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Monetary policy and bank equity values in a time of low interest rates

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Abstract

This paper examines the effects of monetary policy on the equity values of European banks. We identify monetary policy shocks by looking at changes in the EONIA one-month and two-year swap contract rates during narrow windows around the press statements and press conferences announcing monetary policy actions taken by the ECB. We find that an unexpected decrease of 25 basis points on the short-term policy rate increases banks' stock prices by about 1% on average. These effects vary substantially over time; in particular, they were stronger during the crisis period and reversed during the recent period with low and even negative interest rates. That is, with rates close to or below zero, further interest rate cuts became detrimental for banks' equity values. The composition of banks' balance sheets is important in order to understand these effects. In particular, the change in sensitivity to interest rate surprises as rates drop to low and negative levels is much more pronounced for banks with a high reliance on deposit funding, compared to other banks. We argue that this pattern can be explained by a reluctance of banks to pay negative interest rates on retail deposits.

JEL-codes: E52, E58, G21

Keywords: monetary policy, negative rates, bank profitability, ECB.

Non-technical summary

Monetary policy affects banks' profitability through different channels and it is not straightforward to determine what the overall effect of a rate cut will be. Traditionally, banks are engaged in the maturity transformation business: they take short-term deposits and grant longer-term loans. Therefore, their net interest margins tend to benefit from a steep yield curve. Conversely, their margins are reduced when the yield curve flattens. 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. After all, broader economic conditions tend to influence the demand for banks' products and the evolution of non-performing loans. Finally, the fact that banks fund themselves in part with retail deposits at interest rates that are below market rates and somewhat sticky, further complicates the exposure of banks to interest rate risk.

Moreover, the effect of changes in interest rates on bank profitability through these channels is likely to be heterogeneous. It will depend on the particular portfolio of each bank, such as the maturity gap existing between its assets and liabilities and the degree of interest rate pass through of the different types of assets and liabilities.

How does banks' exposure to interest rate risk change when interest rates are near or below zero? The key fact is that banks are extremely reluctant to charge negative 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 with customers, who might find negative rates unacceptable. As a result, reductions in rates can end up having a similar effect as a flattening of the yield curve, as banks interest revenue drops along with rates, but interest costs only adjust partially because of the zero lower bound on retail deposits. In this situation, lowering rates below zero can pose a threat to banks' profitability.

It is improbable that each and one of these effects can be separately quantified in any reliable manner but it possible is to look at the assessment performed by the market in the form of bank stock prices, which capitalize current and expected future profits. Under the

efficient market hypothesis, stock market prices incorporate all existing information related to a particular security, and prices change only in response to the arrival of new information. Thus, we seek to identify the unexpected component of the monetary policy decisions and then measure the effect of this surprise on banks' stock prices, as a summary measure of current and future bank profitability. Our identification strategy is based on a high-frequency event study methodology, similar to Kuttner (2001), Bernanke and Kuttner (2005), and others, but adapted to the institutional features of the euro area. We use intraday (tick-by-tick) data on swap rates, sovereign bond yields and individual bank stock prices.

Our main findings are as follows. First, on average, an unexpected increase of 25 basis points in the short-term interest rate decreases banks' stock prices by 0.97%. We also find negative effects 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 became detrimental for 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 2016).

We argue that the non-standard effect of conventional monetary policy on bank equity values in a time of low and even negative interest rates is, at least in part, due to a "zero lower bound" on interest rates on retail deposits. Banks are reluctant to charge negative rates to depositors, so declines in short-term market rates are likely to squeeze 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 profitability. We test whether this mechanism can explain the reversal by sorting banks on their reliance on deposits as a funding source. Our third main finding is 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. This result 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. We also find evidence that banks' maturity mismatch, captured by loan fixation terms, influences their exposure to interest rate risk.

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 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 favourable 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.

1. Introduction

In July 2012 the ECB set 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/negative rate environment for damaging banks' profitability and even endangering their viability in the medium term.

The aim of this paper is twofold: First, we employ a high-frequency event study methodology to quantify the effect of surprise interest rate changes due to conventional monetary policy actions on bank equity values. Second, we seek to assess if, how, and why this effect has changed in the current regime of low and even negative interest rates.

Monetary policy affects banks' profitability through different channels and it is not straightforward to determine what the overall effect of a rate cut will be. Traditionally, banks are engaged in the maturity transformation business: they take short-term deposits and grant longer-term loans. Therefore, their net interest margins tend to benefit from a steep yield curve. Conversely, their margins are reduced when the yield curve flattens. 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. After all, broader economic conditions tend to influence the demand for banks' products and the evolution of non-performing loans. Finally, the fact that banks fund themselves in part with retail deposits at interest rates that are below market rates and somewhat sticky, further complicates the exposure of banks to interest rate risk.

Moreover, the effect of changes in interest rates on bank profitability through these channels is likely to be heterogeneous. It will depend on the particular portfolio of each bank, such as the maturity gap existing between its assets and liabilities and the degree of interest rate pass through of the different types of assets and liabilities.

How does banks' exposure to interest rate risk change when interest rates are near or below zero? The key fact is that banks are extremely reluctant to charge negative 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 with customers, who might find negative rates unacceptable.[4] As a result, reductions in rates can end up having a similar effect as a flattening of the yield curve, as banks interest revenue drops along with rates, but interest costs only adjust partially because of the zero lower bound on retail deposits. In this situation, lowering rates below zero can pose a threat to banks' profitability.

