Navigating the Low Interest Rate Landscape: Assessing Liquidity Positions of EU Banks under the LCR Constraint[1]

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Abstract

This paper explores the impact of the Liquidity Coverage Ratio (LCR) as a binding constraint on banks. Using a panel dataset encompassing 707 banks located in EU countries over the years 2012 to 2018, we analyze the phased introduction of the LCR, starting at 60% in 2015 and reaching full implementation at 100% in 2018. Our research reveals a positive effect of the LCR on liquidity buffers and a negative impact on the loan-to-deposit ratio, indicating strengthened liquidity positions. Contrary to expectations, estimations across five bank types demonstrate a significant LCR impact on all categories. Additionally, the study investigates the adverse effects of low or negative interest rates, particularly affecting cooperative and savings banks. Based on these findings, we recommend that policymakers maintain a vigilant approach to liquidity regulations, ensuring their adaptability to diverse bank types and considering measures to alleviate the negative impact of prolonged low or negative interest rate environments on specific bank categories.

Keywords: *banks, interest rates, liquidity risk, Liquidity Coverage Ratio, regulation*

JEL Classification: C33, E43, G21

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The data that support the findings of this study are available from the corresponding author upon reasonable request.

Introduction

In the dynamic landscape of global finance, the liquidity positions of banks play a pivotal role in maintaining financial stability and resilience. The EU banking sector, in particular, was navigating through a challenging terrain marked by persistently low interest rates in the 2012 – 2022 period. Against this backdrop, understanding how EU banks manage their liquidity positions becomes paramount, especially in the context of the Liquidity Coverage Ratio (LCR) constraint. In the aftermath of the 2007 – 2009 global financial crisis (GFC), regulatory authorities worldwide embarked on a mission to fortify the banking sector against systemic risks (Acharya et al., 2017). The Basel III framework emerged as a linchpin of these efforts, introducing the LCR as a key component (BCBS, 2017; Allen and Gale, 2017).

The LCR mandates that banks maintain a sufficient stockpile of high-quality liquid assets to withstand a 30-day stress scenario (BCBS, 2013). Within the EU, this framework has been adopted and integrated into the regulatory fabric, shaping the liquidity management strategies of banks across the region. Specifically, the implementation of Basel III reforms occurred through the Capital Requirements Regulation (CRR) and Capital Requirements Directive IV (CRD IV) in the EU. Notably, only the LCR found its place within the CRR, with the net stable funding ratio (NSFR) as a long-term liquidity measure. As outlined in Article 460 of the CRR, the LCR requirement underwent a phased increase, starting at 60% in 2015, progressing to 70% in 2016, 80% in 2017, and reaching the final level of 100% in 2018. The NSFR, on the other hand, awaited formal enforcement through the EU regulation CRR II/CRD V in 2021.

In the current context, this paper seeks to empirically observe the impact of Basel III liquidity requirements in the EU and the gradual introduction of the LCR on the liquidity positions of European banks. Additionally, the period post-GFC has unfolded amidst an unprecedented low and even negative, interest rate environment, intensifying pressure on banks' profitability. This challenge is compounded by reinforced mandates necessitating banks to hold more liquid assets, even as they bear low yields.

This study formulates three key hypotheses based on existing literature. First, this study explores how the gradual implementation of the LCR has influenced the liquidity positions of European banks. The introduction of the LCR mandates that banks hold a buffer of liquid assets to cover their expected net cash outflows in the short term. We hypothesize that this requirement should lead to an increase in banks' liquid asset holdings, as institutions adjust to meet the regulatory demands. Second, the LCR is expected to impact banks' loan-to-deposit ratios. By encourageing a more conservative liquidity management strategy, we anticipate a reduction in the loan-to-deposit ratio as banks prioritize liquidity over extending

loans, thus enhancing their liquidity positions. Finally, given the diverse nature of banks in the EU, we hypothesize that the effect of the LCR will vary across different bank types. Larger, more diversified institutions with significant wholesale funding activities are expected to experience a more substantial impact compared to smaller, more traditional banks, such as cooperative and savings banks, which rely more on customer deposits for funding.

The subsequent sections of this paper unfold as follows: Section 1 – Literature Review conducts a comprehensive review of existing literature on liquidity risk in banking and its regulatory landscape. Section 2 – Empirical Analysis details the dataset employed and variable selection, while section 3 – Methodology delves into the econometric framework and model construction. The estimation results are presented in section 4, and the paper concludes in the last section.

1. Literature Review

The literature on liquidity risk in banking adopts diverse approaches, which can be categorized into four primary groups. The first group focuses on the systemic nature of liquidity risk, examining how individual banks' strategies can have broader, potentially suboptimal, consequences for the entire banking sector. Notable works include Acharya and Pedersen (2005) and Freixas et al. (2011), who explore regulatory impacts on bank behavior, while Adrian and Shin (2009) and Allen and Carletti (2009) highlight the role of liquidity in financial stability. Diamond and Dybvig (1983) introduced a model analyzing the role of deposit insurance in preventing bank runs, providing crucial insights into the relationship between liquidity regulation and financial stability. Further, Huang and Ratnovski (2011) explore the risks associated with wholesale funding, emphasizing the efficiency gains from active monitoring by funders. Hoerova et al. (2018) discuss the costs and benefits of liquidity risk regulation, and, more specifically, the tools that can be used for it. Imbierowicz and Rauch (2014) analyse the relationship between liquidity and credit risk in banks, as these two are the most important factors for the banks' survival.

The second group investigates the long-term liquidity measure, NSFR, introduced by Basel III. King (2013) and Dietrich et al. (2014) reveal that many banks historically did not meet the NSFR minimums. Other studies, such as DeYoung and Jang (2016), Komarkova et al. (2020), and DeYoung et al. (2018), highlight the relationship between liquidity and capital requirements, showing that stricter capital regulations generally lead to improved liquidity positions. A third group examines the determinants of liquidity risk in specific regions, such as Leykun (2016) on Ethiopian banks, Tran et al. (2019) on Vietnamese banks, Tripe and Shi

(2012) on New Zealand's banks, and Vodová (2011) and Teplý et al. (2012) on Slovak banks. These studies emphasize the regional differences in liquidity risk determinants and responses to regulatory changes. Finally, the fourth group focuses on the quantitative impact of the LCR implementation. Studies by the EBA (2020; 2021) document significant improvements in LCR compliance across banks, particularly during the COVID-19 pandemic.

Based on this literature review and the available data discussed in section 2 we formulate three research hypotheses that are presented in section 3.1 – Hypotheses development.

2. Empirical Analysis

2.1. Dataset

Our dataset consists of 707 banks from EU27 member countries, including the United Kingdom, which was a member during the observation period. One bank from Estonia was excluded due to missing data on bank-specific variables, therefore no Estonian bank was included. For a breakdown of the number of banks by individual countries see Table A.3.

