Negative interest rates: Lessons from the Euro Area

J. Eisenschmidt (ECB) and F. Smets (ECB)[1]

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Abstract

This paper reviews the recent literature on the effects of negative interest rates in the euro area. It documents the pass-through of negative policy rates on bank deposit and lending rates as well as loan volumes in the euro area. It shows that the zero lower bound constraint is binding for interest rates on household deposits held at banks. Nevertheless, the pass-through on loan rates is unchanged, even at banks with high reliance on household deposit funding. The negative effect on the interest rate margin and profitability is generally offset by the positive impact of lower market rates on asset values and loan loss provisions.

Keywords: negative rates, bank balance sheets, monetary transmission mechanism

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1. Introduction

In June 2014, the European Central Bank (ECB) decided to cut the rate on its deposit facility (DFR) by 10 basis points (bps) into negative territory, an unprecedented move as no major central bank had used negative rates before.[2] This decision was part of the introduction of a more comprehensive monetary policy easing package, which eventually also included the introduction of targeted long-term refinancing operations (TLTROs) and a large-scale asset purchase programme (APP) of private and public sector bonds. Further rate cuts of 10 bps each followed in September 2014, December 2015 and March 2016, bringing the DFR to -0.40 percent.[3]

The ECB's decision to cut rates below zero was solely motivated by the desire to provide further monetary easing to the economy in response to emerging deflation risks. This contrasts with the declared aim of some other central banks that introduced negative rates to discourage capital inflows and thereby stabilise the exchange rate (e.g. Denmark and Switzerland). Given the ECB's focus on providing additional monetary policy accommodation with its negative DFR, it is natural to ask whether the policy was effective. This assessment is not straightforward, as the decision to implement a negative interest rate policy (NIRP) was accompanied by other easing measures such as the APP, which had a significant downward effect on long-term bond yields, and the TLTRO, which in its second version provided long-term funding to banks at negative interest rates under certain conditions. In this paper, we review the emerging literature on the impact of the NIRP in the

[2] This followed a similar decision by the Danish central bank (Danmarks Nationalbank) in July 2012. Subsequently, the Swiss National Bank and the Swedish Riskbank introduced negative policy rates in December 2014 and February 2015, respectively, see Jackson (2015). The Bank of Japan, as the second major central bank, followed in January 2016.

[3] The negative rate is not only applied to recourses to the deposit facility but to all parts of banks' current accounts with the Eurosystem in excess of their reserve requirements. The same applies to other potential "loopholes", e.g. the remuneration of government deposits as well as deposits in the context of reserve management services offered by the ECB were also lowered in the process to (at least) -0.40%.

euro area and try to shed additional light on the question of the effects of NIRP by examining the behaviour of bank loan and deposit rates and loan volumes before and after the NIRP period.

We proceed in four steps. In section 2, we document that a zero lower bound on interest rates seems to exist only for interest rates on household deposits held at banks. Other interest rates, such as interbank money market rates, interest rates on short-term government debt and even interest rates on bank deposits held by non-financial corporations (NFCs) do not appear to be subject to a hard zero lower bound and have fallen into negative territory as the DFR became negative. In fact, in the current negative interest rate environment, a large share of safe (typically government) securities at shorter maturities are trading at rates below the DFR and yield negative interest rates even way out on the term structure.[4]

This observation raises an important question: What is special about household deposits that banks do not charge negative rates when other funding rates are negative? One explanation is that it is much easier for households to substitute deposits into cash, because individual household deposits are typically of smaller amounts (than e.g. NFC deposits) and therefore carry limited storage costs. As a result, banks charging negative rates would see a sharp outflow of household deposit funding, which could give rise to funding problems. More importantly, negative rates might undermine the business model and franchise value of retail banks, which, in normal times, provide liquidity services to households and use cheap household deposits to fund higher-yielding longer-term loans and other assets. Moreover, new liquidity regulations (in particular the Net Stable Funding Ratio (NSFR) regulation) have increased the value of household deposits as a funding source for banks. Not surprisingly, the

[4] The observation that interest rates other than household deposit rates have traded below zero does not imply there is no lower bound on those rates. But the experience until now suggests that it is probably much lower than current policy rates and the bound may be different depending on the specific market.

importance of household deposits as a (stable) source of bank funding is also the focus of a new literature on the deposit channel of monetary policy (Drechsler et al., 2017a, 2017b).

The finding that the zero lower bound is mostly valid for household deposits and that banks refrain from letting those household deposits run off implies that any distortionary effects from NIRP should be most visible for those banks whose business models rely to a large extent on household deposit funding. In large parts of the empirical literature and in this paper, this observation is used to identify the effects of negative interest rates.

In section 3, we review the small theoretical literature on the transmission of policy-controlled interest rates in a negative rate environment with sticky retail deposit rates (e.g. Brunnermeier and Koby, 2017). These papers generally find that in an environment with capital constraints for banks, which depend on current and expected profitability, a more negative market interest rate may tighten capital constraints and reduce the incentive/ability to lend by negatively affecting interest rate margins and the profitability of the bank. As a result, banks that are dependent on retail deposit funding may restrict lending and/or increase loan rates, particularly in an environment of excess liquidity which exposes them to the negative returns. Most recently, Eggertsson et al. (2017) put a zero interest rate bound on bank deposits in an otherwise standard New Keynesian model and show that it may lead to contractionary effects of a NIRP. These findings contrast with the standard literature (e.g. Gertler and Karadi, 2010), which finds that lower interest rates release capital constraints by boosting asset values and may spur lending and risk-seeking behaviour. Overall, whether such negative effects on the economy dominate will depend on the health of the banking sector as well as the presence of other transmission channels that may boost the economy, increase the demand for loans and improve the overall quality of the loan book.

In section 4, we review the empirical literature that examines bank level data in a NIRP environment, for example Heider et al. (2017) and Demiralp et al. (2017). In addition,

we document the evolution of loan rates and loan volumes of banks with low and high-reliance on household deposits in response to the NIRP episode in the euro area. Using descriptive statistics and standard econometric tools, we provide suggestive evidence that – at least in the euro area – NIRP has not led to counterproductive lending behaviour by banks that are reliant on household deposits.

Finally, in section 5, we report on other channels of negative interest rates in order to get a broader impression of the overall effect on bank lending, bank profitability and the economy. In particular, we review a number of papers that aim to quantify the effects through simulation methods and using bank equity prices. One channel which is often overlooked in this literature is the exchange rate channel: Opening up the zero lower bound on interest rates has changed the possible future distribution of interest rates, implying different effects on the exchange rate than in normal times.

2. The pass-through of the negative DFR to market rates and retail deposit rates in the euro area

The ECB introduced negative rates in June 2014 by lowering the remuneration on its deposit facility to -0.10 percent. Subsequently, three further steps of 10-bps cuts were undertaken and the current level of -0.40 percent was reached in March 2016. Meanwhile, the rate applicable to liquidity providing operations (the MRO rate) was lowered to zero.

Excess liquidity in the system implied that the DFR cuts were passed on to short-term money market rates (such as the EONIA). However, this process took longer than usual and was only completed in May 2015. The initially slow pass-through was likely related to the time needed by financial market participants to adjust to the new environment (e.g. changes to IT systems, legal documentation). All rate cuts after May 2015 did pass through immediately to the EONIA (see Figures 1 and 2). The overnight-index swap (OIS) curve is currently in

negative territory for maturities of up to four years (Figure 3) and short-term government bonds of the highest credit quality are trading at yields well below the DFR (Figure 4), evidencing the by-now complete pass-through of negative rates to euro area financial markets.[5]

While the pass-through of negative policy rates to financial market rates is complete, a different picture emerges when looking at rates paid by banks for deposits of households and NFCs (Figure 5). Comparing the distribution of deposit rates across a representative sample of euro area banks in June 2014 and June 2017, it is clear that both types of deposit rates have declined during the NIRP period, with both distributions now having most of their mass at zero. This piling up of deposit rates at zero suggests the existence of a zero lower bound for bank deposits, although there are some banks that do report rates below zero for their household and NFC deposits.

To further explore the pass-through of negative rates to bank deposit rates, we zoom in on the case of Germany, the country with the lowest sovereign yields and the highest level of excess liquidity of all euro area countries. While in many other euro area countries, bank deposit rates had significant room to decline in response to NIRP, mainly due to higher bank deposit rates when negative rates were introduced, deposit rates in Germany were already close to zero at the beginning of NIRP (see Figure 12). Furthermore, Dombret et al. (2017) argue that low interest rates pose a particular challenge to German banks, as they are especially reliant on interest income. The German case may therefore be considered most representative for studying what a steady-state pass-through of negative policy rates to bank deposit rates looks like.

[5] This is partly due to the scarcity of such bonds created by the ECB's APP.

Figure 6 shows the share of overnight (O/N) bank deposits of households and NFCs that are remunerated below zero for a representative sample of German banks. Strikingly, while for household deposits the floor of zero appears firm even in the German case, there is significant pass-through of negative rates to NFC deposit rates: In July 2017, around 72% of O/N deposits by NFCs were (on average) remunerated at a rate below zero. Note, however, that the average level of remuneration of these deposits at -0.02 percent is only slightly negative (and still relatively far away from the DFR of -0.40 percent).

Overall, the available evidence suggests that the most relevant friction connected with NIRP is a complete lack of pass-through to interest rates paid on banks' household deposits. Naturally, the question arises why banks are reluctant to pass-on the negative rates to their household deposit base, particularly in light of the different treatment of NFC deposits.

The most obvious explanation is the availability of cash as an alternative to a bank deposit. Storage costs of cash (e.g. rent for vault space) and the inconvenience arising if cash needs to be used for (large) transactions are factors potentially driving a wedge between the zero remuneration offered by cash and the remuneration of the alternative bank deposit. The costs of holding (and having to use) cash are likely increasing in the size of the bank deposits that need to be replaced. Household deposits are normally smaller than NFC deposits, which is a likely key driver of the difference in pass-through. In the same vein, the inconvenience cost of having to process payments in cash is much higher for NFCs than for households.

If banks are unable to charge households negative rates on their deposits, why wouldn't they simply reduce their amount of funding provided by household deposits? One answer lies in the observation that banks' funding models are strategic decisions which incur fixed costs (e.g. setting up offices to attract and serve customers) and from an intertemporal perspective a short spell of negative rates may not be enough to change the overall business logic of the banks' funding model.

Another reason, possibly more fundamental, is that banks generally perceive household deposits as a (cheap) source of stable and longer-term funding (see also Drechsler et al., 2017b) which also receives favourable treatment under the new liquidity regulation (e.g. NFSR). The overall attractiveness of household deposits as a source of funding to banks appears to have increased since the start of the great financial crisis, manifesting itself in a secular increase of the share of household deposits in euro area banks balance sheets.

The importance of household deposits (and its consequences for the transmission of monetary policy) is also documented in a new literature on the value of deposits for US retail banks (Drechsler et al., 2017a, 2017b). The authors show that retail deposits effectively protect banks' from interest rate risk and that market power in retail deposit markets is a key factor in explaining the size of spreads of bank deposit rates over money market rates.

