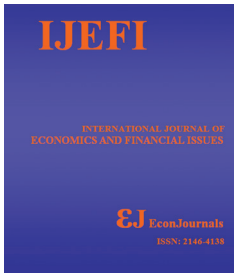

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Testing the Non-Linear Relationship between Liquidity Risk and Bank Stability in the MENA Region

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ABSTRACT

This paper aims to investigate whether the relationship between liquidity risk and bank stability is non-linear. It uses a sample of 83 MENA banks from 2005 to 2020. Due to several economic, financial, and regulation differences, the whole sample was divided into two sub-samples. The first one is related to Middle East countries and covers 56 banks while the second one is related to North African countries and covers 27 banks. We performed the Panel Smooth Threshold Regression (PSTR) model proposed by González et al. (2005) as an empirical approach. The empirical results indicate that exists a threshold effect in the liquidity risk-bank stability relationship. More specifically, we found that below a certain threshold, the loan to-deposit-ratio does not exert any significant effect on bank stability in the Middle East; while it significantly increases the stability of banks in North African countries. Above, the same threshold, the loan-to-deposit ratio significantly decreases bank stability for the two sub-samples.

Keywords: Liquidity Risk, Bank Stability, MENA Region, Non-Linear Relationship
JEL Classifications: G21, O53, O16

1. INTRODUCTION

Banks are considered one of the most important sources for economies financing. The banking system plays a crucial role in the economic development by stimulating business activities and promoting investment. Thus, searching for factors that driving bank profitability and ensures their stability is great of importance. In some indebtedness economies, the stability of a country depends on the stability of its banking system.

Banking activity is based on liquidity which is considered as the main input or the main product and/or service. Hence, credit risk and liquidity risk are recognized as the main alarming risks. Liquidity risk is defined as a situation when a bank can't meet all the request of depositors either totally or partially for a given period (Jenkinson, 2008). It's the first product of each banking establishment. Hence, the creation of liquidity is a key activity of banks. In fact, growth; development and survival of banks depend on bank's ability to provide liquidity to customers.

Associated to their activities, banks are exposed to several financial risks such us liquidity risk, credit risk, market risk and operational risk. However the most important factor for banking survival is liquidity. In fact, in all historical banking crises, liquidity risk has played a key role in the amplification of banking failures.

While prior studies are focused on the linear relationship between liquidity risk and bank profitability or stability Ghenimi et al. (2017), Amara and Mabrouki (2019), Imbierowicz and Rauch (2014), less abundant works are focused on the possible non-linear relationship Djebali and Zaghdoudi (2020). To fill this gap, the purpose of this paper is to investigate the non-linear relationship between liquidity risk and bank stability by using a panel of 83 banks over the period 2005-2020. Due to several economic, social

and financial differences, the whole sample was divided into two sub-samples. The first one covers 55 banks located in the Middle East region. The second one is relative to 28 banks in North Africa.

The MENA region is considered as an appropriate case study for several reasons. First, banking sector is considered as the main source for the economy financing especially in the indebtedness economies. Hence, it will be very useful to investigate factors that ensure bank stability in this region. Second, bank assets range from 60% to over 100% of the gross domestic product (GDP) across MENA countries (Ghosh, 2020). Indeed, banking system in this region suffers a high degree of risk exposure due to its concentrated lending to a few sectors or individuals customers (Malik et al., 2019). Third, the banking system in the MENA region is still characterized by a weak level of liquidity. Therefore, it is necessary to define a threshold of liquidity risks that affects banking stability in the MENA region.

The results of the panel smooth transition regression model indicate that exists a threshold effect in the liquidity risk-bank stability relationship. Additionally, the threshold of liquidity risk and its effect differs from banks in Middle East and other in North Africa.

This paper extends the literature on the liquidity risk and bank stability and contributes in several ways. First; it aims to fill the research gap in the banking literature by focusing on the banking sector in the MENA region. Second, contrary to the previous study that investigated this relationship using linear approaches, the current study is based on non-linear approach that uses PSTR model. Third, the results of this paper define the optimal threshold of liquidity risk that affects positively the level of bank stability and that can helpthe bank's supervisors and policymakers to monitor and evaluate the stability of the banking system.