One approach to quantifying the effects of monetary policy on banks profitability, whether in normal times or when rates are low, would be to calculate the effect of each of the aforementioned channels – net interest margins, capital gains and losses, valuation changes in derivatives, as well as changes in business volumes and non-performing loans – in each of the two regimes. Doing this with a minimum degree of reliability it is an extremely challenging task, especially in light of data limitations and the fact that some of these channels may have long and variable lags.

One way to circumvent this estimation problem is to look at the assessment performed by the market in the form of bank stock prices, which capitalize current and expected future profits. Under the efficient market hypothesis, stock market prices incorporate all existing information related to a particular security, and prices change only in response to the arrival of new information. Thus, we seek to identify the unexpected component of the monetary policy decisions and then measure the effect of this surprise on banks' stock prices, as a summary measure of current and future bank profitability. Our identification strategy is based on a high-frequency event study methodology, similar to Kuttner (2001), Bernanke and Kuttner (2005), and others, but adapted to the institutional features of the euro area. We use intraday (tick-by-tick) data on swap rates, sovereign bond yields and individual bank stock prices.

Our main findings are as follows. First, on average, an unexpected increase of 25 basis points in the short-term interest rate decreases banks' stock prices by 0.97%. We also find

[4] Even if rates would have to be negative enough to overcome the opportunity costs of holding cash, only two German banks are "remunerating" deposits at negative rates (and only for deposits above a certain threshold).

negative effects 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 became detrimental for 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 2016).

We argue that the non-standard effect of conventional monetary policy on bank equity values in a time of low and even negative interest rates is, at least in part, due to a "zero lower bound" on interest rates on retail deposits. Banks are reluctant to charge negative rates to depositors, so declines in short-term market rates are likely to squeeze 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 profitability. We test whether this mechanism can explain the reversal by sorting banks on their reliance on deposits as a funding source. Our third main finding is 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. This result 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. We also find evidence that banks' maturity mismatch, captured by loan fixation terms, influences their exposure to interest rate risk.

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 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 favourable 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.

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 the effects of monetary policy on banks' equity values has been an area of active research for a long period of time. Flannery and James (1984) determined that bank stock returns go down when long rates rise unexpectedly, and that the sensitivity of this reaction depends on the difference in maturity between the bank's assets and liabilities. This seminal study was followed by a series of publications which generally confirmed its results (see the discussion and references in English et al., 2018).

In terms of methodology, these studies relied generally on event type studies at different time frequencies where the explanatory variable was simply the observed change in interest rates. This posed a clear endogeneity problem since, first, other events affecting financial assets returns could be happening contemporaneously to the changes in rates, and second, rate changes could have been discounted already by the market if expected and thus their impact would already be reflected in the asset prices once the rate change occurs.

Kuttner (2001) introduced a methodology to specifically deal with these endogeneity and simultaneity problems. He identified monetary policy surprises by using the change in the federal funds rate futures contract within a narrow window around the policy decision announcements. He first used this methodology to identify the effect of monetary policy on bill, note and bond yields.[5] Bernanke and Kuttner (2005) extended this by measuring the impact on stock market returns. English, Van den Heuvel and Zakrajsek (2018) use this methodology to look at the effect of monetary policy shocks on bank stocks returns. They find that bank stock prices decline substantially following an unanticipated increase in the level of interest rates or a steepening of the yield curve. This decline occurs despite an observed improvement in net interest margins and in part reflects changes in the size and composition of banks' balance sheets, according to English et al. Thus, the response varies systematically in the cross section, depending on balance sheet characteristics, notably banks' reliance on core deposits and their degree of maturity mismatch.

The low rate environment prevalent in most advanced economies in the wake of the global financial crisis spurred a new line of research focused on evaluating the effect of this new environment on bank profitability. The empirical evidence provided by these studies supports the idea that low interest rates have a detrimental effect on bank profitability, measured by banks' interest margins. Analyzing a sample of large international banks, Borio, Gambacorta and Hofmann (2015) confirm the 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. These findings are confirmed by Claessens, Coleman and Donnelly (2016).

Evidence regarding the euro area is much scarcer. Kedan and Stuart (2014) and León and Sebestyén (2012) establish a relationship between policy rate changes and bond yields, and 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. Heider, Saidi, and Schepens (2018) examine the transmission of negative rates to the lending behaviour of banks. They highlight the importance of banks' funding structures and find, in particular, that high-deposit banks take on more risk and lend less than low-deposit ones when rates become negative.

[5] See also Gurkaynak, Sack and Swanson (2005) for an early and influential contribution in this area.

Finally, in recent work, Altavilla, Boucinha and Peydró (2017) examine the impact of interest rates on bank profitability of European banks. Using accounting data, they find evidence that low rates do not systematically harm banks' reported return on assets, unless low rates prevail for a long period of time. 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.

In contrast, we examine 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 low/negative rate period.

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 are 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.

First, 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 policy announcement. 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[6]. We construct a window around each press statement release and each press conference. For press statements, this window goes from 10 minutes before the release of

[6] 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.

the statement until 20 minutes after. For press conferences, the window goes from 10 minutes before the start of the press conference until 20 minutes after the end of the press conference. The difference of the EONIA swap price from the start to the end of the window represents the unexpected change in the level of the ECB's interest rate on the main refinancing operations (MRO).

On top of this, market participants may also be surprised by indications regarding the future path of interest rates. These indications could come through explicit forward guidance or through other types of information released during the press conference or in the press statement. We use the 2-year EONIA swap rate as a proxy for the future long-term rate of interest rates and use it 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.[7]

Figure 1 depicts the two interest rate surprises for the press statement over our sample period: from January 7th 1999 until June 2nd 2016. 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.

[7] 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 for two reasons. First, we believe the interpretation is easier to understand. Second, 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 β_2.

