .
- If no prices are available over that minute, then we use the next available price going backwards in time for 13:34 and forward in time for 14:05.
- In the rare cases that no price is observed between 09:30 and 13:34 then  $P_{13:34}$  is coded as missing. In the rare cases that no price is observed between 14:05 and market closing then  $P_{14:05}$  is coded as missing.

For the press conference:

- The window extends from 10 minutes before the start to 20 minutes after the end of the press conference (the usual duration of the press conference is 1 hour and thus the typical length of the window is 90 minutes).
- Taking as an example a press conference that starts at 14:30, the interest rate surprises are calculated as  $S_{15:50} - S_{14:19}$ , and the stock return is calculated as  $P_{15:50}/P_{14:19} - 1$ .
- If no prices are available over that minute, then we use the next available price going backwards in time for 14:19 and forward in time for 15:50.
- In the rare cases that no price is observed between 09:30 and 14:19 then  $P_{14:19}$  is coded as missing, and when no price is observed between 15:50 and market closing then  $P_{15:50}$  is coded as missing.

When the time is different from the usual one, we shift the window accordingly, except when one of the two times needed to calculate the return falls outside the opening times of the stock market. In these cases, for press statements, we do the following:

- (A): If  $[t-10 \text{ mins}] < 9:30$  we use the price at 17:30 of the previous day.
- (B): If  $[t-10 \text{ mins}] > 17:30$  we use the price at 17:30.
- (C): If  $[t+20 \text{ mins}] < 9:30$  we use the price at 9:30.
- (D): If  $[t+20 \text{ mins}] > 17:30$  we use the price at 9:30 of the following day.
- If no prices are available over that minute, then we use the next available price going backwards in time for cases (A) and (B) and forward in time for cases (C) and (D).

There are no cases of press conferences outside business hours.

Finally, we account for the fact that some policy rate changes become effective more than two days after their announcement. Recall that the period referenced in an EONIA swap starts two days after a trade. In these cases we apply the following re-scaling to the interest rate surprise:

$$\text{Rescaled surprise} = \left( \frac{m}{m - \max(k - 2, 0)} \right) * \text{original surprise}$$

where  $m$  is the number of days in the month and  $k$  the number of days between the announcement of the rate change and its implementation.

## **Appendix II: A simple model of bank profits with a zero lower bound on the depository interest rate**

The bank makes loans ( $L$ ), holds bonds ( $B$ ) and keeps reserves at the central bank ( $M$ ). It finances these assets through equity ( $E$ ), short-term wholesale funding ( $W$ ), and retail deposits ( $D$ ). Its balance sheet identity is thus:

$$L + B + M = E + W + D$$

To understand the bank's exposure to interest rate risk, it is easier to group non-reserve assets into short-term or flexible-rate assets on the one hand, and long-term fixed-rate on the other hand. Thus, with slight abuse of notation,  $L$  will be used to denote short-term or flexible-rate loans or bonds, and  $B$  will be used to denote existing long-term, fixed-rate bonds or loans.

The rate on bank reserves,  $R^M$ , is assumed to be set by the central bank. It can be thought of as the policy rate. The interest rates on short-term/flexible rate loans are equal to the policy rate plus a margin,  $m^L$ , possibly equal to zero. The margin could reflect the bank's market power or prior investments into relationship capital. In contrast, the rate on existing long-term and fixed-rate bonds or loans is predetermined and equal to  $R^B$  – this leads to the possibility of capital gains or losses.

On the funding side, the interest rate paid on wholesale funding is equal to the policy rate plus a risk spread,  $s^W$ , possibly equal to zero. Similarly, the required return on equity is  $R^M + s^E$ .

Retail depositors are paid the policy rate minus a margin,  $m^D$ , which could reflect the bank's market power in deposit markets or non-interest cost of servicing deposits. However, a key assumption is that the bank does not let this rate fall below zero, so

$$R^D = \max(R^M - m^D, 0)$$

For convenience, the assumptions regarding interest rates are summarized below:

$$\begin{array}{ll} R^M : & \text{policy rate} & R^E = R^M + s^E \\ R^L = R^M + m^L & & R^W = R^M + s^W \\ R^B : & \text{fixed} & R^D = \max(R^M - m^D, 0) \end{array}$$

To simplify the analysis, the margins and spreads are assumed to be constant. Bank profits<sup>24</sup> are given by:

$$Profits = R^L L + R^B B + R^M M - R^D D - R^W W - R^E E$$

Next, we ask what the effect on bank profits is of a change in the policy rate. Importantly, as mentioned, we seek to focus on the net interest margin and capital gains channel. For that reason, we hold the size and composition of the balance sheet fixed. In that way, we abstract from any effects through changes in volumes, asset quality or the mix of liabilities, as well as from any off-balance sheet activities (e.g. derivatives).

Inserting the expressions for the interest rates into the equation for profits, and using the balance sheet identity, we obtain:

$$\frac{dProfits}{dR^M} = \begin{cases} -B & \text{if } R^M > m^D \\ D - B & \text{if } R^M < m^D \end{cases}$$