Selection criteria included active banks from EU27 countries categorized under bank holdings and holding companies, commercial banks, cooperative banks, real estate and mortgage banks, or savings banks. Subsequently, data were filtered based on variables adopted for the model, ensuring a balanced panel for 2012 – 2018 with no missing observations. The dataset was augmented with country-specific variables, encompassing GDP growth rate, inflation rate, 3M interbank rate, 10Y government bond yield, and the ratio of issued government bonds to the GDP for each country. Additionally, a proxy variable for the slope of the yield curve was computed as the difference between the 10Y government bond yield and 3M interbank rate. A dummy variable, "negative rate," was introduced to signify a negative 3M interbank rate for a specific country in a given year. Eurostat served as the source for most country-specific variables, except for the 3M interbank rate, obtained from Reuters (CZK and EUR countries) or the ECB statistical data warehouse (other non-EUR countries). Dummy variables were also created for each banking specialization, excluding commercial banks, considered the base group.

2.2. Variable Selection

We select the variables based on standard literature on bank profitability and liquidity including Vodová (2011), Kočišová (2015), Borio et al. (2017), Hoerova et al. (2018) or more recently Komarkova et al. (2020), Hanzlík and Teplý (2022)

and Kuc and Teplý (2023). The models employ two distinct liquidity indicators as dependent variables: liquid assets to deposits and short-term funding and net loans to deposits and short-term funding, as detailed in Table 1. Explanatory variables fall into two categories: bank-specific variables and country-specific variables. Bank-specific variables act as proxies for individual bank characteristics, including size (natural logarithm of total assets), profitability, and efficiency (return on average assets and cost-to-income ratio), credit risk (net loans to total asset ratio and loan loss reserves to gross loans ratio), and capital (equity to total assets), as elaborated in Table 2.

T a b l e 1

Dependent Variables

Liquid assets to deposits and short-term funding	Measure of the liquid asset buffer of the bank. Represents the percentage ratio of liquid assets to the deposits and other short-term funding as defined in the Orbis Bank Focus database.	la_dstf
Net loans to deposits and short-term funding	Serves as a proxy for a loan-to-deposit ratio, a basic liquidity indicator of a bank. Based on a definition from the Orbis Bank Focus database.	nl_dstf

Source: Authors based on Orbis Bank Focus.

T a b l e 2

Bank Specific Variables

Natural logarithm of total assets of the bank	This variable serves commonly as an approximation of the size of a bank. Transformation by natural logarithm is used in order to smooth out large differences in the size of individual banks.	lta
Return on average assets	ROAA is one of the common profitability measures of a bank. Hence, for our purpose we use this variable as a proxy for banks' profitability. The expected sign of the estimated coefficient is most likely to be negative, as higher profitability might be attained at the expense of liquidity, but the relationship is likely to be more complex.	roaa
Net loans to total assets ratio	Indicates to what extent the assets consist of lending to the clients. Hence, it is a proxy for credit risk, but it could also be considered a liquidity indicator. The sign of the estimated coefficient is expected to be negative, as higher share of loans leaves less space for liquid assets holdings.	nl_ta
Equity to total assets ratio	A leverage ratio measuring the level of a bank's capital. The expected sign should be negative, as the better capitalization should by definition decrease the solvency risk and thus also the probability of liquidity stress for the bank, as discussed in Hoerova et al. (2018) and Komarkova et al. (2020).	eq_ta
Cost to income ratio	An indicator of a bank's operational efficiency. The impact on liquidity is ambiguous.	cir
Loan loss reserves to gross loans ratio	Measures the quality of a bank's assets by evaluating the part of loans put aside for potential charge-off. The link to the liquidity position is somewhat unclear, but it serves as another control proxy variable for credit risk.	llr_gl

Source: Authors based on Orbis Bank Focus.

Country-specific variables encompass macroeconomic features such as GDP growth rate and inflation rate, interest rate structure represented by the short-term rate (3M interbank rate), the slope of the yield curve (proxied by the difference between the 10Y government bond yield and 3M interbank rate), and the ratio of issued government debt to the GDP as a proxy for the supply of liquid assets. Additional variables include a dummy variable for the existence of a negative short-term interest rate and a quasi-dummy variable for the Liquidity Coverage Ratio (LCR) requirement, detailed in Table 3.

Moreover, a collection of bank-specific dummy variables, outlined in Table 4, delineates the five distinct specialization types of banks. As fixed effects constitute the principal estimation approach, these variables function as breakout indicators, facilitating separate estimations for each specialization type and remaining distinct from the dummy variables integrated into the model.

T a b l e 3

Country Specific Variables

Short-term interest rate	The average annual 3M interbank rate. For CZK and EUR countries obtained from Reuters, and for other non-EUR countries from the statistical data warehouse of the ECB.	st_ir
Slope of the yield curve	Approximated by the spread between the 3M interbank rate and 10Y government bond yield.	spread
Real annual GDP growth rate	Annual growth rate of real GDP obtained from Eurostat.	gdp
Inflation rate	Annual inflation rate obtained from Eurostat.	infl
Government debt to GDP ratio	The ratio of the total amount of issued government bonds to the GDP of a given country. The impact is expected to be positive, as a higher ratio means a higher supply of liquid assets. On the other hand, this assumption is based on the relatively strong assumption that the banks liquid asset buffers consist predominantly of government bonds issued by the domestic country.	gov_debt
Negative rate	Equals 1 for each country that had a negative short-term interest rate in a given year.	negrate
LCR requirement	A quasi-dummy variable indicating the gradual phase-in of the binding LCR percentage requirement. Equals 0 for years 2012 – 2014, 60 for 2015, 70 for 2016, 80 for 2017 and 100 for 2018.	LCR_req

Note: The country specific variables were obtained from Eurostat, the ECB, Reuters or based on the author's own calculation.

Source: Authors based on Orbis Bank Focus.

T a b l e 4

Bank Specialisation Dummy Variables

Bank holdings and holding companies	Equals 1 for the specialisation Bank holdings and holding companies.	bhhc
Cooperative banks	Equals 1 for the specialisation Cooperative banks.	coop
Real estate and mortgage banks	Equals 1 for the specialisation Real estate and mortgage banks.	rem
Savings banks	Equals 1 for the specialisation Savings banks.	saving

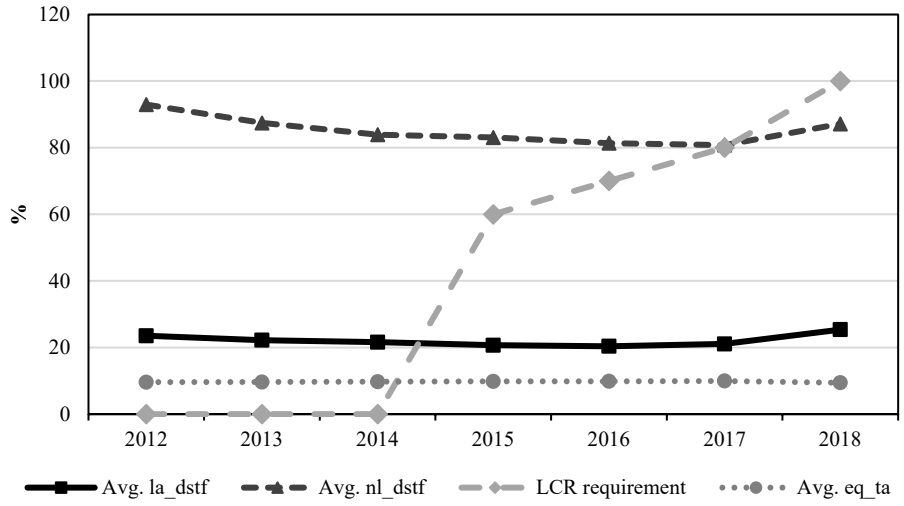
Source: Authors based on the Orbis Bank Focus.