3. Implication of a zero-lower bound on deposit rates in a NIRP environment

The presence of a zero lower bound on (household) deposit rates raises the question how it affects bank profitability and banks' incentives to lend and adjust their assets and liabilities. In this section, we review the small theoretical literature on the transmission of policy-controlled interest rates in a negative rate environment. While lower interest rates may generally stimulate bank lending and increase risk taking, in the presence of a zero lower bound on deposit rates, or more generally sticky deposit rates, there might be "tipping points" beyond which banks cannot tolerate further squeezes in their profits and adopt different strategies to avoid these squeezes (Bech and Malkhozov, 2016). This argument is further taken up in Brunnermeier and Koby (2017), who argue that below some level of the policy rate (the "reversal rate"), further reductions can in fact be contractionary owing to the negative effects of lower profitability on bank capital and the associated contractionary effects

on bank lending. In their model, the exact level of the reversal interest rate depends on a bank's equity capitalisation and the tightness of financial regulation, its interest rate exposure (e.g. the level of excess liquidity) and the market structure of the financial sector, in particular on the deposit side. Brunnermeier and Koby (2017) also show that the negative effects may increase over time, as the positive effects through capital gains on the long-term bond portfolio are fading in importance.

Cavallino and Sandri (2017) discuss a general class of models in which the presence of borrowing constraints can lead to an "expansionary lower bound", defined as the interest rate below which monetary easing becomes contractionary. Their examples are mostly taken from international finance, where a borrowing constraint denoted in foreign currency may lead to contractionary effects of easier monetary policy if this policy leads to a depreciation of the exchange rate and thereby exacerbates the borrowing constraint in domestic currency, counteracting the usual stimulative effects. In one model example, inspired by Brunnermeier and Koby (2017), which includes heterogeneity of borrowers and savers and a monopolistically competitive banking sector, the presence of a net worth constraint on banks may lead to the existence of a reversal rate, subject to two conditions: Firstly, banks face a net worth constraint which is positively affected by current profits. Secondly, the stock of short-term government debt and excess liquidity is sufficiently large relative to deposits. For the empirical work, it is this ratio that will determine how costly negative rates are for banks in the short-term. Less binding borrowing constraints lower the reversal rate, while more competition in deposit markets increases the reversal rate.

Most recently, Eggertsson et al. (2017) document for the Swedish case that the cuts in central bank policy rates into negative territory did not lead to a similar fall in the bank lending rates (in contrast to what usually happens following a cut in policy rates in positive territory). To capture this effect, they develop a New Keynesian model as in Benigno et al.

(2014), with multiple interest rates and bank reserves as in Curdia and Woodford (2011). One key assumption is that the interest rate on household deposits cannot fall below a lower negative bound that is proportional to the storage costs of holding money. If storage costs are negligible, the lower bound on deposit rates will be zero. Another key assumption is that financial intermediation costs, which generate a spread between the remuneration of household deposits and the bank lending rate, depend negatively on current profits. This reduced-form assumption is meant to capture the established finding in the literature that links banks' net worth and profitability to their financing costs due to agency costs. As a result, a drop in demand that leads to an optimal reaction by the central bank to set the interest rate on reserves at a negative level will lead to a binding constraint on the deposit rate. As the bank lending rate is a mark-up over the deposit rate, the drop in the bank lending rate will be also bounded. However, as the banks also hold reserves, the negative interest rate on reserves reduces the profitability of the bank and thereby increases intermediation costs and increases the interest rate margin exacerbating the macro-economic effects of the shock.

The theoretical analysis shows that whether a NIRP will have contractionary effects on bank lending is determined by the bank's reliance on household deposits versus wholesale funding on the liability side and the interest rate sensitivity of the bank's assets on the asset side. Figure 8 shows the aggregate balance sheet of the euro area banking sector. Over the NIRP period, the share of non-financial private sector deposits in the total balance sheet has increased from 26 to 30 percent, whereas the reliance on wholesale funding has decreased from 30 to 27 percent (see Figure 7), probably reflecting the new regulatory emphasis on stable funding. On the asset side, a major change has been the rise in excess liquidity held with the central bank from 0.6 to 5.6 percent of total assets as the ECB has embarked on its APP. The excess liquidity is remunerated at a negative rate of -0.4 percent. More generally,

increasing excess liquidity will lead to increasing costs for banks to the extent that it is funded by an increasing share of (household) deposits.

The aggregate composition of the banks' balance sheets masks quite important differences across bank business models and across countries. As pointed out by Brunnermeier and Koby (2017) in a heterogeneous region model, an interest rate cut might be expansionary in one region and contractionary in another to the extent that banks in the first region borrow while the banks in the other region lend in the interbank market. In the euro area, excess liquidity mostly resides in the core countries, potentially giving rise to exactly such a regional structure as described in Brunnermeier and Koby (2017). In addition, the degree to which loans are priced at fixed or variable rates differs across countries, with banks situated in core countries using more long-term fixed-rate financing and banks in periphery countries applying more variable-rate financing (see Figure 9). This difference in interest rate fixation may also give rise to a differentiated impact of negative rates across euro area countries.[6] In the next section, we will use information on cross-sectional variation between banks to test whether the pass-through of the negative DFR in the euro area to bank loan rates and loan volumes differs across banks with low and high deposit shares.

In contrast to the recent literature on NIRP which emphasises that the negative effects on bank interest rate margins and bank profitability may hamper the transmission of NIRP, the more traditional literature on the bank-lending and risk-taking channels suggests that a NIRP may strengthen these channels. Prominently, the *bank-lending channel* suggests that expansionary monetary policy measures will increase banks' willingness to provide loans. Under NIRP, the incentive for banks to expand their supply of loans is strengthened by the fact that additional reserves injected by the central bank entail a charge on banks. Thus, while

[6] For reference, Figures 10 and 11 give an overview of the distribution of deposit and excess liquidity shares in the euro area banking sector.

NIRP might reduce the ability of banks to pass on interest rate changes to their retail deposits (Horwath et al., 2017), the policy amplifies the credit channel by increasing the cost of holding excess liquidity, in particular for banks with a high share of retail deposit funding on their balance sheet. Several papers support the notion that the bank-lending channel remains intact under NIRP (e.g. Albertazzi et al., 2017; Bräuning and Wu, 2017; Demiralp et al., 2017; Basten and Mariathasan, 2018).

The exchange of very safe assets such as central bank reserves for riskier assets like loans and bonds can also be seen through the lens of the *risk-taking channel*, which emphasises the role of risk perceptions and risk tolerance (Borio and Zhu, 2008; Adrian and Shin, 2009; Jimenez et al., 2014; Dell'Ariccia et al., 2016). The increase in asset prices and collateral values prompted by lower policy rates can increase banks' capacity and willingness to take on more risk. They may, for instance, choose to rely on risk measures that are based on market equity prices, such as expected default frequencies, and make use of Value-at-Risk frameworks for their asset-liability management, all of which are likely to point to lower risks in an environment of lower rates. Moreover, "sticky" rate-of-return targets defined in nominal terms can prompt a *"search for yield"* effect when interest rates are reduced, which necessitates higher risk tolerance. In fact, the promotion of portfolio rebalancing by encouraging lenders to invest in riskier assets when the returns on safer assets decline is considered to be one objective of quantitative easing policies (Aramonte et al., 2015; Heider et al., 2017). This channel is likely to be further reinforced by the prevalence of negative rates.

4. The impact of negative rates on euro area banks

This section briefly reviews the available empirical literature on the effects of NIRP in the euro area and then discusses developments in euro area banks' lending behaviour over the

NIRP period. In our search for the effects of negative rates, we will progressively zoom in on (highly household deposit reliant) German banks. This strategy should lead us to the banks arguably most affected by NIRP. Consequently these banks should have the strongest incentives to react to NIRP, giving us the best chances to identify the effects of NIRP..

4.1 Empiricial studies with focus on the euro area

There is a small literature devoted to the effects of negative rates in the euro area.[7] Heider et al. (2017) start from the premise that banks relying more strongly on deposit funding have a disadvantage in a negative rate environment and consequently compare the lending behaviour of high- to that of low-deposit banks during the early phase of negative rates (June 2014 until January 2015). Their results, obtained by focussing on syndicated loans, which are a relatively small subset of NFC loans, indicate that high-deposit banks react by decreasing their loan supply and start lending to riskier borrowers.

Demiralp et al. (2017) use banks' exposure to the excess liquidity charge to identify the impact of negative policy rates on banks, employing a sample of 256 euro area banks, covering around 70% of bank assets in the euro area. They find that high-deposit banks have reacted to negative rates by granting more loans.[8] Wholesale funded banks, in contrast, increase the holdings of non-domestic government bonds.[9] Both Heider et al. (2017) and Demiralp et al. (2017) find that negative rates are expansionary. The discrepancy in findings between the two studies (with respect to the behaviour of high-deposit banks) could be related to the difference in the loan aggregate as well as the difference in the length of NIRP

[7] In a study based on a pre-NIRP sample, Buchholz et al. (2017) already argue that banks with a more interest-sensitive business model are more responsive to declines in the deposit facility rate, reallocating their liquidity from reserves to loans.
[8] Albertazzi et al. (2017) also find that banks with more deposit funding expand their loan supply under unconventional monetary policy.
[9] Similarly, in an earlier paper investigating ultra-low interest rates in Japan, Deutsche Bank (2013) finds that banks expanded into government bonds to make up for the contraction in core business caused by squeezed interest rate margins.

considered in the papers: Heider et al. (2017) focus on the very beginning of the negative interest rate period, while Demiralp et al. (2017) consider NIRP until October 2016.

Finally, Amzallag et al. (2018) employ a sample of mortgage loans emitted by Italian banks to investigate the effects of NIRP on banks' loan-rate setting behaviour. Comparing fixed and variable rate mortgages issued before and after the onset of NIRP, they find that banks more dependent on deposit funding charge higher rates for fixed rate loans after June 2014, while there is no effect on variable rate loans.

4.2 Negative rates in the euro area: Some further empirical explorations

In order to explore further the behaviour of rates and volumes for bank loans in the euro area under NIRP, we make use of a confidential dataset containing balance sheet data for 256 selected euro area banks at the monthly frequency (IBSI and IMIR). The dataset has been constructed with the objective to reach a high degree of representativeness of the euro area banking sector, containing a broad range of banks of different sizes and specialisation from all euro area countries. Importantly, banks contained in the sample cover a large fraction of loans to the euro area economy (between 70% and 85% of all bank loans, depending on the country). We exclude banks from Cyprus and Greece (due to these banks being affected by domestic economic and banking crises), leaving us with 241 banks.

4.2.1 Did NIRP change banks' lending behaviour: The case of Germany

Figure 12 shows the evolution of bank lending rates[10], bank deposit rates and the interest rate margin in core and periphery countries of the euro area since 2007. A few observations are worth making. First, the decline in bank deposit and lending rates and interest rate margins was particularly pronounced in the peripheral countries (i.e. those

[10] Note that, in contrast to e.g. Amzallag et al. (2018), our lending rates are a composition of both household and NFC loan rates, including a variety of maturities and purposes (such as house purchase, consumption, etc.).

countries most affected by the euro area sovereign debt crisis in 2010-2011), mainly due to the fact that these countries were facing much higher deposit and lending rates in June 2014 due to the fall-out from the sovereign debt crisis. It is interesting to note that, following the comprehensive easing package of the ECB, deposit rates in the peripheral countries converged back almost fully to those of the core countries.

By contrast, bank lending and deposit rates in Germany were among the lowest in June 2014 and hence had least room to decline. Figure 12 confirms that retail deposit rates in the core countries were bound at zero and therefore did not follow the DFR cuts into negative territory from June 2014 onwards. Consequently, in what follows we will focus on the German banking sector, as with this strategy we stand the best chances to uncover the effects of negative rates on bank lending rates (and volumes).

