Negative interest rates: Lessons from the euro area

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Abstract

This paper reviews the recent literature on the effects of negative interest rates. It documents the pass-through of negative policy rates on bank deposit and lending rates and loan volumes in the euro area. It first shows that the zero lower constraint is binding for interest rates on household deposits held at banks. Nevertheless, the pass-through on loan rates is more than complete, even at banks with high deposit shares. 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] The views expressed are those of the authors and do not necessarily reflect those of the ECB. L. Pagenhardt provided excellent research assistance.

1. Introduction

In June 2014 the European Central Bank (ECB) decided to cut the rate on its deposit facility (DFR) by 10 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 also included the introduction of targeted long-term refinancing operations (TLTROs) and eventually a large-scale asset purchase programme (APP) of both private and public sector bonds. Further rate cuts of 10 basis points (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 an easy task because 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

[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%.

conditions. In this paper, we try to shed light on the impact of the 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 first document that there appears to be a zero lower bound on interest rates, but 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 corporates 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 into cash because individual household deposits are typically of smaller amounts and therefore the storage costs are limited. As a result, banks that charge negative rates would see a sharp outflow of household deposit funding, which may raise funding problems and more importantly undermine the business model and franchise value of retail banks that 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 regulation (in particular the Net Stable Funding Ratio (NSFR) regulation) has increased the value of household deposits as a stable funding source for banks.

[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 untill now suggests that it is probably much lower than current policy rates and the bound may be different depending on the specific market.

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 the distortionary effects should be most visible for those bank business models that rely to a large extent on household deposit funding. In the empirical literature and in this paper this observation is used to try to identify the effects of negative interest rates.

Secondly, 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. Brunnermeier and Koby (2017) is the first paper that explicitly analyses the possibility that there may be a threshold level of the policy-controlled interest rate (the reversal rate) below which further interest rate reductions would become counterproductive.[5] The general finding of these papers is that in an environment in which banks face a capital constraint which depends 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, in particular in an environment of excess liquidity which exposes them to the negative returns. 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. In such an environment, the presence of excess liquidity that yields negative returns may induce portfolio rebalancing and a search for yield. Which effect dominates is an empirical question.

Most recently, Eggertson, Juelsrud and Wold (2017) put a zero interest rate bound on bank deposits in an otherwise standard New Keynesian model and show that it may lead to

[5] See also Cavallino and Sandri (2017) and Rognlie (2015).

contractionary effects of a NIRP. Whether such negative effects on the economy dominate will depend on the health of the banking sector and the presence of other transmission channels of lower interest rates that may boost the economy, increase the demand for loans and improve the overal quality of the loan book.

Thirdly, in section 4 of this paper we review the empirical literature that examines bank level data in a NIRP environment like Heider, Saidi and Schepens. (2017) and Demiralp, Eisenschmidt and Vlassopoulos (2017). In addition, we document the evolution of loan rates and loan volumes of banks with low and high-reliance on household deposit in response to the NIRP episode in the euro area. Using descriptive statistics, we provide suggestive evidence that – at least in the euro area – there is no prima facie evidence that the NIRP has lead to counterproductive lending behaviour by banks that are reliant on household deposits. İf anything, we find the opposite effects.

Finally, in the last part of the paper (section 5), we report on other channels of negative interest rates in order to get a sense of the overall effect on bank lending, bank profitability and the economy more widely. In particular, we review a number of papers that try to quantify the effects using bank equity prices and through simulation methods. One channel which is often overlooked in this literature is the exchange rate channel. Opening up the zero lower bound on interest rates has an impact on the distribution of future expected interest rates and therefore may therefore have 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. Three further cuts in steps of 10 bps were subsequently

undertaken so that in March 2016 the current level of -0.40 percent was reached. Meanwhile, the rate applicable to liquidity providing operations (the MRO rate) was lowered to zero.

Excess liquidity in the system implied that the cuts to the DFR were passed on to short-term money market rates (such as the EONIA), although this process took longer than usual and was only complete in May 2015. The initial 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 as shown in Figures 1 and 2.

As shown in Figure 3, currently the risk free OIS curve is in negative territory for maturities of up to four years and short-term government bonds of the best credit quality are trading at yields well below the DFR (Figure 4). This is partly due to the scarcity of such bonds created by the ECB's APP.

While the pass-through of negative policy rates to financial market rates can be considered 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 all 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. Some banks do report rates below zero for 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, being 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, due to higher levels

when negative rates were introduced, deposit rates in Germany were already near zero at the beginning of NIRP (see Figure 12). The German case may therefore be considered most representative for studying how a steady-state pass-through of negative policy rates to bank deposit rates looks like.

Figure 6 shows the share of O/N bank deposits of household 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. As of July 2017, around 72% of O/N deposits by NFCs are 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 by cash. Household deposits are normally smaller than NFC deposits and this difference is very likely a 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 banks simply reduce their household deposit funding? 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 household deposits are widely seen by banks as a (cheap) source of stable and longer-term funding that receive favourable treatment under the new liquidity regulation (e.g. NFSR). Arguably, the overall attractiveness of household deposits as a source of funding to banks has 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.

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

The presence of a zero lower bound on deposit rates raises the question how it affects bank profitability and the bank's incentives to lend and adjust its 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.

Several transmission mechanisms may be activated by banks' reactions to negative rates. Prominently, the bank-lending channel suggests that expansionary monetary policy measures will increase bank willingness to provide loans: Under NIRP, the incentive of 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 NIRP might reduce the ability of banks to pass-on interest rate changes to their retail deposits (Horwath, Kotlebova and Siranova, 2017), the policy amplifies the credit channel by increasing the cost of holding EL, in particular for banks with a high share of retail deposit funding on their balance sheet.

The exchange of very safe assets such as central bank reserves for riskier assets such as 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, Laeven and Suarez, 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, for instance through the reliance on measures of risk that are based on market equity prices such as expected default frequencies and the use of Value-at-Risk frameworks for asset-liability management. Moreover, "sticky" rate-of-return targets defined in nominal terms can prompt a "search for yield" effect when interest rates are reduced, which results in higher risk tolerance. In fact, the promotion of risk taking by encouraging lenders to invest in riskier assets when the returns on safer assets decline is considered one objective of quantitative easing policies (Aramonte, Lee and Stebunov, 2015; Heider et al., 2017). This channel is likely further reinforced by the prevalence of negative rates.

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 lower profitability has on capital constraints and

the ensuing contractionary effects on bank lending. In their model the exact level of the reversal interest rate depends on the banks'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 reduced.

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 come mostly 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. One of their examples is inspired by Brunnermeier and Koby (2017). In this model with heterogeneity of borrowers and savers and the presence of a monopolistically competitive banking sector, the presence of a net worth constraint on banks may lead to the existence of a reversal rate. One condition is that banks face a net worth constraint which is positively affected by profits. Another condition for the reversal rate to exist is that 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 in the short-term. Less binding borrowing constraints lower the reversal rate, while more competition in deposit markets increases the reversal rate.

Most recently, Eggertson 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). They develop a model to capture this effect. The model is a New Keynesian model

as in Benigno, Eggertson and Romei (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 can not fall below a lower negative bound that is proportional to the storage costs of holding money instead. If storage costs are negligible the lower bound on deposit rates will be zero. Another key assumption is that financial intermediation costs, that generate a spread between the household's deposit rate and the bank lending rate, depend negatively on current profits. This is a reduced form assumption that is meant to capture the established 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 desire 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, also the drop in the bank lending rate will be bounded. However, the lower interest rate on reserves reduces the profitability of the bank as there is a demand for reserves even at negative rates and thereby increases intermediation costs and further increases the interest rate margin exacerbating the macro-economic effects of the shock.

The theoretical analysis shows that important determinants of whether a NIRP may have contractionary bank lending effects are 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%, 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 as the ECB has embarked on its APP. The excess reserves are

remunerated at a negative rate of -0.4 percent. A larger amount of excess liquidity will be costly for the banks to the extent that it is funded by a larger share of 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 the banks in the one region borrow from the interbank market while the banks in the other regions lend on these markets. İn the euro area, excess liquidity has resided mostly in the core countries. Also the degree to which loans are priced at fixed rates or variable rates differs across countries, with the core countries have more long-term fixed rate financing and the periphery countries more variable-rate financing (see Figure 9). Figures 10 and 11 give the distribution of deposit and excess liquidity shares in the euro area banking sector. In the next section, we will use this cross-sectional information to investigate whether the pass-through of the negative DFR in the euro area to bank loan rates and loan volumes differs across low and high deposit share banks.