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:

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

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.[8] 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.

[8] Clustering by time leads to virtually identical standard errors, reflecting the fact the two corrections differ only in finite samples.

Even if 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. In light of these findings, we henceforth focus our analysis on the press statement only.

There is not a unique instrument which reflects long-term rates. Within the Eurozone each sovereign country issues bonds, thus, as a robustness check, we use bonds from other 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 (we also use the 2-year Bund for the sake of completeness). As shown in table 1a, our baseline result is robust to the use of any of these alternative instruments to construct the long-term rate surprise. It is worth noting that there is now an effect coming from rate surprises during the press conference in Italy and Spain. These two countries experienced severe tensions which were reflected in their credit spreads, on top of having financial sectors in distress. Indications of future lose monetary policy were beneficial for the banks in these two countries.

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 2nd 2008;

ii) Crisis with normal rates: October 2nd 2008 to July 5th 2012; and

iii) Low/negative rates: July 5th 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. 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 (2016) reversal rate. In the next section, we discuss this further and investigate what might be behind this phenomenon in the euro area.

Moreover, for the low/negative rate period, we also find economically large and statistically significant effects of surprise changes in long-term rates around ECB press statements on bank equity values. These effects operate in the conventional direction, however, which is the same direction as in regular times (as indicated by the negative coefficient). Holding fixed the short rate, a 25 basis point policy-induced reduction in the long rate increases bank stock prices by about 3 percent. The low/negative rate period also encompasses the time that the Governing Council of the ECB embarked for the first time on the use of explicit forward guidance and asset purchases, both tools that work importantly through reductions in long-term interest rates.[9] 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, 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.[10] [11]

[9] 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 term premia.

[10] 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 bank profitability and stock prices, which is consistent with our results.

[11] 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 monetery policy reduces short-term rates without lowering long-term rates. Recall that our regression controls for both short-term and long-term rate surprises. As a result, 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. It is true that forward guidance lengthened the

Further evidence regarding the differential effect of monetary policy under low rates is provided in Figure 2. The chart shows the value of the coefficient on the short-term rate 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 between 0 and 1 percent, between 1 and 2 percent, and so forth. 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 (2016) 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, already noted, that monetary policy affects banks' profitability through various channels, not all of which go in the same direction. Many of these channels have similar effects on

expected duration of low or negative rates, which should, according to our results, weigh on bank equity values. However, forward guidance also 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, for the 10 year maturity the change over the same period was from 3.5% to slightly above 1%; levels which would correspond to a 'normal rate territory.' Moreover, forward guidance also works by reducing uncertainty about future interest rates, which tends to reduce term premiums and lower long-term yields regardless of expected short rates.

banks' profits whether rates are high or low, but some do not. In particular, the effect of monetary policy on net-interest margins is likely to change in a low rate environment, because banks typically rely on deposits to finance a considerable part of their balance sheet.

Deposits are normally a lucrative source of funding for banks, as interest rates on deposits are typically below market rates, or even zero. But this boost to net-interest income is diminished when rates are reduced below zero, as banks are very reluctant to 'pay' negative rates to customers, as argued. Their reluctance to charge negative rates to depositors 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.

5.1.1. A simple model of bank profits under a zero lower bound on the depository interest rate

To draw out the implications of this 'zero lower bound' on deposit rates for banks' exposure to interest rate risk more explicitly, 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, moderate the impact of monetary policy on bank profits. Specifically, the model will show, 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.

Consider a bank that 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 other assumptions regarding interest rates are summarized below:

$$\begin{aligned} R^M &: \text{ policy rate} \\ R^L &= R^M + m^L \\ R^B &: \text{ fixed} \\ R^E &= R^M + s^E \\ R^W &= R^M + s^W \end{aligned}$$

To simplify the analysis, the margins and spreads are assumed to be constant.[12] Bank

[12] Brunnermeier and Koby (2016) provide an extensive theoretical analysis of how deposit and lending margins adjust in an imperfectly competitive setting. We have nothing new to add to their analysis of imperfect competition and focus instead on the effects of the lower bound on deposit rates.

profits[13] 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 the main prediction of the model:

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

The term – B represents capital losses on existing long-term assets when rates rise.[14] 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, hence the term D in the above expression.[15]

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 $D > B$; that is, if retail deposits exceed existing long-term, fixed-rate assets.

[13] Technically, these are economic profits (not accounting profits) as the required compensation to shareholders is subtracted.

[14] 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.

[15] The analogous result for accounting profits simply adds E to the derivative regardless of whether R^M is above or below the threshold.

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 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 favour 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, the equity values of banks with a high reliance on deposits should decline relative to the equity values of banks with little deposit funding.

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

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

where DR is the ratio of deposits to total assets. 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 $\Delta Swap_t^{1m} * DR_{it} * LowRates_t$ is positive: $\theta_1>0$.[16] A positive θ_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 3). Bank size is measured by the log of total assets.

Table 4 presents 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

[16] 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).

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 ψ_1, and the cell in the swap*deposit ratio*period row and the low/negative rates column is the coefficient θ_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.

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; a 100 basis points rate cut increases stock prices of "low deposit banks" by 4.0 % on average, while the effect is 1.5 percentage points higher for "high deposit banks". 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 (ψ_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 (θ_1), shown in the last row of the table. We thus also find evidence in favour of the model's second implication (θ_1>0).

Figure 4 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, apparently hurting their profitability. 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 give loans which have 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.[17] The effect of a surprise increase in the short-term rate is negative and significant in both cases, although, 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).

[17] 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).

