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Net Stable Funding Ratio: Implication for Bank Stability in Europe

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Abstract

This paper investigates the relationship between the net stable funding ratio (NSFR) and bank stability in Europe over the 2007-2022 period. By employing a two-step GMM panel model, we find a positive and significant link between the NSFR and banking stability in the European Union which is however stronger for banks located in the euro area than those in the non-euro area. Moreover, our results show that, within the euro area itself, for banks operating outside the core euro area, stronger liquidity positions do not translate into higher stability but conversely to higher instability. Overall, our findings highlight strong differences into how liquidity requirements relate to bank stability within the European union and also within the euro area itself which call for action by bank regulators.

JEL codes: G21; G28.

Keywords: Basel III, NSFR, Bank Stability, Euro area, Non-euro area, Core and Peripheral.

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1. Introduction

Despite the economic advantages of the Economic and Monetary Union (EMU) in Europe, bank contagion risk remains an important challenge. Indeed, the financial crisis of 2007-2008 (GFC) generated distortions in the euro area banking system and has caused fragmentation between the core (Austria, Belgium, Germany, France, and the Netherlands) and the periphery (Greece, Ireland, Italy, Portugal, and Spain), highlighting emerging challenges for financial integration within the EMU. The governments in the euro area had to support commercial banks against default risk and extend guarantee to their national banks. In return, these governments started providing liquidity to banks with non-eligible assets for European Central Bank refinancing operations. Thus, although the euro area banks previously operated within a highly integrated interbank market, their monitoring, creditworthiness, and solvency remained highly country-specific and asymmetric across the eurozone (Asimakopoulos et al., 2018).

The outbreak of the financial crisis of the GFC and the 2011 sovereign debt crisis in the euro area led banking regulation to focus on liquidity requirements, which until then had been almost exclusively focused on capital ratios (Simion et al., 2024). The liquidity standards introduced by the Basel Committee require banks to hold a sufficient amount of high-quality liquid asset. These standards protect banks from liquidity shocks over a one-month horizon (liquidity coverage ratio, LCR) and maintain a sufficient stable funds over a one-year horizon (net stable funding ratio, NSFR) (BCBS, 2010). The Basel III regulation aspires to make the banking system safer by improving the quality and depth of capital and by renewing the focus on liquidity management that intends to improve banks' risk management techniques.

This paper aims to explore two main aspects. First, we question whether there are differences in the link between the NSFR and banking stability across the euro area and the non-euro area. Second, we look into whether the NSFR shows significant variations in core and peripheral regions within the euro area. Our investigation focuses on the relationship between the net stable funding ratio (NSFR) and the stability of banks. By studying the effectiveness of the NSFR, introduced by Basel III, in enhancing financial stability across different regions, our research aims to provide practical insights that can inform robust policy decisions and regulatory frameworks suitable to the specific challenges faced by banks in diverse economic contexts.

To conduct our investigation, we focus on two areas based on the currency used: the euro area for the countries that have adopted the Euro as their primary currency and the non-euro area in which countries use their own national currencies. This distinction is crucial as the crisis mainly affected the euro area. Second, within the euro area, we distinguish between the safe-haven banks (core country banks) and the PIIGS banks (banks from the periphery countries). This categorization enables a deeper exploration of the NSFR in these two areas, especially after the debt crisis of 2011. This approach not only enriches our understanding of the association between the NSFR and bank stability, but also carries valuable implications for regulatory and policymaking entities. Our primary findings indicate that banks located in the euro area have a much stronger relationship between their NSFR and their stability compared to the non-euro area. This could either indicate that such banks are safer because they are more liquid or alternatively that they have the ability of being more liquid because they are safer and more efficient. In both cases, such stronger link between the NSFR and bank stability is indicative of a superiority of banks in the euro area in jointly managing default risk and liquidity risk. Moreover, our results reveal that for banks operating in the peripheral countries of the euro the relationship between the NSFR and bank stability turns out to be negative instead of positive, revealing either differences in risk-taking incentives, or shortcomings in liquidity risk management practices.

The remaining sections of the paper are organized as follow. The second section presents related literature. In the third section, we describe the econometric specification including data and variables used in our investigation, along with the research methodology. The empirical results of the study are presented in the fourth section. The final section summarizes the findings and conclusions of the paper.

2. Related Literature

A significant body of literature investigates the relationship between bank risk and regulation, particularly highlighting the impact of the new liquidity rules introduced by Basel III.

According to Barth et al. (2004), economic theory provides mixed predictions about the relationship between the restrictions on bank activities and their risk-taking. For instance, Hellmann et al. (2000), González (2005) and Dang and Naguyen (2022) claim that as the

restrictions on banks' activities increase, banks become less profitable, forcing managers to invest in riskier projects. Furthermore, banks are able to diversify their sources of income and reduce their risk when facing fewer activity restrictions. This means that the riskiness of banks increases with higher levels of activity restrictions. In contrast, Boyd et al. (1998) argue that when banks are allowed to expand the scope of their activities, they naturally have more opportunities to take more risk. Due to moral hazards problems and negative externalities on the economy as a whole, specifically for too-big-to-fail banks, the incentives for higher risk-taking are magnified. Accordingly, under such an approach, higher levels of activity restrictions should lead to lower risks.

The empirical evidence is mixed. While Barth et al. (2004), Laeven and Levine (2009), Danisman and Demirel (2019), and Al-Shboul et al. (2020) find that the financial system becomes less stable in the presence of more stringent restrictions on banks' activities, Fernández and Gonzalez (2005), Agoraki et al. (2011), and Wang and Sui (2019) provide evidence that stronger activity restrictions are associated with a decrease in bank risk.

