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Does liquidity regulation impede the liquidity profile of collateral?

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Abstract

We analyze the pledging behavior of Euro area banks during the introduction of the liquidity coverage ratio (LCR). The LCR considers only a subset of central bank eligible assets and thereby offers banks an arbitrage opportunity to improve their regulatory ratio by altering their collateral pledging with the European Central Bank. We use the existence of national liquidity requirements to proxy for banks' incentives to exploit this differential treatment of central bank eligible assets. Using security-level information on collateral pledged with the central bank, we find that banks without a preceding national liquidity requirement pledge more and less liquid collateral than banks with a preceding national liquidity requirement after the LCR introduction. We attribute the difference across banks to a preparation effect of the liquidity regulation on the national level.

JEL Classification: G21, G28, E42, E52, E58

Keywords: Liquidity regulation, monetary policy, central bank refinancing operations

Non-technical Summary

On 1 October 2015, the liquidity coverage ratio (LCR) was introduced as the first quantitative liquidity requirement for financial institutions on the level of the European Union. The introduction is a direct consequence of the financial crisis in which many financial institutions faced heavy liquidity problems. The LCR requires banks to hold a certain amount of highly liquid assets relative to their expected net cash outflow in case of a stress scenario. Thereby, the LCR is meant to promote banks' resilience to liquidity shocks and to reduce the reliance on the central bank.

This paper provides evidence that Euro area banks have altered their collateral pledging behavior with the European Central Bank (ECB) in response to the introduction of the LCR. The altered pledging behavior indicates that banks have exploited an arbitrage opportunity via the central bank's refinancing operations to improve their LCR value. However, if banks use the arbitrage opportunity to alter their LCR rather than to improve their liquidity risk profile, the arbitrage possibility could leave the LCR being ineffective or increase the reliance on the central bank. Therefore, this research bears important implications for policy makers regarding the potential risk mitigating effect of the regulation.

Banks have the possibility to receive funding from the central bank in exchange for the respective interest rate and sufficient collateral. Which assets are eligible as central bank collateral is defined in the collateral framework. Whereas the collateral framework of the ECB is one of the broadest among central banks world wide, the LCR considers only the most liquid of these ECB eligible assets as highly liquid assets. The respective eligible assets can either be used as central bank collateral or counted as highly liquid asset in the LCR. Hence, the differential treatment of ECB eligible assets within the LCR framework creates the incentive for banks to pledge less liquid ECB eligible assets as collateral with the central bank and correspondingly withhold highly liquid assets to be counted into the LCR. Doing so, the bank can improve its LCR value

without altering its liquidity risk profile. In addition to the differential treatment of ECB eligible assets, the regulatory framework of the LCR directly favors central bank funding over other refinancing sources and thereby sets incentives to increase central bank funding.

We use a proprietary dataset with bank-level information on central bank collateral. The sample consist of the biggest Euro area banks participating in the refinancing operations of the Eurosystem and covers the time period before and after the LCR introduction in October 2015. We use the existence of national liquidity requirements to proxy for banks' incentives to exploit this differential treatment of central bank eligible assets. The conjecture is that in the presence of a preceding national liquidity regulation, the need to alter the pledging behavior in response to the LCR introduction is expected to be less pronounced because those banks already made adjustments to comply with their national liquidity regulation.

Empirically, we find that banks without a national liquidity requirement decrease the average liquidity profile for marketable collateral by over 30% in comparison to banks with a preceding national liquidity regulation. This result supports the hypothesis that banks exploit the arbitrage opportunity via the central bank's refinancing operations to improve their LCR value. Further results regarding non-marketable collateral do not contradict this finding. We also estimate that banks increase the collateral value of pledged non-marketable assets by 6%. Given that non-marketable assets are not considered under the LCR framework, this result suggests that banks either increased their central bank funding with LCR ineligible assets or increased their overcollateralization.

1 Introduction

Following the global financial crisis 2007/2008, the need for profound changes in financial supervision was addressed by the introduction of new regulatory measures. Given the central role of liquidity during the crisis, these measures include standards on liquidity. The liquidity coverage ratio (LCR) was introduced in October 2015 as the first of two quantitative liquidity standards. The LCR measures the liquidity resilience of institutions for the next 30 days in case of a stress scenario by setting the liquidity buffer in relation to the expected net cash outflow.

In this paper, we examine whether the introduction of the LCR had adverse effects on the liquidity profile and the quantity of collateral pledged with the European Central Bank (ECB) to secure its refinancing operations. Whereas the collateral framework of the ECB is one of the broadest among central banks world wide, the LCR framework takes into account only the most liquid of these ECB eligible assets. Such differential treatment of ECB eligible assets creates the possibility to improve the LCR by simply pledging assets as collateral that are considered illiquid according to the LCR, while withholding assets eligible for the LCR. Assets are only included in the LCR calculation if they are not encumbered via any kind of banking activity. Hence, banks face the trade-off to use a liquid asset eligible under the LCR framework for the LCR or within the scope of another banking activity, for example to secure a refinancing operation. In addition to the differential treatment of ECB eligible assets, the LCR framework directly favors central bank funding over other refinancing sources by assigning a zero percent outflow rate. Because this regulatory design creates an incentive to increase central bank funding and to complement the estimation on the collateral liquidity profile, we also consider quantity effects of the LCR introduction on collateral pledged with the central bank.

Investigating whether banks exploit the arbitrage opportunity via the central bank to improve their LCR is crucial for the policy evaluation of the liquidity requirement. The

LCR is meant to promote banks' resilience to liquidity shocks and to reduce the reliance on the central bank. However, if banks use the arbitrage opportunity to alter their LCR value rather than to improve their liquidity risk profile, the arbitrage possibility could leave the LCR being ineffective or increase reliance on the central bank. Hence, this research bears important implications for policy makers regarding the potential risk mitigating effect of the regulation.

We use a proprietary dataset with bank-level information on central bank collateral. These collateral data are based on security-level information and are complemented by regulatory data at the bank level. To identify the effect of the LCR introduction on pledged collateral, we exploit the existence of national liquidity requirements in some Euro area countries. These national regulations preceded the EU-level LCR and have resemblance to it. We hypothesize that banks without preceding national liquidity requirement alter their pledging behavior more extensively than banks with a preceding national liquidity requirement in reaction to the LCR introduction. The conjecture is that in the presence of a preceding national liquidity regulation, the need to alter the pledging behavior in response to the LCR introduction is expected to be less pronounced because those banks already made adjustments to comply with their national liquidity regulation. Thus, we have less reason to expect that these banks with a national requirement exploit the differential regulatory treatment in terms of pledging less liquid collateral or making use of the preferential treatment of central bank funding by increasing the refinancing through the central bank.

To measure a potential reaction in the pledging behavior of banks, we use the natural logarithm of the collateral value as a quantity measure. Whereas we exclude the haircut for the quantity measure, we use it to estimate collateral liquidity by calculating the weighted average haircut of pledged collateral. The haircut depends on the price volatility and uncertainty associated with the valuation of the collateral.[1] Therefore, haircuts are smaller for more liquid assets like those considered within the LCR.

[1] Bindseil et al. (2017)

Because only marketable assets are potentially LCR eligible, we subdivide the total of pledged collateral into marketable and non-marketable assets. Marketable assets include securities, while non-marketable assets comprise, for example, credit claims.

Empirically, we find evidence that banks react to the LCR implementation by altering their pledging behavior with the central bank. The two main findings are that banks without a national liquidity requirement decrease the liquidity profile and increase the quantity of pledged collateral relative to banks that already faced a national liquidity regulation before the introduction of the EU-level LCR. For the collateral liquidity profile we find two opposing effects. While the average liquidity profile for marketable collateral decreases by over 30% for banks without national liquidity requirement, the liquidity of non-marketable assets increases by 8.4%. The decrease in marketable collateral liquidity supports the hypothesis that banks without national liquidity requirement have a higher incentive to exploit the regulatory friction by substituting liquid with less liquid collateral. Given that non-marketable collateral is LCR ineligible, an improvement in its average liquidity is no contradiction to our hypothesis but could be driven by the corresponding increase in pledged non-marketable collateral. Banks without a national liquidity requirement increase the collateral value of pledged non-marketable assets by 6% in comparison to banks with a preceding national liquidity regulation. Given that non-marketable assets are not considered under the LCR framework, this result suggests that banks either increased their central bank funding with LCR ineligible assets or increased their overcollateralization. For marketable assets, we find no statistically significant results concerning the quantity of pledged collateral.

To our knowledge, this paper is the first to consider the effect of liquidity regulation on central bank collateral. It is also one of the first to consider the effect of the LCR implementation at the EU level. Our work is closest to Fuhrer et al. (2017)'s study on the LCR introduction in Switzerland. Whereas we focus on the effect on banks' pledging behavior with the central bank, Fuhrer et al. (2017) provide empirical

evidence of a security price premium for assets considered under the LCR framework as suggested by Stein (2013). They examine the friction of assets considered by the LCR framework and all other assets on the market, whereas we concentrate on the differentiation of LCR eligible and ineligible assets within the collateral framework. Their theoretical analysis hints that the premium is driven by additional demand for these assets, the elasticity of the asset supply, and the possibility of banks to reduce net cash outflows.

Another side effect of liquidity regulation is considered by Bonner and Eijffinger (2016), who find for the Dutch interbank market that liquidity requirements seem to increase long-term borrowing, lending rates and long-term interbank loans. These findings support Bech and Keister (2017)'s theoretical model on the externalities of liquidity regulation, which stresses the influence of liquidity regulation on market conditions and the interest rate and by that affects monetary policy implementation. However, since the introduction of the full allotment policy in 2008, Bech and Keister (2017)'s model no longer applies to the monetary policy transmission of the Euro area given that the policy rate is no longer implemented through the interbank market. As we show, this shift in the regime to implement monetary policy does not imply that liquidity regulation has no effect on monetary policy.

We also contribute to the rather small literature on central bank collateral pledging. Within this strand of literature this paper is closest to Drechsler et al. (2016) and Fecht et al. (2016). Like them, we consider the collateral pledged with the central bank. Whereas we consider the effect of the LCR introduction, Drechsler et al. (2016) and Fecht et al. (2016) study the implementation of the full allotment policy of the ECB in 2008. In contrast to our country-level identification, they provide evidence that weaker banks use lower quality collateral and demand disproportionally more central bank funding. Fecht et al. (2016) highlight the possibility of an implicit support of weaker banks and the limited use of lower quality collateral outside of Eurosystem operations as reasons for using lower quality collateral for central bank operations. One

of these reasons is the default risk of the lender as stressed by Ewerhart and Tapking (2008). In a repurchase transaction, the lender is protected against the default of the borrower via the provision of collateral. To minimize the risk that the transaction is too low collateralised due to price fluctuations of the underlying collateral, appropriate haircuts are applied. However, in case the lender defaults, the borrower faces the problem that very high haircuts were applied and the loss of the collateral is higher than the principal amount of the transaction. Our finding, that the LCR induces banks to pledge lower quality collateral indicates another source of asymmetric opportunity costs of pledging collateral with the central bank. Also for the pre-crisis period, Bindseil et al. (2009) find evidence that opportunity costs differ across collateral types when studying the main refinancing operations of the ECB for a 1-year period in 2000/2001. Hence, asymmetric opportunity costs do not seem to be per se a phenomenon of the unconventional monetary policy of the ECB. Cassola and Koulischer (2016) propose a theory of collateral choice to assess how changes in collateral policy of the central bank influence the collateral type pledged by banks and banks' funding choice. The results suggest that an increase in haircuts applied to collateral belonging to a specific asset class reduces the use of this particular group of assets.

The perspective of the central bank is described by Bindseil and Lamoot (2011), who stress the trade-off between the social benefits due to a broad collateral framework versus the social costs potentially associated with it. While Choi et al. (2017), Cassola and Koulischer (2016), and Koulischer and Struyven (2014) highlight the positive effect of a broad collateral framework on market functionality, De Roure (2016) finds an premium of securities eligible as central bank collateral. Similar to Fuhrer et al. (2017)'s approach for LCR eligible assets, De Roure (2016) provides empirical evidence for the distortion of markets due to the collateral policy of the central bank. Also Kacperczyk et al. (2017) show that central bank eligibility itself is a determinant of a safe asset. Such effects on money and asset markets may reduce market discipline and can create distortions in the real economy like the overproduction of illiquid real assets (Nyborg,

2016, 2017). We focus on the interaction effects of the regulatory LCR framework and the collateral framework which is no externality of the collateral framework per se but the result of the differential treatment of assets by the two frameworks.

The remainder of this paper is organized as follows. Section 2 provides information on the institutional background relevant for this paper. It describes the set up of the LCR and ECB's refinancing operations and emphasizes the friction between the relevant frameworks. Also the identification strategy is described. In Section 3, we present the measurement and data, as well as the empirical specifications to estimate the effect of the LCR introduction on bank's pledging behavior. We discuss our results in Section 4 and present robustness checks in Section 5. We conclude in Section 6.

2 Institutional setting

2.1 Liquidity coverage ratio

The liquidity coverage ratio (LCR) determines the amount of banks' liquidity buffer relative to their expected net cash outflows for the next 30 days. It was introduced with a minimum of 60% in October 2015, followed by an increase to 70% in January 2016, and 80% in January 2017. Banks need to adhere to the final minimum requirement of 100% by January 2018. The regulation applies to all EU credit institutions.[2]

In the context of the LCR the liquidity buffer is referred to as the sum of high quality liquid assets (HQLA) held by the respective bank:

$$\text{Liquidity Coverage Ratio} = \frac{\text{High Quality Liquid Assets}}{\text{E[Net cash outflow]}_{30\text{days}}}.$$

HQLA are defined in the legal framework of the LCR and include assets like reserves, marketable government, and central bank securities, but also corporate debt securities

[2]Commission Delegated Regulation (CDR) (EU) 2015/61 of 10 October 2014

of non-financial institutions and covered bonds.[3] The amount of HQLA is calculated based on the market values of the individual assets which are adjusted by respective haircuts. To calculate the expected net cash outflow, liquidity inflows and outflows are evaluated for a 30 day stress period. Outflows and inflows are calculated by multiplying balance sheet and off-balance sheet holdings with a maturity lower than 30 days with inflow/outflow rates assigned to them.[4] These rates are also defined in the LCR framework. They are based on a combination of idiosyncratic and market wide stress scenarios. To improve their LCRs, banks can consequently either increase their HQLA holdings by altering their asset side or opt for funding sources with lower outflow rates.

