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REGULATING THE FLOW: LIQUIDITY RISK IN WAEMU BANKING – AN IN-DEPTH ANALYSIS

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Abstract
The banking sector's role in allocating resources to investment projects is pivotal in developing economies. Banks transform short-term deposits into long-term loans, a process laden with responsibility and risk. Liquidity risk, characterized by a bank's inability to meet short-term commitments, poses a significant threat to its financial stability and reputation. This study delves into the impact of banking regulations on liquidity risk, a topic of contentious debate in the literature.

1. Introduction

The banking sector plays an important role in developing economies. This is because the process of bank intermediation places a heavy responsibility on banks to allocate the resources raised to various investment projects in the economy. As part of this process, banks typically convert short-term deposits into loans with a much longer average maturity (Casu et al, 2019). This transformation of schedules is not without consequences for the bank, as it could eventually compromise its financial structure, and ultimately expose it to liquidity risk. According to Hakimi and Zaghdoudi (2017), liquidity risk refers to a situation in which a bank is unable to meet its short-term commitments. It then becomes insolvent and is unable to meet the withdrawal demands of its customers. Liquidity risk undermines the confidence of depositors and affects both the performance of banks and their reputation.

In light of this definition, the prospect of such a scenario has given rise to much discussion about the ability of banking regulation to address it. However, the effects of regulation on liquidity risk have been hotly debated in the literature. On the one hand, some authors such as Berger and Bowman (2009) argue that bank regulation has the potential to reduce liquidity risk. Indeed, these authors argue that a highly capitalized bank can cope with contingencies resulting from a shock, as capitalization acts as a cushion, which increases the absorptive capacity of banks in case of difficulties or large losses. In contrast to these authors, a section of the literature argues that bank regulation can also increase liquidity risk. According to these authors, if the bank decides to hold enough liquid assets in its portfolio, to reassure its depositors, while investors have a preference for less liquid assets, this could result in a decrease in liquidity creation and an increase in liquidity risk (Horváth et al 2014), known under the banner of the financial fragility hypothesis.

Very recently, the economic literature has emphasized the role that the financial market could play in this analytical framework. Indeed, the financial market is an important component of the financial system whose influence has been growing in recent years. The interest of the literature in the financial market is explained by

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the interactions that it has with the banking market. Indeed, following this literature, it appears substantially, that the considerable growth of the financial market in recent years, would be largely related to banking regulation (Chen et al, 2021).

In this regard, Levine (1991) states that constant regulatory pressures have caused banks to shift from traditional activities to market activities. Similarly, Buchak et al, (2018) argue that traditional banks have been subject to significant regulation since the last financial crisis. This regulation is causing costs to rise and limiting the range of products they can offer, hence the shift from traditional business to disintermediated finance activities.

While market activities are known to contribute significantly to the financing of the economy, they can also undermine the stability of the banking system. For example, Dell'Ariccia et al (2008) find that securitization increases risk because it reduces banks' incentive to monitor borrowers. For Uhde et al (2012), securitization and the complexity of derivatives lead to information losses that can lead to bad investments. Furthermore, banks may have incentives to speculate on certain financial assets to improve their returns. In an interconnected and interdependent world, the instability generated by such practices could lead to a crisis with disastrous consequences for the banking system but also for the real economy (FSB, 2015). Thus, in light of the above, it would appear that the effect of banking regulation on liquidity risk is weakened by the risk-taking induced by the development of the financial market. Thus, the ambivalence about the role of the financial market in the relationship between regulatory capital and liquidity risk is a legitimate concern that deserves attention.

Concerning WAEMU countries, it should be noted that the financial crisis that occurred in the 1980s gave rise to a vast reform program. To improve the resilience and contribution of banks to the development of the countries in the zone, the banking authorities implemented the prudential system as promoted by the Basel Committee. Thus, the union will see the entry into force of the Basel 1 agreements in 2000, followed by an increase in banks' share capital as of 2007. Initially set at 3 billion CFA francs, the capital stock will be raised to 10 billion CFA francs, but the entry into force will be gradual. More recently, in 2018, the union also adopted the Basel 2 and 3 agreements. However, despite all the reforms undertaken, an analysis of the facts raises somme questions. Indeed, over the period 1996 to 2018, there has been a strengthening of the regulatory arsenal. Contrary to the expected negative effect on liquidity risk, the strengthening of the regulatory arsenal has instead been accompanied by an increase in liquidity risk, with the ratio rising from 4.32% to 6.57% (WDI, 2020). At the same time, while the strengthening of the regulatory arsenal was followed by the development of the financial market, with an increase in market capitalization from 1% to 32% (GFDD, 2020), this increase in capitalization seems to have been conducive to an increase in liquidity risk, over the same time.

Thus, based on these facts, it appears that the role of the financial market in the relationship between regulatory capital and liquidity risk merits reflection. And it is here that we place the problem of our study. The central question that we attempt to answer in this study is the following: to what extent does the financial market activity in the relationship between regulation and bank liquidity risk?

Consequently, the general objective of the study is to examine the role of the financial market in the relationship between banking regulation and liquidity risk in the WAEMU zone. Specifically, it is to examine the nature of the relationship between regulatory capital and bank liquidity risk and to determine the role of market capitalization in the relationship between regulatory capital and bank liquidity risk. In connection with these specific objectives, we postulate the following assumptions. The first is that the relationship between regulatory capital and liquidity risk is non-linear. The second is that regulatory capital reduces liquidity risk for a given level of market capitalization.

