Monetary Policy Below Zero: An Empirical Investigation of the Reversal Rate*

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This study considers the transmission of ECB monetary policy measures to bank corporate lending rates of different maturities from 2010 to 2020. Overall, the transmission of short-term policy rates to lending rates appears to have become weaker when below zero. We observe some signs of the reversal rate during the 2014–20 period, but the evidence is stronger as negative rates become more persistent during the low-for-long period starting in 2016. The emergence of the reversal rate is more pronounced for banks more exposed to negative rates and loans of longer maturities. Unconventional monetary policy measures seem to have mitigated these contractionary effects.

JEL Codes: E52, E58, G21.

1. Introduction

Central banks shifted to accommodative monetary policies in the years following the Global Financial Crisis (GFC) of 2008. A few ventured beyond keeping policy rates close to zero, transitioning into negative territory. On June 5, 2014, the European Central Bank (ECB) became the first major central bank to set policy rates below

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zero, launching an era of negative rates that eventually lasted over eight years. Thus, it is hardly surprising that negative rates have become a subject of extensive study in recent years (Heider, Saidi, and Schepens 2021; Balloch, Koby, and Ulate 2022).

Nevertheless, the large body of theoretical and empirical literature has yet to clarify the overall impact of negative policy rates on banks (Balloch, Koby, and Ulate 2022). There are papers that find no evidence that monetary policy becomes ineffective when rates are negative (Erikson and Vestin 2019; Albertazzi, Nobili, and Signoretti 2021; Altavilla et al. 2022), whereas Wang et al. (2022) show that transmission can already be impaired when the policy rate falls below 0.9 percent. However, some argue that prolonged negative interest rates prompt banks to change their practices, so any observed immediate impact of negative rates, on which the literature has mostly focused so far, may differ from the medium- to long-term impacts (Balloch, Koby, and Ulate 2022). Banks can benefit in the short run from capital gains when negative rates are implemented, helping them to withstand negative rates on the reserves they hold at the central bank. These capital gains are insufficient for the long haul, however, making it hard for banks to maintain profitability. Indeed, Claessens, Coleman, and Donnelly (2018) find that for each additional year of low rates (even if the policy rates stay unchanged), margins and profitability of banks erode by several basis points. Ulate (2021), Abadi, Brunnermeier, and Koby (2023), and Eggertsson et al. (2023) show that when the policy rates are low enough, further rate cuts may become contractionary for bank lending. This reversal interest rate is more likely to emerge if rates are kept low-for-long (Balloch, Koby, and Ulate 2022; Abadi, Brunnermeier, and Koby 2023).

In this paper, we study how the transmission of conventional and unconventional monetary policy to corporate lending rates changes as policy rates go below zero and whether there is empirical evidence of a reversal rate in the euro area. More specifically, we aim to answer the following questions: First, did the pass-through of the ECB's monetary policy to corporate lending rates change when the policy rates became negative and especially when the negative interest rates became more persistent during the low-for-long period? Second, how does the transmission of different unconventional monetary policy measures work in this environment?

These questions are particularly important if there is a higher probability of interest rates staying at lower levels and we face the zero lower bound more often (Holston, Laubach, and Williams 2017; Kiley and Roberts 2017). It is therefore essential to understand how monetary policy affects financial conditions in this environment. The transmission of monetary policy might change as policy rate cuts may even turn contractionary (Abadi, Brunnermeier, and Koby 2023), and unconventional monetary policy measures might be necessary to support the economy.

Our results confirm that when short-term policy rates are lowered below zero, transmission becomes weaker or even reverses. As negative rates become more persistent, we find stronger evidence of the reversal rate—with further rate cuts during the period of low-for-long, banks no longer lower their corporate lending rates but instead raise them. This finding is more pronounced for banks that are more exposed to negative policy rates, i.e., those that are reluctant to lower their own retail deposit rates below zero or those with large amounts of negative interest-bearing central bank deposits. The emergence of the reversal rate also varies between loan maturities, with the inverse effect being most distinct at different time horizons for short-, medium-, and long-term loans. The results indicate that this inverse effect is overall more pronounced for loans with longer maturities. Even if the transmission of the short-term policy rate, a conventional policy measure, to bank lending rates is reversed below zero, unconventional monetary policy measures and targeted longer-term refinancing operations (TLTROs) in particular help to mitigate the pass-through by lowering bank funding costs.

We make several contributions to the existing literature. First, we provide empirical evidence in favor of the theoretically reasoned reversal rate, i.e., the theoretical lower bound for policy-rate lowering, below which cuts become contractionary (Ulate 2021; Abadi, Brunnermeier, and Koby 2023). Moreover, in line with Abadi, Brunnermeier, and Koby (2023), evidence for the reversal rate is stronger after the ECB promised to keep interest rates at negative levels for a prolonged period. Our paper is the first to present empirical evidence of the reversal rate in the euro area. So far, evidence of a reversed transmission has been found for Sweden (Eggertsson et al. 2023) and Switzerland (Basten and Mariathasan 2023). For the euro area, existing literature provides mixed results. Some papers find that monetary policy is less effective (but not reversed) when interest rates reach very low or negative levels (Borio and Gambacorta 2017; Molyneux et al. 2019; Kwan, Ulate, and Voutilainen 2025). Others, like Erikson and Vestin (2019), Albertazzi, Nobili, and Signoretti (2021), and Altavilla et al. (2022), find no evidence that monetary policy becomes ineffective when rates are negative. Bottero et al. (2022) even show how negative interest rates have expansionary effects, as more liquid banks increase corporate lending more than other banks.

Indeed, our second contribution is to provide an explanation for these mixed results. As suggested by theoretical reasoning, we show that the detection of the reversal rate depends both on bank heterogeneity and loan maturities. Most of the existing literature focuses predominantly on average effects, and thus reversed effects for certain types of banks or loans might have remained undiscovered.

Our third contribution concerns the evidence on how changes in different monetary policy tools transmit to corporate lending rates. Our paper provides clear-cut evidence on how the pass-through of different monetary policy measures to bank lending rates of different maturities has changed over time. The effects of unconventional monetary policy have been studied intensively in recent years (for asset purchases, see Krishnamurthy and Vissing-Jorgensen 2011; for targeted and nontargeted longer-term refinancing operations, see Andrade et al. 2019; Benetton and Fantino 2021; Laine 2021); yet the literature dealing with time-varying effects above and below zero is scarce. Instead, the focus in the low-rate environment has so far been on the effectiveness of short-term policy rates (e.g., Borio and Gambacorta 2017; Claessens, Coleman, and Donnelly 2018; Kwan, Ulate, and Voutilainen 2025), or on unconventional measures but not distinguishing between different kinds of tools (Boeckx, de Sola Perea, and Peersman 2020; Albertazzi, Nobili, and Signoretti 2021). We look separately at the time-varying effects of short-term policy rates, quantitative easing (QE), and (T)LTROs.

As we aim to investigate the existence of the reversal rate, we focus on bank lending rates. Developments in lending rates are found to be mostly driven by supply shocks, whereas fluctuations in lending volumes are largely explained by demand (Altavilla, Boucinha, and Bouscasse 2022). We exploit a detailed bank-level data set of corporate lending rates at the monthly frequency on 137 individual banks from 13 euro-area countries covering the period from January 2010 to December 2020. Unlike most empirical papers that rely on shorter data samples,[1] our data enable us to properly study the low-for-long period. For our purposes, the low-for-long period begins in 2016, when ECB forward guidance signaled that policy rates would remain in negative territory "for a prolonged time." Moreover, we utilize the detailed information on different loan maturities. Besides information on bank balance sheets, loan and deposit interest rates, central bank deposits, and longer-term borrowing of banks, we employ data from the responses of individual banks to the ECB's Bank Lending Survey to control for bank-level loan demand. We isolate monetary policy shocks by utilizing rate changes around the ECB's monetary policy decisions from the Euro Area Monetary Policy Event-Study Database (EA-MPD; see Altavilla et al. 2019) and bank bond yield changes on (T)LTRO announcement days. These shock proxies allow us to disentangle various types of monetary policy tools: short-term policy rates, targeted long-term refinancing operations, and quantitative easing.

The article has the following structure. Section 2 describes the main aspects of the monetary policy conducted by the ECB during the observation period 2010 to 2020. Section 3 presents our data and various measures of monetary policy. Section 4 provides the methodology, and Section 5 presents the results. Section 6 concludes with a few policy insights.

2. Monetary Policy in the Euro Area

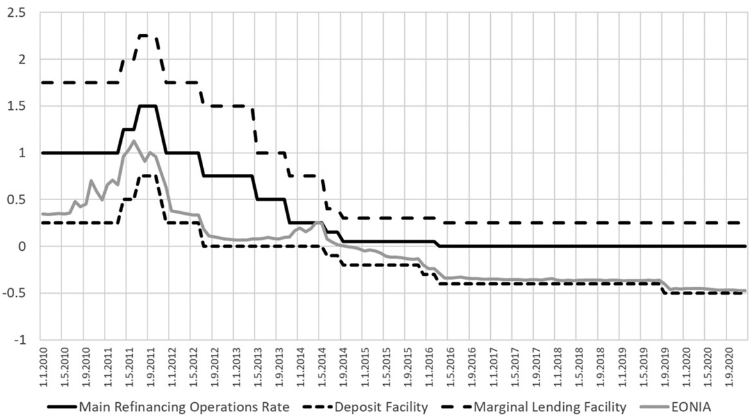
This section presents the main aspects of the ECB's monetary policy during the period from 2010 to 2020.[2] It also discusses how we define the low-for-long period.

Policy rate-setting is the ECB's primary monetary policy tool (Figure 1). Its main refinancing operations (MROs) allow banks to borrow from it on a weekly basis at predetermined rates. Liquidity sharing on the interbank market stalled with the onset of the

[1] See Table 4 in Balloch, Koby, and Ulate (2022) for details concerning the data used in existing empirical studies.

[2] For a more comprehensive description, see Rostagno et al. (2021).

Figure 1. ECB Policy Rates and EONIA (2010–20)



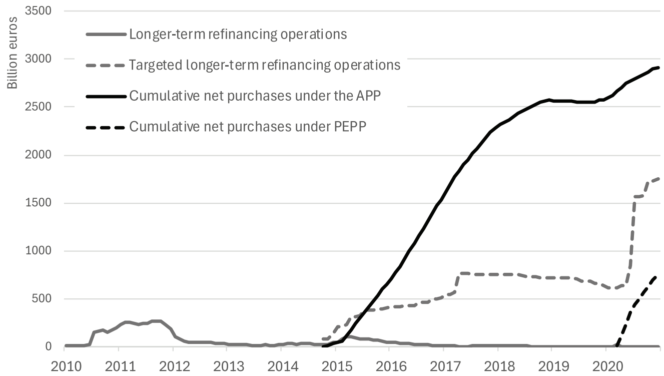
Source: ECB.