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 5 shows the average reaction 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 5, 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 (Brunnermeier and Koby, 2016).

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

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

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 6 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 effects in the low/negative rate period (shown in red) suggest that the reversal phenomenon is present in all sectors, although the sign switch across the two periods is not statistically significant in several cases. By far the largest reversal is observed for the banking sector, and the detrimental effect of rate cuts on stock prices in the low/negative rate period is also the largest for banks. The latter result could be explained because of 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 deteriorating financial strength of banks. 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 became detrimental for 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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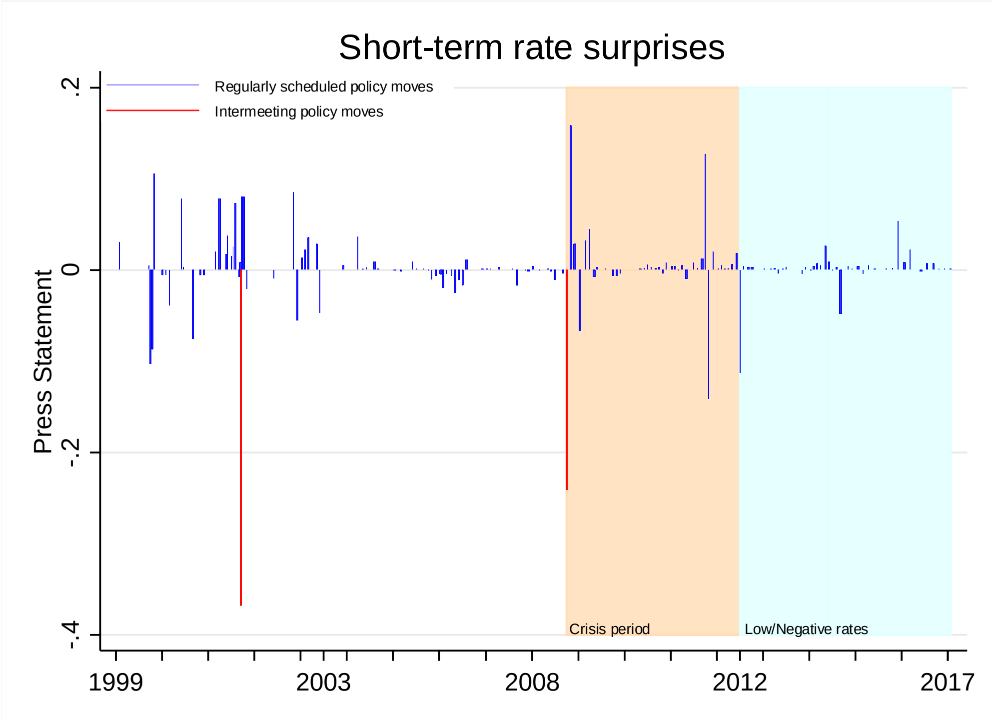
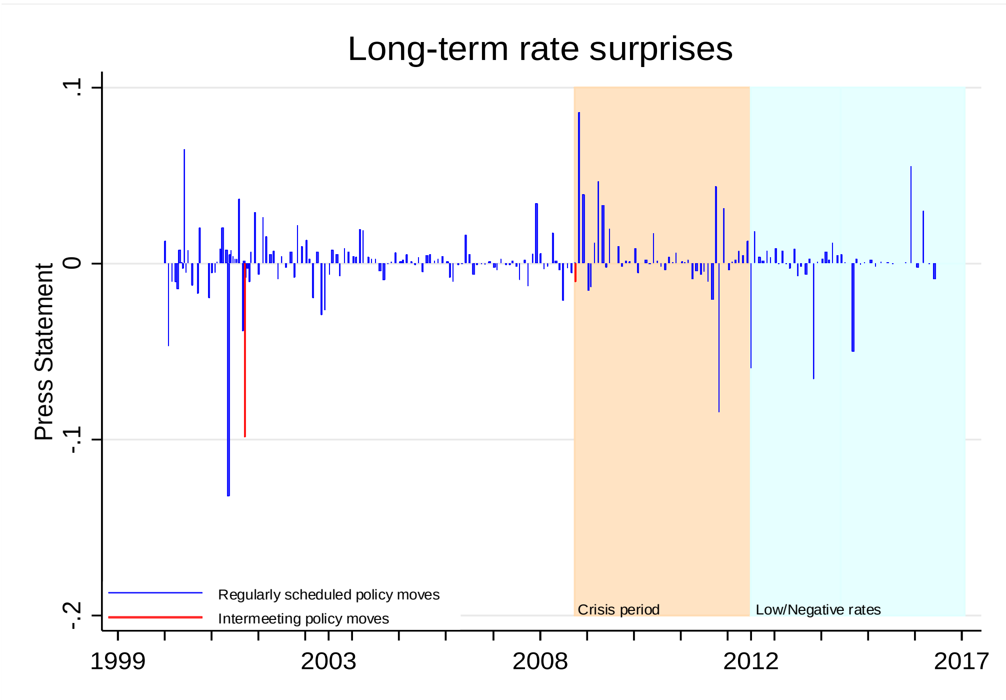
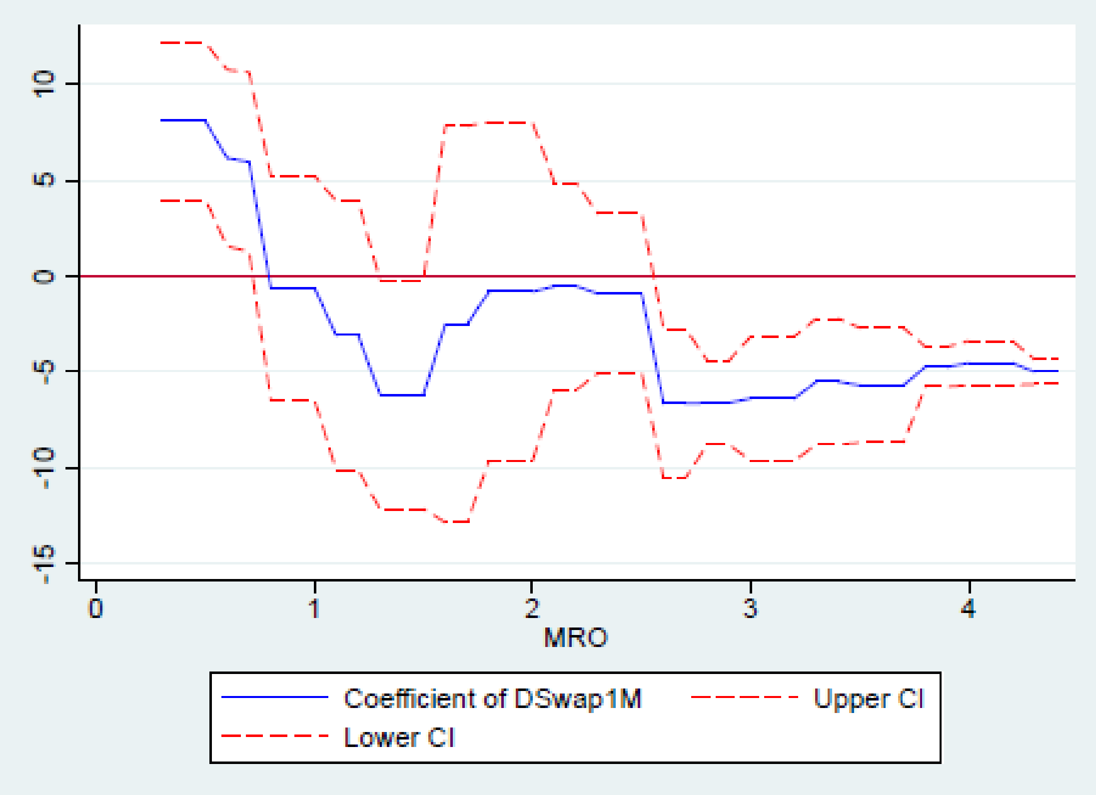
Figure 1: Monetary policy shocks