Pour mener à bien cette étude, les données utilisées dans notre cadre empirique ont été obtenues de la BCEAO (2020) ; WDI (2020), and GFDD (2020) et couvrent la période 1996-2018. Au plan méthodologique, nous avons recouru à la méthode de panel à transition lisse (PSTR) développée par Gonzalez et al (2005). A l'issue des estimations, nos résultats montrent qu'il existe une relation non linéarité entre la règlementation bancaire et le risque de liquidité, en interaction avec le marché financier. En effet, nous montrons que l'efficacité de la règlementation bancaire est réduite au-delà d'un seuil de capitalisation boursière de 24,93%. Plus précisément, la règlementation bancaire réduit le risque de liquidité en dessous du seuil tandis que l'effet au-dessus du seuil est positif mais non significatif. To conduct this study, the data used in our empirical framework were obtained from

BCEAO (2020); WDI (2020), GFDD (2020) and cover the period 1996-2018. Methodologically, we used the smooth transition panel method (STP) developed by Gonzalez et al (2005).

Our results show that there is a non-linear relationship between banking regulation and liquidity risk, in interaction with the financial market. Indeed, we show that the effectiveness of bank regulation is reduced above a market capitalization threshold of 24.93%. More precisely, bank regulation reduces liquidity risk below the threshold while the effect above the threshold is positive but not significant.

Our study is not lacking in interest and stakes. Indeed, while many studies have addressed the troubled role that the financial market can play in preserving banking stability, to our knowledge, no study has conducted empirical verification, in African countries. This study, therefore, aims to draw the attention of banking authorities to the need to take into account disintermediated finance activities in the implementation of regulatory provisions to ensure the sustainability of the regional banking system.

In the following, we structure this paper as follows. The second section discusses the literature review. Section 3 presents the methodological framework adopted. Section 4 is devoted to the details of the data, the definition of the variables, and the descriptive statistics. In Section 5, we present the main results of this study. The conclusion is presented in Section 6.

2. Banking regulation, bank liquidity risk, and financial markets: theoretical and empirical contributions

This section is organized around two main points: the theoretical review and the empirical review. The theoretical review focuses on the theoretical foundations linking banking regulation, liquidity risk, and the financial market, while the empirical review provides an overview of the various empirical works.

2.1. Review of the theoretical literature

The link between banking regulation and liquidity risk is a very controversial topic in the literature. The various contributions from this literature are essentially based on two main opposing points of view. Indeed, while some authors claim that bank regulation reduces liquidity risk, other authors take a contrary view. However, these two views are respectively summarized under the risk absorption hypothesis and the financial fragility hypothesis. In this section, two main points will be discussed. The first point relates to the arguments underlying each of the postures in this literature, while the second point highlights the role of the financial market in these dynamics.\

Concerning the link between banking regulation and liquidity risk, many authors postulate the existence of a negative relationship. Theoretically, the main arguments developed in this approach are largely based on the risk absorption hypothesis (Varotto, 2011). According to this hypothesis, banks create bank liquidity by transforming illiquid assets into liquid assets. Since this process generates risk, the bank may quickly find itself unable to meet withdrawal demands from customers. Thus, to mitigate such a situation and ensure the continuity of banking activity, banks are required to hold sufficient capital (Berger and Bowman, 2009). Indeed, in an environment marked by the permanent presence of risks, meeting capital requirements has several advantages. First, bank capitalization can increase the ability of banks to create liquidity, thereby removing the specter of a crisis associated with low liquidity asset holdings in their portfolios (Bhattacharya and Thakor, 1993; Allen and Gale, 2004). Second, by enabling banks to cope with shocks or situations of an unforeseen nature, bank capitalization contributes greatly to the strengthening of banking stability (Repullo, 2004). Thus, bank capital plays, in this case, the role of a cushion allowing banks to improve their resilience to instability.

In contrast to the above-mentioned work, one strand of the literature emphasizes that bank regulation can exacerbate liquidity risk. The argument developed in the framework of this approach is based on the work of Diamond and Rajan (2001). According to these authors, this positive relationship could be explained by the fragility of the bank's financial structure. Thus, according to this hypothesis, banks as financial intermediaries allocate the resources collected to investments by granting loans. Following the loans, they are obliged to monitor until the interest is fully repaid. However, when banks are poorly capitalized, they make more effort in monitoring to avoid the risk of deposit run-off. To reassure their depositors, banks are forced to adopt a fragile financial structure, i.e., composed largely of liquid assets (Horvàth et al 2014). Yet, under these conditions, equity providers are less likely to invest their money in less risky assets, thus reducing liquidity creation. Similarly, Gorton and Winton (2001) argue that bank capital increases liquidity risk. For these authors, the high sensitivity of bank capital to information is a potential risk factor for investors, as it may force them to sell capital at a price below its value, thereby exacerbating liquidity risk within the bank.

The dynamics of the relationship between bank capital and liquidity risk can also be influenced by the financial market. Indeed, in light of the recent financial crisis, it has become apparent that the numerous regulatory requirements that followed have led banks to become increasingly involved in market activities. Yet, there is formal evidence that these activities can amplify risk and reduce overall welfare (Plantin, 2015; Irani et al, 2021). The concern about these activities, in general, is about the instruments used, and in particular securitization and derivatives. In this respect, Dell'Ariccia et al (2008) indicate that derivatives promote risk. According to them, since derivatives allow banks to transfer their risk exposure to third parties, they no longer have the incentive to screen and monitor borrowers. Moreover, the resulting loss of information could severely aggravate the problems of information asymmetry while reducing market efficiency (Uhde et al, 2012).