GFC, and in October 2008, the ECB began carrying out its MROs as fixed-rate tenders with full allotment. This shift led to a buildup of liquidity inside the banking sector. Because of this excess liquidity, the shortest money market rates (e.g., the Euro Overnight Index Average, or EONIA) began to track the ECB's deposit facility rate rather than the MRO.

Following the ECB's initial cut of its deposit facility rate to –0.10 percent in June 2014, key interest rates were lowered a total of five times. The final cut, in September 2019, brought the deposit facility rate to –0.50 percent. When the deposit facility rate is negative, banks have less to withdraw from their central bank accounts than their previous day's deposit. Individual banks can reduce their own excess liquidity by lending it out to other banks or purchasing assets, but as liquidity is always passed on from one bank to another, the banking system as a whole cannot shed its total excess liquidity. This burden was reduced in October 2019 with the adoption of a two-tier system for reserve remunerations.

The ECB also contributed to lowering banks' funding costs by lending funds on highly favorable terms under both nontargeted and targeted longer-term refinancing operations (Figure 2). Two LTROs with a maturity of three years were agreed upon in December 2011. The operations became targeted (i.e., TLTROs) in 2014 as the aim

Figure 2. ECB's Longer-Term Refinancing Operations and Asset Purchases under the Asset Purchase Programme (APP) and Pandemic Emergency Purchase Programme (PEPP)



Source: ECB.

was refined such that banks would use the new liquidity to increase lending to nonfinancial corporations and households for consumption. The cost of TLTROs was bank-specific and became cheaper the more the recipient bank increased its lending to the private sector. The first series of TLTROs (TLTRO I) was announced in June 2014, followed by TLTRO II in March 2016, and TLTRO III in March 2019.

Additional excess liquidity was also created by the ECB's Expanded Asset Purchase Programme (APP). The Eurosystem conducted net purchases of securities under several asset purchase programs (the Public Sector Purchase Programme (PSPP), the Third Covered Bond Purchase Programme (CBPP3), the Corporate Sector Purchase Programme (CSPP), and the Asset-Backed Securities Purchase Programme (ABSPP)) at varying monthly purchase paces between October 2014 and December 2018. APP net purchases stalled between January and October 2019 but were restarted in November 2019 and kept running at a pace of 20 billion euros a month until the end of our observation period in December 2020. In March 2020, as the first wave of the COVID-19 pandemic was hitting Europe, the ECB launched its Pandemic Emergency Purchase Programme (PEPP). It made additional purchases in all categories eligible under the APP (plus some extensions such as Greek government securities).

Our analysis focuses on the changes in the transmission of monetary policy through banks (i) after policy interest rates fall into negative territory, and (ii) when economic agents realize that negative rates are here to stay, i.e., when the economy enters the low-for-long period.

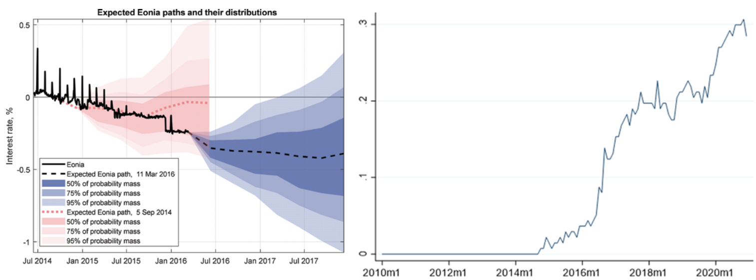
The first deposit facility rate cut below zero in June 2014 marked the beginning of the negative rates era that lasted until the end of our sample. However, in our estimations, we extend the period of negative rates to January 2014 in order to make sure that any surprises related to the transition into negative territory are also included in the subsample.

Defining the start date for the low-for-long period is more challenging. The ECB lowered its deposit facility rate a third time in December 2015, from –0.20 to –0.30 percent, and again to –0.40 percent in March 2016. On January 21, 2016, ECB President Mario Draghi announced a shift in the ECB's forward guidance with the following statement after the monthly monetary policy meeting:

> Based on our regular economic and monetary analyses, and after the recalibration of our monetary policy measures last month, we decided to keep the key ECB interest rates unchanged, and we expect them to remain at present or lower levels for an extended period of time. (ECB 2016)

The change in the expected interest rate path was significant after these policy changes. Panel A of Figure 3 depicts the expected path (forward curve) of the euro-area short-term rate and its distributions at two different points in time: the second rate cut in September 2014 (pink distribution) and the fourth rate cut in March 2016 (blue distribution). These expectations are derived from the EURIBOR (euro-area interbank offered rate) future option market assuming risk-neutrality following the method of Shimko (1993). Note that even after the policy rate was lowered to –0.20 percent, the scenario in which interest rates would return to positive territory over the course of one year was within 50 percent confidence bands. However, entering 2016, this perception had changed. Looking at the probability distribution in March 2016, markets clearly started to understand that negative interest rates were a persistent phenomenon.

Figure 3. Expected Euro-Area Short-Term Rate Paths and Their Option-Implied Probability Distributions (Panel A). Share of Banks Having at Least One Retail Deposit Account at Negative Rate (Panel B)



Source: ECB; authors' calculations.

The change in perception of the persistence of negative interest rates is also visible when examining the number of banks in our data set that started to charge negative interest rates on their retail deposits. As shown in panel B of Figure 3, the share of banks with at least one retail deposit account (including both household and corporate, overnight, and other maturities) bearing negative interest rates increased considerably from the beginning of 2016 to around 20 percent by the end of 2017 and 30 percent in 2020. Banks that started to charge negative interest rates on their retail deposits were on average not different from their nonnegative deposit rate counterparts with respect to their ex ante (or ex post) level of net interest margin. In addition, charging negative deposit rates does not correlate with the amount of variable interest lending nor the initial level of either lending or deposit rates. Out of the 13 countries in our sample, there were in total 9 countries where we observed banks charging negative deposit rates. Based on the reasoning above, we place the beginning of the low-for-long period in January 2016, and it lasted until the end of our observation period in December 2020.

3. Data

This section presents the data used and defines our monetary policy measures.

3.1 Data Description

We employ different sources of data to create our unique data set. First, our dependent variables, i.e., the lending rates for new loans, are drawn from the ECB's confidential individual MFI interest rate statistics (IMIR). We have bank-specific interest rate observations at a monthly frequency on new domestic nonfinancial corporation[3] (henceforth corporate) loans of different maturities. We use four dependent variables for our main estimations. The average lending rate for corporate loans is a weighted average of lending rates for all new corporate loans of different maturities granted by a bank in each month. We also look at the lending rates for corporate loans separately for maturities of up to one year, one to five years, and over five years.

Our main explanatory variables are the measures of monetary policy. We use a local projection method to disentangle the effects of specific monetary policy measures: policy interest rate, (T)LTROs, and QE. To that end, we use the EA-MPD and our own calculations. Monetary policy measures used are discussed more thoroughly in Section 3.2.

To form our bank-specific variables, capitalization (ratio of equity to total assets), liquidity (ratio of liquid assets to total assets), and bank size (log of total assets), we predominantly rely on monthly bank-specific balance sheet information provided by the ECB (individual MFI balance sheet item data set, IBSI); the exception being liquidity, where we use annual data from BankFocus. In addition, we use monthly observations on each bank's borrowing from the central bank under targeted and nontargeted longer-term operations, as well as each bank's monthly reserves in central bank deposit accounts. The data are from two confidential ECB data sets (bank-level borrowing and repayments from different longer-term refinancing operations and bank-level current account deposits).

With access to the ECB's individual Bank Lending Survey data with quarterly survey responses of individual banks, we have the

[3]We focus on corporate loans to keep our analysis concise. Nevertheless, the examination of housing loans yields similar results. These results are available upon request.

possibility to control directly for loan demand encountered by each bank. Our question of interest is worded as follows:

> Over the past three months (apart from normal seasonal fluctuations), how has the demand for loans or credit lines to enterprises changed at your bank? Please refer to the financing need of enterprises independent of whether this need will result in a loan or not.

Respondents could choose from "(i) decreased considerably, (ii) decreased somewhat, (iii) remained basically unchanged, (iv) increased somewhat, or (v) increased considerably." Based on the responses, we construct two dummies for loan demand: one for increasing demand (equal to one if the bank responded with (iv) or (v)), and one for declining demand (equal to one if the bank responded with either (i) or (ii)). Each estimation includes both dummies.

To control for macroeconomic developments affecting all banks in one country at the same time, we include country-specific year-on-year growth in industrial production and the harmonized unemployment rate, both from Eurostat at a monthly frequency. In addition, to take into account euro-area-wide macroeconomic developments and uncertainty, we further include normalized total returns of the euro-area STOXX index, as well as the first principal component of short-, medium-, and long-term expectations of euro-area GDP growth, inflation, and unemployment from the ECB Survey of Professional Forecasters (SPF) at monthly frequency.

Altogether, our data set is an unbalanced panel covering 137 individual euro-area banks from 13 countries (Austria, Belgium, Estonia, Finland, France, Germany, Ireland, Italy, Lithuania, Luxembourg, Portugal, Slovakia, and Spain) for the period January 2010–December 2020. The smaller coverage of the individual Bank Lending Survey (iBLS) ultimately limits our sample. Even if the number may seem small at first, banks participating in the BLS provide a representative sample of euro-area banks and take into account the characteristics of the respective national banking structures (see also Figure A.1 in the appendix). Definitions of all variables used are presented in Table 1. Descriptive statistics for the full time period and two different subperiods (period of negative policy rates and period of low-for-long) can be found in Table 2. We

Table 1. Definitions of Variables

Variable	Definition	Source
NFC Lending Rate	NFC loan rate weighted average (weighted average calculated using the amount of new loans provided every month)	ECB IMIR
NFC Lending Rate, up to One Year	NFC loan rate for new loans up to one year of maturity	ECB IMIR
NFC Lending Rate, One to Five Years	NFC loan rate for new loans one to five years of maturity	ECB IMIR
NFC Lending Rate, over Five Years	NFC loan rate for new loans over five years of maturity	ECB IMIR
Liquidity	Liquid assets to total assets ratio	Bank Focus
Capitalization	Equity to total assets ratio	ECB IBSI
Size	Log of bank total assets	ECB IBSI
Central Bank Deposits	Banks' monthly reserves in central bank deposit accounts	ECB confidential database
Central Bank Operations	Banks' borrowings from the central bank's targeted and non-targeted longer-term operations	ECB confidential database
Industrial Production	Country-specific industrial production year-on-year growth	Eurostat
Unemployment	Country-specific harmonized unemployment rate	Eurostat
Stock Return	Euro area, STOXX index, total return, close (in EUR), normalized	STOXX, Macrobond
Exp. Euro-Area Inflation	Expected rate of inflation in the euro area, 1st principal component of short-, medium-, and long-term expectations	ECB Survey of Professional Forecasters
Exp. Euro-Area Unemployment	Expected rate of unemployment in the euro area, 1st principal component of short-, medium-, and long-term expectations	ECB Survey of Professional Forecasters
Exp. Euro-Area GDP	Expected rate of GDP in the euro area, 1st principal component of short-, medium-, and long-term expectations	ECB Survey of Professional Forecasters
Krippner	Euro-area shadow rate by Krippner (2015)	Macrobond
Demand Increase	Dummy for increasing NFC loan demand (equals one if a bank responded either 4 or 5)	ECB individual Bank Lending Survey
Demand Decrease	Dummy for decreasing NFC loan demand (equals one if a bank responded either 1 or 2)	ECB individual Bank Lending Survey