The complete lack of pass-through of negative rates to retail deposit rates puts banks that are heavily reliant on these deposits in a disadvantageous position relative to less reliant banks.[11] As a consequence, we may expect that high deposit banks are less willing or able to decrease their loan rates, as found by Amzallag et al. (2018) for the case of the Italian fixed rate mortgage market, and may even be inclined to increase them. Figure 13 checks this hypothesis for the German banks in our sample by looking at weighted average bank lending rates of all quintiles of the distribution of their household deposit share over time. There is no prima facie evidence that banks with a high degree of reliance on retail deposits price their loans differently from banks with a lower degree of reliance under NIRP.

Similarly, banks adversely affected by NIRP may also reduce their lending or even contract their loan book (figure 14). Figure 15 shows the change in the loan market share of German banks according to the degree of banks' exposure to NIRP. Again, as in the case with

[11] This is arguments is also supported by Arteta et al. (2016).

bank lending rates, we do not find evidence that highly affected banks are reducing their lending activity relative to less affected banks.

In Figure 15 these changes in bank lending rates and loan market shares in the NIRP period are compared with those following the earlier interest rate reductions in 2012 at positive levels. If anything, the cross-plots show that the lending rates of banks with a high deposit share have fallen by more than those with low deposit shares. Similarly, the loan market shares of high deposit banks have, if anything, have risen. But this reaction is not different from the earlier period of interest rate reductions in our sample (2012-2013). We therefore do not find prima facie evidence of a contractionary effect of the reductions in negative interest rates. Of course, this may partly be explained by the impact of the other components of the ECB's easing package. On the asset side, the reduction in both private and public sector bonds may have put pressure on the loan rates as, for example, large firms found it easier to tap bond markets to obtain financing. At the same time, all banks are exposed in a similar fashion to the simultaneous other policy programmes conducted by the ECB and we would therefore expect that banks particularly exposed to the friction associated with NIRP to react differently than banks less exposed, even in the presence of other easing measures. Furthermore, as shown in section 4.2.3 below, the APP did not materially affect the pass-through of negative rates to bank lending rates.

This overall assessment is confirmed by ad hoc survey evidence from the euro area bank lending survey. The surveyed banks confirm that the negative interest rate has reduced their profitability, but at the same time has led to lower bank loan rates and easier lending conditions.[12]

4.2.2 Did NIRP change the pass-through of policy rates to bank lending rates?

[12] See Altavilla et al (2017a).

Bank lending rates of euro area banks generally display a strong co-movement with policy rates. In this section we employ a simple panel econometric exercise to see whether the introduction of NIRP has changed this correlation. We follow the same logic used up to now and concentrate our testing on the case of German banks as these banks should be most affected by the negative interest rate policy.

Table 2 reports the estimates from a standard fixed-effects panel model estimated at quarterly frequency using individual bank lending rate data.[13] In the main specification, quarterly changes in lending rates are regressed on changes in the DFR and its interaction with a variable marking the NIRP period. Column 1 in Table 2 contains the pass-through coefficient from a univariate regression including only changes in the DFR. As expected, the estimated coefficient is positive and significant.[14]

Column 2 reports the main specification where the model is augmented with an interaction term of the changes in the DFR with a dummy variable capturing the NIRP period. Another interaction is created with the share of retail deposits on each banks' balance sheet. None of the interactions is significant and the overall size of the pass-through coefficient is unchanged, confirming that NIRP did not lead to a change in pass-through and that banks' retail deposit reliance does not change their reaction to monetary policy under NIRP either.

Column 3 reports the estimation augmented with a control variable capturing the announcement effects of the APP. The APP dummy takes the value of 1 in January 2015 and the share of survey respondents expecting asset purchases by the ECB in 2014 Q3 and Q4 as provided in Blattner and Joyce (2016) before that date. This dummy variable is then interacted

[13] The data used covers 252 banks from all euro area countries over a sample from 2009 to 2016 (IBSI and IMIR dataset). The data are at monthly frequency. Quarterly values are computed by averaging the original monthly values. Changes are then computed as the quarter on quarter changes of the quarterly values.

[14] Since monetary policy responds to changes in aggregate demand, the coefficient in this univariate specification is likely biased upwards. A simple way to control for the business cycle would be to include time fixed effects. Doing this (e.g. year fixed effects), indeed almost halves the coefficient but otherwise does not change our results.

with the change in the DFR, to test for any changes in the interest rate pass-through during that period. As expected, the APP announcement had a strong impact on bank lending rates. The overall size of the pass-through coefficient, however, controlling for the NIRP period and APP announcement is very similar to the one reported in column 2 leading to the conclusion that the pass-through has not materially changed following the introduction of NIRP and is not affected by the effects of the APP announcement.

5. Other effects of negative rates

5.1. Bank profitability

Several papers have investigated the effects of low and negative interest rates on overall bank profitability. For example, in a pre-NIRP study of 109 large international banks, Borio et al. (2017) find a positive relationship between the short-term rate and bank profitability (as measured by the return on assets). In particular, whereas loan loss provisions decrease and non-interest income increases when interest rates go down, net interest income decreases, offsetting the positive effects. The authors conclude that very low rates erode bank profitability. Similar conclusions are drawn by Deutsche Bank (2013) and Dell'Ariccia et al. (2017), who argue that profitability is lowered by reduced interest rate margins. In addition, Claessens et al. (2016) find that low rates weakened bank profitability more in the euro area than e.g. in Canada and the US. In a study based on stress testing scenarios of US banks, Arseneau (2017) finds that the effect of negative rates on banks would depend on the bank business type, with banks primarily active in lending (liquidity provision to borrowers) expecting to lose from negative rates through a squeeze in lending rates. In contrast, banks focused on deposits expect to gain due to the reduction in funding costs.

Arteta et al. (2016) suggest that bank profitability depends on the general health of the economy rather than just monetary policy measures. In line with this reasoning, Altavilla et al.

(2017b) argue that low monetary policy rates and a reduced slope of the yield curve are associated with lower bank profits only if important variables, such as the expected macroeconomic developments and forward-looking credit risk, are omitted. If such controls are introduced, the positive impact of easier monetary policy on loan loss provisions and non-interest rate income largely offsets the negative one on net interest income.

Altavilla et al. (2017a) also shed light on the question of the overall effect of the ECB's easing measures (including the NIRP) on euro area banks' profitability, disentangling several channels (Figure 16). They find that the total effect of monetary policy measures on euro area banks' return on assets over the NIRP period (2014-2017) is broadly neutral as positive and negative effects cancel each other out. Figure 16 also shows the effects per country. As expected, the negative effect through the charge on excess liquidity is largest in France and Germany. By contrast, Spain and Italy are most affected by the drop in interest rate margins due to the widespread prevalence of variable rate loans. On the other hand, those countries also benefit most from the positive effects of lower market interest rates on the quality of the loans and the loan loss provisions.

5.2. Bank equity and stock prices

Ampudia and Van den Heuvel (2017) use the unexpected component of monetary policy shocks and investigate their effects on bank equity, represented by stock prices. They find that an unexpected decrease in policy rates in a positive rate environment raises bank equity, as also suggested by English et al. (2014). However, in low and negative rate environments this effect is reversed: Further interest rate cuts at already low rates lead to lower bank equity prices. The authors attribute their findings to a squeeze in the interest rate margin due to the zero lower bound on deposit interest rates, as banks more dependent on deposit funding are more negatively affected by cuts. In contrast, Altavilla et al. (2017b) find the opposite results. Bank equity prices responded positively to the drop in the DFR by 10bps

in on 5 June 2014 and 4 September 2014 respectively. In particular during the latter episode, bank equity prices responded more positively than other stock prices. Moreover, this paper also finds positive responses to expansionary APP announcements during the NIRP period (with the exception of the December 2015 event). The difference in the finding of Altavilla et al. 2017 to Ampudia and Van den Heuvel (2017) can be explained by the different focus of the paper. Altavilla et al. 2017 focus on a broad series of events including two interest rate changes in the negative rate period as well as a variety of non-standard measures, while Ampudia and Van den Heuvel (2017) analyse only changes in interest rates covering all policy meetings.

5.3 Interest rates expectations and foreign exchange markets

In assessing the overall effects of the NIRP it is also important to take into account the alternative transmission channels beyond the bank lending channel of lower interest rates on the economy. One channel that has been operative in the euro area case is its signalling effect on the term structure. As shown in Rostagno et al. (2016), lowering the policy controlled rate through the zero lower bound has the advantage of removing the non-negativity restriction on expected future short-term rates. As a result the forward curve becomes flatter than it would be if short rates were expected to be constrained by a zero lower bound. Indeed, as shown in Figure 17, the ECB's NIRP contributed to a flatter yield curve since 2014 than was the case in the United States during the QE period.

Such stronger signalling effects may in turn lead to larger effects on the exchange rate. Results by Khayat (2015) suggest that negative interest rates put depreciation pressure on the currency, and that the effects are distinct from lowering rates in positive territory. Gräb and Mehl (2015) find that exchange rates of countries with negative policy rates tend to react more strongly to changes in their corresponding bond yield differentials vis-a-vis the US. For the euro area, their estimates suggest that a cut in the deposit facility rate by 20 bps is

associated with a depreciation of the euro against the US dollar which is around 0.5 percentage points larger in negative territory than in “normal” times. Overall, their empirical results suggest that negative interest rates make exchange rates more elastic to shocks.

6. Conclusions

In June 2014 the ECB became the first major central bank to reduce one of its key policy rates to a level below zero. Naturally, the question arises whether the transmission of monetary policy is different when interest rates become negative. This paper offers an overview of the available research with a specific focus on the euro area. Furthermore, it documents the dynamics of deposit rates, lending rates and loan volumes of euro area banks in the recent NIRP period.

The paper first establishes that the friction associated with negative rates, at least in the euro area, is the zero lower bound on household deposits and to a lesser extent deposits by non-financial corporates. All other bank liabilities reprice in line with negative policy rates. A simple econometric exercise shows that the interest rate-pass through of policy rate changes to bank lending rates appears largely unchanged over the negative interest period. Moreover, this result also appears to hold for banks that are most affected by the friction associated with negative rates, i.e. those with a high reliance on retail deposits and which are situated in a country with overall low deposit rates. The same exercise for loan volumes (proxied by loan market share) finds that the most affected banks, if anything, increased their overall share in loan markets. This is in line with findings that the negative interest rate policy has induced most affected banks to increase their lending activities in a bid to reduce their excess liquidity holdings.

Studies focussing on specific markets and financial intermediaries tend to find differentiated effects, pointing to interesting side effects of negative rates within the banking sector. These effects are, however, quantitatively small and unlikely to change to overall picture that negative rates in the euro area have been expansionary. Finally, the paper discusses several studies dealing with other effects of negative rates like their impact on foreign exchange markets, bank equity prices and bank profitability.