Kirilenko and Lo (2013), they believe that high-frequency trading feeds speculation on certain assets with the consequence of increasing volatility. In addition to volatility, Gemayed and Preda (2018) argue that it can also promote procyclicality and be the cause of a financial crisis. Moreover, in the face of stressful episodes, the observed mimicry effects can promote contagion and create a crisis of systemic nature. In this context, marketrelated activities could potentially weaken the banking system by attenuating the capacity of banking regulation to deal with risks.

2.2. Review of the empirical literature

In their seminal contribution, Berger and Bowman (2009) analyze the effects of bank regulation on liquidity creation. They use a sample of U.S. commercial banks over the period 1993 to 2003. The results of this study reveal that regulatory capital reduces liquidity risk at large banks while it tends to exacerbate it at small banks. At the level of medium-sized banks, however, this relationship is not significant, indicating a suppression of both effects for banks belonging to this class. Fungáčová et al (2010) focus on the case of Russia, following the adoption of the deposit insurance system. Applying an experimental method, to bank data, between 1999 and 2007, they find that bank regulation increases liquidity risk before and after the adoption of the deposit insurance system. Moreover, they find that this relationship varies with size and ownership structure. Indeed, the increase in liquidity risk is significant for small banks, medium-sized banks, and domestic private banks, while it is not significant for large banks, foreign banks, and state-owned banks.

Berger et al (2014) study how regulatory interventions and capital injections jointly influence risk-taking and liquidity creation in Germany. Using the instrumental variables method, they find that regulatory interventions increase liquidity risk while capital support appears to be insignificant. For the Czech Republic, Horvàth et al (2014) examined the relationship between bank capital and liquidity creation. This study differs from the previous ones by taking into account a possible causality between these two variables. The use of the granger causality test allows us to find the existence of a negative bidirectional causal relationship between bank capital and liquidity creation. These results show that capital requirements reduce liquidity creation (increase liquidity risk). On the other hand, bank liquidity creation can also reduce bank capital and expose the bank to insolvency risk. With a simultaneous equation model, Distinguin et al (2013) indicate in the European case that banks reduce their regulatory capital when they create a lot of liquidity.

On the Asia-Pacific side, Fu et al.(2016) examines a set of commercial banks from 14 countries. They observe that bank capital improves the liquidity of large banks as well as banks located in developing countries in Asia. Furthermore, the causality study finds that the trade-off between the financial stability benefits of higher capital requirements and those of greater liquidity creation applies to all banks in the sample, regardless of their size and economic region. Examining 35 Asian countries, Hsieh et al (2022) show that bank capital increases liquidity but does not lead to increased bank lending. Thus, the higher the political risk, the lower the liquidity, given the uncertainty it generates. However, it appears that only well-capitalized banks can increase their liquidity in such an environment. Over the period 2003 to 2014, Umar et al (2018) show that the increase in bank capital increases liquidity risk in the BRICS, thus confirming the financial fragility hypothesis. For their part, the work of Lei and Song (2013) focuses on a panel of Chinese banks. The study concludes that bank capital increases liquidity risk. In contrast, this relationship seems weaker for foreign banks. Building on this work, Chen et al (2021) consider the role of shadow banking activities in the relationship between bank capital and liquidity creation. First, they note that banks with less capital create a lot of liquidity, which confirms the risk-taking hypothesis. In contrast, regulatory capital improves bank liquidity when shadow banking is taken into account.

Some authors have focused on how prudential regulation interacts with the securitization process. In this vein, Keys et al (2009) examined the effect of different regulations on the moral hazard problem associated with securitization. The results reveal that loan quality is inversely related to the amount of regulation. Thus, the more regulated the lenders behind the securitization, the worse the loan quality. Fève et al. (2019) implement a smallscale DSGE model for the US economy in which traditional banks interact with shadow banking. They find that shadow banking activities amplify the transmission of shocks and mostly help banks escape regulatory constraints. Furthermore, they observe that the rush of banks into shadow banking activities reduces the ability of macroprudential policies targeting traditional credit to reduce economic volatility. Using syndicated credit data, Irani et al. (2021) find that capital requirements in the banking sector have favored the emergence of shadow banking. In particular, they note that weakly capitalized banks are reducing their exposure through asset sales while shadow banking is taking over the credit market. According to the authors, this situation led to a relative decline in credit and the volatility that occurred during the 2008 financial crisis. Also in South Korea, Lee et al (2022) find that regulatory capital requirements led to a decline in credit among regulated banks and an increase of about three quarters in lending by shadow banking lenders.

Finally, Harutyunyan et al (2015) find that shadow banking increases procyclicality and volatility more than traditional bank activities. The study of 26 jurisdictions thus confirms the perverse effects of disintermediated finance activities on the stability of the banking system.

3. The Methodological Framework of the Study

This section includes two points, through which, respectively, the specification of the PSTR model and the estimation procedure will be presented.