Basel III imposes various restrictions, and one of them is the liquidity standard. A recent body of literature has examined the influence of Basel III liquidity standards on various aspects, including bank failures, and funding liquidity risk (Raz, McGowan, and Zhao 2022). Analyzing data from U.S. commercial banks over the 2001-2011 period, Hong et al. (2014) conducts a comprehensive investigation of the NSFR and the LCR to investigate the impact of these ratios on banking failure. They find a marginal impact of the liquidity standards on banks' failures, leading to the conclusion that idiosyncratic liquidity risk plays a minor role. Vazquez and Federico's (2015) find that, based on a 2001-2009 dataset of U.S. and European banks, maintaining a higher level of NSFR in the pre-crisis years diminishes the probability of bank failure during periods of global turmoil. Lallour and Mio (2016) suggest that NSFR would have protected European and US banks against the failure during the financial crisis, had these banks complied with this requirement. Similarly, Chiamonte and Casu (2017) show, using data from European banks spanning from 2004 to 2013, that a higher NSFR is associated with a lower likelihood of bank failure or encountering financial distress, in line with the regulator's aims. Also, Ly et al. (2017) examine the impact of US banks' pace of adjusting to the NSFR on systemic risks. Their findings indicate that systemic risk becomes lower when banks respond to the new regulatory regime and increase the NSFR. Furthermore, Ayed et al. (2024)

study the role of bank liquidity in ensuring financial stability in the MENA region using a sample of 124 banks with data ranging from 2014 to 2021. Their results show a positive impact of the NSFR on financial stability and supports the BCBS's recommendation in developing guidelines for the NSFR to enhance bank's liquidity risk management.

3. Econometric Specification

3.1 Variables

3.1.1 Dependent variable

To assess a bank's financial stability, we employ the widely used z-score measure. This metric is utilized by researchers to gauge a bank's default risk. Specifically, it quantifies the standard deviations by which returns would need to decline to erode bank equity (Elfeituri, 2022). In simpler terms, it denotes the standard deviations required for a bank's returns to fall below the expected value, leading to a depleted equity and insolvency (Boyd and Runkle, 1993; Lepetit et al., 2008; Laeven and Levin, 2009; Sufian and Habibullah, 2012; Lepetit and Strobel, 2015; Asteriou et al., 2021). Additionally, the z-score is considered as the inverse of the likelihood of a bank's bankruptcy (Elfeituri, 2022). As the z-score rises, it signifies a heightened strength and stability, whereas a lower value suggests an increased likelihood of insolvency risk (Hou et al., 2016; Bermpei et al., 2018; Elfeituri, 2022).

In accounting for banking stability, the z-score is calculated using the return on assets, level of capital $[\frac{EQ}{TA_{i,t}}]$, and the volatility (standard deviation) of the return on assets (Laeven and Levine, 2009; Hossain et al., 2018).

$$z - score_{i,t} = \frac{ROA_{i,t} + CAR_{i,t}}{\sigma_{ROA_{i,t}}} \quad (1)$$

Where $ROA_{i,t}$ is the return on assets. $CAR_{i,t}$ is the capital ratio $[\frac{EQ}{TA_{i,t}}]$; where EQ is the equity and TA stands for total assets. The standard deviation of return on assets is represented by $\sigma_{ROA_{i,t}}$, for bank i and time t .

The z-score ascends in tandem with the heightened profitability and an increased ratio of equity to total assets, while it declines as the volatility of ROA rises. Theoretically, the z-score provides a time varying measure of a bank's stability that does not experience endogeneity issues. However, because ROA and its standard deviation are calculated from

different distributions, this could generate an inconsistency issue. Laeven and Levine (2009) and Houston et al. (2010) support the use of the natural log of the z-score, $\ln(z)$, over the traditional z-score, on the basis that the traditional z-score distribution is heavily skewed, whereas the log of the z-score is not. In addition, Lepetit and Strobel (2015) indicate that the traditional z-score provides a less effective upper bound of the probability of insolvency. Also, they assert the $\ln(z)$ is an improvement of this traditional measure without enforcing any further distributional assumptions. Therefore, our preferred measure of insolvency risk is the $\ln(z)$.

3.1.2 Main Independent Variable

We consider the net stable funding ratio (NSFR) as our central explanatory variable to investigate its link with bank stability. We anticipate a positive correlation relationship between the NSFR and bank stability. For instance, Ashraf et al. (2016) and Mutarindwa et al. (2020) find that the NSFR improves bank stability measured by the z-score. According to this view, a higher NSFR, indicating more stable and long-term funding, enhances the ability of banks to withstand financial shocks, thereby improving stability. However, according to Ly et al. (2017), and Khan et al. (2017) higher NSFR requirements may lead banks to increase their risk-taking to maintain profitability, consequently reducing their stability. We follow the work of Dietrich et al. (2014), and Vazquez and Federico (2015) to construct the historical NSFR (see [Table 1](#)).

Insert Table 1 around here

The NSFR is calculated by dividing the available stable funding ratio over the required stable funding ratio (BCBS, 2010a, p.25-31). Available stable funding (ASF) represents as the weighted sum of funding sources according to their stability features. Conversely, the required stable funding (RSF) defines as the weighted sum of uses of funding sources according to their liquidity. The required stable funding (RSF) indicates the portion of exposure that requires stable funding support; as asset liquidity increases, the RSF factor typically decreases (Dietrich et al., 2014).

$$NSFR = \frac{\text{Available Stable Funding}}{\text{Required Stable Funding}} = \frac{\sum_i w_i L_i}{\sum_j w_j L_j} \quad (2)$$

ASF and RSF are weight factors documented in the Basel III Accord, which apply to funding sources and assets to determine their respective risk levels. Higher ASF factor values

assign to funding sources that are more stable while a higher value of the RSF factor indicates a lower liquidity of an asset (Le et al., 2020).

1.1.1 Control Variables

We introduce several control variables in our model. These control variables encompass the capital ratio, competition, profitability, efficiency, diversification, bank size, macroeconomic indicators, and institutional factors based on previous banking literature such as Soedarmono, Machrouh, and Tarazi (2011), Dietrich et al. (2014), Ashraf et al. (2016) Cai et al. (2019), Mutarindwa et al. (2020) and El Moussawi & Mansour, (2022).

- **Capital Ratio**

Regulators determine capital requirements to make banks sufficiently stable in the sense that they should be able to absorb losses and recover without public help. Capital requirements are essential drivers of bank stability. We use the capital asset ratio (equity/asset) to measure its impact on the stability of banks (CAR). The coefficient of the capital ratio is expected to be significant and positive (Gambacorta et al., 2011; Roulet, 2018; Mutarindwa et al., 2020). Alternatively, if banks are constrained in holding too much capital, they could be encouraged to take on higher risk to maintain shareholder's return. The expected sign can be negative, or the coefficient could be insignificantly different from 0 if such increase in risk and the higher capital ratio offset each other (Kim & Santomero, 1988; Koehn & Santomero, 1980).