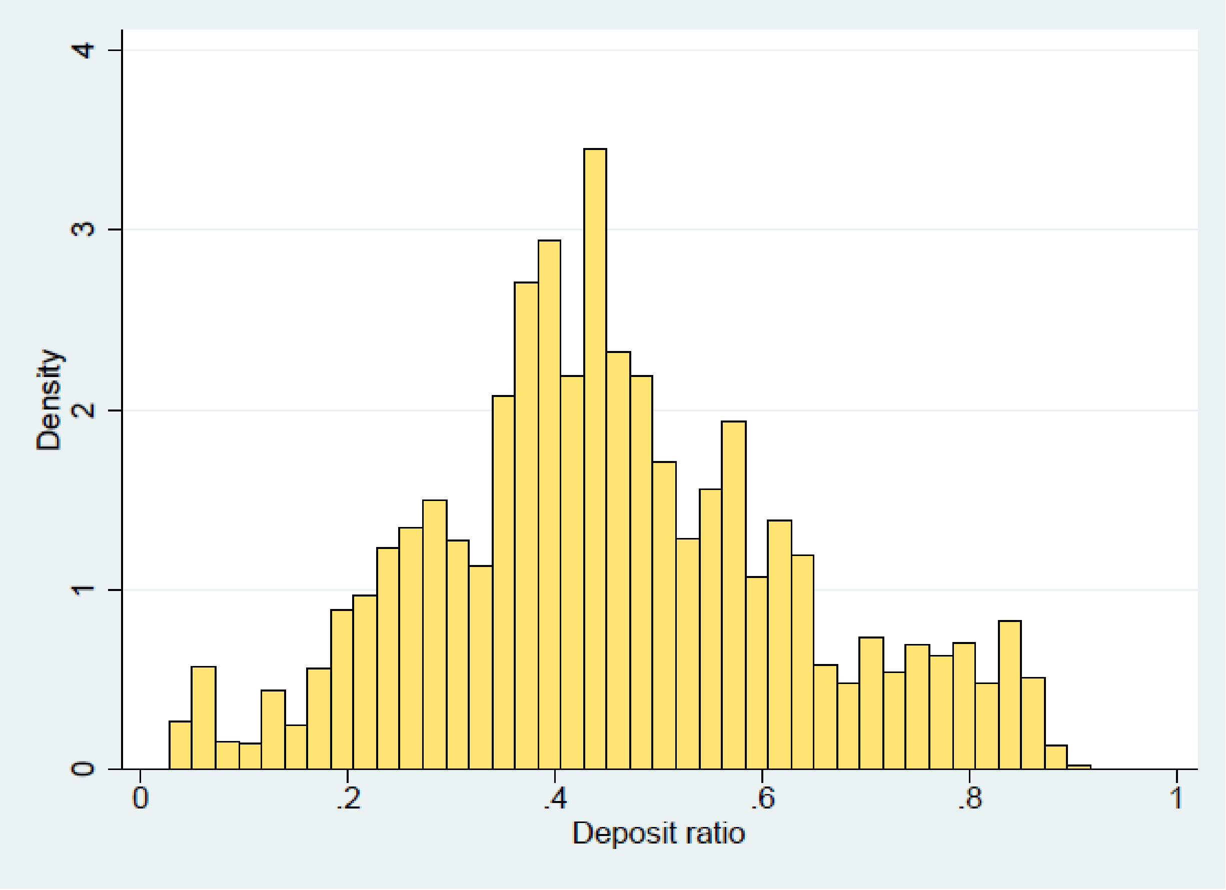
Notes: The upper chart shows short-term interest rate shocks given by movements in the EONIA 1 month swap during a 30 minute window around ECB's Governing Council press statements The lower chart shows long-term interest rate shocks given by movements in the 2 year swap during a 30 minute window around ECB's Governing Council press statements

