EUROPEAN CENTRAL BANK

EUROSYSTEM

Working Paper Series

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A study on the interaction of capital, liquidity and bank stability

No 3134

Abstract

The purpose of this paper is to empirically examine the effects of capital and liquidity on bank stability as well as the existence of a potential complementary or substitute relationship between both dimensions to explain bank stability. We use a sample of 16,061 banks from 27 countries during the period 2013-2023. Our results show that both capital and liquidity increase bank stability. However, the joint interactive effect presents a negative coefficient indicating the existence of a potential substitution effect between both variables. We also provide evidence on market power acting as a potential mechanism explaining the baseline relationships. Furthermore, the results seem to be modulated by specific bank- and country-level factors.

Keywords: Capital; liquidity; bank stability; bank-level characteristics; country-level characteristics

JEL codes: G20, G21, G28, K00

Non-Technical Summary

The costs associated with the Global Financial Crisis (GFC) in 2007/2008 have provoked an imperative for academics and practitioners to help ensure the financial stability of banking systems. In this respect, regulators and policymakers have also highlighted the critical importance of capital and liquidity in ensuring stability.

Within this context, the aim of this paper is to contribute to this reality and examine empirically and from an international perspective the effects of both capital and liquidity on bank stability, trying to shed some light on the joint effect of both dimensions as well as on the mechanisms underlying this relationship. Moreover, we also highlight that bank- and country-level features may shape the baseline relationships.

Using a sample of 16,061 banks from 27 countries during the 2013-2023 period, we find that the higher the level of capital and the level of liquidity, the higher the bank stability, which is something in line with expectations. Moreover, we find that the interaction between both variables is negative, which would indicate that the higher the levels of capital (or liquidity), the less effective the increase in liquidity (or capital) is in bank stability. Another interesting result is that, if we disaggregate the effects, we find that this reduction in risk comes from bank stability and not from a reduction in the ROA.

We also address the question about the mechanism through which solvency and liquidity influence bank stability in the way presented above. To do this, we develop a two-stage analysis: in the first stage, we propose bank market power as a potential channel through which capital and liquidity may influence bank stability. In the second stage we regress bank stability on capital, liquidity and its interaction term, as well as on the first-stage predicted value of bank market power. Our results show that bank market power acts as one of the channels through which the effect of capital and liquidity on stability is transmitted to bank stability.

Finally, our results also highlight the role of bank-level characteristics and country-level factors, related to the institutional quality and the performance of the banking sector, to shape the main relationships.

1. INTRODUCTION

The costs associated with the Global Financial Crisis (GFC) in 2007/2008 (Laeven and Valencia, 2008; 2012; 2018) have provoked an imperative for academic and practitioners to work in order to help to ensure the financial stability of banking systems. In this respect, regulators and policymakers have highlighted the critical importance of capital and liquidity in ensuring this stability. In this line, the Basel Committee on Banking Supervision (BCBS) has developed Basel III, which requires enhanced quality and quantity of capital, stable funding, and the liquidity of bank assets. What the Basel Committee is pursuing with these measures is building a foundation for sustainable economic growth with a strong and resilient banking system (BCBS, 2011).

Contrary to what happens with solvency, liquidity appeared only recently in the banking literature. However, it is well known that financial institutions may go to failure due to a lack of liquidity triggered by a loss of short-term funding (see, for example, Duffie, 2010; or Gorton, 2012). This has happened frequently throughout history. Chicago state bank failures during the Great Depression were linked to lack of liquid assets to face deposit withdrawals (Postel-Vinay, 2016). The collapse of interbank and wholesale funding was the key element in the German banking crisis of 1931 (Blickle et al., 2019).

Many examples can also be found during the 2007/2008 GFC. McDonald and Paulson (2015) show that, after a credit downgrade, the lack of liquidity resources to face margin calls triggered the AIG failure, a giant with a trillion-dollar balance sheet. Moreover, the over-abundant short-term wholesale funding was the main cause of the failure of Northern Rock in 2007 (Shin, 2009). Bear Stearns is another clear example of a failure triggered by a lack of liquidity resources, not capital, as noted in a famous letter of Christopher

Cox, then chairman of the SEC, to the Basel Committee[1]. More recent examples can be found in the literature (see, for example, Vuillemey, 2014 and Cont et al., 2020).

Considering these events, Basel III (BCBS, 2011) developed two measures, the Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR), to promote short (LCR) and long (NSFR) term resilience of a bank's liquidity risk. Moreover, regulators and supervisors have carried out liquidity stress testing to assess the adequacy of liquidity resources of banks (ECB, 2019).

In examining the joint relationship between capital, liquidity and risk in a bank, Repullo (2005) models the strategic interaction between a bank and a lender of last resort (LLR). He estimates optimal levels of risk, capital and liquidity with and without adjustments in capital and with and without penalties. He concludes that, in contrast with the general view, the existence of an LLR does not increase the incentives to take risks, while penalty rates do. Aspachs et al. (2005) formally test the implications of Repullo (2005).

As stated by Cont et al. (2020), more recently, many theoretical and empirical research has highlighted the relevance of interactions between solvency and liquidity risk (Bernanke, 2013; Cecchetti and Kashyap, 2018; Farag et al., 2013; Fungáčová et al, 2017; Madhi and Abbes, 2018; Imbierowicz and Rauch, 2014; Morris and Shin, 2016; Pierret, 2015; Distinguin et al., 2013; Rochet and Vives, 2004; Schmitz et al., 2019; Begenau, 2020 Basel Committee on Banking Supervision, 2015). Morris and Shin (2016) provide a theoretical decomposition of bank credit risk into insolvency risk and illiquidity risk. Liang et al. (2013) computed both insolvency and illiquidity default probabilities in this

[1] Source: Chairman Cox Letter to Basel Committee in Support of New Guidance on Liquidity Management, Securities and Exchange Commission, March 20, 2008. https://www.sec.gov/news/press/2008/2008-48.htm

multiperiod setting using a structural credit risk model approach. Cont (2017) links solvency and liquidity and describes the role of margin requirements in the transformation of solvency risk into liquidity risk. Distinguin et al. (2013) examine the link between bank capital and liquidity, using a model of simultaneous equations. They conclude that the relationship between capital, risk and liquidity could not be linear.

Naturally, in models of bank runs and debt roll-over coordination failures are present the interactions between solvency and liquidity (Allen and Gale, 1998; Altermatt et al., 2024; Diamond and Rajan, 2005; Rochet and Vives, 2004). Altermatt et al. (2024) develop a general equilibrium model of self-fulfilling bank runs. They find that a misallocation of liquidity could lead to a run. Moreover, Pierret (2015) finds that banks lose their access to short-term funding when markets expect they will be insolvent in a crisis. The results suggest that capital not only acts as a loss-absorbing buffer, but it also ensures the confidence of creditors to continue to provide funding to the banks in a crisis.