which is the result in the main text.<sup>25</sup>

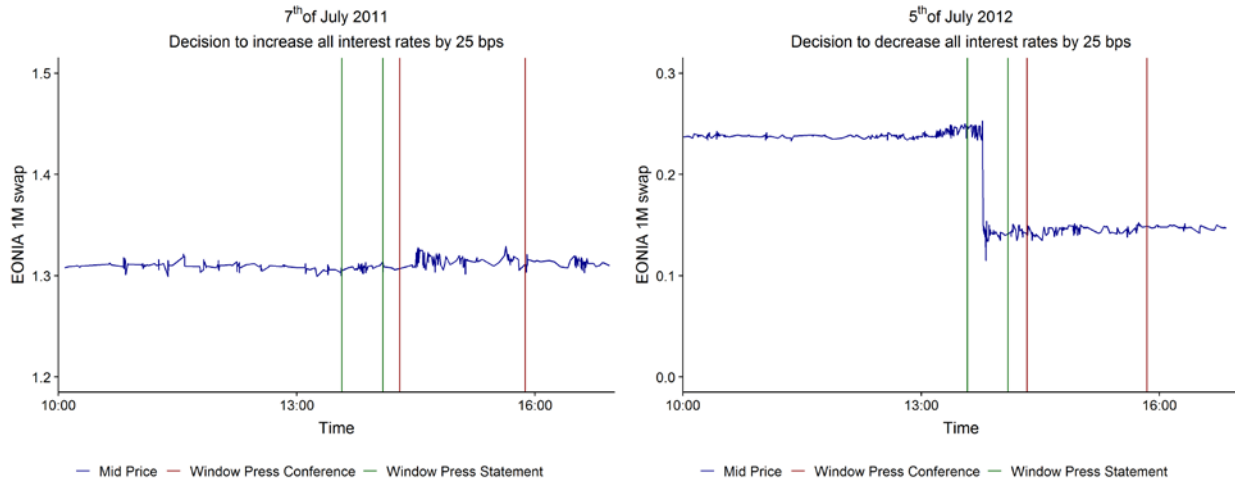
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<sup>24</sup> Technically, these are economic profits (not accounting profits) as the required compensation to shareholders is subtracted.

<sup>25</sup> The analogous result for accounting profits simply adds  $E$  to the derivative regardless of whether  $R^M$  is above or below the threshold.