- **Competition**

We gauge the competition between banks by estimating the Lerner's index, as done by Carbó et al. (2009), Albaity et al. (2019), EL Moussawi & Mansour (2022). The Lerner index (LERNER) serves as a metric for assessing a bank's market power by examining its pricing strategy for the products and services it provides to its customers. This indicator gauges the level of competition by analyzing the relative disparity between the price of a banking product and its marginal cost (Jiménez et al., 2013; Shaffer & Spierdijk, 2020). It determines the extent to which a firm can raise its price beyond the marginal cost and is derived from the cost function (El Moussawi, Mansour, 2022; Shaffer & Spierdijk, 2020). The Lerner indicator ranges from 0 to 1, from perfect competition to pure monopoly. If the value of this index turns negative, it indicates that the prices fall below the marginal cost, which signifies non-optimal bank

behavior resulting from inefficiency (Noman et al., 2017; Albaity et al., 2019). Equation 3 introduces the formula.

$$\mathbf{LERNER}_{i,t} = \frac{\mathbf{P}_{TA_{i,t}} - \mathbf{MC}_{TA_{i,t}}}{\mathbf{P}_{TA_{i,t}}} \quad (3)$$

Where $\mathbf{P}_{TA_{i,t}}$ is calculated by dividing the price of banking outputs, proxied by the ratio of total revenues (interest and noninterest), to the value of the total assets for the i th bank at time t . $\mathbf{MC}_{TA_{i,t}}$ is the marginal cost for the i th bank at time t . The calculation of the Lerner index follows the methodology outlined by Clerides et al. (2015); Albaity et al. (2019) and EL Moussawi & Mansour (2022). First, the bank-level valuations of the Lerner index are calculated after estimating the marginal cost and the output price of the bank. Then the average of the bank-level valuations is used to calculate the country-level Lerner index (Albaity et al., 2019). We anticipate a positive and significant relationship between competition and bank stability. Boyd and de Nicolo (2005) prove that a greater competition increases banks' stability. Goetz (2018) find that a greater competition increases the stability of banks, reduces the share of non-performing loans, which in turn increases the profitability of banks. This aligns with the competition-stability hypothesis, which states that the probability of default decreases because borrowers have a higher likelihood of repaying their loans (Boyd, De Nicolò, and Jalal, 2006; Risfandy, Tarazi, and Trinugroho, 2022). However, the competition-fragility view suggests that lower competition and hence higher market power in the banking sector can be beneficial. This view states that high pressure on profits due to stronger competition leads to a decline in the franchise value of banks, encouraging riskier behavior and potentially decreasing stability (Keeley, 1990; Suarez, 1994; Nyola et al., 2021).

- Profitability, Efficiency and Diversification

Profitability: The banking literature commonly assesses a bank's profitability by using the return on assets (ROA) ratio (Schaeck and Cihak, 2014; Goetz, 2018). Notably, Golin and Delhaise (2013) argue that the ROA remains consistent despite fluctuations in debt levels. We anticipate a positive correlation between profitability and banking stability, as suggested by Albaity et al. (2019).

Efficiency: Following previous studies (Haan and Poghosyn; 2012, Liu and Wilson; 2013, Cubillas and Gonzalez; 2014), we use the cost-to-income ratio (COST) to proxy the efficiency of bank operations, where a higher ratio implies less efficiency.

Diversification: We use non-interest income to measure diversification (DIV). The expected impact of diversification is mixed (Liang, Moreria & Lee, 2020; Shabir et al., 2024). Wang & Lin (2021) support evidence that the bank's risk decreases with diversity in its activities. They argue that diversification can reduce risk via expanding activities to various sectors and geographic regions (Adesina, 2021; Berger et al., 2010), gaining economic scope (Drucker & Puri, 2009), improving income quality by decreasing asymmetric information (Baele et al., 2007), and promoting financial innovations and market competition (Lepetit et al., 2008). However, some studies find contradictory results and show that diversification adversely impacts bank stability (Ben Lahouel et al., 2022; Berger et al., 2010). An increase in bank diversification has been found to sharpen competition (Winton, 1999), and increase profit volatility (Acharya et al., 2006).

- Bank size

We utilize the natural logarithm of total assets to accommodate differences in bank size (SIZE). We anticipate a positive relationship between bank size and stability, as suggested by Adusei et al. (2015) who find that an increase in bank size results in an increase in its stability. Also, Saghi-Zedek and Tarazi (2015) highlight that larger banks can diversify their activities to mitigate risks. However, de Haan et al. (2012) find a negative relationship between bank size and stability, noting that larger banks exhibit greater earning volatility, which can lead to instability. Additionally, Ashraf et al. (2016) indicate that larger banks have incentives to engage in excessive risk-taking specifically in the presence of public safety nets and if they are considered as too-big-to-fail.

- Macroeconomic factors

We incorporate country-level controls derived from previous research on bank stability (Beltratti and Stulz, 2012). The GDP growth rate serves as a control variable to adjust for cyclical fluctuations in output, which could potentially influence bank lending and risk-taking. Additionally, we include Log (GDP per Capita) to capture variations at different levels of economic development. It is anticipated that low levels of GDP growth (GDPG) would decrease banks' stability (Adusei, 2015; Chiaramonte and Casu, 2017).

- Regulatory quality

Regulatory quality refers to the competence of regulators in creating and enforcing regulations that uphold the stability of the financial system (REGL) (Kaufmann, Kraay and Mastruzzi, 2010). Good regulatory quality encompasses prudential rules, supervision, safety nets, and other related factors. Consequently, it reduces the chances of excessive risk-taking by banks, mitigates bank instability, and stimulates banks to increase lending to the economy. We expect a positive impact of regulatory quality on the stability of banks (El Moussawi and Mansour, 2022; Nguyen; 2022).

3.2 Data and Model

3.2.1 Data

In investigating the relationship between the NSFR and banks' stability, we have collected data from various sources. Data on the financial statements of commercial banks in the European Union between 2007 and 2022 are sourced from the Orbis Bank database. The study focuses on 27 European countries: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, Greece, Croatia, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Poland, Portugal, Romania, Sweden, Slovenia, and Slovakia (see [Table 2](#)).