The remainder of this paper is structured as follows: section 2 presents the literature review. The sample and the empirical methods are given in section 3. Section 4 discusses the empirical findings while section 5 tests the robustness of the results. Finally, Section 6 concludes and addresses some policy recommendations.

2. LITERATURE REVIEW

The banking system plays an important role in the financial system and the whole economy. Through the process of financial intermediation, banks create liquidity by receiving money from depositors and making loans to borrowers. They are recognized as important institution since they stimulate business activities, promote investment and contribute to economic growth of countries and industries.

Liquidity is the first product of each banking establishment. Hence, the creation of liquidity is based at the centre of much of a bank's activities. In fact growth; development and survival of banks depend on liquidity.

After the recent global financial crisis of 2008, liquidity becomes a vital factor that potentially influences banks' survival (DeYoung and Jang, 2016) in other words, Liquidity become one of the most critical issues for both regulatory authorities and academics. Literature based on the relationship between liquidity and bank performance is ambiguous. Several studies reported that liquidity affects positively bank performance Bourke (1989), Kosmidou et al. (2005), Olagunju et al. (2012). However, other studies defended the opposite thesis Molyneux and Thorton (1992) confirmed that liquidity exerts a negative effect on bank performance under the misallocation of resources. Banks with high level of liquidity accept to finance risky projects with a high return but with a weak probability of success. Liquidity is considered as the main pillar that affects banks' performance and survival.

Associated to their activities, banks are exposed to several financial risks such us liquidity risk, credit risk, market risk and operational risk. However, the two most important factors for banking survival are liquidity and credit risks. In fact, in all historical banking crises, liquidity risk has played a key role in the amplification of banking failures.

Drehmann and Nikolaou (2013) define liquidity risk as, "the possibility that over a specific horizon the bank will become unable to settle obligations with immediacy." Following the recent global financial crisis of 2008, liquidity risk is recognized as the most important cause of bank failures. This crisis has focused the attention of regulators and academicians on the issues related to liquidity risk which can affect not only bank performance but also bank stability.

Most of the studies of liquidity risk are focused on the bank performance dimension and showed mixed result. The European context was explored by Cuong Ly (2015), the author used a panel data of EU 27 countries over 2001-2011 to investigate the relationships between liquidity risk, regulation, supervision and bank performance. The major findings of this study confirm that liquidity risk is negatively associated with bank performance. On the same context, Mamatzakis and Bermpei (2014), using a sample of 97 banks in the G7 and Switzerland, examined the factors that affect the performance of banks. They found a strong positive effect of Z-score on performance however, liquidity exerts a negative effect. Athanasoglou et al. (2006), used a panel data of South Eastern European. The estimation results indicate that the ratio of loans to total assets has no effect on return on assets (ROA) and return on equity (ROE).

For The Asian context, Tabari et al. (2013), Used a sample of Iranian banks over the period 2003-2010 to analyze the impact of liquidity risk on bank performance. Results show that liquidity risk deceases the performance of Iranian banks. The Pakistan example was investigated by Arif and Nauman (2012) they used a sample of 22 Pakistani banks over the period 2004-2009 to study the effect of liquidity risk on bank performance. The main results indicate that bank performance is negatively and significantly correlated with the liquidity risk. Hakimi and Zaghdoudi (2017). Used a sample of 10 Tunisian banks over the period 1990-2013 to study the effect of liquidity risk on the Tunisian bank performance. They found that liquidity risk decreases significantly Tunisian bank performance.