Table 2. Summary Statistics

Variable	Full Time Span (2010–20)			Negative Policy Rates (2014–20)			Period of Low-for-Long (2016–20)		
	# of Obs	Mean	Std. Dev	# of Obs	Mean	Std. Dev	# of Obs	Mean	Std. Dev
NFC Lending Rate	11,557	2.366	1.111	7,821	2.037	0.963	5,495	1.853	0.855
NFC Lending Rate, up to One Year	11,426	2.312	1.102	7,756	2.013	0.961	5,464	1.841	0.854
NFC Lending Rate, One to Five Years	10,407	2.806	1.637	7,060	2.223	1.348	5,008	1.942	1.202
NFC Lending Rate, over Five Years	9,880	2.995	1.614	6,813	2.418	1.314	4,910	2.138	1.154
Liquidity	13,020	0.187	0.147	8,616	0.193	0.150	6,012	0.207	0.150
Capitalization	12,519	0.096	0.049	8,463	0.101	0.049	5,957	0.100	0.047
Size	12,519	10.780	1.487	8,463	10.732	1.509	5,957	10.759	1.507
Central Bank Deposits	13,020	0.013	0.031	8,616	0.017	0.033	6,012	0.020	0.036
Central Bank Operations	13,020	0.190	4.618	8,616	0.286	5.675	6,012	0.404	6.790
Industrial Production	13,020	1.206	7.267	8,616	1.022	7.798	6,012	0.254	7.428
Unemployment	13,020	9.176	5.009	8,616	8.481	4.495	6,012	7.769	3.908
Stock Return	13,020	0.037	0.971	8,616	0.634	0.561	6,012	0.862	0.486
Exp. Euro-Area Inflation	13,020	–0.011	1.630	8,616	–0.895	1.180	6,012	–0.698	1.256
Exp. Euro-Area Unemployment	13,020	0.044	1.736	8,616	–0.507	1.713	6,012	–1.436	1.110
Exp. Euro-Area GDP	13,020	–0.023	1.188	8,616	0.469	1.152	6,012	0.755	1.256
Krippner	13,020	–1.533	1.149	8,616	–2.162	0.666	6,012	–2.289	0.726
Demand Increase	13,020	0.175	0.380	8,616	0.213	0.409	6,012	0.219	0.414
Demand Decrease	13,020	0.158	0.365	8,616	0.121	0.326	6,012	0.112	0.316

exclude the extreme values by dropping 1 percent of observations from each side of the distribution of the dependent variables.

3.2 Measuring Monetary Policy

As discussed in Section 2, the ECB employed a number of monetary policy instruments during the 11 years covered by our data set. Our focus is to determine whether the pass-through of monetary policy to bank corporate lending rates changed after policy interest rates entered into negative territory and further when banks entered the low-for-long period in January 2016.

A standard strategy in the recent literature is to use monetary policy shocks derived from external VAR models (e.g., Boeckx, de Sola Perea, and Peersman 2020 utilize shocks from Boeckx, Dossche, and Peersman 2017) or event studies (e.g., Albertazzi, Nobili, and Signoretti 2021; Ampudia, Ehrmann, and Strasser 2023; Kho 2025). The monetary policy shocks and surprises represent exogenous variation in monetary policy, and they also allow us to disentangle different types of monetary policy.[4]

We employ the local projections method and three different monetary policy surprises to disentangle the impacts of short-term policy rates, credit easing policies ((T)LTROs), and large-scale asset purchases (QE).

We take the one-week overnight index swap (OIS) surprise around the ECB's monetary policy decisions using the monetary event window (that is, the change in the median quote from the window 13:25–13:35 before the press release to the median quote in the window 15:40–15:50 after the press conference) to measure the impact of conventional monetary policy (the short-term interest rate) and the 10-year OIS surprise to measure the impact of large-scale asset purchases or QE. Both of these surprises are derived from the euro-area event-study database produced in accordance with Altavilla et al. (2019). When studying QE using the 10-year

[4]Alternatively, we could measure monetary policy using an endogenous (shadow) policy rate and control for observed variables in the central bank reaction function as discussed by Bluedorn, Bowdler, and Koch (2017). This approach was utilized in the earlier version of this article. The results based on this alternative strategy are in line with the results presented in the latter sections.

OIS surprise, we use the one-week surprise as a contemporaneous control variable because long-term interest rates are affected by changes in the short-term rates. To measure credit easing policies, we use bank bond yield changes around the ECB announcements involving (T)LTROs when controlling for other changes in monetary policy using the one-week and 10-year surprises. We use the same days as in Altavilla et al. (2023, Appendix B): May 8, 2014, June 5, 2014, July 3, 2014, July 29, 2014, January 22, 2015, March 10, 2016, and May 3, 2016. In addition, we add the following days: December 8, 2011 (three-year LTRO announcement), February 28, 2012 (eligibility of Greek bonds used as collateral in monetary policy operations), March 7, 2019 (TLTRO III announcement), June 6, 2019 (details about the operations), July 29, 2019 (legal act published), and September 9, 2019 (TLTRO rate reduced). We use a single series of average yield to maturity of euro-area banks (senior unsecured bonds), and based on this single series, we calculate the daily change. The data are from Bloomberg.

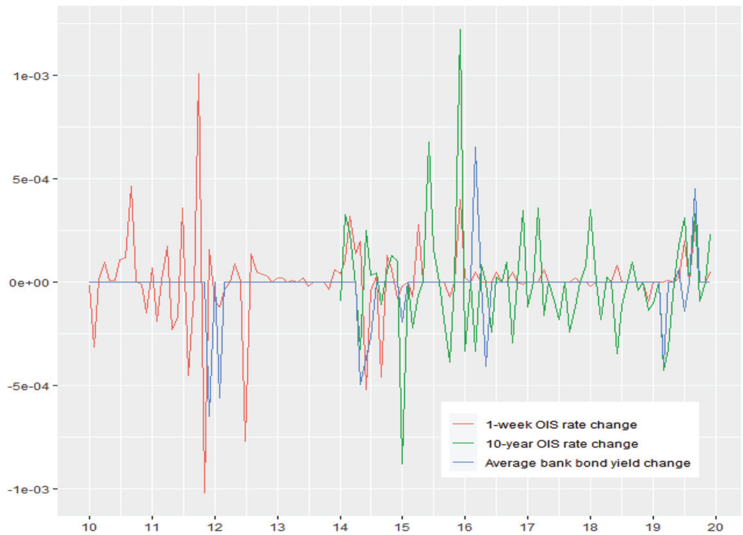
Figure 4 presents the time series of these three surprises for 2010–19. We do not use data concerning the shock proxies after 2019 due to extreme values related to the COVID-19 pandemic.

4. Methodology

We utilize a local projections model as formalized by Jordà (2005), although the idea of estimating regression coefficients of a model where the left-hand-side variable is several periods ahead of the right-hand-side variable is of course much older (e.g., Cox 1961). This approach enables us to estimate the effects of policy shocks at different horizons and thereby tease out the timing and dynamics of these effects. Furthermore, high-frequency monetary policy surprises provide us with an identification strategy for causal effects. In line with the recent literature (Boeckx, de Sola Perea, and Peersman 2020; Altavilla et al. 2022; Altavilla et al. 2023; Kho 2025), we estimate a model that applies local projection methods to bank-level data:

$$r^{L}_{i,t+h} = a_{i,h} + \rho_h(L)Y_{t-1} + \gamma_h(L)X_{i,t-1} + \theta_h Shock_t + e_{i,t+h} \quad (1)$$

Figure 4. Monetary Policy Shocks Used in Local Projections



Source: EA-MPD; Bloomberg; authors' calculations.

for different horizons h. In the equation, $r_{i,t}^{L}$ is the bank lending rate for firms at different maturities, L, charged by bank i at time t; $a_{i,h}$ are bank-specific fixed effects (for different h); Y_t is the vector of macroeconomic control variables; and $X_{i,t}$ is the vector of bank-specific control variables. $Shock_t$ stands for proxy variables for monetary policy shocks (we use three shocks: a policy rate shock, a (T)LTRO shock, and a QE shock), defined in more detail in Section 3.2. The majority of the recent literature (Boeckx, de Sola Perea, and Peersman 2020; Ampudia, Ehrmann, and Strasser 2023; Altavilla et al. 2023; Kho 2025) includes the shock proxy directly in the equation as we do. Some papers, such as Altavilla et al. (2022), use shock proxies as an instrumental variable for the endogenous policy rate. We assess the robustness of our main results regarding conventional monetary policy using this alternative approach. Following the application of local projections by Boeckx, de Sola Perea, and Peersman (2020) to similar data, we assume the number of lags in the baseline specification to be three. The regressions are estimated using OLS. In all the figures, we show 90 percent confidence intervals for θ_h. The confidence intervals are calculated based on a nonparametric robust covariance matrix estimator à la Driscoll and Kraay (1998).

We control for expectations about the macroeconomic environment at the euro-area level by including GDP growth, inflation, and unemployment forecasts from the Survey of Professional Forecasters (SPF), and the current environment by including normalized Eurostoxx stock returns, as well as country-specific industrial production growth and unemployment rates to control for country-specific macroeconomic developments affecting all banks inside a country. Bank-specific controls include liquidity, capitalization, and bank size. We account for corporate loan demand using bank-specific responses from the ECB's individual Bank Lending Survey (iBLS) on how demand for loans or credit lines to enterprises has changed. We use two dummy variables in each estimation: an increasing demand dummy and a declining demand dummy. In addition, we control for the stance of monetary policy prior to the shock using the EONIA and Krippner shadow rates.