2.3. Descriptive Analysis

As mentioned, our dataset encompasses 707 banks situated in 27 EU member countries. Comprehensive summary statistics for all variables are available in Table A.1. In Figure 1, we present a summary of the evolution of average liquidity indicators within the sample. Notably, the liquid assets to deposits and short-term funding indicator has demonstrated improvement primarily over the last two years. This trend implies that the LCR requirement significantly impacted a substantial number of banks only when it reached its final threshold of 100%. During the phase-in period, it appears that the LCR requirement was likely not constraining for many banks, aligning with the findings of the EBA (2016). Consequently, these banks were not compelled to augment their holdings of liquid assets until the LCR requirement became more stringent. Conversely, the net loans to deposits and short-term funding indicator unveils a different liquidity policy trajectory for banks. Initially, banks enhanced their liquidity position by reducing the ratio of loans to deposits, decreasing from around 93% in 2012 to approximately 81% in 2017. Subsequently, the ratio experienced an uptick to approximately 87%. This pattern may be linked to a balance sheet "cleaning up", encompassing the write-off of non-performing loans by the banks. For additional context, we included the development of the equity to total assets ratio in the chart, illustrating the banks' relatively stable capital position, alongside the gradual phase-in of the LCR requirement.

F i g u r e 1

Average Liquidity and Capital Indicators and the LCR Requirement (%) in the EU in 2012 – 2018

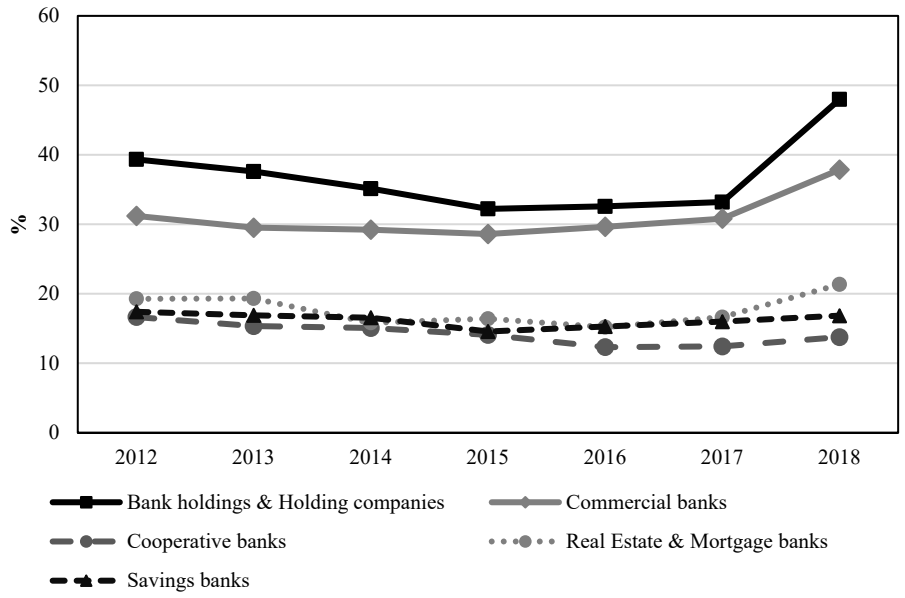


Source: Authors based on Orbis Bank Focus.

Figure 2 illustrates the progression of liquid assets to deposits and short-term funding categorized by bank specialization. Notably, bank holdings and holding companies and commercial banks, characterized as larger institutions with enhanced interbank market access, consistently exhibit elevated levels of liquid asset buffers. Furthermore, these two categories appear to be significantly affected by the LCR requirement, evident in a substantial surge in this variable in 2018, coinciding with the full implementation of the LCR.

F i g u r e 2

Average Liquid Assets to Deposit and ST Funding Ratio (%) by Bank Specialisation in 2012 – 2018



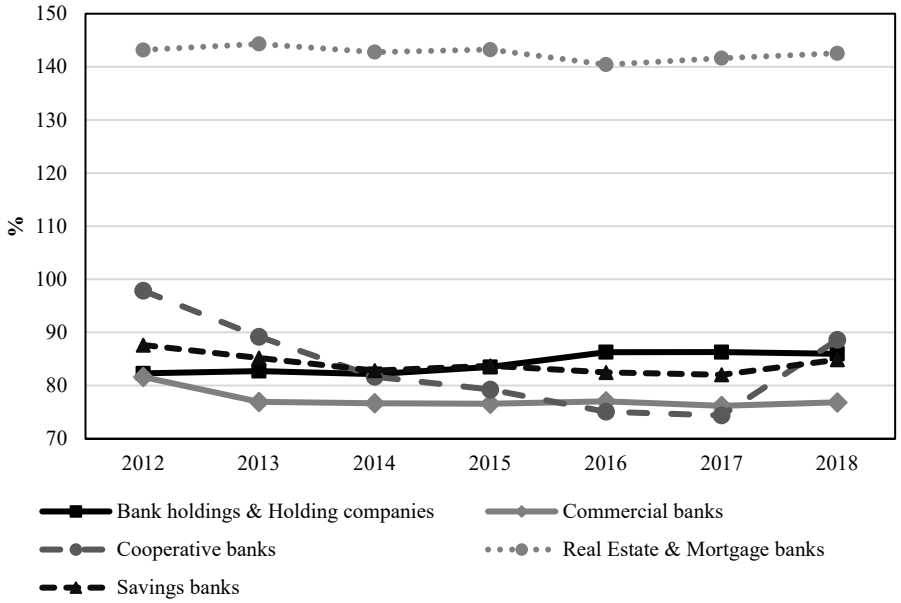
Source: Authors based on Orbis Bank Focus.

Figure 3 depicts net loans to deposits and short-term funding according to specialization. Notably, real estate and mortgage banks consistently maintain a significantly higher level throughout the entire period. This distinction aligns with their business model, primarily centered on offering mortgage loans financed through the issuance of covered bonds rather than relying on retail deposits, as observed in other bank types.