4. The impact of negative rates on banks

This section briefly reviews the available literature and then turns to discuss developments on euro area banks' balance sheets over the NIRP period. In our search for the effects of negative rates, we will progressively zoom in on banks which are most exposed to household deposits as a source of funding.

4.1 Emirical literature

There is a small, but fast growing literature devoted to the effects of negative rates on banks balance sheets. Heider et al. (2017) focus on the euro area and 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 also start lending to riskier borrowers. Basten and Mariathasan (2017) investigate the reactions of Swiss banks to negative rates and find that relatively more affected banks (a higher proportion of banks' holding of central bank reserves exposed to negative rates) show a more pronounced transmission. To avoid the charge on excess reserves, they lend more and are incentivised to invest in financial assets, whilst also increasing their risk taking and fees.

In another study focussing on the euro area, Demiralp et al. (2017) also use banks' exposure to the excess liquidity charge to identify the impact of negative policy rates on banks, using a sample of 256 euro area banks, covering around 70% of bank assets in the euro area. They find that a subset of banks has indeed reacted to negative rates by granting more loans (high deposit banks) and increasing the holdings of non-domestic government bonds (wholesale funded banks). Overall, both studies basing their identification on the importance of excess liquidity find that negative rates are expansionary. The discrepency in findings between Heider et al. (2017) and Demiralp et al. (2017) could be related to the difference in the loan aggregate as well as the difference in the lenght of NIRP 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.

Several other papers support the notion that the bank-lending channel remains intact under NIRP (e.g. Albertazzi, Nobili and Signoretti, 2017; Bräuning and Wu, 2017).

4.2 Data

In order to explore further the behaviour of bank loan rates and volumes under NIRP, we make use of a confidential dataset containing balance data for 256 selected euro area banks at the monthly frequency (IBSI and IMIR). The dataset has been constructed with a view 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 with monthly balance sheet data from August 2007 until October 2016, giving rise to 111 bank months of data.

4.3 Bank lending rates and volumes under NIRP

Bank lending rates of euro area banks generally display a strong comovement with policy rates and this has not changed with the introduction of NIRP. Formal modelling of the relationship between changes in the DFR and changes in bank lending rates using a simple fixed effects panel model at quarterly frequency shows that this relationship has even strengthened in the NIRP period (Table 2: the coefficient increases). Such an outcome is, however, hardly surprising given the almost coincidental launch of the ECBs asset purchase programme (APP) in March 2015 which has put significant downward pressure on virtually all financial market rates.

Figure 12 shows the evolution of bank lending rates, 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, lending rates and interest rate margins was particularly pronounced in the peripheral countries (i.e. those 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 rates and lending rates in June 2014 due to fall-out from the sovereign debt crisis. İt is interesting to note that following the comprehensive easing package of the ECB deposit rates in the peripheral countries converged back almost fully to that 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 reduction into negative interest rates of the DFR. Consequently, in what follows we will again 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). Note that also in the core countries the interest rate margins fell quite significantly.

The complete lack of pass-through of negative rates to deposit rates puts banks that are heavily reliant on these deposits in a disadvantageous position relative to banks which are less reliant on household deposits. As a consequence, we may expect that high deposit banks are less willing or able to decrease their loan rates (and may even be inclined to increase them). Figure 13 checks this hypothesis for the German banks by looking at weighted average bank lending rates of all quintiles of the distribution of their household deposit share over time. There is no 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 start lending less or even contract their loan book. 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 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 have, if anything, risen. But this is not different from the earlier period of interest rate reductions in 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 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.

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

5. Other transmission channels

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, Gambacorta and Hofman (2017) find a positive relationship between the short-term

rate and bank profitability (as measures 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. However, Altavilla, Boucinha and Peydró (2017) find that low monetary policy rates and a reduced slope of the yield curve are associated with lower bank profits only if there are important variables such as the expected macroeconomic developments and forward-looking credit risk omitted. İf 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.

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 in a positive rate environment an unexpected decrease in policy rates raises bank equity very much like in the publication by English, Van den Heuvel and Zakrajsek (2014). In a low and negative rate environments this effect is however reversed. Further interest rate cuts at already low rates lead to lower bank equity. 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. However, 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).

Arseneau (2017) argues that the effect of negative rates on banks would depend on the bank business type. His results, based on bank expectations, show that banks primarily active in lending (liquidity provision to borrowers) expect to lose from negative rates through a

squeeze in lending rates. However, banks focused on deposits expect to gain due to the reduction in funding costs. Buchholz, Schmidt and Tonzer (2017) 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. Similarly, Albertazziet al. (2017) find that lending increases more strongly for banks more dependent on deposit funding.

Altavilla et al. (2017a) also shed light on the question of the overall effect of the easing measures by the ECB including the NIRP on euro area banks' profitability disentangling several channels (Figure 16). They find that the total effect of monetary policy measures taken over the NIRP period on euro area banks' return on assets over the period 2014-2017 is broadly neutral as positive and negative effects cancel out each other. Figure 13 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. But 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.

In assessing the overall effects of the NIRP it is therefore important to also 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 future expected short rates. As a result the forward rate 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. This is confirmed by

event studies that show that a cut in the DFR into negative territory had a comparatively larger effect on expected interest rates at the 2 to 4 year horizon.

Such stronger signalling effects may in turn lead to larger effects on the exchange rate. 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.

5. Conclusions

[To be done]

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: Estimated pass-through coefficient from DFR to bank loans rates

Loan rates	**Pre-NIRP**	**NIRP**
Coefficient (DFR)	0.7542	0.8203
Standard Error (cluster robust)	0.0445	0.2473
R-squared (overall)	0.3311	0.0078

Figures

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

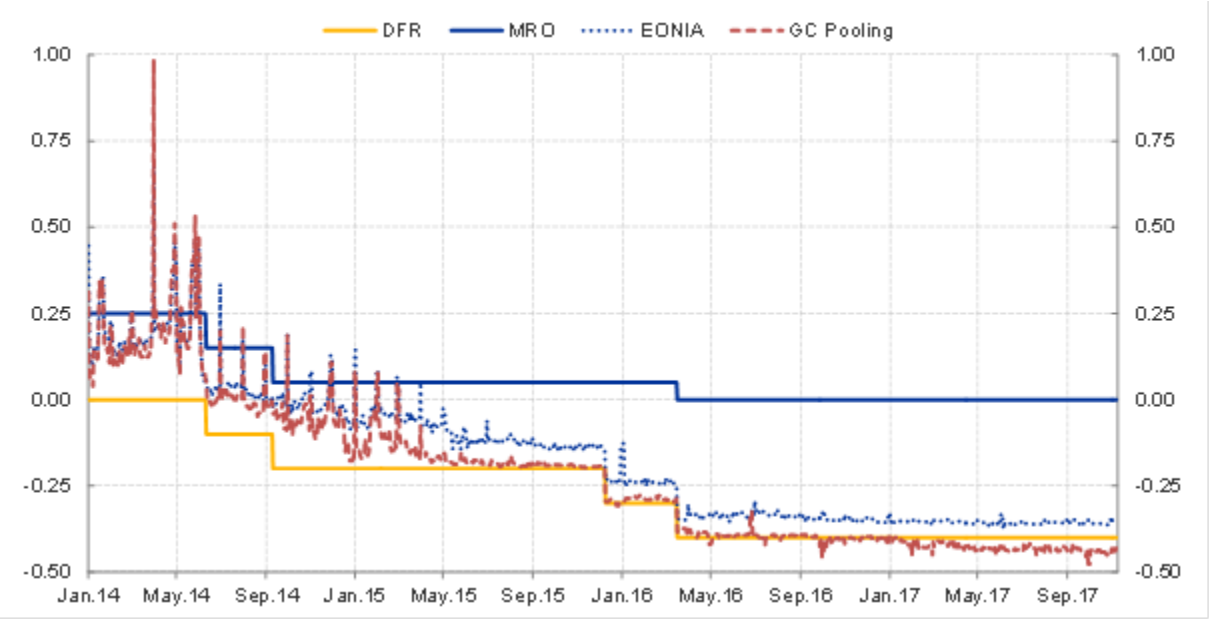


Figure 2: EONIA reaction to policy rate changes in the first maintenance period after the rate change