Figure 2: The effect of monetary policy at different MRO levels



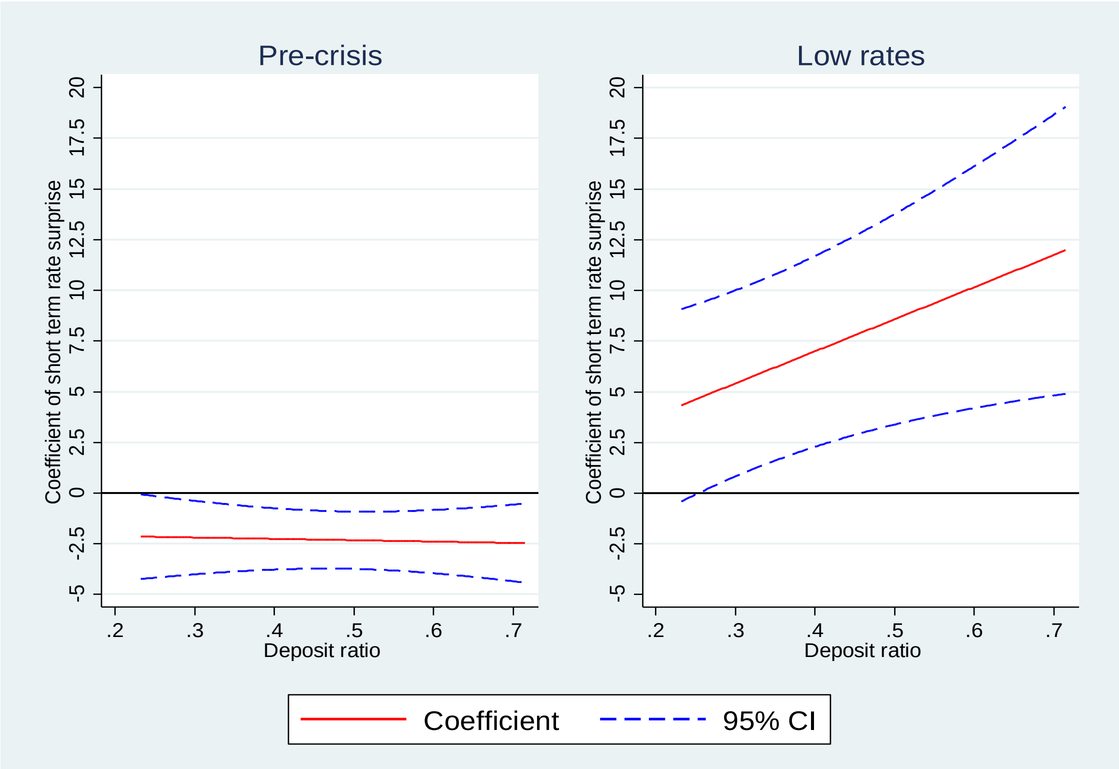
Notes: The figure shows coefficients on the short-term rate surprise and 90% confidence intervals from regressions as specified in section 4 and run for different subsamples based on the values of the MRO. Specifically, each subsample contains the set of observations when –at the start of the policy meeting -- the MRO is in a bin of 100 basis points centred on the value shown on the horizontal axis.

