Preliminary and incomplete

The impact of negative interest rates on bank balance sheets: Evidence from the euro area

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Abstract

In June 2014 the ECB became the first major central bank to lower one of its key policy rates to negative territory. The theoretical and empirical literature on the role of banks in monetary policy transmission is silent on whether their reaction would be different when the policy rate is lowered to negative levels compared to a standard reaction to a rate cut. In this paper we examine this question empirically by using individual bank data for the euro area to identify possible adjustments by banks triggered by the introduction of negative interest rates through three channels: government bond holdings, bank lending, and wholesale funding. We find evidence that there is a significant portfolio adjustment during the negative interest rate period, as banks tend to hold more non-domestic bonds, extend more loans and rely less on wholesale funding. This reaction is driven by banks in less vulnerable countries and in particular by those that have high excess liquidity.

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

JEL Classifications: E43, E52, G11, G21

[1] The views expressed are those of the authors and do not necessarily reflect those of the ECB.

1. Introduction

Until the onset of the financial crisis, credit institutions in the euro area did not systematically hold more reserves than needed to meet their legal requirements. Banks were able to rely on a well-functioning, liquid interbank money market to which they could turn in the event of a liquidity shock. Small remaining frictions (e.g. operating windows of payments systems being wider than money market trading windows) would occasionally lead to end-of-day recourse to either the deposit or the marginal lending facility, but overall monetary policy was implemented under neutral liquidity conditions (i.e. reserve holdings above the minimum reserve requirements – so-called “excess liquidity” – were zero).

At the peak of the crisis in October 2008, the ECB implemented its “Fixed Rate Tenders with Full Allotment” policy (FRFA) with which it provided all banks with as much liquidity as they demanded. Excess liquidity started to build up in the system, as banks in the aggregate borrowed more funds than they needed (for precautionary reasons as well as due to lack of market access). Excess liquidity became a salient feature of Eurosystem monetary policy implementation, with fluctuations in it mainly driven by the degree of prevailing financial market stress and money market fragmentation.[2]

A turning point in this framework was the decision by the ECB to cut the deposit facility rate to negative territory in June 2014.[3] This policy action was motivated by the aim to provide further monetary easing to the economy by lowering a large range of interest rates, many of which into negative territory. This policy change also implied that banks would start to pay a charge for their excess liquidity holdings while many banks would likely find

[2] More recently, the introduction of the expanded asset purchase programme by the ECB, under which it is acquiring large amounts of assets from the market, has meant that the amount of excess liquidity in the system is primarily determined by the pace of these purchases, see Section 2.
[3] This follows 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).

themselves unable to pass this charge on to their customers.[4] Individual banks may therefore engage in efforts to minimise this charge by reducing their excess liquidity holdings through balance sheet adjustments. These adjustments, in turn, are likely to empower the easing effect that the reduction in interest rates would have on the economy.

The focus of this paper is to examine whether the introduction of negative policy rates precipitated a change in banks' behaviour, compared to a standard reaction to a reduction in policy rates. We use individual bank balance sheet information available at a monthly frequency from a confidential dataset collected for the compilation of aggregate monetary statistics. We match this data with banks' excess liquidity positions with the ECB and add further control variables. Results based on panel, fixed-effect regressions suggest that the reaction of banks to the negative interest rate environment depends on whether or not they reside in countries having experienced some form of financial stress during the financial crisis, past or present. We call these countries vulnerable countries.[5] Banks resident in non-stressed (less-vulnerable henceforth) countries tend to react to the negative interest rate on the deposit facility by increasing their non-domestic government bond holdings, by increasing their loan book and by reducing their wholesale funding.[6] Moreover, the reaction depends on whether a bank is listed or not. We find that non-listed banks tend to adjust by increasing bond holdings whereas listed banks tend to extend more loans. Meanwhile both types of banks tend to decrease their wholesale borrowing.

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[4] An often cited example is that the rate applicable to retail deposits is, for a variety of reasons, floored at zero in many countries, see Section 2 below for a more detailed discussion.

[5] Throughout this paper "vulnerable countries" refers to Ireland, Greece, Spain, Italy, Cyprus, Portugal and Slovenia, while the term "less-vulnerable countries" refers to the remaining euro area countries.

[6] This finding is likely driven by the fact that excess liquidity is concentrated in banks residing in less-vulnerable countries that this concentration in turn is driven by structural factors, leading to high involuntary holdings of excess liquidity by these banks.

The next section of the paper provides a brief account of the introduction of negative policy rates in the euro area and the impact it had on money market rates. Section 3 offers a conceptual discussion of why bank adjustments to monetary policy rate changes may be different when policy rates are in negative territory and what these adjustments to bank balance sheets are likely to be. Section 4 describes our empirical approach and reports our results, while Section 5 concludes.

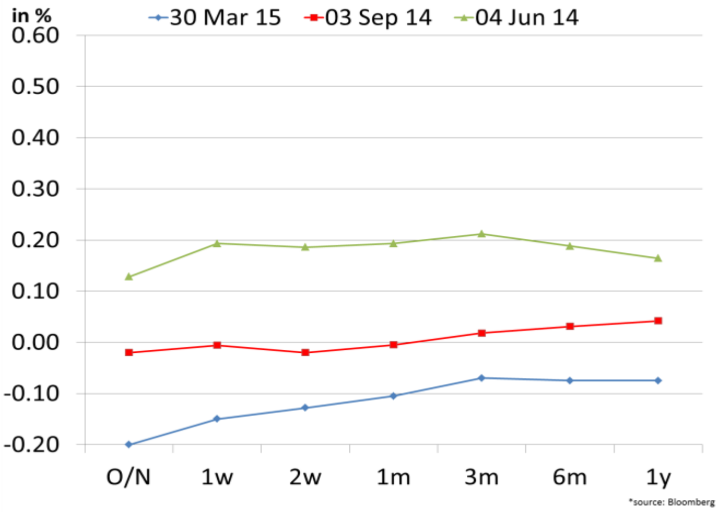
2. The introduction of a negative policy rate in the euro area

The remuneration of recourses to the deposit facility was first cut to negative territory on 5 June 2014 (from 0% to -0.10%) and subsequently cut further to -0.20% on 4 September 2014. To render the rate cut effective, the negative rate is not only applied to recourses to the deposit facility but also 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 to (at least) -0.20%.

The first rate cut in June 2014, while effective in terms of pass-through due to the simultaneous release of additional excess liquidity,[7] was not sufficient to lower short-term money market rates persistently below zero, e.g. EONIA stayed above zero most of the time, while repo rates (which are typically lower) only moved consistently into negative territory following the September rate cut (red line in Chart 1) and the start of the Asset Purchase Programme (APP, blue line in Chart 1) in March 2015.

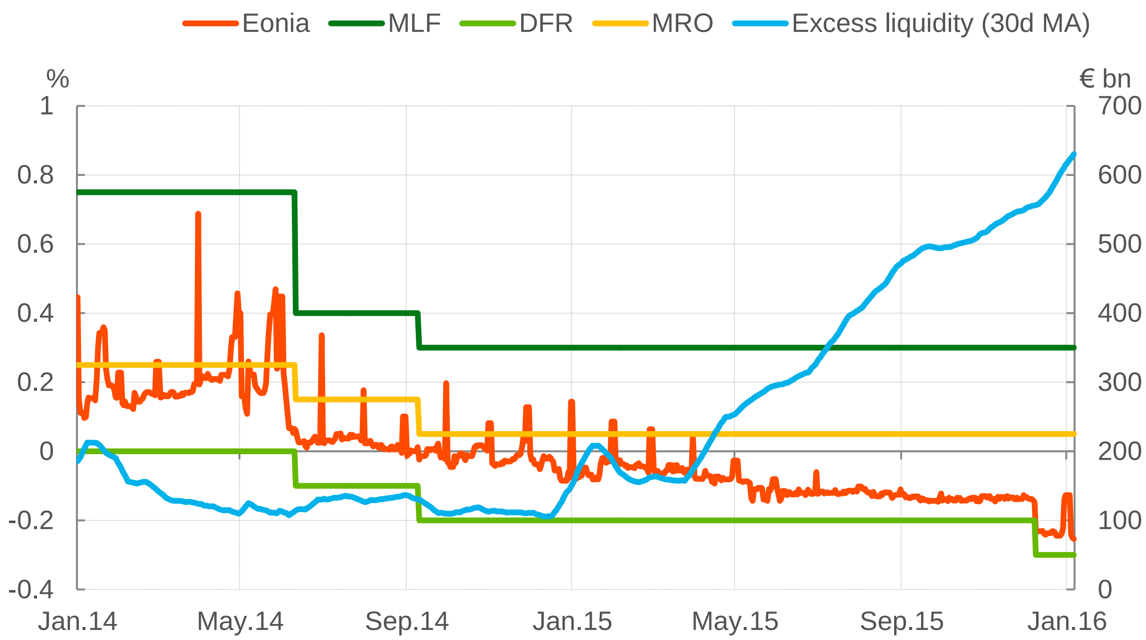
[7] On 5 June 2014 the ECB decided to discontinue the weekly sterilisation of the liquidity injected through purchases under the Securities Markets Programme (SMP). This led to in increase of excess liquidity of around EUR 170 billion, which contributed to the lowering of EONIA in the maintenance periods following the decision of 5 June.

Chart 1: Repo curve (GC Pooling) on several key dates



The pass-through of the September rate cut was initially incomplete as parts of the banking sector tried to avoid negative rates in a variety of ways (e.g. through increasing working balances at clearing houses etc.) and it was not until May 2015 – with significant volumes of additional excess liquidity in the market – that the pass-through of the September rate cut to EONIA rates could be considered complete (Chart 2 below).

Chart 2: EONIA within the interest rate corridor and excess liquidity since January 2014



Liquidity provision through the APP (as opposed to refinancing operations) is likely to be qualitatively different in its impact on money market rates and bank balance sheets. First, the implementation of the APP since March 2015 with monthly purchases of 60 billion euro implies a significant increase in (aggregate) excess liquidity that is almost deterministic in nature and can be expected to lead to a peak in excess of around 1.1 trillion by September 2016 (the originally announced end date of purchases). This number, in conjunction with the negative rate on the deposit facility, implies that euro area banks face a peak annual charge of around two billion euros (which many banks may not be able to pass on to their customers). All else equal, this situation (and its predictability) should have led banks to intensify their deliberations on possible strategies to mitigate the expected impact on their balance sheet (we will return to that specific point in the econometric analysis). Second, due to market structure, APP flows are heavily concentrated (e.g. the Eurosystem is often purchasing the bonds from banks specialised in brokerage services), bringing further changes to the way excess liquidity is distributed at the bank as well as the country level. Typically, excess liquidity is concentrated in less-vulnerable countries, e.g. the share of excess liquidity held in these countries never fell below 85% during the crisis. The APP has reinforced that tendency with the excess liquidity share being held in these countries further rising and now exceeding 90%. Again, given its economic implications and in particular its predictability, the process of reserve built-up at specific banks should be expected to trigger some adjustment specific to that group of banks (again, we will return to this point in the econometric analysis). This concentration of excess liquidity in less-vulnerable countries underlines our results where we find a significant adjustment in bank behaviour in these countries.

Finally, it is interesting to note that any extension of the APP as well as any further cut in the rate of the deposit facility should serve to strengthen the effect of the negative rate on banks' balance sheets as it increases the costs for banks. For example, the package announced on 3 December 2015 (10 bps cut in the deposit facility, APP extension by 6 months until March 2017) has increased the peak annual excess liquidity charge by 1.5 billion euros. Moreover, it has increased the expected duration of excess liquidity in the market by almost a year, contributing to significantly higher expected costs for banks who end up holding excess liquidity.