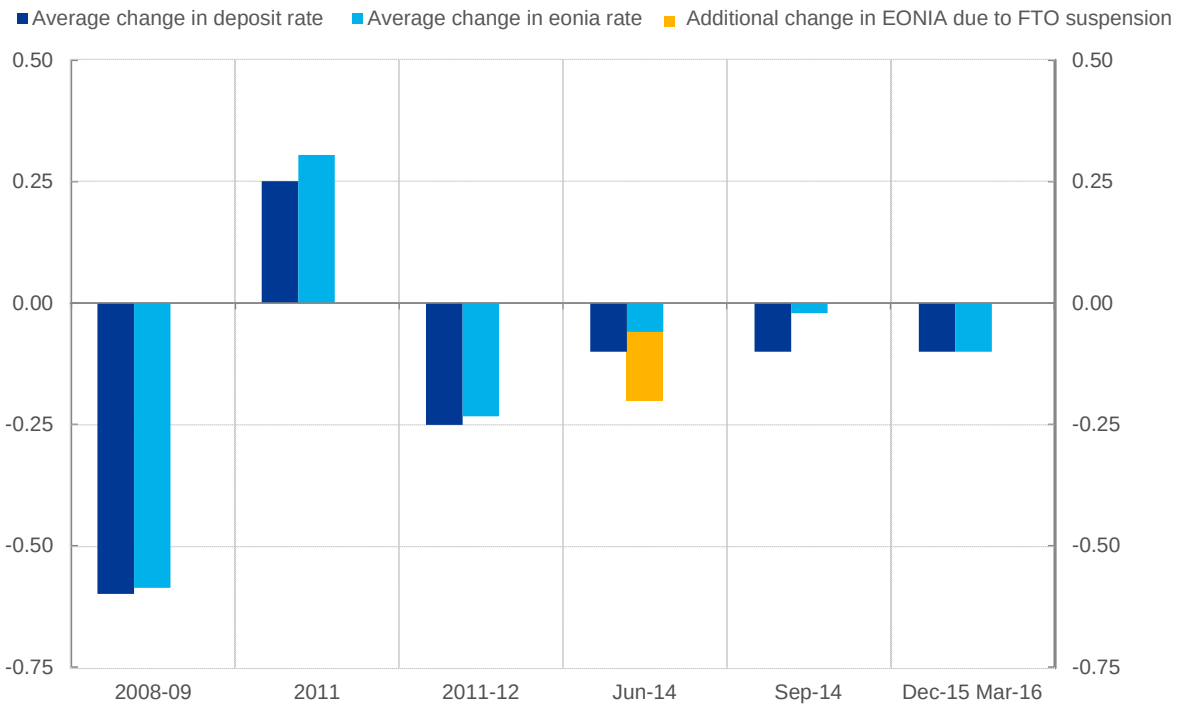


Figure 3: The term structure of risk-free rates

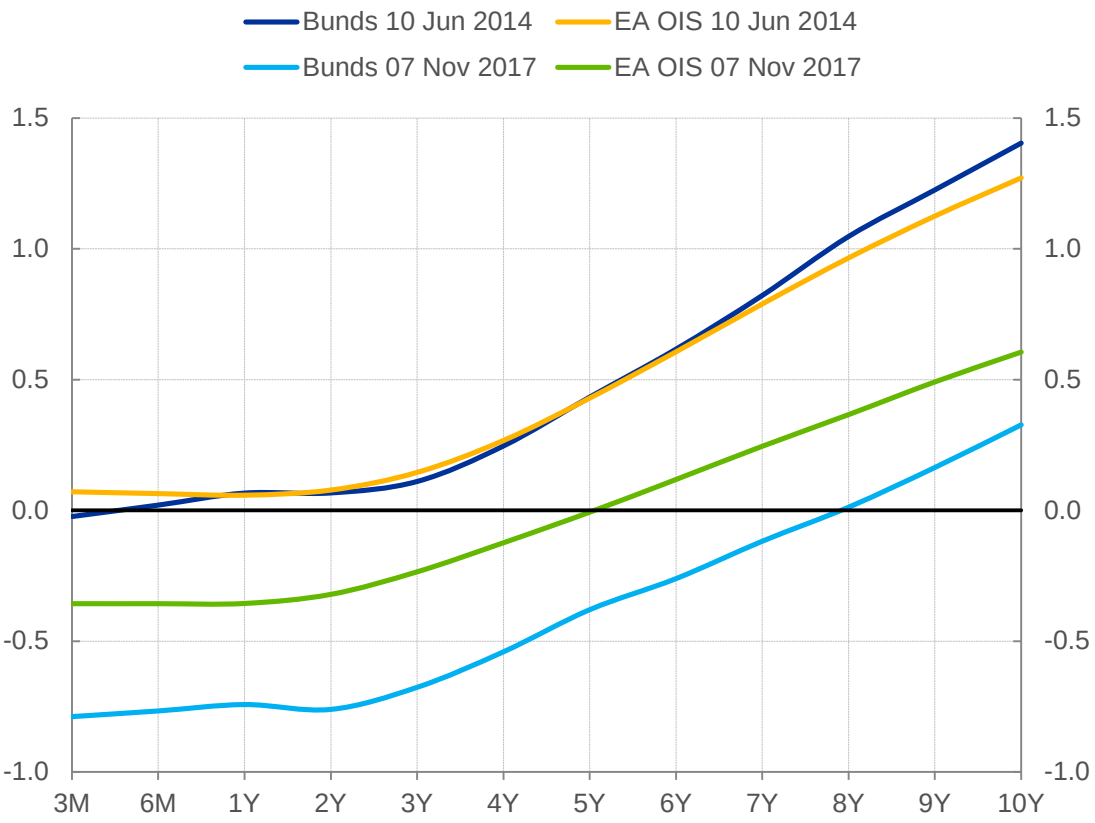


Figure 4: The term structure of AAA-rated government bonds (zero coupon)

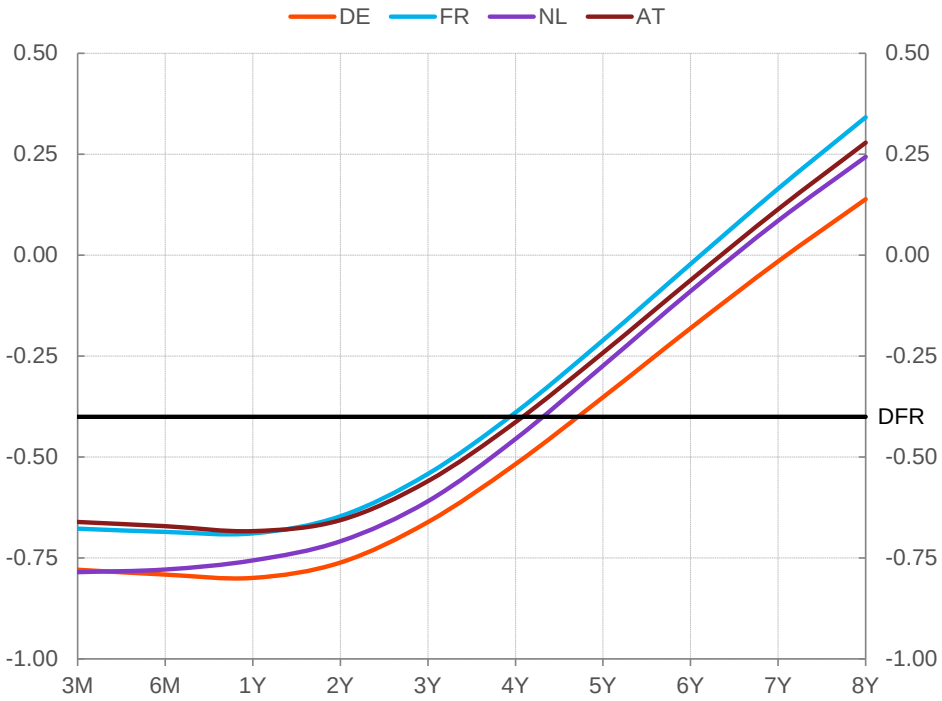
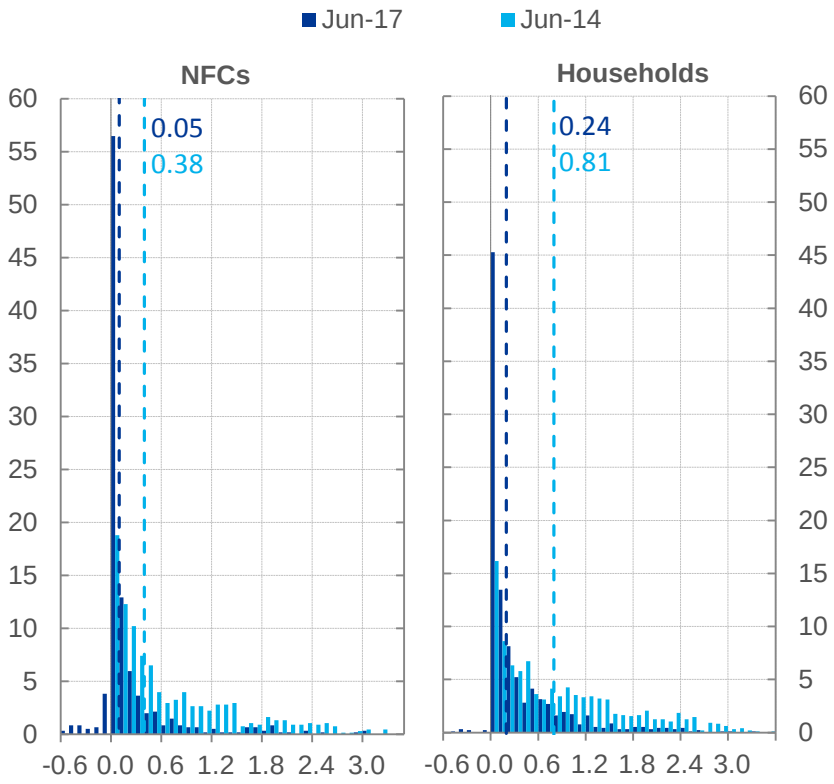