Because our proxy variables for monetary policy shocks can be assumed to be exogenous, control variables are not necessary for identification. Nevertheless, adding control variables to the regression reduces the confidence intervals and helps produce more accurate estimates. In addition, adding macro controls to the model removes a potential concern that, for example, more stimulating surprises might occur when the economic situation is bad. The control variables are lagged because we do not want to control out a potential effect of monetary policy on lending rates via immediate effects on the variables used as controls (e.g., Jordà 2005; Plagborg-Møller and Wolf 2021). In some cases, as explained in Sections 5.2 and 5.3, we add one or more contemporaneous policy surprises as control variables to disentangle different types of monetary policies from each other. For example, when studying asset purchases via a surprise change in the long-term rate, we add a one-week rate surprise as a control variable because the long-term rate may be affected by contemporaneous short-term rate surprises.

5. Results

We aim to study how the transmission of conventional and unconventional monetary policy to corporate lending rates changes as policy rates go below zero. To do so, we analyze whether there are differences in the effects of specific monetary policy tools used by the ECB. Such differences are crucial from a policy standpoint. Section 5.1. starts with the conventional monetary policy tool, the short-term policy rate. Section 5.2. moves on to longer-term refinancing operations, and Section 5.3. looks at asset purchase programs.

5.1 Policy Interest Rate

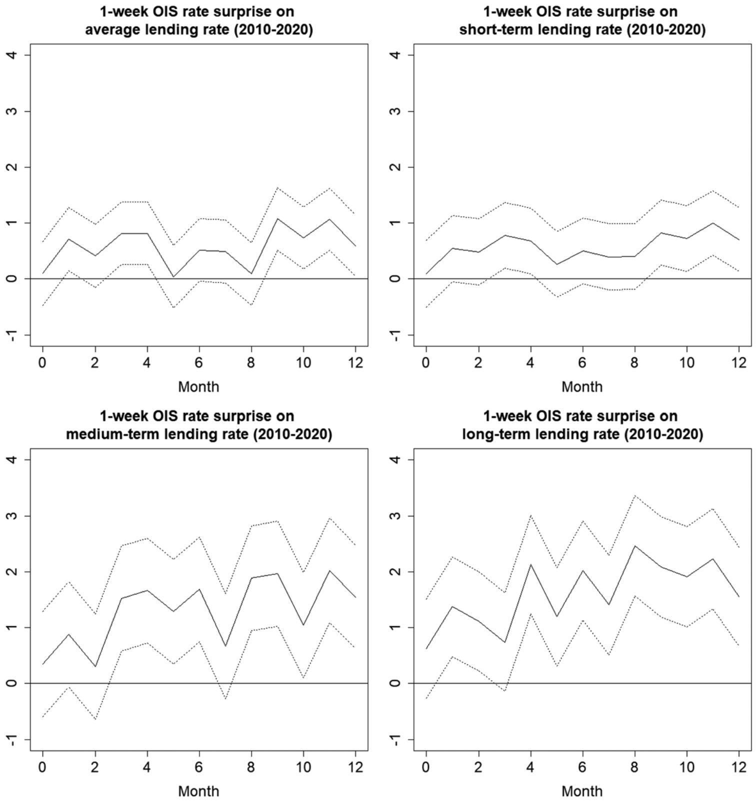
As discussed in Section 4, the short-term policy rate is proxied by a one-week OIS rate shock.[5] We use full calendar years and overlapping samples: (i) the full time span (2010–20), (ii) the period of negative rates (2014–20), and (iii) the period of low-for-long (2016–20).

Figure 5 shows the local projection results for 12-month horizons for the average corporate loan rate and three different maturities for the full time span (2010–20). The peak effects on the average rate are reported in Table A.2. The results suggest that (unexpected) short-term rate changes transmit to bank lending rates approximately one-to-one. When it comes to the average lending rate (upper left panel of Figure 5), the peak effect materializes nine months after the shock (at horizon 9). The point estimate is about 1, which means that, e.g. a negative short-term rate surprise of 25 basis points induces a 25 basis point decrease in the average lending rate. There are some differences with the timing of the peak effect when looking at loans of different maturities. Transmission seems to be stronger overall for loans of longer maturities.

Once policy rates fall below zero, things change. Panels in Figure 6 suggest that the pass-through of policy rate changes to bank lending rates is greatly impaired below zero, as they no longer have the same impact on these rates. For the average corporate lending rate, the effect is statistically not different from zero. The same applies for lending rates of short- and medium-term loans. In the case of the long-term lending rate, results start providing a hint of the reversal rate, as the effect is negative and statistically significant around six months after the shock. Following a 25

[5] We also use a one-month rate surprise instead of the one-week rate surprise. This does not affect the results.

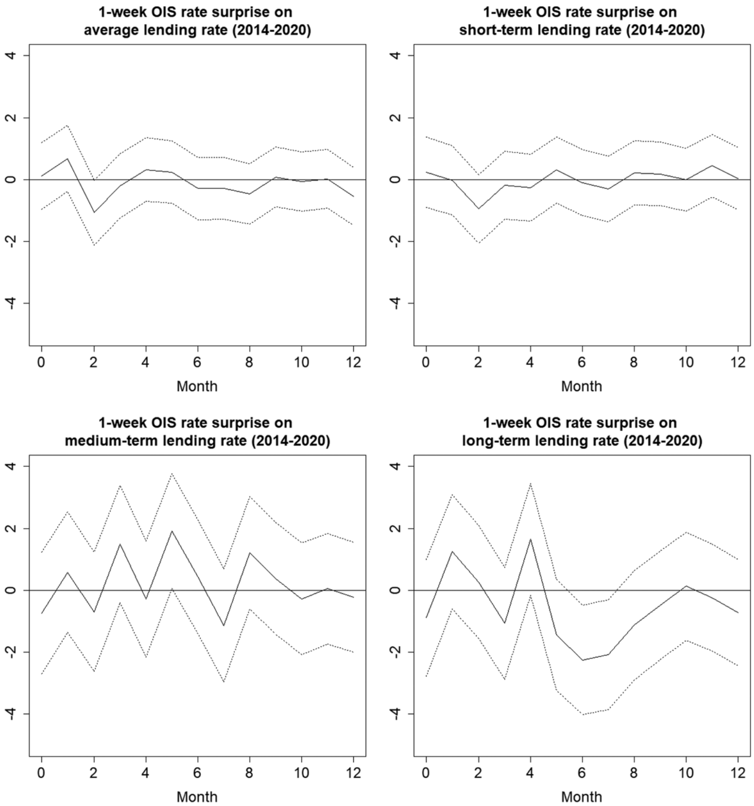
Figure 5. Effect of Short-Term Rate Shock for the Average Corporate Lending Rate and Three Different Maturities, Full Observation Period (January 2010–December 2020)



Note: Maturities: less than one year, one to five years, and over five years. Time horizon: 12 months. 90 percent confidence intervals à la Driscoll and Kraay (1998) are reported.

basis point negative short-term rate surprise, banks increase their long-term lending rates by 50 basis points. Note that in this particular exercise we utilize both positive and negative short-term rate surprises during the period of negative rates. Even though rates were not raised after 2014, market participants at times anticipated more aggressive rate cuts than those that were actually decided

Figure 6. Effect of Short-Term Rate Shock for the Average Corporate Lending Rate and Three Different Maturities, Period of Negative Rates (January 2014–December 2020)

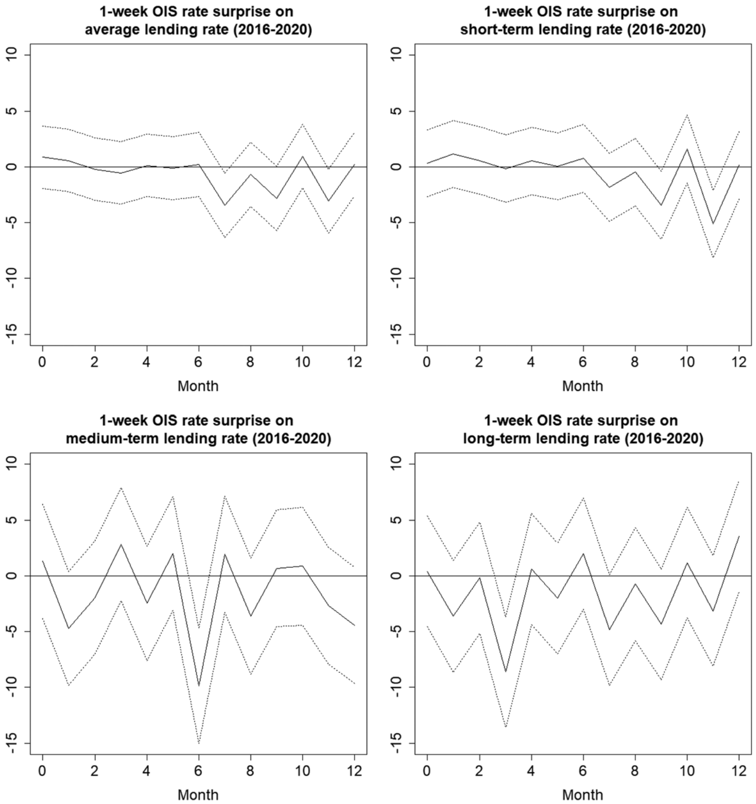


Note: Maturities: less than one year, one to five years, and over five years. Time horizon: 12 months. 90 percent confidence intervals à la Driscoll and Kraay (1998) are reported.

at ECB policy meetings (i.e., contractionary rate surprises). Using only the negative rate surprises for this subsample does not alter the results (see Figure A.2 in the appendix).

As negative rates become a more persistent phenomenon, we again see changes in the estimated coefficients. Figure 7 presents the results for the low-for-long period subsample, which runs from

Figure 7. Effect of Short-Term Rate Shock for the Average Corporate Lending Rate and Three Different Maturities, Low-for-Long Period (January 2016–December 2020)



Note: Maturities: less than one year, one to five years, and over five years. Time horizon: 12 months. 90 percent confidence intervals à la Driscoll and Kraay (1998) are reported.

2016 to 2020. We now see more frequent instances of horizons with negative and statistically significant coefficients, suggesting the existence of the reversal rate, where additional (here unexpected) rate cuts made banks increase their corporate lending rates. The estimated reversal effect for the average lending rate is economically significant. The peak effect at horizon 7 is about –3, meaning that a 25 basis point negative short-term rate surprise further into the negative territory would raise the average lending rate by about 75 basis points. The loan maturities again play a role, as the peak effect occurs at different horizons for different maturities. The statistical significance and the absolute size of the coefficients are higher for medium- and long-term loans.