3. Conceptual considerations regarding bank adjustment to negative interest rates

Banks are important for the transmission of monetary policy impulses to the economy, especially for bank-centred financial systems such as the one in the euro area. Changes in monetary policy rates trigger reactions in bank behaviour, which are typically analysed in the literature in the framework of two channels: the broad credit channel and the risk-taking channel.

The broad credit channel relies on the existence of informational frictions in the market for external finance, which gives rise to an external finance premium. A lowering of monetary policy rates in this context boosts the net worth of banks, thereby reducing the external finance premium they are facing and allowing them to access more external funds and expand their balance sheet. Meanwhile, the same mechanism – dubbed the 'financial accelerator' – lifts the value of the collateral that borrowers can offer, thereby increasing the amounts of loans that banks are willing to lend out and lowering the associated costs (Bernanke and Gertler, 1989; Bernanke and Gertler 1995, Kiyotaki and Moore, 1997). The combined effect is an increase in bank lending.

The risk-taking channel amplifies the effects that changes in monetary policy rates have on bank behaviour via the financial accelerator mechanism, by emphasising the role of risk perceptions and risk tolerance (Borio and Zhu, 2008; Adrian and Shin, 2009). The increase in asset prices and collateral values prompted by lower monetary 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, one objective of quantitative easing policies is considered to be promoting risk taking by encouraging lenders to invest in riskier assets when the returns on safer assets decline (see Aramonte et al., 2015).

Historically, a third line of literature investigates the effects of liquidity creation on other assets through portfolio adjustments. Friedman and Schwartz (1963) note that creation of excess liquidity prompts banks to increase their holdings of securities and loans. Tobin (1969) argues that a higher supply of bank reserves leads to adjustments in bank portfolios until the marginal return from holding alternative assets is equalized. This implies larger holdings of securities and more loan issuance until the rates of return on these assets decline to the return of holding reserves.

The theoretical and empirical literature on these channels refers to environments where policy rates are adjusted but remain in positive territory. It is therefore ex ante unclear whether these mechanisms carry over, or indeed are even amplified, in a context where policy interest rates are reduced to levels below zero.

Prima facie, negative policy interest rates are not special in the narrow sense that they are interest rates like any other. What matters for a financial intermediary is not the level of policy rates per se, but instead the spread between the interest rate it pays and the interest rate it earns for a unit of money it intermediates. This spread determines the interest income of the financial intermediary. The level of policy rates may have an impact on the spread that the financial intermediary can earn. For example, lower policy rates may lead to an overall flatter yield curve constellation, which typically lowers the spread an intermediary can earn by using short-term liabilities to fund long(er)-term assets. Negative policy rates could thus be associated with lower margins for the financial intermediary, but this effect would merely be an extension of a mechanism already at work with positive rates and the "specialness" of negative policy rates would mainly relate to their potential to additionally squeeze bank profits beyond the squeeze that would occur if policy rates were set to zero.[8]

The narrow spread perspective on the impact of negative policy rates on banks behaviour may not be fully sufficient to capture the full impact of negative policy rates on banks. In the presence of frictions, negative policy rates may have implications for banks that are not captured by simple changes to the spreads that banks can earn in financial markets. A case in point is the remuneration of retail deposits. For a variety of reasons[9], banks may be unable to charge negative rates to their retail depositors, while being significantly dependant on this funding source. Therefore, in the extreme, the interest rate spread that the bank can earn with (some of) its products may become very small or even negative. This situation may be further aggravated in the presence of excess liquidity, in particular if this excess liquidity is generated by retail deposits. Banks with excess liquidity will earn a negative return on this asset, which may, however, be funded by deposits that carry a zero interest rate. While this specific channel may not matter for small levels of excess liquidity, it may well become significant in a situation in which the central bank is committed to a policy of asset purchases which inevitably leads to increasing levels of excess liquidity which may end up to be very large. Furthermore, while moderately negative interest rates might cause additional

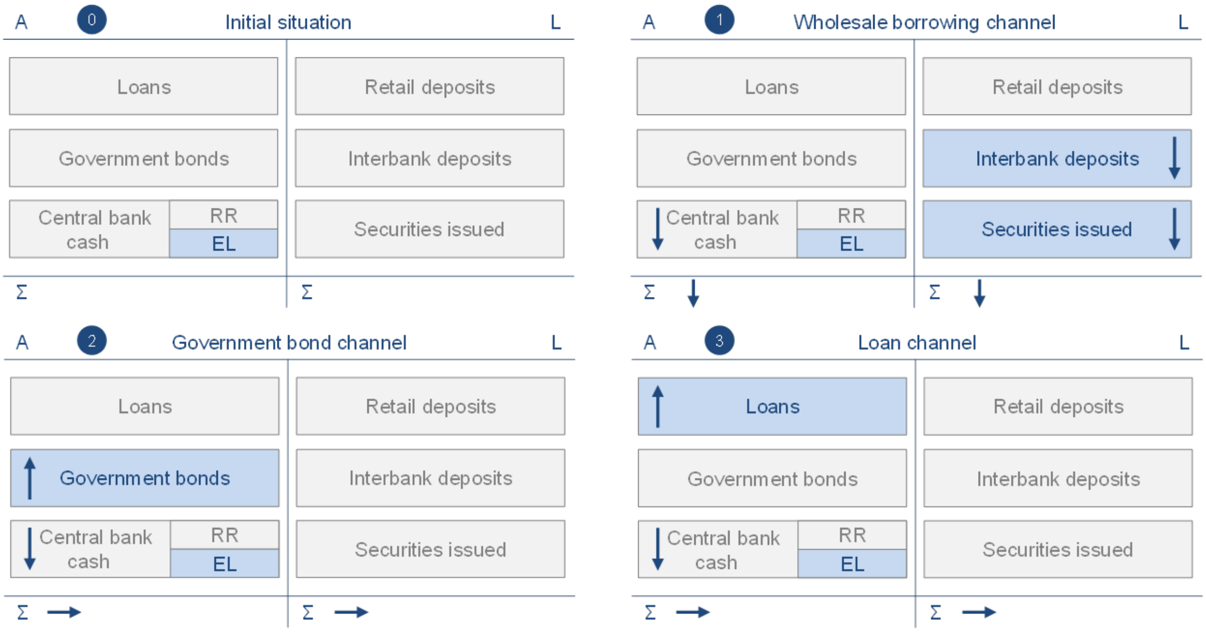
[8] For an overview of potential implications of negative rates for bank profitability as well as broader implications for the economy and financial stability, see Arteta and Stocker (2015) and McAndrews (2015).

[9] Examples often mentioned are legal constraints, inability to price discriminate among retail depositors and intense bank competition for highly-valued retail deposits.

adjustments in bank portfolios and thus enhance the monetary transmission mechanism, 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 (2016) who argue that below some level of the policy rate, further reductions can in fact be contractionary owing to the financial instability that they induce and the ensuing contractionary effects on bank lending. At the same time, these authors recognise that this threshold rate is not necessarily zero. Rognlie (2015) shows in a theoretical model that for an economy that is expected to be in a recession over the planning horizon, negative interest rates are beneficial and hence zero is not a lower bound for the central bank that wants to boost economic growth.

Another factor contributing to the "specialness" of negative rates could be internal rules (and similar institutional factors like legal provisions). For example, anecdotal evidence suggests that there are market participants who are prevented by internal rules from entering into trades that imply a loss on principal. Negative rates are a prime example for such a trade. Treasury desks at banks facing such restrictions would not be able to continue interacting in short-term money markets and would need to implement policies ensuring that they would not end the day (from a maintenance period perspective) with excess liquidity. Clearly, the prevalence of negative rates would likely trigger, over time, a change in these policies as they may prove too restrictive in a market environment in which the safest rates are below zero for maturities of up to 10 years. Other examples of possible institutional restrictions are the tax treatment of negative interest rate income (which is often not symmetric to the treatment of positive interest rate income, e.g. not tax deductible in Germany), generic provisions in national banking laws, leading to legal uncertainty (e.g. the Finnish banking law stipulating that a bank is expected to pay interest if it borrows and to receive interest if it lends), established practices in the formulation of financial contracts (such as money market funds, floating rate notes etc., see Witmer and Yang (2015)) and problems in adjusting IT systems to properly reflect negative interest rates. The plethora of possible frictions, many of them being bank specific, would let us to expect a more significant reaction to excess liquidity the more pervasive the holdings of it in any one country are.

Chart 3: Possible adjustment channels for banks to reduce their excess liquidity holdings



What are the strategies that banks could employ to reduce their exposure to excess liquidity or the spread compression through negative rates, or both? To answer this question, a look at a typical bank balance sheet is instructive (see Chart 3).

On its asset side this bank will have reserves, loans, and securities (e.g. sovereign debt holdings) refinanced with private sector deposits (from households, the corporate and institutional sector as well as from other banks), securities issued (e.g. covered bonds and unsecured bank bonds) and borrowing from the central bank (not shown in Chart 3). A large excess liquidity position of the bank reflects more reserves than the legal requirement, and is a direct expression of a so-called funding overhang: the bank has more funding available than what it needs for its core business. A funding overhang does not necessarily need to manifest itself in a large built-up in excess liquidity. Equally, the bank may increase its vault cash holdings or increase its securities holdings above the level that would be implied by its stock (and risk profile) of loans alone. The latter point hints at an important adjustment channel for banks when faced with a large (and costly) funding overhang: banks could simply buy (sovereign) bonds (lower left panel in Chart 3). Likewise, a bank can try to reduce its funding overhang by using the available funding to grant more loans (lower right panel). Adjustments on its liability side are another possibility to shrink the funding overhang. Simply by reducing its demand for refinancing (e.g. not rolling-over maturing bonds, repaying interbank loans and central bank funding) it can reduce a funding overhang (upper right panel).