Insert Table 2

Additionally, the study uses macroeconomic data such as annual growth domestic product and inflation, as well as regulatory quality from the World Bank's data website. A summary of all the variables used in the paper, as well as their definition, is presented in [Table 3](#).

Insert Table 3

The descriptive statistics of bank-specific, macroeconomic, and institutional variables are presented in [Table 4](#).

Insert Table 4

To address the issue of outliers, we apply winzORIZATION at the 1st and 99th percentile. [Table 5](#) displays the correlations between the variables examined in our empirical study and shows no major multicollinearity issues except for capital ratios (CAR and CARW).

Insert Table 5

3.2.2 Empirical Model

In this section, we discuss the econometric approach developed to evaluate the link between the net stable funding ratio and banks' stability. Establishing such a relationship poses two types of issues: omitted variable bias and endogeneity bias (see Asteriou et al., 2021).

To address these issues, we implement a dynamic panel method that enables us to correct the biases. We follow the methodologies outlined by Laeven & Levine (2009), Berger et al. (2009), Ashraf et al. (2016) and El Moussawi & Mansour (2022) to build our regression models.

Model 1:

$$\begin{aligned} \ln(z)_{i,t} = & \beta_0 + \beta_1 \ln(z)_{i,t-1} + \beta_2 \text{NSFR}_{i,t} + \beta_3 \text{CAR}_{i,t} + \beta_4 \text{LERNER}_{i,t} + \beta_5 \text{ROA}_{i,t} \quad (3) \\ & + \beta_6 \text{COST}_{i,t} + \beta_7 \text{DIV}_{i,t} + \beta_8 \text{SIZE}_{i,t} + \beta_9 \text{GDPG}_{i,t} + \beta_{10} \text{REGL}_{i,t} \\ & + \varepsilon_{i,t} \end{aligned}$$

Given that we have a large number of time periods (T=16) in our panel data framework, we can utilize the two-step Generalized Method of Moments (GMM) estimator. This estimator was first introduced by Arellano-Bover and Blundell-Bond (Blundell and Bond, 1998) and is primarily based on instrumental variables to address the endogeneity biases in our estimation. The Arellano and Bond (1991) estimator eliminates unobserved fixed effects through first differencing, while the right-hand side variables are instrumentalized using lagged values of the regressors. Both the equation in the first differences and in levels are jointly estimated. However, it's important to note that the standard errors of the two-step GMM estimator often exhibit a downward bias. To mitigate this concern, we adopt the finite sample correction procedure proposed by Windmeijer (2005). Additionally, in selecting instrumental variables to ensure the stability of banks' variables, we follow the literature (Baum et al., 2003). We choose instrument variables that are exogenous (uncorrelated with the error term of the regression) and relevant (i.e., strongly influencing) to the endogenous regression in our model. Thus, in each

case, we choose to regress the remaining lagged indicators apart from the one used in the main regression as a dynamic term. The selection of the number of lagged terms is based on the Schwartz-Bayesian information criterion. To ensure the validity of the instruments, we employ the Hansen J-test statistic to test the over-identifying restrictions. Additionally, the models are considered to be correctly identified, as they satisfy the second order no-autocorrelation criterion AR (2) and pass the Hansen J-tests.

In an additional specification, we also add $NSFR * NSFR_{(i,t)}$ representing the net stable funding ratio squared. This addition allows us to capture potential threshold effects and examine the relationship between banks' stability and liquidity at various points along the curve.

Model 2:

$$\begin{aligned} \ln(z)_{i,t} = & \beta_0 + \beta_1 \ln(z)_{i,t-1} + \beta_2 NSFR_{i,t} + \beta_3 CAR_{i,t} + \beta_4 LERNER_{i,t} + \beta_5 ROA_{i,t} \quad (4) \\ & + \beta_6 COST_{i,t} + \beta_7 DIV_{i,t} + \beta_8 SIZE_{i,t} + \beta_9 GDPG_{i,t} \\ & + \beta_{10} NSFR * NSFR_{i,t} + \varepsilon_{i,t} \end{aligned}$$

4. Empirical Results

4.1 *The relationship between Basel III Liquidity Regulation and the Stability of Banks in the Euro area and non-euro area.*

Table 6 shows that our main variable of interest, the net stable funding ratio (NSFR), consistently and positively links with banking stability, measured by the z-score ($\ln(z)$), at the 5% significance level. Our models successfully passed diagnostic and control tests, including the Hansen test (p-value >10%) and the Arellano and Bond's second-order autocorrelation test (p-value >10%). This confirms the validity of our instruments and the absence of a second-order autocorrelation, respectively. In other words, our findings suggest that higher NSFR corresponds to a higher z-score, indicating an enhanced stability in banks.

Insert Table 6

The positive relationship between NSFR and the banks' stability is consistent with the results of a prior research conducted by Chalermchatvihien, Jumreornvong, and Jirapon (2014), Ashraf et al. (2016), and Mutarindwa et al. (2020), which argue for a positive relationship between NSFR implementation and the banking sectors' stability. It is important to note that

the Required Stable Funding (RSF), which serves as the denominator of NSFR, represents asset liquidity. A decrease in RSF signifies an increased asset liquidity and a reduced liquidity risk. Consequently, NSFR tends to be higher, thereby strengthening the stability of banks with higher NSFR (Le et al., 2020).

Additionally, the coefficient of $NSFR*NSFR$ is statistically significant and negative, while the coefficient of the NSFR remains significant and positive (Models 2 and 3 in Table 6). Our findings hence suggest that excessive liquidity has a minimal positive relationship with banks' stability in line with previous studies (Le et al., 2020). There is effectively an optimal level of liquidity that maximizes banks' stability. In other words, a higher NSFR generally promotes stability, yet beyond this optimal threshold any additional level of liquidity does not significantly enhance stability.

For a thorough investigation of the stability of banks in the euro area compared to the non-euro area, we also run regressions using a dummy variable denoted by DUM. This dummy variable takes the value of 1 if the bank is in the euro area, and 0 if it is in the non-euro area. The estimated results are reported in Models 3 and 4 of Table 6. We start by conducting a regression with the dummy variable (Model 3), which is positive and significant. This indicates that, on average, European banks located in the euro area exhibit a higher stability than those outside this area.