3.1. Specification du modèle

The choice of the estimation method is an important factor that must take into account the nature of the data as well as the objectives to be achieved. In this study, since we are interested like the relationship (linear vs. nonlinear) between regulatory capital and liquidity risk, we opt for the smooth transition panel method (PSTR) developed by Gonzalez et al. The PSTR model is a fixed effect model with an exogenous regressor. Moreover, it is a non-linear homogeneous panel model whose theoretical specification is as follows:

$$y_{it} = \mu_i + \beta_0' x_{it} + \beta_1' x_{it}\, g(q_{it}, \gamma, c) + \varepsilon_{it} \qquad (1)$$

In this equation, $i = 1, \ldots, N$; and $t = 1, \ldots\ldots, T$ with N and T representing the individual and time dimensions, respectively. y_{it} is the dependent variable, μ_i is the individual vector of fixed effects, and et $g(q_{it}, y, c)$ is the transition function that depends on the transition variable q_{it}, the threshold parameter c as well as the smoothing parameter y. $x_{it} = (x_{it}^1, \ldots\ldots\ldots, x_{it}^k)$ is the vector kk of explanatory variables and ε_{it} is the error term. β_1 and β_2 denote the vector of linear and nonlinear model parameters. The transition function $g(q_{it}, y, c)$ allows the system to gradually transition from one regime to the other. To better define this transition function Gonzalez et al (2005); Granger and Teräsvirta (1993); Teräsvirta (1994); Jansen and Teräsvirta (1996) propose an m-order logistic function as follows:

$$g(q_{it}, \gamma, c) = \left[1 + \exp\left(-\gamma \prod_{j=1}^{m} (q_{it} - c_j)\right)\right]^{-1} \qquad (2)$$

where $y > 0$; $c_1 < \cdots < c_m$ and $c = (c_1 \ldots\ldots c_m)$ is the vector of the parameter in level. γ represents the assumed positive smoothing parameter. Ibarra and Trupkin (2011) state that if γ is large, then the PSTR model can be considered a 2-regime model. Under these conditions the transition function can be written as follows:

$$y_{it} = \mu_i + \beta_0' x_{it} + \sum_{j=1}^{m} \beta_j' x_{it}\, g(q_{itj}, \gamma, c_j) + \varepsilon_{it} \qquad (3)$$

3.2. Estimation procedure

 Linearity test

Since the study seeks to establish a non-linear relationship between bank capital and liquidity risk, we must first perform the linearity test. This test consists in checking whether the link between bank capital and liquidity risk can be estimated by a standard panel model (linear panel model) or by a PSTR model. The null hypothesis of the test is $H_0: \beta_1 = 0$ versus the alternative hypothesis $H_1: \beta_1 \neq 0$. However, due to the presence of unidentified nuisance parameters in the PSTR model, under the null hypothesis, the associated test is nonstandard (Gonzalez et al, 2005). To circumvent this identification problem, the transition function $g(q_{it}, y, c)$ is replaced by the firstorder Taylor expansion around $\gamma = 0$. Thus, the new transition function can be written as follows:

y it   *i* 0'* *X it* 1'* *X it q it* .... *m*'* *X it q itm* *it** (4)

where the parameter vectors $\beta_0'^*, \ldots\ldots\ldots, \beta_m'^*$ are multiples of γ and $\varepsilon_{it}^* = \varepsilon_{it} + R_m \beta^* X_{it}$ where R_m is the residual of the Taylor expansion. The null hypothesis can be tested using Fischer's LM test, Wald's test as well as the LR test likelihood ratio test. The statistics associated with these three tests are as follows:

LM Fischer test : *LM F* (*SSR*$_0$ *SSR*$_1$) / *K* / *SSR*$_0$ / (*NT* *N* *K*) (5)

LM Wald Test : *LM*$_W$ *NT* (*SSR*$_0$ *SSR*$_1$) / *SSR*$_0$ (6)

LR Test : *LR*   2 log(*SSR*$_1$) log(*SSR*$_0$) (7)

where SSR_0 is the sum of the squares of the panel residuals under H_0 (linear panel model with individual effects) and SSR_1 the sum of the squares of the panel residuals under H1 (PSTR model with two regimes). Note also that the Fischer LM_F statistic follows a Fischer distribution with *K* and *NT-N-K* degrees of freedom, where K, N, and T represent the number of explanatory variables, number of countries, and number of years, respectively.

The Wald statistic and the LR test follow a Chi2 distribution with K degrees of freedom $\chi^2(k)$. If at the end of the test, the null hypothesis is rejected, this would imply that the model can be estimated using the PSTR. In this case, the next step would be to determine the number of regimes in the model.

 Test of the number of regimes

The second step of the procedure aims at testing the number of regimes of the PSTR model. In practical terms, this test consists in identifying whether the PSTR model with two regimes is appropriate to capture the nonlinearity between bank capital, and liquidity risk. The null hypothesis of the PSTR model with two regimes is tested against the alternative hypothesis of the PSTR model with at least three regimes. The test decisions are also based on Wald, Fischer and LR test statistics. If the null hypothesis is accepted at the end of the test then the PSTR model with two regimes will be estimated. Otherwise, the PSTR model with three regimes will be estimated. After selecting the number of regimes, the last step is to estimate the model with the nonlinear least squares method.

4. Specification of the study model

The purpose of this section is to define the specification of the model used and the source of the data.

4.1. Model specification and variable description

As mentioned above, we use the smooth transition panel method (STP) to examine the relationship between bank capital and liquidity risk. To do so, we adopt the following specification:

RLIQ it   *i* 1*CAR it* 2 *CAPit* 3*CRED it* 4 *CR* 3 *it* 5*TCPIB it* 6 *INFit* (1' *CAR it* (8)

2 *CAPit* 3 *CRED it* 4 *CR* 3 *it* 5*TCPIB it* 6 *INFit*) * *g* (*CAPit* ,, *c*) *it*

In equation 8, the endogenous variable is liquidity risk. Liquidity risk typically arises when the bank is unable to meet its short-term liabilities. This leads to considerable losses that can negatively affect the bank's performance and above all, impact the real economy severely (Hakimi and Zaghdoudi, 2017). In the literature, the liquidity ratio is measured as the share of liquid assets held by the bank to total assets. Thus, an increase in liquid assets leads to a decrease in liquidity risk while a decrease in liquid assets reflects an increase in liquidity risk. Since the liquidity ratio and liquidity risk move in opposite directions, we decide to capture liquidity risk by the inverse of the liquidity ratio, which we multiply by 100 to facilitate our interpretations.