A noteworthy decline in the loan-to-deposit ratio is evident for cooperative banks, dropping from 98% in 2012 to 74% in 2017, with a subsequent increase to 89% in 2018. Conversely, the other three categories exhibit a relatively stable ratio, hovering around 80%.

F i g u r e 3

Average Net Loans to Deposit and ST Funding Ratio (%) by Bank Specialisation in 2012 – 2018



Source: Authors based on Orbis Bank Focus.

3. Methodology

3.1. Hypotheses Development

Based on the literature review conducted in Section 1 and the available data we formulate the following hypotheses:

Hypothesis #1 (increase in liquid assets holdings): The LCR of a bank measures the coverage of the expected net outflows of cash (expected cash outflows minus expected cash inflows) over the 30-day horizon by holdings of liquid assets (cash and bonds that can be easily sold or put in repo) to cover these net outflows. Hence, we assume that the introduction of a binding LCR requirement should therefore lead to an increase in holdings of liquid assets proxied by the variable *liquid assets to deposits and short-term funding* as further discussed in Section 2.

Hypothesis #2 (decrease in loan-to-deposit ratio): The ratio of loans to deposit is the basic liquidity indicator of a bank. A higher loan-to-deposit ratio, especially if it is higher than 100%, is a sign of a worse liquidity situation of a bank (and higher reliance on funding from the wholesale market). Hence, we assume that the liquidity regulation aimed at improving the banks' liquidity position should lead

to a decrease in the loan-to-deposit ratio (proxied by variable *net loans to deposits and short-term funding*) further described in Section 2.

Hypothesis #3 (different impact according to bank specialisation): We assume that the introduction of the binding LCR requirement will have significant impact mainly on the banks with more diversified business models with a higher share of wholesale activities, while it should have only limited impact on more traditional banks focusing on collecting deposits and providing loans. We consider five types of banks in our sample: bank holdings and holding companies, commercial banks, savings banks, cooperative banks and real estate and mortgage banks. We expect that the impact should be mainly on the first two types of banks, while the other three types are expected to show an insignificant impact of the LCR constraint.

3.2. Methodology

For testing our hypotheses, we used a standard methodology for estimation with panel data (Baltagi, 2005; Wooldridge, 2010). We considered using methods such as pooled OLS, fixed effects (within or LSDV estimator) or random effects (FGLS estimator), which, under certain assumptions, allow at least the consistent estimation of a model of the following form:

$$y_{it} = \alpha + \boldsymbol{x}'_{it}\,\boldsymbol{\beta} + c_i + \epsilon_{it}$$

where $i = 1, ..., N$ (cross-sectional units) and $t = 1, ..., T$ (time periods), c_i is the unobservable group-specific fixed or random effect and $\epsilon_{it} \sim i.i.d.N(0,\sigma^2)$. The basic setup of the estimated model for *liquid assets to deposits and short-term funding* is as follows:

$$la\_dstf_{it} = \alpha + \boldsymbol{x}'_{it}\,\boldsymbol{\beta} + \boldsymbol{z}'_{it}\,\boldsymbol{\gamma} + \delta LCR\_req_t + (c_i + \epsilon_{it})$$

where $\boldsymbol{x}'_{it}$ is a vector of the bank-specific variables described in Table 2 and $\boldsymbol{z}'_{it}$ is a vector of the country-specific variables described in Table 3, LCR_req_t is the LCR requirement as the main variable of interest and the error term consists of the fixed effects component c_i and the exogenous component ϵ_{it}.

Similarly, for *net loans to deposits and short-term funding* the model is defined as follows:

$$nl\_dstf_{it} = \alpha + \boldsymbol{x}'_{it}\,\boldsymbol{\beta} + \boldsymbol{z}'_{it}\,\boldsymbol{\gamma} + \delta LCR\_req_t + (c_i + \epsilon_{it})$$

where $\boldsymbol{x}'_{it}$ is a vector of the bank-specific variables described in Table 2 and $\boldsymbol{z}'_{it}$ is a vector of the country-specific variables described in Table 3, LCR_req_t is the LCR requirement as the main variable of interest, c_i is the fixed effects component and ϵ_{it} the exogenous component.

We estimate the above specified models by both fixed effects and random effects and use the Hausman test to check whether the random effects provide consistent results. We then use the fixed effects estimation also for subsamples for each bank specialisation.

4. Results and Findings

4.1. Empirical Results

In this section, we present the estimation results for both liquidity indicators used as dependent variables in our models. Table 5 displays the estimation results for both fixed effects and random effects models, encompassing both dependent variables.

The key variable of interest, the LCR requirement, emerges as significant in all four models. For models with the liquid assets to deposits and short-term funding as the dependent variable, the estimated impact is positive. Conversely, for models with net loans to deposits and short-term funding as the dependent variable, the estimated impact is negative. This aligns with our hypothesis, suggesting that a binding LCR requirement should enhance a bank's liquidity position.

Notably, this result is consistent with the findings of the EBA (2016), despite the EBA report indicating that most banks already met the 100% requirement in December 2015. The results here, however, indicate that some smaller banks still did not meet the 100% requirement at that time. The broader sample used in this paper (707 banks) compared to the EBA report (171 banks) provides a more comprehensive perspective.

The estimated coefficients for bank-specific variables yield mixed results. The logarithm of total assets exhibits a significant positive impact on both dependent variables, implying that larger banks tend to maintain higher liquid asset buffers. However, larger banks also use a larger proportion of their deposit funding for client loans, indicating that larger banks do not universally possess better liquidity positions. The link between a bank's profitability and liquidity appears weak, with the return on average assets (ROAA) mostly insignificant, and the cost-to-income ratio significantly negative only for net loans to deposits and short-term funding.

In contrast, the link with credit risk is robust. The loan loss reserves to gross loans ratio significantly impacts both ratios negatively, suggesting that banks with lower loan quality tend to have smaller liquid asset buffers. The significance of the estimated coefficients for net loans to total assets further supports the notion that higher credit risk is associated with increased liquidity risk. The interpretation

of these coefficients is nuanced, revealing that a higher share of bad loans correlates with a lower ratio, while more total assets composed of loans leave less room for liquid assets. The estimated coefficients for the liquid assets to deposits and short-term funding are negative, while for net loans to deposits and short-term funding are positive, aligning with expectations.

The equity to total assets ratio exhibits a significant positive impact on both variables. This outcome suggests that a higher capital buffer correlates with a lower proportion of deposits on the liability side of the balance sheet, resulting in a higher liquid asset buffer when expressed as a ratio to deposits and short-term funding. Similarly, a higher capital buffer is associated with a greater share of net loans funded by capital rather than deposits and other short-term funding.