Furthermore, the coefficient of the interaction variable $NSFR*DUM$ is positive and significant indicating that the relationship between the NSFR and bank stability is stronger for banks located in the euro area than for their counterparts outside this area.

The coefficient on the lagged banks' stability variable is positive and highly significant. This suggests a strong positive link between the current and previous values of the dependent variable as is usually expected in dynamic models

Moreover, the capital ratio CAR appears to be a key element of banking stability in our findings which show a significant positive relationship between the capital ratio, measured by equity to total assets, and banking stability. This outcome aligns with Kosak et al. (2015), and Jimenez et al. (2012), who argue that the banks with higher levels of capital are better equipped to withstand losses from their asset-side operations, thus leading to greater banking stability.

Furthermore, the relationship between profitability, measured by ROA, and banking stability is consistently significant and positive across all estimated specifications. Higher profitability is expected to allow banks to accumulate reserves which makes them more resilient.

Additionally, competition, as measured by LERNER, exhibits a consistently negative and significant link with the stability of banks across all estimated specifications. This finding aligns with Keeley (1990), Suarez (1994), Berger et al. (2009) and Fungacova and Weill (2009). According to Berger et al. (2009), higher market power, indicating lower competition, correlates with increased risk exposure for banks. Similarly, Fungacova and Weill (2009) support the idea that increased competition may lead to greater fragility or instability within the banking system, as indicated by the competition fragility hypothesis.

Regarding bank size, except Model 1, the coefficient of SIZE is significantly positive suggesting that larger banks are less risky than smaller ones. This finding is consistent with Adussei et al. (2015), and Saghi-Zedek and Tarazi (2015), who find that larger banks can diversify their activities to reduce risks.

Concerning the cost-to-income ratio COST, this variable is not significant in all models suggesting that inefficiency in cost management is not significantly linked with bank stability.

Moreover, the diversification ratio DIV exhibits a negative and significant link with banking stability. This finding is consistent with Liang et al. (2020), who find that higher diversification leads to increased systemic risk and reduced bank stability.

Although we expect a positive link between economic growth (GDPG) and banks' stability, the results do not show any significance across all the regression models. These results contradict findings of many studies; for instance, Yin (2019) identifies a positive relationship between economic growth and banks' stability, whereas Fouejieu (2017) reports mixed results.

Finally, there is a positive and significant coefficient for the institutional variable, as measured by regulatory quality REQL. Bermpei et al. (2018), and El Moussawi & Mansour (2022) argue that regulatory quality contributes to enhancing banking stability.

4.2 *The relationship between Basel III Liquidity Regulation and the Stability of Banks in Core and Peripheral countries in the euro area*

To gain a deeper understanding of the relationship between NSFR and banking stability in the euro area we consider two dummy variables to differentiate between banks located in the core and peripheral euro areas. DCOR is a dummy variable that takes the value of 1 if the bank operates in the core euro area (France, Austria, Belgium, Germany, and the Netherlands), and 0 otherwise. Similarly, DPERP is a dummy variable that takes the value of 1 if the bank operates in the peripheral euro area (Greece, Ireland, Italy, Portugal, and Spain), and 0 otherwise. The estimated results are reported in [Table 7](#).

The results for the core euro area are as expected. The coefficient of DCOR is positive and significant (Model 5), the interaction variable NSFR*DCOR is positive and significant (Model 6), and NSFR is positive and significant. In contrast, the coefficients for the peripheral euro area are negative and significant (Model 7 & 8).

This finding suggests that banks operating in the peripheral euro area exhibit a negative relationship between with the NSFR and stability, revealing potential vulnerabilities in the banking system. Despite the full implementation of the NSFR, the negative coefficient in the peripheral euro area suggests that regulation may not effectively address stability concerns in such countries. These findings suggest the existence of a possible discrepancy between the required stable funding (RSF) and the available stable funding in the peripheral euro area. Such findings could mean that banks in these countries struggle to meet the required stable funding levels mandated by NSFR, posing a threat to their stability.

4.3 *Robustness Checks*

To ensure the robustness of our findings, we conduct models using capital-to-risk weighted assets ratio instead of the capital to asset ratio, as suggested by previous studies (Soedarmono and Tarazi, 2015; Rahman et al., 2018). Additionally, we include the inflation variable following the approach of Salim et al. (2023). The results are reported in [Table 8](#). Our results remain unchanged. We also conduct an analysis focusing on both the core and peripheral euro area by using these alternative variables ([Table 9](#)) and obtain similar findings. We also run the regressions separately for core euro area countries and peripheral euro area countries. The results are reported in [Table 10](#) and are consistent with our main findings.

5. Conclusion

Our study examines the relationship between the NSFR and banks' stability in the European Union over the 2007-2022 period. Using the two-step GMM panel model, we identify a positive and significant link between the NSFR and bank stability but also that excessive liquidity has only a minimal positive effect on bank stability.

Our results however reveal that the positive and significant link between the NSFR and bank stability is stronger in the euro area than in the non-euro area and mostly prevalent in core euro area countries. Indeed, in the peripheral euro area the relationship between the NSFR and bank stability turns to be significantly negative raising the issue of whether sounder liquidity risk management practices are effectively leading to lower default risk.

Overall, our findings highlight the necessity for regulators to define an optimal range for the NSFR and discourage banks from holding excessive liquidity buffers. Regulators might also need to consider implementing region-specific NSFR requirements. For instance, banks in the euro area might need to comply with different NSFR thresholds compared to banks in non-euro areas due to varying financial stability and economic conditions. Moreover, because the expected positive link between the NSFR and bank stability is only observed in core euro area countries and not in peripheral euro area countries, policymakers need to accelerate the process of European banking integration within a unified supervisory framework. If different liquidity risk management practices persist within the European union and specifically within euro area countries, banks supervision within a banking union will pose more complex challenges in the future. Eventually, regulators could also create a framework that allows for rapid response to changing economic conditions. This would enable them to ease NSFR requirements during periods of economic stress to support lending and recovery and tighten NSFR requirements during period of excess risk-taking.

Appendix

Table 1 Funding Factor used for calculation of NSFR. Source: BankScope data item structure.