There are two important caveats to any such strategy: banks cannot change aggregate excess liquidity (currently at least) and prudential regulation. Regarding the first, while any individual bank can have some hope that a strategy to reduce its funding overhang will be successful, it will not work for the system as a whole, i.e. some banks will inevitably end up with excess liquidity holdings as there is no escape from aggregate excess liquidity to be held by the banking sector.[10] The system as a whole can only actively reduce excess liquidity by repaying borrowing from the Eurosystem or by acquiring banknotes. Balance sheet adjustments involving the acquisition of assets or the repayment of other liabilities merely redistribute excess liquidity from one bank to another but do not reduce it in aggregate terms. Regarding the second, the impact of prudential regulation, it suffices to note that a multitude of regulations govern the possible evolution of a banks' balance sheet (e.g. capital needed for loans, liquidity regulations constraining the funding strategy and leverage ratios limiting the balance sheet size). For example, a bank may want to increase its holdings of government bonds to decrease its excess liquidity holdings but may be barred from doing so by its

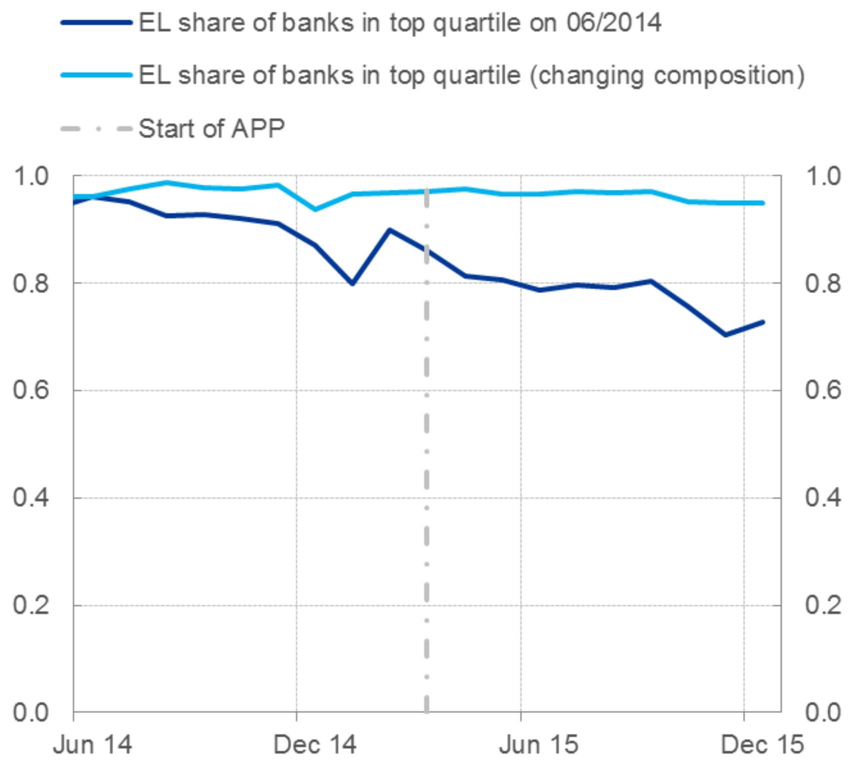
[10] This statement is true if banks holding excess liquidity are diffferent from the ones having borrowed from the central bank, which is a good approximation of the situation in the euro area. Furthermore, after the introduction of APP this statetement is always true. Excess liquidity circulates within the closed system of the banks that are counterparties to Eurosystem operations.

regulator who considers the exposure of the banks to the sovereign as too high. Regulation can thus be considered as an additional constraint on banks' attempts to manage their funding overhang (see Bonner (2016) for the example of government bonds).

The distribution of excess liquidity at the bank level is heavily skewed. There are many banks with zero or almost zero excess liquidity holdings and most excess liquidity is held by a relatively small number of banks.[11] The top quartile of banks' excess liquidity holdings accounts for more than 95% of total excess liquidity at each point in time since 2008. Holding the group of banks belonging to the top quartile of excess liquidity holders in June 2014 (63 banks) constant and plotting the evolution of their share in excess liquidity against the share of the top quartile at each point in time (Chart 4 below) provides first evidence for our conjecture that banks with large excess liquidity holdings were incentivised to try redistributing parts of their excess liquidity: the share in excess liquidity of the first quartile banks of June 2014 is steadily decreasing since the introduction of negative rates and reaches a distance of almost 20 percentage points from the share of the top quartile in December 2015.

[11] For example, in November 2015, 31% of the banks in our sample had zero excess liquidity holdings and the 60% lowest excess liquidity holders accounted for less than 1% of total excess liquidity held by the 253 banks in our sample.

Chart 4: Share of excess liquidity of top quartile excess liquidity holders in June 2014 vs. excess liquidity share of top quartile excess liquidity holders at each point in time, June 2014 until December 2015



4. Empirical analysis

In line with the conceptual discussion in the previous section, our empirical analysis focuses on tracing out the possible bank balance sheet adjustments triggered by the introduction of negative interest rates (NIR) through three channels: government bond holdings, bank lending and wholesale funding.

As alluded to in Section 2, the introduction of NIR occurred in tandem with the announcement of other non-standard monetary policy measures by the ECB. In particular, the first reduction of the deposit facility rate (DFR) to negative territory in June 2014 coincided with the announcement of the targeted long-term refinancing operations (TLTROs, starting in September 2014). The further reduction of the DFR to -0.20% was decided in September 2014, together with the asset backed securities purchases programme (ABSPP) and the third covered bond purchase programme (CBPP3). Moreover, the NIR period partly coincides with the period during which the market started developing expectations that the ECB would embark in large-scale purchases of government bonds. These expectations were eventually confirmed in January 2015 with the announcement of the APP, which started in March 2015.

This confluence of various policy measures can have a bearing on banks' decisions and thus renders the identification of the effects of the NIR based purely on the timing of its introduction problematic. For example, Krishnamurthy and Vissing-Jorgensen (2011) recently ask how declines in governement bond yields spill over to yields on other assets in the context of large scale asset purchases conducted by the Federal Reserve. They note that when the Federal Reserve buys safe, longer-term assets it could induce investors to shift their portfolios toward other, potentially riskier assets, pushing down those yields. Hence, it is plausible to expect that similar portfolio rebalancing effects would be triggerred by the APP. The availability of long-term funding at an attractive price through the TLTRO is also expected to incentivise the acquisition of assets. Moreover, the targetting elements of this measure would be expected to spur increased lending in particular.

In view of this, our identification strategy relies on the idea that the intensity of the pressure for banks to pursue one of the balance sheet adjustment strategies identified in the previous section depends on the volume of excess liquidity that each bank holds.. This is because it is the volume of excess liquidity held by a bank that defines the overall charge the bank has to pay for its recourse to the deposit facility (and parts of its current account with the Eurosystem). By the same logic, banks not holding any excess liquidity will not be subject to the charge on excess liquidity and we would not expect these banks to react to the negative rate environment with pronounced changes to their balance sheet. This means that there is cross-sectional variation on the intensity of the "treatment" (the negative rate policy) and this variation is linked to a variable that is observable: excess liquidity. We exploit this cross-sectional variation in the treatment to identify this effect of the negative rate policy from the effects of other non-standard measures, such as the APP, the effect of which is common across banks as it operates mainly through the impact on yields on bonds and broader financial market prices.

To implement this identification strategy a micro-based approach using individual bank data is required. To this end, we employ a confidential dataset of selected balance sheet indicators for a sample of individual monetary financial institutions (MFIs), collected for the compilation of the aggregate monetary statistics. The MFIs included in the dataset account for approximately 70 percent of total outstanding amounts of main assets of euro area MFIs. This dataset is matched with data on banks relationships with the Eurosystem: their deposit holdings, minimum reserve requirements and borrowing from Eurosystem lending operations.

4.1. Government bond holdings

The goal in this sub-section is to examine whether the negative interest rate period prompts banks to convert their excess liquidity (EL) into government bond holdings, over and above what standard determinants of bank holdings of these instruments would suggest. To answer this question we need to frame it within the broader context of the motivations driving banks' government bond holding decisions. As bank holdings of government bonds are a portfolio allocation decision, standard considerations relating to the return of the bonds and that of alternative investment opportunities need to be taken into account. In addition, there is a considerable body of literature making the case that banks also hold sovereign bonds for reasons other than their expected return. In their seminal paper, Bernanke and Blinder (1992) note that holdings of government securities, loans, and corporate bonds are imperfect substitutes and lay the groundwork for the credit channel through bank portfolio adjustments. Gennaioli et al. (2013) and Holmstrom and Tirole (1993) argue that banks hold government bonds as a buffer against the materialisation of liquidity shocks. Other authors, such as Bonner (2016) and Popov and van Horen (2013) highlight the relevance of the preferential treatment of government bonds in capital and liquidity regulation as a driver for holding government bonds. With these considerations in mind, we use the following equation, which is similar in spirit to the liquid assets regression in Cornett et al. (2011), to estimate the impact of the negative interest period on bank bond holdings.

$$
\begin{aligned}
Gov.\ bond\ ratio_{i,t,} \quad &(1)\\
= T_t + B_i + \beta_0 \times Gov.\ bond\ ratio_{i,t-1} + \beta_1 \times EL\ ratio_{i,t-1}\\
\times (1 - D^{NIR}) + \beta_2 \times EL\ ratio_{i,t-1} \times (D^{NIR}) + \beta_3\\
\times Liquidity\ ratio_{i,t-1} + \beta_4 \times Leverage\ ratio_{i,t-1} + \beta_5\\
\times r^{Loan}_{i,t-1} - r^{10y}_{j,t-1} + \beta_6 \times Core\ ratio_{i,t-1} + \beta_7\\
\times \log(Assets)_{i,t-1} + \beta_8 \times Rating_{i,t-1} + \beta_9 \times \Delta \log(IP)_{j,t-1}\\
+ \beta_{10} \times Loan\ ratio_{i,t-1} + \beta_{11} \times Wholesale\ ratio_{i,t-1} + \varepsilon_{it}
\end{aligned}
$$

where $Gov.\ bond\ ratio_t = \frac{Gov.\ bonds_{i,t}}{Assets_{i,t-1}}$ constructed from flow data on bond holdings, $EL\ ratio_{i,t} = \frac{Excess\ Liquidity_{i,t}}{Assets_{i,t}}$, $Liquidity\ ratio_{i,t} = \frac{Liquid\ assets_{i,t}}{Assets_{i,t}}$, $Leverage\ ratio_{i,t} = \frac{(Capital+Reserves)_{i,t}}{Assets_{i,t}}$, $Core\ ratio_{i,t} = \frac{Core\ Deposits_{i,t}}{Assets_{i,t}}$, $Loan\ ratio_t = \frac{Loans_{i,t}}{Assets_{i,t}}$, constructed from flow data on loans to the non-financial private sector, $Wholesale\ ratio_t = \frac{Wholesale\ funding_{i,t}}{Assets_{i,t}}$, constructed from flow data on debt securities issued and interbank loans, and D^{NIR} is a dummy variable that is equal to 1 for the negative interest rate (NIR) period after June 2014. The subscript *i* denotes individual bank *i*, whereas the subscript *j* denotes the respective country where the bank is located in.

Liquid assets are defined as the sum of interbank lending, holdings of government bonds, holdings of debt securities issued by MFIs, holdings of debt securities issued by the private sector, and holdings of equity. Core deposits are defined as deposits (of all maturities) of households and non-financial corporations. r^{Loan}_i is the composite lending rate of bank *i*, while r^{10y}_j is the yield on the 10-year government bonds issued in the country *j*, i.e. the country where the respective bank is located in. Summary descriptive statistics for the variables used in our empirical analysis are provided in Table A1 in the Annex.

Our strategy for identifying the effects of the NIR on bank holdings of government bonds is operationalised in equation (1) by interacting the EL ratio with a dummy variable for the NIR period. If banks are indeed more motivated to turn their EL into bonds during the NIR period, then we expect $\beta_2 > 0$ and $\beta_2 > \beta_1$.

Equation (1) is estimated as a panel fixed effects model. We include bank fixed effects (B_i) to control for unobservable time-invariant bank-specific factors that affect the decision to acquire government bonds.[12] Moreover, our specifications include time fixed effects (T_t) to control for aggregate shocks. The errors are clustered at the bank level. The estimation sample covers the period from August 2007 to May 2015. The monthly frequency of our dataset allows us to work with a long panel with over 90 observations, which does not require the use of an Arellano and Bond (1991) type of estimator to address the dynamic structure.[13] In order to address potential endogeneity problems, all bank-level variables enter with a one-month lag. To avoid that our results are unduly influenced by outliers, all bank-level flow data are winsorised at the 1 and 99 percent levels. Moreover, we have excluded banks resident in Greece and Cyprus from our sample as these countries faced banking crises during part of the sample, which profoundly restricted banks' capacity to adjust their portfolios in an optimal manner.