It is important to note that HQLA are only considered for regulatory purposes if they are not encumbered via any kind of banking activity. Hence, with the introduction of the LCR, banks face the trade-off to use a liquid asset eligible under the LCR framework as HQLA or within another banking activity, for example to secure a refinancing operation.

2.2 Central bank refinancing operations

Since the introduction of the full allotment policy in October 2008, European financial institutions can receive unlimited amounts of liquidity at the main refinancing rate and against adequate collateral during the weekly auctions of the ECB. Like in an ordinary repurchase transaction the borrower (bank) must provide a sufficient amount of collateral to the lender (central bank) at the start date. At the end date of the transaction the borrowed amount plus interest payments are returned to the lender, while the collateral is returned to the borrower (see Figure 1).

Within the Eurosystem, all assets pledged as collateral with the central bank belong to the collateral pool of the respective bank. Put differently, banks do not pledge one particular asset to secure a certain amount of funding, but the value of the collateral

[3] For more details consider title 2, chapter 2 of the CDR (EU) 2015/61.
[4] For more details consider title 3 of the CDR (EU) 2015/61.

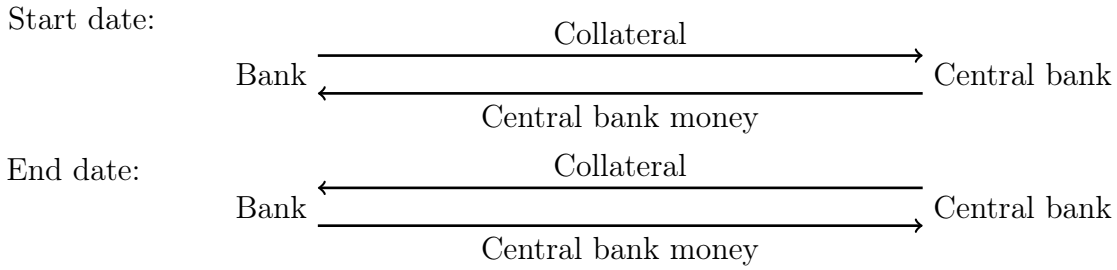

Figure 1: Central bank refinancing operation

Notes: The figure shows the transactions of a central bank refinancing operation. From the start date onwards, the bank has to provide central bank eligible collateral to the central bank to secure the amount of central bank money received from the same. On the end date, the bank is free to withdraw its collateral after repaying the principal amount and the interest obligations to the central bank.

pool has to cover the face value of central bank refinancing operations.

Assets pledged with the central bank as collateral need to be eligible for the collateral framework. The collateral value of asset i is the asset price at date t times one minus the assigned haircut.[5] In contrast to the asset price, haircuts are not revalued every business day but are fairly stable over time. The haircut is a percentage discount to account for the risk of loss that the asset possess and is applied to protect the Eurosystem against financial losses in case the collateral has to be realized due to an default of the counter-party. Counter-party risk is not considered in haircut considerations but is indirectly included by applying counter-party eligibility criteria (Bindseil et al., 2017).[6]

The asset price is the price of the business day preceding the valuation day. For marketable assets, like ECB debt certificates and other marketable debt instruments, the asset price is usually the most reliable market price.[7] However, for non-marketable assets like credit claims, retail mortgage-backed debt instruments and fixed-term deposits from eligible counter-parties either a theoretical model calculates the asset price or the outstanding amount is used as such.[8]

Bindseil et al. (2017), Nyborg (2016, 2017), BIS Markets Committee and others (2013), and Eberl and Weber (2014) provide detailed discussions on ECB's collateral framework and risk mitigation procedures.

[5] Collateral value$_{it}$ = asset price$_{it}$ $*$ (1 − haircut$_{it}$)
[6] For details: https://www.ecb.europa.eu/ecb/legal/pdf/celex_32016o0032_en_txt.pdf.
[7] For details: http://www.ecb.europa.eu/paym/coll/standards/marketable/html/index.en.html.
[8] For details: http://www.ecb.europa.eu/paym/coll/standards/nonmarketable/html/index.en.html.

2.3 Friction and identification

Our research question is motivated by the friction of the ECB's collateral framework and the assets considered as HQLA within the LCR framework. While the collateral framework covers a broad range of marketable assets and non-marketable assets, the LCR framework considers only the most liquid marketable assets as HQLA.

The differentiation of assets in HQLA and non-HQLA creates additional regulatory value for HQLA (Fuhrer et al., 2017). Given that the distinction is also present within the collateral framework, the increase in regulatory value also affects banks' pledging behavior with the central bank. Instead of using HQLA to secure central bank operations, banks have an incentive to keep HQLA unencumbered to let them be counted into the LCR. While the LCR regulation framework punishes the switch to less liquid collateral with other counter-parties by increasing the outflow rate, and therefore the denominator of the LCR, the outflow rate for central bank operations is independent of the underlying collateral.[9] Therefore, it is reasonable to expect that with the introduction of the LCR banks are more likely to pledge non-HQLA instead of HQLA to secure central bank operations.

In addition to this friction induced mechanism there is another potential channel affecting the pledging behavior of banks with the central bank. Regulators consider central bank funding as 100% stable and therefore assign an outflow rate of 0%. In contrast, other refinancing sources considered secure like stable retail deposits, have an outflow rate of at least 5% and outflow rates for operational deposits are not below 25%. Hence, the introduction of the LCR and the variation in outflow rates across different funding sources can induce banks to switch from high-outflow-rate-funding sources to funding sources with lower outflow rates and by that increasing its LCR via reducing the denominator of the ratio. The substitution of funding sources would have

[9] If a bank switches its collateral from HQLA to non-HQLA to secure non-central bank funding source, the applied outflow rate increases to 100 %. Short-term funding secured by HQLA has outflow rates of only 0% to 50%. For further details on the exact outflow rates consider Article 28 of the Commission Delegated Regulation (EU) 2015/61.

an direct effect on the quantity of collateral pledged with the central bank and could have an indirect effect on the liquidity profile of collateral.

Summing up, the introduction of the LCR in the context of the ECB's collateral framework can influence the pledging behavior of banks with the central bank via the incentive to substitute HQLA with non-HQLA and the substitution of funding sources.

These arbitrage opportunities undermine the effectiveness of liquidity regulation, given that the intention of liquidity regulation is to reduce the reliance on central bank funding in times of economic stress. The reason for this issue is the problematic distinction between structural and regulatory liquidity needs. Turning to the central bank to demand funding, a bank might want to satisfy regular funding needs due to business activities, not to exploit the arbitrage opportunity of the LCR framework. Treating central bank funding stricter within the LCR framework is also not reasonable as it is a secure funding source especially in times of distress. Hence, to avoid that banks face even more costs due to liquidity regulation, central bank funding is preferentially treated.[10] Bindseil and Lamoot (2011) give an extensive description and discussion of the separate treatment of liquidity regulation and the central bank's operational framework and the unwanted interactions stemming from it.

To identify the potential effect of this friction, we exploit the fact that in 12 out of 19 Euro area countries the EU-wide LCR was preceded by a national liquidity requirement comparable to the EU-level counterpart (Figure 2 in the appendix). The national regulation either has or had a time horizon of 30 days or a similar calculation of liquid assets, cash outflows, and inflows. We assume that in the presence of a preceding national liquidity regulation the need to alter the pledging behavior in response to the LCR introduction is less pronounced because those banks already made adjustments, for example reducing their liquidity risk profile or altering the pledging behavior, to comply with their national liquidity regulation. Thus, we have less reason to expect that these banks with national liquidity requirement exploit the differential regulatory

[10] In the theoretical literature, Stein (2013) suggests to use central bank funding to cap the tax of liquidity regulation. However, the author does not comment on the consequences.

treatment.

Although national liquidity requirements are not exogenous to the liquidity holdings of the national banking sector, they are far less endogenous than individual liquidity indicators like the LCR value itself. To control for effects of differences in the regulatory design of the liquidity requirements, we control for the regulatory toughness and the intensity of the LCR introduction in Section 4.3.

3 Method and data

3.1 Measurement and Data

We obtain data of banks' pledging behavior from the ECB. At weekly frequency, we observe which bank pledged what kind of asset on the security level. These information are combined with regulatory bank-level data of the Single Supervisory Mechanism (SSM).

To evaluate the pledging behavior of banks, we consider the liquidity profile and the quantity of the collateral pool. Similar to Fecht et al. (2016) and Drechsler et al. (2016), we measure the liquidity profile of collateral using the weighted average haircut for each bank's collateral pool in time t. The advantage of using the weighted average haircut is that it is available for marketable and non-marketable collateral. Given that haircuts are meant to reduce the probability of losses in case the borrower defaults and the collateral has to be liquidated, less liquid assets like non-HQLA have higher haircuts than more liquid assets like HQLA.

The quantity of pledged collateral is measured by the natural logarithm of the total value of the collateral pool, which is the sum of all assets pledged as collateral excluding haircuts. The collateral value is not the exact amount of requested central bank funding, but is closely connected to it. Disparity arises because banks tend to pledge more collateral than needed to secure the principal amount of the central bank loan. In

the private market so called overcollateralization is used to reduce refinancing costs. In the context of central bank funding, overcollateralization has no effect on the required interest rate, but is likely done to account for variations in the daily valuations of the pledged collateral. Also fluctuations in the demand for central bank funding can lead to overcollateralization, if the respective bank does not adjust its pledged collateral accordingly.[11] Collateral pledged with the central bank is legally encumbered. As mentioned in Section 2.1, encumbered assets cannot be sold until the debt is satisfied or used to secure other transactions. Hence, banks have an incentive to limit their overcollateralization. Also the legal framework of the LCR claims that HQLA can not be encumbered. Despite this legal requirement, in practice, assets pledged with the central bank in excess to the required amount of collateral are included in the calculation of the LCR, provided these assets are HQLA. Thereby, non-HQLA are considered first and only if this amount is not sufficient to secure the credit claim of the central bank, HQLA are considered as collateral. This practice can limit the incentive of banks to substitute their HQLA within the collateral pool with non-HQLA due to the LCR introduction. They can simply add a sufficient amount of non-HQLA and by that increase overcollateralization to the extend that the HQLA included in the collateral pool is not needed to secure the refinancing operation with the central bank. Whether this practice is reasonable in the sense of an efficient use of assets could be questioned, however, it can not be ruled out with certainty. Hence, the quantity of collateral is no exact proxy for the quantity of central bank funding because we can not distinguish whether a change in the amount of pledged collateral value is due to a change in central bank funding or a change in overcollateralization. However, in both cases the effect of the LCR introduction on the quantity of collateral is of interest for us because it either indicates whether banks take advantage of the preferential treatment of central bank funding or complements the results for collateral liquidity profile. An increase in overcollateralization because non-HQLA is added but HQLA is not withdrawn, can

[11] For example, banks with a significant demand for intraday credit are likely to hold substantial end-of-day overcollateralization.

lead to an underestimation of the effect of the LCR introduction with the remaining HQLA in the collateral pool diluting the change in the weighted average liquidity. In general, the estimates on the quantity of pledged assets complement our results because a change in the quantity offers alternative explanations for the change in the collateral liquidity profile next to the substitution of collateral. For example, the liquidity profile decreases when banks withdraw the most liquid assets first, or add less liquid assets to their collateral pool.

We distinguish the collateral pool into the sub-categories marketable and non-marketable collateral because non-marketable collateral is never considered to be a HQLA, while marketable collateral can be both. Hence, considering marketable and non-marketable collateral separately disentangles potentially contrary effects.

Our sample covers 77 banks supervised by the SSM that hold a collateral pool to back their borrowings during our sample period. Since our covariates are end of quarter measures, we use the latest available weekly observation within the respective quarter. The amount of collateral pledged by our sample banks covers approximately 47% of collateral value pledged with the ECB for the two sample periods.[12] This magnitude is reasonable given that only the largest and most significant banks of the Euro area are supervised by the SSM. Our baseline specification considers two cross-sections, the second quarter of 2015 and the first quarter of 2016. We exclude the intermediate period, Q3 and Q4 2015, to control for anticipation effects, which are likely because of the end-of-period set up of our data. Q3 2015 is likely to show anticipation effects as the regulation came into force on the 1st of October 2015.[13] Therefore, it is likely that banks already adjusted their pledging behavior end of September. The period Q4 2015 is excluded because it is likely to show anticipation effects of the first LCR increase in January 2016, when the minimum threshold was increased from 60% to 70%.[14] To

[12]Our end of quarter aggregate divided by the average of the three end of month observations over the respective quarter. The aggregate data are available here: https://www.ecb.europa.eu/paym/coll/charts/html/index.en.html.

[13]Article 39, Commission Delegated Regulation (EU) 2015/61

[14]Article 38, Commission Delegated Regulation (EU) 2015/61

avoid the uncertainty that estimated effects are due to the LCR introduction or due to anticipation effects of the following increase in the LCR requirement, we consider both events as one treatment and consider Q1 2016 as the first post-treatment period.

We restrict our baseline sample to two cross-sections to reduce the possibility of confounding events. In Section 5 we test how sensitive our estimates are regarding the sample period by extending the two cross-sections to a panel as well as including the treatment period. Furthermore we include bank-level controls from the harmonized reporting standards, the common solvency reporting (COREP) and the financial reporting (FINREP), of the SSM.

As stressed in Section 2.3, banks are defined in two groups: banks with *no national liquidity requirement* (NNLR) and banks with national liquidity requirement. Table 1 presents mean and standard deviation for each group per pre- and post-treatment period as well as the difference, and the statistical significance of the difference of the pre- and post-period. For the two pre-treatment samples, we find no significant differences in the covariates. For the post-treatment period, covariates remain to be not significantly different except for capital ratio and deposits of financial institutions. For the left-hand side variables, we find that in the pre-treatment period only marketable collateral value is significantly different for NNLR and non-NNLR banks, while all the liquidity profile measures are significantly different in the post-treatment-period. More details on individual variable definitions are provided in the appendix by Table 8.