We assess the robustness of our results concerning policy rates in multiple ways. First, Table A.1 in the appendix provides results using the rolling window approach instead of subjectively chosen subsamples. Results confirm that negative and statistically significant coefficients for the average lending rate can only be found for time windows that incorporate at least the year 2016, so that the reversal rate emerges only when looking at the subsamples containing the low-for-long period. We observe positive, statistically significant coefficients for time windows ending in 2015 or earlier. Second, Figure A.3 presents results for the average lending rate accounting for the future values (leads) of expected GDP growth and loan demand dummy variables, as monetary policy could also affect lending rates indirectly via its dynamic effect on loan demand.[6] This does not change the results. Third, Figure A.4 reports results for the main specification of the average lending rate after replacing the country-specific macro variables in the baseline specification by country and country-year fixed effects to control for any country-specific variation. Here again, the results corroborate our main results. Fourth, although our focus is on lending rates when investigating the existence of the reversal rate (as explained in Section 1), we complement our analysis with regressions for loan amounts (Figure A.5). Using the full sample or the sample prior negative rates, the results suggest that monetary policy easing has a positive effect on loan volumes.

[6]Additionally, instead of a one-week OIS surprise, we use the Target shock constructed as in Altavilla et al. (2019). We use the replication of this shock proxy from Laine and Pihlajamaa (2024) and the poor man's method by Jarociński and Karadi (2020) to clean out the potential information effects. As the correlation between the high-frequency shock proxies and money market rates might differ across subsamples, we use the shock proxy as an instrumental variable for the change in the three-month Euribor rate. For the period of negative rates (2014–20) we find evidence for a reversal rate. Focusing only on the period of low-for-long yields statistically insignificant results. This is not surprising as the number of nonzero values in the shock proxy is very low after 2016 in this specification. These results are available upon request.

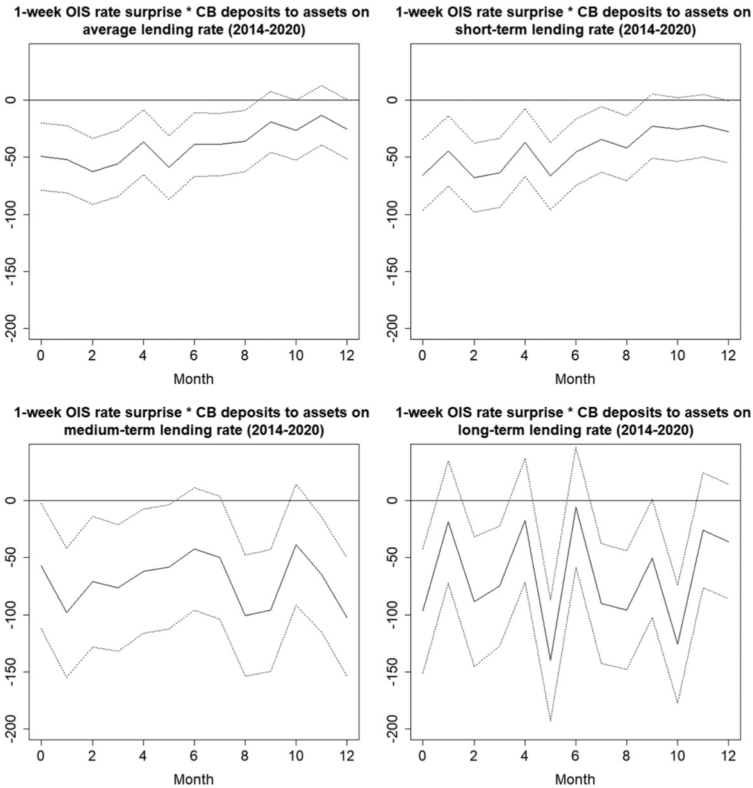
During the period of low-for-long, things change. In the same way as for loan rates, we find evidence that an unexpected policy rate surprise has an inverse effect on loan volumes. The results are in line with the idea of the reversal rate. Nevertheless, we acknowledge that the results may capture equilibrium relationships between policy rate changes and banks' loan pricing decisions, rather than pure supply-side effects, as firms' demand for credit may react immediately to monetary policy. We assess the role of loan demand by controlling for the future values of our loan demand control variable in Figure A.3 in the appendix. The results remain qualitatively the same, but we cannot rule out that our control variables do not capture all the changes in credit demand.

5.1.1 Bank Heterogeneity

To understand our reversal rate results better, we assess if the negative effect is stronger for banks that are more exposed to negative rates. Following Demiralp, Eisenschmidt, and Vlassopoulos (2021), we analyze whether banks with a high share of central bank deposits behave differently from the average bank. We augment Equation (1) to include an interaction term of our shock proxy and the lagged share of central bank deposits on bank i's balance sheet. Figure 8 presents the results, providing evidence that banks with more central bank deposits (i.e., bearing the additional cost of the negative central bank deposit rate) raise lending rates for their borrowers. At horizon 2, the coefficient estimate for the interaction term is about –60 and the estimate for the coefficient of the one-week OIS surprise is about –0.4. This means that for a bank with central bank deposits to total assets at 10 percent, a 25 basis point negative short-term rate surprise leads to an increase in the average lending rate of about 160 basis points. In turn, a bank with a central bank deposit ratio of 1 percent raises its average lending rate by 25 basis points. This result corroborates the theoretical reasoning of Ulate (2021).

Bank heterogeneity also matters in how banks are able to keep lowering their interest expenses as policy rates go below zero. As argued by Abadi, Brunnermeier, and Koby (2023) and Eggertsson et al. (2023), the key constraint preventing policy rate pass-through to bank lending rates in a below-zero environment is that some banks cannot lower their retail deposit rates into negative territory. We

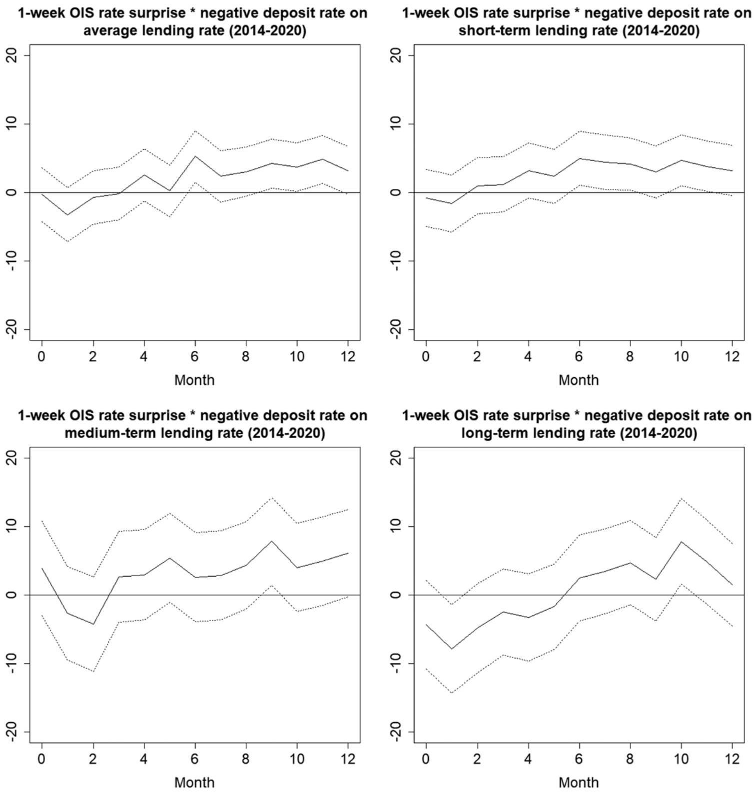
Figure 8. Effect of Short-Term Policy Rate Shock on Banks with High Share of Central Bank Deposits for the Average Corporate Lending Rate and Three Different Maturities, Period of Negative Rates



Note: Maturities: less than one year, one to five years, and over five years. Time horizon: 12 months. 90 percent confidence intervals à la Driscoll and Kraay (1998) are reported.

address this question by augmenting Equation (1) with the interaction term between our short-term policy rate shock and a lagged dummy variable that has a value of 1 if a bank sets at least one of its retail deposit rates to negative. Figure 9 reports the coefficient of this interaction term for different horizons.

Figure 9. Effect of Short-Term Rate Shock on Banks with Negative Retail Deposit Rates for the Average Corporate Lending Rate and Three Different Maturities, Period of Negative Rates



Note: Maturities: less than one year, one to five years, and over five years. Time horizon: 12 months. 90 percent confidence intervals à la Driscoll and Kraay (1998) are reported.

Our results indicate that banks that manage to lower their retail deposit rates below zero are still transmitting changes in interest rates to their borrowers. This is fully in line with the reasoning of Abadi, Brunnermeier, and Koby (2023), and Eggertsson et al. (2023), who argue that those banks that can further decrease their interest expenses can pass on costs from changes in the short-term policy rate to their customers in the form of lower lending rates. Indeed, these results clearly demonstrate that bank heterogeneity matters for the transmission of policy rates to bank lending and may be a defining factor in whether further rate cuts below zero become contractionary.

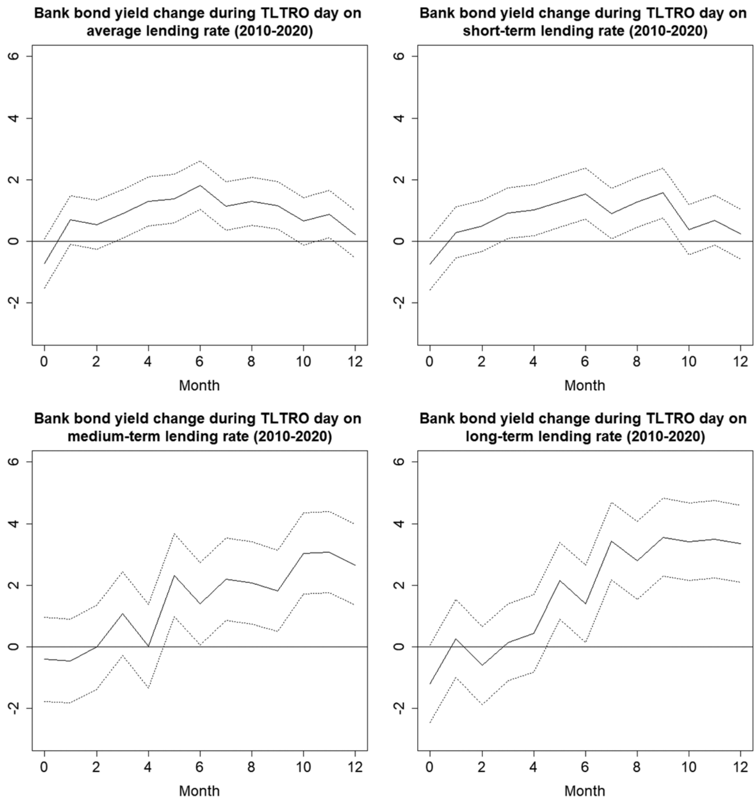
5.2 (T)LTROs

Besides eventually lowering the conventional monetary policy measure below zero, the ECB introduced a variety of different unconventional monetary policy tools. In this subsection, we study the transmission of those instruments to bank lending rates. Our (T)LTRO shock proxy series thus includes two LTRO-related yield movements and all variations after 2014 are related to targeted operations. Equation (1) now includes (T)LTRO-related policy changes proxied by the average bank bond yield change during the days of ECB announcements. In addition, we augment the equation with contemporaneous one-week and ten-year rate surprises to ensure that our (T)LTRO proxy is not contaminated by other monetary policy tools.