Figure 5: Distribution of the remuneration of household and NFC deposits across banks in the euro area



Source: ECB, dashed lines represent mean of distribution

Figure 6: Share of deposits remunerated below zero

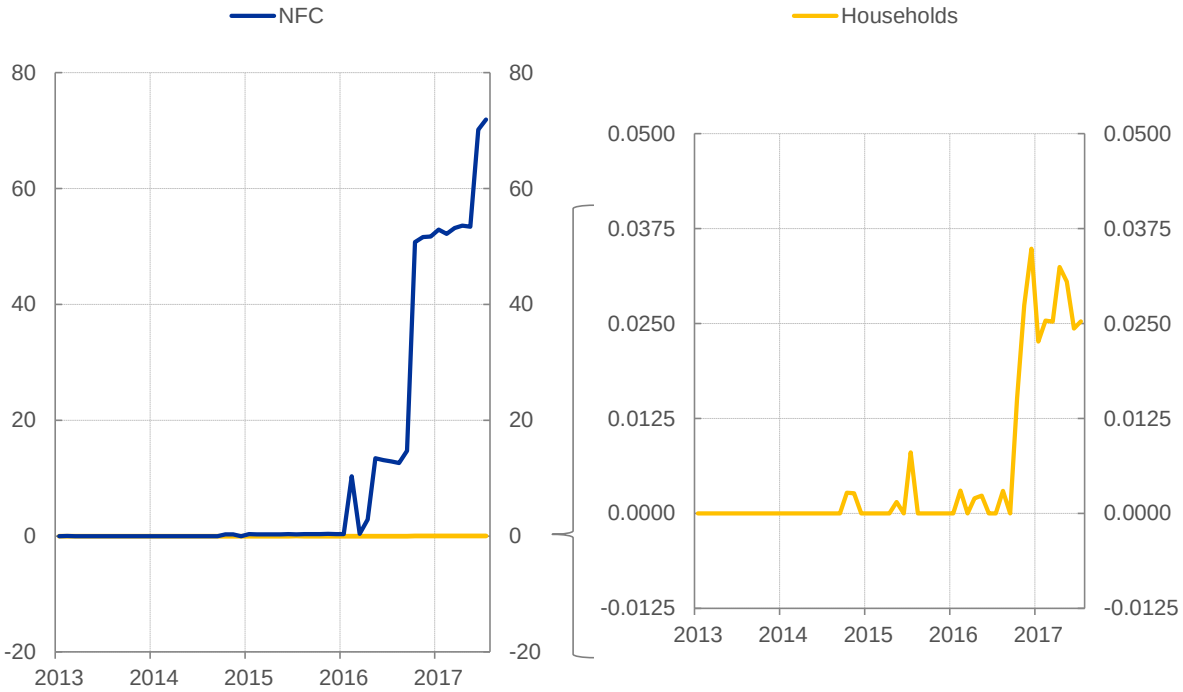


Figure 7: Evolution of household deposits and wholesale funding, as shares of total liabilities, in the Euro Area since August 2007

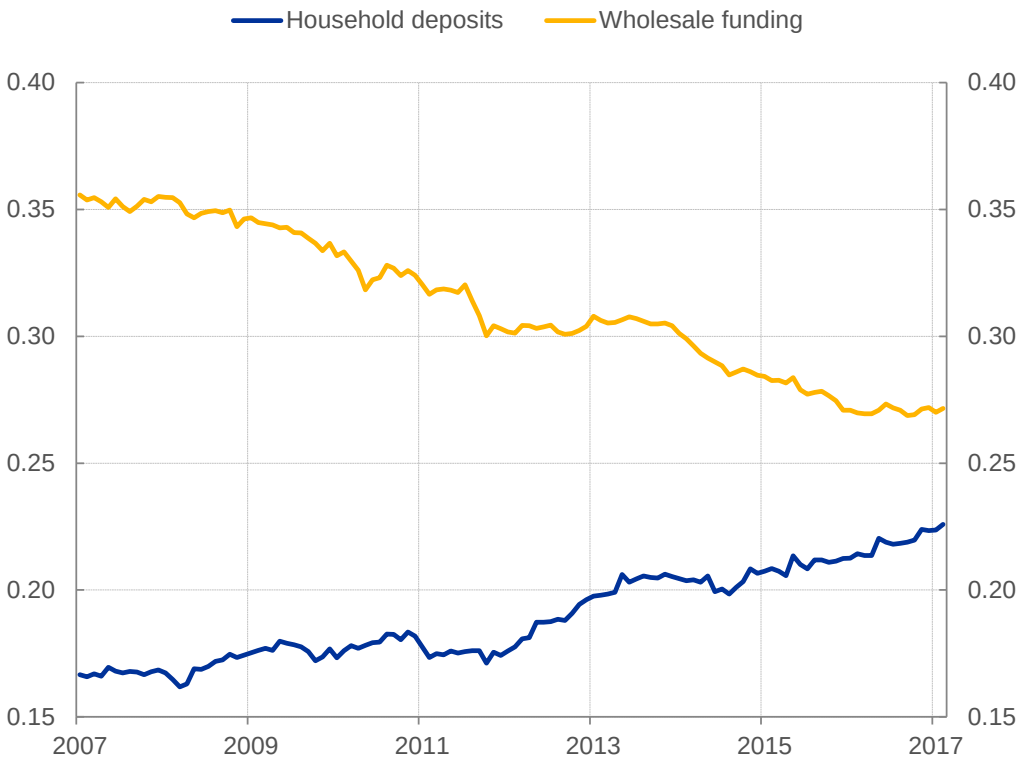
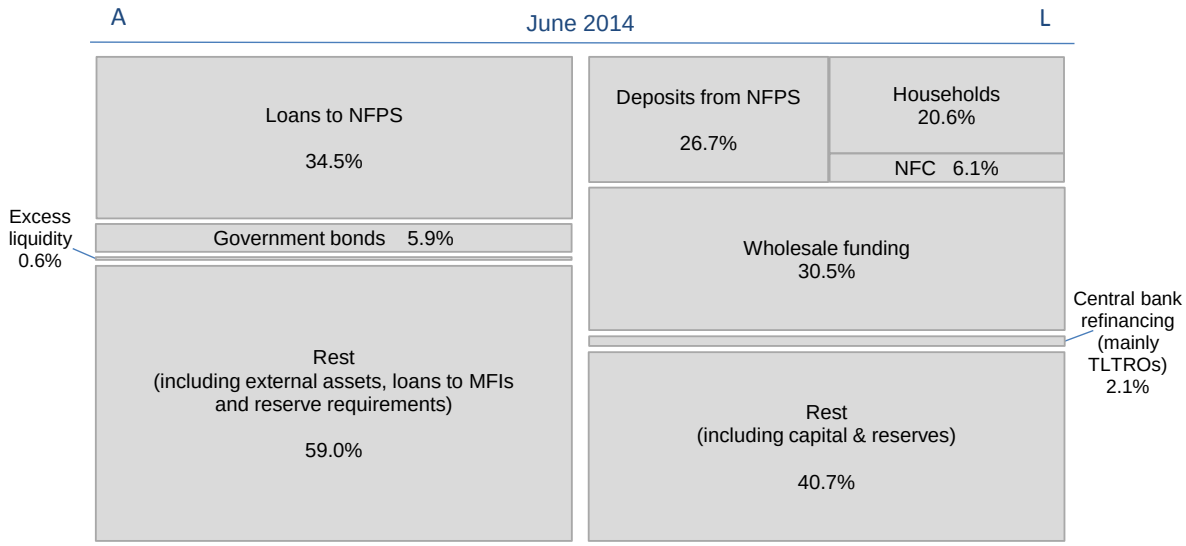