Tables

Table 1: Deposit rates (HH & NFC, weighted average) and share of retail deposits (HH only) in total assets, as of June 2014, by country

Core	Deposit rate	Retail share	No. of banks	Periphery	Deposit rate	Retail share	No. of banks
MT	0.940	0.510	4	PT	1.247	0.313	6
AT	0.565	0.192	9	SI	0.981	0.398	5
LU	0.461	0.126	8	ES	0.880	0.297	19
SK	0.226	0.457	3	IE	0.422	0.226	7
DE	0.165	0.203	50	IT	0.251	0.282	23
EE	0.118	0.274	4				
FI	0.070	0.177	5				
LV	0.068	0.209	5				
FR	0.032	0.244	22				
NL	0.009	0.206	9				
BE	0.007	0.402	9				

Note: Only banks that reported a deposit rate in June 2014 are included in the calculation. Reported rates are weighted by their respective bank's share in the country's deposit market. Retail shares are computed over the total balances of the included banks.

Table 2: Interest rate pass-through during NIRP and APP period

	Change in composite loan rate		
	(1)	(2)	(3)
Change DFR	0.611***	0.625***	0.625***
	(0.068)	(0.145)	(0.145)
Change DFR x NIRP		0.609	0.454
		(0.572)	(0.605)
Change DFR x Deposit share x NIRP		−0.009	−0.009
		(0.009)	(0.009)
Change DFR x APP			1.644**
			(0.835)
Observations	1,779	1,779	1,779
R^2	0.064	0.066	0.072
Adjusted R^2	0.064	0.062	0.067

Notes: *p<$0.1; **p<0.05; ***p<0.01. Sample covers 59 German banks from 2009Q1 to 2016Q3. Standard errors are White-Hubert heteroscedasticity robust

Figures

Figure 1: Key policy-controlled interest rates and interbank overnight rates

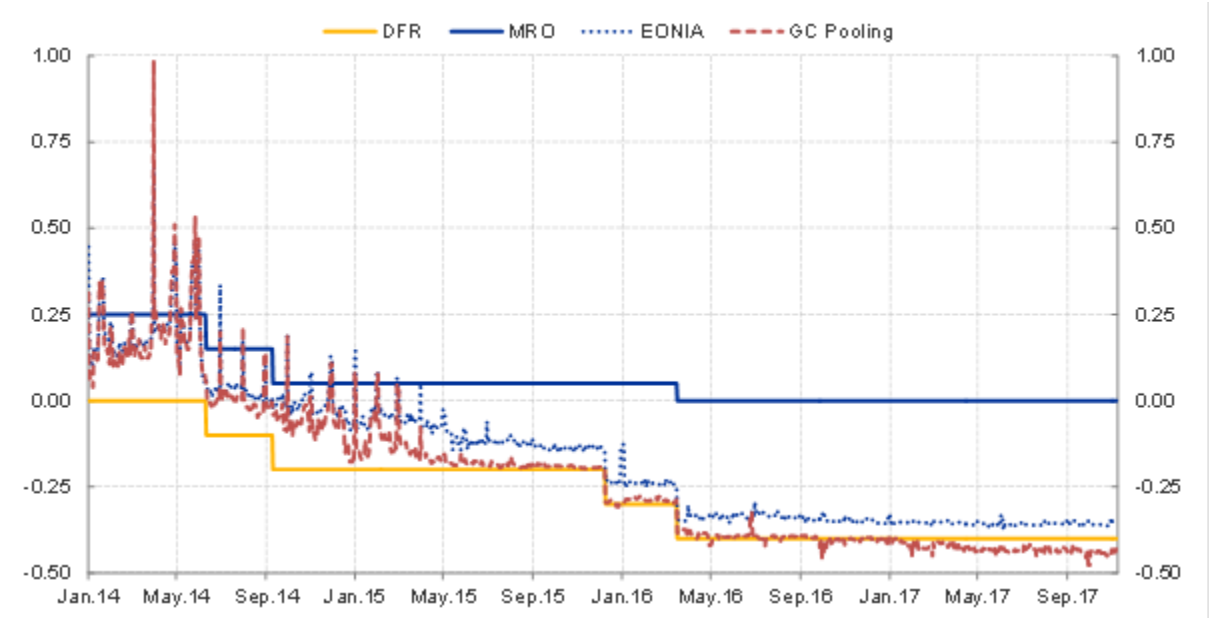


Figure 2: EONIA reaction to policy rate changes in the first maintenance period after the rate change

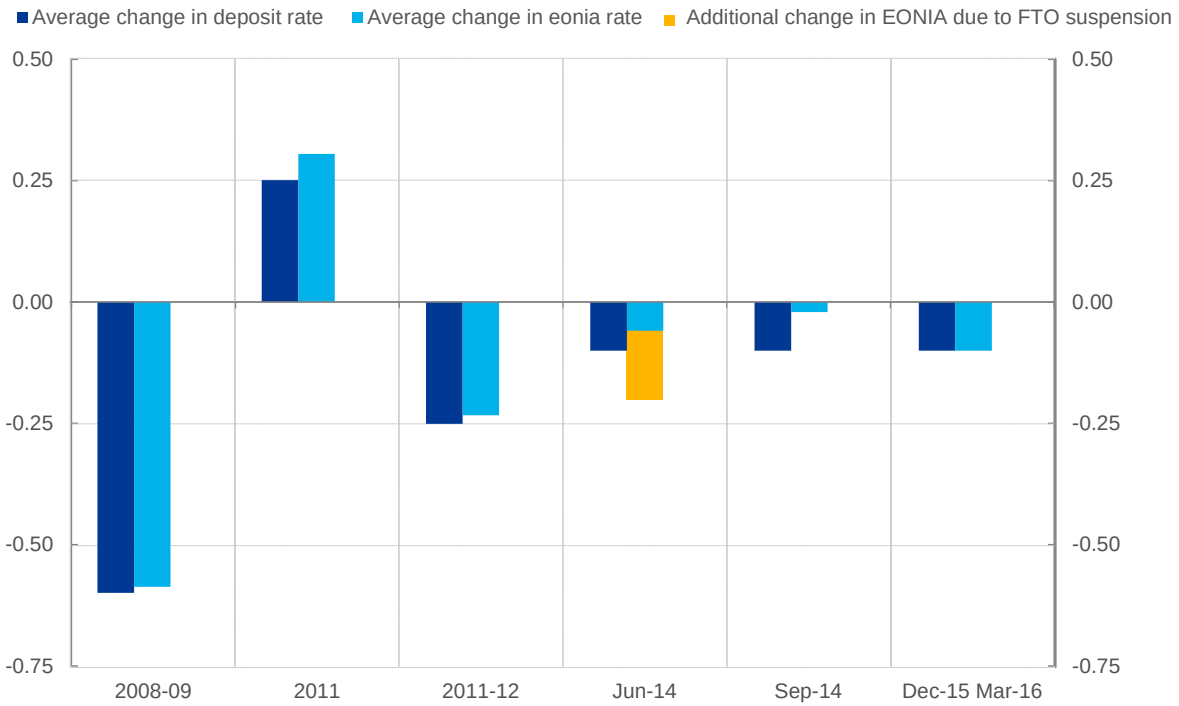


Figure 3: The term structure of risk-free rates

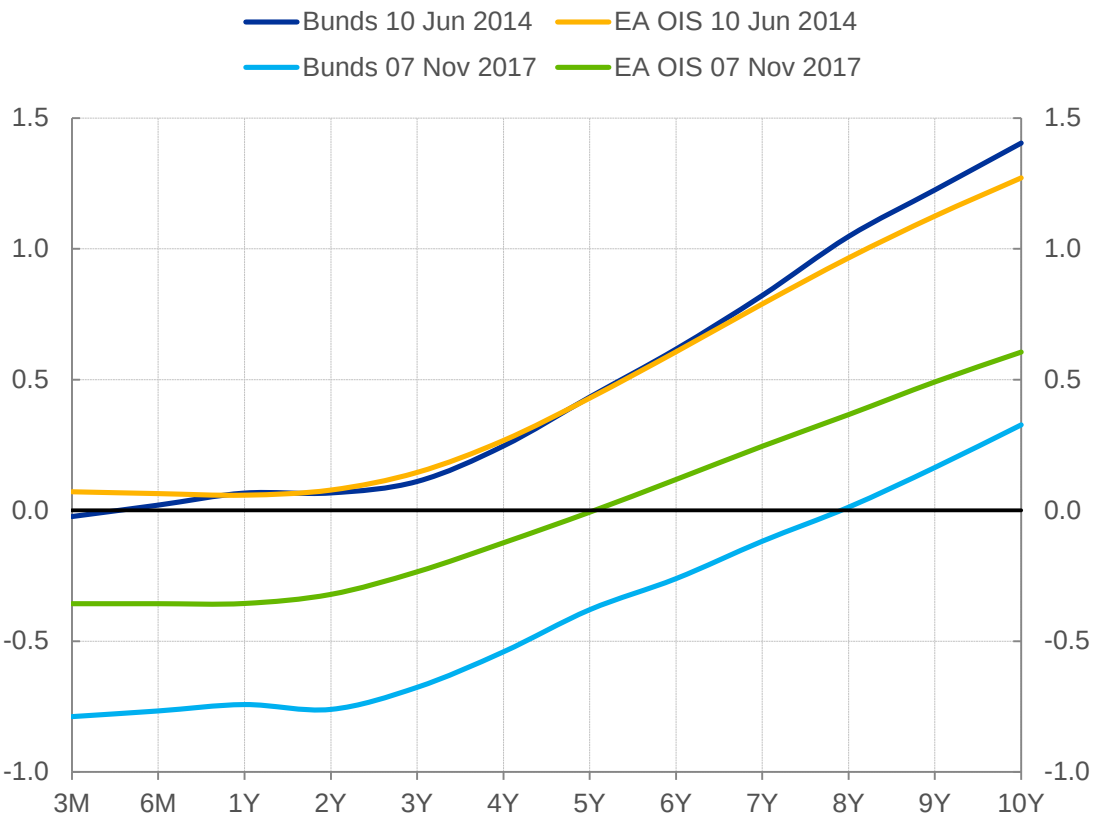


Figure 4: The term structure of AAA-rated government bonds (zero coupon)