However few studies investigated the liquidity risk-stability relationship. The empirical literature based on this topic provided three groups. On the negative side of the relationship between liquidity risk and bank stability, The American context was explored by Imbierowicz and Rauch (2014). They Used a sample of 4300 commercial banks over the period 1998-2010 to explore the impact of liquidity and credit risk on the probability of bank's default the main findings of this study indicate that the two risks can affect the default of banks. To investigate the effect of liquidity and credit risks in the MENA context, Ghenimi et al. (2017) used a sample of 49 banks over the 2006-2013 period. Findings indicate there is a negative effect of credit and liquidity risks on bank stability. Recently, Matey (2021) investigates the relationship between liquidity and credit risks on bank stability. He uses a sample of nine banks in Ghana and panel data from 2008 to 2018.The author found that liquidity risk negatively affects bank stability.

On the positive side of the relationship between liquidity risk and bank stability, Zaghdoudi (2019), using data of Tunisian banks during the period 2005-2015, found a positive relationship between liquidity risk and bank stability.

A third part of literature support the neutrality hypothesis, Amara and Mabrouki (2019) investigated the effect of liquidity risk on bank stability. They used a sample of Tunisian banks over the2006 to 2015 period and they found a non-significant relationship between liquidity risk and bank stability.

The examination of the existing literature show that many studies that focused on the relationship between liquidity risk and bank stability are based on linear approaches that used either fixed, random effect or dynamic panel data Ghenimi et al. (2017), Amara and Mabrouki (2019), Imbierowicz and Rauch (2014). Few studies explored this relationship within a non-linear approach. Djebali and Zaghdoudi (2020) used a panel data of 75 conventional banks of the MENA region over the period 1999-2017.They found a non-linear relationship between bank stability-credit risk and bank stability-liquidity risk with two optimal thresholds 13.16% for credit risk and 19.03% for liquidity risk.

This study comes to fill this gap by testing the non-linear relationship between liquidity risks and banking stability for the MENA region.

3. SAMPLE AND METHODS

3.1. The Sample

To investigate the nonlinear relationship between bank stability and liquidity risk, we used a sample of conventional banks located in MENA countries over the period 2005-2020. The initial sample is made by 109 banks. However, due to the availability and the continuity of bank information, several banks have been excluded. For example, we exclude Islamic banks and banks for which data related to non-interest income (NII) were missing for more than 3 years. Hence, the final sample was reduced to only 83 conventional banks. Due to several economic, social and financial differences, the whole sample was divided into two sub-samples. The first one covers 55 banks located in the Middle East region. The second one is relative to 28 banks in North Africa.

The current study uses both Z-Score (ROA) and Z-Score (ROE) as dependent variables. Liquidity risk measured by the loan to deposit ratio (LDR) is the transition variable. As explanatory variables, we introduced in the econometric model three categories of variable. The first category is relative to bank specifics and covers bank diversification measured by the ratio of the NII. We also included bank size (BS) to explain changes in bank stability. Bank performance measured by the net interest margin (NIM) was considered as a key determinant of bank stability. The second category of variables is relative to industry specifics. Bank concentration (CONC) and bank competition (LERN) are recognized as drivers for bank profitability and bank stability. The third category is relative to the global financial crisis of 2008 (crisis) and the macroeconomic conditions proxied by the growth rate of GDP (GDPG) and the inflation rate (INF). Banks operate in a financial and macroeconomic environment that affects their stability.

Data related to bank-level data which concern financial and accounting variables are obtained from the Thomson Reuters database and annual reports of each bank. However, country-level data that reflect industry specifics and macroeconomic conditions are collected from two main sources. The first one is the Global financial indicators database and the World Bank Indicators Database.

3.2. Empirical Approach and Model Specification

Recently, the empirical modelling seems to be shifting towards non-linear analysis compared to linear regression. The non-linearity has been considered as one of the important priorities in economics and finance studies. It is clear that the non-linearity concept was dated form the works of Quandt (1958) and Goldfeld and Quandt (1972; 1973) which were pioneered modelling nonlinear relationships. These pioneer authors develop a piecewise and locally linear AR process. Followed by Tong and Lim (1980) and Tong (1983) that develop a threshold Autoregressive model (TAR). Hansen (1996), Peel and Speight (1996); Peel and Speight (1998; 2000) argue that the TAR model could be the value of the process in the previous period, the autoregressive process becomes self-exciting. Hence, the generalization of the Self-Exciting Threshold Autoregressive (SETAR) model. Terasvirta and Anderson (1992) Granger and Terasvirta (1993) and Terasvirta (1994) have developed the Smooth Transition Autoregressive (STAR) since the SETAR model does not consider continuous and smooth transitions.