Figure 8: Total euro area bank balance sheet



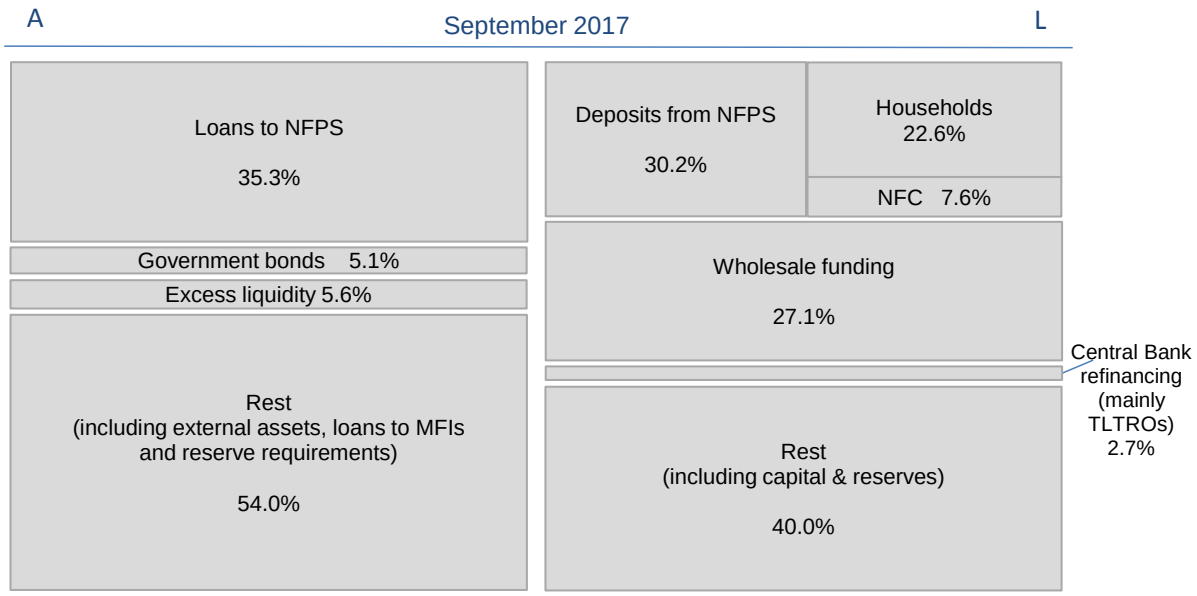


Figure 9: Share of household and NFC loans fixed at short- and long-term, as of June 2017

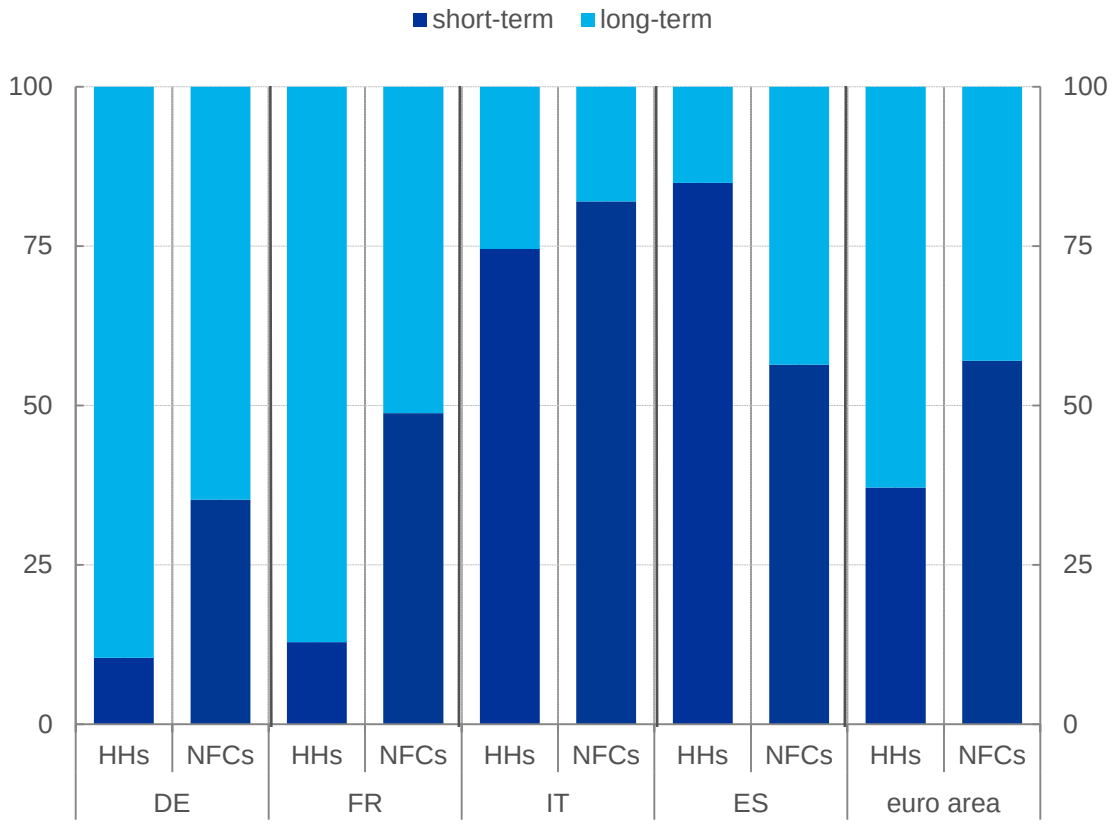


Figure 10: Distribution of share of retail deposits in the balance sheet, all banks excluding Greece and Cyprus

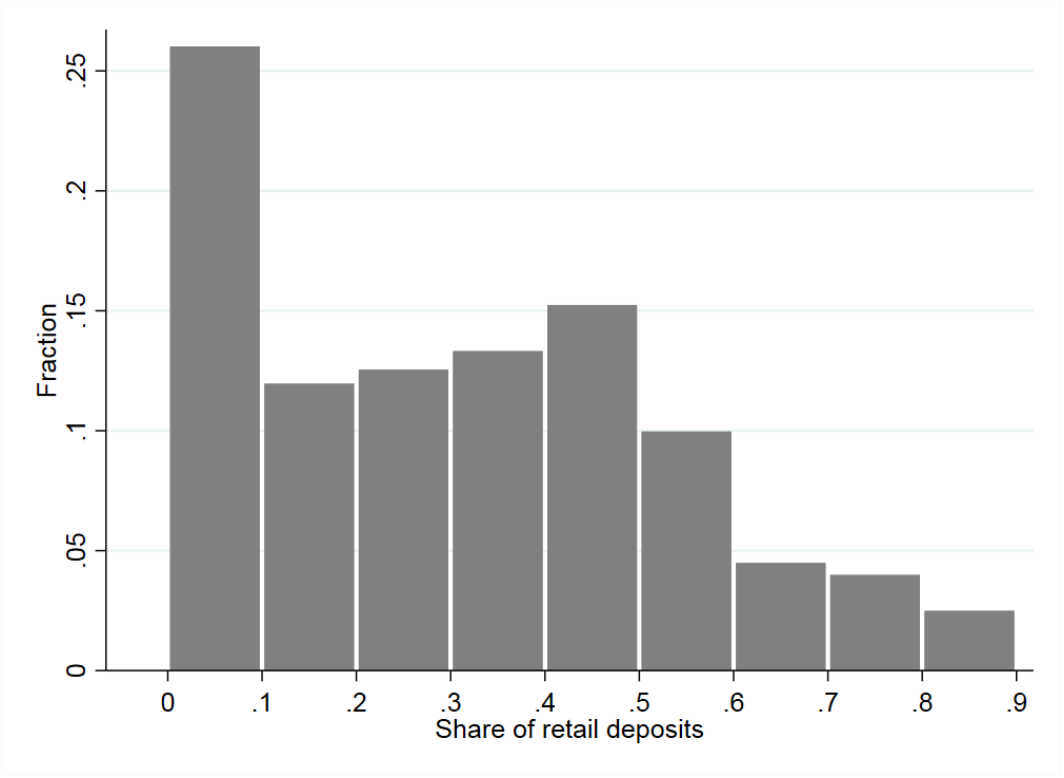


Figure 11: Distribution of share of excess liquidity, all banks excluding Greece, Cyprus and high EL banks