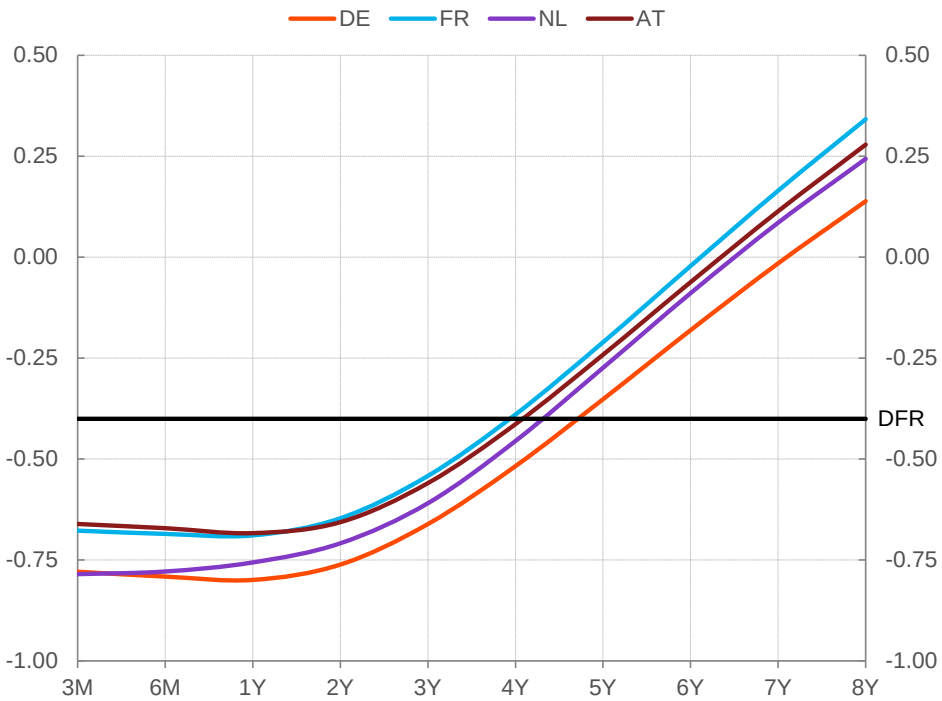
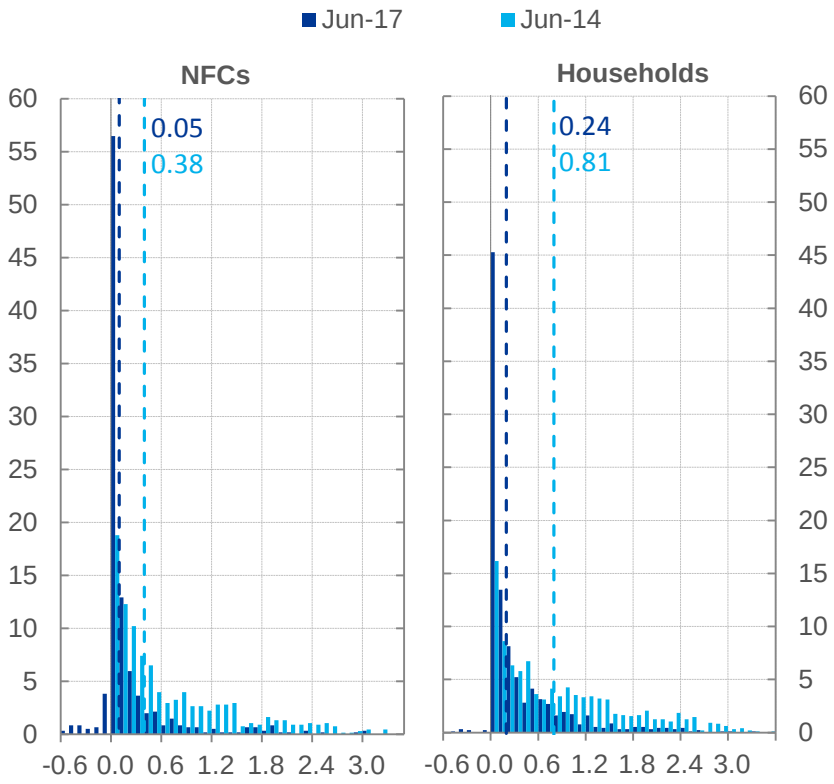


Figure 5: Distribution of the remuneration of household and NFC deposits across banks in the euro area



Source: ECB, dashed lines represent mean of distribution

Figure 6: Share of deposits remunerated below zero

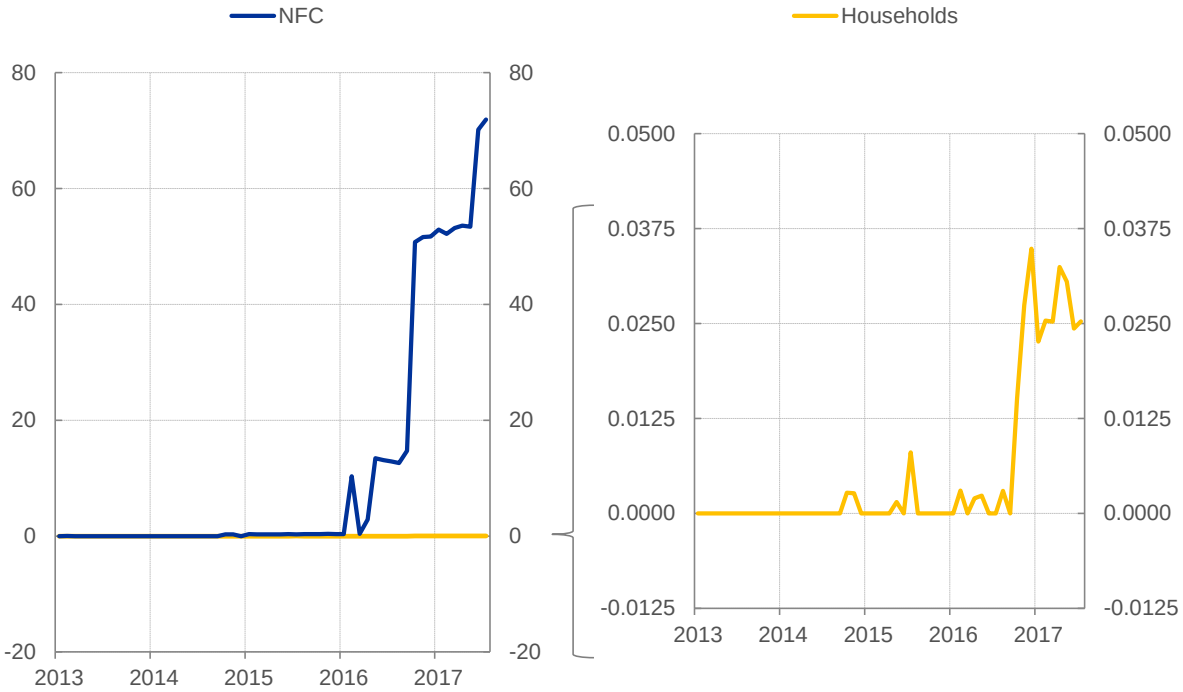


Figure 7: Evolution of household deposits and wholesale funding, as shares of total liabilities, in the Euro Area since August 2007

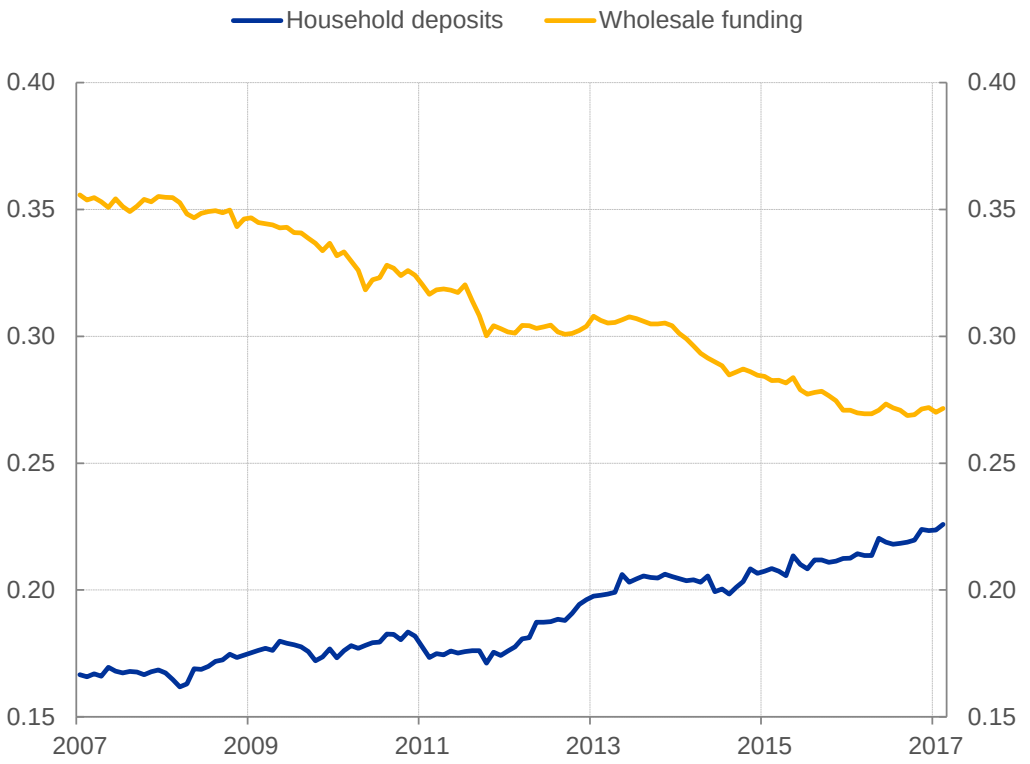
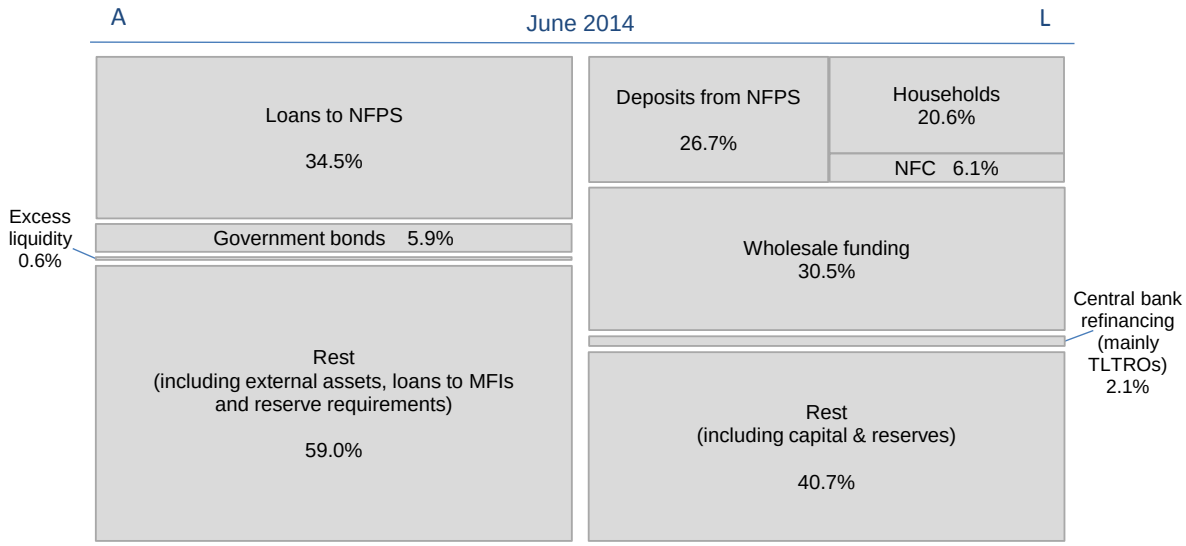