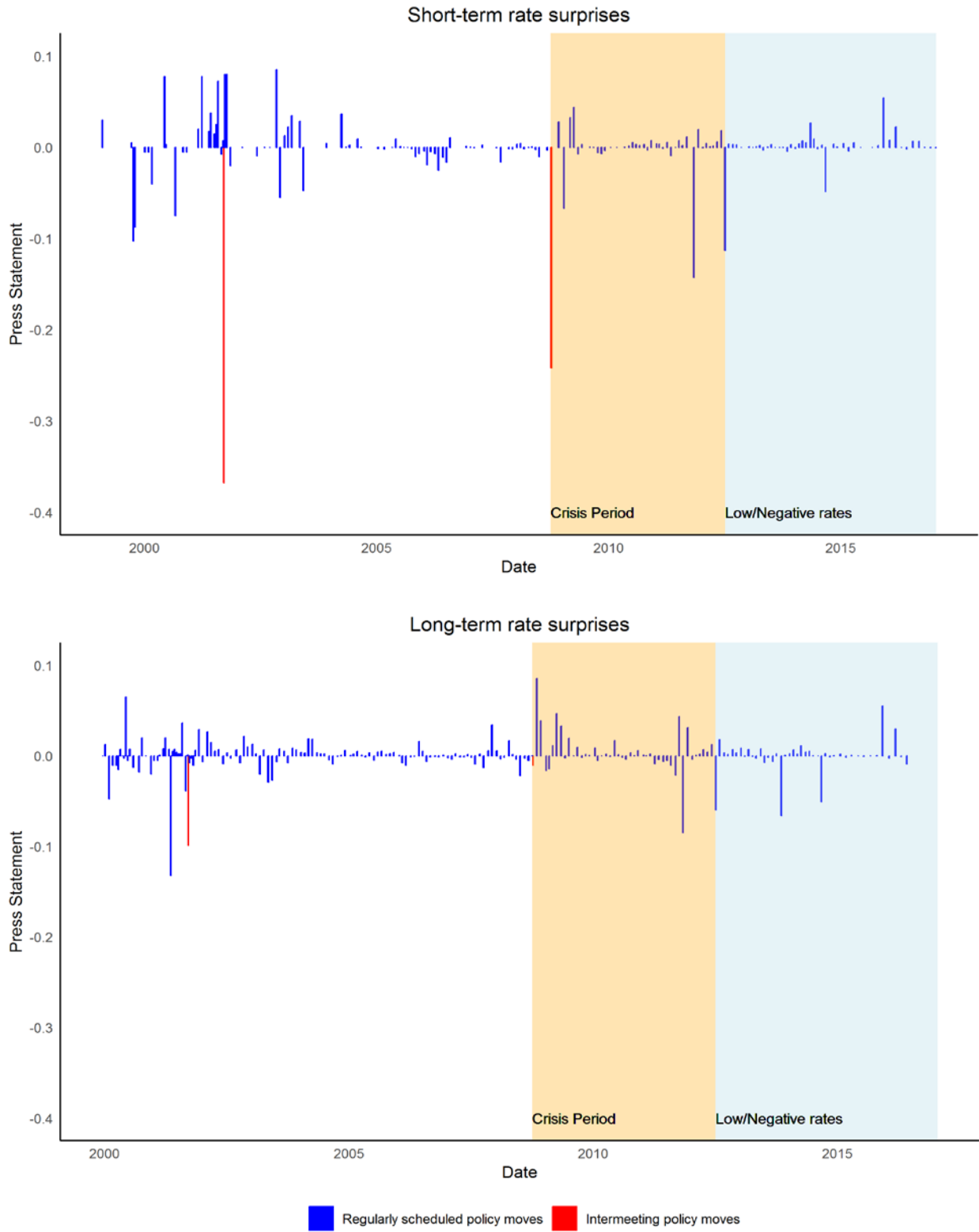


**Figure 1: Evolution of EONIA 1-month swap price on selected dates**



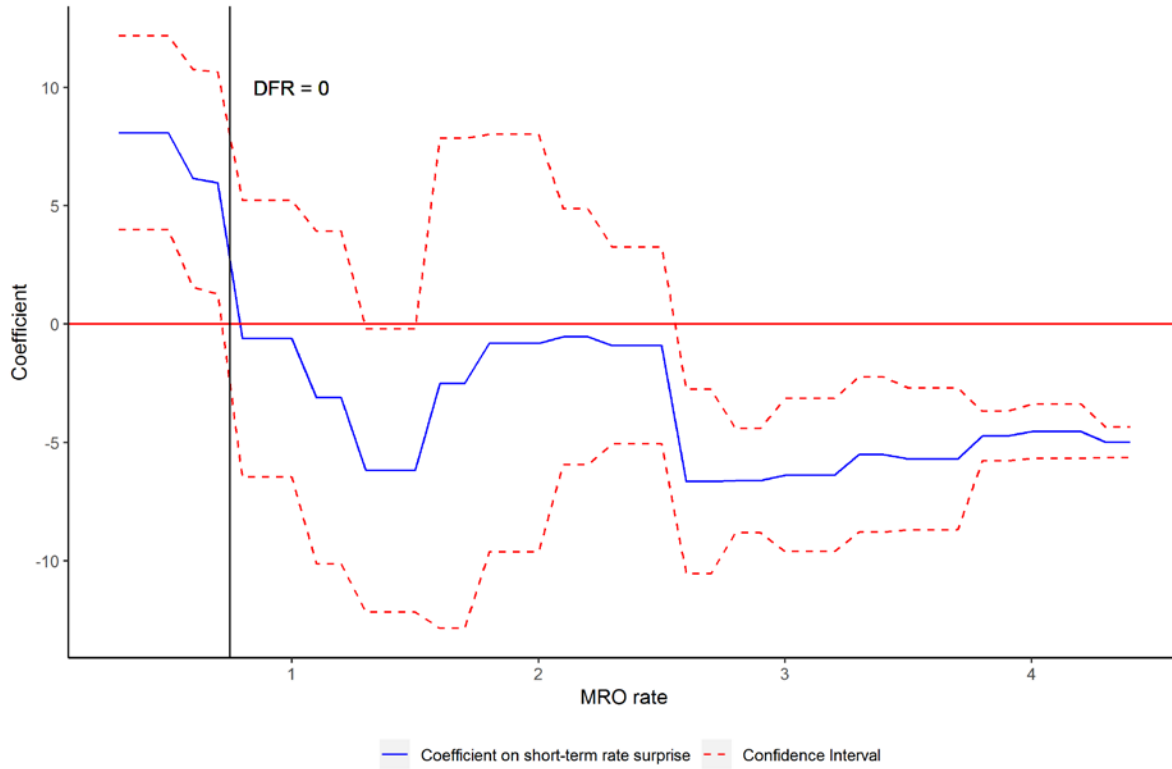
Notes: The left panel shows the mid-price of the EONIA 1-month swap contract on July 7<sup>th</sup> 2011, and the right panel shows the mid-price of the EONIA 1 month swap contract on July 5<sup>th</sup> 2012.

**Figure 2: Monetary policy shocks**



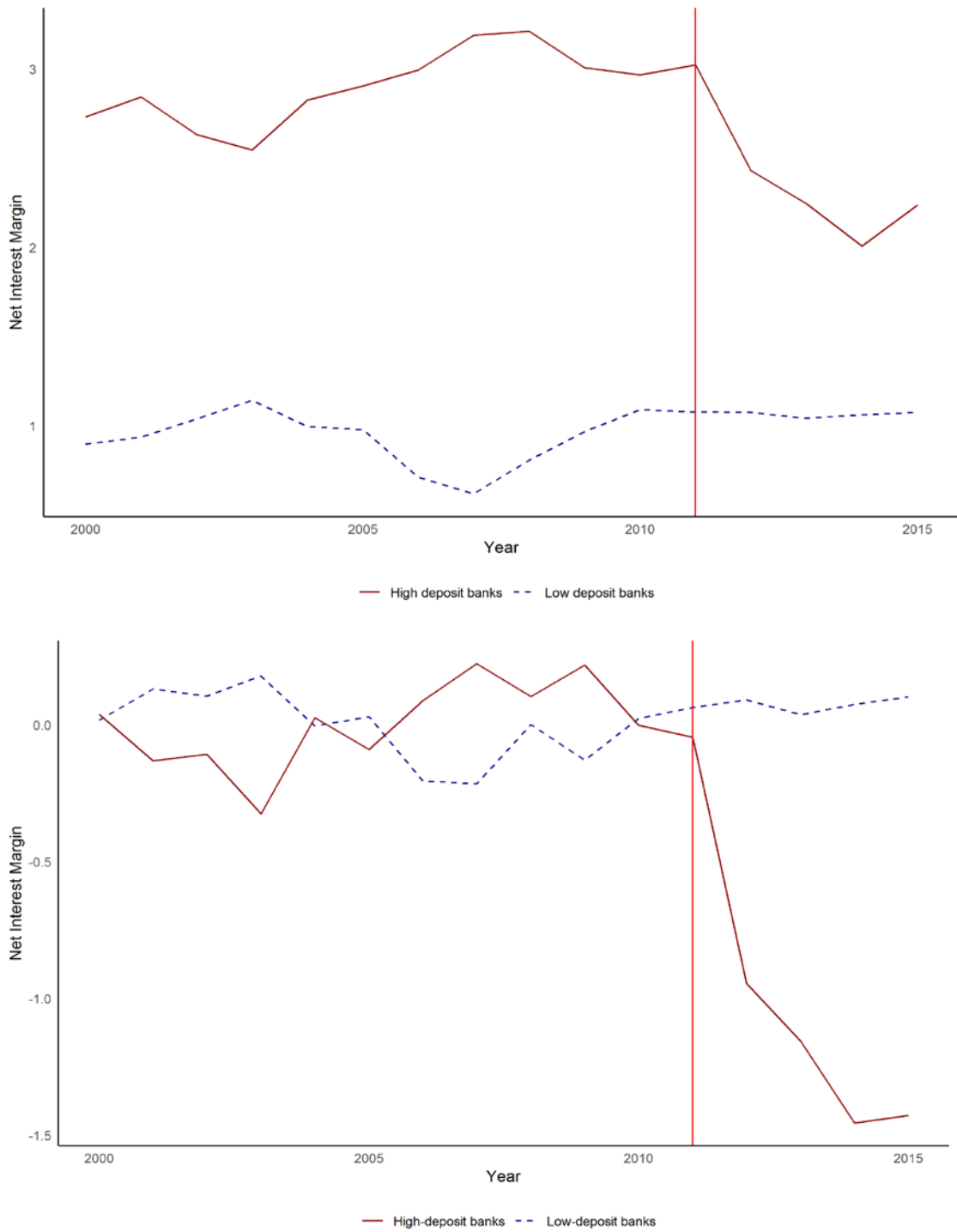
Notes: The upper panel shows short-term interest rate surprises calculated as the change in the EONIA 1-month swap rate during 30 minute windows around ECB Governing Council press statements. The lower panel shows long-term interest rate surprises calculated as the change in the EONIA 2-year swap rate over the same windows.