Bank capitalization (CAR) is the variable of interest in this study. It is calculated as the ratio of bank capital to total assets. According to the Bale agreements, a ratio higher than 8% indicates that the bank is sufficiently capitalized, while a ratio lower than this threshold suggests that the bank is not solvent. Looking at the literature, studies on the link between regulatory capital and liquidity risk lead to contradictory results. Some argue for a decrease in liquidity risk while others postulate the opposite effect (Berger and Bowman, 2009; Berger et al, 2014; Fu et al, 2016). The expected effect can therefore be positive or negative. The second variable of interest in the study is the financial market. It can be captured using different proxies such as market capitalization, turnover, and the number of shares traded (Jun et al, 2003). However, since the most widely used measure in the literature is bank capitalization, it will be used in this study as a proxy for capturing capital market growth (CAP). Similarly, regarding the objectives initially set, market capitalization will be used as a transition variable to test the non-linearity of the relationship between regulatory capital and liquidity risk. The first control variable is the credit ratio (CRED). The credit ratio represents the share of credit granted by banks to the private sector as a percentage of GDP. The choice of this variable in the model is motivated by the fact that the main activity of banks in the zone is granting credit. Moreover, credit is the primary cause of risk in the banking industry (Pantalone and Platt 1987). Thus, a bank that extends a lot of credit may lack the cash resources to meet the withdrawal demands of its customers.

Banking concentration (CR3) measures the market share of the 3 largest banks in the country. The higher the market share, the more concentrated the banking sector is, while the lower the market share, the more competitive the banking sector becomes. The literature is divided on the effect of concentration on liquidity risk. Some authors argue that since concentration gives banks market power, they can use it to establish and develop long-term relationships with their customers. On this basis, banks would be less exposed to risk given the privileged relationship they have with their customers (Petersen and Rajan, 1995). On the other hand, when the banking market becomes competitive, it erodes the value of the banks' franchise (rents), pushing them to take more risk to compensate for the decline in revenues (Brei et al 2020). Based on this work, the expected effect can be both positive and negative. To capture the effect of macroeconomic conditions on bank liquidity management, we add the GDP growth rate (TCPIB) and inflation (INF) to the model. In general, expansionary periods are conducive to the development of banking activities, because banks experience fewer defaults from their counterparties. In contrast, during a recession, the general price level rises and affects the ability of agents to repay their loans (Kanga et al, 2021). Consequently, the expected effects of GDP growth and inflation are positive and negative, respectively.

4.2. Data sources

For this study, the data used covers 7 countries, all members of the WAEMU, except Guinea-Bissau, due to a lack of sufficient data for the study period, which runs from 1996 to 2018. The data comes from multiple sources, including the World Bank (WDI, 2020); Global Financial Development Data (GFDD, 2020); and the Central Bank of West African States (BCEAO, 2020).

5. Results and discussions of the study

This section is structured around two main points. The first point is related to the analysis of the data, and the preliminary tests. The second point is dedicated to the analysis of the results obtained from the PSTR model

5.1. Data analysis and preliminary tests

In this section, we proceed to the analysis of the data as well as the various preliminary tests. These include descriptive statistics, the correlation matrix, the linearity test, and the determination of the regime number. The results of the descriptive statistics are shown in Table 1 below:

Table 1: Descriptive statistics of variables

Variables	Observations	Mean	Standard Deviation	Minimum	Maximum
RLIQ	161	4.387	1.550	1.422	9.186
CAR	161	9.562	2.141	5.637	17.351
CAP	161	21.171	11.218	0.511	37.826
CRED	161	15.588	7.118	2.659	40.055

CR3	161	74.785	16.140	39.655	100
TCPIB	161	4.562	3.108	-4.666	15.376
INF	161	2.241	2.557	-3.099	11.305

Source: Authors based on WDI (2020), GFDD (2020), BCEAO (2020)

The analysis in Table 1 shows that the average liquidity risk in the union is 4.387%. Over the study period, it varies between 1.422% and 9.186%. The low standard deviation of 1.550 indicates that banks have almost the same risk-taking behavior regardless of the country. Bank capital averages 9.562%, which suggests a good level of capitalization in line with the Bale agreements. Market capitalization represents on average 21.17% of GDP with a dispersion of about 11.21. The credit granted by banks, is, on average 15.58% between 1996 and 2018. Its minimum and maximum values are 2.65% and 40.05% respectively. In the subregion, the three major banks hold an average of 74.78% of banking assets, indicating that the banking sector is highly concentrated in the union. Over the study period, the countries benefited from a rather favorable macroeconomic context, as the average growth rate of the gross domestic product stood at 4.56%. Inflation averaged 2.24. The low dispersion of 2.55 shows that, overall, the general price level in the union has varied very little. Following the descriptive statistics, we perform the correlation matrix analysis of the variables to guard against the risk of multicollinearity. The results of the matrix are reported in Table 2 below.