The estimation results for country-specific variables present mixed findings. GDP growth shows a significant impact only on net loans to deposits and short-term funding, with a negative influence. For inflation, there is a significant positive impact on liquid assets to deposits and short-term funding, possibly reflecting higher expected outflows during periods of inflation. The link with the government debt to GDP ratio appears weak, especially for the liquid asset buffer, where no significant impact is observed. Conversely, the negative impact on net loans suggests the crowding-out effect of government debt. Lastly, the negative rate dummy variable exhibits a clear negative impact on the liquid asset buffer, indicating that the existence of a negative short-term interbank rate encourages banks to hold fewer liquid assets with potentially negative yields.

The estimation diagnostics at the bottom of Table 5 indicate the overall significance of the models, albeit with a moderate level of R-squared. The results of the Hausman test reject the null hypothesis, signifying that the random effects estimation is inconsistent. Therefore, fixed effects are deemed a superior method for subsequent estimations.

In Table 6, we present the results of separate estimations on subsamples for each bank specialization type. The LCR requirement remains significantly positive for all types, with slight variations in estimated magnitudes. Other variables exhibit minimal differences compared to the estimation results for the entire sample, except for instances where certain variables are insignificant for specific types. Notable distinctions include the significant negative impact of ROAA on the liquid asset buffer for cooperative and savings banks, along with the significant influence of the interest rate structure on these two types. Particularly for cooperative banks, a notably high coefficient for the negative rate dummy suggests a substantially negative impact on their liquidity position in the presence of a negative interest rate. Lastly, a significant negative impact of the government debt to GDP ratio is observed for bank holdings and holding companies.

T a b l e 5

Fixed Effects and Random Effects Estimation Results (whole sample)

	FE	**RE**	**FE**	**RE**
	la_dstf	la_dstf	nl_dstf	nl_dstf
lta	3.773***	2.305***	3.862***	3.212***
	(0.964)	(0.246)	(1.166)	(0.476)
roaa	0.0155	0.250	–0.550*	–0.626**
	(0.240)	(0.235)	(0.290)	(0.291)
nl_ta	–0.606***	–0.645***	1.216***	1.253***
	(0.0257)	(0.0201)	(0.0310)	(0.0284)
eq_ta	1.284***	1.019***	1.936***	1.756***
	(0.0969)	(0.0739)	(0.117)	(0.103)
cir	–0.00874	0.000494	–0.0251**	–0.0367***
	(0.00940)	(0.00902)	(0.0114)	(0.0113)
llr_gl	–0.383***	–0.306***	–0.621***	–0.616***
	(0.0796)	(0.0684)	(0.0962)	(0.0915)
st_ir	0.930*	–0.408	0.869	0.342
	(0.511)	(0.452)	(0.618)	(0.594)
spread	0.271	–0.286	–0.0305	–0.0162
	(0.243)	(0.211)	(0.294)	(0.280)
gdp	–0.182	–0.392***	–0.757***	–0.988***
	(0.153)	(0.145)	(0.184)	(0.182)
infl	0.897***	1.207***	–0.270	0.0662
	(0.207)	(0.194)	(0.250)	(0.241)
gov_debt	–0.0402	–0.116***	–0.390***	–0.100***
	(0.0485)	(0.0178)	(0.0587)	(0.0325)
negrate	–6.245***	–6.534***	–0.950	0.167
	(0.795)	(0.752)	(0.962)	(0.944)
LCR_req	0.102***	0.0927***	–0.0387***	–0.0508***
	(0.0103)	(0.00949)	(0.0125)	(0.0121)
Constant	–8.363	25.36***	–27.07	–39.59***
	(15.58)	(5.036)	(18.83)	(9.124)
Observations	4949	4949	4949	4949
F/Wald statistic	71.61***	1617.16***	212.3***	3099.44***
R-squared	0.180	0.176	0.395	0.390
Hausman test	–	100.88***	–	255.14***

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: Authors' calculation in Stata 11.2.

Subsequently, Table 7 presents the estimation results by specialization for net loans to deposits and short-term funding. Similar to the findings for liquid assets, the primary distinctions in significance compared to the estimation for the entire sample emerge for cooperative and savings banks concerning ROAA, the negative rate dummy, and, in the case of cooperative banks, the interest rate structure variables. These outcomes further corroborate that negative rates predominantly exacerbate liquidity positions for cooperative banks and, to a lesser extent, savings banks.

As an additional robustness check, we conducted estimations with clustered standard errors, clustering at both the country and bank levels. A comparison of these estimations with the baseline estimation using classic standard errors is presented in Table A.4 and Table A.5.

The results exhibit minimal changes, although in certain cases, the estimated coefficients lose their significance. Notably, in the case of the LCR requirement, the impact is no longer significant for net loans to deposits and short-term funding when clustering is applied at the country level.

T a b l e 6

FE Estimation Results for Liquid Assets to Deposits and ST Funding by Specialisation

	bhhc	***comm***	***coop***	***rem***	***savings***
	la_dstf	la_dstf	la_dstf	la_dstf	la_dstf
lta	1.481 (6.766)	6.542*** (1.617)	–1.670 (1.026)	12.12*** (4.144)	–2.579 (2.322)
roaa	0.470 (1.149)	–0.0313 (0.386)	–0.922*** (0.310)	–1.029 (1.894)	1.199** (0.595)
nl_ta	–1.232*** (0.152)	–0.871*** (0.0554)	–0.266*** (0.0218)	–1.531*** (0.116)	–0.759*** (0.0569)
eq_ta	–0.568 (0.709)	1.795*** (0.152)	0.791*** (0.122)	0.599 (0.430)	–0.380 (0.265)
cir	0.0862 (0.0964)	–0.0354** (0.0153)	–0.00175 (0.0102)	0.0438 (0.0449)	0.0416** (0.0199)
llr_gl	1.518 (1.140)	–0.414*** (0.138)	–0.153** (0.0770)	–0.192 (0.284)	–0.448** (0.216)
st_ir	9.848** (4.134)	0.710 (0.786)	4.907*** (1.406)	1.040 (1.532)	3.779*** (1.209)
spread	–0.599 (1.557)	0.469 (0.384)	–0.832** (0.364)	1.191 (1.273)	2.701*** (0.762)
gdp	–0.187 (1.188)	–0.132 (0.256)	–1.147*** (0.255)	0.306 (0.351)	0.482 (0.334)
infl	1.295 (1.136)	0.869** (0.363)	0.0559 (0.294)	–0.578 (0.761)	0.357 (0.398)
gov_debt	–1.483*** (0.321)	–0.117 (0.0879)	0.0147 (0.0587)	0.0707 (0.194)	0.227*** (0.0874)
negrate	2.737 (4.316)	–3.690*** (1.397)	–11.56*** (1.309)	–4.938* (2.566)	–2.929* (1.584)
LCR_req	0.143*** (0.0456)	0.0829*** (0.0172)	0.180*** (0.0218)	0.119*** (0.0297)	0.0907*** (0.0226)
Constant	154.0 (129.6)	–30.82 (27.04)	45.90*** (16.12)	–73.80 (70.02)	88.57** (39.03)
Observations	203	1932	2016	329	469
F	8.264***	38.65***	32.03***	16.76***	18.17***
R-squared	0.400	0.234	0.195	0.447	0.378

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: Authors' calculation in Stata 11.2.