The nonlinearity of panel data was specified by the panel threshold regression model (PTR) of Hansen (1999) and the Panel Smooth Threshold Regression (PSTR) model proposed by González et al. (2005). The PSTR model is based on a smooth transition mechanism and it is therefore similar to the class of STAR models developed in time series.

This study uses the Panel Smooth Transition Regression (PSTR) model, proposed by González et al. (2005) to check whether the

relationship between bank diversification and bank performance is non-linear. The PSTR model is an extension of the PTR model and can be written by the equation (1) as follows:

$$y_{i,t} = \mu_i + \beta_0' x_{i,t} + \beta_1' x_{i,t} g\left(q_{i,t}, \gamma, c\right) + \varepsilon_{i,t} \quad (1)$$

Where; $i = 1,..., N$, and $t = 1,..., T$,

The $g(q_{i,t}, \gamma, c)g$ is the transition function. This transition function is dependent on three parameters: the transition variable (q_{it}), the optimal threshold (C) and the smooth transition parameter (γ). González et al. (2005), Granger and Teräsvirta (1993), Teräsvirta (1994), and Jansen and Teräsvirta (1996) have proposed the following logistic form of m orders in the equation (2):

$$g\left(q_{i,t}, \gamma, c\right) = \left[1 + \exp(-\gamma \prod_{j=1}^{m}\left(q_{i,t} - C_j\right)\right]^{-1} \quad (2)$$

To study the nonlinear relationship between bank diversification and bank performance in MENA countries, we have written the following nonlinear model in equation (3).

$$\begin{aligned} STAB_{i,t} &= \beta_0 + \beta_1 STAB_{i,t-1} + \beta_2 LTD_{i,t} \\ &+ \beta_3 NPLs_{i,t} + \beta_4 NII_{i,t} + \beta_5 BS_{i,t} + \beta_6 CAR_{i,t} \\ &+ \beta_7 CONC_{i,t} + \beta_8 LERN_{i,t} + \beta_9 CRISIS_t \\ &+ \beta_{10} GDPG_{i,t} + \beta_{11} INF_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (3)$$

Profitability (PROF) is measured by ROA and ROE. All variables' definitions are given in Table 1.

Table 1: Definition of variables

Variables	Definitions	Measurements
Dependent variables (STAB)		
LnZROA	Return on assets	Net income after tax to total assets
LnzROE	Return on equity	Net income after tax to total equities
Transition variables (LDR)		
Bank specifics		
LDT	Liquidity risk	Loan to deposit ratio (%)
NII	Bank diversification	Non-interest income in % of total income.
NIM	Net interest margin ratio	Net interest margin to total assets (%)
BS	Bank size	Natural logarithm of total assets
Industry specifics		
CONC	Bank Concentration	Bank concentration (%)
LERN	Bank competition	The Lerner index
Financial environment and macroeconomic conditions		
CRISIS	Global financial crisis of 2008	Dummy variable that takes 0 before the crisis of 2008 and 1 after
GDPG	The growth rate of GDP	Annual growth rate of GDP (%)
INF	The inflation rate	Consumer price index (%)
Institutional quality		
CCOR	Control of corruption	
POLIS	Political Stability	

4. EMPIRICAL ANALYSIS

In this section, we firstly provide summary statistics and a correlation matrix. Second, we check the suitability of the application of the PSTR model by testing the linearity hypothesis, searching the number of regimes and defining the optimal threshold.

4.1. Summary Statistics and Correlation Matrix

The statistics displayed in Table 2 indicate that the mean value of bank stability is 2.88 for ZROA and 2.16 for ZROE. Liquidity risk measured by the LDR recorded on average a value of 76.84%. The higher value of the LTD ratio is 215.32%.