**Figure 3: The effect of monetary policy at different levels of the MRO rate**



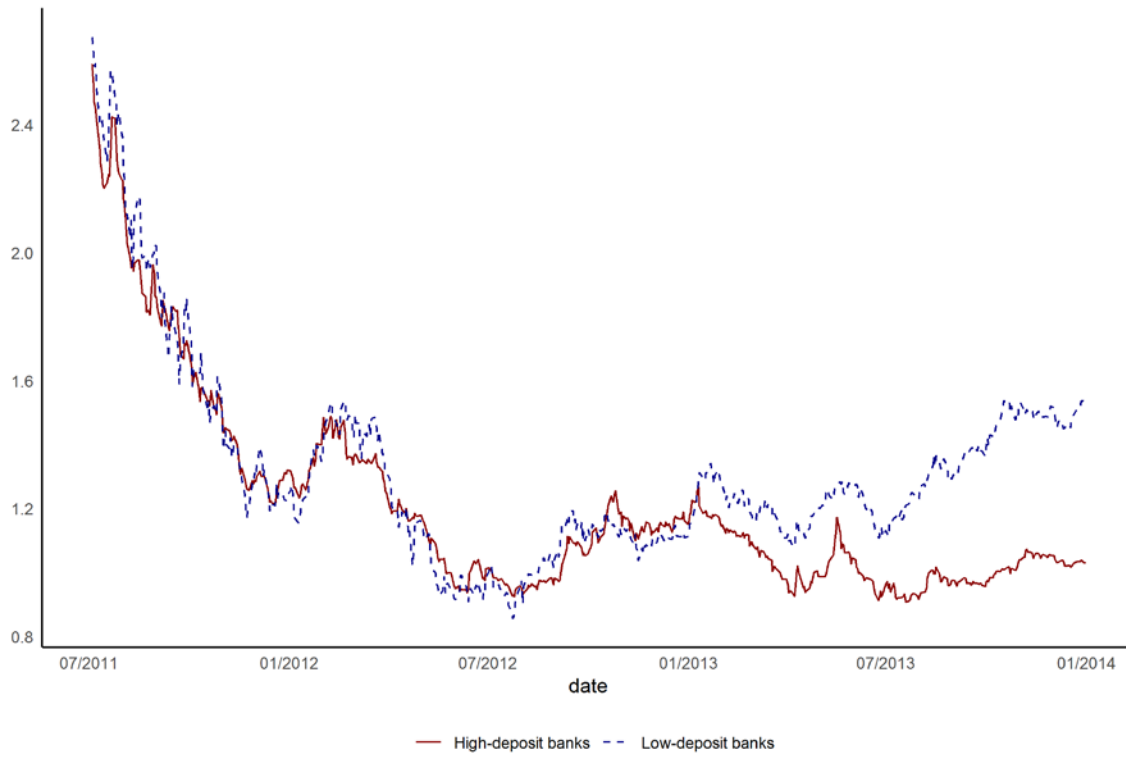
Notes: The figure shows coefficients on the short-term rate surprise and 90% confidence intervals from regressions as specified in section 4 and run for different subsamples based on the values of the MRO. Specifically, each subsample contains the set of observations when –at the start of the policy meeting– the MRO is in a bin of 100 basis points centered on the value shown on the horizontal axis. The vertical line marks the boundary of the low/negative rate period. Specifically, it indicates the level of the MRO rate (75 bps.) at which the DFR (which was then the most relevant policy rate) has reached zero.

**Figure 4: Net interest margins by banks' deposit ratios**



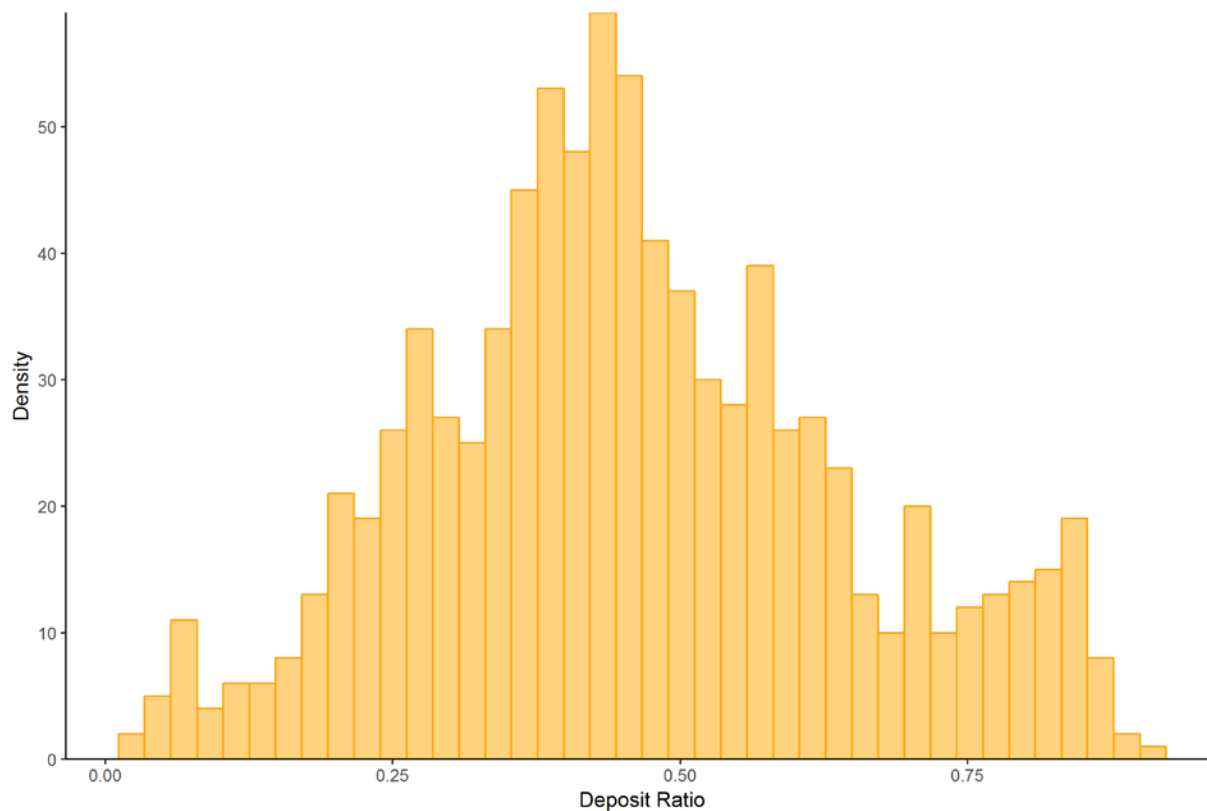
Notes: The top panel shows the asset-weighted average net interest margins of banks in the highest and lowest quartile of the deposit ratio distribution. The bottom panel shows, for each of the two groups of banks, the residuals of a regression of group-aggregated net interest margins on the 1-month Eonia swap rate and the 5 year Bund yield using the 2000-2011 period; the 2012-2015 residuals are thus out-of-sample.