Table 1 reports the estimation results where the dependent variable is the ratio of changes in total bond holdings over assets. The first column displays the results for all the

[12] Pooled OLS estimates without fixed effects (not reported in the paper) as well as a model that replaces bank fixed effects with country fixed effects give qualitatively similar results.

[13] The Arellano-Bond (1991) estimator is designed for short panels. In long panels, a shock to the cross-sectional fixed effect declines with time and the correlation of the lagged dependent variable with the error term becomes insignificant. Judson and Owen (1999) use Monte-Carlo simulations and show that the so-called "Nickell bias" is no longer significant for panels where the time dimension is larger than 30.

banks in our sample. Row 3 reports the coefficients for our main variable of interest, which turns out to be economically and statistically significant and indicates that banks are more likely to convert their EL into government bond holdings during the NIR era when EL holdings are discouraged. By contrast, in the previous period there is no significant reaction of banks' government bond holdings to EL (row 2). The finding for the period before NIR is consistent with Ennis and Wolman (2015) who find no evidence of substitution between excess reserves and other forms of liquid assets for the US.

The remaining variables are used as controls so we discuss them only briefly. Banks that have more liquid assets in the previous month are less inclined to increase their bond holdings (row 4), as the liquidity buffer motivation for such purchases is weaker. This is analogous to the results reported in Cornett et al. (2011), who note that banks that have a higher ratio of illiquid assets in the previous period are more likely to increase their holdings of liquid assets. Better capitalised banks (row 5) tend to be less inclined to acquire government bonds – presumably as they have the capacity to acquire riskier but higher yielding assets – although the coefficient is not significant. There is no significant reaction to the opportunity cost of holding government bonds (row 6) or to the share of core deposits in banks' funding structure (row 7). Smaller banks tend to acquire significantly more government bonds relative to their size (row 8), a result that may reflect a more limited universe of investment opportunities than their larger peers, perhaps owing to more limited portfolio management capacity and sophistication. Banks' perceived credit standing as captured by their rating does not seem to significantly influence government bond buying behaviour (row 9), nor do general macroeconomic conditions as proxied by industrial production (row 10). To allow for some interaction among the adjustment channels considered we also include the loan and wholesale funding ratios as controls in our specifications. There seems to be a negative relationship between banks' holdings of bonds and extension of loans and this relationship is significant for the high EL banks in less vulnerable countries (row 11). Meanwhile, there is no impact of wholesale funding on bond holdings (row 12).

Columns II to VII report the results of estimating this baseline specification for different cross sections. Column II considers the sample of banks located in "vulnerable" euro area countries while column III reports the results for the banks in "less-vulnerable" countries. Comparing these two columns, column III suggests that the propensity to convert EL into bond holdings is a behaviour that is significant in "less vulnerable" countries, which therefore drive the full-sample results in column I. This result is likely driven by the fact that banks in less-vulnerable countries generally have higher levels of excess liquidity compared to their counterparts in vulnerable countries.

In order to investigate the above argument in more detail, Column IV considers the banks that are in the top 25th percentile in terms of their average EL ratio in the year to May 2014, i.e. before the implementation of negative interest rates. The reasoning for focussing on this group is that there may be non-linear effects in how the volume of excess liquidity may affect balance sheet adjustments. This is because the costs associated with paying a negative rate on EL holdings may only justify an adjustment of bank balance sheets if they exceed a certain threshold. We define high-excess liquidity banks using a reference period that precedes the NIR to avoid endogeneity.[14] We view this group as the set of banks that structurally receive large amounts of EL, owing to their role in the payments system and the interbank market or their specific business model. To give an idea about the economic significance of this group of banks, they capture about 19 percent of total assets and 16 percent of total loans in our sample. Row 3 suggests that there is no special reaction of bond

[14] Specifically, we compute the average EL ratio for the 12-months period from June 2013 to May 2014 and banks in the highest quantile based on this criterion are classified as high excess liquidity banks for the full sample.

purchases in the NIR period. When, however, we focus on those highest EL banks that are located in “less vulnerable” countries (column V), the coefficient estimate as well as the precision of estimation increases and the coefficient is significant at a 89 percent level of confidence. In the next sub-section, we formally test whether the differences across alternative cross sections are driven by the high EL holders and our findings confirm this expectation.

Ceteris paribus, we expect the high EL holders to buy more bonds during the NIR period. Nevertheless, this finding might be offset in the presence of certain factors. For example, if the high EL holders are also the banks with high bond holdings, then there may not be a lot of room for adjustment during NIR period. In order to test this claim, we first check the number of banks in the high EL category. Of the 25 banks in this group (row 13, column IV), 16 of them are also the highest bond holders (i.e. they are in the top two quartiles in terms of their average bond holdings during the year before NIR). Next, we test whether a bank’s initial ratio of bond holdings before the NIR period play a role in its adjustment process during NIR. To that end, we run our baseline regressions for the four sub-samples based on the quartiles determined by their average bond holdings during the year before NIR. We find that the results obtained in Table 1 are driven by those banks in the first two quartiles (not shown). This is an intuitive result suggesting that banks that already hold high levels of bonds in their portfolios are less likely to increase their bond holdings during NIR.

Columns VI and VII report the results of another approach to splitting the sample in order to homogenise the role of various factors in the decision to acquire government bonds. In particular, we show results for banks whose shares are not listed on a stock exchange (column VI) and for those who are (column VII). The rationale for this split is that listed banks are subject to higher regulatory and investor scrutiny, which is likely associated with more sophisticated and efficient asset-liability management practices and the use of more advanced risk management systems. The results reveal that in fact it is the non-listed banks whose bond purchases react significantly to the size of EL holdings in the NIR period. We interpret this result as evidence that a different reaction to the NIR compared to interest rate constellations in positive territory is associated – as discussed in section 3 – with some type of "money illusion" reflecting institutional or other rigidities (such as access to interbank and funding markets) that make negative rates special. Such rigidities are more likely to affect less sophisticated financial institutions that are typically not listed.

Table 2 shows the same analysis for purchases of domestic government bonds while Table 3 considers purchases of bonds issued by euro area governments other than the one the respective bank is located in (non-domestic government bonds). Comparing row 3 across the three tables, we note that our findings for the aggregate bond ratios in Table 1 are maintained for some sub-samples in the case of non-domestic bond purchases. There is no evidence, however, of a special reaction to the NIR in the purchases of domestic government bonds. As regards non-domestic bonds, the effects are found to be larger for high-excess liquidity banks in less-vulnerable countries (column V).

Robustness analysis

We check the robustness of our results in several ways. First, we consider alternative cut off points for various reductions in the deposit facility rate to determine if the NIR period is indeed special. Our goal is to understand whether other reductions in the deposit rate that took place in positive territory trigger reactions similar to the reductions in negative territory. To that end, we consider three additional rate cut periods and construct dummy variables to capture them: D^{08-09} captures the period from October 2008 to April 2009, which can be regarded as the "fast" rate cut phase. D^{11-12} captures the period from December 2011 to June 2012 which can be considered as the "slow" rate cut phase. D^{2013} captures the period from

May 2013 to December 2013 when the ECB lowered the MRO rate but not the deposit rate. We interact these dummy variables with the EL ratio and add them to our specification.

Table 4a shows the regression results. For the sake of brevity, we only report the coefficient estimates for the interactive dummies. Our results suggest that the switch to negative interest rate territory is indeed special. There is no attempt to convert EL into bonds for the first two periods. There is some evidence of adjustment in the second half of 2013 following the reductions in the MRO rate but the coefficient estimates that are associated with the NIR period are generally larger and in these instances we fail to reject the hypothesis that the coefficients in the NIR period are twice the size of the coefficients obtained in the second half of 2013.

Table 4b shows the results from an alternative specification where a dummy variable from March 2015 onwards is generated to capture the APP period (D^{APP}) and interacted with the EL variable. The results for the NIR period (row 2) are mainly identical. The coefficient for the APP period is only significant for the banks in vulnerable countries where it is negative and large. This could be capturing some selling of sovereign bond holdings to the Eurosystem by these banks during that time.

A critical question in our empirical analysis is whether the high excess liquidity holders reduce their EL more aggressively during NIR relative to those with low excess liquidity. In order to test whether the coefficient associated with $\boldsymbol{EL\ ratio_{t-1} \times (D^{NIR})}$ is significantly larger in column IV (i.e. the high EL sample) relative to other groups, we consider an alternative specification where we separate the impact of this variable into two components: the effect coming from high liquidity holders, $EL\ ratio_{t-1} \times (D^{NIR}) \times (D^{EL})$ and the effect coming from low liquidity holders, $EL\ ratio_{t-1} \times (D^{NIR}) \times (1 - D^{EL})$ where D^{EL} is a dummy variable that is equal to 1 if a bank is classified to be a high EL holder as we described in Table 1, column IV.

Table 4c shows the coefficient estimates from this specification. Once again, we only report the coefficient estimates for the interactive dummies. Recall that in Table 1 we had found a significance response associated with the EL variable for the banks in less vulnerable countries as well as non-listed banks. Our analysis in this section confirms that these findings are driven by high EL holders. Altogether, these findings suggest that banks in "less vulnerable" countries and particularly with high EL ratios are the ones that are most motivated to turn their EL into government bond holdings during the NIR period.

We also conduct several further robustness analyses such as checking whether the results are driven by the period in which the two-year bond yields are negative rather than the NIR period per se, whether the results are driven by Germany owing to the fact that sovereign yields in this country were the deepest in negative territory or whether the results are driven by those banks that do not lend in the overnight interbank markets at negative rates in the post September 2014 period.[15] What is common in all these sub-sample analyses (not reported) is that the coefficients are rather imprecisely estimated, likely owing to a low number of cross sections in each case. For example, there are only 13 cross sections available for the negative 2-year bond era, 8 cross sections for high EL banks in Germany and only 20 cross sections for banks that do not lend at negative rates.

4.2. Bank lending

In line with our broader goal, our aim in this sub-section is to investigate whether the negative interest rate period prompts banks to use their EL to extend more loans. Determinants of bank loans have been heavily investigated in the literature. Consistent with our specification in the previous section, we specify an equation that is similar to the loan regression in Cornett et al. (2011), to estimate the impact of the negative interest period on bank loans.

[15] These banks are identified using confidential data on TARGET2 transactions.

$$Loan\ ratio_{i,t,} = T_t + B_i + \beta_0 \times Loan\ ratio_{i,t-1} + \beta_1 \times EL\ ratio_{i,t-1} \times (1 - D^{NIR}) + \beta_2 \times EL\ ratio_{i,t-1} \times (D^{NIR}) + \beta_3 \times Liquidity\ ratio_{i,t-1} + \beta_4 \times Leverage\ ratio_{i,t-1} + \beta_5 \times BLS\ demand_t + \beta_6 \times BLS\ credit\ standards_t + \beta_7 \times r^{Loan}_{i,t-1} + \beta_8 \times Core\ ratio_{i,t-1} + \beta_9 \times Borrowing\ ratio_{i,t-1} + \beta_{10} \times \log(Assets)_{i,t-1} + \beta_{11} \times \log(IP)_{j,t-12} + \beta_{12} \times Wholesale\ ratio_{i,t-1} + \beta_{13} \times Bond\ ratio_{i,t-1} + \varepsilon_{it} \qquad (2)$$

where $BLS\ demand_t$ is a proxy for loan demand measured from the BLS survey, $BLS\ credit\ standards_t$ is a proxy of credit tightness as measured from the BLS survey,[16] $Borrowing_{i,t} = \frac{Borrowing_{i,t}}{Assets_{i,t}}$ is the ratio of net borrowing from the Eurosystem, where the numerator is defined as the sum of LTROs, MROs, TLTROs and VLTROs.