The link between solvency and liquidity is also very relevant in the context of financial stability (Cornett et al., 2011; Chen et al., 2021; Khan et al., 2017; Polizzi et al., 2020; Du et al., 2019; Imbierowicz and Rauch, 2014; Kim and Sohn, 2017; Zheng et al., 2019; Pierret, 2015; Thornton and di Tommaso, 2020; Patel et al., 2022). Du et al. (2019) empirically show that credit quality affect counterparty choice and, therefore, creditworthiness affects the volume rather than the price of short-term funding. Schmitz et al. (2019) present evidence on the relationship between bank solvency and funding costs. They show that neglecting the solvency-funding cost nexus leads to underestimate the impact of shocks on bank capital ratios. Vuillemey (2014) provides a decomposition of banks' probability of default between a solvency and a liquidity component. Moreover, it shows that the increase in banks' probabilities of default in most banking sectors in the

Euro area during the boom is principally attributable to liquidity risk. Kim and Sohn (2017) examine whether the effect of bank capital on lending differs depending upon the level of bank liquidity. Their result suggest that bank capital has a substantially positive effect on lending only after large banks retain sufficient liquid assets.

Moreover, there is also research on regulation (Walther, 2016; Hugonnier and Morellec, 2017; Chiva, 2022; Thakor, 2018; DeYoung et al., 2018). Chiva (2022) shows that current liquidity and capital regulation (Basel Accord) reduces the probability of financial crisis after a recession. Hugonnier and Morellec (2017) finds that liquidity and leverage requirements reduce both the likelihood of default and the magnitude of bank losses in default. Walther (2016) studies macro and micro prudential regulation and states that micro and macroprudential rules are imperfect substitutes.

However, even though the link between liquidity and solvency is clear in what is presented above, in practice liquidity and capital goes independently (Cecchetti and Kashyap, 2018). Although some theoretical proposal has been presented (Cont et al, 2020; Han and Leika, 2019; Baudino et al. 2018), liquidity stress tests are conducted separately from solvency stress tests (ECB, 2019; Schuermann, 2014). In this respect, Cont et al (2020) propose a structural framework for the joint stress testing of solvency and liquidity. The solvency-liquidity nexus is used to model liquidity and solvency risk in a coherent framework. They also define the concept of "Liquidity at Risk", which quantifies the liquidity resources required for a financial institution facing a stress scenario.

Our paper aims to contribute to this debate analyzing the effects of capital and liquidity on bank stability. We consider that it is necessary to study the potential joint effect of both aspects in order to better understand their relationship with bank stability.

Moreover, we explore bank market power as a potential channel driving the main relationships between capital, liquidity and bank stability. Furthermore, we propose that the final effects may not be homogeneous across banks, nor across countries, but they may finally depend on individual bank-level characteristics as well as on country-level dimensions.

We use an international sample of banks from 27 countries examined during the 2013-2023 period. Our results show that both capital and liquidity positively contribute to increasing bank stability. However, when interactive effects are considered, the results seem to be consistent with a potential substitution effect between these two factors. We also find evidence supporting bank market power as a potential mechanism through which capital and liquidity affect bank stability. Finally, the above-mentioned relationships seem to ultimately being shaped by the characteristics of each bank and each country.

The empirical evidence obtained in this paper may have important policy implications since we study the influence of capital and liquidity (and their interactions) in bank stability. Moreover, this policy implications are highly related to the channels through capital and liquidity impact bank stability.

In Section 2, we describe the sample, the methodology, and variables, used in the empirical analysis. Our results are presented in Section 3. Finally, Section 4 concludes.

2. METHODOLOGY

2.1. Sample

To carry out the empirical analyses we use a unique bank-level dataset retrieved from several sources. Bank-level information is obtained from the ORBIS Bank Focus Database (Bureau Van Dijk). Country-level data on bank market characteristics, macroeconomic variables, and the features of the legal and institutional framework come from the World Bank Global Financial Development database, and the Heritage Foundation.

Our final sample is made up of an unbalanced panel for a maximum of 16,061 banks in 27 countries during the 2013-2023 period. This makes a total of 61,442 bank-year observations in our sample. Table 1 reports a more detailed description of the composition of the sample.

<INSERT TABLE 1 ABOUT HERE>

2.2. Econometric model and variables

Our empirical approach relies on linear regressions with panel data estimators. We regress our proxy for bank stability on the main explanatory variables: capital and liquidity, as well as the interactive term of both variables. Apart from explicitly controlling for traditional bank- and country-level variables potentially affecting bank stability, in all the estimates we include bank- and time-fixed effects. The structural equation to be estimated is defined as follows:

$$ZSCORE_{ijt} = \beta_0 + \beta_1 CAPITAL_{ijt-1} + \beta_2 LIQUIDITY_{ijt-1} + \beta_3 CAPITAL * LIQUIDITY_{ijt-1} + \sum_{l=1}^{4} \gamma_l \ BANK_{ijt-1} + \sum_{h=1}^{2} \delta_h \ COUNTRY_{jt} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad [1]$$

where *i*, *j*, and *t* refer to the bank, country, and year, respectively. We regress our proxy for bank stability, the natural logarithm of the Z-Score (*ZSCORE*), on the main explanatory variables: the ratio of total equity over total assets (*Capital*) and the liquidity ratio (*Liquidity*) measured as the percentage of liquid assets over total assets in the balance sheet. The coefficient β_3 would capture whether and to what extent the joint consideration of capital and liquidity affects the stability of individual bank entities. This means, we aim at testing if there are complementary/substitution effects between capital and liquidity to promote bank stability.

According to previous literature on bank stability (see, for instance, Beck et al., 2013; Behr et al., 2010; Cuadros-Solas et al., 2024; or Laeven et al., 2016; among others), the vector *BANK* includes bank-level control variables. We consider the natural logarithm of total assets in the bank balance sheet as the proxy for bank size (*Size*); the cost-to-income ratio, as an inverse proxy of bank entity efficiency (*Cost-to-Income*); the share of interest income in total assets (*Traditional Activity*) as a proxy for bank business activity; and the annual growth rate in the volume of granted loans (*ΔLoans*). At this point, it is necessary to mention that, as bank-level determinants are likely to be endogenously determined and reverse causality is arguably possible, in all our estimates all bank-level control variables are lagged by one period to ameliorate the impact of this potential econometric concern.

The vector *COUNTRY* includes the country-level controls. In particular, to control for the potential influence of the economic cycle on bank stability, we include the annual percentage change in the consumer price index (*Inflation*). Furthermore, as bank soundness could be to some extent explained by the characteristics of each country in terms of institutional quality, in all the estimates we include an indicator proxying for the quality of the legal and institutional environment (*KKZ*).

Finally, μ_i is a parameter that represents an independent bank-term. These specific controls allow us to capture any unobserved effects that are specific to each bank, persistent over time, and not directly included in the regressions. λ_t is a set of year dummy variables to capture unobserved bank-invariant time effects not included in the regression.