**Figure 5: Evolution of stock prices of high- and low-deposit banks.**



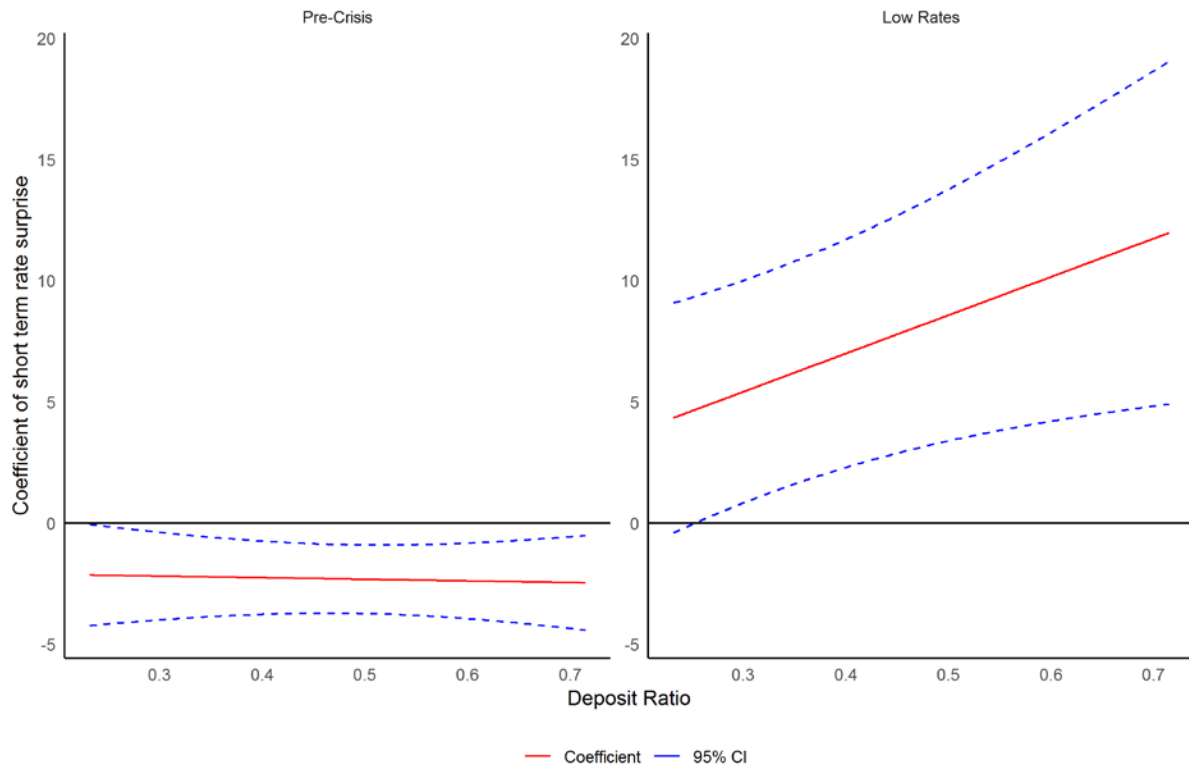
Notes: The chart shows the average stock price, normalized 100 on 5th July 2012 for each stock, for banks in the highest and lowest quartiles of the deposit ratio distribution.