Table 2: Correlation matrix

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
[1] RLIQ	1						
[2] CAR	-0.410*	1					
[3] CAP	0.419*	-0.158*	1				
[4] CRED	0.576*	-0.420*	0.587*	1			
[5] CR3	-0.395*	0.171*	-0.311*	-0.262*	1		
[6] TCPIB	0.241*	-0.183*	0.135	0.103	-0.109	1	
[7] INF	-0.191*	0.095	-0.156*	-0.199	0.190*	0.069	1

Source: Authors based on WDI (2020), GFDD (2020), BCEAO (2020)

Note: * represents significance at the 5% level

From the results provided in Table 2, we see that all the correlation coefficients are on the whole lower than 0.8. Thus, there is no problem of multicollinearity between our variables. Bank capital is negatively correlated with liquidity risk with a coefficient of 0.410. On the other hand, we observe a moderate correlation between market capitalization and liquidity risk on the one hand, and between credit and liquidity risk on the other. Their respective coefficients are 0.419 and 0.576. As for the growth rate, it is weakly related to liquidity risk. The associated correlation coefficient is 0.241. The same is true for inflation, which has a correlation coefficient of 0.191. After the analysis of the data, we can now turn to the second point concerning the results of the preliminary tests. These are mainly the linearity test and the regime number test.

The linearity test consists of testing whether the relationship between bank capital and liquidity risk can be captured by a linear panel model or by a non-linear panel model. The results of the linearity test are summarized in the following table:

Table 3: Linearity test

Test	Statistics	P-value
Wald (LM_W) test	10.777	0.096
Fischer (LM_F) test	1.770	0.109
LRT test	11.155	0.084

Source: Authors based on WDI (2020), GFDD (2020), BCEAO (2020)

The null hypothesis that the linear panel model is appropriate for analyzing the relationship between bank capital and liquidity risk is rejected at the 10% threshold by two out of three tests. It follows that the financial market has a non-linear effect on the relationship between bank capital and liquidity risk and that this non-linear effect can be captured by a PSTR model with at least two regimes. The second test is related to the determination of the number of regimes of the PSTR model. This test consists of testing whether the relationship between bank capital and liquidity risk can be estimated by a PSTR model with two regimes (one threshold), or a PSTR model with at least three regimes (two thresholds). The results of the test are presented in the following table:

Table 4: Number of regimes test

Test	Statistics	P-value
Wald test	3.230	0.780
Fischer test	0.464	0.834
LRT test	3.263	0.775

Source: Authors based on WDI (2020), GFDD (2020), BCEAO (2020)

Through Table 4, we see that all our probabilities are not significant. Therefore, the null hypothesis cannot be rejected. In other words, the PSTR model with two regimes, i.e., with a threshold is adequate to analyze the non-linear relationship between bank capital and liquidity risk. Following the analysis of the various preliminary tests, we can now proceed to the interpretation of the results of the PSTR model.

5.2. Result of the PSTR model

For the analysis of the non-linearity between bank capital and liquidity risk, the various tests carried out led us to estimate a PSTR model. The purpose of this section is to comment on the results and to draw the main lessons from them. The results of the estimation are listed in table 5 above:

Table 5: Result of the PSTR model estimation

Variables	Explained variable: RLIQ	
	Regime 1 : CAP ≤ 24.93%	Regime 2 : CAP > 24.93%
CAR	-0.155** (-2.444)	0.016 (0.256)
CAP	-0.023 (-1.052)	0.065*** (2.610)
CRED	0.243*** (6.917)	-0.039 (-1.293)
CR3	0.019*** (2.519)	-0.023*** (-2.711)
TCPIB	0.029 (1.241)	-0.004 (-0.103)
INF	0.008 (0.663)	0.005 (0.334)

Source: Authors based on WDI (2020), GFDD (2020), BCEAO (2020)

*Note: ** significant at 5% level, *** significant at 1% level*

The analysis of Table 5 allows us to appreciate the effect of the different variables on liquidity risk.

Indeed, bank capital negatively influences liquidity risk for a level of market capitalization below the threshold of 24.93%. On the other hand, above the threshold, its influence becomes positive but not significant. Similarly, market capitalization negatively influences the liquidity risk below the threshold without this influence is significant. However, above the threshold, the influence becomes significant and positive. As for bank credit, its influence remains significant and positive only in the first regime. Bank concentration has a positive influence in the first regime and a negative influence in the second regime. The growth rate and inflation remain insignificant, regardless of the regime considered.

The negative influence of bank capital on liquidity risk reflects the fact that bank capital reduces liquidity risk for a market capitalization level below 24.93%. Indeed, this result suggests that the effect of bank capital on liquidity risk is dependent on the evolution of the financial market. To this effect, for a low level of financial market development (CAP ≤ 24.93%), bank capital reduces liquidity risk. However, when the financial market develops (CAP > 24.93%), it weakens the effectiveness of bank capital and leads to an increase in liquidity risk. Indeed, this result could be explained by the fact that in the absence of a developed financial market, the banks that provide the bulk of banking intermediation are subject to increased supervision. Thus, the pressure of the regulator to respect capital requirements encourages banks to be cautious and leads to a decrease in liquidity risk. On the other hand, when the financial market develops, it offers banks new investment and placement possibilities, outside the regulatory provisions. However, in the absence of control and supervision, a moral hazard problem arises, which favors risk-taking, hence the increase in liquidity risk in the second regime although not significant. This result is consistent with that obtained by Fève et al (2019) whose study focused on the US economy. Indeed, they showed in their work that shadow banking activities amplified the transmission of shocks, and more importantly, reduced the effectiveness of macroprudential policies. However, in the case of China, Chen et al (2021) reach contradictory results. Analyzing the role of shadow banking in the relationship between bank capital and liquidity risk, they observe that, on the one hand, in the absence of shadow banking activities, banks with low capital ratios were more involved in liquidity creation. On the other hand, when shadow banking activities are taken into account, they find that banks with sufficient equity created much more liquidity.