Available Stable Funding (ASF)		ASF factors (%)
Equity	Total equity	100
	Pref. shares and hybrid capital accounted for as debt	100
	Pref. shares and hybrid capital accounted for as equity	100
	Non-controlling interest (minorities)	-100
Liabilities	Total customer deposits	90
	Deposits from banks	0
	Repos and cash collateral	50
	Other deposits and short-term borrowings	0
	Total long-term funding	60
	Reserves for pensions and other	100
	All other liabilities and equity	0
Required stable funding (RSF)		RSF factors (%)
Loans	Residential Mortgage loans	65
	Other Mortgage loans	65
	Other consumer/retail loans	85
	Corporate and commercial loans	85
	Other loans	100
Other	Loans and advances to banks	0
	Total securities	40
	Investment in property	100
	Insurance assets	100
	Other earning assets	100
	Cash and due from banks	0
Off-Balance sheet	All other non-earning assets	100
	Guarantees	5
	Acceptances and documentary credits reported off balance sheet	5
	Committed credit lines	5
	Other contingent liabilities	5

*Minus factor to eliminate ASF related to non-controlling interests, which were added as component of total equity.

Table 2 Bank Classification

Country	No. of banks	Percentage
Austria	35	11%
Belgium	11	3%
Bulgaria	15	5%
Cyprus	7	2%
Czech Republic	9	3%
Germany	23	7%
Denmark	12	4%
Estonia	5	2%
Spain	32	10%
Finland	7	2%
France	25	8%
Greece	5	2%
Croatia	7	2%
Hungary	9	3%
Ireland	5	2%
Italy	24	8%
Lithuania	4	1%
Luxembourg	10	3%
Latvia	7	2%
Malta	4	1%
Netherlands	11	3%
Poland	12	4%
Portugal	11	3%
Romania	7	2%
Sweden	10	3%
Slovenia	7	2%
Slovakia	6	2%

Table 3 Variables

Variables		Definition	Data Sources	Expected Sign
Bank Stability	Natural Logarithm of z-score [ln(z)]	Natural logarithm of [(Equity/total asset) +ROAA]/variance of ROAA	Orbis Bank Authors calculations	+
Capital Ratio	CAR CARW	Equity/total assets Total equity/total risk weighted assets	Orbis Bank Orbis Bank	+
Basel III liquidity Regulation	NSFR	Net Stable Funding Ratio	Orbis Bank Authors calculations	+
Profitability	ROA	Return on assets	Orbis Bank	+
Competition	LERNER	Lerner index using Fourier profit function	Authors calculations	-
Bank Size	SIZE	Ln (total assets)	World Data Bank	+
Efficiency	COST	Cost-to-income ratio	Orbis Bank	-
Diversification	DIV	Non-interest income	Orbis Bank	-
Macroeconomic Factors	GDPG INFL	GDP growth inflation	World Data Bank World Data Bank	- -
Institutional Variable	REQL	Regulatory Quality	World Data Bank	+

Note: This table provide brief definitions and sources for the variables used in our analysis for the period 2007-2022.

Table 4 Descriptive Statistics

Variables	Obs	Mean	Min	Max	Std. dev.
NSFR	5120	3.80	0.04	378.36	13.63
LNZ	5120	2.84	-6.92	5.88	0.96
CAR	5120	0.10	0.00	0.38	0.09
CARW	5120	0.27	0.00	0.52	0.24
COST	5120	0.71	0.002	58.11	2.08
DIV	5120	0.01	-0.39	0.38	0.02
SIZE	5120	15.87	8.71	21.84	2.34
ROA	5120	0.00	-0.47	0.46	0.02
INFL	5120	0.02	-0.04	0.19	0.02
GDPG	5120	0.01	-0.14	0.24	0.03
DUM	5120	0.76	0.00	1.00	0.42
DPERP	5120	0.24	0.00	1.00	0.42
DCOR	5120	0.32	0.00	1.00	0.46
REQL	5120	1.17	0.13	2.04	0.42
LERNER	5120	0.48	0.01	0.65	0.06

Note: This table presents summary statistics for the variables used in our analyses for the period 2007-2022.

Table 5 Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) NSFR	1														
(2) Lnz	0.01	1													
(3) CAR	0.05***	0.1***	1												
(4) CARW	0.05***	0.1***	0.9***	1											
(5) COST	-0.04***	0.03***	0.2***	0.2***	1										
(6) DIV	0.01	-0.01	0.3***	0.3***	0.1***	1									
(7) SIZE	-0.1***	-0.02	-0.4***	-0.4***	-0.2***	-0.2***	1								
(8) ROA	0.23***	0.1***	0.2***	0.2***	0.00	0.1***	-0.1***	1							
(9) LERNE R	-0.1***	-0.0***	-0.0**	-0.03**	0.03**	-0.01	0.4***	-0.05***	1						
(10) DUM	0.00***	0.03**	0.01	0.01	0.00	0.01	0.07***	-0.03**	0.1***	1					
(11) DPERP	0.02*	-0.1***	0.07***	0.08***	-0.0***	-0.02	0.05***	-0.02	0.09***	0.3***	1				
(12) DCOR	0.02*	0.1***	-0.0***	-0.08***	0.00	0.06***	0.1***	-0.03**	0.08***	0.3***	-0.3***	1			
(13) REQL	0.08***	0.2***	-0.06***	-0.07***	-0.00	0.01	0.1***	0.02	0.05***	0.1***	-0.3***	0.4***	1		
(14) INFL	-0.03**	-0.0***	-0.01	-0.05***	-0.00	-0.01	-0.04***	0.03***	-0.01	-0.1***	-0.1***	-0.07***	-0.1***	1	
(15) GDPG	-0.01	0.01	0.00	0.01	0.00	-0.01	-0.01	0.07***	-0.04	-0.1***	-0.1***	-0.06***	0.00	0.2***	1

Note: This table displays the correlation matrix for the variables that are used in our baseline analysis. *, **, *** indicate significance at 10%, 5%, 1% respectively.