Figure 8: Total euro area bank balance sheet



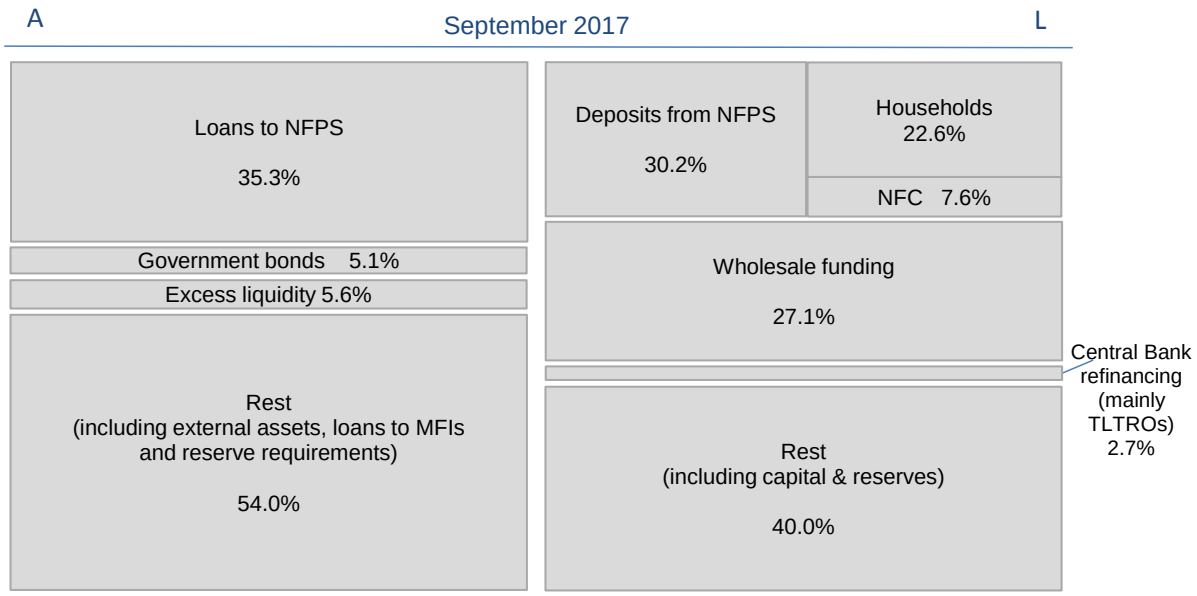


Figure 9: Share of household and NFC loans fixed at short- and long-term, as of June 2017

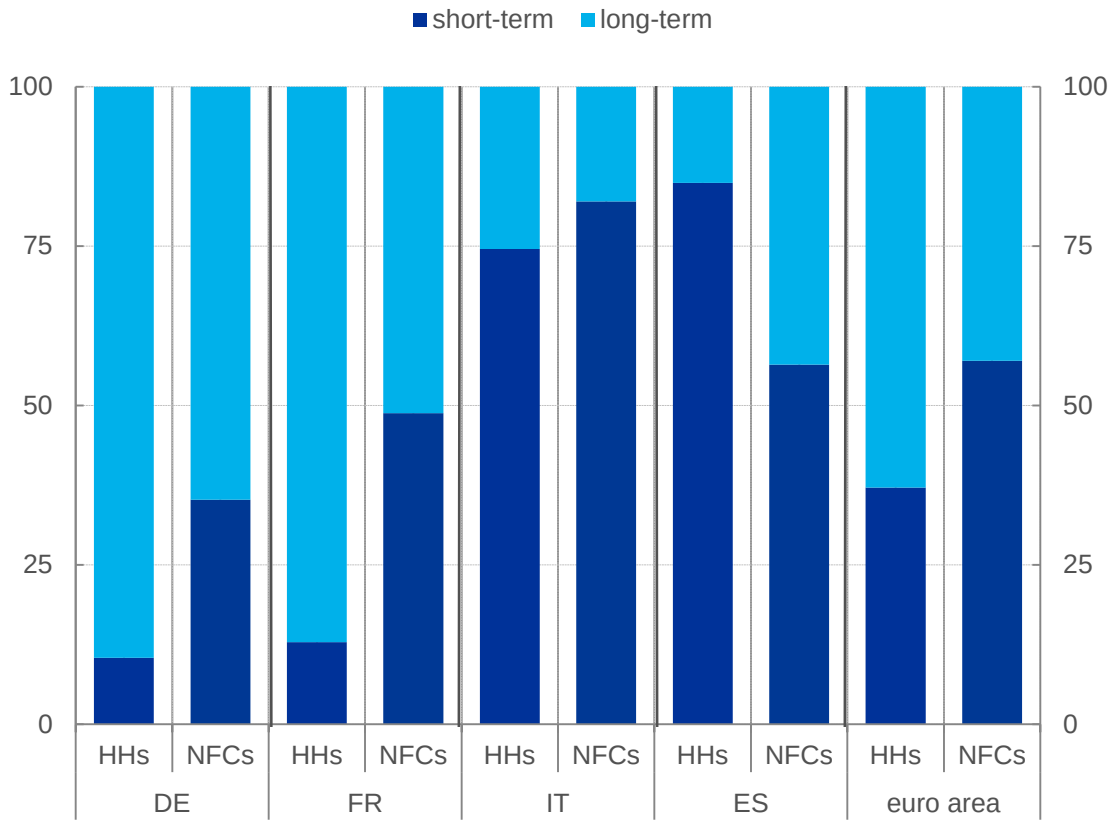


Figure 10: Distribution of share of retail deposits in the balance sheet, all banks excluding Greece and Cyprus

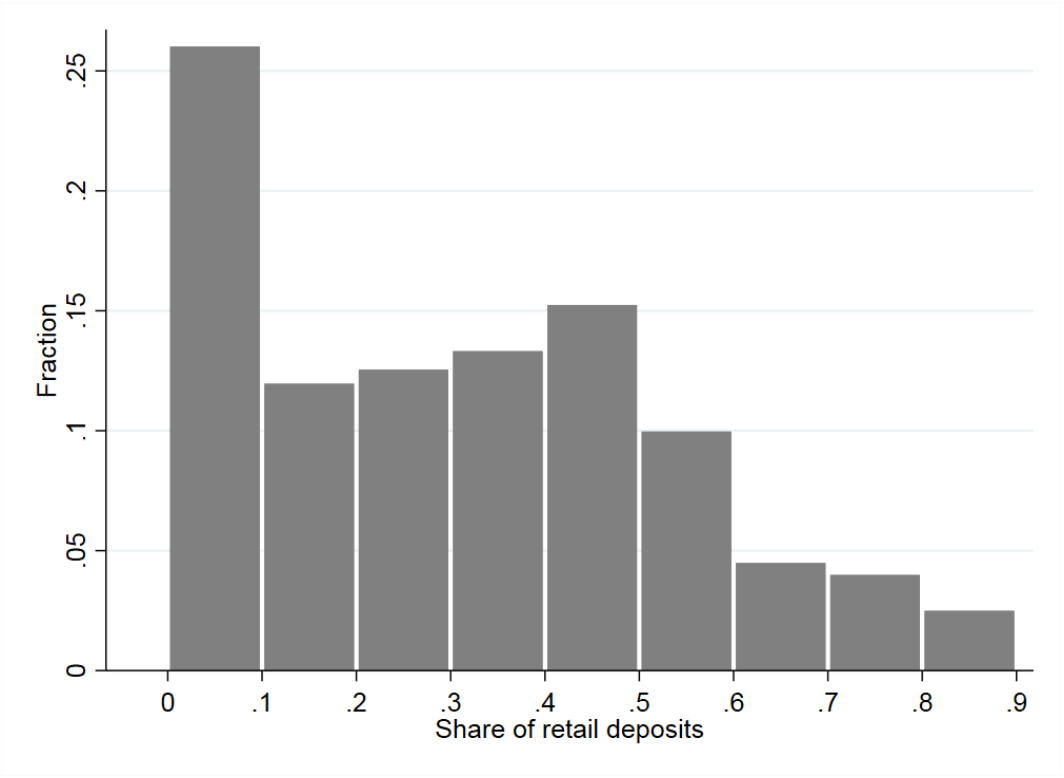


Figure 11: Distribution of share of excess liquidity, all banks excluding Greece, Cyprus and high EL banks