We follow the same logic as in the previous section to identify the effects of the NIR for bank loans in equation (2). If banks are more motivated to turn their EL into loans during the NIR period, then we expect β_2>0 and β_2>β_1.

Banks that have more liquid balance sheets or higher capital ratios are expected to issue more loans ($\beta_3, \beta_4 > 0$). An increase in demand should increase the volume of loans (β_5>0) while a tightening of credit standards should reduce loan issuance ($\beta_6 < 0$). Banks that have more funding either through core deposits or Eurosystem borrowing are also more likely to issue loans ($\beta_8, \beta_9 > 0$). We capture the banks' size with total assets and a priori we do not have any expectations about how bank size should affect loan issuance. We control for demand with industrial production index. Because demand for bank lending typically lags the business cycle (see Carpenter et al., 2014) we use a one-year lag.

Table 5 shows the estimation results. Focusing on row 3, and moving across different cross sections, we note that banks in less vulnerable countries have a bigger tendency to convert their EL holdings into loans during the NIR period (column III). Indeed, comparing

[16] Note that country results for the BLS are used, which ensures cross-sectional variation across countries and therefore does not lead to collinearity problems with the time fixed effects.

the coefficient estimates in rows 2 and 3 yields a statistically significant difference between the period before and after the negative interest rate period. This behaviour is particularly pronounced for high EL holders (column IV) and for high EL holders in less vulnerable countries (column V). Unlike the bond regressions where banks that are not listed exhibited a tendency to convert their EL into bonds during the NIR period, this time we observe that it is the listed banks that react to NIR and turn their EL into loans. One interesting finding is associated with the negative coefficient of the EL ratio in banks in vulnerable countries, which may reflect the ongoing deleveraging efforts by banks in these countries in the face of financial stress (column II).

Other control variables are generally in line with our expectations. Banks that have more liquid balance sheets or higher leverage ratios tend to issue more loans (rows 4 and 5). The positive coefficient associated with credit standards suggests an increase in bank loans when banks tighten their standards (row7) which is not intuitive, albeit the coefficient estimates are economically insignificant. Banks that obtain more funding through core deposits generate more loans (row 9). Similarly, banks in less vulnerable countries seem to use their Eurosystem borrowing to issue more loans as well (row 10). Banks that are able to generate higher wholesale funding use these funds to issue more loans (row 13). Meanwhile there seems to be a trade-off between bond holdings and loan issuance as suggested by the negative coefficients on the bond ratio (row 14).

Robustness analysis

Our robustness analysis for loan issuance is analogous to our robustness checks for the bond regressions. Specifically, we test whether the NIR period is special in prompting banks to extend more loans compared to other policy easing cycles. Equation (2) is modified slightly to include the EL ratio and four interactive dummies to capture the effects of three different easing periods as described in the previous sub-section.

Table 6a shows the coefficient estimates associated with the interactive EL coefficients in these regressions. There is no attempt to convert EL into loans for the first two periods similar to our analysis for the bond regressions. There is evidence of adjustment in the second half of 2013 following the reductions in the MRO rate for the banks in the less vulnerable countries, highest EL holders, and those who are listed. In those instances in which both the coefficient for the second half of 2013 and the coefficient for the NIR period are significant, we fail to reject the hypothesis that the coefficients in the NIR period are twice the size of the coefficients obtained in the second half of 2013, except for the highest EL sub-sample. This seems to suggest that there is evidence that the NIR period is special as regards the reaction of loan extension to EL, although this result cannot be generalized to the other cross sections.

Table 6b shows the results from the alternative specification that controls for the APP period. Once again, the results are mainly preserved. In Table 6c, we test whether the response of high EL holders are significantly different from the other cross sections, similar to our analysis for bond regressions in Table 4c. In Table 5 we had reported that banks in less vulnerable countries and listed banks use their EL to fund their loans during the NIR period. In Table 6c we confirm that the adjustment by these groups are indeed triggered by high EL holders, consistent with and strengthening our findings in Table 5.

In section 3, we had noted that the presence of market frictions may squeeze the profit margins of banks during NIR. This may be binding for high EL holders particularly if this excess liquidity is generated by retail deposits. In order to test this hypothesis, we check whether the response that we observe for high EL holders is further aggravated for banks with high deposits. Table 6d displays the results from this exercise for banks in less vulnerable countries. The first column in Table 6d simply replicates column III in Table 6c for comparison purposes. In the second column, we add another interactive dummy to observe whether the response of high EL holders increases for banks that have high deposits: $\boldsymbol{EL\ ratio_{t-1}}$ ×($\boldsymbol{D^{NIR}}$) ×($\boldsymbol{D^{EL}}$) ×($\boldsymbol{D^{Dep}}$). In this specification, $\boldsymbol{D^{Dep}}$ indicates a dummy variable for high deposit banks which is constructed as the banks in the top decile, based on their average deposits during the period from June 2013 through May 2014. We observe that there is a significant increase in the banks' motivation to turn their EL into bank loans if they are high deposit banks as well as high EL holders.[17]

Ennis and Wolman (2015) note that while high levels of reserves may motivate a bank to expand its loans, because loans are riskier than reserves, they necessitate higher capital requirements. Because raising capital is costly, even if a bank with excess liquidity may want to convert these funds into loans, it may not do so if there is not enough capital. In order to test whether banks with higher leverage ratios are more eager to turn their EL into loans during the NIR period, we consider another interactive term for banks in the top 25th quartile in terms of their average leverage during the year before May 2014 ($\boldsymbol{D^{Lev}}$). The results, shown in column III of Table 6d, suggest that banks with higher leverage ratios are indeed more motivated to turn their EL into loans. This finding is also consistent with Brunnermeier and Koby (2016) who argue that higher levels of capitalization reduces the wealth effect and hence the reversal rate.

4.3. Wholesale funding

Wholesale funding refers to uninsured bank liabilities such as inter-bank loans and debt securities issued that provide additional funding opportunities beyond retail deposits.

[17] Note that a similar test is not applicable to the bond or wholesale funding regressions where the sample sizes are smaller and hence there are not enough observations to estimate the regressions for the high deposit holders. The reason for the smaller sample size in these regressions is the presence of the ratings variable which is not available for each bank in our sample.

Wholesale funding, owing to its uninsured nature tends to be costlier than retail deposits and can, in some cases, be adjusted flexibly. One potential impact of the NIR policy could, therefore, be to motivate banks to use their excess liquidity to pay back wholesale funding debt.

We consider an empirical specification that is similar to the earlier ones:

$$\begin{aligned} Wholesale\ ratio_{i,t} &= T_t + B_i + \beta_0 \times Wholesale\ ratio_{i,t-1} + \beta_1 \times EL\ ratio_{i,t-1} \\ &\times (1 - D^{NIR}) + \beta_2 \times EL\ ratio_{i,t-1} \times (D^{NIR}) + \beta_3 \\ &\times Liquidity\ ratio_{i,t-1} + \beta_4 \times Leverage\ ratio_{i,t-1} + \beta_5 \\ &\times BLS\ demand_t + \beta_6 \times \left(r_{j,t-1}^{2y} - r_{i,t-1}^{Deposit}\right) + \beta_7 \\ &\times Core\ ratio_{i,t-1} + \beta_8 \times Borrowing\ ratio_{i,t-1} + \beta_9 \\ &\times Rating_{i,t-1} + \beta_{10} \times \mathrm{Dlog}(IP)_{j,t-1} + \beta_{11} \times \mathrm{Vol}(IP)_{j,t-1} \\ &+ \beta_{12} \times Loan\ ratio_{i,t-1} + \beta_{13} \times Bond\ ratio_{i,t-1} + \varepsilon_{it} \end{aligned} \quad (3)$$

where $r_{j,t-1}^{2y}$ is the yield on the respective two-year sovereign bond, $r_{i,t-1}^{Deposit}$ is the composite deposit rate of each bank, and $\mathrm{Vol}(IP)_{j,t-1}$ is the annual standard deviation of the industrial production estimated as a 12-month moving average.

If banks are more motivated to use their excess liquidity to pay back their wholesale borrowing during the NIR period, then we expect β_2<0 and β_2<β_1.

The spread between the two-year sovereign bond rate and the deposit rate is a proxy to capture the relative cost of wholesale funding. Billett and Garfinkel (2004) note that banks' choice between insured and uninsured funding depends on the differential rates charged in the two markets. An increase in this spread reflects an increase in the cost of wholesale funding and hence implies a negative coefficient: $\beta_6 < 0$. Variables such as ratings and the leverage ratio control for banks' unsecured funding costs as well (see Babihuga and Spaltro, 2014). Accordingly, banks that have higher credit quality (as captured by the ratings variable) or better capitalisation (i.e. a higher leverage ratio as defined here) should have lower wholesale funding costs and are, therefore, more likely to tap wholesale funding resources: $\beta_4 > 0$ and

β_{10}> 0. We include the ratio of bank loans because loans are an essential determinant of bank funding needs. An increase in bank loans should increase the need for wholesale funding: $\beta_9 > 0$. Output volatility as captured by the standard deviation of the IP is expected to capture overall uncertainty. During times of elevated overall uncertainty, banks may tighten their lending standards and reduce their wholesale funding before they reduce retail deposits which are typically less flexible and slower and costlier to adjust (Dinger and Craig, 2013). Thus, we expect $\beta_{12} < 0$.

Table 7 shows the estimation results. Row 3 suggests that banks have indeed used their EL in the NIR period to reduce their wholesale borrowing, a behaviour that is significant for banks in less vulnerable countries and for those with the highest EL ratios. Both listed and non-listed banks conform to this behavioural pattern.

Looking at the other control variables, banks that have higher levels of core deposits or higher levels of borrowings from the ECB tend to rely on more wholesale funding as well. The loan ratio appears to be a significant determinant of wholesale funding needs as expected. Surprisingly, banks with higher ratings, for whom the cost of wholesale funding should be lower, seem to rely less on wholesale borrowing. Indeed the interest rate spread, that captures the relative cost of wholesale funding, is not significant either. An increase in overall economic uncertainty seems to generate more conservative borrowing behaviour as suggested by the negative and significant coefficient attained for this variable. Once again, the positive relationship between wholesale funding and bank loans are confirmed (row 13) similar to our loan regressions. Meanwhile, higher levels of bond ratios are associated with higher wholesale funding as well (row 14).

Robustness analysis

Similar to the earlier sections, we test whether the NIR period is special in triggering a reduction in wholesale funding compared to other policy easing cycles. We modify equation

(3) to include the EL ratio and four interactive dummies to capture the effects of three different easing periods as described in the sub-section 4.1.

Table 8a shows the coefficient estimates associated with the interactive EL coefficients in these regressions. There is evidence that the NIR period is special because this seems to be the only sub –sample for which the coefficient associated with the EL ratio is significant and negative (row 5) for the majority of the cross sections.

Table 8b shows the results from the alternative specification that controls for APP. Here, we observe that once we control for the APP period, the coefficients associated with the NIR period are generally larger in absolute value, suggesting stronger incentives to reduce wholesale funding during this period. Indeed, the coefficient estimates for the APP period are mostly positive and significant for the same cross sections for which the NIR period is effective, which could point to the APP having contributed to lowering market fragmentation, through improving the supply of interbank loans triggered by a generalised search for yield behaviour. This suggests that not controlling for the APP period overlooks the offsetting impact and underestimates the effects of the NIR policies.