Figure 3



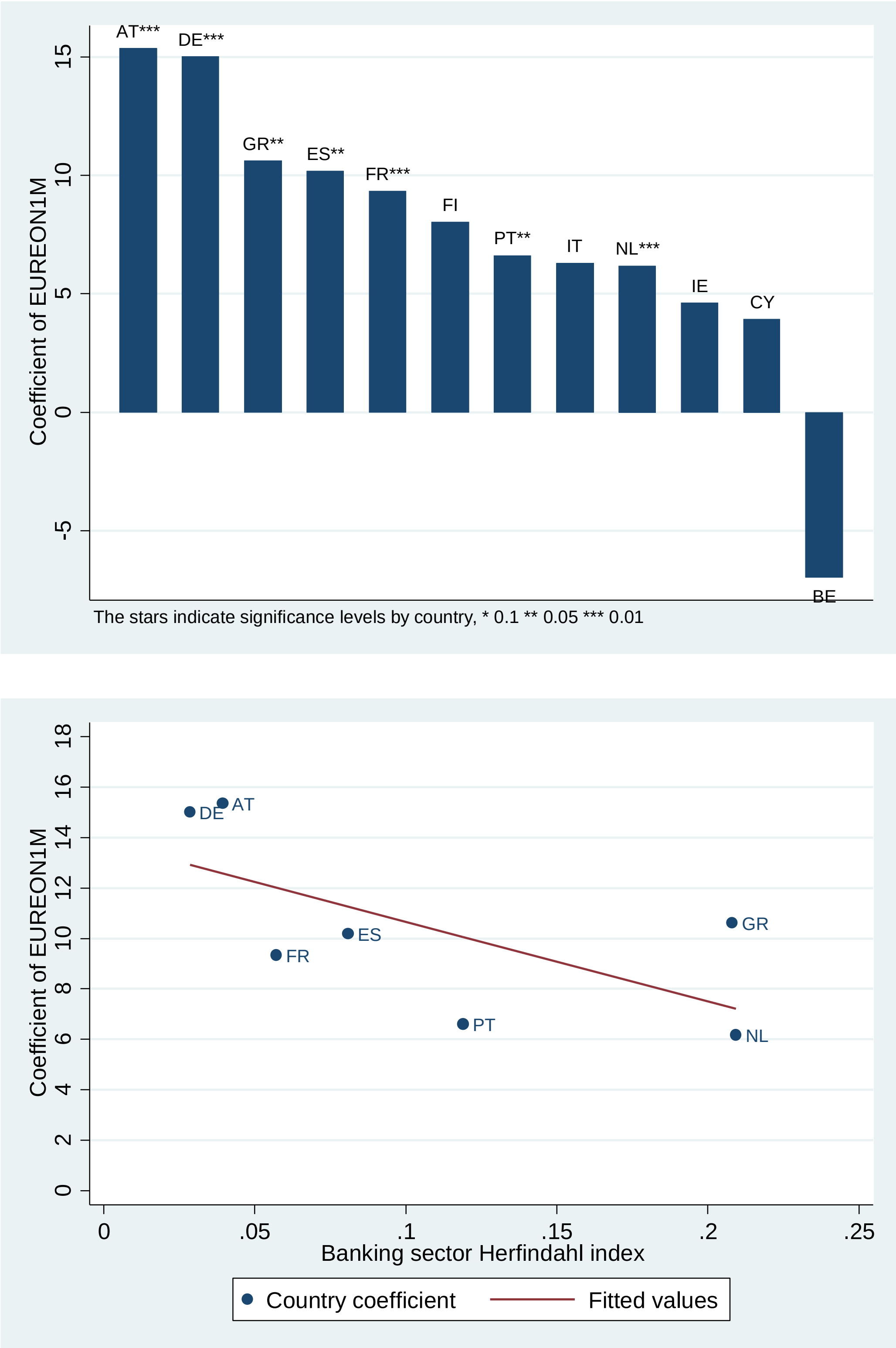
Notes: Deposit ratio is defined as total customer deposits over total assets. The histogram shows the cross sectional distributional for the year 2015. The sample of banks includes all listed euro area banks.

Figure 4



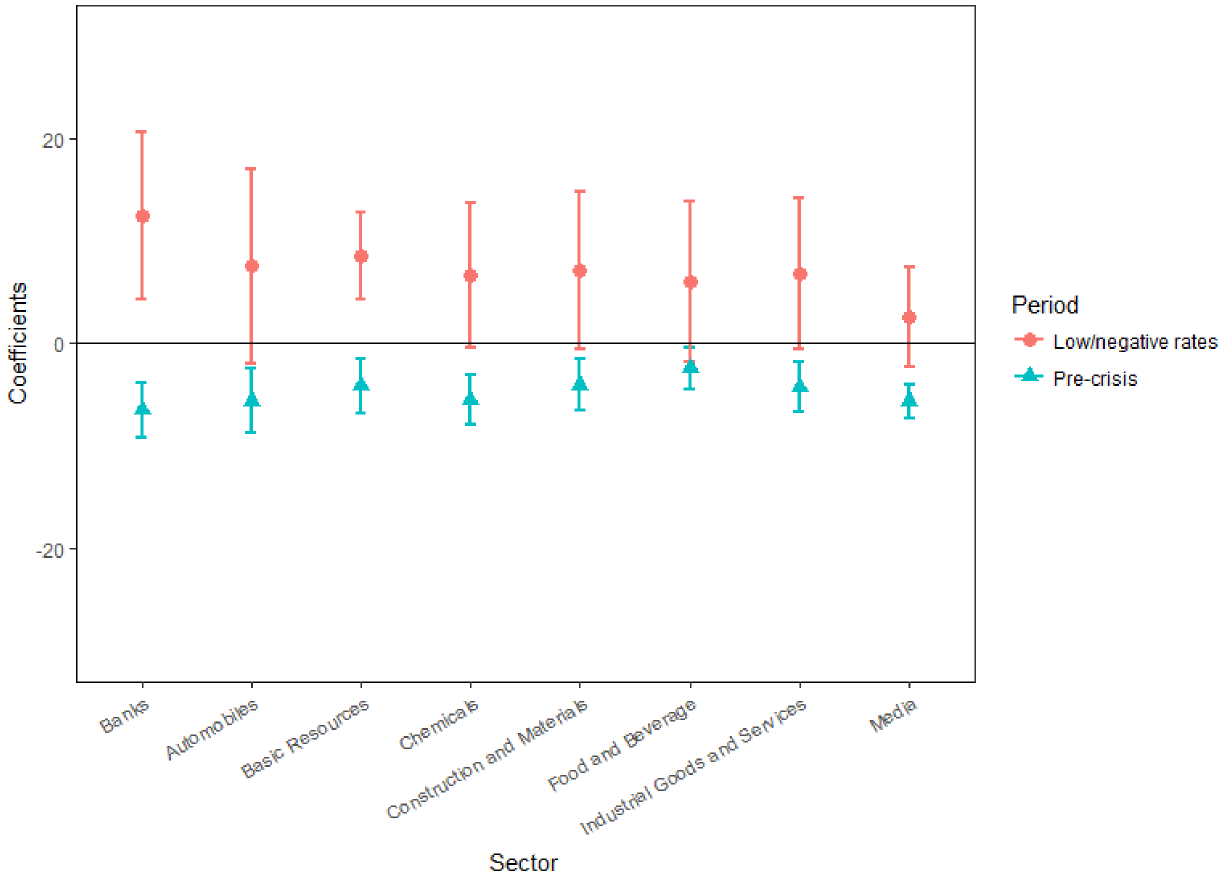
Notes: The figures show estimated impact and 95% confidence intervals of the short-term rate surprise on bank equity values, as a function of the bank's deposit ratio, based on the regression specified in section 4.3.1.2. For ease of presentation, the sample mean of the trend in the deposit ratio is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