$\varepsilon_{i,t}$ is a white-noise error term. Moreover, to address potential correlations in the dependent variable, standard errors are clustered at the bank-level. Table 2 provides the descriptive statistics of the main variables.

<INSERT TABLE 2 ABOUT HERE>

3. RESULTS

3.1. Baseline results

In this section, we present the results of our baseline model analyzing how capital and liquidity influence bank stability. The results are reported in Table 3. In column (1) the dependent variable is the logarithm of the Z-Score, representing bank stability (*ZSCORE*). Our results show that both capital and liquidity exhibit a significant positive coefficient, highlighting their contribution to strengthening banks' financial stability. This positive effect, however, is counteracted when both capital and liquidity are considered. As can be observed, the coefficient for the interaction term between capital and liquidity is negative and statistically significant. This would indicate that although on average there is a positive influence of both bank-level characteristics on bank stability, it emerges a potential substitution effect between both of them, meaning that capital and liquidity, jointly considered, do not contribute more to higher levels of bank stability. In other words, the higher the levels of capital (or liquidity), the less effective the increase in liquidity (or capital) is in bank stability.

To further examine the impact of bank capital and liquidity on stability, we decompose the Z-Score indicator into its components: the capital equity ratio and ROA (*log(roa+equity/assets)*) as the numerator; and the standard deviation of ROA over a three-year rolling window (*log(sd(roa))*) as the denominator. In each case, these variables replace the Z-Score as the dependent variable in eq. (1), enabling us to assess how each bank's strength in terms of capital and liquidity influences different dimensions of bank stability. The capital equity ratio and ROA (numerator of the Z-Score indicator) are positively associated with the Z-Score, indicating their role in enhancing financial resilience. The standard deviation of ROA (denominator) is negatively associated with the global indicator of bank stability, as greater variability in returns signals higher systemic risk. This approach aligns with the methodology of Beck et al. (2022) and offers a more detailed understanding of how each component contributes to the overall assessment of bank stability.

In columns (2) and (3), therefore, we present the results for the decomposition of the Z-Score indicator. As can be seen in column (2), the individual coefficients for capital and liquidity present a positive and statistically significant effect for explaining the direct measure of bank stability. In the same vein as in column (1), the interaction term *Capital*Liquidity* shows a negative coefficient, consistent with the capacity of bank capital to increase bank stability in the case of more illiquid banks (and vice-versa). The results in column (3), however, show that capital and liquidity do not have a statistically significant effect on return volatility, as a direct measure of bank risk (i.e. the denominator of the Z-score indicator), suggesting these bank-level characteristics and their joint interactive effect may have a limited direct impact on this dimension. Hence, taken together, these results are consistent with the effect of capital and liquidity directly affecting the extent to which banks are more stable (numerator of the Z-Score) and not to the extent to which entities reduce their risk levels.

<INSERT TABLE 3 ABOUT HERE>

3.2. Bank market power as mechanism

In this section, we present evidence supporting bank market power may act as a channel through which capital and liquidity may affect bank stability. Previous literature examined the relationship between bank market power and bank stability (see, Agoraki et al., 2011; Jiménez et al., 2013; or Turk-Ariss, 2010; among others) and how different bank-level dimensions affecting bank market structure influence market power and, thereby, bank stability (Beck et al., 2013; Cubillas and González, 2014). The *competition-stability view*, on one side, argues that greater competition in the banking sector fosters efficiency and can contribute to more stability. The argument would be that a more competitive environment forces banks to operate more efficiently and be more innovative in providing services. Furthermore, competition can decrease profit margins, which reduces incentives for excessive risk-taking, as banks have less "franchise value" to protect. In a competitive market, banks are also less prone to engage in "search for yield" activities if they cannot obtain extraordinary margins, which could lead to a more efficient allocation of capital and a lower accumulation of systemic risk.

On the other hand, the *competition-fragility view* (Hellmann et al., 2000) posits that greater competition can, in fact, undermine banking stability. The central argument is that an increase in competition erodes banks' market power and, consequently, reduces their profit margins and "franchise value". This can encourage banks to take greater risks in pursuit of additional income sources to compensate for the loss of profitability. In this scenario, banks might be pushed to grant loans to riskier borrowers or invest in riskier assets, which would increase the likelihood of bank failures and, by extension, systemic instability.

Hence, it is easily arguable that the extent to which banks hold capital and liquid assets may also influence their competitive position, thereby affecting their stability. As for the relationship between capital and market power, there are arguments suggesting that higher capitalization can strengthen a bank's competitive position. Banks with higher capital levels may present a more solid position to compete, take risks and preserve higher margins, which translates into greater market power (Repullo, 2004). Furthermore, reduced reliance on external financing due to strong capital offers greater independence in strategic decision-making, thereby reinforcing market power (Agoraki et al., 2011; Jiménez et al., 2013).

Conversely, maintaining higher capital levels can be costly and may imply higher lending rates or lower deposit rates, potentially diminish a bank's competitiveness and thus reduce its ability to exert market power in contested markets (Hellmann et al., 2000). Stricter capital requirements can also incentivize banks to engage in regulatory arbitrage, shifting certain activities or risks to less regulated non-bank financial institutions (Buchak et al., 2018), which could reduce their direct market presence and market power in those segments. Additionally, highly capitalized banks might prioritize safety and stability over aggressive market share pursuit, leading to avoidance of risky, high-return activities, which could result in a lower observed market power compared to less capitalized, more aggressive competitors (Claessens and Laeven, 2004). In a similar vein, a bank with a robust liquidity position, can significantly enhance its market power by diminishing its vulnerability to funding shocks and reducing its cost of capital (Nguyen et al., 2024). Furthermore, effective liquidity management, particularly during periods of financial instability, may foster depositor and creditor confidence, which in turn may reinforce a bank's market power.

Hence, we propose a two-stage procedure to examine whether and to what extent capital and liquidity affect bank market power and thereby bank stability. We thus use instrumental variables in a Two-Stage Least Squares (2SLS) procedure for panel-data models. We regress our proxy for bank stability on capital, liquidity, its interaction term, and on our measure of bank market power, controlling for other relevant factors at both the bank and country level. The structural equation to be estimated is defined as follows:

$$\begin{aligned} ZSCORE_{ijt} \; = \; & \beta_0 + \beta_1 CAPITAL_{ijt-1} + \beta_2 LIQUIDITY_{ijt-1} \\ & + \beta_3 CAPITAL * LIQUIDITY_{ijt-1} + \beta_4 \widehat{LERNER}_{ijt-1} \\ & + \sum_{l=1}^{4} \gamma_l \; BANK_{ijt-1} + \sum_{h=1}^{2} \delta_h \; COUNTRY_{jt} + \mu_i + \lambda_t + \varepsilon_{i,t} \end{aligned} \qquad [2]$$

where i, j, t refer to the bank, country, and year, respectively. $\widehat{LERNER}_{it-1}$ is the instrumented Lerner index obtained in a first-stage regression. In eq. (2), coefficient β_4 would indicate how capital and liquidity affects bank stability through market power.