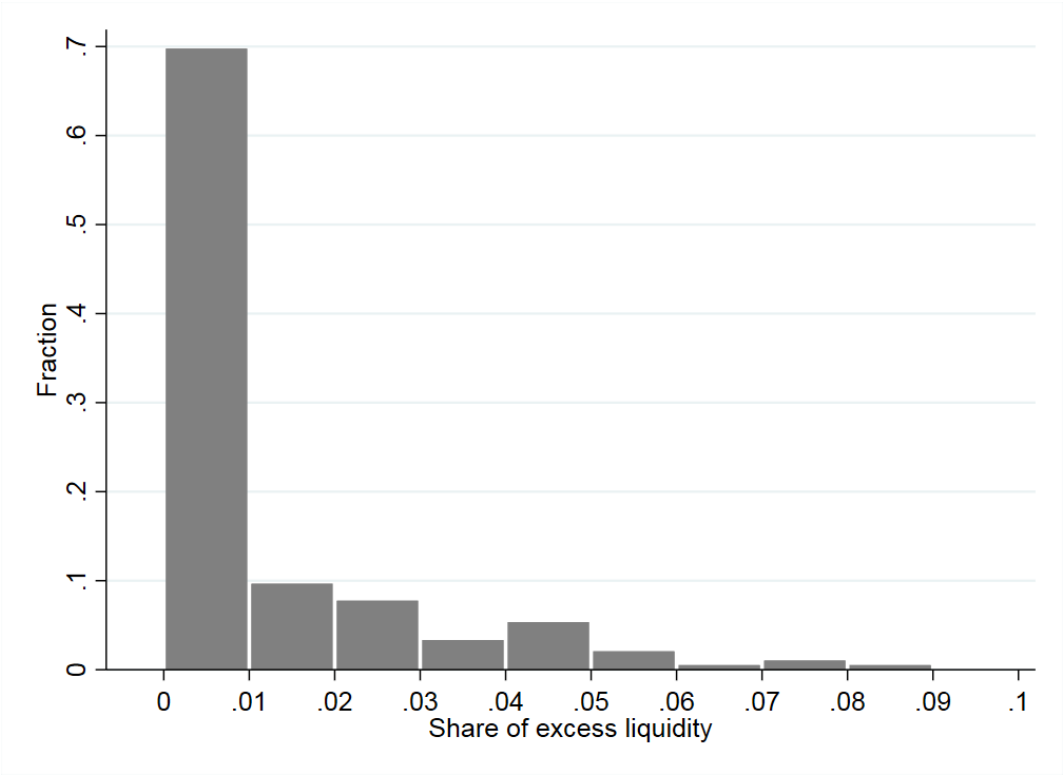
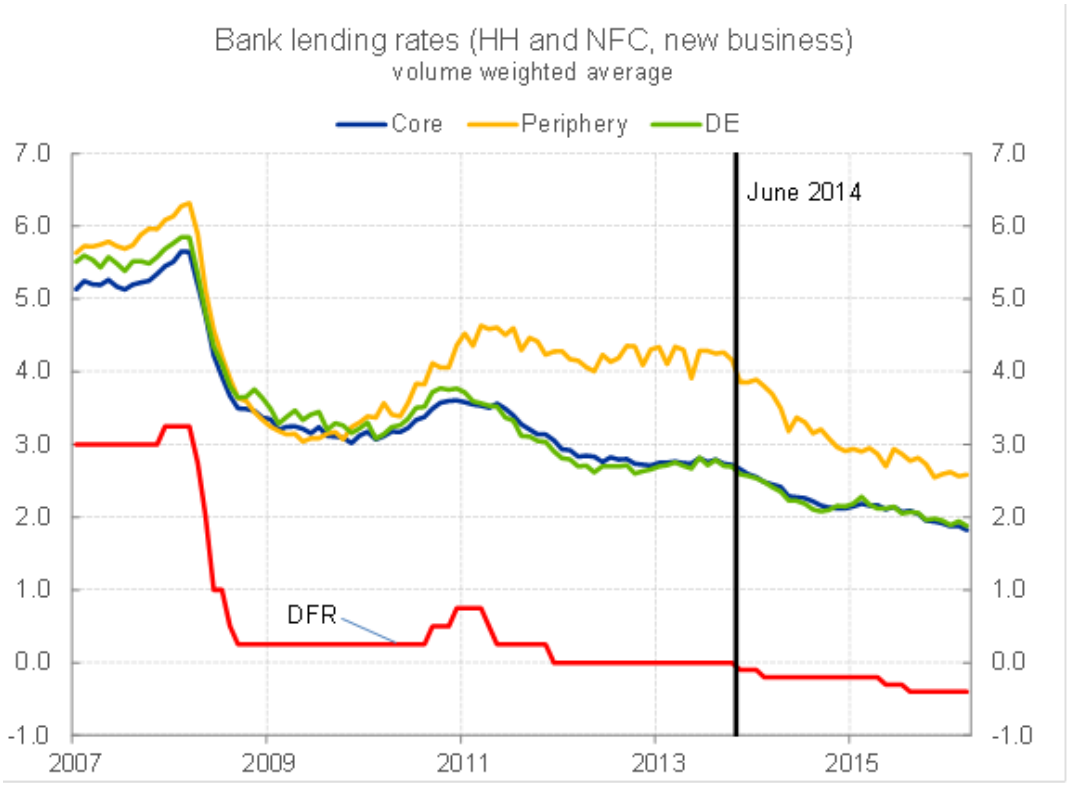
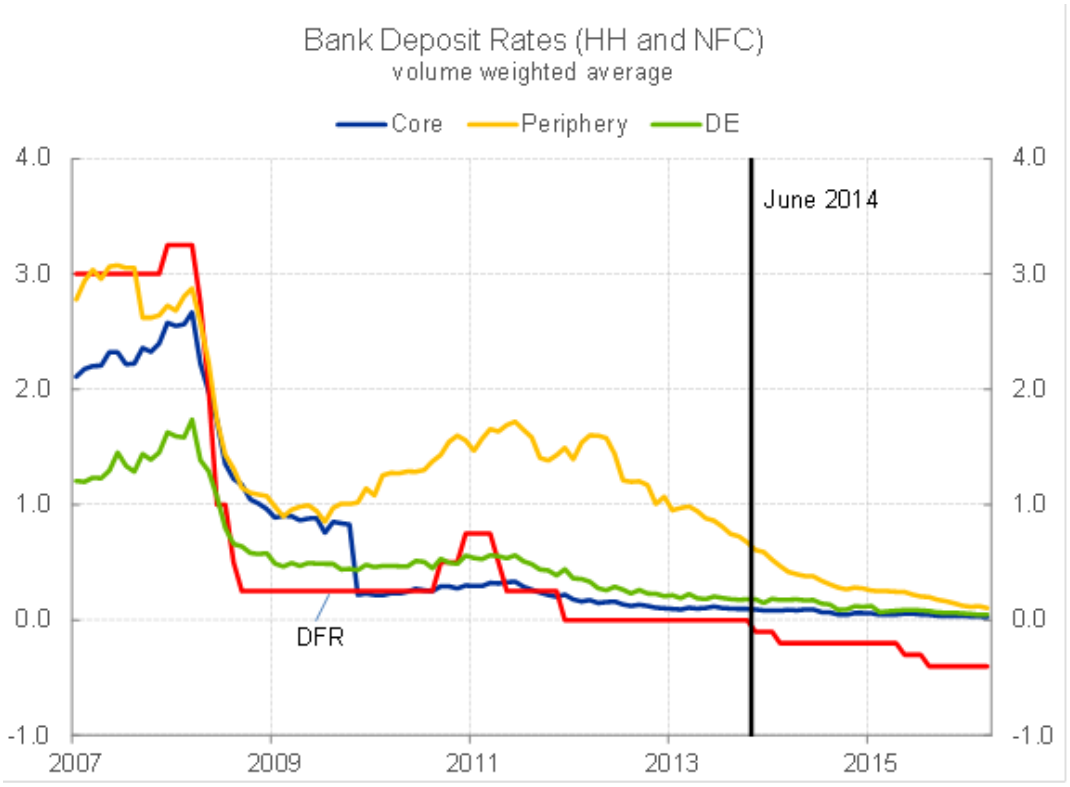
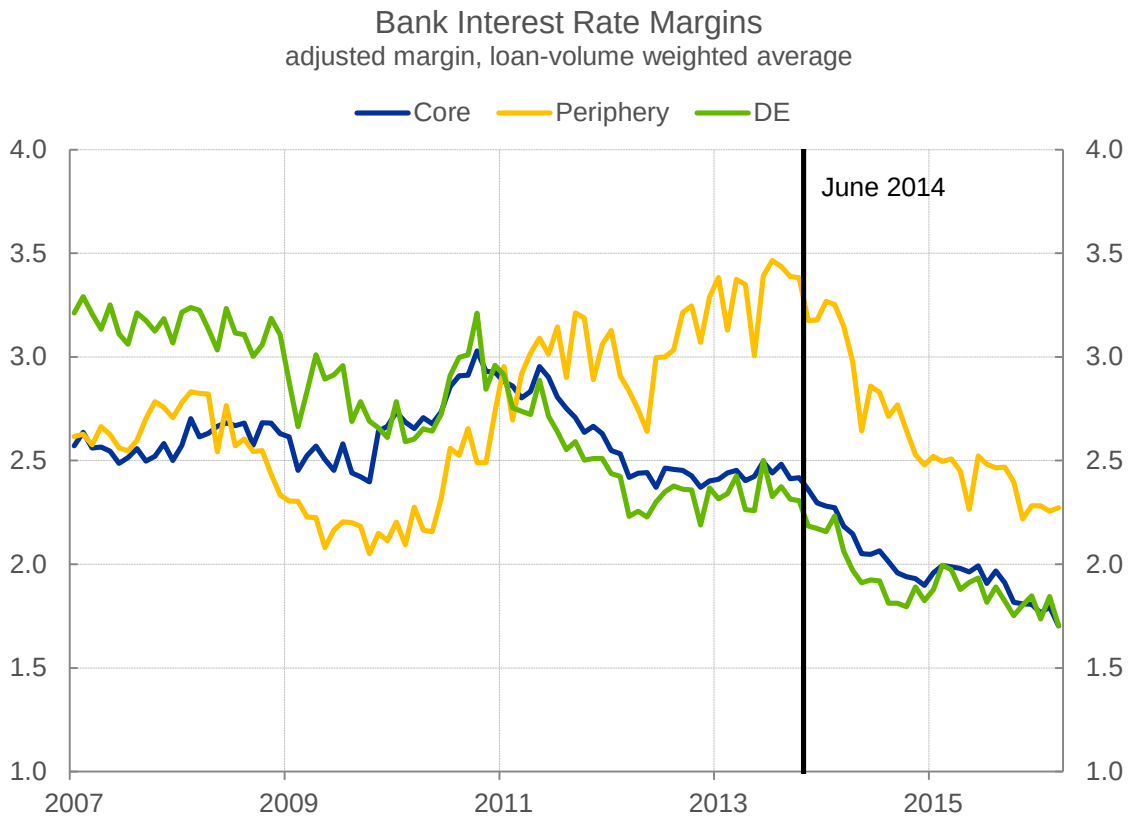


Figure 12: Bank lending rates, bank deposit rates and interest rate margins in core and periphery countries

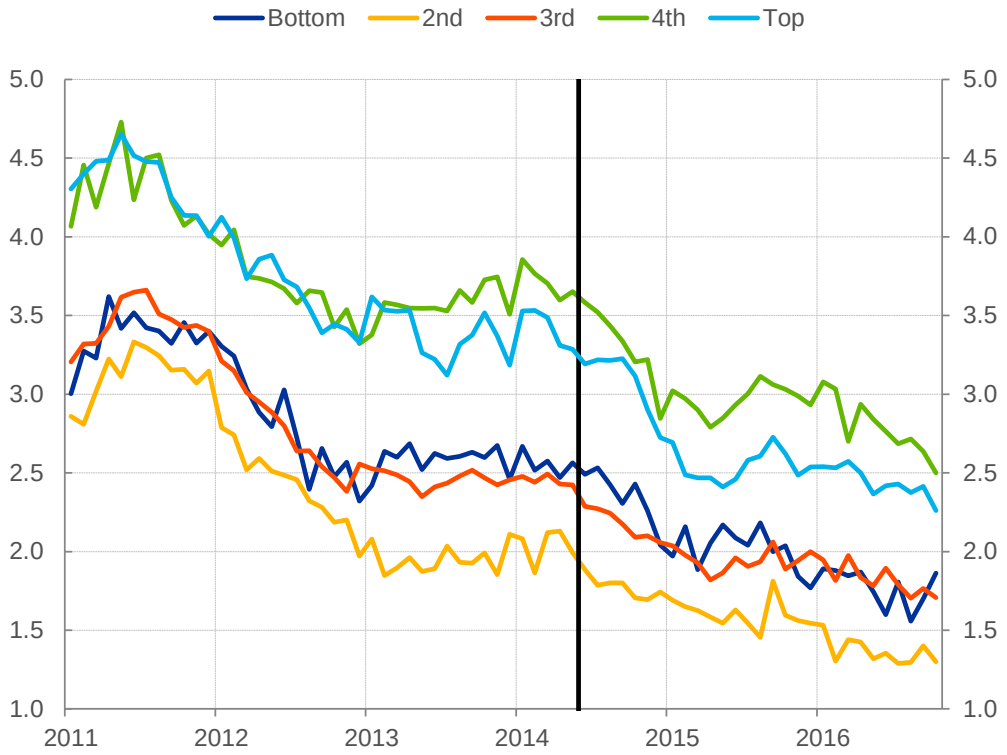






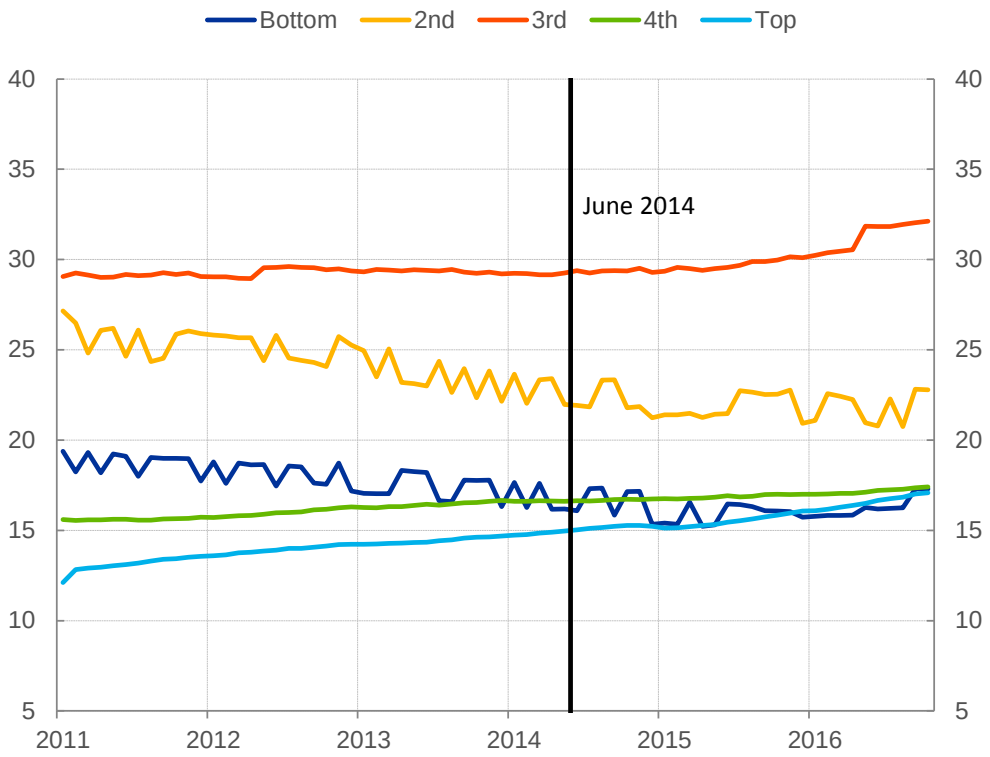
Notes: Core countries include AT, BE, DE, EE, FI, FR, LU, LV, MT, NL and SK. Periphery countries include ES, IE, IT, PT and SI, whereas banks from Greece and Cyprus are excluded. Lending and deposit rates are weighted by their respective loan or deposit volumes. Margins are weighted by the respective bank's loan volumes.