T a b l e 7

FE Estimation Results for Net Loans to Deposits and ST Funding by Specialisation

	bhhc	***comm***	***coop***	***rem***	***savings***
	nl_dstf	nl_dstf	nl_dstf	nl_dstf	nl_dstf
lta	9.132*** (3.066)	5.390*** (1.867)	3.158*** (1.219)	9.747 (9.151)	4.665** (2.297)
roaa	0.881* (0.521)	–0.611 (0.445)	–1.232*** (0.368)	3.303 (4.183)	–1.331** (0.588)
nl_ta	1.127*** (0.0689)	1.243*** (0.0639)	1.364*** (0.0259)	1.436*** (0.257)	1.107*** (0.0562)
eq_ta	0.0101 (0.321)	1.948*** (0.176)	2.192*** (0.145)	0.537 (0.949)	1.442*** (0.262)
cir	–0.0105 (0.0437)	–0.0218 (0.0177)	–0.0554*** (0.0121)	0.164 (0.0992)	–0.0303 (0.0197)
llr_gl	–0.531 (0.517)	–0.159 (0.159)	–0.822*** (0.0914)	–1.039* (0.627)	–1.151*** (0.213)
st_ir	–2.835 (1.873)	–0.206 (0.908)	–6.368*** (1.669)	11.45*** (3.382)	–1.537 (1.196)
spread	–0.211 (0.706)	0.0513 (0.443)	–2.611*** (0.432)	–2.589 (2.811)	0.0484 (0.753)
gdp	–1.311** (0.538)	–0.361 (0.295)	–2.886*** (0.303)	–0.547 (0.776)	–1.120*** (0.331)
infl	–0.722 (0.515)	0.276 (0.419)	1.937*** (0.350)	–6.477*** (1.681)	–0.183 (0.394)
gov_debt	–0.218 (0.145)	0.0105 (0.102)	–0.286*** (0.0697)	–1.807*** (0.428)	–0.402*** (0.0865)
negrate	2.154 (1.956)	–0.00717 (1.613)	10.12*** (1.555)	–6.061 (5.667)	4.355*** (1.567)
LCR_req	–0.0549*** (0.0207)	–0.0251 (0.0198)	–0.223*** (0.0258)	–0.0149 (0.0657)	–0.115*** (0.0224)
Constant	–117.1** (58.72)	–93.85*** (31.22)	–18.90 (19.14)	–22.35 (154.6)	–41.24 (38.61)
Observations	203	1932	2016	329	469
F	26.55***	42.14***	598.6***	7.359***	74.09***
R-squared	0.682	0.250	0.819	0.262	0.712

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: Authors' calculation in Stata 11.2.

4.2. Summary of Results

In this section, we evaluate the hypotheses outlined in Section 2 and draw conclusions based on our empirical findings, determining whether they are rejected or upheld.

Hypothesis #1 (increase in liquid assets holdings) – not rejected: The estimation results for both the entire sample and each bank specialization consistently demonstrated a significant positive impact of the LCR requirement variable. This aligns with the observed pattern in Figure 1 and Figure 2, where a notable rise in liquid assets to deposits and short-term funding occurred, particularly in 2018

when the LCR requirement reached its full implementation at the 100% level. The evidence strongly supports the assertion that the LCR requirement contributed to the augmentation of liquid asset holdings among the analyzed banks.

Hypothesis #2 (decrease in loan-to-deposit ratio) – not rejected: The results for the alternative dependent variable, net loans to deposits and short-term funding, also indicate a clear contribution of the LCR requirement to improved liquidity positions when assessed through the loan-to-deposit ratio. The consistently significant negative estimated coefficient for the LCR requirement, evident in both the overall sample and the specializations, reinforces the conclusion that the LCR requirement led to a reduction in the loan-to-deposit ratio for the observed banks.

Hypothesis #3 (different impact by bank specialisation) – rejected: The third hypothesis posited that the impact of the LCR requirement would be notably significant for bank specializations such as bank holdings and holding companies and commercial banks. Contrary to this expectation, the results demonstrated similar effects across all observed specializations, suggesting that various types of banks adjusted their liquidity positions to comply with the LCR requirement. Therefore, we reject this hypothesis.

Conclusion

In this study, we conducted an analysis of the factors influencing the liquidity positions of EU banks within the timeframe of 2012 – 2018. Our primary focus was on examining the repercussions of the gradual implementation of the binding LCR requirement, particularly in the context of an environment characterized by persistently low or even negative interest rates. To ensure a comprehensive assessment, we accounted for various bank-specific and country-specific (macroeconomic) factors. Our analytical approach involved utilizing an extensive dataset encompassing 707 banks across 27 EU member countries, including the United Kingdom.

The key contributions of our paper can be distilled into three primary findings. Firstly, our evaluation aimed to ascertain whether the introduction of the LCR indeed resulted in an enhancement of liquidity buffers within EU banks. Our findings indicate a significant positive impact of the LCR requirement on the proxy variable representing the liquid asset buffer. Moreover, we observed a substantial negative impact on the proxy for the loan-to-deposit ratio. Both outcomes collectively support the conclusion that the binding LCR requirement effectively improves the liquidity positions of banks.

Secondly, our study allowed us to model estimations separately for the five distinct types of banks. While expectations suggested that the LCR requirement

would likely exert a significant impact primarily on bank holdings and holding companies and commercial banks – given their diversified business model and enhanced access to the interbank market – the results revealed a comparable, significant impact across all five types of banks. This inclusive impact encompassed cooperative banks, real estate and mortgage banks, and savings banks.

Thirdly, our dataset facilitated an exploration of the impact of a low or even negative interest rate environment. The findings indicate a significant negative impact of such an environment on the liquidity positions of banks, with a particularly pronounced effect on cooperative and savings banks.

There are several promising avenues for further research in this area. First, future studies could explore the effects of the NSFR, which became binding in 2021. Investigating how the NSFR influences bank balance sheets would require more sophisticated methodologies than those used for the LCR, given its focus on long-term liquidity. This research would benefit from dynamic estimation approaches, as the lack of a phased implementation for the NSFR makes traditional methods less suitable. Additionally, the potential return to a higher interest rate environment, driven by post-pandemic inflation, presents an interesting context for further analysis. The monetary policy tightening by central banks, such as the Czech National Bank in 2021 and the European Central Bank in 2022, provides a basis for investigating how elevated rates interact with existing liquidity regulations, offering insights into the resilience of EU banks.