Table 6 Link between NSFR and Bank Stability in the euro area and the non-euro area

Variable	ln(z) Model 1	ln(z) Model 2	ln(z) Model 3	ln(z) Model 4
Constant	0.751*** (0.208)	1.076*** (0.309)	2.290*** (0.194)	2.357*** (0.1004)
lnz(-1)	0.720*** (0.089)	0.632*** (0.121)	0.384*** (0.097)	0.275*** (0.104)
CAR	0.274** (0.129)	0.250** (0.125)	2.064*** (0.245)	2.206*** (0.141)
NSFR	0.0008** (0.0003)	0.001** (0.0007)	0.003*** (0.0009)	0.006*** (0.0021)
ROA	2.818** (1.274)	4.146* (2.127)	8.576*** (1.638)	9.320*** (2.546)
LERNER	-0.318* (0.163)	-0.445** (0.192)	-1.445*** (0.172)	-1.495*** (0.189)
SIZE	0.004 (0.004)	0.012** (0.005)	0.046*** (0.0052)	0.047*** (0.002)
COST	-0.102 (0.144)	-0.019 (0.159)	0.070 (0.393)	-0.0323 (0.568)
DIV	-0.851*** (0.323)	-0.933** (0.389)	-2.850*** (0.546)	-2.987*** (0.619)
GDPG	-0.290 (1.028)	-0.820 (1.775)	-1.391 (4.103)	-2.029 (10.38)
REQL	0.133*** (0.042)	---	---	---
NSFR*NSFR	---	-0.0003** (0.0001)	-0.0003** (0.0001)	----
DUM	---	---	0.076** (0.032)	0.099** (0.04)
NSFR*DUM	---	---	---	0.012*** (0.002)
Wald Test	---	---	---	0.01***
observations	4800	4800	4800	4800
Number of banks	320	320	320	320
Arellano-Bond test for AR(1)	0.020**	0.026**	0.018**	0.045**
Arellano-Bond test for AR(2)	0.181	0.16	0.176	0.227
Hansen test Probability (Hansen test)	0.743	0.764	0.696	0.407

Note: Results from GMM panel data estimations to study the link between net stable funding ratio and the stability of banks in European countries (Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, Greece, Croatia, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia). The dependent variable (ln(z)) captures bank stability. CAR is the capital asset ratio. NSFR is the net stable funding ratio. ROA is the return on assets. LERNER is the market competition. SIZE is the natural logarithm of the total assets. COST is the cost-to-income. DIV is the diversification. GDPG is the growth domestic product. REQL is the regulatory regulation DUM is dummy variable with a value of 1 if it's in the euro area and 0 if it's in non-euro area. Standard errors are in parentheses. *, **, *** indicate statistical significance at 1%, 5% and 10% respectively.

Table 7 Link between NSFR and Bank Stability in the Core euro area and Periphery euro area

Variable	ln(z) Model 5	ln(z) Model 6	ln(z) Model 7	ln(z) Model 8
Constant	0.787*** (0.175)	0.780*** (0.175)	2.286*** (0.427)	2.236*** (0.413)
lnz(-1)	0.782*** (0.062)	0.783*** (0.064)	0.202 (0.169)	0.259** (0.103)
CAR	0.329** (0.161)	-0.312* (0.164)	1.488*** (0.417)	1.430*** (0.403)
NSFR	0.002** (0.0009)	0.001** (0.0007)	-0.001 (0.001)	0.0002 (0.001)
ROA	2.651*** (0.695)	2.579*** (0.662)	5.563*** (1.815)	5.895*** (1.808)
LERNER	-0.189 (0.208)	-0.180 (0.205)	-1.608*** (0.419)	-1.55*** (0.406)
SIZE	-0.003 (0.004)	-0.003 (0.004)	0.047*** (0.012)	0.046*** (0.011)
COST	-0.179 (0.153)	-0.179 (0.152)	0.499 (0.360)	0.520 (0.356)
DIV	-0.943*** (0.331)	-0.936*** (0.332)	-3.055*** (0.860)	-3.07*** (0.847)
GDPG	-0.501 (3.605)	-0.421 (3.675)	-7.120 (9.557)	-7.291 (9.369)
NSFR*NSFR	-0.0003** (0.0001)	---	-0.000003 (0.000007)	---
DCOR	0.088*** (0.031)	0.09** (0.035)	---	---
NSFR*DCOR	---	0.004** (0.002)	---	---
DPERP	---	---	-0.307*** (0.093)	-0.27*** (0.092)
NSFR*DPERP	---	---	---	-0.005** (0.002)
Wald Test	---	0.006***	---	-0.005***
Observations	4800	4800	4800	4800
Number of Banks	320	320	320	320
Arellano-Bond test of AR(1)	0.000***	0.000***	0.002***	0.008***
Arellano-Bond test of AR(2)	0.326	0.521	0.305	0.457
Hansen test probability (Hansen test)	0.136	0.139	0.158	0.118

Note: Results from GMM panel data estimations to study the link between net stable funding ratio and the stability of banks. The dependent variable (lnz) is the stability of banks. CAR is the capital asset ratio. NSFR is the net stable funding ratio. ROA is the return on assets. LERNER is the market competition. SIZE is the natural logarithm of the total assets. COST is the cost-to-income. DIV is the diversification. GDPG is the growth domestic product. DCOR is a dummy variable with a value of 1 if it's in the core euro area (France, Austria, Belgium, Germany, and the Netherlands) and 0 otherwise. DPERP is a dummy variable with a value of 1 if it's in the peripheral euro area (Greece, Ireland, Italy, Portugal, and Spain) and 0 otherwise. Standard errors are in parentheses. *, **, *** indicate statistical significance at 1%, 5% and 10% respectively.