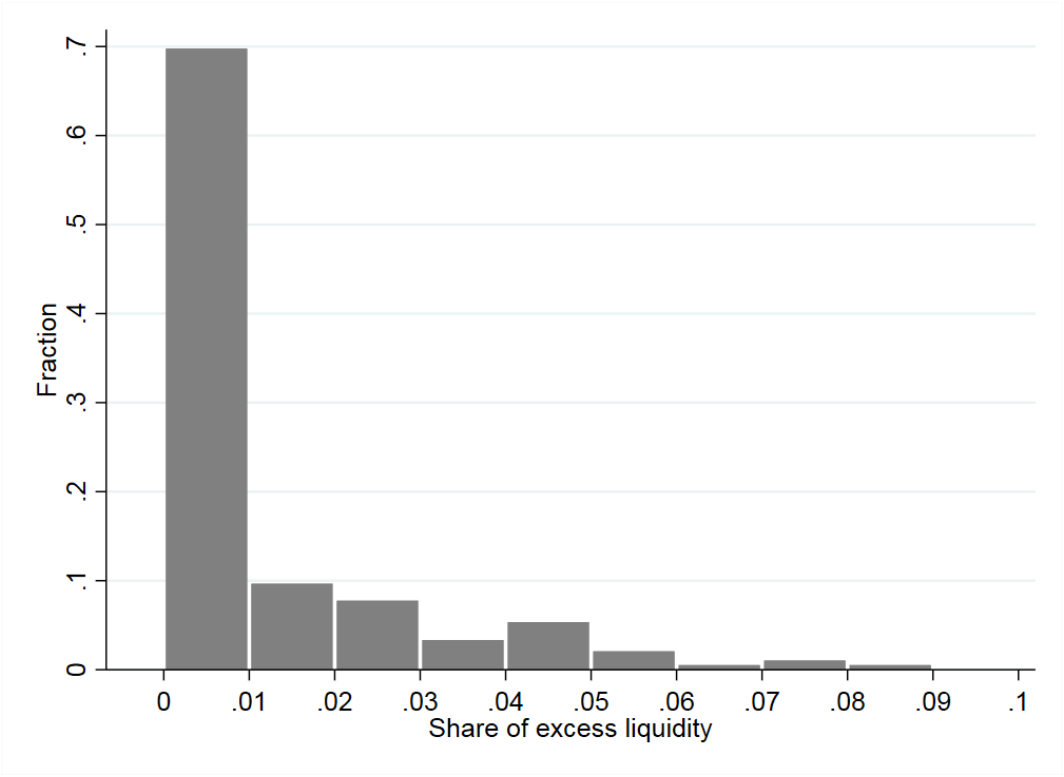
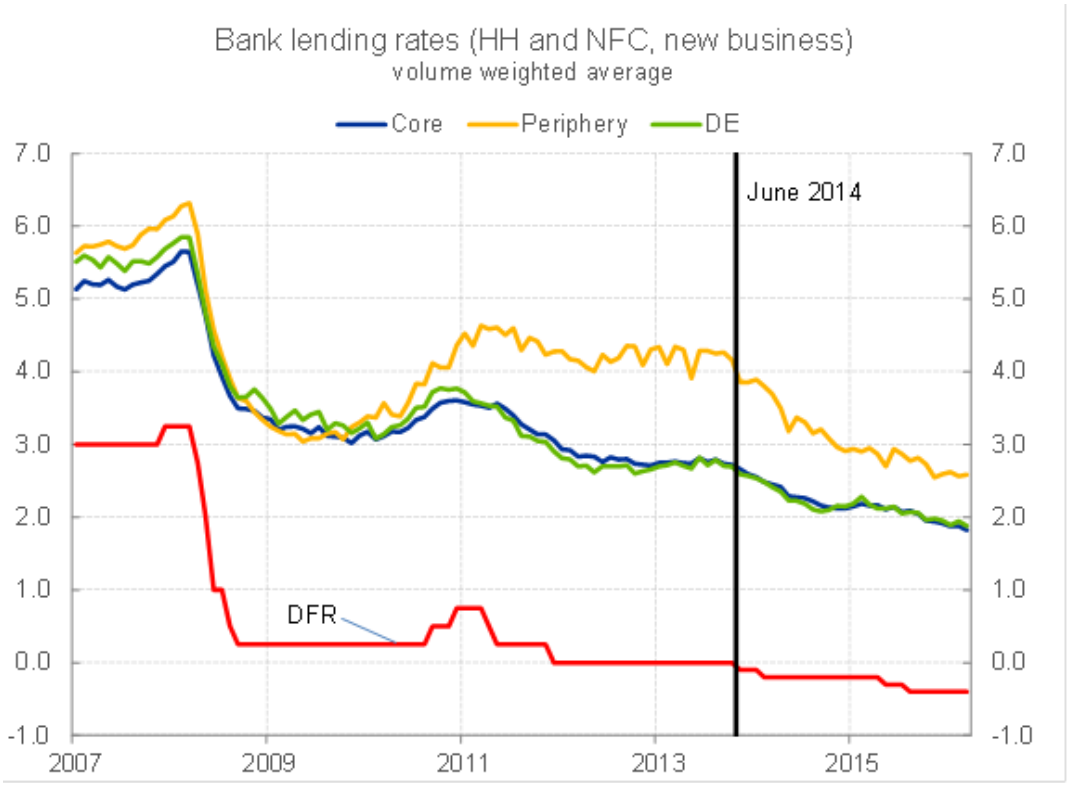
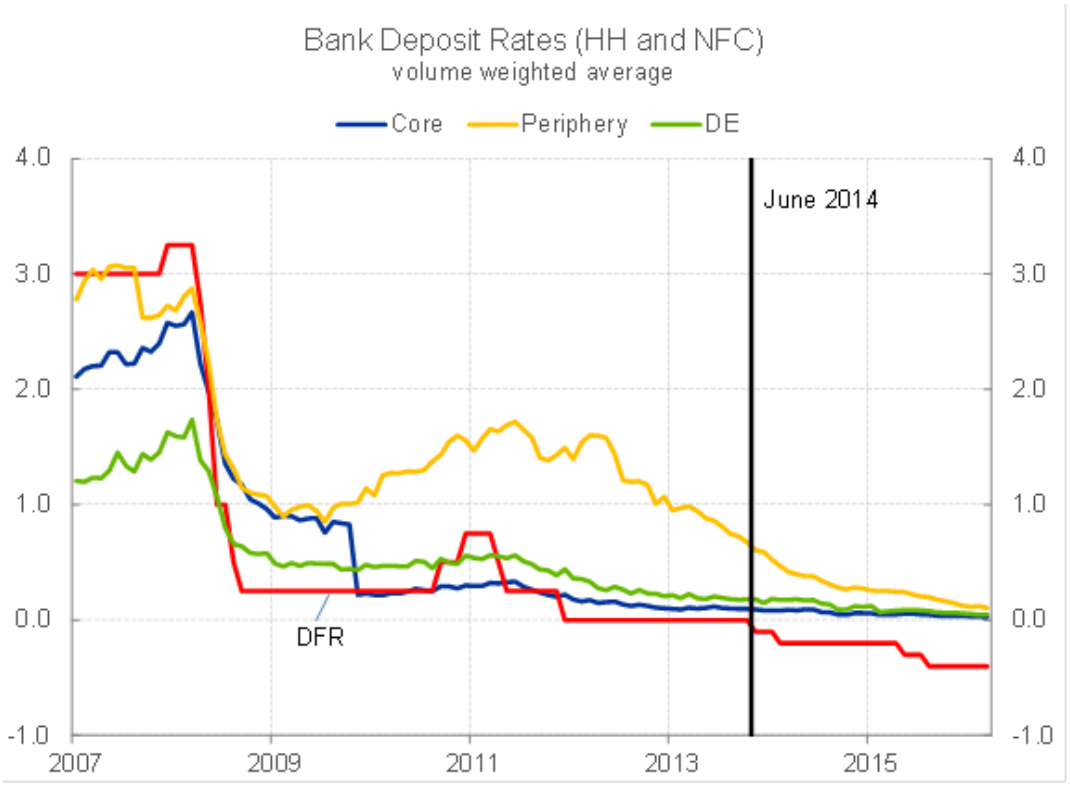
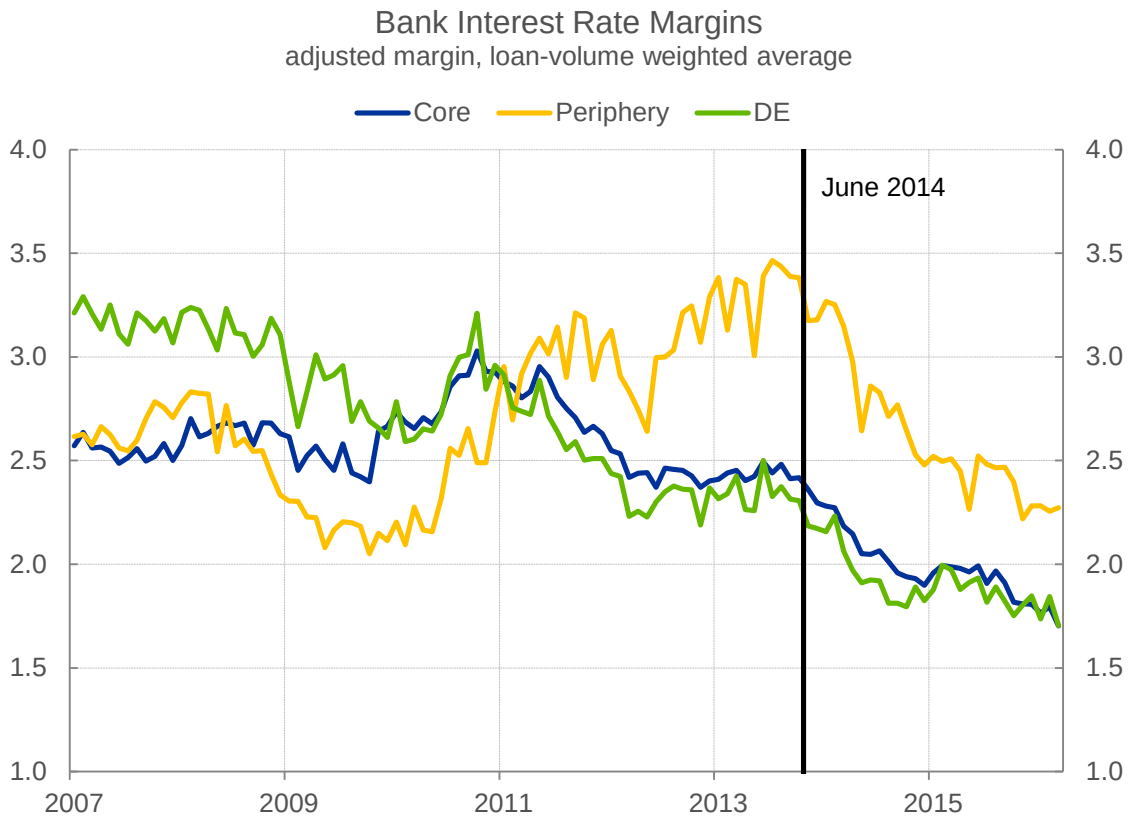