In order to be consistent, the first-stage equation (Lerner equation) is the same used in the baseline model eq. (1). This 2SLS procedure requires including its own predetermined variables or instruments in the first-stage equation, which should affect the second-stage variable only through their effect on the first-stage endogenous variable. Specifically, we consider the annual growth rate of the intangible assets-to-total assets ratio (*ΔIntangible Assets (% Total Assets))* as an instrument for explaining the Lerner index. Intangible assets, including reputation and customer loyalty, may allow banks to differentiate themselves from competitors, reducing price sensitivity and fostering customer retention (Fiordelisi et al., 2013).

Table 4 provides the results of the 2SLS procedure. The results of the first-stage regressions from which we obtain the predicted *Lerner Index* are reported in column (1). As can be observed, we find a positive and statistically significant coefficient for the intangible assets ratio, indicating that banks with higher growth rates of intangible assets over total assets in their balance sheet have higher levels of market power. In addition to selecting our instrument based on economic arguments, we require it to be both relevant and valid. As can be observed, the first-stage F-test is statistically significant. Moreover, the Durbin-Wu-Hausman test suggests the need to consider potential endogeneity concerns that would be partially addressed through this 2SLS procedure.

The second-stage regressions [eq.2] reported in column (2) show that the coefficient of $\widehat{LERNER}_{it-1}$ (β_4) is negative and statistically significant. This result provides empirical evidence of the indirect effect of capital and liquidity on bank stability through bank market power. This finding suggests that the increased degree of market power caused by higher levels of capitalization and liquidity affects bank stability. This result points to the role of market power as a channel underlying the relationship between capital and liquidity, and bank stability. Moreover, we also find that the individual coefficients for *Capital* and *Liquidity* are positive and statistically significant, whereas the coefficient for the interaction term *Capital*Liquidity* remains negative (even less negative than before) and statistically significant, suggesting that there is a direct negative effect of capital and liquidity on bank stability. In other words, part of the effect of both capital and liquidity on bank stability is not taking place through bank market power.

<INSERT TABLE 4 ABOUT HERE>

3.3. The role of bank- and country-level characteristics

We now analyze whether certain bank-level characteristics might shape the influence of capital and liquidity on bank stability. The results obtained are presented in Table 5. In columns (1)-(4), we sequentially introduce the interactions between capital and liquidity, and each one of the variables capturing the different bank-level characteristics, namely: *Size, Cost-to-Income, Traditional Activity* and *ΔLoans*. Results indicate that the positive and significant individual coefficient for both *Capital* and *Liquidity* remains invariant to explain bank stability. Furthermore, the coefficient for their interaction term, *Capital*Liquidity*, also remains in all the estimates.

In columns (1) to (3) we obtain negative and statistically significant coefficients for the interaction terms for bank capital with size, cost-to-income ratio and traditional bank activity. These results suggest that, although on average there is a positive effect of bank capital on stability, the effect is more positive in the case of smaller banks, more efficient and more diversified banks. Smaller banks often have a less diversified business, making them more vulnerable to potential shocks. Higher capital may therefore act as a relatively more relevant mechanism to absorb losses, as they may have fewer alternatives (i.e. access to wholesale funding markets or implicit "too-big-to-fail" guarantees). In the case of efficient banks, the positive effect of higher capital on stability is amplified because these banks could be better at converting their capital into profitable and potentially more stable operations. Traditional banking activities are generally considered more stable and predictable than non-traditional, often riskier, activities. For banks with a higher proportion of traditional activities, higher capital supports the traditional business model, which is inherently less volatile. The results in column (2) present also a positive and statistically coefficient for the *Liquidity*Cost-to-Income*. This would indicate that the positive effect of bank liquid assets on fostering bank stability is particularly relevant in the case of inefficient banks. Inefficient banks, by definition, struggle with higher operating costs. These costs can deplete internal funds and expose the bank to liquidity shortfalls. A strong liquid asset buffer directly addresses this vulnerability, providing available funds to cover operational needs.

Regarding the triple interaction terms, we obtain negative and statistically significant coefficients in column (2) suggesting that the negative joint effect of capital and liquidity on bank stability is more relevant in the case of more inefficient banks. Both capital and liquid assets imply the existence of opportunity costs. Capital, while absorbing losses, may tie up funds that could otherwise be allocated in the credit market. Liquid assets, by definition, yield lower returns than less liquid assets like loans. In the case of an inefficient bank, these opportunity costs can be particularly worrying. When such a bank simultaneously holds high levels of both capital and liquidity, it may face a severe drag on profitability, higher than in the case of an efficient bank. A sustained decline in profitability may lead to a lower Z-Score in the long run, as it may erode retained earnings, thereby increasing the probability of insolvency despite seemingly high buffers.

<INSERT TABLE 5 ABOUT HERE>

We also analyze whether certain country-level characteristics related to both the institutional environment and the banking sector might shape the influence of capital and liquidity on bank stability. In particular, we consider the KKZ indicator (*KKZ*) and the rule of law indicator (*Rule of Law*). *KKZ* is an indicator computed as the average of six country-level dimensions: voice and accountability in the political system, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption, where higher values indicate better institutional quality. In a similar vein, *Rule* *of Law*, as an individual component of the KKZ indicator, captures perceptions of the extent to which agents have confidence in and abide by the rules of society and, particularly, the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. More specifically related to the banking sector, we use the financial freedom index (*Financial Freedom*), as a proxy for whether and to what extent financial institutions are free from government control. Higher values of this indicator would mean higher levels of financial freedom. Finally, we also consider an aggregate proxy for banking sector profitability (*ROA Banking Sector*).

The results obtained are presented in Table 6. In columns (1)-(4), we sequentially introduce the interactions between capital, liquidity and each one of the variables capturing the above-mentioned country-level characteristics: *KKZ*, *Rule of Law, Financial Freedom* and *ROA Banking Sector.* As can be seen, our results indicate that the positive and significant individual coefficient at conventional levels of both *Capital* and *Liquidity* remain invariant to explain bank stability. In the same line, the coefficient for the interaction *Capital*Liquidity* also remains. The positive coefficients obtained for the interaction terms between bank capital and each of the proxies for the characteristics of the institutional environment (*KKZ*, *Rule of Law* and *Financial Freedom*) suggest that the role of bank capital to promote stability is reinforced in the case of banks from countries with higher levels of institutional quality and financial freedom. In the same vein, bank liquidity contributes more to higher levels of Z-Score in countries with higher institutional quality (proxied by the KKZ indicator). In environments with strong institutions, it could be assumed that information asymmetry problems are lower, and capital and liquidity dimensions may act as a more credible signal of bank strength, and its protective capacity is enhanced by better contract enforcement and a more predictable operating environment (La Porta et al., 1997; 1998).