Statistics also indicate that the average value of NIM is 2.89% with a maximum value of 58.13% and 0.26% as a minimum value. Concerning the liquidity risk, the mean value of the LTD ratio is 48.49%. In the sample, some banks recorded a low level of liquidity risk with a LTD ratio only of 17%. However, this does not prevent that it exists banks with high liquidity risk and show a ratio of LTD around 132%. On average banks of the sample as well- capitalized. The mean value of the capital adequacy ratio is 15.15%. Additionally, some banks are highly capitalized with a maximum CAR ratio of 40.34%. While others are less- capitalized with a CAR ratio only of 1.62%.

For the macroeconomic environment, statistics indicate that over the period 2005-2020, the MENA region has experienced unstable macroeconomic conditions. The average value of the GDPG and the inflation rate are 3.25% and 3.84% respectively. However, statistics also show that this region has been subject to a weak level of economic growth with a minimum value of 21.46% and a high level of interest rate with a maximum value of 84.86%.

After having some information about all variables, the following step consists to check for the multicollinearity problem.

The correlation between all independent variables is given in Table 3. From this table, we can note that this correlation is very weak. Thus, we confirmed that there was no significant problem with multicollinearity.

4.2. Results of the Pre-Tests

Before testing the PSTR model, some initial conditions should be checked. First, linearity between the dependent variable and the transition function should be rejected at the 5% level. Second, the number of regimes should be defined. Finally, the optimal threshold should be specified.

Three tests are performed to reject the linearity liquidity risk and bank stability. These three tests are the Lagrange Multiplier (Wald test), the Lagrange Multiplier (F-test) and the Likelihood-ratio test (LR). Results of the linearity tests are given in Table 4.

Table 4 shows that the null hypothesis is rejected at the 1% level for the three tests. These statistics confirm the non-linearity between bank liquidity risk (LDR) and bank stability (ZROA) in MENA countries. When the nonlinearity hypothesis is confirmed, we can

Table 2: Descriptive statistics

Variable	Middle East				North Africa			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Lnzroa	2.88	0.62	0.35	4.58	2.16	1.21	−2.80	4.33
Lnzroe	1.40	0.64	−1.27	3.23	1.12	0.73	−1.22	2.30
Ltd	76.84	22.19	1.44	167.08	94.57	34.89	24.00	215.32
Bs	10.05	2.74	5.05	18.08	9.21	2.06	6.21	13.25
Nim	2.89	3.69	0.20	48.00	2.68	1.31	−2.95	6.75
Nii	37.23	17.04	2.00	96.00	31.45	17.25	3.00	94.00
Conc	69.77	18.38	42.94	100.00	66.09	21.07	40.22	100.00
Lern	0.44	0.11	0.16	0.62	0.34	0.07	0.10	0.42
Crisis	0.81	0.39	0.00	1.00	0.81	0.39	0.00	1.00
Gdpg	3.38	4.73	−21.46	26.17	2.86	3.17	−9.18	7.57
Inf	3.32	6.67	−4.86	84.86	5.30	4.53	0.30	29.51
Ccor	0.34	0.58	−1.15	1.57	−0.29	0.22	−0.81	−0.04
Polis	−0.03	0.78	−2.12	1.22	−0.62	0.49	−1.64	0.21