- Insert Table 1 around here -

3.2 Empirical specification

With the implementation of the LCR, we hypothesize that banks have an incentive to alter their collateral pledging behavior with the central bank as it offers the possibility to improve the regulatory ratio and thereby ease the regulatory burden. To identify the effect of the EU-wide introduction on banks' pledging behavior we use country-

level information on national liquidity requirements preceding to the EU-wide LCR implementation and employ a difference-in-difference set up. To evaluate the pledging behavior of banks, we consider the average weighted haircut of pledged securities for bank i of country j in period t and the natural logarithm of the amount of collateral after haircuts pledged by bank i of country j in period t as dependent variable (Y_{ijt}).

$$\begin{aligned} Y_{ijt} = \alpha_i + \alpha_t + \gamma X_{it-1} \\ + \beta_1 NoNationalLiquidityRequirement_j * PostLCR_t + \epsilon_{ijt} \end{aligned} \tag{1}$$

The binary dummy variable $NoNationalLiquidityRequirement_j$ is one if country j did not have some kind of liquidity requirement comparable to the EU-level LCR and zero if there was or still is a national liquidity regulation in place. The main coefficient of interest, β_1, is showing the differential effect of the LCR introduction ($PostLCR_t$) on banks without national liquidity requirement ($NoNationalLiquidityRequirement_j$). $PostLCR_t$ is a time dummy, which is equal to one for the post-treatment period(s). We control for bank fixed effects, α_i, time fixed effects, α_t, and cluster standard errors at the bank level. All covariates (X_{it-1}) are lagged by one period to reduce simultaneity concerns. Because this does not solve the issue of possible reverse causality, our estimates should be interpreted as correlations.

In a second step, we control for country and bank-specific effects by extending the interaction term with a third indicator variable. As a placeholder, this variable is named $Treated_{i/j}$. It is either defined on the bank level i or the country level j.

$$\begin{aligned} Y_{it} = \alpha_i + \alpha_t + \gamma X_{it-1} + \beta_1 PostLCR_t * Treated_{i/j} \\ + \beta_2 PostLCR_t * NoNationalLiquidityRequirement_j \\ + \beta_3 PostLCR_t * Treated_{i/j} * NoNationalLiquidityRequirement_j + \epsilon_{ijt} \end{aligned} \tag{2}$$

As for the baseline specification, we include bank and time fixed effects and cluster standard errors at the bank level.

4 Results

Due to the differential treatment of identical assets under the collateral framework and the LCR regulation, as well as the preferential treatment of central bank operations within the LCR framework, banks have the opportunity to reduce the regulatory burden of the LCR implementation by altering their pledging behavior with the central bank.

4.1 Do banks alter the liquidity profile of pledged collateral?

Using the pre-treatment period Q2 2015 and the post-treatment period Q1 2016 to estimate the effect of the EU-wide LCR introduction, we first consider the liquidity measure as dependent variable. The results are shown by Table 2.

We find no macro-level evidence of the LCR introduction by regressing only the treatment dummy, $PostLCR_t$, on the collateral haircut. Column (1) shows that for the haircut no statistically significant effect of the LCR introduction can be estimated. The same applies to the group indicator, $NNLR_i$, (column (2)). When estimating the difference-in-difference specification of Equation (1) without controlling for observables or unobservables, the individual effects of the two indicators, as well as the interaction term remain insignificant (column (3)). However, the low (within) R-squared of this model indicates a high level of noise within the data. Therefore, we extend our analysis by controlling for bank-specific characteristics in column (4) and by including bank and quarter fixed effects in column (5). The regression model shown by column (4) controls for bank size, capital ratio, returns on assets, loan ratio, debt instruments, interest income, deposits of financial institutions, household deposits, and interest expenses.[15]

[15]While the literature provides ambiguous results concerning the relevance of bank size on banks' liquidity holdings (Delechat et al. (2012), Kashyap et al. (2002), and Aspachs et al. (2005)), Drechsler et al. (2016) provide strong evidence for the significance of banks' capitalization for the magnitude of central bank funding as well as the quality of pledged collateral. Controlling for return on assets, we follow the lender of last resort literature and the argumentation that central banks should lend to "illiquid but solvent" banks (Choi et al. (2017), Rochet and Vives (2004), and Delechat et al. (2012)). Given that alternative adjustment strategies can reduce the need to alter the pledging behavior of a bank, we control for changes in banks asset holdings by including loan ratio, debt instruments, and interest income. To control for changes in the quality of bank holdings is also important because collateral liquidity could be directly affected by changes of the same. Besides increasing their relative

For the specification with bank controls the coefficient of the LCR-introduction indicator is statistically significant. The effect of 3 percentage points accounts on average to a rise of 25% in the weighted average haircut (column (4)). An increase in the weighted average haircut represent a decrease in the collateral liquidity profile. The interaction coefficient of the NNLR indicator and the treatment dummy remains insignificant in column (4) and continues to have no statistical relevance, also when we control for unobservables by including bank and time fixed effects (column (5) and (6)). Unobservables like asset purchase programs (APPs) or changes in the collateral framework affect banks' asset holdings and, therefore, are very likely to have an effect on banks' pledging behavior with the central bank. Hence, it is reasonable to account for them in our estimation.

- Insert Table 2 around here -

When disaggregating the overall collateral liquidity measure in marketable haircut and non-marketable haircut and including bank-level controls, we estimate a highly significant correlation of the LCR introduction indicator for the haircut of marketable collateral (column (7)). This result suggests that the average haircut of marketable collateral increased after the LCR introduction. However, the national liquidity regulation indicator seems to be of no statistical relevance (column (8)). Estimating the difference-in-difference specification with time and bank fixed effects, we find evidence that banks with no preceding national liquidity requirement increased their marketable haircut by nearly 1.8 percentage points more than banks with a preceding national liquidity regulation after the LCR implementation (column 9). With respect to the mean of the sample, the estimated effect accounts to an increase of over 30% in the marketable haircut. This estimate is in line with our hypothesis that NNLR banks have a higher incentive to switch to less liquid collateral, exploiting the arbitrage opportunity

HQLA holdings, banks can reduce the denominator of the ratio by decreasing the expected outflows. Therefore, we include deposits of financial institutions, household deposits, and interest expenses, to control for changes in refinancing sources considered stable (household deposits) or unstable (deposits of financial institutions) within the LCR framework (Bindseil, 2013; Cornett et al., 2011). For a detailed definition of the variables refer back to Table 8 in the appendix.

of central bank collateral pledging. For the haircut of non-marketable collateral, we find no macro-level effect of the LCR introduction or the national regulation indicator (column (10) and (11)). For the specification of Equation (1), we estimate a decrease of -2.7 percentage points (column (12)). With a mean of more than 32 percentage points, this result accounts to a decrease of 8.4% in the average non-marketable haircut. The high mean of the non-marketable haircut is not necessarily due to a lower overall quality of non-marketable collateral compared to marketable collateral but is instead due to the valuation (nominal amount for non-marketable assets) method and the lower liquidity of non-marketable assets in general.

These estimates support the hypothesis that the LCR introduction creates an incentive for banks to pledge less liquid collateral. The findings are also in line with the assumption that banks without preceding national liquidity requirement are more responsive than banks with preceding national regulation. While the finding of the drastic decrease in the liquidity of marketable collateral of NNLR banks is straight forward, the improvement of the average liquidity of non-marketable collateral is not. However, given that non-marketable assets are never HQLA, we can state that the improvement in the liquidity of non-marketable collateral is no contradiction of the hypothesis.

4.2 Do banks alter the quantity of pledged collateral?

We repeat our estimations for the liquidity profile of pledged collateral with the natural logarithm of the amount of pledged collateral after haircuts as dependent variable to evaluate whether the introduction of the LCR had an effect on collateral quantity.

We find no macro-level evidence for an effect of the LCR introduction, $PostLCR_t$, on the total collateral value as shown in column (1) of Table 3. Also the absence of a preceding national liquidity requirement, $NNLR_i$, is not of statistical significance for the quantity measure (column (2)). When also including the interaction term of the two indicator variables, the individual terms, as well as the interaction term remain

insignificant as shown by column (3). Like for the liquidity measure, the estimated (within) R-squared is very small. To control for the noise in the data, we again include the bank controls used for collateral liquidity profile. The estimates in column (4) show that the interaction term and the individual terms of the two indicators remain insignificant when including bank controls. However, the estimate for the interaction term is highly significant for the regression with the fixed effects shown in column (5). Including time and bank fixed effects, as well as covariates, the interaction term remains highly significant. Bank size and capital ratio are no longer significant when including the fixed effects, but interest income and interest expense show statistical relevance (column (6)).

- Insert Table 3 around here -

As for the liquidity profile of collateral, we distinguish between marketable and non-marketable collateral. We find no macro-level effect of the LCR introduction on the marketable collateral value (column (7)), but a significant effect of the national regulation indicator (column (8)). This result suggests that NNLR banks seem to pledge on average approximately 9% more marketable collateral than banks with a preceding national liquidity requirement. Given that we do not control for unobservables, this estimate should not be overstated. However, it supports our assumption that banks with preceding national regulation already made adjustments in response to the national regulation, either in their liquidity risk profile or by altering their pledging behavior. For the marketable collateral value, we find no statistically significant effect of the interaction of the NNLR indicator and the LCR-introduction indicator when estimating the specification of Equation (1) (column (9)). For non-marketable collateral value as dependent variable, the LCR introduction dummy is statistically significant, while the group indicator is not (column (10) and (11)). These estimates suggest that banks increased the value of non-marketable collateral on average by over 4% in response to the LCR introduction, but that there is no fundamental difference for NNLR and non-NNLR banks. As mentioned before, given that we do not control for time and

bank specific fixed effects, the estimates of the individual coefficients of the indicator variables should be considered with care. Column (12) shows that estimating the specification of Equation (1), we find that the interaction coefficient is highly significant for non-marketable collateral value.

The estimates in column (6), (9), and (12) indicate that NNLR banks increased the collateral value pledged with the ECB in comparison to non-NNLR banks during the LCR introduction. This increase in collateral value seems to be driven by non-marketable collateral. In terms of economical significance, banks increase the non-marketable collateral value pledged with the central bank by approximately 6% more than banks with a preceding national liquidity requirement. The results complement our estimations for the liquidity measure of pledged collateral. The estimated improvement in the weighted average liquidity of the non-marketable collateral could be driven by the increase in pledged collateral. Because we can not distinguish whether the increase in pledged collateral is driven by an increase in central bank funding or overcollateralization, we can not be sure that the preferential treatment of central bank funding within the LCR framework has enhanced the demand for central bank funding backed by non-HQLA. If the estimated increase in the quantity of pledged collateral is due to overcollateralization, this would have implications for the results on the collateral liquidity profile. With HQLA remaining in the collateral pool, the estimated effect of the added non-HQLA on the weighted average liquidity of the collateral pool is weaker, compared to if the HQLA are withdrawn and substituted by non-HQLA. Therefore, the estimated effect of the LCR introduction on the liquidity profile of pledged (and required) collateral could be underestimated with an increase in overcollateralization. Both cases, the increase in overcollateralization and the increase in central bank funding, do not stand in contrast to our hypothesis.

Concerning the preparation effect of the national liquidity requirement, we find evidence that banks with a preceding national liquidity requirement pledge less marketable collateral compared to NNLR banks.

4.3 Heterogeneities

Since certain countries were more exposed than others to the financial crisis and the sovereign debt crisis, we extent our analysis by controlling for the so called GIIPS countries, Greece, Ireland, Italy, Portugal, and Spain. While time fixed effects control for uniform factors across banks, the GIIPS indicator accounts for differences across the two country groups, GIIPS and non-GIIPS. Such a group specific confounding factor is for example the unconventional monetary policy of the ECB, especially the APPs. Table 4 reports the estimates for total, marketable, and non-marketable haircut and the total, marketable and non-marketable collateral value.

- Insert Table 4 around here -

For the total and marketable haircut we estimate no significant GIIPS specific effect of the LCR introduction. The LCR-introduction-NNLR interaction estimates are in line with our baseline results (column (1) and (2)). Column (3) shows that the previously estimated relative reduction in the non-marketable haircut of NNLR banks in response to the LCR introduction is driven by NNLR-GIIPS banks. This is not surprising given that more than 40% of the observations are from NNLR-GIIPS banks (Italy, Portugal, or Spain). Only for marketable collateral (column (5)), we find a weakly significant effect of the triple interaction but no statistically significant effect for the non-marketable collateral value (column (6)). These results contrast with our baseline results which indicate an increase in non-marketable collateral value.

Until the final minimum requirement was reached in January 2018, member states could maintain or introduce national liquidity regulations in addition to the LCR.[16] To control for this, we specify an indicator called toughness (TH). TH is equal to one if the bank faces a national liquidity requirement even after the LCR was introduced. Table 9 in the appendix provides further details on which country kept/reviewed to keep its national liquidity requirements. Since we are not aware of a country to have

[16]Paragraph 5, article 412, CRR 2013

introduced a new national regulation for the implementation period of the LCR, the triple interaction term of Equation (2) drops out. The estimated results are reported by Table 5. For all dependent variables, the estimated LCR-introduction-NNLR interaction effects are consistent with the baseline results. Only for the non-marketable haircut, we estimate a (weakly) significant negative effect of the LCR introduction for banks with an additional national liquidity requirement. Although the finding for the non-marketable haircut is difficult to rationalize, the estimates provide no evidence that the retention of a national liquidity requirement is of high relevance for banks reaction to the LCR introduction.

- Insert Table 5 around here -

Besides their national liquidity regulation, countries have the discretion to introduce the LCR immediately with 100% rather than opting for the step wise introduction.[17] Introducing the LCR with 100% is called front-loading and can be considered a harsher implementation strategy as it puts additional burden on affected banks. We control for the potential effect of front-loading by introducing the indicator FL. FL is one if a country requires a LCR minimum of 100% from its banks from October 2015 onwards. Table 9 (appendix) provides country specific details. The estimates reported in Table 6 show that front-loading seems to have no NNLR-LCR-introduction specific effect on the liquidity profile or the quantity of pledged collateral. The estimated effects for the LCR-introduction-NNLR interaction term are consistent with the baseline results. Only for the non-marketable haircut, we estimate a positive and significant effect of the LCR-introduction-front-loading interaction (column 3). This result supports the hypothesis that front-loading puts additional pressure on affected banks.

- Insert Table 6 around here -

While the results of marketable collateral are very consistent, the findings for non-marketable collateral show that multiple effects are at work.

[17] Paragraph 1, article 38 of the Commission Delegated Regulation (EU) 2015/61. For details regarding the step wise introduction see Figure 6 in the appendix.

5 Robustness

To test whether certain countries drive the results, we include one country specific-LCR-introduction dummy at a time in the empirical specification. We find that the estimates of the LCR-introduction-NNLR-interaction coefficient are in line with the baseline results for each of the 6 dependent variables (Table 10 in the appendix). The coefficient estimates of the respective country specific LCR-introduction-NNLR-interaction is only occasionally significant. The results are also robust when excluding one country after another from the sample (Table 11 in the appendix) except for the specification with the non-marketable haircut as dependent variable when Italy is excluded. In this case the interaction effect is no longer significant but remains negative. This result is likely due to the substantial reduction in observations from 104 to only 80 observations.