The negative coefficients obtained for *Capital*ROA Banking Sector* and *Liquidity*ROA Banking Sector* would be consistent with the role of capital and liquidity to promote bank stability in the case of countries with less profitable banking sectors. These results are consistent with the argument that the role of capital and liquidity in promoting bank stability becomes more critical in countries with less profitable banking sectors. When the overall banking sector profitability is low, banks may have less internal capacity to absorb potential losses or generate liquidity. Consequently, capital and liquid assets become more important for maintaining stability, as their marginal contribution to resilience is higher in such constrained environments.

As for the triple interaction terms, we only obtain statistically significant coefficients at conventional levels in columns (1) and (4). In column (1) the negative coefficient obtained for the interaction term *Capital*Liquidity*KKZ* is consistent with the baseline results and indicates that the substitution effect found between capital and liquidity to promote stability is more pronounced, precisely in countries with higher levels of institutional quality. In countries where institutions more effectively, banks face fewer frictions and uncertainties (La Porta et al., 1997; 1998), allowing them to optimize their balance sheet structure by substituting between capital and liquidity more efficiently while maintaining stability. This implies that the marginal benefit of holding both buffers simultaneously diminishes when the external mechanisms, in the shape of institutional support, are strong. Results in column (4) show that in countries with higher levels of profitability in the banking sector, the joint effect of capital and liquidity to promote bank stability is more relevant (i.e. the coefficient for the interaction term

*Capital*Liquidity*ROA Banking Sector* is positive and statistically significant). This suggests that a profitable operating environment allows capital and liquidity to work synergistically, enhancing their joint contribution to bank stability.

<INSERT TABLE 6 ABOUT HERE>

4. CONCLUSIONS

In this paper, we investigate the impact of solvency and liquidity and their interactions on bank stability (measured at a bank-level as the Z-Score indicator). As expected, the higher the level of capital (solvency) and the level of liquidity, the higher the bank stability. However, our results are consistent with the existence of a potential substitution effect between these two dimensions in promoting bank stability, as the interaction between both variables is negative. When diving deeper into these relationships, we show that the increase in Z-Score provoked by higher levels of capital and liquidity (as well as the substitution effect) takes place from an increase in the direct measure of stability (numerator of the bank Z-Score indicator) and not as a consequence of the reduction in bank risk, proxied as the ROA volatility (denominator of the Z-Score).

Moreover, we also address the question about the mechanism from which capital and liquidity influence bank stability. In doing so, we develop a two-stage analysis: in the first stage, we propose the level of bank market power, proxied by the Lerner index, as a bank-level feature that may act as a channel through which capital and liquidity may finally influence bank stability. Using the growth of intangible assets over total assets in the bank balance sheet as an instrument, we find that banks with more market power are less stable (the *competition-stability view* would be the main thread here). Therefore, these results suggest that one of the channels through which the effect of capital and liquidity on stability is transmitted is through their impact on banks' competitive conditions.

Finally, we examine whether and to what extent the results are homogenous across banks and countries. Hence, we consider the role of individual bank-level characteristics (size, efficiency, weight of traditional activity, and loan growth) and country-level factors (global institutional quality, rule of law, financial freedom and banking sector profitability) in shaping the effect of capital and liquidity on bank stability. In the case of bank-level characteristics, the results suggest that, although there is a positive effect of bank capital on stability, the effect is more positive in the case of smaller, more efficient and more diversified banks. Moreover, the positive effect of bank liquid assets on fostering bank stability is more relevant in inefficient banks. Lastly, the negative joint effect of capital and liquidity on bank stability is more relevant in the case of more inefficient banks. As for the country-level characteristics, the results suggest that the role of bank capital to promote stability is reinforced in the case of banks from countries with higher levels of institutional quality and financial freedom. In the same way, bank liquidity contributes more to higher levels of Z-Score in countries with higher institutional quality. Moreover, the substitution effect is also more pronounced in countries with higher levels of institutional quality.

We think that the results obtained in this paper could have important policy implications since we examine the influence of capital and liquidity (and their interactions) in bank stability. Moreover, since we also study the channels from which solvency and liquidity influence bank risk these policy implications are richer. As stated above, market power is one of these channels, however there should be more that can be studied and open the doors to new lines of research.

Annex 1. Definitions of the variables and data sources

This table describes the variables used in the paper and indicates the sources from which the data were retrieved.

Variable	Definition	Source
Panel A. Dependent variable		
Z-Score	The natural logarithm of (ROA + CAP)/sd(ROA), where ROA is the return on assets, CAP is the capital to asset ratio, and sd(ROA) is an estimate of the standard deviation of the rate of return on assets. To calculate the standard deviation of ROA, we use a three-year moving window. A higher Z-score indicates that the bank is more stable because it is inversely related to the bank's default probability.	Own calculations with data from Orbis Bank Focus (Bureau Van Dijk).
Panel B. Main Variables		
Capital	It is measured as the ratio total capital over total assets.	Orbis Bank Focus (Bureau Van Dijk).
Liquidity	It is computed as the liquid assets-to-total assets ratio.	Orbis Bank Focus (Bureau Van Dijk).
Panel C. Bank-level variables		
Size	It is the measure of bank size computed as the natural logarithm of total assets.	Orbis Bank Focus (Bureau Van Dijk).
Cost-to-Income	Total operating expenses by total operating income. It represents the efficiency of a bank's operations. Lower values of this ratio mean the bank is more efficient	Orbis Bank Focus (Bureau Van Dijk).
Traditional Activity	Total interest income to total bank assets. A higher ratio means that the bank is less diversified	Orbis Bank Focus (Bureau Van Dijk).
ΔLoans	Annual growth rate in the volume of bank loans.	Orbis Bank Focus (Bureau Van Dijk).
Panel D. Country-level variables		
Inflation	Annual percentage change of end-of-period consumer prices.	World Bank Global Financial Development Database.
KKZ	It is an indicator of institutional quality computed as the average of six country-level dimensions: voice and accountability in the political system, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption.	World Bank Governance Indicators Database (Kaufmann et al., 2009).
Rule of Law	It captures perceptions of the extent to which agents have confidence in and abide by the rules of society and, particularly, the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.	World Bank Governance Indicators Database (Kaufmann et al., 2009).
Financial Freedom	It measures proxy whether and to what extent financial institutions are free from government control.	Heritage Foundation
ROA Banking Sector	Average return on assets (ROA) of the banking sector.	World Bank Global Financial Development Database.
Panel E. Mechanism analysis variables		

ΔIntangible Assets	Annual growth rate of the ratio intangible assets over total assets.	Orbis Bank Focus (Bureau Van Dijk).
Lerner Index	The difference between the interest rate and marginal cost expressed as a percentage of price. This index moves between 0 (pure perfect competition) and 1 (perfect monopoly).	Own calculations with data from Orbis Bank Focus (Bureau Van Dijk).

REFERENCES

Agoraki, M.-E. K., Delis, M. D., Pasiouras, F. (2011). Regulations, competition and bank risk-taking in transition countries. *Journal of Financial Stability* 7(1), 38–48.

Allen, F., Gale, D., 1998. Optimal financial crises. J. Finance 53 (4), 1245–1284.