Table 8 Robustness Check: Link between NSFR and Bank Stability in the euro area and non-euro area

Variable	ln(z) Model 9	ln(z) Model 10	ln(z) Model 11
Constant	0.719*** (0.162)	0.878*** (0.216)	0.820*** (0.200)
lnz(-1)	0.759*** (0.067)	0.724*** (0.082)	0.736*** (0.078)
CARW	0.096 (0.073)	0.083 (0.082)	0.089 (0.080)
NSFR	0.001*** (0.0006)	0.001*** (0.0006)	0.003** (0.001)
ROA	2.574*** (0.681)	2.970*** (0.794)	3.011*** (0.792)
LERNER	-0.196 (0.191)	-0.276 (0.222)	-0.218 (0.207)
SIZE	-0.003 (0.004)	0.001 (0.006)	0.0006 (0.005)
COST	-0.148 (0.152)	-0.087 (0.167)	-0.090 (0.164)
DIV	-0.905*** (0.332)	-0.843** (0.345)	-0.859** (0.343)
GDPG	0.664 (0.515)	1.126* (0.619)	0.917 (0.578)
INFL	-0.856* (0.483)	-0.418 (0.561)	-0.440 (0.549)
DUM	---	0.046** (0.019)	0.066*** (0.022)
REQL	0.135*** (0.036)	---	---
NSFR*DUM	---	---	0.006*** (0.002)
Wald test	---	---	0.01***
Observations	4800	4800	4800
Number of Banks	320	320	320
Arellano-Bond test of AR(1)	0.004***	0.028**	0.0008***
Arellano Bond test of AR(2)	0.208	0.610	0.491
Hansen test probability (Hansen test)	0.648	0.468	0.365

Note: Results from GMM panel data estimations to study the link between net stable funding ratio and the stability of banks. The dependent variable (lnz) is the stability of banks (Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, Greece, Croatia, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia). CAR is the equity to asset ratio. NSFR is the net stable funding ratio. ROA is the return on assets. LERNER is the market competition. SIZE is the natural logarithm of the total assets. COST is the cost-to-income. DIV is the diversification. GDPG is the growth domestic product. INFL is the inflation rate. DUM is dummy variable with a value of 1 if it's in the euro area and 0 if it's in non-euro area. Standard errors are in parentheses. *, **, *** indicate statistical significance at 1%, 5% and 10% respectively .

Table 9 Robustness Check: Link between NSFR and Bank Stability in Core euro area and Periphery euro area

Variable	ln(z) Model 12	ln(z) Model 13	ln(z) Model 14	ln(z) Model 15
Constant	0.747*** (0.169)	0.859*** (0.203)	0.779*** (0.175)	0.744*** (0.162)
lnz(-1)	0.789*** (0.060)	0.737*** (0.076)	0.776*** (0.063)	0.782*** (0.060)
CARW	0.122* (0.067)	0.076 (0.081)	0.111** (0.053)	0.123* (0.066)
NSFR	-0.001*** (0.0005)	0.001** (0.0005)	0.007** (0.003)	0.005** (0.002)
ROA	2.538*** (0.663)	2.773*** (0.739)	2.565*** (0.675)	2.72*** (0.688)
LERNER	-0.122 (0.175)	-0.153 (0.189)	-0.154 (0.181)	-0.051 (0.159)
SIZE	-0.004 (0.004)	0.001 (0.005)	-0.004 (0.004)	-0.002 (0.004)
COST	-0.208 (0.146)	-0.164 (0.158)	-0.200 (0.149)	-0.188 (0.148)
DIV	-0.901*** (0.328)	-0.871** (0.342)	-0.956*** (0.338)	-0.770** (0.308)
GDPG	0.894* (0.541)	1.091* (0.618)	0.980* (0.557)	0.795 (0.543)
INFL	-0.433 (0.478)	-1.091* (0.557)	-0.382 (0.488)	-1.06** (0.523)
DCOR	0.089*** (0.025)	---	0.106*** (0.028)	---
NSFR*DCOR	---	---	0.002*** (0.001)	---
		-0.073*** (0.025)	---	-0.04** (0.019)
NSFR*DPERP	---	---	---	-0.003*** (0.001)
Wald test	---	---	0.01***	0.002***
Observation	4800	4800	4800	4800
Number of Banks	320	320	320	320
Arellano-Bond test of AR(1)	0.023**	0.0003***	0.009***	0.0009***
Arellano-Bond test of AR(2)	0.625	0.656	0.627	0.722
Hansen test probability (Hansen test)	0.235	0.542	0.295	0.444

Note: Results from GMM panel data estimations to study the link between net stable funding ratio and the stability of banks. The dependent variable (lnz) is the stability of banks. CAR is the equity to asset ratio. CARW is the assets to risk weighted assets. NSFR is the net stable funding ratio. ROA is the return on assets. LERNER is the market competition. SIZE is the natural logarithm of the total assets. COST is the cost-to-income. DIV is the diversification. GDPG is the growth domestic product. INFL is the inflation. DCOR is a dummy variable with a value of 1 if it's in the core euro area (France, Austria, Belgium, Germany, and the Netherlands) and 0 otherwise. DPERP is a dummy variable with a value of 1 if it's in the peripheral euro area (Greece, Ireland, Italy, Portugal, and Spain) and 0 otherwise. Standard errors are in parentheses. *, **, *** indicate statistical significance at 1%, 5% and 10% respectively.

Table 10 Robustness Check: Link between NSFR and Bank Stability in the Core euro area and Periphery euro area

Variable	ln(z) Model-core	ln(z) Model-periph
Constant	-0.081 (0.186)	0.818** (0.346)
lnz(-1)	1.046*** (0.045)	0.834*** (0.080)
CAR	0.695*** (0.216)	0.259** (0.116)
NSFR	0.0017** (0.0008)	-0.002* (0.001)
ROA	4.073*** (1.527)	1.019 (0.839)
LERNER	-0.429*** (0.129)	0.222 (0.230)
SIZE	0.012*** (0.002)	0.022* (0.012)
COST	0.041 (0.254)	-5.462** (2.475)
DIV	-0.142 (0.368)	1.831 (2.304)
GDPG	1.230*** (0.461)	-0.116 (4.984)
Observations	1575	1155
Number of Banks	105	77
Arellano-Bond test of AR(1)	0.00004***	0.063*
Arellano-Bond test of AR(2)	0.227	0.307
Hansen test probability (Hansen test)	0.604	0.727

Note: Results from GMM panel data estimations to study the link between net stable funding ratio and the stability of banks. The dependent variable (lnz) is the stability of banks. CAR is the equity to asset ratio. NSFR is the net stable funding ratio. ROA is the return on assets. LERNER is the market competition. SIZE is the natural logarithm of the total assets. COST is the cost-to-income. DIV is the diversification. GDPG is the growth domestic product. Model-core included banks located in: France, Austria, Belgium, Germany, and the Netherlands. Model-periph included banks located in: Greece, Ireland, Italy, Portugal, and Spain. Standard errors are in parentheses. *, **, *** indicate statistical significance at 1%, 5% and 10% respectively.

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