The results for the full sample are shown in Figure 10. They suggest that these policies affect lending rates with some lag, as the full effect does not materialize until after a year has passed. Following a 10 basis point decrease in (T)LTRO-induced bank bond yields, we observe a roughly 20 basis point decrease in the average lending rate. As with short-term policy rates, this effect is larger and more pronounced for lending rates of longer maturities.

Figure 11 shows the results for the period of negative rates. The estimated effects in this subsample are much smaller and statistically less significant (although positive) for the average corporate lending rate and the lending rate for short-term loans. For medium and long maturities, positive and statistically significant results remain. The slightly stronger positive effect for long-term lending rates remains during the low-for-long period (Figure 12). Even so, caution is warranted in interpreting these results due to the tiny number of TLTRO announcement days for this last subperiod. In addition, the time-varying effectiveness of TLTROs likely reflects differences in their "calibration:" the first, second, and third series of TLTROs differ when it comes to maturity and incentives.

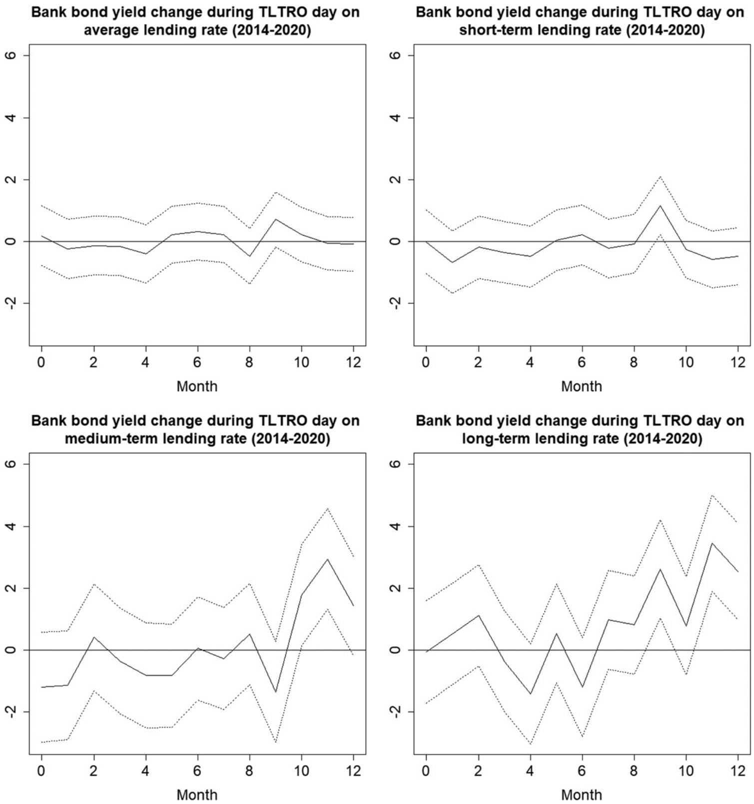
Figure 10. Effect of (T)LTRO Shock for the Average Corporate Lending Rate and Three Different Maturities, Full Observation Period (January 2010–December 2020)



Note: Maturities: less than one year, one to five years, and over five years. Time horizon: 12 months. 90 percent confidence intervals à la Driscoll and Kraay (1998) are reported.

The results above assess the effect on the lending rates of an average bank. However, one may assume that the effects are stronger for banks that participated in these operations and received more financing on favorable terms. This is in line with Gertler and Kiyotaki (2010), where an injection of liquidity from a lender of last resort relieves the bank's credit constraint, which then further alleviates liquidity shocks to the nonfinancial sector. Our data set includes

Figure 11. Effect of (T)LTRO Shock for the Average Corporate Lending Rate and Three Different Maturities, Period of Negative Rates (January 2014–December 2020)

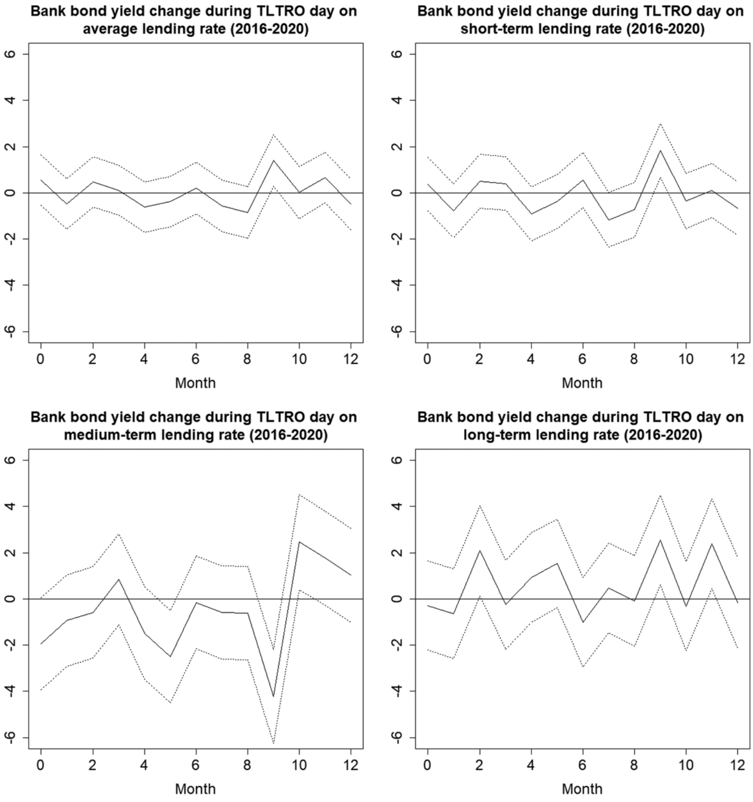


Note: Maturities: less than one year, one to five years, and over five years. Time horizon: 12 months. 90 percent confidence intervals à la Driscoll and Kraay (1998) are reported.

an actual measure of each bank's amount of funds lent from these longer-term operations, so we can test this directly. We thus augment the model by an interaction term with our (T)LTRO measure and the lagged share of central bank funding on bank i's balance sheet. Figure 13 shows the results for the 2014–20 period.

We see that the interaction is positive and significant, especially when it comes to loans of long maturities. The result is intuitive, as

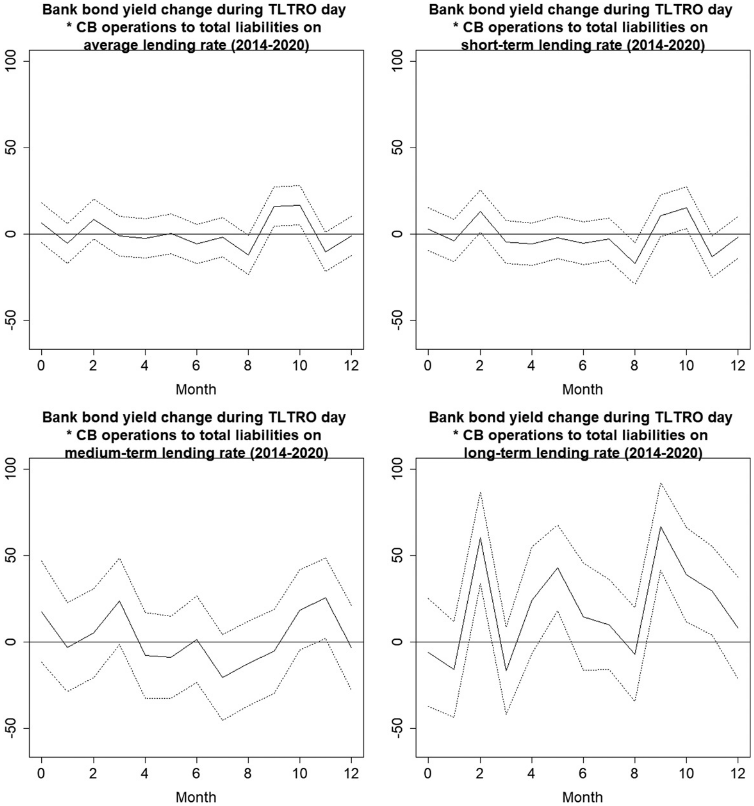
Figure 12. Effect of (T)LTRO Shock for the Average Corporate Lending Rate and Three Different Maturities, Low-for-Long Period (2016–20)



Note: Maturities: less than one year, one to five years, and over five years. Time horizon: 12 months. 90 percent confidence intervals à la Driscoll and Kraay (1998) are reported.

the TLTROs had a built-in incentive for lending in a certain time window. The banks were rewarded with a lower interest rate by the ECB if lending was increased during this relatively long monitoring period. It thus made less sense to lend short-term, as the ECB only cared about the average lending change at the end of the period. For example, in the case of TLTRO II, launched in 2016, the potential reward to banks for lending depended on their total growth in

Figure 13. Effect of (T)LTRO Shock on Banks with High Share of TLTRO Loans for the Average Corporate Lending Rate and Three Different Maturities, Period of Negative Rates (January 2014–December 2020)



Note: Maturities: less than one year, one to five years, and over five years. Time horizon: 12 months. 90 percent confidence intervals à la Driscoll and Kraay (1998) are reported.

lending (loans to firms and households, excluding lending for house purchases) from February 2016 to January 2018. Therefore, there were fewer incentives for lending short-term (at least immediately after the announcement). We conclude that TLTROs contributed to mitigating the pass-through of monetary policy easing to bank lending rates below zero, and this effect was stronger for banks taking on more funding directly from these operations.