The possibility to improve the LCR by exploiting the friction of the collateral framework and assets considered as HQLA is open to every bank with access to the Eurosystem's refinancing operations. However, the incentive to do so might differ for the individual bank. Fecht et al. (2016) and Drechsler et al. (2016) provide evidence that especially weaker banks exploit the credit-risk loophole of central bank refinancing operations by requesting a greater quantity of funding and by pledging riskier collateral.

With the introduction of the LCR the relative opportunity costs to pledge HQLA instead of non-HQLA increases. The magnitude of this change in evaluations depends on the individual situation of the bank. A less solvent or liquidity constraint bank might be more heavily hit by the regulatory shock of the LCR implementation, while a collateral scarce bank might not have the opportunity to exploit the friction of the two frameworks in the first place. Figure 3, 4, and 5 in the appendix show the marginal effects of the triple interaction term $PostLCR$-NNLR-$Treated$ when $Treated$ is defined based on the bank characteristics z-score, risk adjusted returns, or risk density.[18] The three figures show that our baseline results are unlikely to be driven by banks

[18] To limit the number of graphs, we consider only the collateral value and the haircut of marketable and non-marketable collateral as dependent variables.

with certain bank characteristics like a high risk to default (low z-score), low financial stability (low risk adjusted returns), or a high liquidity need/low ratio of central bank eligible assets (high risk density).

In our estimations we solely consider two cross-sections to avoid confounding events. Potential confounding factors are changes in the collateral framework, APPs, targeted longer-term refinancing operations (TLTROs), and other regulatory or monetary policy events. Confounding factors which equally affect all sample banks are captured by the included time fixed effects. However, bank specific differences in the effect of those factors are not considered. Concerning the collateral framework, we are aware of only one change during our sample period. Since November 2015 non-marketable debt instruments backed by eligible credit claims can be used to secure refinancing operations with the ECB.[19] This particular change in the collateral framework affects the eligibility of non-marketable collateral and therefore can only influence our estimates concerning the total and non-marketable collateral measures. Other than this change, we are not aware of any changes in the collateral framework, and also of no change concerning the applied haircuts or the evaluation techniques. Like changes in the collateral framework, APPs affect the amount and composition of central bank eligible asset holdings of banks. Considering that our sample covers only very large banks, we can expect that all sample banks are affected by the APPs and that these uniform effects are captured by time fixed effects. A likely difference in the effect of APPs on sample banks is between crisis and non-crisis banks. For such a GIIPS specific effect of the APPs, we control in Section 4.3. A similar argumentation can be applied to banks' participation in TLTROs. TLTROs could affect our results because they provide an incentive to increase central bank funding due to their long maturity (up to four years) and attractive interest rates. TLTROs were first introduced in September 2014 and from then on were exercised with a quarterly frequency throughout our sample period. In addition to time fixed effects, we control for bank specific differences in regard to the TLTROs by including the loan share in banks' balance sheets within our regressions.

[19] Alvarez et al. (2017) and Bindseil et al. (2017)

Doing so is relevant because the amount that banks can borrow is linked to the amount of loans they provide to non-financial corporations and households. In addition, Bock et al. (2018) provide evidence that TLTRO funding was used to replace other, shorter maturity refinancing operations like the longer-term refinancing operations and not so much to increase central bank funding.[20] Furthermore, we are not aware of other regulatory events occurring during the sample period and affecting banks' asset holdings or their decision on what to pledge with the central bank.

Another source of possible bias concerning our estimations is the practice of pledging too much collateral. Overcollateralization is already mention in Section 3.1 in regard to the informative value of the variable collateral value. We expect excess collateral to reduce the volatility of the liquidity profile and the quantity of pledged collateral. In this regard, the change in the weighted average haircut is likely to be underestimated, given that banks are more likely to pledge less liquid collateral in excess already. The change in quantity of pledged collateral could also be underestimated because the magnitude of excess collateral could be reduced if the overall demand of central bank funding increases.

To test how sensitive our results are concerning the sample period, we extend our sample period to multiple pre- and post-treatment periods. The pre-treatment period can be extended by one additional quarter and consequently varies between Q1 2015 and Q2 2015. The post-treatment period can be extended until Q4 2016. Hence, the post-treatment period covers up to four quarters. Table 7 reports only the interaction results of the LCR introduction indicator and the NNLR indicator for the total, marketable, and non-marketable haircut, and collateral value. The respective and varying sample periods used for the estimations are specified in the lower part of the table. The baseline estimates with the pre-treatment period Q2 2015 and the post-treatment period Q1 2016 are shown in column (2). The specification with the longest sample

[20] Chart 9 in Bock et al. (2018) shows the aggregate evolution and composition of ECB's refinancing operations. With regard to our (post) sample period, the 6th and 7th operation of TLTRO-I are most relevant.

period is column (7), employing the two quarters Q1 and Q2 2015 as pre-treatment period and the entire year 2016 as post-treatment period. Table 7 shows that all estimates are consistent with our baseline results. The interaction effect on the total haircut is positive and partly significant (part (A)). For the marketable haircut, we find positive and highly significant interaction effects for all sample period variations (part (B)), while the interaction coefficient for the non-marketable haircut is highly significant and negative (part (C)). For the total collateral value, we find positive and highly significant effects (part (D)). The coefficient of interest is positive but not significant for the marketable collateral value (part (E)), except when using Q1 and Q2 2015 as pre-treatment period and Q1 2016 as only post-treatment quarter (column (1)). Part (F) shows that the interaction coefficient is highly significant for all sample period variations for the non-marketable collateral value. The magnitude of the estimated effects is also very stable.

- Insert Table 7 around here -

The estimations shown in Table 7 exclude the treatment periods Q3 and Q4 2015. To consider the effect of the treatment period on our results, we rerun our estimations including the two quarters. Given that the LCR was introduced in October 1st, 2015, Q3 2015 is considered within the pre-treatment period, while Q4 2015 is included in the post-treatment period. In this set up, the start of the pre-treatment period varies between the first quarter of 2015 until the third quarter of 2015, while the end of the post-treatment period varies from Q4 2015 until Q4 2016. The results confirm our earlier findings. The interaction term coefficient for the aggregate haircut remains insignificant but highly significant and negative for the non-marketable haircut. For the marketable haircut the estimated interaction term is positive and significant, unless only Q4 2015 is considered as post-treatment period. These results strongly indicate that there was an anticipation effect. Also the results for collateral quantity support previous estimates with the interaction term for total collateral remaining positive and mostly significant. The difference in difference effect for marketable collateral remains

insignificant and positive, as well as highly significant for non-marketable collateral. Results are reported by Table 13 in the online appendix.

6 Conclusion

In this paper, we study whether the introduction of the LCR had adverse effects on the liquidity profile and the quantity of collateral provided by banks to secure central bank refinancing operations. The change in the liquidity profile of collateral is triggered by a differential treatment of assets by the LCR framework and the collateral framework. Whereas, the change in the quantity of collateral either indicates an increase in central bank funding motivated by the preferential treatment of central bank funding over other funding sources or an increase in overcollateralization due to the calculation practice of the LCR. We use the existence of national liquidity requirements to proxy for banks' incentives to exploit these differential treatments.

For banks without national liquidity requirement, the weighted average haircut of marketable collateral increases by more than 30% after the LCR introduction compared to banks with national liquidity requirement. For non-marketable collateral, we find a decrease of 8.4% in the weighted average haircut, which could be driven by the corresponding increase in non-marketable collateral value of 6%. These results support our hypothesis that banks without preceding national liquidity requirement have a higher incentive to exploit the differential treatments in response to the LCR introduction and also indicate that banks take advantage of the differential treatments to improve their LCR value, without altering their liquidity risk profile or by just increasing their reliance on the central bank. This is a relevant finding given that such a development reduces the regulatory effectiveness of the LCR.

Our estimates are robust when controlling for one-country-specific effects and when extending the sample period from the two cross sections of the baseline specification to a panel, including and excluding the treatment period. We find no strong indications

that our results are driven by less solvent banks. Also controlling for the regulatory design does not affect our previous results. However, we can not exclude the possibility that our results are affected by the APPs, TLTROs, or other changes affecting banks' asset holdings. Changes in the collateral framework are unlikely to exert a confounding effect, given that there was only a minor change for non-marketable collateral.

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Table 1: Summary statistics

		Pre-LCR-introduction-period NNLR = 1		Pre-LCR-introduction-period NNLR = 0				Post-LCR-introduction-period NNLR = 1		Post-LCR-introduction-period NNLR = 0			
	Variable	Mean	Std. dev.	Mean	Std. dev.	△(0-1)	P-value	Mean	Std. dev.	Mean	Std. dev.	△(0-1)	P-value
LHS	Haircut	13.09	12.85	10.75	10.90	-2.34	0.39	13.46	7.63	11.83	11.99	-1.63	0.50
	Marketable haircut	4.52	2.56	5.35	7.55	0.83	0.54	7.20	2.82	6.03	7.68	-1.18	0.40
	Non-marketable haircut	36.61	15.92	29.92	14.25	-6.69	0.11	33.41	14.04	29.65	14.91	-3.76	0.36
	Collateral value	8.31	1.85	7.87	2.06	-0.44	0.33	8.69	1.30	7.86	1.92	-0.84	0.03
	Marketable collateral value	8.26	1.49	7.40	2.56	-0.86	0.08	8.40	1.46	7.39	2.45	-1.01	0.04
	Non-marketable collateral value	6.76	1.90	6.77	1.70	0.02	0.97	7.41	1.28	6.53	1.73	-0.88	0.05
RHS	Log of total assets	25.00	1.23	24.83	1.79	-0.17	0.64	25.10	1.14	24.76	1.76	-0.34	0.34
	Capital ratio	13.63	7.62	15.11	4.23	1.48	0.29	13.98	5.99	16.71	4.93	2.73	0.04
	ROA	0.14	0.18	0.13	0.15	-0.01	0.84	-0.01	0.29	-0.09	0.56	-0.08	0.44
	Loan ratio	67.18	11.35	64.44	13.58	-2.74	0.35	66.17	9.89	63.59	12.76	-2.58	0.34
	Debt instruments	17.45	9.65	19.30	10.37	1.84	0.43	17.64	7.87	19.48	10.11	1.85	0.39
	Interest Income	0.64	0.31	0.75	0.28	0.11	0.12	0.58	0.20	0.62	0.55	0.04	0.72
	Deposits of fin. Institutions	7.46	6.17	10.94	11.53	3.48	0.11	5.76	4.37	9.75	10.39	4.00	0.04
	Household deposits	31.77	12.70	30.86	23.24	-0.91	0.84	33.83	13.06	31.28	22.85	-2.55	0.57
	Interest expense	0.28	0.16	0.34	0.24	0.07	0.17	0.23	0.11	0.26	0.36	0.04	0.56
	Number of banks/obs.	36		40				34		40		Total 150 obs./77 banks	

Notes: This table reports bank-level statistics for the pre-LCR-introduction-period Q2 2015 and post-LCR-introduction-period Q1 2016 by groups. The indicator variable NNLR is 1 if the bank was not exposed to a national liquidity regulation similar to the LCR preceding to the EU-level LCR introduction. The sample comprises a subset of SSM banks participating in ECB refinancing operations. The reported p-values are two sided. Covariates are lagged by one quarter. Variables are further described by Table 8 in the appendix.

Table 2: Liquidity profile of pledged collateral

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Haircut						Marketable haircut			Non-marketable haircut		
PostLCR	0.721		1.079	3.003**			2.418***			-2.431		
	(0.910)		(0.750)	(1.185)			(0.727)			(1.582)		
NNLR		1.978	2.337	1.658				0.052			0.668	
		(2.360)	(2.758)	(3.006)				(1.095)			(4.817)	
PostLCR#NNLR			-0.707	-1.810	0.802	0.905			1.767***			-2.722***
			(1.863)	(1.826)	(0.829)	(0.770)			(0.600)			(0.996)
Log of assets				-1.741*		0.542	-1.509**	-1.445*	5.974***	-0.236	-0.431	1.130
				(1.022)		(3.443)	(0.751)	(0.739)	(2.070)	(1.673)	(1.657)	(4.769)
Capital ratio				-0.791***		-0.120	-0.366***	-0.327***	0.162*	-1.373**	-1.504**	0.292
				(0.148)		(0.113)	(0.102)	(0.107)	(0.091)	(0.667)	(0.568)	(0.209)
ROA				0.692		3.973***	1.557	0.480	3.035***	-16.398***	-15.337***	0.236
				(2.820)		(0.662)	(2.367)	(2.025)	(0.580)	(4.159)	(4.225)	(2.190)
Loan ratio				-0.242		0.096	-0.250*	-0.246*	0.073**	0.171	0.116	0.088
				(0.174)		(0.058)	(0.130)	(0.127)	(0.036)	(0.264)	(0.256)	(0.194)
Debt instruments				-0.630***		0.047	-0.414**	-0.402**	0.299**	-0.024	-0.054	0.533
				(0.176)		(0.138)	(0.158)	(0.162)	(0.117)	(0.276)	(0.277)	(0.337)
Interest income				3.131		-1.196	1.234	1.232	0.810	3.380	2.917	-6.759
				(4.258)		(1.773)	(3.458)	(3.266)	(1.197)	(11.303)	(11.581)	(4.841)
Deposits of fin. institution				0.058		0.235	0.026	0.023	-0.099	-0.332	-0.291	0.252
				(0.217)		(0.211)	(0.065)	(0.071)	(0.113)	(0.322)	(0.329)	(0.206)
Household deposits				0.030		-0.379*	0.087	0.088	-0.049	-0.129	-0.103	0.438
				(0.068)		(0.211)	(0.062)	(0.062)	(0.100)	(0.223)	(0.223)	(0.275)
Interest expense				3.076		1.341	4.543	4.287	-3.301	4.930	6.258	6.661
				(8.049)		(4.237)	(5.643)	(5.535)	(3.261)	(17.313)	(17.559)	(9.716)
R-squared	0.00	0.01	0.01	0.27	0.12	0.36	0.32	0.29	0.54	0.31	0.30	0.35
Bank FE	No	No	No	No	Yes	Yes	No	No	Yes	No	No	Yes
Time FE	No	No	No	No	Yes	Yes	No	No	Yes	No	No	Yes
Number of banks	77	77	77	77	77	77	76	76	76	54	54	54
Number of obs. NNLR=1	70	70	70	70	70	70	69	69	69	51	51	51
Observations	150	150	150	150	150	150	149	149	149	104	104	104
Dependent variable												
Mean	12.21	12.21	12.21	12.21	12.21	12.21	5.76	5.76	5.76	32.39	32.39	32.39
Std. dev.	11.03	11.03	11.03	11.03	11.03	11.03	5.89	5.89	5.89	14.90	14.90	14.90