Similarly, when we consider the direct effect of market capitalization, we find that it reduces liquidity risk in the first regime, while it increases liquidity risk in the second regime. The positive effect of market capitalization above the threshold confirms the hypothesis that capital market development increases exposure to liquidity risk. This result is in line with the work of Dell'Ariccia et al (2008) and González et al (2016). These authors respectively showed that market activities in particularty securitization and derivatives increase risk and in turn financial instability.

For the control variables, bank lending increases liquidity risk only in the first regime. This effect is because credit granting is the main activity of banks. As such, it represents the primary risk factor for banks. Indeed, given that the resources used to finance come, to a large extent, from depositors, rapid credit growth can unbalance the structure of the balance sheet and weaken the banks. Eichengreen and Arteta (2002) have shown in this context that rapid growth in bank credit can increase the probability of a crisis.

Finally, bank concentration increases liquidity risk in the first regime and decreases it in the second regime. Indeed, bank concentration gives banks market power. With market power, banks can charge sufficiently for loans and pay low interest on deposits to build up large margins (Brei et al, 2020). However, the low remuneration of deposits may discourage deposits and encourage depositors to seek better investment alternatives. Under such a perspective, banks would not have enough liquid assets to meet immediate needs, which will result in increased liquidity risk. In contrast, in the second regime, the decrease in liquidity risk could result from gains in market power. Indeed, market power can reduce liquidity risk if it promotes the diversification of services. The major advantage of diversification is that it generates new sources of revenue that contribute to the stability of banks. In addition, risk reduction can result from the development of a long-term relationship with customers to protect against potential risks (Petersen and Rajan, 1995).

6. Conclusion

The objective of this study was to analyze the role of the financial market in the relationship between bank capital and liquidity risk in the WAEMU zone. To do so, we used a panel of 7 countries, all members of the region, over the period 1996 to 2018. Guinea-Bissau was excluded due to the lack of sufficient data over the period indicated above. Methodologically, the estimation strategy consisted in applying the smooth transition panel method (PSTR) developed by Gonzalez et al (2005). We show that there is a non-linearity between bank regulation and liquidity risk about the financial market characterized by a smooth transition between the two regimes. Indeed, bank capital negatively influences liquidity risk for a level of market capitalization below the 24.93% threshold. On the other hand, above this threshold, market capitalization weakens the effectiveness of bank capital and leads to risk-taking, although not significantly. In light of these results, it is clear that the development of regulatory and prudential provisions cannot be done without taking into account these possible effects on the financial market at the risk of accentuating the fragility of the entire financial system. Thus, frank cooperation between the banking and financial market regulators could mitigate moral hazard problems and strengthen the stability of the banking system.

References

Allen, F., & Gale, D. (2004). Financial intermediaries and markets. *Econometrica*, *72*(4), 1023-1061.

BCEAO (2020). BCEAO (2020). Data from the website of the Central Bank of West African States.

Berger, A. N., & Bouwman, C. H. (2009). Bank liquidity creation. *The review of Financial Studies*, *22*(9), 3779-3837.

Berger, A. N., Bouwman, C. H., Kick, T., & Schaeck, K. (2014). Bank liquidity creation following regulatory interventions and capital support. *Journal of Financial Intermediation*, *26*, 115-141.

Bhattacharya, S., & Thakor, A. V. (1993). Contemporary banking theory. *Journal of Financial Intermediation*, *3*(1), 250.

Brei, M., Jacolin, L., & Noah, A. (2020). Credit risk and bank competition in Sub-Saharan Africa. *Emerging Markets Review*, *44*, 100716.

Buchak, G., Matvos, G., Piskorski, T., & Seru, A. (2018). Fintech, regulatory arbitrage, and the rise of shadow banks. *Journal of Financial Economics*, *130*(3), 453-483.

Casu, B., Di Pietro, F., & Trujillo-Ponce, A. (2019). Liquidity creation and bank capital. *Journal of Financial Services Research*, *56*(3), 307-340.

Chen, T. H., Shen, C. H., Wu, M. W., & Huang, K. J. (2021). Effect of shadow banking on the relation between capital and liquidity creation. *International Review of Economics & Finance*, *76*, 166-184.

Dell'Ariccia, G., Igan, D., & Laeven, L. (2008). Credit booms and lending standards : Evidence from the subprime mortgage market. *Available at SSRN 1141005*.

Diamond, D. W., & Rajan, R. G. (2001). Liquidity risk, liquidity creation, and financial fragility : A theory of banking. *Journal of Political Economy*, *109*(2), 287-327.

Distinguin, I., Roulet, C., & Tarazi, A. (2013). Capital réglementaire et liquidité des banques : preuves des banques américaines et européennes cotées en bourse. *Journal of Banking & Finance*, *37* (9), 3295-3317.

Eichengreen, B., & Arteta, C. (2002). Banking Crises in Emerging Markets : Presumptions and Evidence, in M.Bleijer and M. Skreb (eds) *Financial Policies in Emerging Markets*, Cambridge, MA : MIT Press.

Fève, P., Moura, A., & Pierrard, O. (2019). Shadow banking and financial regulation: A small-scale DSGE perspective. *Journal of Economic Dynamics and Control*, *101* (C), 130-144.