Figure 12: Bank lending rates, bank deposit rates and interest rate margins in core and periphery countries

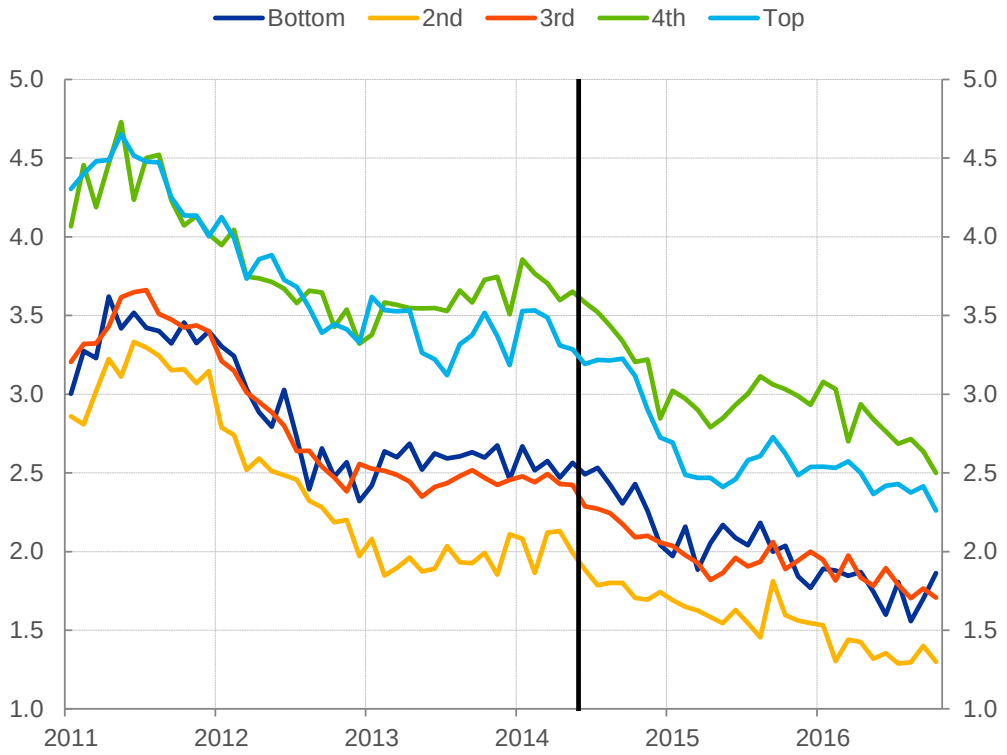






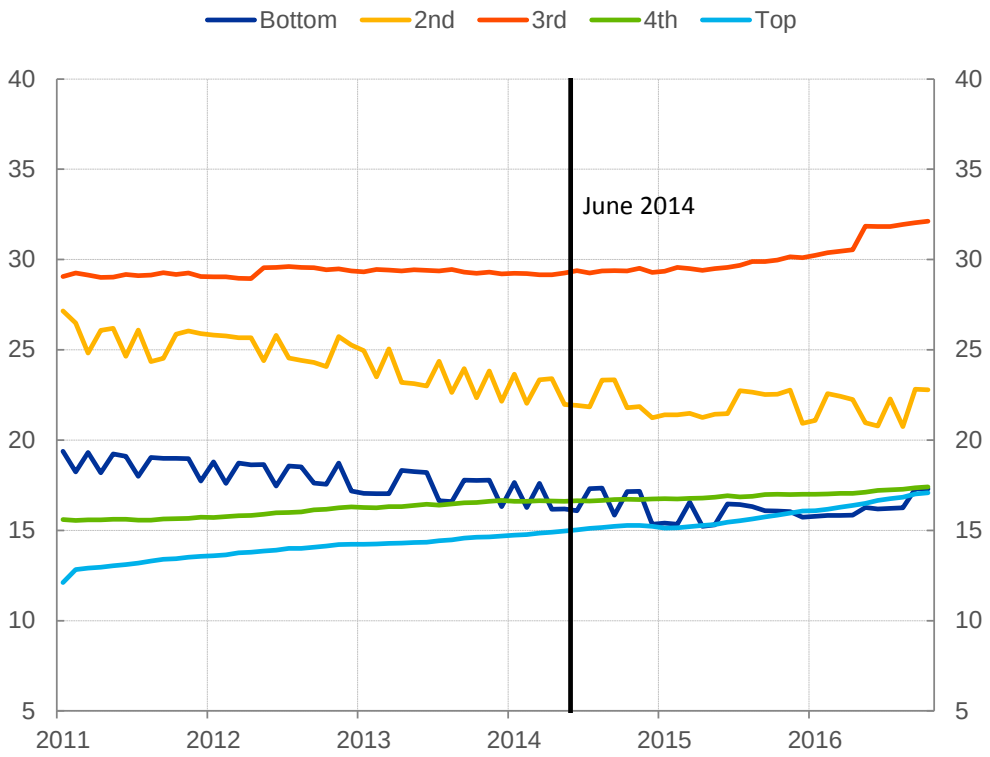
Notes: Core countries include AT, BE, DE, EE, FI, FR, LU, LV, MT, NL and SK. Periphery countries include ES, IE, IT, PT and SI, whereas banks from Greece and Cyprus are excluded. Lending and deposit rates are weighted by their respective loan or deposit volumes. Margins are weighted by the respective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