Altermatt, L., Buggenum, H., and Voellmy, L. (2024). Systemic bank runs without aggregate risk: How a misallocation of liquidity may trigger a solvency crisis. Journal of Financial Economics (161). 103929

Aspachs, O., Nier, E., Tiesset, M. (2005). Liquidity, Banking Regulation and the Macroeconomy: Evidence on Bank Liquidity Holdings from a Panel of UK-resident Banks Working Paper. Bank of England.

Basel Committee on Banking Supervision (2011). Basel III: A Global Regulatory Framework for More Resilient Banks and Banking Systems. Bank for International Settlements (BIS) publications.

Basel Committee on Banking Supervision (2015). Making supervisory stress tests more macroprudential: Considering liquidity and solvency interactions and systemic risk. Working Paper. Bank for International Settlements.

Baudino, P., Goetschmann, R., Henry, J., Taniguchi, K., Zhu, W., (2018). Stress-testing banks – a comparative analysis. FSI Insights on policy implementation No 12. *Bank for International Settlements.*

Beck, T., De Jonghe, O., Schepens, G. (2013). Bank competition and stability: Cross-country heterogeneity. *Journal of Financial Intermediation* 22(2), 218–244.

Beck, T., Gambacorta, L., Huang, Y., Li, Z., Qiu, H. (2022). Big techs, QR code payments and financial inclusion. *BIS Working Papers No 1011*, *May 2022*: 1–47.

Begenau, J. (2020). Capital requirements, risk choice, and liquidity provision in a business-cycle model. Journal of Financial Economics 136; 355–378.

Behr, P., Schmidt, R. H., Xie, R. (2010). Market structure, capital regulation and bank risk taking. *Journal of Financial Services Research*, 37(2–3): 131–158.

Bernanke, B. (2013). The federal reserve and the financial crisis. Princeton University Press.

Blickle, K., Brunnermeier, M.K., Luck, S., 2020. Micro-Evidence from a System-Wide Financial Meltdown: The German Crisis of 1931. Working Paper.

Buchak, G., Matvos, G., Piskorski, T., Seru, A. (2018). Fintech, regulatory arbitrage, and the rise of shadow banks. *Journal of Financial Economics* 130: 453-483.

Cecchetti, S., Kashyap, A. (2018). What binds? interactions between bank capital and liquidity regulations. The Changing Fortunes of Central Banking 192–202.

Chen W., Chen Y., Huang, S. (2021). Liquidity risk and bank performance during financial crises. Journal of Financial Stability (56); 100906.

Chiba, A. (2022). Bank capital and liquidity regulation. Journal of Banking Regulation 23; 120–138.

Claessens, S., Laeven, L. (2004). What drives bank competition? Some international evidence. *Journal of Money, Credit and Banking*, *36*(3), 563–583.

Cont, R. (2017). Central clearing and risk transformation. Financial Stability Review; 127–140.

Cont, R., Kotlicki, A. and Valderrama, L. (2020). Liquidity at risk: Joint stress testing of solvency and liquidity. Journal of Banking and Finance, 118, 1-16.

Cornett, M.M., McNutt, J.J., Strahan, P.E., Tehranian, H. (2011). Liquidity risk management and credit supply in the financial crisis. Journal of Financial Economics. 101 (2), 297–312.

Cuadros-Solas, P.J., Cubillas, E., Salvador, C., Suárez, N. (2024). Digital disruptors at the gate. Does FinTech lending affect bank market power and stability? *Journal of International Financial Markets, Institutions & Money* 92: 101964.

Cubillas, E., González, F. (2014). Financial liberalization and bank risk-taking: International evidence. *Journal of Financial Stability* 11(1), 32–48.

DeYoung, R., Distinguin, I., and Tarazi, A. (2018). The joint regulation of bank liquidity and bank capital. Journal of Financial Intermediation (34); 32–46.

Diamond, D.W., Rajan, R.G. (2005). Liquidity shortages and banking crises. J. Finance 60 (2), 615–647.

Distinguin I, Roulet C, Tarazi A (2013) Bank regulatory capital and liquidity: evidence from US and European publicly traded banks. J Bank Finance 37(9):3295–3317

Du, W., Gadgil, S., Gordy, M.B., Vega, C. (2019). Counterparty risk and counterparty choice in the credit default swap market. Working Paper. Federal Reserve Board.

Duffie, D. (2010). How big banks fail and what to do about it. Princeton University Press.

European Central Bank (2019). ECB Sensitivity analysis of Liquidity Risk - Stress Test 2019. Methodological note. Banking Supervision.

Farag, M., Harland, D., Nixon, D. (2013). Bank capital and liquidity. Bank of England Quarterly Bulletin.

Fiordelisi, F., Schwizer, P., Soana, M.G. (2013). The determinants of reputational risk in the banking sector. Journal of Banking and Finance, 37: 1359-1371

Fungáčová, Z., Weill, L., Zhou, M. (2017). Bank capital, liquidity creation and deposit insurance. Journal of Financial Services Research 51: 97–123.

Gorton, G. (2012). Misunderstanding financial crises. Oxford University Press.

Han, F., Leika, M. (2019). Integrating solvency and liquidity stress tests: The use of Markov Regime-Switching Models. IMF Working Paper WP/19/250.

Hellmann, T.F., Murdock, K.C., Stiglitz J.E. (2000). Liberalization, moral hazard in banking, and prudential regulation: Are capital requirements enough? American Economic Review 90(1): 147-165.

Hugonnier, J., Morellec, E. (2017). Bank capital, liquid reserves, and insolvency risk. Journal of Financial Economics 125; 266–285.

Imbierowicz, B., Rauch, C. (2014). The relationship between liquidity risk and credit risk in banks. Journal of Banking and Finance 40, 242–256.

Jiménez, G., Lopez, J. A., Saurina, J. (2013). How does competition affect bank risk-taking? *Journal of Financial Stability* 9(2), 185–195.

Khan, M., Scheule, H, Wu, E. (2017). Funding liquidity and bank risk taking. Journal of Banking and Finance (82); 203–216.

Kim, D., Sohn, W. (2017). The effect of bank capital on lending: Does liquidity matter? Journal of Banking and Finance 77; 95–107.

Laeven, L., Ratnovski, L., Tong, H. (2016). Bank size, capital, and systemic risk: Some international evidence. *Journal of Banking and Finance* 69: S25–S34.

Laeven, L., Valencia, F., (2008). Systemic banking crises: A new database. IMF Working Paper 08/224, 1–80.

Laeven, L., Valencia, F., (2012). Systemic banking crises database: An update. IMF Working Paper 12/163, 1–32.

Laeven, L., Valencia, F., (2018). Systemic banking crises revisited. IMF Economic Review, 61(2), 225–270.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., Vishny, R. W. (1997). Legal Determinants of External Finance. *The Journal of Finance*, *LII*(3), 1131–1150.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., Vishny, R. W. (1998). Law and Finance. *Journal of Political Economy*, *106*(6), 1113–1155.