FSB (2015). *Global Shadow Banking Monitoring Report*

Fu, X., Lin, Y., & Molyneux, P. (2016). Bank capital and liquidity creation in Asia Pacific. *Economic Inquiry*, *54*(2), 966-993.

Fungáčová, Z., Weill, L., & Zhou, M. (2010). Bank capital, liquidity creation and deposit insurance. *Journal of Financial Services Research*, *51*(1), 97-123.

Gemayel, R., & Preda, A. (2018). Does a scopic regime produce conformism? Herding behavior among trade leaders on social trading platforms. *The European Journal of Finance*, *24*(14), 1144-1175.

GFDD (2020). *Global Financial Development Data*

Gonzalez, A., Teräsvirta, T., & van Dijk, D. (2005). Panel Smooth Transition Regression Models.” SSE/EFI Working Paper Series in Economics and Finance 604

González, L. O., Gil, L. I. R., Cunill, O. M., & Lindahl, J. M. M. (2016). The effect of financial innovation on European banks' risk. *Journal of Business Research*, *69*(11), 4781-4786

Gorton, G., & Winton, A. (2017). Liquidity provision, bank capital, and the macroeconomy. *Journal of Money, Credit and Banking*, *49*(1), 5-37.

Granger, C., & Teräsvirta, T. (1993). *Modelling non linear economic relationship*. Oxford University Press.

Hakimi, A., & Zaghdoudi, K. (2017). Liquidity risk and bank performance : An empirical test for Tunisian banks. *Business and Economic Research*, *7*(1), 46-57.

Hansen, B. E. (1999). Threshold effects in non-dynamic panels : Estimation, testing, and inference. *Journal of Econometrics*, *93*(2), 345-368.

Harutyunyan, A., Massara, M. A., Ugazio, G., Amidzic, G., & Walton, R. (2015). *Shedding light on shadow banking*. International Monetary Fund.

Horváth, R., Seidler, J., & Weill, L. (2014). Bank capital and liquidity creation: Granger-causality evidence. *Journal of Financial Services Research*, *45*(3), 341-361.

Hsieh, M. F., Lee, C. C., & Lin, Y. C. (2022). New evidence on liquidity creation and bank capital : The roles of liquidity and political risk. *Economic Analysis and Policy*, *73*, 778-794.

Ibarra, R., & Trupkin, D. (2011). The relationship between inflation and growth : a panel smooth transition regression approach. *Research Network and Research Centers Program of Banco Central (Working Paper).*

Irani, R. M., Iyer, R., Meisenzahl, R. R., & Peydro, J. L. (2021). The rise of shadow banking : Evidence from capital regulation. *The Review of Financial Studies*, *34*(5), 2181-2235.

Jansen, E., & Teräsvirta, T. (1996). Testing parameter constancy and super exogeneity in econometric equations. *Oxford Bulletin of Economics and Statistics*, *58*, 735-763.

Jun, S. G., Marathe, A., & Shawky, H. A. (2003). Liquidity and stock returns in emerging equity markets. *Emerging Markets Review*, *4*(1), 1-24.

Kanga, D., Murinde, V., & Soumaré, I. (2021). How has the rise of Pan-African banks impacted bank stability in WAEMU ? *Journal of International Financial Markets, Institutions and Money*, *73*, 101364.

Keys, B. J., Mukherjee, T., Seru, A., & Vig, V. (2009). Financial regulation and securitization: Evidence from subprime loans. *Journal of Monetary Economics*, *56*(5), 700-720.

Kirilenko, A. A., & Lo, A. W. (2013). Moore's law versus murphy's law: Algorithmic trading and its discontents. *Journal of Economic Perspectives*, *27*(2), 51-72.

Lee, H., Lee, S., & Paluszynski, R. (2022). Capital regulation and shadow finance : a quantitative analysis. https://uh.edu/~rpaluszy/banking.pdf

Lei, A. C., & Song, Z. (2013). Liquidity creation and bank capital structure in China. *Global Finance Journal*, *24*(3), 188-202.

Levine, R. (1991). Stock markets, growth, and tax policy. *The Journal of Finance*, *46*(4), 1445- 1465.

Pantalone, C. C., & Platt, M. B. (1987). Predicting commercial bank failure since deregulation. *New England Economic Review*, issue Jul, 37-47.

Petersen, M. A., & Rajan, R. G. (1995). The effect of credit market competition on lending relationships. *The Quarterly Journal of Economics*, *110*(2), 407-443.

Plantin, G. (2015). Shadow banking and bank capital regulation. *The Review of Financial Studies*, *28*(1), 146-175.

Repullo, R. (2004). Capital Requirements, Market Power and Risk-Taking in Banking. *Journal of Financial Intermediation* 13 (2), 156–182.

Teräsvirta, T. (1994). Specification estimation and evaluation of smooth transition autoregressive models. *Journal of American Statistical Association, 89*(425), 208-218.

Uhde, A., Farruggio, C., & Michalak, T. C. (2012). Wealth effects of credit risk securitization in European banking. *Journal of Business Finance & Accounting*, *39*(1 2), 193-228.

Umar, M., Sun, G., & Shahzad, K. (2018). Bank regulatory capital and liquidity creation: evidence from BRICS countries. *International Journal of Emerging Markets*, *24*(4), 430-452.

Varotto, S. (2011). Liquidity risk, credit risk, market risk and bank capital. *International Journal of Managerial Finance*, 7(2),1-27.

WDI (2020). World Development Indicator