Figure 13: Bank lending rates in Germany by retail deposit share quintile (volume weighted average)



Notes: Calculated on the basis of the 59 German banks that report lending rates and volumes over the entire period. Lending rates are weighted by their respective loan volumes. Quintiles are formed based on the average retail deposit share of each bank in the year before NIRP (June 2013 to May 2014).

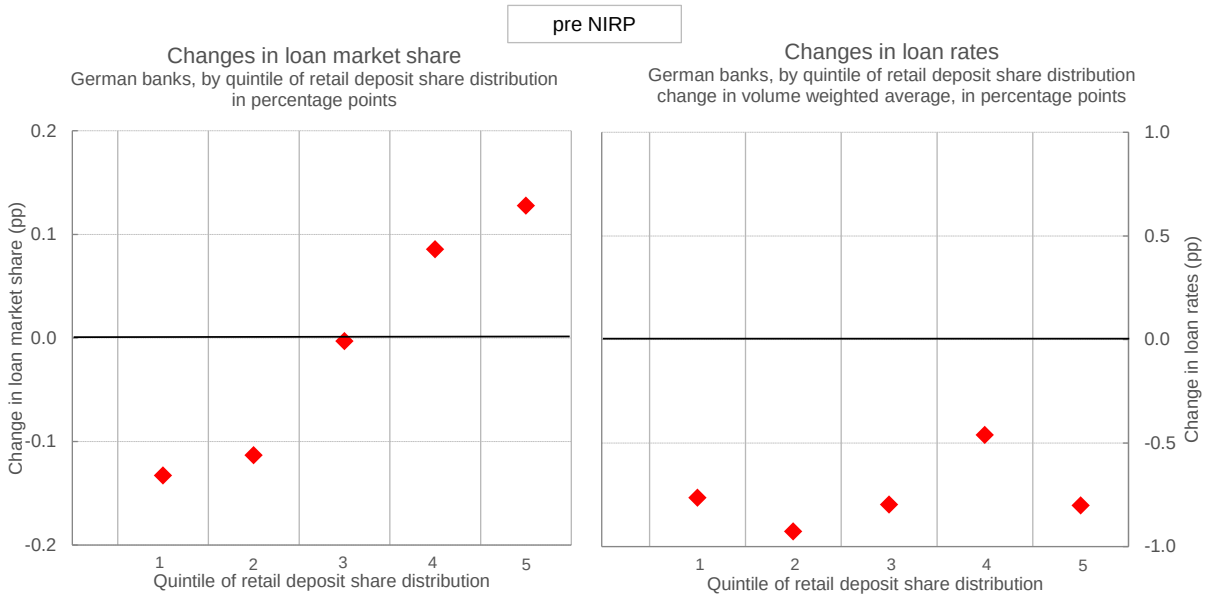
Figure 14: Bank lending volumes in Germany by retail deposit share quintile (mean, in EUR bn)



Notes: Calculated on the basis of the 59 German banks that report lending rates and volumes over the entire period. Quintiles are formed based on the average retail deposit share of each bank in the year before NIRP (June 2013 to May 2014).

Figure 15: Changes in bank lending rates and loan market shares in NIRP and pre-NIRP period per deposit share quintile.

Pre NIRP : Feb 2012 to June 2014



NIRP: June 2014 to October 2016

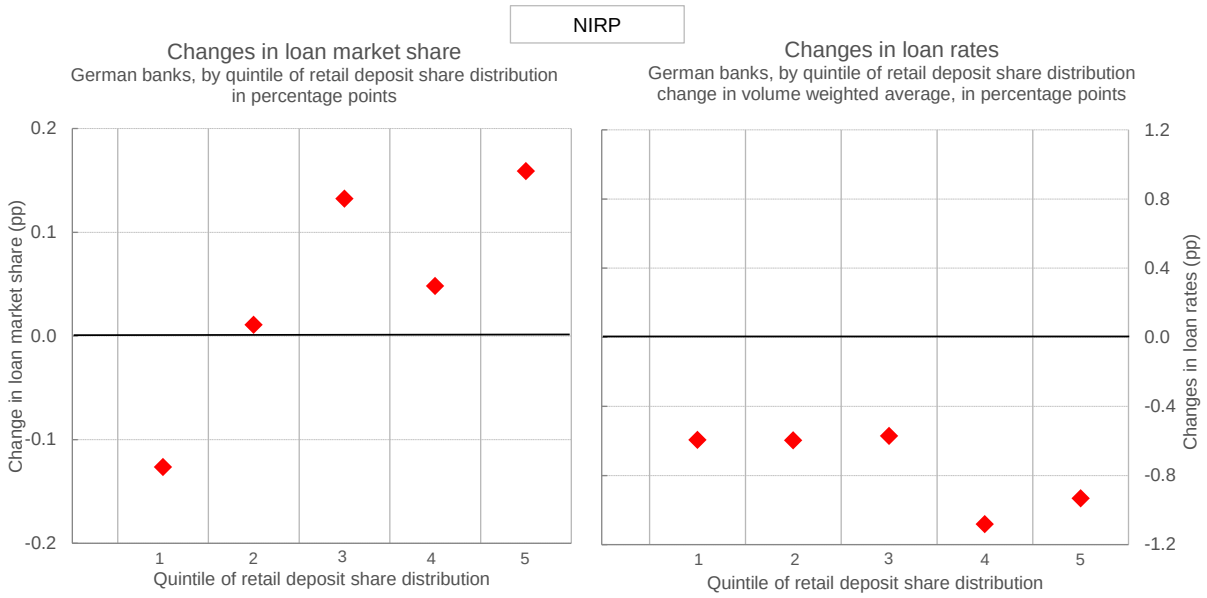
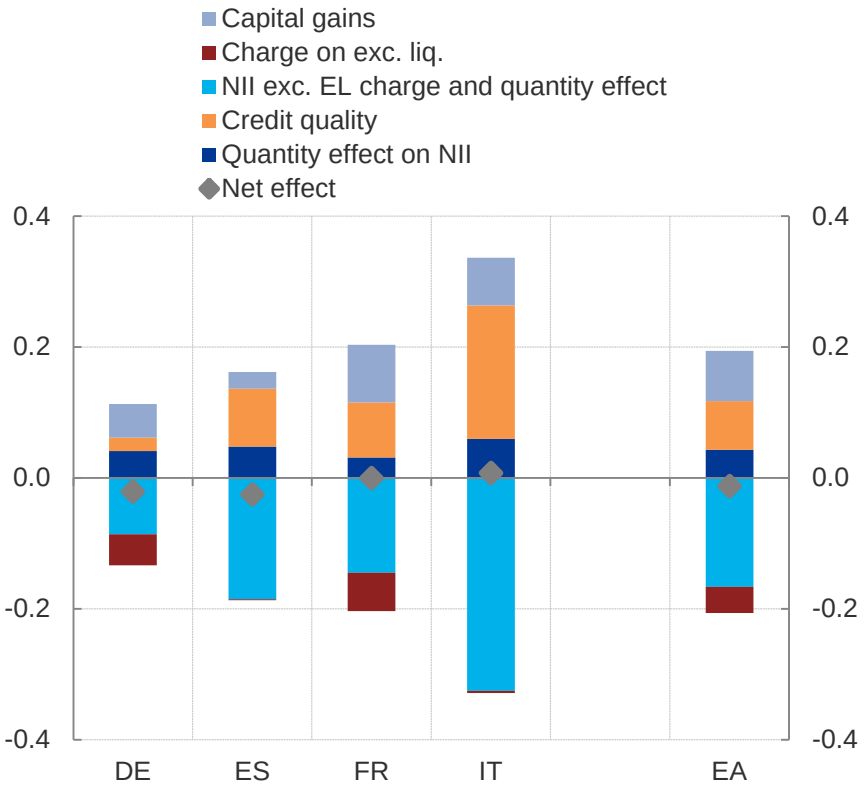
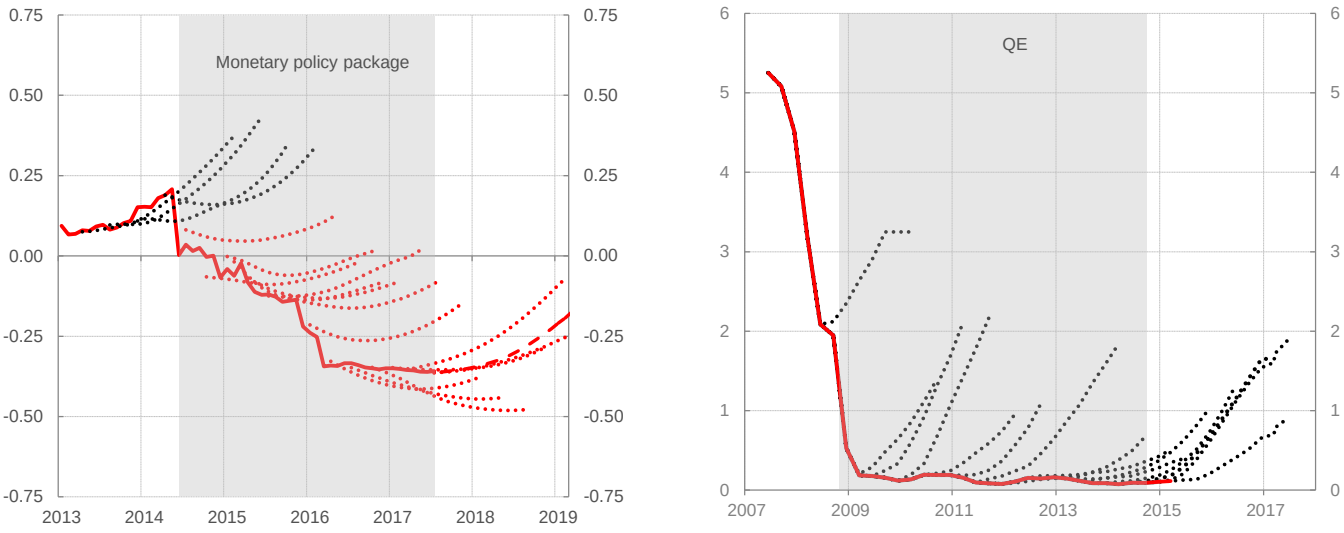


Figure 16: Decomposition of the impact of monetary easing on bank return on assets.



Source: Altavilla, C., D. Andreeva, M. Boucinha, and S. Holton (2017). Monetary policy, credit institutions and the bank lending channel in the euro area. *ECB Occasional Paper Series, forthcoming*.

Figure 17: Forward curves during periods of non-conventional monetary policy (with and without NIRP)



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