Liang, G., Ltkebohmert, E., Xiao, Y. (2013). A multiperiod bank run model for liquidity risk. Review of Finance. 1–40.

Mahdi, I., Abbes, M. (2018). Relationship between capital, risk and liquidity: a comparative study between Islamic and conventional banks in MENA region. Research in International Business and Finance (45); 588–596.

McDonald, R., Paulson, A. (2015). AIG In hindsight. Journal of Economic Perspectives 29 (2), 81–106.

Morris, S., Shin, H.S. (2016). Illiquidity component of credit risk. Int. Econ. Rev. (Philadelphia) 57 (4), 1135–1148.

Nguyen, D. T., Le, T. DQ., Tran, S. (2024). Competition and bank financial stability: evidence from an emerging economy. *Cogent Business & Management*, *11*(1). https://doi.org/10.1080/23311975.2024.2365422

Patel, A., Sorokina, N., Thornton, J. (2022). Liquidity and bank capital structure. Journal of Financial Stability (62); 101038.

Pierret, D. (2015). Systemic risk and the solvency-Liquidity nexus of banks. International Journal of Central Banking 11 (3), 193–227.

Polizzi, S., Scannella, E., Suárez, N. (2020). The role of capital and liquidity in bank lending: Are banks safer? Global Policy (11); Supplement 1; 28-38.

Postel-Vinay, N. (2016). What caused Chicago bank failures in the great depression? a look at the 1920s. J. Econ. Hist. 76 (2), 478–519.

Repullo, R. (2004). Capital requirements, market power, and risk-taking in banking. *Journal of Financial Intermediation* 13(2), 156–182.

Repullo, R. (2005). Liquidity, risk taking, and the lender of last resort. International Journal of Central Banking 1 (2), 47–80.

Rochet, J.-C., Vives, X. (2004). Coordination failures and the lender of last resort: was bagehot right after all? Journal of European Economic Association. 2 (6), 1116–1147.

Schmitz, S.W., Sigmund, M., Valderrama, L. (2019). The interaction between bank solvency and funding costs: A crucial effect in stress tests. Economic Notes 48 (2), 1-31.

Schuermann, T. (2014). Stress testing banks. International Journal Forecast. 30 (3); 717–728.

Thakor, A. (2018). Post-crisis regulatory reform in banking: Address insolvency risk, notilliquidity! Journal of Financial Stability 37; 107–111.

Thornton, J., di Tommaso, C. (2020). Liquidity and capital in bank lending: Evidence from European banks. Finance Research Letters 34; 101273.

Turk Ariss, R. (2010). On the implications of market power in banking: Evidence from developing countries. *Journal of Banking and Finance* 34(4), 765–775.

Vayanos D, Gromb D. (2010). A model of financial market liquidity based on intermediary capital. Journal of the European Economic Association 8 (2–3); 456–466.

Vuillemey, G. (2014). Solvency vs. liquidity. A decomposition of European banks' credit risk over the business cycle. International Economics 137 (2014) 32–51.

Walther, A. (2016). Jointly Optimal Regulation of Bank Capital and Liquidity. Journal of Money, Credit and Banking (48); No. 2–3.

Zheng, C., Cheung, A., Cronje, Tom. (2019). The moderating role of capital on the relationship between bank liquidity creation and failure risk. Journal of Banking and Finance (108). 105651.

Table 1. Sample composition

This table shows the number of bank-year observations per country.

Country	Observations
Argentina	386
Austria	421
Belgium	233
Brazil	4,842
Canada	861
Canada	1,899
Chile	186
France	1,660
Germany	9,483
Hong Kong	287
India	600
Indonesia	874
Ireland	73
Italy	3,911
Japan	5,018
Korea South	245
Luxemburg	550
Mexico	1,088
Netherlands	177
Saudi Arabia	81
Singapore	74
South Africa	105
Spain	861
Switzerland	2,491
Turkey	379
United Kingdom	597
United States	24,060
Total	61,442

Table 2. Descriptive statistics

This table shows the descriptive statistics of the main variables.

Variable	Mean	Min.	Median	Max.	St. Dev.
Z-Score	4.0091	0.0098	4.0004	13.1847	1.1000
Capital	0.9943	0	1	1	0.0751
Liquidity	0.2154	0	0.1129	1	0.2617
Size	13.4038	6.0831	13.5574	19.5724	2.5903
Cost-to-Income	0.7131	0.1977	0.6950	1.7662	0.2266
Traditional Activity	0.0428	0.0054	0.0311	0.2458	0.0431
ΔLoans	0.0350	-0.4781	0.0153	0.8919	0.1690
Lerner Index	0.4779	0.0536	0.5053	0.7407	0.1431
ΔIntangible Assets (% Total Assets)	0.3717	-1	0	1.4614	0.7691
KKZ	0.9209	-0.5656	1.0037	1.8340	0.6001
Inflation	3.9105	-2.091	3.1429	134.044	5.5506
Rule of Law	1.1044	-0.8694	1.3692	1.9902	0.7049
Financial Freedom	68.725	20	70	90	14.345
ROA Banking Sector	0.7083	-1.5228	0.4340	5.3715	0.8213

Table 3. Capital, liquidity and bank stability

This table shows the results for the relationship between capital, liquidity and bank stability. The dependent variable in column (1) is the bank Z-score. Columns (2) and (3) show the results using log(roa+(equity/assets)) and sdROA as dependent variables, respectively. All the variables are defined in Table A1 of the Appendix. In all the estimates, bank and year fixed effects are included (not reported). T-statistics for the clustered standard errors are in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: *Z-Score*	Dependent Variable: *log(roa+(equity/assets))*	Dependent Variable: *sdROA*
	(1)	(2)	(3)
Capital	2.4550***	1.3311**	-0.0058
	(3.68)	(2.66)	(-1.25)
Liquidity	1.8596***	0.9858**	0.0553
	(4.61)	(3.18)	(0.75)
*Capital * Liquidity*	-2.1143***	-0.8726**	-0.0524
	(-5.24)	(-2.84)	(-0.71)
Size	-0.0383***	-0.0827***	-0.0005**
	(-5.38)	(-21.72)	(-2.81)
Cost-to-Income	-0.9955***	-0.4320***	0.0060***
	(-8.44)	(-11.81)	(4.29)
ΔLoans	-0.0935	0.0311	0.0051**
	(-0.69)	(0.88)	(2.54)
Traditional Activity	-2.7669***	4.7609***	0.1062***
	(-4.39)	(10.84)	(5.72)
Inflation	-0.0251***	0.0022	0.0001
	(-5.90)	(1.16)	(1.58)
KKZ	0.4977***	-0.0845***	-0.0011*
	(7.75)	(-4.31)	(-1.85)
Time Fixed Effects	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes
Clustered Standard Errors	Bank-level	Bank-level	Bank-level
Observations	61,442	61,442	61,442
Number of banks	16,061	16,061	16,061
R2	0.2358	0.4021	0.0967
F-Test (p-value)	0.0000	0.0000	0.0000