Finally, Table 8c once again checks whether the coefficients attained by high EL banks are significantly different from low EL banks. We confirm that for most cross sections analysed in Table 7, the estimated significant response is driven by the high EL holders.

5. Conclusions

The existing theoretical and empirical literature on banks' role in the monetary policy transmission mechanism is largely silent on whether bank reactions to changes in policy rates might be special when these changes occur in or drive rates to negative territory. Using bank-level data for the euro area we examined whether bank balance sheet reactions to holdings of excess liquidity have changed since the ECB introduced a negative rate on the deposit facility in June 2014. We find evidence that banks' reaction to the negative rate is indeed special. Holdings of excess reserves during the negative interest rate period tend to be associated with significantly higher acquisitions of non-domestic bonds and extension of loans to the non-financial private sector and lower levels of wholesale funding. This reaction is driven by banks in less vulnerable countries and in particular by those that hold large amounts of excess liquidity. These results can be seen as suggesting that the negative deposit facility rate has acted as an empowerment to the ECB's large-scale asset purchases that were also inaugurated during this period and that inject large amounts of excess liquidity into the banking system. The charge on this excess liquidity seems to encourage banks to take action to avoid it, thereby catalysing more active portfolio rebalancing.

The channels for balance sheet adjustment in the face of negative rates that have been considered in this paper focus exclusively on internal, i.e. euro area, assets. Another potentially important channel, however, relates to possible increases in the holdings of foreign assets, as argued by Khayat (2015). Exploring the impact of the ECB's negative deposit facility rate on banks' external capital flows is, therefore, an interesting area for future work.

Table 1: Dependent variable: $Gov.\ Bond\ ratio$

		I.	II.	III.	IV.	V.	VI.	VII.
		Full sample	**Vulnerable countries**	**Less vulnerable countries**	**Highest EL**	**Highest EL in less vulnerable countries**	**Non-listed**	**Listed**
1.	Lagged dependent variable	0.05	0.05	0.04	0.08	0.10	0.10	0.00
		1.09	*1.40*	*0.47*	*0.59*	*0.58*	*1.27*	*0.08*
2.	$EL\ ratio_{t-1}$ ×(1-D^{NIR})	0.00	-0.01	0.01*	0.01**	0.01**	0.01	0.01
		1.27	*-0.22*	*1.87*	*2.61*	*2.74*	*1.47*	*1.28*
3.	$\boldsymbol{EL\ ratio_{t-1}}$ **×($\boldsymbol{D^{NIR}}$)**	**0.05****	**0.12**	**0.04***	**0.04**	**0.05**	**0.06****	**0.05**
		2.21	*0.76*	*1.71*	*1.09*	*1.60*	*2.64*	*1.37*
4.	$Liquidity\ ratio_{t-1}$	-0.01**	-0.01**	0.00*	-0.01	0.00	-0.01**	-0.004**
		-2.49	*-2.33*	*-1.68*	*-1.49*	*-0.62*	*-2.12*	*-2.40*
5.	$Leverage\ ratio_{t-1}$	-0.01	0.00	-0.02*	-0.03*	-0.03	-0.01	-0.01
		-0.73	*-0.58*	*-1.80*	*-1.64*	*-1.43*	*-0.63*	*-0.73*
6.	$r_{t-1}^{Loan} - r_{t-1}^{10y}$	0.00	0.00	0.0002*	0.00	0.00	-0.0002**	0.00
		-1.27	*-0.33*	*1.89*	*1.25*	*1.20*	*-2.02*	*-0.37*
7.	$Core\ ratio_{t-1}$	0.00	0.00	0.00	0.00	0.00	0.00	0.01*
		0.53	*0.40*	*0.50*	*-1.01*	*-0.27*	*-1.00*	*1.68*
8.	$\log(Assets)_{t-1}$	-0.001**	-0.001**	-0.001**	0.00	0.00	-0.002**	-0.001**
		-2.15	*-2.12*	*-2.26*	*-1.59*	*-1.44*	*-2.08*	*-1.93*
9.	$Rating_{t-1}$	0.00	0.00	0.00	0.00	0.0003*	-0.0001*	0.00
		0.16	*1.27*	*1.60*	*1.43*	*1.80*	*-1.62*	*0.63*
10.	$\Delta\log(IP)_{t-1}$	0.00	0.00	0.01*	0.00	0.01	-0.01	0.01**
		0.98	*-0.56*	*1.91*	*-0.15*	*0.83*	*-1.43*	*2.74*
11.	$Loan\ ratio_{t-1}$	-0.01	0.02	-0.02	-0.03	-0.07**	-0.01	-0.01
		-0.63	*0.73*	*-0.87*	*-0.95*	*-2.03*	*-0.36*	*-0.62*
12.	$Wholesale\ ratio_{t-1}$	0.00	-0.01	0.00	0.00	0.00	0.00	0.00
		-1.04	*-0.56*	*-1.17*	*0.10*	*0.10*	*-0.72*	*-0.68*

13.	Number of cross sections	139	52	87	25	18	67	72
14.	Adjusted R^2	0.02	0.04	0.02	0.01	0.01	0.03	0.02

Regressions include a constant. t-ratios under coefficient estimates. **/* reflects significance at 95/90 percent level of confidence. Regressions include cross section and period fixed effects.

Table 2: Dependent variable: $Domestic\ Gov.Bond\ ratio$

		I.	II.	III.	IV.	V.	VI.	VII.
		Full sample	**Vulnerable countries**	**Less vulnerable countries**	**Highest EL**	**Highest EL in less vulnerable countries**	**Non-listed**	**Listed**
1.	Lagged dependent variable	0.08*	0.05	0.11	0.15	0.22	0.13	0.04
		1.69	*1.56*	*1.20*	*1.16*	*1.44*	*1.50*	*1.22*
2.	$EL\ ratio_{t-1}$ ×(1-D^{NIR})	0.00	-0.01	0.003**	0.01**	0.01**	0.00	0.00
		0.83	*-0.37*	*1.96*	*2.36*	*2.46*	*0.68*	*1.44*
3.	**$\boldsymbol{EL\ ratio_{t-1}}$ ×($\boldsymbol{D^{NIR}}$)**	**0.02**	**0.02**	**0.01**	**0.00**	**0.01**	**0.03**	**0.02**
		1.37	*0.19*	*1.01*	*0.15*	*0.50*	*1.31*	*1.17*
4.	$Liquidity\ ratio_{t-1}$	-0.004**	-0.01**	0.00	-0.01*	0.00	-0.01**	-0.003**
		-2.48	*-2.65*	*-1.35*	*-1.87*	*-0.99*	*-2.17*	*-2.48*
5.	$Leverage\ ratio_{t-1}$	-0.01	-0.01	-0.01	-0.03	-0.02	-0.01	-0.01
		-1.24	*-1.21*	*-1.24*	*-1.45*	*-1.20*	*-0.83*	*-1.19*
6.	$r_{t-1}^{Loan} - r_{t-1}^{10y}$	-0.0001**	0.00	0.00	0.00	0.00	-0.0003**	0.00
		-2.43	*-0.74*	*1.16*	*0.64*	*0.93*	*-2.26*	*-1.23*
7.	$Core\ ratio_{t-1}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		0.11	*0.15*	*0.32*	*-0.41*	*0.64*	*-1.09*	*1.47*
8.	$\log(Assets)_{t-1}$	-0.001**	-0.003**	0.00	0.00	0.00	-0.002**	-0.0006*
		-1.99	*-2.28*	*-1.60*	*-1.22*	*-1.00*	*-2.14*	*-1.68*
9.	$Rating_{t-1}$	0.00	0.0001**	0.00	0.00	0.00	0.00	0.00
		0.22	*2.07*	*1.14*	*1.54*	*1.52*	*-1.34*	*0.67*
10.	$\Delta\log(IP)_{t-1}$	0.00	-0.01	0.01**	0.00	0.01*	-0.01	0.004**
		0.36	*-1.20*	*2.11*	*-0.02*	*1.69*	*-1.56*	*2.13*
11.	$Loan\ ratio_{t-1}$	-0.01	0.03	-0.02*	-0.01	-0.05*	-0.02	-0.01
		-1.03	*1.08*	*-1.69*	*-0.35*	*-1.87*	*-0.67*	*-0.85*
12.	$Wholesale\ ratio_{t-1}$	0.00	0.00	-0.004*	0.00	-0.01	0.00	0.00
		-1.29	*-0.58*	*-1.64*	*-0.45*	*-1.19*	*-0.37*	*-1.20*

13.	Number of cross sections	139	52	87	25	18	67	72
14.	Adjusted R^2	0.03	0.04	0.03	0.02	0.04	0.04	0.02

Regressions include a constant. t-ratios under coefficient estimates. **/* reflects significance at 95/90 percent level of confidence. Regressions include cross section and period fixed effects.

Table 3: Dependent variable: $Non - Domestic\ Gov.\ Bond\ ratio$

		I.	II.	III.	IV.	V.	VI.	VII.
		Full sample	**Vulnerable countries**	**Less vulnerable countries**	**Highest EL**	**Highest EL in less vulnerable countries**	**Non-listed**	**Listed**
1.	Lagged dependent variable	-0.04	0.02	-0.07	-0.09	-0.17**	0.02	-0.07
		-1.06	*0.33*	*-1.49*	*-1.01*	*-2.08*	*0.63*	*-1.43*
2.	$EL\ ratio_{t-1}$ ×(1-D^{NIR})	0.00	0.01	0.00	0.00	0.00	0.01**	0.00
		1.07	*0.69*	*0.75*	*0.53*	*0.76*	*2.42*	*0.29*
3.	$\boldsymbol{EL\ ratio_{t-1}}$ **×($\boldsymbol{D^{NIR}}$)**	**0.03***	**0.10**	**0.03**	**0.04***	**0.05****	**0.04***	**0.03**
		1.76	*1.23*	*1.37*	*1.79*	*2.06*	*1.67*	*1.03*
4.	$Liquidity\ ratio_{t-1}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		-1.31	*-0.36*	*-1.23*	*0.97*	*1.01*	*-1.29*	*-0.86*
5.	$Leverage\ ratio_{t-1}$	0.00	0.002**	-0.01	0.00	0.00	0.00	0.00
		0.66	*2.12*	*-1.13*	*-1.03*	*-0.74*	*0.39*	*0.42*
6.	$r_{t-1}^{Loan} - r_{t-1}^{10y}$	0.00006**	0.00	0.0001*	0.0001**	0.0002*	0.00	0.00006*
		2.32	*0.84*	*1.79*	*2.61*	*1.91*	*0.64*	*1.84*
7.	$Core\ ratio_{t-1}$	0.00	0.00	0.00	-0.002*	0.00	0.00	0.00
		1.02	*0.85*	*0.49*	*-1.89*	*-1.39*	*-0.20*	*1.08*
8.	$\log(Assets)_{t-1}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		-1.20	*-0.68*	*-1.27*	*-1.57*	*-1.11*	*-1.11*	*-1.02*
9.	$Rating_{t-1}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		-0.03	*-1.39*	*1.33*	*-0.08*	*1.29*	*-1.53*	*0.09*
10.	$\Delta\log(IP)_{t-1}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1.12	*1.56*	*0.29*	*-0.37*	*-0.76*	*0.16*	*1.40*
11.	$Loan\ ratio_{t-1}$	0.00	-0.01	0.00	-0.01	-0.01	0.01	0.00
		0.24	*-0.53*	*0.35*	*-0.90*	*-1.00*	*0.90*	*-0.26*
12.	$Wholesale\ ratio_{t-1}$	0.00	0.00	0.00	0.00	0.01	0.00	0.00
		0.05	*-0.07*	*-0.17*	*0.69*	*1.58*	*-0.61*	*0.90*

13.	Number of cross sections	139	52	87	25	18	67	72
14.	Adjusted R^2	0.02	0.02	0.02	0.4	0.06	0.02	0.01

Regressions include a constant. t-ratios under coefficient estimates. **/* reflects significance at 95/90 percent level of confidence. Regressions include cross section and period fixed effects.