**Figure 6: Distribution of bank's deposit ratios**



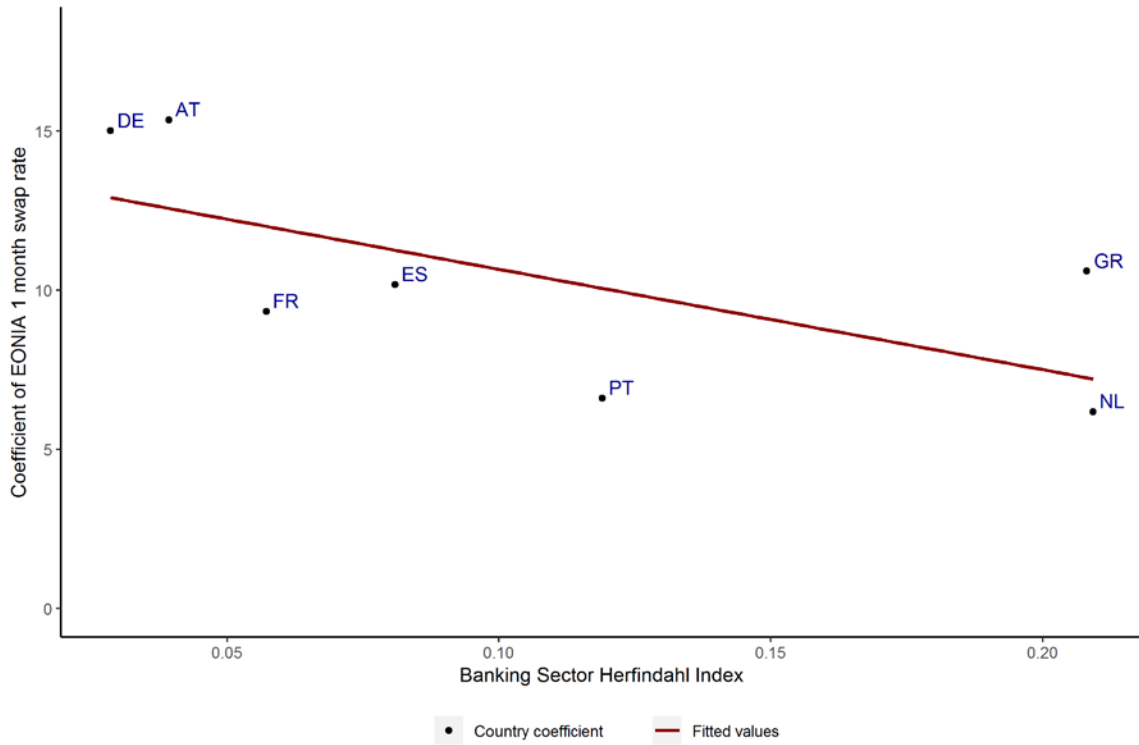
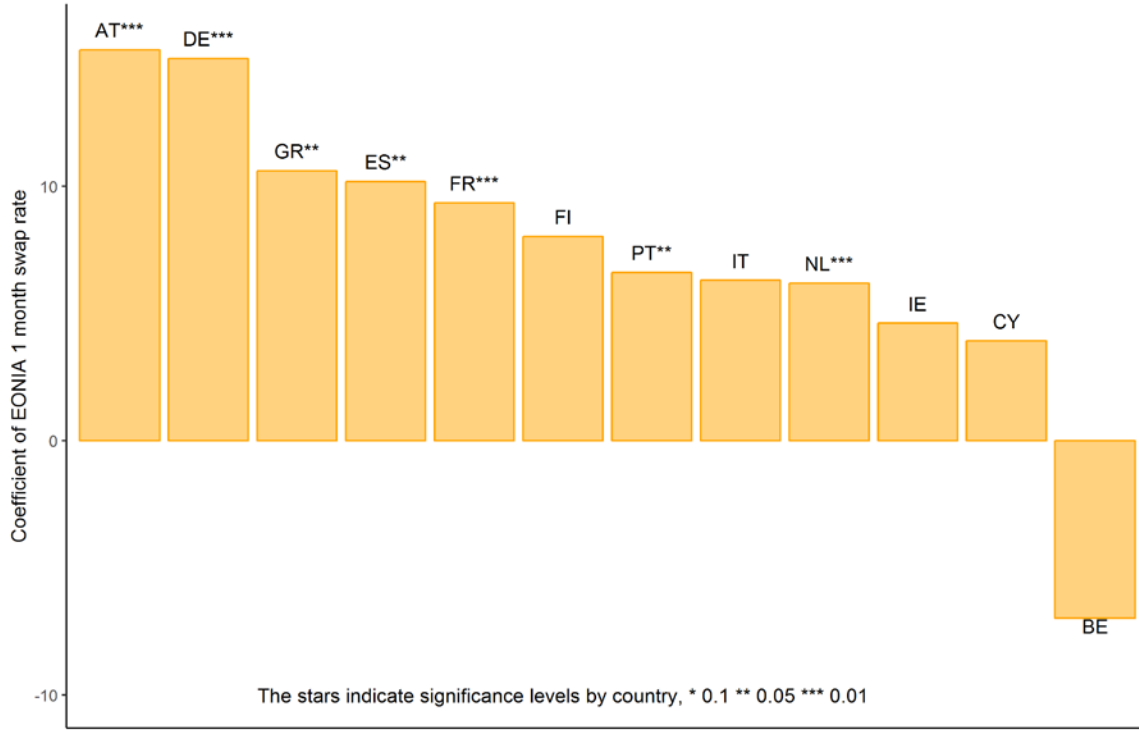
Notes: Deposit ratio is defined as total customer deposits over total assets. The histogram shows the distribution for all listed euro area banks across all years in our sample.

**Figure 7: The role of deposits in explaining the “reversal rate”**



Notes: The figure shows the estimated impact and 95% confidence intervals of the short-term rate surprise on bank equity values, as a function of the bank’s deposit ratio, based on the regression specified in section 4.3.1.2. The left panel is for the pre-crisis period and the right panel for the low/negative rate period. For ease of presentation, the sample mean of the trend in the deposit ratio is added back to its de-trended ratio.