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A p p e n d i x

T a b l e A.1

Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
la_dstf	22.12	22.35	0.06	467.16
nl_dstf	85.22	40.32	0.03	849.25
lta	15.16	2.31	9.83	21.71
roaa	0.37	1.01	–13.52	13.02
nl_ta	60.39	17.38	0.03	99.66
eq_ta	9.72	4.91	–3.30	69.30
cir	66.45	25.95	1.95	587.41
llr_gl	4.91	4.73	0.00	43.92
st_ir	0.19	0.70	–0.50	8.06
spread	2.06	1.58	–0.41	21.92
gdp	1.07	2.02	–7.10	25.20
infl	1.14	1.06	–1.60	5.70
gov_debt	77.88	29.76	10.30	110.90
LCR_req	44.29	39.95	0.00	100.00
negrate	0.50	0.50	0.00	1.00
bhhc	0.04	0.20	0.00	1.00
coop	0.41	0.49	0.00	1.00
rem	0.07	0.25	0.00	1.00
savings	0.10	0.29	0.00	1.00
Number of observations	4949			
Number of groups	707			
Observations per group	7			

Source: Authors' calculation in Stata 11.2.

T a b l e A.2

Cross-Correlation Table

	la_dstf	**nl_dstf**	**lta**	**roaa**	**nl_ta**	**eq_ta**	**cir**
la_dstf	1.00 –						
nl_dstf	–0.15 (0.00)	1.00 –					
lta	0.19 (0.00)	0.17 (0.00)	1.00 –				
roaa	0.12 (0.00)	0.01 (0.40)	0.00 (0.76)	1.00 –			
nl_ta	–0.54 (0.00)	0.60 (0.00)	0.06 (0.00)	–0.02 (0.20)	1.00 –		
eq_ta	0.14 (0.00)	–0.08 (0.00)	–0.40 (0.00)	0.27 (0.00)	–0.11 (0.00)	1.00 –	
cir	0.10 (0.00)	–0.22 (0.00)	–0.08 (0.00)	–0.44 (0.00)	–0.17 (0.00)	0.02 (0.25)	1.00 –
llr_gl	–0.02 (0.16)	–0.17 (0.00)	–0.22 (0.00)	–0.28 (0.00)	–0.15 (0.00)	0.10 (0.00)	0.07 (0.00)
st_ir	0.02 (0.09)	0.02 (0.08)	0.07 (0.00)	–0.03 (0.02)	–0.01 (0.60)	0.05 (0.00)	–0.00 (0.76)
spread	–0.16 (0.00)	0.00 (0.92)	–0.22 (0.00)	–0.18 (0.00)	–0.01 (0.36)	0.06 (0.00)	0.00 (0.77)
gdp	0.10 (0.00)	–0.06 (0.00)	0.22 (0.00)	0.15 (0.00)	0.01 (0.35)	–0.02 (0.11)	0.02 (0.28)
infl	0.08 (0.00)	0.06 (0.00)	0.08 (0.00)	0.00 (0.94)	0.04 (0.00)	–0.03 (0.05)	0.05 (0.00)
gov_debt	–0.22 (0.00)	–0.08 (0.00)	–0.36 (0.00)	–0.08 (0.00)	–0.07 (0.00)	0.04 (0.00)	–0.00 (0.82)
LCR_req	0.01 (0.71)	–0.05 (0.00)	0.00 (0.84)	0.07 (0.00)	0.05 (0.00)	0.00 (0.79)	0.05 (0.00)
negrate	–0.07 (0.00)	–0.02 (0.13)	–0.07 (0.00)	0.02 (0.17)	0.05 (0.00)	–0.01 (0.31)	0.02 (0.14)
bhhc	0.14 (0.00)	–0.01 (0.71)	0.27 (0.00)	0.07 (0.00)	–0.12 (0.00)	–0.05 (0.00)	0.03 (0.07)
coop	–0.29 (0.00)	–0.03 (0.03)	–0.41 (0.00)	–0.02 (0.11)	–0.02 (0.11)	0.14 (0.00)	–0.08 (0.00)
rem	–0.05 (0.00)	0.38 (0.00)	0.11 (0.00)	–0.00 (0.96)	0.26 (0.00)	–0.16 (0.00)	–0.11 (0.00)
savings	–0.09 (0.00)	–0.01 (0.53)	0.08 (0.00)	0.01 (0.31)	0.13 (0.00)	–0.00 (0.86)	0.06 (0.00)
	llr_gl	**st_ir**	**spread**	**gdp**	**infl**	**gov_debt**	**LCR_req**
llr_gl	1.00 –						
st_ir	0.09 (0.00)	1.00 –					
spread	0.27 (0.00)	0.05 (0.00)	1.00 –				
gdp	–0.02 (0.20)	–0.13 (0.00)	–0.58 (0.00)	1.00 –			
infl	–0.22 (0.00)	0.32 (0.00)	0.17 (0.00)	–0.32 (0.00)	1.00 –		
gov_debt	0.12 (0.00)	–0.27 (0.00)	0.33 (0.00)	–0.42 (0.00)	–0.07 (0.00)	1.00 –	
LCR_req	0.02 (0.27)	–0.47 (0.00)	–0.32 (0.00)	0.49 (0.00)	–0.18 (0.00)	0.02 (0.24)	1.00 –
negrate	0.03 (0.06)	–0.59 (0.00)	–0.30 (0.00)	0.36 (0.00)	–0.30 (0.00)	0.13 (0.00)	0.82 (0.00)

bhhc	–0.11 (0.00)	0.03 (0.07)	–0.08 (0.00)	0.07 (0.00)	0.05 (0.00)	–0.08 (0.00)	0.00 (1.00)
coop	0.09 (0.00)	–0.19 (0.00)	0.26 (0.00)	–0.32 (0.00)	–0.06 (0.00)	0.60 (0.00)	–0.00 (1.00)
rem	–0.20 (0.00)	0.03 (0.04)	–0.16 (0.00)	0.11 (0.00)	0.05 (0.00)	–0.19 (0.00)	0.00 (1.00)
savings	–0.10 (0.00)	–0.03 (0.02)	–0.13 (0.00)	0.04 (0.00)	0.02 (0.20)	–0.16 (0.00)	0.00 (1.00)
	negrate	**bhhc**	**coop**	**rem**	**savings**		
negrate	1.00 –						
bhhc	–0.04 (0.00)	1.00 –					
coop	0.12 (0.00)	–0.17 (0.00)	1.00 –				
rem	–0.03 (0.03)	–0.06 (0.00)	–0.22 (0.00)	1.00 –			
savings	0.03 (0.04)	–0.07 (0.00)	–0.27 (0.00)	–0.09 (0.00)	1.00 –		

Note: p-values in parentheses.

Source: Authors' calculation in Stata 11.2.

T a b l e A.3

Number of Banks by Countries

Country	**Number of banks**
Austria	21
Belgium	6
Bulgaria	9
Cyprus	5
Czech Republic	5
Germany	72
Denmark	27
Spain	10
Finland	5
France	106
United Kingdom	41
Greece	7
Croatia	15
Hungary	6
Ireland	5
Italy	279
Lithuania	4
Luxembourg	11
Latvia	1
Malta	5
Netherlands	18
Poland	14
Portugal	5
Romania	7
Sweden	13
Slovenia	5
Slovakia	5
Total	***707***

Source: Authors based on Orbis Bank Focus.