Table 4a: Robustness checks 1**-** Dependent variable: $Gov.\ Bond\ ratio$

		I.	II.	III.	IV.	V.	VI.	VII.
		Full sample	Vulnerable countries	Less vulnerable countries	Highest EL	Highest EL in less vulnerable countries	Non-listed	Listed
1.	$EL\ ratio_{t-1}$	0.00	-0.04	0.00	0.01	0.01*	0.01	0.00
		0.69	-1.93	0.99	1.80	1.86	1.60	0.55
2.	$EL\ ratio_{t-1}$ ×(D^{08-09})	0.05	0.14	0.04	-0.02	-0.04	0.01	0.08
		1.09	1.03	0.86	-0.40	-1.19	0.17	1.35
3.	$EL\ ratio_{t-1}$ ×(D^{11-12})	-0.01	0.04	-0.01	0.00	0.00	-0.03*	0.00
		-0.89	0.74	-0.61	-0.39	-0.40	-1.76	-0.42
4.	$EL\ ratio_{t-1}$ ×(D^{2013})	0.02**	0.19**	0.01*	0.00	0.00	0.01	0.02
		2.04	2.04	1.68	0.25	0.18	1.48	1.50
5.	$EL\ ratio_{t-1}$ ×(D^{NIR})	0.05**	0.16	0.03*	0.03	0.04	0.05**	0.05
		2.31	1.13	1.73	0.83	1.30	2.81	1.39

t-ratios under coefficient estimates. **/* reflects significance at 95/90 percent level of confidence.

Table 4b: Robustness checks 2**-** Dependent variable: $Gov.\ Bond\ ratio$

		I.	II.	III.	IV.	V.	VI.	VII.
		Full sample	**Vulnerable countries**	**Less vulnerable countries**	**Highest EL**	**Highest EL in less vulnerable countries**	**Non-listed**	**Listed**
1.	$EL\ ratio_{t-1}$ ×(1-D^{NIR})	0.00	-0.01	0.004*	0.01**	0.01**	0.01	0.01
		1.29	*-0.23*	*1.87*	*2.59*	*2.76*	*1.48*	*1.41*
2.	$\boldsymbol{EL\ ratio_{t-1}}$ **×($\boldsymbol{D^{NIR}}$)**	**0.06****	**0.16**	**0.04***	**0.03**	**0.05***	**0.05****	**0.10**
		2.03	*0.85*	*1.71*	*0.89*	*1.82*	*2.00*	*1.45*
3.	$EL\ ratio_{t-1}$ ×(D^{APP})	-0.02	-0.35*	0.00	0.02	0.01	0.04	-0.10
		-0.43	*-1.68*	*0.06*	*0.49*	*0.12*	*1.18*	*-1.36*

t-ratios under coefficient estimates. **/* reflects significance at 95/90 percent level of confidence.

Table 4c: Robustness checks 3**-** Dependent variable: $Gov.\ Bond\ ratio$

		I.	II.
		Less vulnerable countries	**Non-listed**
1.	$EL\ ratio_{t-1}$ ×(1-D^{NIR})	0.004*	0.01
		1.86	1.47
2.	$EL\ ratio_{t-1}$ ×(D^{NIR}) ×($1 - D^{EL}$)	0.07	0.03
		1.14	0.31
3.	$\boldsymbol{EL\ ratio_{t-1}}$ **×($\boldsymbol{D^{NIR}}$) ×($\boldsymbol{D^{EL}}$)**	**0.04***	**0.06****
		1.68	2.66

t-ratios under coefficient estimates. **/* reflects significance at 95/90 percent level of confidence.

Table 5: Dependent variable: $Loans\ ratio$

		I.	II.	III.	IV.	V.	VI.	VII.
		Full sample	**Vulnerable countries**	**Less vulnerable countries**	**Highest EL**	**Highest EL in less vulnerable countries**	**Non-listed**	**Listed**
1.	Lagged dependent variable	0.00	-0.01	-0.02	0.01	-0.02	0.04	-0.01
		0.04	*-0.64*	*-1.07*	*0.28*	*-0.58*	*1.51*	*-0.68*
2.	$EL\ ratio_{t-1}$ ×(1-D^{NIR})	0.0002**	-0.02	0.0002**	0.0002**	0.0003**	-0.02**	0.0002**
		7.05	*-1.28*	*12.96*	*9.21*	*18.74*	*-2.20*	*7.75*
3.	$\boldsymbol{EL\ ratio_{t-1}}$ **×($\boldsymbol{D^{NIR}}$)**	**0.00**	**-0.27****	**0.01****	**0.01***	**0.01****	**-0.11**	**0.01****
		0.66	*-2.39*	*2.56*	*1.90*	*2.03*	*-1.03*	*2.40*
4.	$Liquidity\ ratio_{t-1}$	0.003**	0.01**	0.00	0.00	0.00	0.00	0.004**
		2.32	*2.58*	*1.27*	*0.93*	*-0.08*	*0.27*	*2.39*
5.	$Leverage\ ratio_{t-1}$	0.01	0.00	0.03**	0.02	0.05**	0.02	0.01
		0.44	*0.69*	*2.21*	*0.64*	*3.37*	*1.24*	*0.39*
6.	$BLS\ demand_t$	0.00	0.00001*	0.00	0.00	0.00	0.00	0.00
		0.68	*1.68*	*0.36*	*0.41*	*0.37*	*1.62*	*0.07*
7.	$BLS\ credit\ standards_t$	0.00002**	0.00	0.00002**	0.00003**	0.00003**	0.00002**	0.00002**
		4.14	*-1.05*	*2.10*	*1.93*	*1.93*	*3.37*	*2.49*
8.	r_{t-1}^{Loan}	-0.0002**	0.00	0.00	0.00	0.00	0.00	0.00
		-2.15	*0.86*	*-0.32*	*-0.58*	*-0.06*	*-0.99*	*-1.35*
9.	$Core\ ratio_{t-1}$	0.004*	0.01**	0.00	0.01	0.01**	0.00	0.01*
		1.66	*3.59*	*0.95*	*1.22*	*3.41*	*0.60*	*1.79*
10.	$Borrowing\ ratio_{t-1}$	-0.003**	0.00	0.00	0.00	0.001*	-0.01*	0.00
		-2.06	*-0.03*	*0.73*	*-0.79*	*1.77*	*-1.74*	*-1.49*
11.	$\log(Assets)_{t-1}$	0.00	0.00	0.00	0.0002**	0.001**	-0.001*	0.00
		0.49	*-0.91*	*0.56*	*1.94*	*2.96*	*-1.91*	*0.92*
12.	$\log(IP)_{t-12}$	0.01**	-0.01**	0.00	0.01*	0.00	0.00	0.004*

		2.69	*-2.00*	*0.73*	*1.71*	*0.46*	*1.37*	*1.79*
13.	$Wholesale\ ratio_{t-1}$	0.01**	0.00	0.004**	0.01**	0.003**	0.00	0.01**
		5.48	*0.76*	*2.38*	*2.70*	*1.97*	*0.50*	*5.07*
14.	$Bond\ ratio_{t-1}$	-0.02	0.00	-0.03*	-0.02	-0.03**	0.00	-0.02*
		-1.60	*0.23*	*-1.69*	*-1.26*	*-1.93*	*0.05*	*-1.87*
15.	Number of cross sections	180	64	116	40	30	70	110
16.	Adjusted R^2	0.12	0.22	0.12	0.09	0.09	0.19	0.10

Regressions include a constant. t-ratios under coefficient estimates. **/* reflects significance at 95/90 percent level of confidence. Regressions include cross section and period fixed effects.

Table 6a: Robustness checks 1**-** Dependent variable: $Loan\ ratio$

		I.	II.	III.	IV.	V.	VI.	VII.
		Full sample	**Vulnerable countries**	**Less vulnerable countries**	**Highest EL**	**Highest EL in less vulnerable countries**	**Non-listed**	**Listed**
1.	$EL\ ratio_{t-1}$	0.0002**	-0.01	0.0002**	0.0003**	0.0003**	-0.02**	0.0002**
		7.46	-0.52	12.49	9.50	18.42	-2.08	8.05
2.	$EL\ ratio_{t-1} \times (D^{08-09})$	0.00	0.04	0.00	0.00	-0.00002*	-0.02	0.00
		-1.36	0.92	-1.35	-0.96	-1.68	-0.52	-0.43
3.	$EL\ ratio_{t-1} \times (D^{11-12})$	0.00	0.01	0.00	0.00	0.00	-0.01	0.00
		-1.34	0.58	-1.20	-1.39	-0.58	-0.93	-1.14
4.	$EL\ ratio_{t-1} \times (D^{2013})$	0.00	-0.08**	0.002**	0.01**	0.01**	0.00	0.01**
		0.65	-2.16	2.14	3.17	2.57	-0.29	2.38
5.	$EL\ ratio_{t-1} \times (D^{NIR})$	0.00	-0.26**	0.01**	0.01*	0.01**	-0.10	0.01**
		0.55	-2.62	2.30	1.86	1.97	-0.92	2.23

t-ratios under coefficient estimates. **/* reflects significance at 95/90 percent level of confidence.

Table 6b: Robustness checks 2- Dependent variable: $Loan\ ratio$

		I.	II.	III.	IV.	V.	VI.	VII.
		Full sample	**Vulnerable countries**	**Less vulnerable countries**	**Highest EL**	**Highest EL in less vulnerable countries**	**Non-listed**	**Listed**
1.	$EL\ ratio_{t-1}$ ×(1-D^{NIR})	0.0003**	-0.02	0.0002**	0.0002**	0.0003**	-0.02**	0.0002**
		7.05	*-1.25*	*12.99*	*9.22*	*18.87*	*-2.23*	*7.76*
2.	$\boldsymbol{EL\ ratio_{t-1}}$ **×($\boldsymbol{D^{NIR}}$)**	**0.00**	**-0.32****	**0.01****	**0.01**	**0.01***	**-0.15**	**0.01****
		0.67	*-2.48*	*2.20*	*1.52*	*1.65*	*-1.12*	*2.25*
3.	$EL\ ratio_{t-1}$ ×(D^{APP})	0.00	0.26**	-0.01	0.00	-0.01	0.13	-0.01
		-0.45	*2.67*	*-1.11*	*-0.45*	*-0.57*	*1.28*	*-1.12*

t-ratios under coefficient estimates. **/* reflects significance at 95/90 percent level of confidence.

Table 6c: Robustness checks 3- Dependent variable: $Loan\ ratio$

		I.	II.
		Less vulnerable countries	**Listed**
1.	$EL\ ratio_{t-1}$ ×(1-D^{NIR})	0.0002**	0.0002**
		12.93	7.72
2.	$EL\ ratio_{t-1}$ ×(D^{NIR}) ×($1 - D^{EL}$)	0.05	0.02
		0.95	0.31
3.	$\boldsymbol{EL\ ratio_{t-1}}$ **×($\boldsymbol{D^{NIR}}$) ×($\boldsymbol{D^{EL}}$)**	**0.01****	**0.01****
		2.56	2.39

t-ratios under coefficient estimates. **/* reflects significance at 95/90 percent level of confidence.