5.3 Asset Purchase Programs

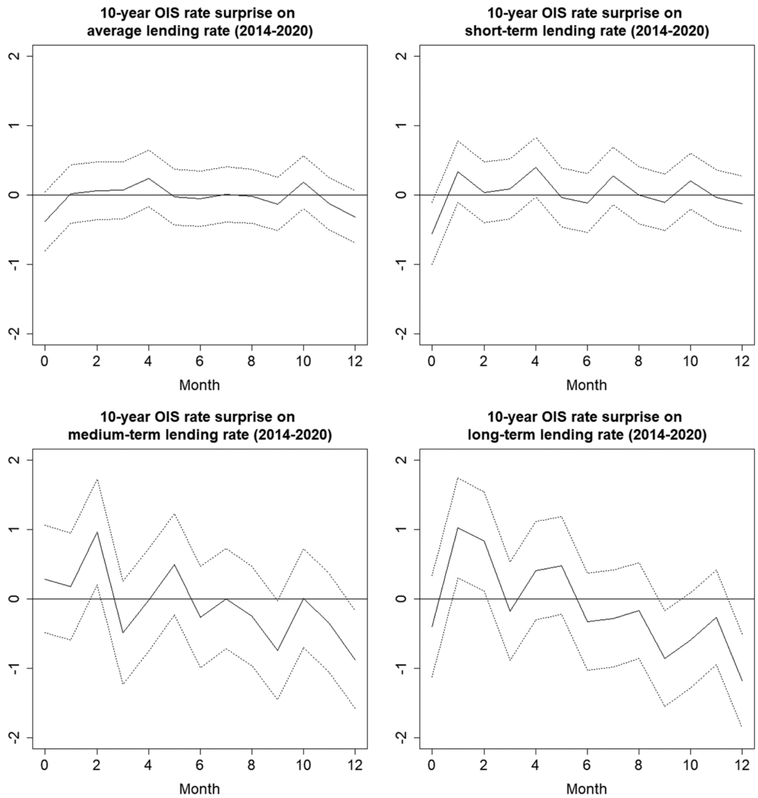
Finally, we focus on the ECB large-scale asset purchase programs, or QE, proxied by the 10-year OIS rate shock. We include in Equation (1) the one-week OIS rate surprise as a contemporaneous control variable. This control is added because, as conventional monetary policy may affect long-term rates, asset purchases do not affect short-term rates contemporaneously. For QE, we only have observations starting in 2014, when the ECB launched the APP package and other large-scale asset purchase programs. The estimations for the full period of 2010–20 are thus omitted in this subsection.

Figure 14 presents the results for the period of negative rates. The results suggest that QE had no effect on average corporate lending rates; the coefficients are statistically insignificant. However, there is evidence that QE had some positive effect on lending rates of medium- and long-term loans at shorter horizons. That is, as QE induced an unexpected decrease at the longer end of the yield curve, banks lowered their lending rates for loans of longer maturities. This could stem from the fact that they are more likely to be closer substitutes for long-term bonds. Focusing solely on the low-for-long period (Figure 15), we find no clear evidence of a favorable effect on lending rates.

Bank heterogeneity can again affect the impact of QE. With asset purchases having a large impact on security prices, the mark-to-market value of bank security holdings increases, raising bank net worth (Brunnermeier and Sannikov 2014). Assuming that commercial banks target somewhat constant leverage ratios, this induces banks to expand their lending (Adrian and Shin 2010), which here would be related to lower lending rates. To account for bank heterogeneity, we use bank-level data on bond holdings. Figure 16 shows the estimated coefficients for the interaction term between the 10-year rate surprise and the lagged share of bonds in a bank's total assets. Our results, however, provide no evidence that QE policies would have any stronger effect on lending rates of banks directly more exposed to bond purchases.

The ABSPP and CBPP3 asset purchase programs, which focus on asset-backed securities and covered bonds, are linked to loans to the private sector granted by banks—not to the bonds they are holding. Although their share is small compared to the PSPP, focusing

Figure 14. Effect of QE Shock for the Average Corporate Lending Rate and Three Different Maturities, Period of Negative Rates (January 2014–December 2020)



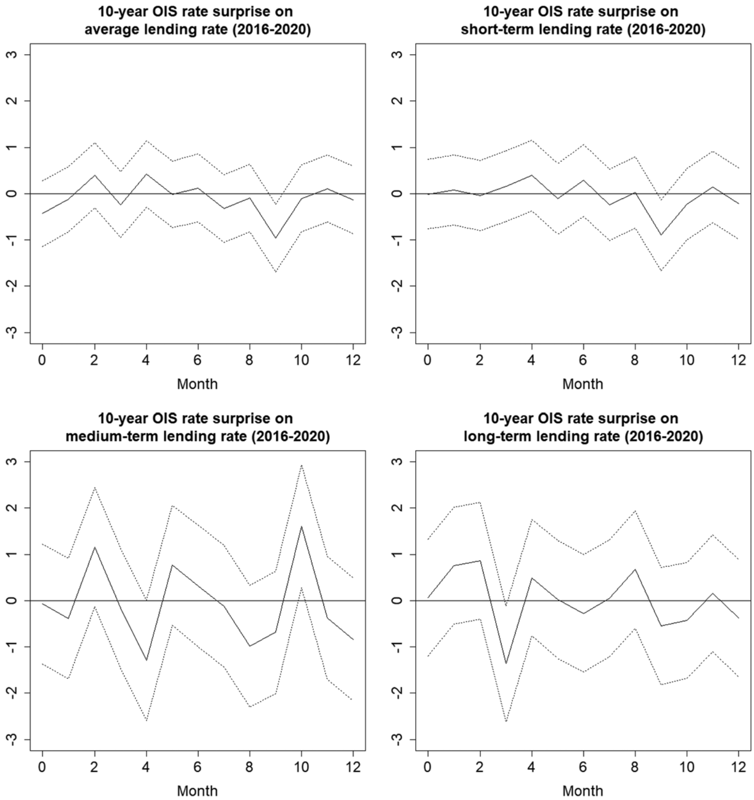
Note: Maturities: less than one year, one to five years, and over five years. Time horizon: 12 months. 90 percent confidence intervals à la Driscoll and Kraay (1998) are reported.

on public-sector bonds, this could partly explain why banks specifically holding more bonds are not differently affected by QE shocks in our estimations.

6. Conclusion

In this paper, we study how various monetary policy measures adopted by the ECB transmit to corporate lending rates in a

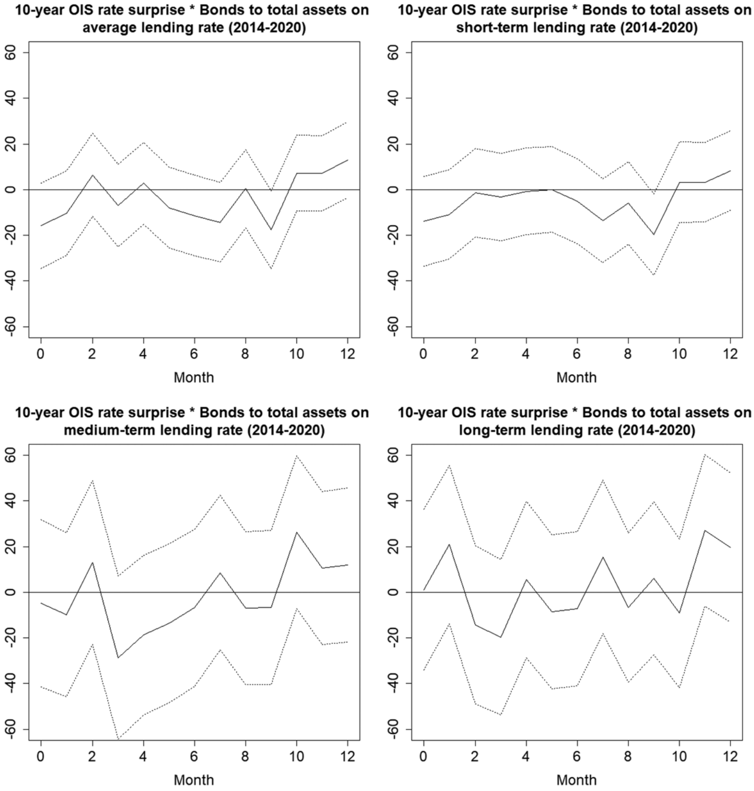
Figure 15. Effect of QE Shock for the Average Corporate Lending Rate and Three Different Maturities, Low-for-Long Period (January 2016–December 2020)



Note: Maturities: less than one year, one to five years, and over five years. Time horizon: 12 months. 90 percent confidence intervals à la Driscoll and Kraay (1998) are reported.

negative interest rate environment. Utilizing a detailed bank-level data set covering 137 individual banks from 13 euro-area countries at a monthly frequency for the period from January 2010 to December 2020, we examine how the pass-through changed when policy rates turned negative in June 2014 and further after early 2016, when negative rates came to be regarded as persistent due to the ECB's revised forward guidance and additional rate cuts.

Figure 16. Effect of QE Shock on Banks with High Share of Bond Holdings for the Average Corporate Lending Rate and Three Different Maturities, Period of Negative Rates (January 2014–December 2020)



Note: Maturities: less than one year, one to five years, and over five years. Time horizon: 12 months. 90 percent confidence intervals à la Driscoll and Kraay (1998) are reported.

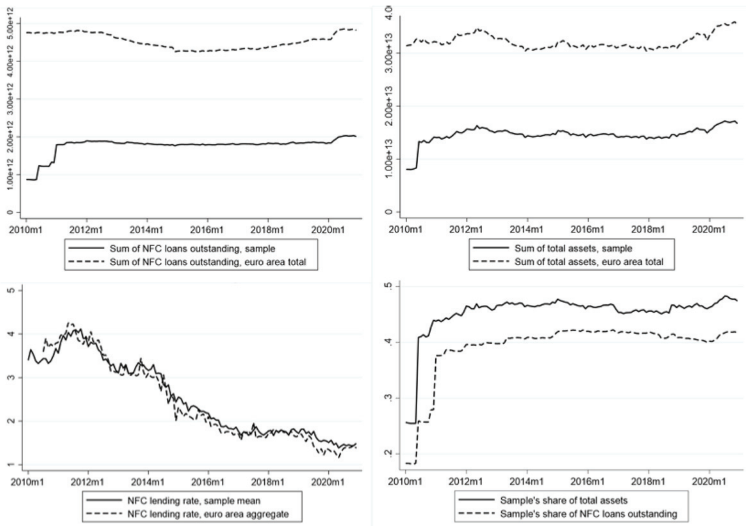
We find several noteworthy results. First, the transmission of short-term policy rates is clearly hampered below zero. Although we already see some signs of the reversal rate during the 2014–20 period, the evidence becomes much stronger as negative rates become more persistent during the low-for-long period. Following further policy rate cuts, banks started to raise their lending rates. Second, bank heterogeneity plays a role. Stronger evidence for the reversal rate is obtained for banks more exposed to negative policy rates: those that did not lower their own retail deposit rates below zero, and those holding more negative interest-bearing central bank deposits on their balance sheets. Third, loan maturities matter. The inverse peak effect occurs at different horizons for different maturities, which may explain the weaker results when looking at the average lending rates. Moreover, the statistical significance and the absolute size of the inverse effect increase with the length of the loan. Fourth, even if the transmission of the short-term policy rate to bank lending rates is hampered below zero, unconventional monetary policy measures—especially TLTROs—help mitigate the pass-through by lowering bank lending rates, especially for loans of longer maturities.

Our analysis helps with understanding why empirical studies so far have struggled to find common ground for the existence of the reversal rate. The results confirm what previous literature suggests: that its existence depends greatly on bank heterogeneity, such that the reversal rate is more pronounced for banks that are most exposed to negative rates (those that are reluctant to lower their own retail deposit rates below zero or those with large amounts of negative interest-bearing central bank deposits). We also show that different loan maturities play an important role, as the inverse effect is stronger for loans of longer maturities. Furthermore, by employing a long enough data sample with negative rates, we confirm that negative rates must first become persistent before we can seek to uncover evidence of the reversal rate.