Figure 5: Country level effects



Notes: The upper chart shows coefficients for country level regressions for short-term rate surprises in the low rates period following the specification detailed in section 3 of the paper. The lower chart shows coefficients for country level regressions in the low rates period vs Herfindahl index of the banking sector for those countries which coefficients are statistically significant at the 10% level.

Figure 6



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 rate period are shown.

Table 1: Baseline specification

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

Notes: The sample period comprises 245 policy actions between 07/01/1999 and 19/01/2017 (17/09/2001 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: Alternative instruments for long-term rate surprise

	France	Netherlands	Italy	Spain	Bund 2y	Bund 5y	Bund 10y
Short-term rate surprise	-4.357***	-4.508***	-4.277***	-3.723***	-3.712***	-4.471***	-4.530***
	(1.079)	(1.055)	(1.178)	(1.116)	(1.104)	(1.125)	(1.220)
Long-term rate surprise	-0.713	-0.0577	-2.719	-2.550	-3.308	-0.534	0.212
	(1.427)	(1.805)	(2.368)	(1.877)	(2.183)	(2.566)	(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
Short-term rate surprise	4.832	4.264	7.048*	4.295	4.282	3.536	2.742
	(2.953)	(3.069)	(4.084)	(3.544)	(2.964)	(2.953)	(2.723)
Long-term rate surprise	-2.033	-1.852	-5.414***	-4.531***	-1.755	-1.736	-1.601
	(1.328)	(1.366)	(1.335)	(1.599)	(1.251)	(1.489)	(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: Upper panel shows results for the press statement and lower panel shows results for the press conference. 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). The sample period comprises 245 policy actions between 07/01/1999 and 19/01/2017 (17/09/2001 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: Time varying effects

	Pre-Crisis	Crisis	Low/negative rates
Short-term rate surprise	-3.040***	-5.305***	8.080***
	(0.894)	(0.909)	(2.489)
Long-term rate surprise	-0.858	-3.759	-12.27***
	(1.207)	(3.432)	(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 sample period comprises 245 policy actions. Pre-crisis period covers from 07/01/1999 to 02/08/2008 (17/09/2001 is excluded), crisis period covers from 02/08/2008 to 05/07/2012 and low/negative rates period covers from 05/07/2012 to 19/01/2017. 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 2b: Time varying effects with orthogonal component of long-term rate surprise

	Pre-Crisis	Crisis	Low/negative rates
Short-term rate surprise	-3.310***	-6.490***	4.215*
	(0.762)	(1.104)	(2.086)
Long-term rate surprise	-0.858	-3.759	-12.27***
	(1.207)	(3.432)	(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 sample period comprises 245 policy actions. Pre-crisis period covers from 07/01/1999 to 02/08/2008 (17/09/2001 is excluded), crisis period covers from 02/08/2008 to 05/07/2012 and low/negative rates period covers from 05/07/2012 to 19/01/2017. There are 56 banks in the sample. The long-term rate surprise is the orthogonal component of the surprise coming from the EONIA 2 year swap with the respect to the surprise coming from the EONIA 1 month swap contract. 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)

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

Notes: The sample period comprises 245 policy actions. 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 4: Banks' deposit ratios

	Deposit ratio	Pre-crisis	Crisis	Low/negative rates
Short-term rate surprise	Low	-2.149**	-4.046***	4.335*
		(1.066)	(0.896)	(2.419)
	Medium	-2.286***	-4.654***	7.594***
		(0.738)	(0.864)	(2.473)
	High	-2.469***	-5.472***	11.976***
		(0.995)	(1.307)	(3.610)
Long-term rate surprise	Low	-0.275	-3.105	-10.769***
		(1.637)	(3.279)	(1.718)
	Medium	-0.883	-3.885	-11.996***
		(1.096)	(3.279)	(1.718)
	High	-1.701	-4.935	-13.645***
		(1.507)	(4.091)	(3.294)
R-squared		0.059	0.180	0.214
Observations		2622	1940	1788
Swap*period (ψ_1)			-2.359**	10.441***
			(1.157)	(2.590)
Swap*deposit ratio*period (θ_1)			-1.880	16.672**
			(4.068)	(7.795)

Notes: This table shows marginal effects for banks with low (10th percentile), medium (50th percentile) and high (90th percentile) deposit ratios, measured as total customer deposits over total assets. The sample period comprises 245 policy actions. Pre-crisis period covers from 07/01/1999 to 02/08/2008 (17/09/2001 is excluded), crisis period covers from 02/08/2008 to 05/07/2012 and low/negative rates period covers from 05/07/2012 to 19/01/2017. 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 5: Fixed vs adjustable rate loans

	Adjustable	Fixed
Short-term rate surprise	-3.253**	-5.321***
	(1.278)	(1.186)
Long-term rate surprise	-3.776	-3.056
	(2.370)	(2.549)
Observations	4,652	1,687
R-squared	0.117	0.212
Number of groups	39	13

Notes: 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 period comprises 245 policy actions from 07/01/1999 to 19/01/2017 (17/09/2001 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.

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