Table 6d: Robustness checks 4- Dependent variable: $Loan\ ratio$ (Less vulnerable countries)

		I.	II.	III.
1.	$EL\ ratio_{t-1}$ ×(1-D^{NIR})	0.0002	0.0002*	0.0002
		12.93	12.89	12.90
2.	$EL\ ratio_{t-1}$ ×(D^{NIR}) ×($1 - D^{EL}$)	0.05	0.05	0.05
		0.95	0.98	1.03
3.	$\boldsymbol{EL\ ratio_{t-1}}$ **×($\boldsymbol{D^{NIR}}$) ×($\boldsymbol{D^{EL}}$)**	**0.01****	**0.01****	**0.01****
		2.56	**2.48**	**2.44**
4.	$\boldsymbol{EL\ ratio_{t-1}}$ **×($\boldsymbol{D^{NIR}}$) ×($\boldsymbol{D^{EL}}$) ×($\boldsymbol{D^{Dep}}$)**	**--**	**0.04****	**0.04****
		--	**3.02**	**3.07**
5.	$\boldsymbol{EL\ ratio_{t-1}}$ **×($\boldsymbol{D^{NIR}}$) ×($\boldsymbol{D^{EL}}$) ×($\boldsymbol{D^{Lev}}$)**	**--**	**--**	**0.21***
		--	**--**	**1.88**

t-ratios under coefficient estimates. **/* reflects significance at 95/90 percent level of confidence.

Table 7: Dependent variable: $Wholesale\ ratio$

		I.	II.	III.	IV.	V.	VI.	VII.
		Full sample	**Vulnerable countries**	**Less vulnerable countries**	**Highest EL**	**Highest EL in less vulnerable countries**	**Non-listed**	**Listed**
1.	Lagged dependent variable	-0.12**	-0.04	-0.17**	-0.10*	-0.07	-0.11**	-0.13**
		-3.95	*-1.34*	*-5.19*	*-1.92*	*-1.25*	*-2.64*	*-3.41*
2.	$EL\ ratio_{t-1}$ ×(1-D^{NIR})	0.00	-0.01	-0.01	-0.01	-0.01	-0.05*	0.02*
		-0.10	*-0.26*	*-0.34*	*-0.68*	*-0.85*	*-2.22*	*1.80*
3.	$\boldsymbol{EL\ ratio_{t-1}}$ **×($\boldsymbol{D^{NIR}}$)**	**-0.10****	**-0.05**	**-0.08****	**-0.10****	**-0.09**	**-0.12****	**-0.12****
		-3.19	*-0.45*	*-2.91*	*-2.04*	*-1.42*	*-3.64*	*-2.26*
4.	$Liquidity\ ratio_{t-1}$	-0.01	0.00	-0.01	0.00	0.00	-0.01	0.00
		-1.31	*-0.56*	*-1.40*	*0.15*	*0.10*	*-0.89*	*-0.31*
5.	$Leverage\ ratio_{t-1}$	0.01	0.02*	0.04	0.04	0.03	-0.02	0.03**
		0.98	*1.90*	*1.08*	*0.69*	*0.40*	*-0.96*	*2.09*
6.	$BLS\ demand_t$	0.00	0.00	0.00	0.00004*	0.00	0.00	0.00
		0.38	*-0.58*	*0.32*	*1.97*	*1.18*	*0.06*	*-0.54*
7.	$r^{2y}_{i.t-1} - r^{Deposit}_{i.t-1}$	0.00	0.0006*	0.00	0.00	0.00	0.00	0.00
		0.27	*1.86*	*-0.65*	*-0.37*	*-0.43*	*1.16*	*-0.43*
8.	$Core\ ratio_{t-1}$	0.03**	0.04**	0.03**	0.01	0.01	0.04**	0.03**
		3.92	*2.93*	*3.32*	*0.74*	*0.60*	*3.68*	*3.10*
9.	$Borrowing\ ratio_{t-1}$	0.02**	0.03*	0.02	-0.01	-0.01	0.02	0.02
		1.96	*1.89*	*1.10*	*-1.11*	*-0.69*	*1.51*	*1.56*
10.	$Rating_{t-1}$	-0.0006**	-0.0006*	-0.0005**	0.00	-0.0007**	0.00	-0.0009**
		-2.68	*-1.66*	*-2.31*	*-0.93*	*-2.56*	*-1.40*	*-2.78*
11.	$\Delta\log(IP)_{t-1}$	0.01	0.00	0.01	-0.04**	-0.06*	0.01	0.01
		0.71	*0.15*	*0.21*	*-1.94*	*-1.89*	*0.67*	*0.57*
12.	$Vol(IP)_{t-1}$	-0.0004*	0.00	-0.001**	-0.001*	-0.001**	0.00	-0.0007**

		-1.78	*0.41*	*-2.18*	*-1.87*	*-3.14*	*0.39*	*-3.39*
13.	$Loan\ ratio_{t-1}$	0.12	0.29**	0.06	0.14*	0.05	0.15*	0.09
		1.86	*2.56*	*0.88*	*1.64*	*0.52*	*1.75*	*1.04*
14.	$Bond\ ratio_{t-1}$	0.19**	0.24	0.16*	0.23**	0.28**	0.26	0.12**
		2.01	*1.44*	*1.89*	*2.15*	*2.01*	*1.46*	*2.04*
15.	Number of cross sections	137	50	87	24	18	67	70
16.	Adjusted R^2	0.05	0.05	0.06	0.03	0.04	0.05	0.05

Regressions include a constant. t-ratios under coefficient estimates. **/* reflects significance at 95/90 percent level of confidence. Regressions include cross section and period fixed effects.

Table 8a: Robustness checks 1**-** Dependent variable: $Wholesale\ ratio$

		I.	II.	III.	IV.	V.	VI.	VII.
		Full sample	Vulnerable countries	Less vulnerable countries	Highest EL	Highest EL in less vulnerable countries	Non-listed	Listed
1.	$EL\ ratio_{t-1}$	-0.01	0.04	-0.02	-0.02	-0.02	-0.07**	0.01
		-0.59	0.80	-0.84	-0.70	-0.80	-1.96	0.78
2.	$EL\ ratio_{t-1}$ ×(D^{08-09})	-0.13	-0.16	-0.12	-0.12	-0.14	-0.05	-0.19
		-1.25	-1.24	-1.02	-0.89	-0.91	-0.52	-1.27
3.	$EL\ ratio_{t-1}$ ×(D^{11-12})	0.05*	-0.11	0.06*	0.02	0.01	0.03	0.05
		1.66	-1.61	1.73	0.67	0.41	0.64	1.32
4.	$EL\ ratio_{t-1}$ ×(D^{2013})	0.03	-0.12	0.04	0.03	0.04	0.05	0.02
		0.90	-0.81	1.16	0.76	0.96	0.89	0.63
5.	$EL\ ratio_{t-1}$ ×(D^{NIR})	-0.09**	-0.09	-0.06**	-0.08*	-0.07	-0.06	-0.13**
		-2.77	-0.64	-2.16	-1.70	-1.20	-1.47	-2.43

t-ratios under coefficient estimates. **/* reflects significance at 95/90 percent level of confidence.

Table 8b: Robustness checks 2**-** Dependent variable: $Wholesale\ ratio$

		I.	II.	III.	IV.	V.	VI.	VII.
		Full sample	**Vulnerable countries**	**Less vulnerable countries**	**Highest EL**	**Highest EL in less vulnerable countries**	**Non-listed**	**Listed**
1.	$EL\ ratio_{t-1}$ ×(1-D^{NIR})	0.00	-0.01	-0.01	-0.01	-0.01	-0.05**	0.02*
		-0.13	-0.26	-0.40	-0.68	-0.85	-2.23	1.73
2.	$\boldsymbol{EL\ ratio_{t-1}}$ **×($\boldsymbol{D^{NIR}}$)**	**-0.15****	**-0.04**	**-0.16****	**-0.12**	**-0.11**	**-0.17****	**-0.18****
		-4.30	-0.37	-5.59	-1.46	-1.15	-3.67	-2.62
3.	$EL\ ratio_{t-1}$ ×(D^{APP})	0.15*	-0.06	0.21**	0.05	0.04	0.18**	0.12
		1.72	-0.24	2.39	0.33	0.28	2.45	0.85

t-ratios under coefficient estimates. **/* reflects significance at 95/90 percent level of confidence.

Table 8c: Robustness checks 3**-** Dependent variable: $Wholesale\ ratio$

		I.	II.	III.	IV.
		Full sample	**Less vulnerable countries**	**Non-listed**	**Listed**
1.	$EL\ ratio_{t-1}$ ×(1-$Dummy^{NIR}$)	0.00	-0.01	-0.05**	0.02*
		-0.11	-0.33	-2.21	1.73
2.	$EL\ ratio_{t-1}$ ×(D^{NIR}) ×($1 - D^{EL}$)	-0.03	-0.11	-0.22	0.12
		-0.26	-0.66	-1.09	0.91
3.	$\boldsymbol{EL\ ratio_{t-1}}$ **×($\boldsymbol{D^{NIR}}$) ×($\boldsymbol{D^{EL}}$)**	**-0.10****	**-0.08****	**-0.12****	**-0.14****
		-3.26	-2.89	-3.49	-2.72

t-ratios under coefficient estimates. **/* reflects significance at 95/90 percent level of confidence.

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Annex

Table A1: Summary descriptive statistics

	p25	p50	p75	mean	sd	N
$Gov.\ Bond\ ratio$	-0.0354	0.0000	0.0725	0.0219	1.2627	22,034
$Domestic\ Gov.Bond\ ratio$	-0.0087	0.0000	0.0340	0.0250	0.9532	22,067
$Non-Domestic\ Gov.\ Bond\ ratio$	-0.0012	0.0000	0.0000	-0.0032	0.7730	22,034
$Loans\ ratio$	-0.1458	0.0176	0.2793	0.0566	1.6961	22,116
$EL\ ratio$	0.000	0.000	0.004	0.048	1.304	19,174
$Liquidity\ ratio$	0.218	0.316	0.459	0.352	0.209	22,201
$Leverage\ ratio$	0.042	0.067	0.101	0.080	0.204	22,201
$r^{Loan} - r^{10y}$	-0.671	0.546	1.323	0.113	2.580	16,233
$Core\ ratio$	0.055	0.306	0.507	0.319	0.254	22,201
$\log(Assets)$	9.471	10.449	11.359	10.395	1.429	22,201
$Rating$	5.000	6.000	8.000	7.010	4.163	14,823
$\log(IP)$	4.562	4.610	4.676	4.616	0.086	23,782
$\Delta\log(IP)$	-0.011	0.000	0.010	-0.001	0.025	23,529
$BLS\ demand$	-25.606	-2.993	14.069	-7.182	30.725	23,137
$BLS\ credit\ standards$	-0.458	4.766	19.366	12.769	23.144	23,137
r^{Loan}	2.569	3.585	4.996	3.826	1.588	16,233
$Borrowing\ ratio$	0.000	0.000	0.029	0.036	0.091	22,201

Note: *Gov.Bond ratio, Domestic Gov.Bond ratio, Non-Domestic Gov.Bond ratio* and *Loans ratio* have been multiplied by 100.