Notes: This table examines the effect of the EU-level LCR introduction on the weighted average haircut of collateral pledged with the ECB. The reported effects are estimated based on the empirical specification of Equation (1) for the two cross-sections Q2 2015 and Q1 2016. Haircut is the weighted average haircut of all assets included in the collateral pool of the individual bank (columns (1) to (6)). Marketable (columns (7) to (9)) and non-marketable (columns (10) to (12)) haircut are the respective measures for the two sub-categories of the haircut aggregate. PostLCR is an indicator variable for the period after the EU-level LCR introduction. NNLR is one for countries with no preceding national liquidity requirement. All covariates are lagged by one quarter. Standard errors are clustered at the bank level and are reported in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Quantity of pledged collateral

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Collateral value						Marketable collateral value			Non-marketable collateral value		
PostLCR	0.163		-0.010	0.115			0.069			0.278*		
	(0.131)		(0.142)	(0.093)			(0.093)			(0.142)		
NNLR		0.635	0.445	0.188				0.671**			-0.061	
		(0.391)	(0.449)	(0.287)				(0.334)			(0.417)	
PostLCR#NNLR			0.392	0.179	0.154***	0.143**			0.084			0.426***
			(0.271)	(0.175)	(0.051)	(0.061)			(0.069)			(0.089)
Log of assets				0.931***		0.415	0.926***	0.905***	0.477	0.854***	0.876***	-0.284
				(0.088)		(0.320)	(0.099)	(0.095)	(0.345)	(0.130)	(0.127)	(0.513)
Capital ratio				-0.043**		-0.001	-0.037*	-0.024	0.005	-0.011	0.004	-0.044*
				(0.018)		(0.011)	(0.021)	(0.023)	(0.012)	(0.060)	(0.060)	(0.023)
ROA				-0.187		-0.050	-0.532	-0.763	-0.083	0.131	0.004	0.184
				(0.352)		(0.049)	(0.462)	(0.479)	(0.063)	(0.407)	(0.404)	(0.144)
Loan ratio				0.005		0.005	0.037	0.029	0.002	0.030	0.036	0.019
				(0.010)		(0.005)	(0.039)	(0.036)	(0.005)	(0.025)	(0.025)	(0.019)
Debt instruments				0.005		0.005	0.024	0.024	0.031*	-0.005	-0.002	-0.002
				(0.014)		(0.010)	(0.030)	(0.030)	(0.016)	(0.029)	(0.028)	(0.026)
Interest income				0.273		0.268**	0.043	0.280	0.275*	-0.546	-0.489	0.469
				(0.594)		(0.116)	(0.649)	(0.555)	(0.153)	(1.050)	(1.101)	(0.498)
Deposits of fin. institution				-0.025		-0.011	-0.025	-0.011	-0.026	-0.053*	-0.058*	0.013
				(0.025)		(0.013)	(0.021)	(0.020)	(0.019)	(0.029)	(0.031)	(0.016)
Household deposits				-0.013		-0.004	-0.008	-0.005	0.016	-0.004	-0.007	-0.074***
				(0.008)		(0.009)	(0.009)	(0.009)	(0.012)	(0.017)	(0.017)	(0.024)
Interest expense				0.210		-0.598**	0.854	0.780	-0.648*	1.614	1.462	-0.898
				(0.764)		(0.265)	(1.174)	(1.115)	(0.358)	(1.317)	(1.359)	(0.993)
R-squared	0.00	0.03	0.04	0.79	0.11	0.18	0.51	0.53	0.21	0.62	0.62	0.48
Bank FE	No	No	No	No	Yes	Yes	No	No	Yes	No	No	Yes
Time FE	No	No	No	No	Yes	Yes	No	No	Yes	No	No	Yes
Number of banks	77	77	77	77	77	77	76	76	76	54	54	54
Number of obs. NNLR=1	70	70	70	70	70	70	69	69	69	51	51	51
Observations	150	150	150	150	150	150	149	149	149	104	104	104
Dependent variable												
Mean	8.16	8.16	8.16	8.16	8.16	8.16	7.83	7.83	7.83	6.85	6.85	6.85
Std. dev.	1.83	1.83	1.83	1.83	1.83	1.83	2.12	2.12	2.12	1.69	1.69	1.69

Notes: This table examines the effect of the EU-level LCR introduction on the collateral value pledged with the ECB. The reported effects are estimated based on the empirical specification of Equation (1) for the two cross-sections Q2 2015 and Q1 2016. Collateral value is the natural logarithm of the total collateral minus the respective haircut (columns (1) to (6)). Marketable (columns (7) to (9)) and non-marketable (columns (10) to (12)) collateral value are the respective measures for the two sub-categories of the collateral aggregate. PostLCR is an indicator variable for the period after the EU-level LCR introduction. NNLR is one for countries with no preceding national liquidity requirement. All covariates are lagged by one quarter. Standard errors are clustered at the bank level and are reported in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Liquidity profile and quantity of pledged collateral (GIIPS)

VARIABLES	(1) Haircut	(2) Marketable haircut	(3) Non-marketable haircut	(4) Collateral value	(5) Marketable collateral value	(6) Non-marketable collateral value
PostLCR#NNLR#GIIPS	-3.971	-2.078	-5.283**	0.203	0.400*	0.246
	(3.532)	(1.714)	(2.352)	(0.158)	(0.236)	(0.220)
PostLCR#NNLR	2.113*	2.190**	0.443	0.106	-0.071	0.186
	(1.092)	(1.063)	(1.798)	(0.085)	(0.154)	(0.135)
PostLCR#GIIPS	2.780	1.780	1.879	-0.180	-0.227	0.053
	(3.255)	(1.305)	(1.180)	(0.140)	(0.168)	(0.164)
R-squared	0.40	0.55	0.40	0.22	0.26	0.51
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of banks	77	76	54	77	76	54
Number of obs. NNLR=1	70	69	51	70	69	51
Number of obs. GIIPS=1	68	68	56	68	68	56
Observations	150	149	104	150	149	104
Dependent variable						
Mean	12.21	5.76	32.39	8.16	7.83	6.85
Std. dev.	11.03	5.89	14.90	1.83	2.12	1.69

Notes: This table examines the effect of the EU-level LCR introduction on haircut and collateral value of assets pledged with the ECB, while controlling for a specific group of countries. The reported effects are estimated based on the empirical specification of Equation (2) for the two cross-sections Q2 2015 and Q1 2016. PostLCR is zero for the earlier period and one for the later period. NNLR is one for countries with no preceding national liquidity requirement. GIIPS is one if the bank originates in Greece, Ireland, Italy, Portugal or Spain. All columns include bank and time fixed effects, as well as bank controls. All covariates are lagged by one quarter. Standard errors are clustered at the bank level and are reported in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Liquidity profile and quantity of pledged collateral (Regulatory design: toughness)

VARIABLES	(1) Haircut	(2) Marketable haircut	(3) Non-marketable haircut	(4) Collateral value	(5) Marketable collateral value	(6) Non-marketable collateral value
PostLCR#NNLR	0.068	2.300***	-5.485***	0.110**	0.037	0.543***
	(1.241)	(0.694)	(1.761)	(0.045)	(0.058)	(0.148)
PostLCR#TH	-1.108	0.705	-3.514*	-0.043	-0.063	0.149
	(1.434)	(0.735)	(1.786)	(0.067)	(0.071)	(0.155)
R-squared	0.37	0.54	0.42	0.19	0.21	0.49
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of banks	77	76	54	77	76	54
Number of obs. NNLR=1	70	69	51	70	69	51
Number of obs. TH=1	64	64	43	64	64	43
Observations	150	149	104	150	149	104
Dependent variable						
Mean	12.21	5.76	32.39	8.16	7.83	6.85
Std. dev.	11.03	5.89	14.90	1.83	2.12	1.69

Notes: This table examines the effect of the EU-level LCR introduction on haircut and collateral value of assets pledged with the ECB, while considering whether the national liquidity regulation is still in place during the transition period. The reported effects are estimated based on the empirical specification of Equation (2) for the two cross-sections Q2 2015 and Q1 2016. PostLCR is zero for the earlier period and one for the later period. NNLR is one for countries with no preceding national liquidity requirement. TH is one if the country where the bank originates keeps the national liquidity requirement in place parallel to the LCR. All columns include bank and time fixed effects, as well as bank controls. All covariates are lagged by one quarter. Standard errors are clustered at the bank level and are reported in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Liquidity profile and quantity of pledged collateral (Regulatory design: front-loading)

VARIABLES	(1) Haircut	(2) Marketable haircut	(3) Non-marketable haircut	(4) Collateral value	(5) Marketable collateral value	(6) Non-marketable collateral value
PostLCR#NNLR#FL	-1.134	1.449	1.656	0.105	-0.155	-0.427
	(2.547)	(2.034)	(2.931)	(0.143)	(0.362)	(0.310)
PostLCR#NNLR	1.324	1.597**	-2.512***	0.143*	0.094	0.439***
	(0.836)	(0.624)	(0.940)	(0.076)	(0.079)	(0.102)
PostLCR#FL	1.944	-0.316	5.038**	0.052	-0.019	-0.012
	(1.517)	(1.236)	(1.932)	(0.071)	(0.079)	(0.142)
R-squared	0.38	0.54	0.48	0.20	0.22	0.50
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of banks	77	76	54	77	76	54
Number of obs. =1	70	69	51	70	69	51
Number of obs. FL=1	24	23	7	24	23	7
Observations	150	149	104	150	149	104
Dependent variable						
Mean	12.21	5.76	32.39	8.16	7.83	6.85
Std. dev.	11.03	5.89	14.90	1.83	2.12	1.69

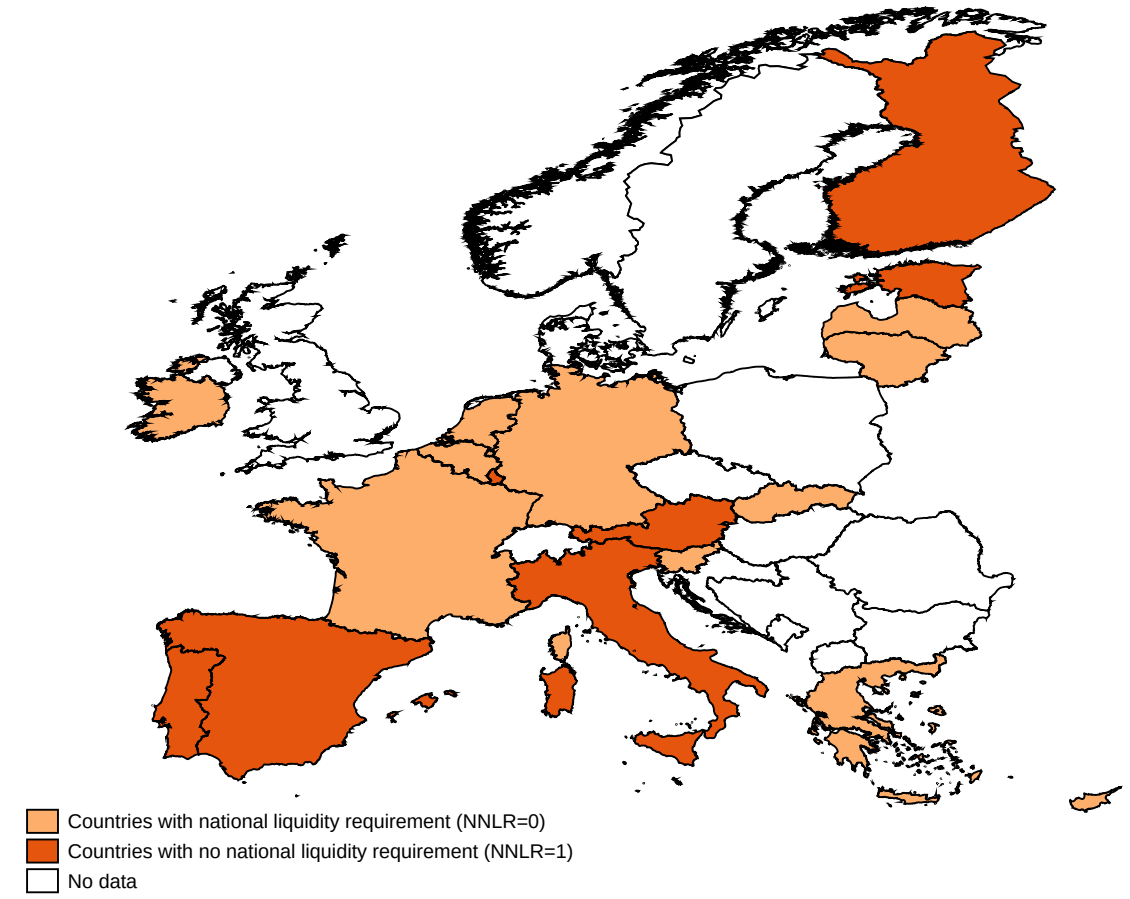
Notes: This table examines the effect of the EU-level LCR introduction on haircut and collateral value of assets pledged with the ECB, while controlling for the intensity of the LCR introduction. The reported effects are estimated based on the empirical specification of Equation (2) for the two cross-sections Q2 2015 and Q1 2016. PostLCR is zero for the earlier period and one for the later period. NNLR is one for countries with no preceding national liquidity requirement. FL is one if the country where the bank originates introduces the LCR with 100% instead of 60%. All columns include bank and time fixed effects, as well as bank controls. All covariates are lagged by one quarter. Standard errors are clustered at the bank level and are reported in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Liquidity profile and quantity of pledged collateral (panel)