Table 4. Capital, liquidity and bank stability: Market power as mechanism

This table shows the results for the relationship between capital, liquidity and bank stability using market power as a mechanism. The results in columns (1) and (2) show the estimates for the Lerner index as the dependent variable of the 1st stage regression of the 2SLS model. In column (2) we show the results for the 2nd stage estimates on the bank Z-Score. All the variables are defined in Table A1 of the Appendix. In all the estimates, bank- and country-level control variables, as well as bank and year fixed effects are included (not reported). T-statistics for the clustered standard errors are in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: *Lerner Index*	Dependent Variable: *Z-Score*
	(1)	(2)
ΔIntangible Assets (% Total Assets)	0.0217***	
	(10.53)	
$\widehat{Lerner}$		-4.1157***
		(-5.90)
Capital	0.0758**	2.6430***
	(2.93)	(3.94)
Liquidity	0.0685**	1.6429**
	(2.26)	(3.16)
*Capital * Liquidity*	-0.0589***	-1.8714***
	(-3.70)	(-3.50)
Control Variables	Yes	Yes
Time Fixed Effects	Yes	Yes
Bank Fixed Effects	Yes	Yes
Clustered Standard Errors	Bank-level	Bank-level
Observations	14,340	14,340
Number of banks	49,745	49,745
R2	0.2884	0.2824
F-Test (p-value)	0.0000	0.0000
Durbin-Wu-Hausman Test (p-value)	0.0000	-

Table 5. Capital, liquidity and bank stability: The role of bank level characteristics

This table shows the results for the role of bank-level characteristics in shaping the relationship between capital, liquidity and bank stability. The dependent variable in column (1) is the bank Z-score. All the variables are defined in Table A1 of the Appendix. In all the estimates, bank- and country-level control variables, as well as bank and year fixed effects are included (not reported). T-statistics for the clustered standard errors are in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: *Z-Score*			
	(1)	(2)	(3)	(4)
Capital	6.39***	3.0567***	3.0234***	2.4546***
	(4.55)	(4.38)	(5.30)	(3.70)
Liquidity	3.7698*	0.5762	1.6516***	1.8569***
	(1.69)	(1.13)	(3.84)	(4.63)
*Capital * Liquidity*	-3.7765	-0.6516	-2.1704***	-2.1119***
	(-1.74)	(-1.27)	(-4.68)	(-5.27)
Size	0.2383**			
	(2.29)			
Cost-to-Income		0.2265		
		(0.91)		
Traditional Activity			7.8200*	
			(1.85)	
ΔLoans				-0.2022
				(-0.49)
*Capital * Size*	-0.2713**			
	(-2.62)			
*Liquidity * Size*	-0.1301			
	(-0.83)			
*Capital * Liquidity * Size*	0.1095			
	(0.73)			
*Capital * Cost-to-Income*		-1.1663***		
		(-3.24)		
*Liquidity * Cost-to-Income*		1.8765**		
		(2.77)		
*Capital * Liquidity * Cost-to-Income*		-2.1207**		
		(-2.79)		
*Capital * Traditional Activity*			-12.903**	
			(-2.91)	
*Liquidity * Traditional Activity*			4.2181	
			(0.45)	
*Capital * Liquidity * Traditional Activity*			-0.3164	
			(-0.04)	
*Capital * ΔLoans*				0.1026
				(0.26)
*Liquidity * ΔLoans*				0.5395
				(0.89)
*Capital * Liquidity * ΔLoans*				-0.5241
				(-0.72)
Control Variables	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes
Clustered Standard Errors	Bank-level	Bank-level	Bank-level	Bank-level
Observations	61,442	61,442	61,442	61,442
Number of banks	16,061	16,061	16,061	16,061
R2	0.2368	0.2374	0.2401	0.2358
F-Test (p-value)	0.0000	0.0000	0.0000	0.0000

Table 6. Capital, liquidity and bank stability: The role of country-level characteristics

This table shows the results for the role of country-level characteristics in shaping the relationship between capital, liquidity and bank stability. The dependent variable in column (1) is the bank Z-score. All the variables are defined in Table A1 of the Appendix. In all the estimates, bank- and country-level control variables, as well as bank and year fixed effects are included (not reported). T-statistics for the clustered standard errors are in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: *Z-Score*			
	(1)	(2)	(3)	(4)
Capital	0.5879***	1.3483**	1.3929***	3.6294***
	(5.63)	(2.40)	(4.51)	(4.98)
Liquidity	0.7331**	0.9880	1.0799**	2.8877***
	(3.03)	(1.75)	(2.37)	(6.70)
*Capital * Liquidity*	-0.6266***	-1.0082*	-1.0012***	-3.5721***
	(-4.68)	(-1.88)	(-3.37)	(-8.14)
KKZ	-1.1290***			
	(-10.08)			
Rule of Law		-0.6675		
		(-1.56)		
Financial Freedom			-0.0171**	
			(-2.64)	
ROA Banking Sector				0.7504***
				(6.45)
*Capital * KKZ*	1.7605***			
	(13.84)			
*Liquidity * KKZ*	0.8137**			
	(2.27)			
*Capital * Liquidity * KKZ*	-1.3723***			
	(-3.66)			
*Capital * Rule of Law*		1.1439**		
		(2.81)		
*Liquidity * Rule of Law*		0.1248		
		(0.19)		
*Capital * Liquidity * Rule of Law*		-0.4756		
		(-0.72)		
*Capital * Financial Freedom*			0.0229***	
			(4.88)	
*Liquidity * Financial Freedom*			0.0049	
			(0.39)	
*Capital * Liquidity * Financial Freedom*			-0.0113	
			(-0.91)	
*Capital * ROA Banking Sector*				-0.9905***
				(-7.80)
*Liquidity * ROA Banking Sector*				-0.7809***
				(-6.18)
*Capital * Liquidity * ROA Banking Sector*				1.1891***
				(8.08)
Control Variables	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes
Clustered Standard Errors	Bank-level	Bank-level	Bank-level	Bank-level
Observations	61,442	61,442	61,359	49,271
Number of banks	16,061	16,061	16,060	16,025
R2	0.2485	0.2409	0.2102	0.2383
F-Test (p-value)	0.0000	0.0000	0.0000	0.0000

Acknowledgements

This paper should not be reported as representing the views of the Banco de España (BdE) or the European Central Bank (ECB). The views expressed are those of the authors and do not necessarily reflect those of the BdE or ECB. All errors remain entirely the authors. N. Suárez acknowledges financial support from the the Spanish Ministerio de Economía, Industria y Competitividad (Project PID2023-149010NB-I00), and the Professorship Excellence Program in accordance with the multi-year agreement signed by the Government of Madrid and the Universidad Autónoma de Madrid (Line #3).

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PDF ISBN 978-92-899-7493-6 ISSN 1725-2806 doi:10.2866/1036459 QB-01-25-242-EN-N