T a b l e A.4

Clustered Standard Errors Estimation Results for Liquid Assets to Deposits and Short-Term Funding

	FE	**RE**	**FE**	**RE**	**FE**	**RE**
	Classic SE	*Classic SE*	*Clustered SE (country level)*	*Clustered SE (country level)*	*Clustered SE (bank level)*	*Clustered SE (bank level)*
	la_dstf	la_dstf	la_dstf	la_dstf	la_dstf	la_dstf
lta	3.773*** (0.964)	2.305*** (0.246)	3.773 (2.948)	2.305*** (0.654)	3.773* (2.175)	2.305*** (0.642)
roaa	0.0155 (0.240)	0.250 (0.235)	0.0155 (0.512)	0.250 (0.635)	0.0155 (0.454)	0.250 (0.558)
nl_ta	–0.606*** (0.0257)	–0.645*** (0.0201)	–0.606*** (0.207)	–0.645*** (0.167)	–0.606*** (0.0695)	–0.645*** (0.0514)
eq_ta	1.284*** (0.0969)	1.019*** (0.0739)	1.284** (0.569)	1.019** (0.484)	1.284* (0.745)	1.019* (0.569)
cir	–0.00874 (0.00940)	0.000494 (0.00902)	–0.00874 (0.0106)	0.000494 (0.0142)	–0.00874 (0.0110)	0.000494 (0.0126)
llr_gl	–0.383*** (0.0796)	–0.306*** (0.0684)	–0.383*** (0.0746)	–0.306** (0.131)	–0.383** (0.170)	–0.306** (0.149)
st_ir	0.930* (0.511)	–0.408 (0.452)	0.930 (1.134)	–0.408 (1.074)	0.930 (1.156)	–0.408 (0.710)
spread	0.271 (0.243)	–0.286 (0.211)	0.271 (0.375)	–0.286 (0.378)	0.271 (0.381)	–0.286 (0.191)
gdp	–0.182 (0.153)	–0.392*** (0.145)	–0.182 (0.176)	–0.392 (0.245)	–0.182 (0.168)	–0.392* (0.211)
infl	0.897*** (0.207)	1.207*** (0.194)	0.897** (0.402)	1.207*** (0.468)	0.897** (0.356)	1.207*** (0.275)
gov_debt	–0.0402 (0.0485)	–0.116*** (0.0178)	–0.0402 (0.0909)	–0.116** (0.0561)	–0.0402 (0.0783)	–0.116*** (0.0233)
negrate	–6.245*** (0.795)	–6.534*** (0.752)	–6.245** (2.456)	–6.354*** (1.787)	–6.245*** (2.146)	–6.354*** (1.894)
LCR_req	0.102*** (0.0103)	0.0927*** (0.00949)	0.102*** (0.0290)	0.0927*** (0.0221)	0.102*** (0.0369)	0.0927*** (0.0301)
Constant	–8.363 (15.58)	25.36*** (5.036)	–8.363 (43.89)	25.36 (19.09)	–8.363 (42.14)	25.36 (16.96)
Observations	4949	4949	4949	4949	4949	4949
F	71.61***	1617.16***	57.10***	918.93***	21.22***	471.09***
R-squared	0.180	0.176	0.180	0.176	0.180	0.176

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: Authors' calculation in Stata 11.2.

T a b l e A.5

Clustered Standard Errors Estimation Results for Net Loans to Deposits and Short-Term Funding

	FE	**RE**	**FE**	**RE**	**FE**	**RE**
	Classic SE	*Classic SE*	*Clustered SE (country level)*	*Clustered SE (country level)*	*Clustered SE (bank level)*	*Clustered SE (bank level)*
	nl_dstf	nl_dstf	nl_dstf	nl_dstf	nl_dstf	nl_dstf
lta	3.862***	3.212***	3.862**	3.212***	3.862**	3.212***
	(1.166)	(0.476)	(1.560)	(1.079)	(1.518)	(0.583)
roaa	–0.550*	–0.626**	–0.550**	–0.626***	–0.550**	–0.626**
	(0.290)	(0.291)	(0.220)	(0.228)	(0.272)	(0.249)
nl_ta	1.216***	1.253***	1.216***	1.253***	1.216***	1.253***
	(0.0310)	(0.0284)	(0.0557)	(0.0578)	(0.0349)	(0.0324)
eq_ta	1.936***	1.756***	1.936***	1.756***	1.936***	1.756***
	(0.117)	(0.103)	(0.301)	(0.298)	(0.404)	(0.361)
cir	–0.0251**	–0.0367***	–0.0251	–0.0367	–0.0251**	–0.0367***
	(0.0114)	(0.0113)	(0.0202)	(0.0227)	(0.0114)	(0.0115)
llr_gl	–0.621***	–0.616***	–0.621***	–0.616***	–0.621***	–0.616***
	(0.0962)	(0.0915)	(0.161)	(0.156)	(0.135)	(0.121)
st_ir	0.869	0.342	0.869	0.342	0.869	0.342
	(0.618)	(0.594)	(1.249)	(1.318)	(0.916)	(0.848)
spread	–0.0305	–0.0162	–0.0305	–0.0162	–0.0305	–0.0162
	(0.294)	(0.280)	(0.269)	(0.562)	(0.362)	(0.388)
gdp	–0.757***	–0.988***	–0.757	–0.988	–0.757***	–0.988***
	(0.184)	(0.182)	(0.489)	(0.603)	(0.217)	(0.241)
infl	–0.270	0.0662	–0.270	0.0662	–0.270	0.0662
	(0.250)	(0.241)	(0.441)	(0.523)	(0.442)	(0.382)
gov_debt	–0.390***	–0.100***	–0.390*	–0.100	–0.390***	–0.100**
	(0.0587)	(0.0325)	(0.219)	(0.0710)	(0.103)	(0.0430)
negrate	–0.950	0.167	–0.950	0.167	–0.950	0.167
	(0.962)	(0.944)	(1.923)	(1.894)	(1.009)	(0.975)
LCR_req	–0.0387***	–0.0508***	–0.0387	–0.0508	–0.0387***	–0.0508***
	(0.0125)	(0.0121)	(0.0314)	(0.0341)	(0.0140)	(0.0134)
Constant	–27.07	–39.59***	–27.07	–39.59**	–27.07	–39.59***
	(18.83)	(9.124)	(30.15)	(16.78)	(26.37)	(11.82)
Observations	4949	4949	4949	4949	4949	4949
F	212.3***	3099.44***	441.33***	9541.52***	155.03***	2244.87***
R-squared	0.395	0.390	0.395	0.390	0.395	0.390

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: Authors' calculation in Stata 11.2.