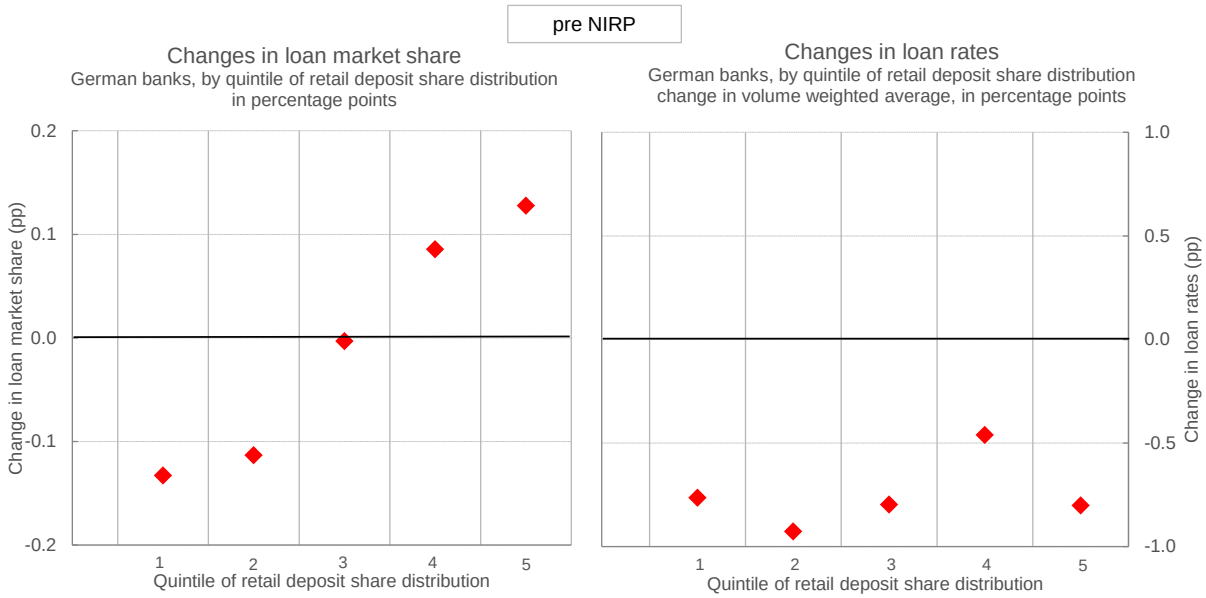
Figure 14: Bank lending volumes in Germany by retail deposit share quintile (mean, in EUR bn)



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

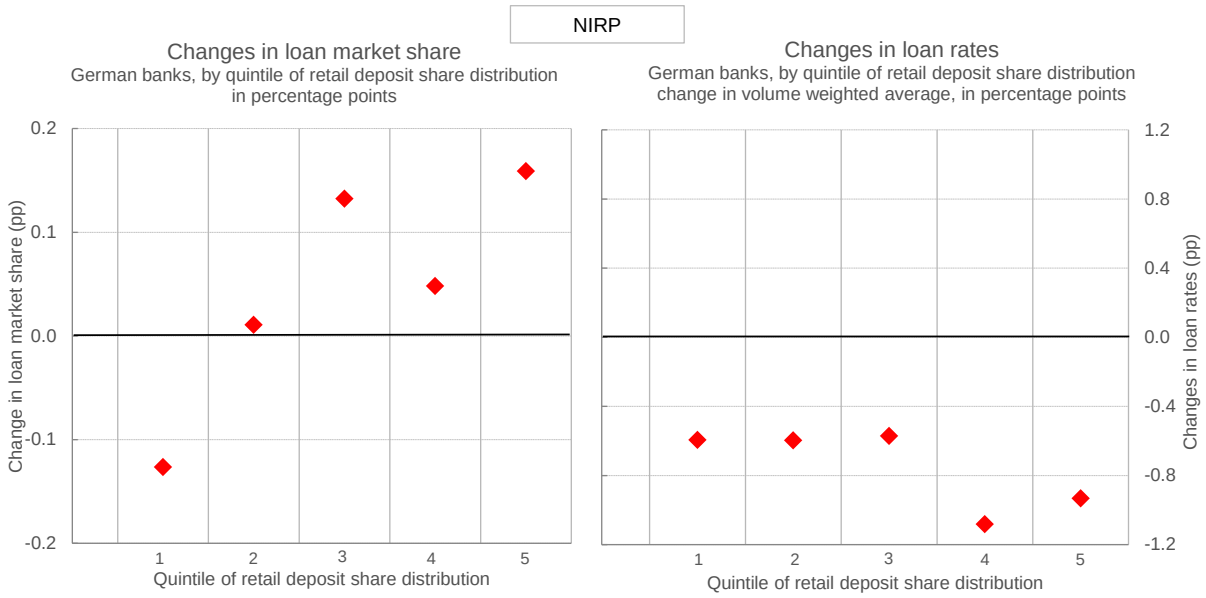


Figure 16: Decomposition of the impact of monetary easing on bank return on assets.

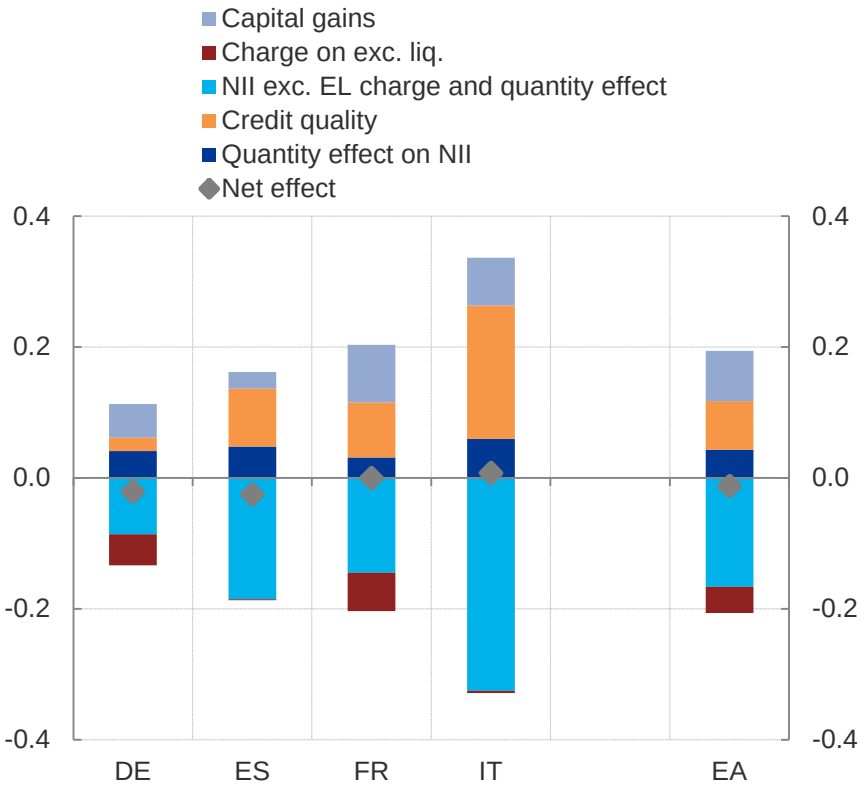
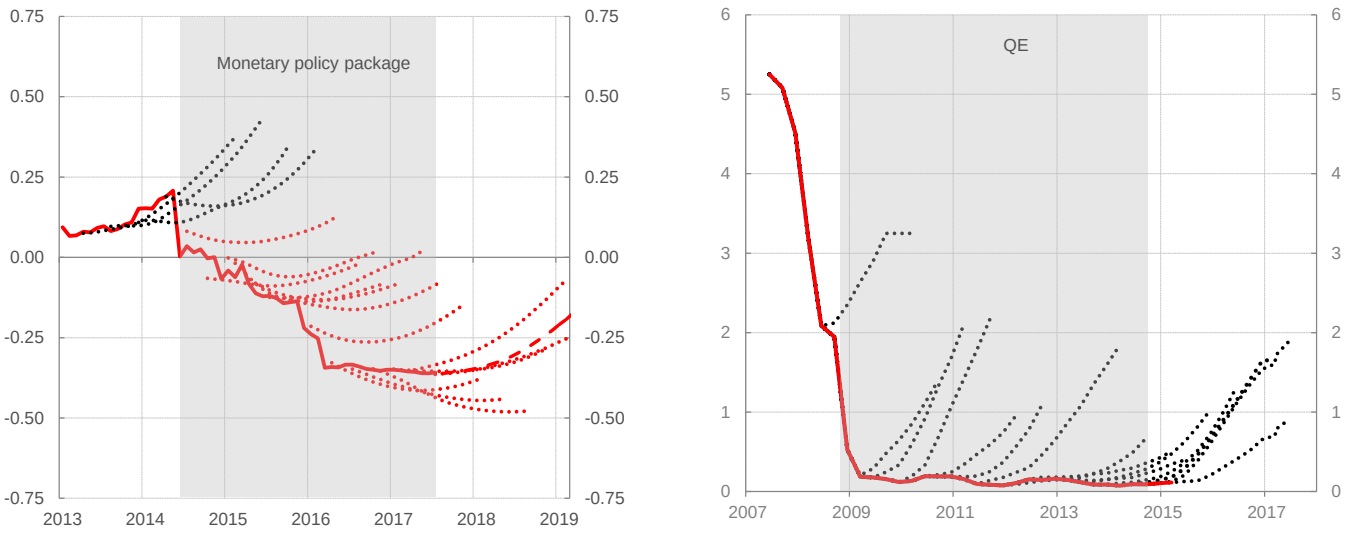


Figure 17: Forward curves during periods of non-conventional monetary policy (with and without NIRP)



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