		(1)	(2) Baseline	(3)	(4)	(5)	(6)	(7)	(8)
					Haircut				
(A)	PostLCR#NNLR	0.743	0.905	1.139	1.489*	1.765*	2.142**	1.621	1.446
		(0.742)	(0.770)	(0.788)	(0.816)	(0.985)	(1.013)	(1.186)	(1.333)
	Observations	222	150	296	224	370	298	444	372
	R-squared	0.14	0.36	0.08	0.15	0.08	0.09	0.09	0.07
	Dependent var.								
	Mean	12.41	12.21	12.31	12.15	12.35	12.23	12.42	12.35
	Std. dev.	11.56	11.03	11.10	10.56	10.82	10.35	10.70	10.29
					Marketable haircut				
(B)	PostLCR#NNLR	1.469**	1.767***	1.966***	2.380***	2.473***	2.792***	2.746***	2.955***
		(0.620)	(0.600)	(0.681)	(0.717)	(0.824)	(0.892)	(0.948)	(1.030)
	Observations	220	149	294	223	368	297	442	371
	R-squared	0.38	0.54	0.17	0.17	0.15	0.13	0.14	0.12
	Dependent var.								
	Mean	5.60	5.76	5.75	5.91	5.91	6.06	6.04	6.19
	Std. dev.	5.88	5.89	5.41	5.25	5.16	4.97	5.08	4.90
					Non-marketable haircut				
(C)	PostLCR#NNLR	-2.338**	-2.722***	-2.801**	-2.709**	-3.337***	-2.862***	-2.834**	-3.143**
		(1.086)	(0.996)	(1.117)	(1.050)	(1.163)	(0.983)	(1.266)	(1.358)
	Observations	157	104	209	156	259	206	310	257
	R-squared	0.21	0.35	0.20	0.24	0.18	0.24	0.16	0.15
	Dependent var.								
	Mean	32.83	32.39	32.53	32.13	32.39	32.05	32.24	31.94
	Std. dev.	15.04	14.90	14.87	14.70	14.80	14.65	14.71	14.57
					Collateral value				
(D)	PostLCR#NNLR	0.207***	0.143**	0.276***	0.220***	0.290***	0.238***	0.342***	0.325***
		(0.066)	(0.061)	(0.069)	(0.068)	(0.088)	(0.086)	(0.104)	(0.114)
	Observations	222	150	296	224	370	298	444	372
	R-squared	0.19	0.18	0.16	0.11	0.15	0.11	0.17	0.14
	Dependent var.								
	Mean	8.15	8.16	8.17	8.18	8.15	8.15	8.12	8.12
	Std. dev.	1.87	1.83	1.86	1.83	1.90	1.89	1.92	1.91
					Marketable collateral value				
(E)	PostLCR#NNLR	0.151**	0.084	0.125	0.047	0.125	0.059	0.151	0.094
		(0.072)	(0.069)	(0.114)	(0.126)	(0.140)	(0.147)	(0.154)	(0.157)
	Observations	220	149	294	223	368	297	442	371
	R-squared	0.15	0.21	0.03	0.02	0.02	0.02	0.03	0.04
	Dependent var.								
	Mean	7.80	7.83	7.84	7.87	7.82	7.84	7.80	7.81
	Std. dev.	2.24	2.12	2.16	2.05	2.15	2.07	2.14	2.07
					Non-marketable collateral value				
(F)	PostLCR#NNLR	0.475***	0.426***	0.474***	0.416***	0.482***	0.385***	0.492***	0.442***
		(0.101)	(0.089)	(0.106)	(0.093)	(0.128)	(0.106)	(0.143)	(0.143)
	Observations	157	104	209	156	259	206	310	257
	R-squared	0.36	0.48	0.32	0.38	0.25	0.28	0.18	0.18
	Dependent var.								
	Mean	6.86	6.85	6.86	6.86	6.88	6.89	6.89	6.90
	Std. dev.	1.70	1.69	1.73	1.73	1.73	1.73	1.72	1.72
	Startperiod	Q1 2015	Q2 2015	Q1 2015	Q2 2015	Q1 2015	Q2 2015	Q1 2015	Q2 2015
	Endperiod	Q1 2016	Q1 2016	Q2 2016	Q2 2016	Q3 2016	Q3 2016	Q4 2016	Q4 2016

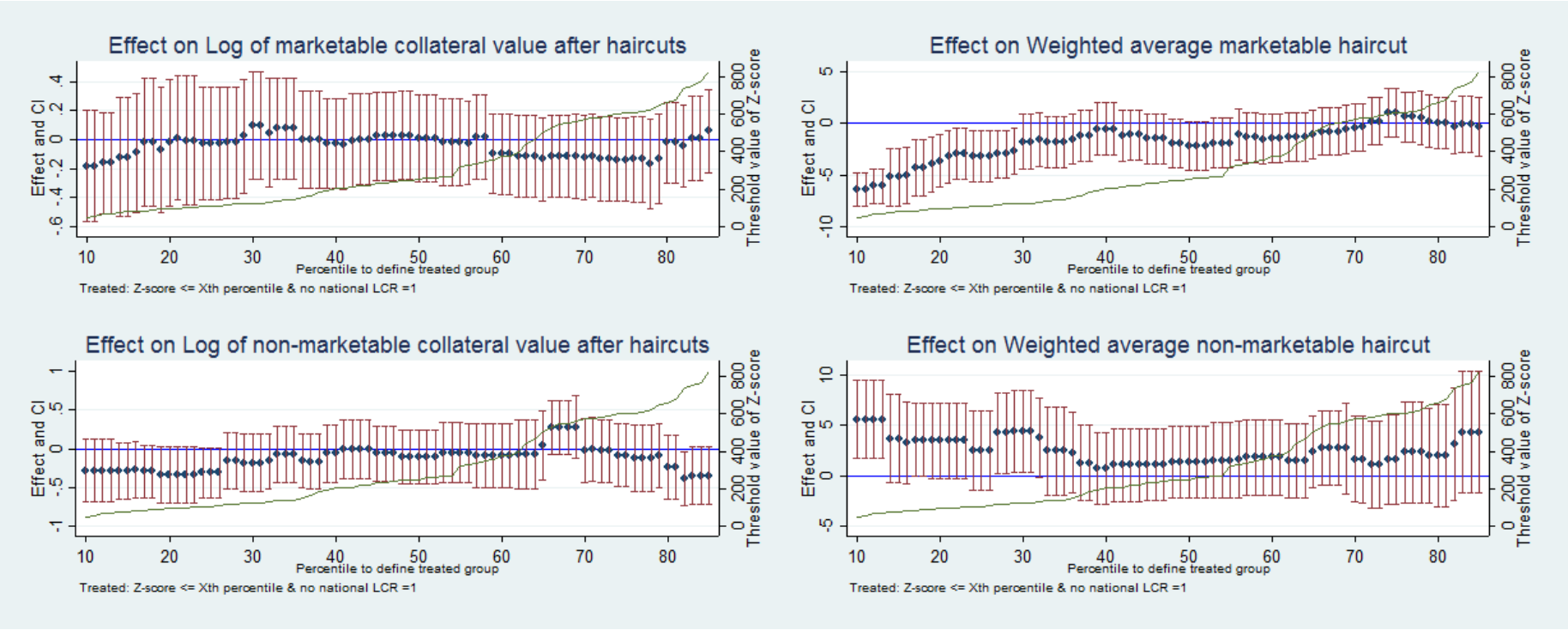
Notes: This table reports the interaction effect of estimating the empirical specification of Equation (1) for different sample periods. The respective sample period is indicated in the lower part of the table. Like for the baseline specification the treatment period Q3 and Q4 2015 are excluded in all estimations. *** p<0.01, ** p<0.05, * p<0.1.

Figure 2: National liquidity requirements



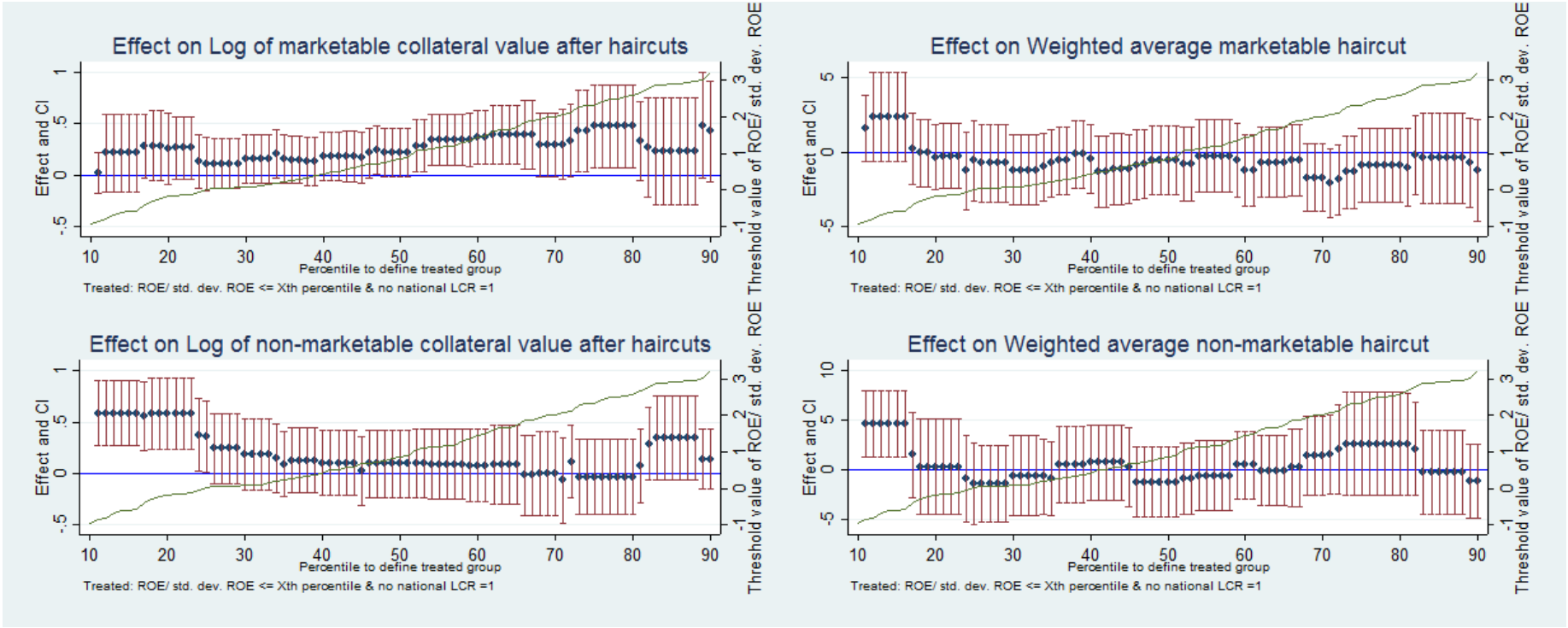
Notes: Countries with no national liquidity requirement (NNLR) were not exposed to a national liquidity requirement with features comparable to the LCR. Similarities to the LCR could be regarding the time horizon of the ratio or the calculation of the ratio components HQLA, outflow or inflows.

Figure 3: Marginal effect of triple interaction (PostLCR-NNLR-Treated) on liquidity and quantity measures for different percentile thresholds of Treated (based on z-score)



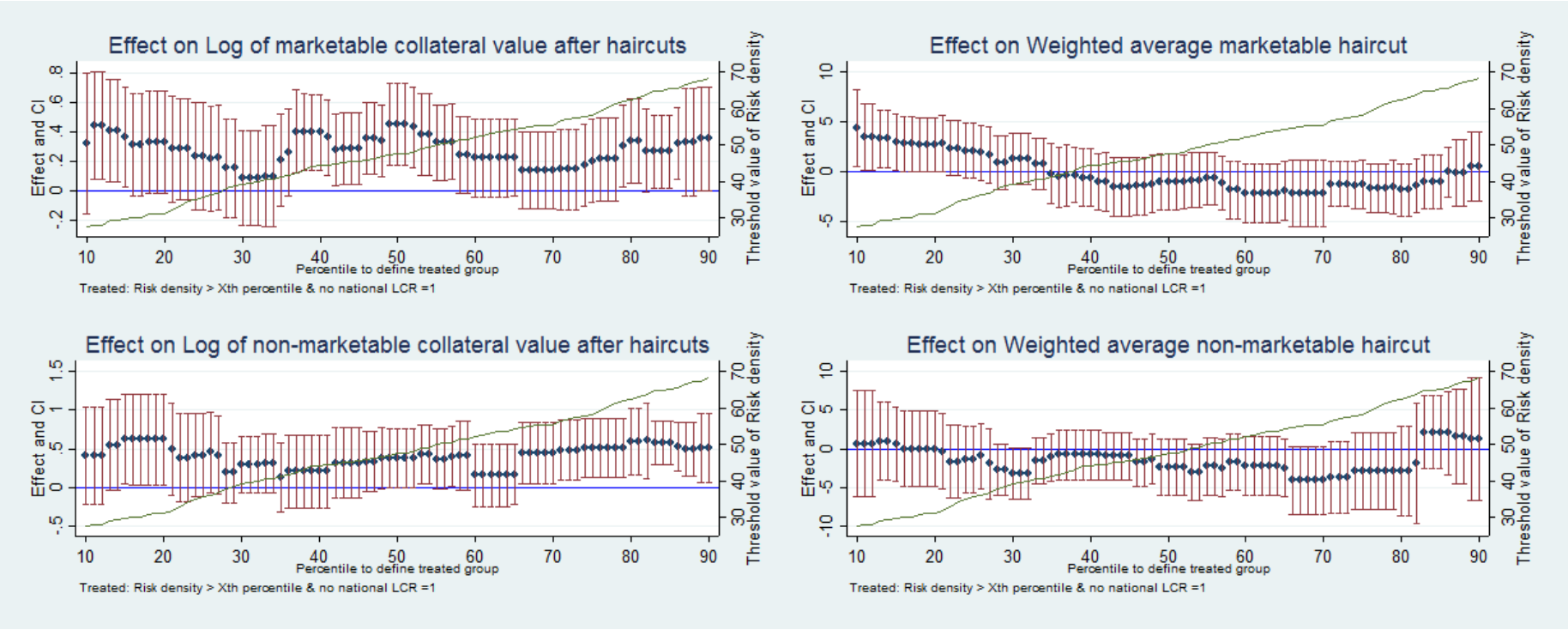
Notes: These graphs show the estimated marginal effects of the PostLCR-NNLR-Treated interaction on the respective collateral measure (left y-axis). Treated is estimated based on an threshold value determined by the percentile of the x-axis. The respective threshold is shown by the right y-axis. A bank is considered to be Treated=1, if its pre-sample period z-score (Q3 2014 until Q1 2015) is **smaller or equal** to the Xth percentile of the pre-sample period sample. The estimates are generated including bank and time fixed effects, as well as bank controls following Equation (2). For each of the 81 estimates the respective 95% confidence interval is shown.