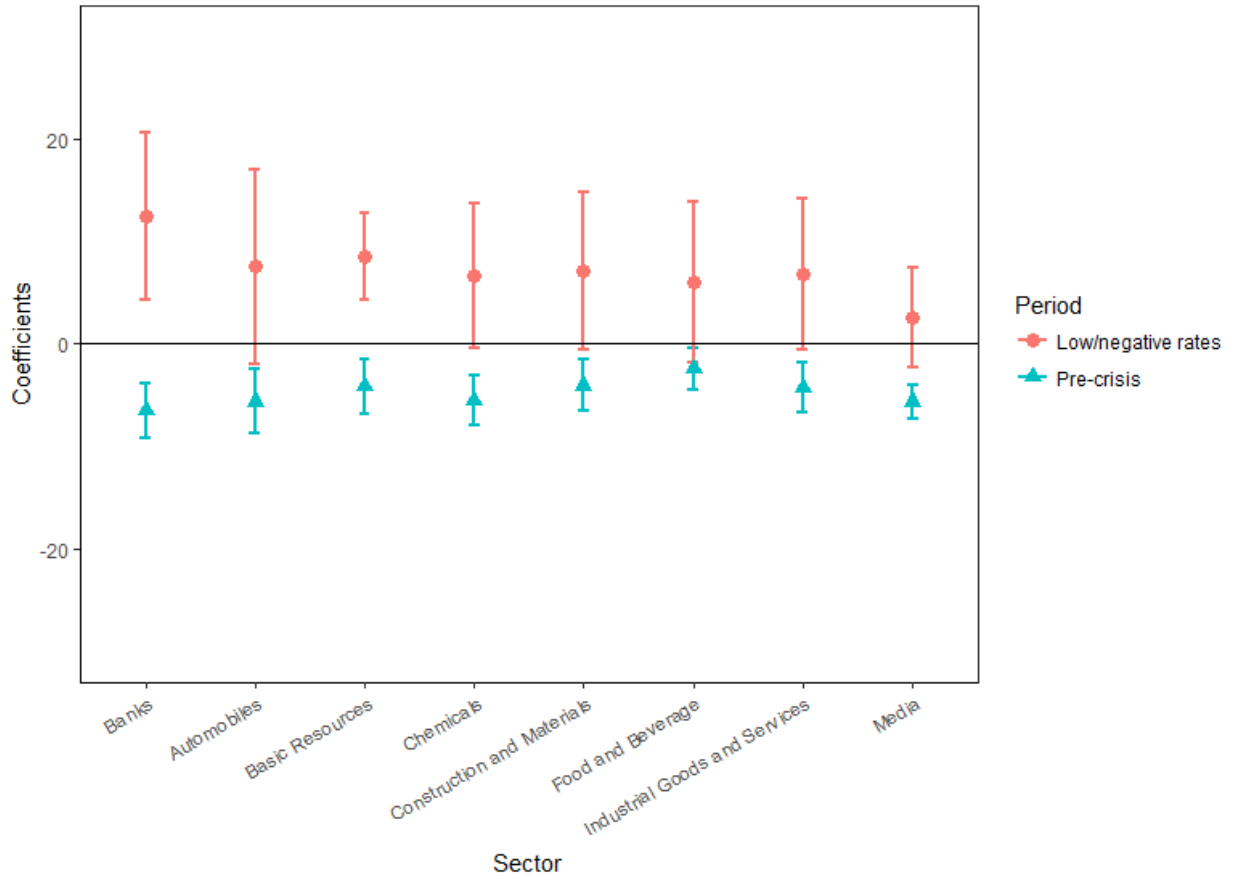
**Figure 8: Average effects in the low/negative rate period by country**



Notes: The upper panel shows estimated effects of the short-term rate surprise on bank equity values in the low/negative rate period, obtained by estimating separately for each country the specification detailed in section 4. The lower panel depicts these estimated country-level effects in the low/negative rate period versus the Herfindahl index of the banking sector in those countries for which the estimated effects in the upper panel are statistically significant at the 10% level.



**Figure 9: All sectors in the economy**



Notes: The figure shows coefficients and 95% confidence intervals of the short-term rate surprise from regressions as specified in section 6 of the paper. For each sectoral index, results for the pre-crisis period and for the low/negative rates period are shown.

**Table 1: Interest rate surprises and bank stock returns**

	Press statement	Press conference
Short-term rate surprise	-3.860*** (1.099)	6.382 (4.888)
Long-term rate surprise	-3.586 (2.308)	-1.836 (1.530)
Observations	6,389	5,957
R-squared	0.142	0.028
Number of groups	56	56

Notes: The dependent variable is the bank's stock return over the event window. The sample period comprises 245 events (policy actions) between Jan 7, 1999 and Jan 19, 2017 (Sep 17, 2001 is excluded). There are 56 banks in the sample. Driscoll-Kraay standard errors are reported in parentheses. \*, \*\*, \*\*\* denote statistical significance at the 10-, 5-, and 1-percent level, respectively.

**Table 1a: Placebo test**

	Placebo press statement	Placebo press conference
Short-term rate surprise	1.213 (0.870)	4.852 (7.217)
Long-term rate surprise	3.303 (2.796)	6.659 (4.355)
Observations	2,031	3,951
R-squared	0.001	0.016
Number of groups	53	56

Notes: The dependent variable is the bank's stock return over the event window. The sample period comprises 245 dates which are one week prior to each true policy date. There are 56 banks in the sample. Driscoll-Kraay standard errors are reported in parentheses. \*, \*\*, \*\*\* denote statistical significance at the 10-, 5-, and 1-percent level, respectively.

**Table 1b: Alternative instruments for long-term rate surprise**

	<b>France</b>	<b>Netherlands</b>	<b>Italy</b>	<b>Spain</b>	<b>Bund 2y</b>	<b>Bund 5y</b>	<b>Bund 10y</b>
<i>Press Statement</i>							
<b>Short-term surprise</b>	-4.357*** (1.079)	-4.508*** (1.055)	-4.277*** (1.178)	-3.723*** (1.116)	-3.712*** (1.104)	-4.471*** (1.125)	-4.530*** (1.220)
<b>Long-term surprise</b>	-0.713 (1.427)	-0.0577 (1.805)	-2.719 (2.368)	-2.550 (1.877)	-3.308 (2.183)	-0.534 (2.566)	0.212 (3.038)
Observations	6,462	6,544	5,202	5,827	6,582	6,764	6,720
R-squared	0.133	0.133	0.160	0.147	0.130	0.122	0.128
Number of groups	56	56	54	56	56	56	56
<i>Press Conference</i>							
<b>Short-term surprise</b>	4.832 (2.953)	4.264 (3.069)	7.048* (4.084)	4.295 (3.544)	4.282 (2.964)	3.536 (2.953)	2.742 (2.723)
<b>Long-term surprise</b>	-2.033 (1.328)	-1.852 (1.366)	-5.414*** (1.335)	-4.531*** (1.599)	-1.755 (1.251)	-1.736 (1.489)	-1.601 (1.946)
Observations	5,895	5,968	4,982	5,175	6,178	6,268	6,132
R-squared	0.031	0.029	0.084	0.061	0.028	0.026	0.024
Number of groups	56	56	54	56	56	56	56