Looking to the policy implications of these findings, we provide evidence that monetary policy rate cuts cease to have the desired effect on private-sector lending costs when negative rates become persistent. Without the mitigating effects of additional policies specifically aimed at lowering bank funding costs, further rate cuts below zero run the risk of becoming contractionary. Moreover, although reducing volatility and uncertainty about future interest rate developments, central bank signaling of a low-for-long environment could bring the reversal rate forward.

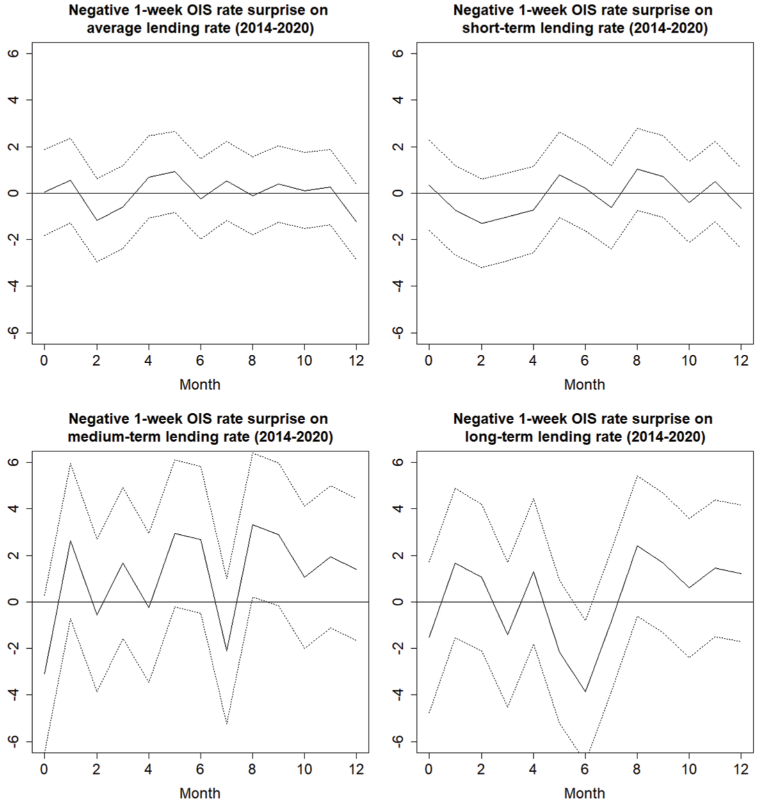
Appendix

Figure A.1. Representativeness of Our Sample



Note: Euro-area totals: ECB MIR and BSI databases.

Figure A.2. Results Regarding the Short-Term Rate Surprise for the Negative Rates Sample (2014–20) When Only Negative Rate Surprises Are Considered



Note: The results show that rate cut surprises in the below-zero environment increase lending rates. Note that the figure reports regression coefficients as such (not multiplied by –1).

Table A.1. Rolling Window Results

Subsample/ Horizon	2010–14	2011–15	2012–16	2013–17	2014–18	2015–19	2016–20
0	0.01	0.07	0.63	1.03	0.13	0.11	0.86
1	0.15	0.44	1.60***	1.68***	1.28***	1.37*	0.56
2	0.01	0.34	0.54	–0.35	–1.58***	–1.04**	–0.23
3	0.65**	0.67**	1.25**	0.46	–0.09	–0.89	–0.55
4	0.28	0.43	0.53	0.25	0.03	–0.15	0.12
5	–0.34	–0.35	0.5	0.87	1.03**	–1.67**	–0.13
6	0.34	0.13	0.05	–0.28	–0.56	–0.66	0.23
7	0.4	–0.02	–0.36	–0.4	0.25	–1.00*	–3.43***
8	–0.15	–0.56	–0.78	–0.96**	–0.66**	–0.31	–0.69
9	1.10**	0.22	–0.95***	–0.87*	0.53	0.31	–2.85
10	0.42	–0.34	–1.08***	–0.73	–0.22	0.79	0.96
11	0.7	0.04	0.33	0.21	0.47	–0.06	–3.07**
12	0.13	–0.52	–1.28***	–0.62	–0.81	1.25	0.21

Note: Monetary policy is measured using the one-week OIS surprise. The endogenous variable is the average lending rate. The models include our standard set of control variables that are used in all the local projection analyses: GDP growth, inflation, and unemployment forecasts from the Survey of Professional Forecasters (SPF) to control for expectations about the macroeconomic environment, as well as growth in industrial production, the unemployment rate, and the Eurostoxx stock return to control for the current environment. Bank-specific controls include liquidity, capitalization, and bank size. We control for credit demand using dummy variables based on the bank lending survey. In addition, we control for the stance of monetary policy prior the shock using the EONIA and Krippner shadow rates. Three lags of each control variable are included. The standard errors are calculated based on a nonparametric robust covariance matrix estimator à la Driscoll and Kraay (1998). *, **, *** denote an estimate significantly different from zero at the 10 percent, 5 percent, and 1 percent level, respectively.

Table A.2. Statistically Significant Peak Effects on Average Lending Rates of a One-Unit (100 Basis Point) Surprise in the Shock Proxy of Interest

Subsample/Policy Tool	2010–20	2014–20	2016–20
Conventional MP	1.07) (h=9)	–1.07 (h=2)	–3.43 (h=7)
QE		–0.38 (h=0)	–0.96 (h=9)
TLTRO	1.82 (h=6)	0.72 (h=9)	1.41 (h=9)

Note: Horizon (h) is reported in parentheses.

Table A.2 summarizes our main results by reporting the statistically significant peak effects on average lending rates of a one-unit (100 basis point) surprise in the shock proxy of interest.

Figure A.3.

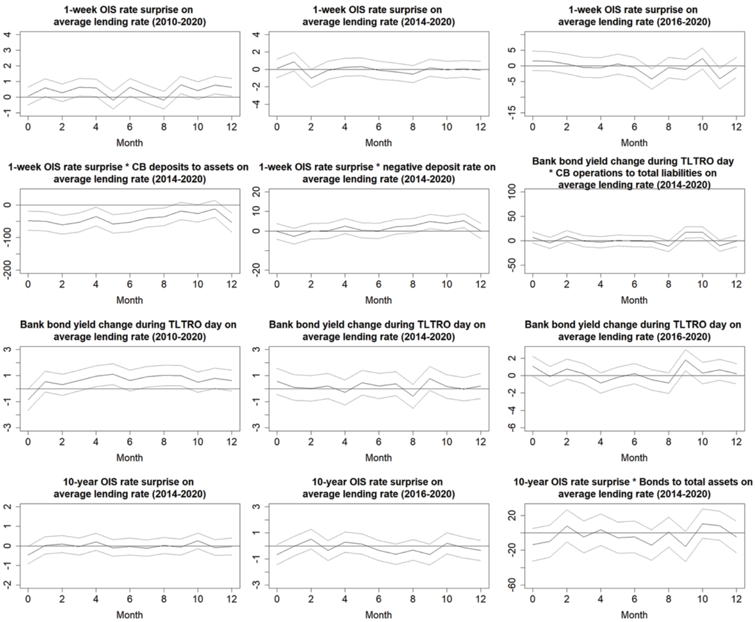


Figure A.3 presents our results regarding average lending rates after controlling for the leads ($t+3$) of SPF GDP growth expectation and loan demand dummy variables.

Figure A.4.

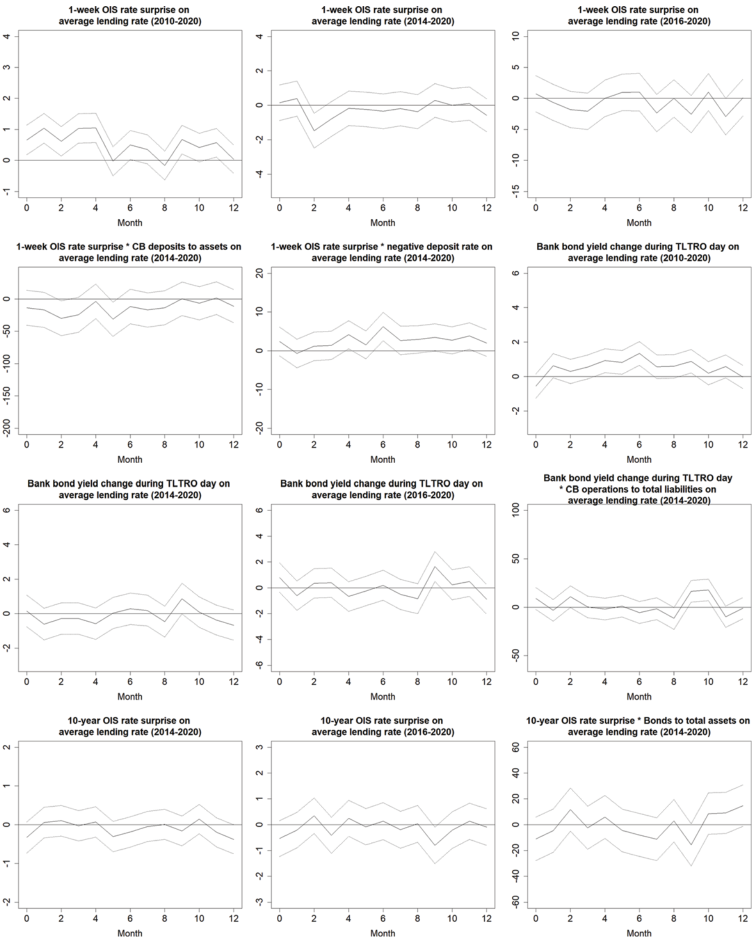


Figure A.4 presents the results for the average lending rates after replacing country-specific macro variables with the country and country-year fixed effects.

Figure A.5.

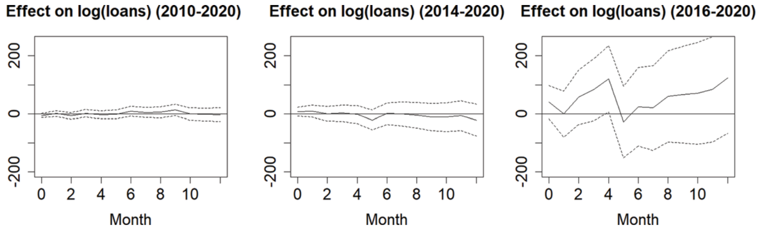


Figure A.5 presents the results regarding conventional monetary policy for the cumulative change of (log) loan amounts from $t{-}1$ to $t + h$.

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