Figure 4: Marginal effect of triple interaction (PostLCR-NNLR-Treated) on liquidity and quantity measures for different percentile thresholds of Treated (based on risk adjusted returns)



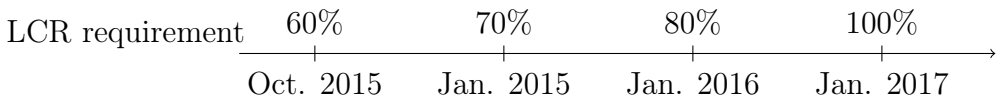
Notes: These graphs show the estimated marginal effects of the PostLCR-NNLR-Treated interaction on the respective collateral measure (left y-axis). Treated is estimated based on an threshold value determined by the percentile of the x-axis. The respective threshold is shown by the right y-axis. A bank is considered to be Treated=1, if its pre-sample period risk adjusted returns (Q3 2014 until Q1 2015) is **smaller or equal** to the Xth percentile of the pre-sample period sample. The estimates are generated including bank and time fixed effects, as well as bank controls following Equation (2). For each of the 81 estimates the respective 95% confidence interval is shown.

Figure 5: Marginal effect of triple interaction (PostLCR-NNLR-Treated) on liquidity and quantity measures for different percentile thresholds of Treated (based on risk density)



Notes: These graphs show the estimated marginal effects of the PostLCR-NNLR-Treated interaction on the respective collateral measure (left y-axis). Treated is estimated based on an threshold value determined by the percentile of the x-axis. The respective threshold is shown by the right y-axis. A bank is considered to be Treated=1, if its pre-sample period risk density (Q3 2014 until Q1 2015) is **larger** than the Xth percentile of the pre-sample period sample. The estimates are generated including bank and time fixed effects, as well as bank controls following Equation (2). For each of the 81 estimates the respective 95% confidence interval is shown.

Figure 6: Timeline of LCR introduction in EU



Notes: As described by paragraph 1, article 38 of the Commission Delegated Regulation (EU) 2015/61, the LCR introduction followed a step-wise implementation. Countries could also opt for a so called front-loading approach by introducing the LCR directly with 100% in October 2015. These countries are listed by Table 9.

Table 8: Data Appendix

Variable	Description	Data source
Dependent variables		
Haircut	$[\frac{\sum_{i=c} \text{MV}_{ijt} - \sum_{i=c} \text{CV}_{ijt}}{\sum_{i=c} \text{MV}_{ijt}}]_{jt}$, with c = every asset included in the collateral pool from bank j in time t	Market Operations Department, ECB
Marketable haircut	$[\frac{\sum_{i=c} \text{MV}_{ijt} - \sum_{i=c} \text{CV}_{ijt}}{\sum_{i=c} \text{MV}_{ijt}}]_{jt}$, with c = every marketable asset included in the collateral pool from bank j in time t	
Non-marketable haircut	$[\frac{\sum_{i=c} \text{MV}_{ijt} - \sum_{i=c} \text{CV}_{ijt}}{\sum_{i=c} \text{MV}_{ijt}}]_{jt}$, with c = every non-marketable asset included in the collateral pool from bank j in time t	
Collateral value	$\text{Log}[\sum_{i=c} \text{MV}_{ijt}(1-\text{haircut}_{it})]_{jt}$, with c = every asset included in the collateral pool of bank j in time t	
Marketable collateral value	$\text{Log}[\sum_{i=c} \text{MV}_{ijt}(1-\text{haircut}_{it})]_{jt}$, with c = every marketable asset included in the collateral pool of bank j in time t	
Non-marketable collateral value	$\text{Log}[\sum_{i=c} \text{MV}_{ijt}(1-\text{haircut}_{it})]_{jt}$, with c = every non-marketable asset included in the collateral pool of bank j in time t	
Covariates		
Log of total assets	Calculated based on FINREP data, sheet 01.01 x=10 y=380	
Capital ratio	Tier 1 capital ratio (in %), calculated based on COREP data, sheet 01.00 x=10 y=15	SSM, ECB
ROA	Profit or loss to total assets (in %) Calculated based on FINREP data, sheet 02.00 x=10 y=670	SSM, ECB
Loans	Loans to total assets (in %), calculated based on FINREP data, sheet 01.01 x=10 y=40,90,130,170, 200, 230	SSM, ECB
Debt instruments	Debt instruments to total assets (in %), calculated based on FINREP data, sheet 01.01 x=10 y=80,120,160,190,220	SSM, ECB
Interest income	Interest income to total assets (in %), calculated based on FINREP data, sheet 02.00 y=10 x=10	SSM, ECB
Interest expense	Interest expense to total assets (in %), calculated based on FINREP data, sheet 02.00 y=10 x=90	SSM, ECB
Household deposits	Household deposits to total assets (in %), calculated based on FINREP data, sheet 08.01 y=310 x=10,20,30,34,35	SSM, ECB
Deposits of fin. institutions	Deposits of financial institutions to total assets (in %), calculated based on FINREP data, sheet 08.01 y=160 x=10,20,30,34,35	SSM, ECB
Dummies		
PostLCR	Dummy variable (0/1) =1 for all time periods from Q4 2015 onwards	
NNLR	Dummy variable (0/1) =1 if EU-wide LCR was not preceded by national liquidity requirement with features similar to the EU-wide counterpart, see Figure 2 for details	
FH	Front-loading dummy, dummy variable (0/1) =1 if EU-wide LCR is introduced with 100% by country, see Table 9 for details	
TH	Toughness dummy, dummy variable (0/1) =1 if national liquidity requirement is still in place or under review, see Table 9 for details	
GIIPS	Dummy variable (0/1) =1 if bank is Greece, Italian, Irish, Portuguese or Spanish	
Others		
Risk density	Calculated based on COREP data, sheet 01.00 x=10 y=15	SSM, ECB
Z-score	$\big[\mu(\text{ROA}) + \text{capital assets ratio}\big] / \big[\sigma(\text{ROA})\big]$, μ and σ based on period Q4 2014 till Q4 2016 ROA = quarterly returns times 4 / total assets FINREP data, sheet 01.03 x=10 y=10, FINREP data, sheet 02.00 x=10 y=670	SSM, ECB
Risk adjusted returns	ROE/σ (ROE), σ based on period Q4 2014 till Q4 2016 FINREP data, sheet 01.03 x=10 y=300, FINREP data, sheet 02.00 x=10 y=670	SSM, ECB

Notes: MV = market value, CV = collateral value, market value reduced by haircut; haircut formula deviation: CV = MV(1-haircut) ⇒ haircut = 1 - CV/MV = (MV - CV)/MV; $\text{Treated}_{i/j}$, as included in Equation 2, is a placeholder for FH TH GIIPS. In Section **??**, Treated_i is also a 0/1 dummy variable and based on values of risk density, z-score or risk adjusted returns.

Table 9: Categorization of countries

With preceding national liquidity regulation	Without preceding national liquidity regulation
NNLR = 0	NNLR = 1
Belgium°	Austria°
Cyprus*°	Estonia°
Germany*	Finland
France	Italy
Greece*	Luxembourg
Ireland*	Portugal
Latvia*	Spain
Lithuania°	
Malta*	
Netherlands*°	
Slovenia*	
Slovakia*	

Notes: * indicates whose national liquidity requirements are still in place/ currently under review and will be maintained until 2018, ° indicates which country introduces the EU-wide LCR with 100% in October 2015 instead of using the step wise introduction.

Table 10: Liquidity profile and quantity of pledged collateral (one-country-specific-LCRintro-effect)

	VARIABLES	(1) Haircut	(2) Marketable haircut	(3) Non-marketable haircut	(4) Collateral value	(5) Marketable collateral value	(6) Non-marketable collateral value
(1)	PostLCR#NNLR	0.905	1.767***	-2.722***	0.143**	0.084	0.426***
		(0.770)	(0.600)	(0.996)	(0.061)	(0.069)	(0.089)
(2)	PostLCR#Austria^D	1.218	1.002	7.458***	0.166	-0.249	-0.441**
		(2.455)	(2.159)	(2.214)	(0.133)	(0.446)	(0.193)
	PostLCR#NNLR	0.837	1.711***	-2.954***	0.134**	0.098	0.440***
		(0.769)	(0.605)	(1.005)	(0.061)	(0.065)	(0.093)
(3)	PostLCR#Belgium ^{D}	0.861	-2.683***	7.989***	0.041	0.092	0.049
		(2.752)	(0.577)	(1.159)	(0.078)	(0.098)	(0.115)
	PostLCR#NNLR	0.966	1.577**	-2.280**	0.146**	0.091	0.429***
		(0.795)	(0.604)	(0.921)	(0.066)	(0.073)	(0.094)
(4)	PostLCR#Cyprus ^{D}	2.460	1.660		-0.026	-0.102	
		(2.628)	(2.415)		(0.077)	(0.081)	
	PostLCR#NNLR	1.142	1.927***		0.141**	0.075	
		(0.786)	(0.599)		(0.066)	(0.072)	
(5)	PostLCR#Estonia^D	-2.221	1.639		0.054	0.199	
		(2.309)	(2.214)		(0.318)	(0.323)	
	PostLCR#NNLR	0.961	1.725***		0.142**	0.079	
		(0.793)	(0.605)		(0.064)	(0.072)	
(6)	PostLCR#Finland^D	1.684	0.827	1.011	-0.229*	-0.257**	-0.253
		(1.989)	(2.392)	(1.237)	(0.115)	(0.108)	(0.168)
	PostLCR#NNLR	0.749	1.690***	-2.858***	0.164**	0.108	0.460***
		(0.806)	(0.616)	(1.024)	(0.063)	(0.071)	(0.093)
(7)	PostLCR#France^D	0.043	0.411	1.412	0.019	0.094	-0.203
		(1.784)	(0.704)	(2.018)	(0.067)	(0.083)	(0.238)
	PostLCR#NNLR	0.910	1.817***	-2.537**	0.145**	0.096	0.400***
		(0.844)	(0.647)	(1.077)	(0.066)	(0.073)	(0.090)
(8)	PostLCR#Germany^D	-2.030	-0.505	-2.865**	0.013	-0.007	0.155
		(1.390)	(0.793)	(1.402)	(0.084)	(0.092)	(0.125)
	PostLCR#NNLR	0.373	1.635**	-3.782***	0.147**	0.083	0.484***
		(0.951)	(0.641)	(1.019)	(0.068)	(0.077)	(0.103)
(9)	PostLCR#Greece^D	-0.761	1.543	2.311	-0.283*	-0.203	-0.316
		(2.515)	(1.219)	(1.887)	(0.154)	(0.190)	(0.202)
	PostLCR#NNLR	0.886	1.805***	-2.478**	0.136**	0.079	0.393***
		(0.794)	(0.603)	(1.014)	(0.062)	(0.069)	(0.094)
(10)	PostLCR#Ireland^D	4.702	1.707	0.772	-0.092	-0.220	0.333***
		(4.752)	(1.754)	(1.119)	(0.162)	(0.223)	(0.093)
	PostLCR#NNLR	1.314*	1.915***	-2.670**	0.135**	0.065	0.449***
		(0.694)	(0.581)	(1.023)	(0.063)	(0.069)	(0.091)
(11)	PostLCR#Italy^D	-1.171	-1.181	-0.778	0.162***	0.171**	0.212**
		(0.939)	(1.009)	(1.228)	(0.058)	(0.078)	(0.090)
	PostLCR#NNLR	1.342*	2.208***	-2.298*	0.083	0.020	0.311***
		(0.799)	(0.639)	(1.158)	(0.064)	(0.078)	(0.091)
(12)	PostLCR#Latvia^D	-0.370	0.427		0.569***	0.588***	
		(0.978)	(0.538)		(0.074)	(0.085)	
	PostLCR#NNLR	0.891	1.783***		0.164***	0.106	
		(0.797)	(0.616)		(0.060)	(0.068)	
(13)	PostLCR#Lithuania^D	3.800**	-0.412	2.589	0.092	-0.086	-0.169
		(1.828)	(1.296)	(1.842)	(0.159)	(0.168)	(0.216)
	PostLCR#NNLR	1.106	1.745***	-2.650**	0.148**	0.080	0.422***
		(0.780)	(0.619)	(1.002)	(0.064)	(0.071)	(0.093)
(14)	PostLCR#Luxembourg^D	1.098	-1.361		-0.053	-0.024	
		(1.446)	(0.831)		(0.082)	(0.197)	
	PostLCR#NNLR	0.824	1.867***		0.147**	0.086	
		(0.816)	(0.644)		(0.064)	(0.071)	
(15)	PostLCR#Malta^D	-3.653***	-2.093*	-1.243	-0.480***	-0.239*	-0.865***
		(1.286)	(1.166)	(1.282)	(0.088)	(0.129)	(0.087)
	PostLCR#NNLR	0.726	1.665***	-2.787***	0.120*	0.073	0.381***
		(0.776)	(0.614)	(1.042)	(0.061)	(0.071)	(0.079)
(16)	PostLCR#Netherlands^D	-1.605**	-0.686		0.126***	0.123**	
		(0.695)	(0.436)		(0.046)	(0.050)	
	PostLCR#NNLR	0.858	1.747***		0.147**	0.088	
		(0.787)	(0.610)		(0.063)	(0.070)	
(17)	PostLCR#Portugal^D	-1.216	0.621	-2.592**	-0.084	-0.046	0.027
		(0.999)	(1.551)	(1.254)	(0.073)	(0.085)	(0.164)
	PostLCR#NNLR	1.021	1.707***	-2.601**	0.151**	0.089	0.425***
		(0.787)	(0.609)	(0.997)	(0.063)	(0.071)	(0.090)
(18)	PostLCR#Slovenia^D	0.284	0.370	0.016	-0.158	-0.151	0.053
		(1.826)	(1.322)	(1.243)	(0.103)	(0.158)	(0.099)
	PostLCR#NNLR	0.923	1.790***	-2.720**	0.133**	0.075	0.432***
		(0.806)	(0.615)	(1.048)	(0.064)	(0.071)	(0.097)
(19)	PostLCR#Slovakia^D	-1.900	-0.752	-0.370	0.257	0.299	0.234
		(1.365)	(0.788)	(1.684)	(0.290)	(0.315)	(0.169)
	PostLCR#NNLR	0.701	1.686***	-2.751**	0.171***	0.117*	0.445***
		(0.835)	(0.635)	(1.085)	(0.059)	(0.066)	(0.098)
(20)	PostLCR#Spain^D	0.956	0.758	0.175	-0.118*	-0.045	-0.124
		(0.875)	(0.808)	(1.449)	(0.059)	(0.090)	(0.103)
	PostLCR#NNLR	0.633	1.552**	-2.764**	0.177***	0.097	0.457***
		(0.821)	(0.720)	(1.115)	(0.062)	(0.074)	(0.096)

Notes: This table reports the interaction effects of estimating the empirical specification of Equation (2) with Treated=1 for one country at a time. The triple interaction drops out due to collinearity. Row (1) repeats the baseline results from Table 3 and 2.