Notes: The dependent variable is the bank's stock return over the event window. The first four columns use the 2 year bond of each respective country in order to construct the long-term rate surprise (as explained in the main text). 'Short-term surprise' and 'Long-term surprise' stand for the short-term rate surprise and long-term rate surprise, respectively. The sample period comprises 245 events (policy actions) between Jan 7, 1999 and Jan 19, 2017 (Sep 17, 2001 is excluded). There are 56 banks in the sample. Driscoll-Kraay standard errors are reported in parentheses. \*, \*\*, \*\*\* denote statistical significance at the 10-, 5-, and 1-percent level, respectively.

**Table 2: Effects of monetary policy surprises over time**

	Pre-Crisis	Crisis	Low/negative rates
Short-term rate surprise	-3.040*** (0.894)	-5.305*** (0.909)	8.080*** (2.489)
Long-term rate surprise	-0.858 (1.207)	-3.759 (3.432)	-12.27*** (1.796)
Observations	2,634	1,963	1,792
R-squared	0.026	0.157	0.211
Number of groups	53	51	51

Notes: The dependent variable is the bank's stock return over the event window. In total, the sample comprises 245 events (press statement releases) and 56 banks. Pre-crisis period covers from Jan 7, 1999 to Oct 2, 2008 (Sep 17, 2001 is excluded), crisis period covers from Oct 2, 2008 to July 5, 2012 and low/negative rates period covers from July 5, 2012 to Jan 19, 2017. Driscoll-Kraay standard errors are reported in parentheses. \*, \*\*, \*\*\* denote statistical significance at the 10-, 5-, and 1-percent level, respectively.

**Table 3: Time-varying effects (interactive specification)**

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Short-term rate surprise	-3.093*** (0.902)
Short-term rate surprise × crisis	-1.893 (1.294)
Short-term rate surprise × low rates	13.27*** (2.229)
Long-term rate surprise	-0.874 (1.221)
Long-term rate surprise × crisis	-3.722 (3.783)
Long-term rate surprise × low rates	-8.200** (4.095)
LTRO1	0.250 (0.163)
LTRO2	-0.257** (0.109)
TLTRO1	0.487*** (0.0262)
TLTRO2	2.928*** (0.0473)
Constant	-0.0203 (0.0222)
Observations	6,389
Number of groups	56
R-squared	0.161

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Notes: The dependent variable is the bank's stock return over the event window. The sample comprises 245 events (press statement releases) between Jan 7, 1999 and Jan 19, 2017 (Sep 17, 2001 is excluded) and 56 banks. Driscoll-Kraay standard errors are reported in parentheses. \*, \*\*, \*\*\* denote statistical significance at the 10-, 5-, and 1-percent level, respectively.

**Table 4: Banks' deposit ratios**

	Deposit ratio	Pre-crisis	Crisis	Low/negative rates
Short-term rate surprise	Low	-2.149** (1.066)	-4.046*** (0.896)	4.335* (2.419)
	Medium	-2.286*** (0.738)	-4.654*** (0.864)	7.594*** (2.473)
	High	-2.469*** (0.995)	-5.472*** (1.307)	11.976*** (3.610)
Long-term rate surprise	Low	-0.275 (1.637)	-3.105 (3.279)	-10.769*** (1.718)
	Medium	-0.883 (1.096)	-3.885 (3.279)	-11.996*** (1.718)
	High	-1.701 (1.507)	-4.935 (4.091)	-13.645*** (3.294)
R-squared		0.059	0.180	0.214
Observations		2622	1940	1788
Short-term rate surprise $\times$ period ( $\psi_I$ )			-2.359** (1.157)	10.441*** (2.590)
Short-term rate surprise $\times$ deposit ratio $\times$ period ( $\theta_I$ )			-1.880 (4.068)	16.672** (7.795)

Notes: The dependent variable is the bank's stock return over the event window. The sample comprises 245 events (press statement releases) and 56 banks. This table shows marginal effects for banks with low (10<sup>th</sup> percentile), medium (50<sup>th</sup> percentile) and high (90<sup>th</sup> percentile) deposit ratios, measured as total customer deposits over total assets. Pre-crisis period covers from Jan 7, 1999 to Oct 2, 2008 (Sep 17, 2001 is excluded), crisis period covers from Oct 2, 2008 to July 5, 2012 and low/negative rates period covers from July 5, 2012 to Jan 19, 2017. Driscoll-Kraay standard errors are reported in parentheses. \*, \*\*, \*\*\* denote statistical significance at the 10-, 5-, and 1-percent level, respectively.

**Table 5: Fixed vs adjustable rate loans**

	Adjustable	Fixed
Short-term rate surprise	-3.253** (1.278)	-5.321*** (1.186)
Long-term rate surprise	-3.776 (2.370)	-3.056 (2.549)
No difference test, p-value <sup>#</sup>		0.0837
Observations	4,652	1,687
R-squared	0.117	0.212
Number of groups	39	13

Notes: The dependent variable is the bank's stock return over the event window. Adjustable rates countries are Austria, Cyprus, Finland, Greece, Ireland, Italy, Luxembourg, Slovenia, Spain and Portugal. Fixed rate countries are Belgium, France, Germany and The Netherlands (see ECB, 2009). The sample comprises 245 events (press statement releases) from Jan 7, 1999 to Jan 19, 2017 (Sep 17, 2001 is excluded) and 56 banks. Driscoll-Kraay standard errors are reported in parentheses. \*, \*\*, \*\*\* denote statistical significance at the 10-, 5-, and 1-percent level, respectively.

<sup>#</sup> p-value for F-test of the hypothesis that the coefficients on the short-term rate surprise and on the long-term rate surprise are equal across the two country groups.