*** p<0.01, ** p<0.05, * p<0.1.

Table 11: Liquidity profile and quantity of pledged collateral (excluding individual countries)

VARIABLES		(1) Haircut	(2) Marketable haircut	(3) Non-marketable haircut	(4) Collateral value	(5) Marketable collateral value	(6) Non-marketable collateral value
Baseline	PostLCR#NNLR	0.905	1.767***	-2.722***	0.143**	0.084	0.426***
(1)		(0.770)	(0.600)	(0.996)	(0.061)	(0.069)	(0.089)
	Observations	150	149	104	150	149	104
W/o Austria	PostLCR#NNLR	0.786	1.665***	-2.954***	0.131**	0.088	0.440***
(2)		(0.770)	(0.601)	(1.002)	(0.060)	(0.064)	(0.092)
	Observations	145	145	101	145	145	101
W/o Belgium	PostLCR#NNLR	0.982	1.575**	-2.280**	0.146**	0.091	0.429***
(3)		(0.794)	(0.602)	(0.917)	(0.066)	(0.073)	(0.094)
	Observations	146	145	102	146	145	102
W/o Cyprus	PostLCR#NNLR	1.111	1.784***		0.132**	0.063	
(4)		(0.788)	(0.608)		(0.066)	(0.071)	
	Observations	144	143		144	143	
W/o Estonia	PostLCR#NNLR	0.961	1.725***		0.142**	0.079	
(5)		(0.791)	(0.604)		(0.064)	(0.072)	
	Observations	147	146		147	146	
W/o Finland	PostLCR#NNLR	0.809	1.769***	-2.839***	0.168***	0.110	0.467***
(6)		(0.805)	(0.612)	(1.025)	(0.063)	(0.071)	(0.094)
	Observations	146	145	100	146	145	100
W/o France	PostLCR#NNLR	0.924	1.819***	-2.533**	0.146**	0.096	0.411***
(7)		(0.846)	(0.647)	(1.071)	(0.066)	(0.073)	(0.090)
	Observations	142	141	98	142	141	98
W/o Germany	PostLCR#NNLR	0.346	1.655**	-4.205***	0.145**	0.086	0.474***
(8)		(0.945)	(0.648)	(1.053)	(0.069)	(0.078)	(0.095)
	Observations	126	125	82	126	125	82
W/o Greece	PostLCR#NNLR	0.842	1.725***	-2.283**	0.130**	0.073	0.394***
(9)		(0.782)	(0.596)	(0.997)	(0.062)	(0.069)	(0.097)
	Observations	142	141	96	142	141	96
W/o Ireland	PostLCR#NNLR	1.144*	1.926***	-2.662**	0.139**	0.073	0.448***
(10)		(0.652)	(0.579)	(1.024)	(0.061)	(0.066)	(0.091)
	Observations	144	143	100	144	143	100
W/o Italy	PostLCR#NNLR	1.352*	2.243***	-1.821	0.077	0.014	0.284***
(11)		(0.801)	(0.633)	(1.225)	(0.065)	(0.079)	(0.089)
	Observations	126	125	80	126	125	80
W/o Latvia	PostLCR#NNLR	0.891	1.783***		0.164***	0.106	
(12)		(0.795)	(0.614)		(0.060)	(0.068)	
	Observations	147	146		147	146	
W/o Lithuania	PostLCR#NNLR	1.087	1.714***	-2.650**	0.152**	0.082	0.422***
(14)		(0.771)	(0.623)	(0.997)	(0.063)	(0.070)	(0.093)
	Observations	146	145	102	146	145	102
W/o Luxembourg	PostLCR#NNLR	0.867	1.874***		0.146**	0.079	
(13)		(0.825)	(0.651)		(0.064)	(0.070)	
	Observations	146	145		146	145	
W/o Malta	PostLCR#NNLR	0.695	1.674***	-2.787***	0.122*	0.071	0.381***
(15)		(0.762)	(0.613)	(1.038)	(0.062)	(0.072)	(0.078)
	Observations	146	145	102	146	145	102
W/o Netherlands	PostLCR#NNLR	0.858	1.747***		0.147**	0.088	
(16)		(0.784)	(0.608)		(0.062)	(0.070)	
	Observations	148	147		148	147	
W/o Portugal	PostLCR#NNLR	1.017	1.718***	-2.591**	0.150**	0.087	0.426***
(17)		(0.784)	(0.608)	(0.991)	(0.063)	(0.071)	(0.090)
	Observations	142	141	99	142	141	99
W/o Slovakia	PostLCR#NNLR	0.696	1.678***	-2.751**	0.165***	0.110*	0.445***
(18)		(0.833)	(0.634)	(1.080)	(0.058)	(0.065)	(0.098)
	Observations	144	143	102	144	143	102
W/o Slovenia	PostLCR#NNLR	0.913	1.783***	-2.718**	0.134**	0.076	0.432***
(19)		(0.805)	(0.613)	(1.046)	(0.064)	(0.071)	(0.096)
	Observations	145	144	99	145	144	99
W/o Spain	PostLCR#NNLR	0.816	1.651**	-2.887**	0.175***	0.096	0.489***
(20)		(0.827)	(0.728)	(1.185)	(0.064)	(0.074)	(0.105)
	Observations	128	127	89	128	127	89

Notes: This table reports the interaction effect of estimating the empirical specification of Equation (1) for different samples. Row (1) reports the estimated interaction effects of the baseline sample already presented by Table 3 and 2. Row (2) to (20) report the estimates when the indicated country is excluded from the estimation sample.
*** p<0.01, ** p<0.05, * p<0.1.

Table 12: Correlation matrix

	Collateral value	Marketable collateral value	Non-marketable collateral value	Haircut	Marketable haircut	Non-marketable haircut	Log of total assets	Capital ratio	Loan ratio	Debt instruments	Interest Income	Deposits of fin. Institutions	Household deposits	Interest expense	ROA
Collateral value	1.00														
Marketable collateral value	0.80	1.00													
Non-marketable collateral value	0.79	0.33	1.00												
Haircut	0.03	-0.11	0.23	1.00											
Marketable haircut	-0.01	0.00	0.29	0.51	1.00										
Non-marketable haircut	0.05	0.10	0.16	0.65	0.03	1.00									
Log of total assets	0.86	0.68	0.72	0.07	-0.07	0.04	1.00								
Capital ratio	-0.45	-0.38	-0.30	-0.29	-0.16	-0.43	-0.35	1.00							
Loan ratio	-0.22	-0.05	-0.12	0.15	0.09	0.16	-0.26	0.10	1.00						
Debt instruments	-0.10	-0.12	-0.21	-0.32	-0.26	-0.18	-0.15	-0.13	-0.61	1.00					
Interest Income	0.08	0.13	0.11	0.17	0.19	0.08	0.04	-0.08	0.29	-0.13	1.00				
Deposits of fin. Institutions	0.07	0.08	-0.14	0.02	-0.11	-0.21	0.17	0.02	0.04	-0.09	0.05	1.00			
Household deposits	-0.36	-0.24	-0.23	-0.01	0.18	0.05	-0.39	0.10	0.32	0.00	0.08	-0.57	1.00		
Interest expense	0.29	0.30	0.23	0.15	0.11	0.06	0.30	-0.18	0.14	-0.08	0.78	0.37	-0.26	1.00	
ROA	-0.13	-0.15	0.03	-0.10	-0.03	-0.30	-0.08	0.22	0.03	0.11	0.24	0.07	0.03	0.18	1.00

Notes: This table reports the correlation matrix for our baseline sample, the cross-sections Q2 2015 and Q1 2016. The covariates used in our estimations are here also included being lagged.

Table 13: Liquidity profile and quantity of pledged collateral (panel regression incl. treatment period)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
								Haircut							
PostLCR#NNLR	-0.933	-0.822	-0.588	0.017	0.172	0.345	0.690	0.788	0.808	1.174	1.255*	1.103	0.965	0.816	0.370
	(0.586)	(0.617)	(0.658)	(0.587)	(0.623)	(0.629)	(0.569)	(0.554)	(0.631)	(0.721)	(0.728)	(0.788)	(0.956)	(1.014)	(1.207)
Observations	297	225	149	371	299	223	445	373	297	519	447	371	593	521	445
R-squared	0.06	0.08	0.27	0.09	0.15	0.19	0.04	0.05	0.05	0.05	0.04	0.05	0.04	0.05	0.05
Dependent var.															
Mean	11.92	11.63	11.51	12.05	11.86	11.87	12.04	11.90	11.91	12.11	11.99	12.02	12.20	12.11	12.15
Std. dev.	11.55	11.18	10.86	11.28	10.93	10.63	11.01	10.67	10.37	10.83	10.51	10.24	10.74	10.45	10.21
								Marketable haircut							
PostLCR#NNLR	-0.086	0.166	0.472	0.822*	1.033**	1.112**	1.427***	1.618***	1.673***	1.866***	1.975***	1.835***	2.130***	2.153***	1.926**
	(0.403)	(0.426)	(0.485)	(0.441)	(0.462)	(0.434)	(0.515)	(0.530)	(0.520)	(0.645)	(0.662)	(0.648)	(0.768)	(0.784)	(0.760)
Observations	294	223	148	368	297	222	442	371	296	516	445	370	590	519	444
R-squared	0.12	0.09	0.17	0.27	0.31	0.36	0.13	0.13	0.11	0.12	0.11	0.09	0.11	0.10	0.09
Dependent var.															
Mean	4.98	4.89	4.86	5.30	5.31	5.43	5.45	5.49	5.63	5.61	5.66	5.80	5.75	5.81	5.96
Std. dev.	5.60	5.51	5.40	5.70	5.66	5.64	5.42	5.33	5.22	5.25	5.14	5.00	5.18	5.08	4.95
								Non-marketable haircut							
PostLCR#NNLR	-2.598***	-2.446***	-2.003***	-2.485***	-2.284***	-1.874***	-2.637***	-2.395***	-2.069***	-2.821***	-2.442***	-2.146***	-2.808***	-2.809***	-2.645***
	(0.725)	(0.627)	(0.502)	(0.755)	(0.655)	(0.589)	(0.813)	(0.733)	(0.652)	(0.832)	(0.755)	(0.675)	(0.945)	(0.978)	(0.979)
Observations	209	156	103	260	207	154	312	259	206	362	309	256	413	360	307
R-squared	0.18	0.29	0.45	0.20	0.27	0.31	0.20	0.24	0.29	0.17	0.21	0.23	0.12	0.13	0.13
Dependent var.															
Mean	33.04	32.82	32.56	32.72	32.47	32.18	32.54	32.30	32.04	32.44	32.22	31.99	32.32	32.12	31.91
Std. dev.	15.01	14.91	14.74	14.90	14.78	14.62	14.80	14.69	14.54	14.76	14.66	14.53	14.70	14.60	14.48
								Collateral value							
PostLCR#NNLR	0.074*	0.042	0.020	0.125***	0.082**	0.066*	0.187***	0.142***	0.126***	0.212***	0.172***	0.178***	0.275***	0.251***	0.275***
	(0.044)	(0.043)	(0.045)	(0.043)	(0.039)	(0.038)	(0.049)	(0.047)	(0.046)	(0.063)	(0.060)	(0.055)	(0.082)	(0.085)	(0.093)
Observations	297	225	149	371	299	223	445	373	297	519	447	371	593	521	445
R-squared	0.12	0.07	0.11	0.10	0.07	0.07	0.12	0.08	0.08	0.12	0.11	0.12	0.13	0.11	0.11
Dependent var.															
Mean	8.14	8.14	8.18	8.16	8.17	8.20	8.18	8.18	8.21	8.16	8.16	8.18	8.14	8.14	8.15
Std. dev.	1.90	1.88	1.85	1.86	1.84	1.80	1.86	1.84	1.81	1.88	1.87	1.86	1.90	1.89	1.89
								Marketable collateral value							
PostLCR#NNLR	0.101	0.073	0.045	0.109**	0.068	0.055	0.089	0.046	0.038	0.088	0.047	0.062	0.108	0.071	0.084
	(0.063)	(0.063)	(0.058)	(0.048)	(0.046)	(0.049)	(0.078)	(0.079)	(0.075)	(0.106)	(0.107)	(0.101)	(0.123)	(0.121)	(0.114)
Observations	294	223	148	368	297	222	442	371	296	516	445	370	590	519	444
R-squared	0.10	0.09	0.16	0.10	0.08	0.08	0.03	0.03	0.05	0.03	0.03	0.07	0.04	0.04	0.07
Dependent var.															
Mean	7.82	7.84	7.86	7.82	7.85	7.86	7.85	7.87	7.89	7.83	7.85	7.86	7.81	7.83	7.83
Std. dev.	2.21	2.13	2.12	2.19	2.12	2.11	2.14	2.08	2.06	2.14	2.08	2.07	2.13	2.08	2.07
								Non-marketable collateral value							
PostLCR#NNLR	0.203***	0.164***	0.125**	0.311***	0.255***	0.213***	0.338***	0.285***	0.244***	0.344***	0.281***	0.245***	0.379***	0.336***	0.310***
	(0.061)	(0.057)	(0.050)	(0.067)	(0.060)	(0.060)	(0.075)	(0.065)	(0.065)	(0.089)	(0.076)	(0.073)	(0.106)	(0.103)	(0.103)
Observations	209	156	103	260	207	154	312	259	206	362	309	256	413	360	307
R-squared	0.11	0.16	0.46	0.18	0.20	0.24	0.20	0.21	0.20	0.17	0.18	0.16	0.15	0.15	0.14
Dependent var.															
Mean	6.85	6.85	6.89	6.87	6.87	6.91	6.87	6.87	6.90	6.88	6.89	6.91	6.89	6.90	6.92
Std. dev.	1.73	1.72	1.70	1.70	1.69	1.66	1.72	1.71	1.70	1.72	1.72	1.71	1.71	1.71	1.70
Startperiod	Q1 2015	Q2 2015	Q3 2015	Q1 2015	Q2 2015	Q3 2015	Q1 2015	Q2 2015	Q3 2015	Q1 2015	Q2 2015	Q3 2015	Q1 2015	Q2 2015	Q3 2015
Endperiod	Q4 2015	Q4 2015	Q4 2015	Q1 2016	Q1 2016	Q1 2016	Q2 2016	Q2 2016	Q2 2016	Q3 2016	Q3 2016	Q3 2016	Q4 2016	Q4 2016	Q4 2016

Notes: This table reports the interaction effect of estimating the empirical specification of Equation (1) for different sample periods. The sample period is indicated in the lower part of the table. In contrast to Table 7, the treatment periods Q3 and Q4 2015 are included in the estimations. *** p<0.01, ** p<0.05, * p<0.1.

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