Table 3: Correlation matrix

Middle East										
	ltd	bs	nim	nii	Conc	Lern	Crisis	Gdpg	inf	ccor	polis
ltd	1.0000										
bs	−0.1838*	1.0000									
	0.0000										
nim	0.2531*	−0.1129	10000								
	0.0024	0.1540									
nii	0.0682	−0.0261	0.1723*	1.0000							
	0.0879	0.4584	0.0344								
conc	0.0310	−0.4122*	0.0885	−0.0114	1.0000						
	0.4208	0.0000	0.2641	0.747							
lern	0.4496*	−0.2287*	0.1875	0.3811*	−0.0094	1.000					
	0.0000	0.0000	0.2121	0.0000	0.8306						
crisis	0.0802*	0.1199*	−0.2812*	0.1120*	−0.0194	0.1947*	1.0000				
	0.0373	0.0004	0.0003	0.0014	0.5695	0.0000					
gdpg	0.0048	−0.1336*	0.1472	−0.0574	0.1085*	−0.0667	−0.3693*	1.0000			
	0.905	0.0001	0.0632	0.1033	0.0014	0.1283	0.0000				
inf	−0.1960*	0.1159*	0.2443*	−0.0231	0.1712*	−0.1698*	−0.0760*	−0.1441*	1.0000		
	0.0000	0.0010	0.0020	0.5260	0.0000	0.0002	0.0307	0.0000			
ccor	0.5116*	−0.2976*	0.1175	0.1387*	0.0325	0.4385*	−00075	0.1967*	−0.2042*	1.0000	
	0.0000	0.0000	0.1378	0.0001	0.3393	0.0000	0.8250	0.0000	0.0000		
polis	0.5022*	−0.3442*	0.1643*	0.1051*	0.1097*	0.5478*	−0.0723*	0.1806*	−0.1432*	0.4565*	1.000
	0.0000	0.0000	0.0373	0.0028	0.0012	0.0000	0.0336	0.000	0.0000	0.0000	
North Africa											
	ltd	bs	nim	nii	Conc	Lern	Crisis	Gdpg	inf	ccor	Polis
ltd	1.0000										
bs	−0.5077*	1.0000									
	0.0000										
nim	−0.2464*	0.4151*	1.0000								
	0.0023	0.0000									
nii	−0.0026	0.3731*	0.0941	1.0000							
	0.9683	0.0000	0.2635								
conc	−0.2734*	0.4563*	−0.1030	0.1421*	1.0000						
	0.0000	0.0000	0.1949	0.0232							
lern	0.4323*	−0.3842*	−0.4612*	−0.2046*	−0.4802*	1.0000					
	0.0000	0.0000	0.0000	0.0109	0.0000						
crisis	0.0619	0.1488*	−0.3235*	−0.1824*	0.3251*	0.1758*	1.0000				
	0.3100	0.0115	0.0000	0.0035	0.0000	0.0226					
gdpg	−0.2369*	0.1341*	0.3280*	0.0690	−0.3944*	−0.2718*	−0.3688*	1.0000			
	0.0001	0.0228	0.0000	0.2723	0.0000	0.0004	0.0000				
inf	−0.4596*	0.0498	0.2882*	−0.3200*	0.0219	−0.3847*	0.1797*	0.1394*	1.0000		
	0.0000	0.3996	0.0002	0.0000	0.7114	0.0000	0.0022	0.0179			
ccor	0.5237*	−0.4879*	−0.5538*	−0.0344	0.0617	0.5374*	0.1630*	−0.4319*	−0.4817*	1.0000	
	0.0000	0.0000	0.0000	0.5847	0.2969	0.0000	0.0056	0.0000	0.0000		
polis	0.4966*	−0.2522*	0.0590	0.2430*	−0.3856*	0.4373*	−0.4217*	0.1351*	−0.5489*	0.2925*	1.0000
	0.0000	0.0000	0.4590	0.0001	0.0000	0.0000	0.0000	0.0218	0.0000	0.0000	

*indicate significance levels respectively at 5%

test for the number of regimes for the transition variable (LDR). Results of the number of regimes are given in Table 5.

The test of the number of the regime is used to check if the PSTR model has one function of transition (m=1) (null hypothesis) or if it has at least two functions of transition (m=2) (alternative hypothesis). From Table 5, we note that both the hypothesis without threshold (r=0) and the hypothesis with at least two thresholds (r=2) are rejected at the 1% significance level for the two tests. Hence, we reject the null hypothesis and we admit that it exists at least two functions of transition and the model has one threshold.

The initial condition of the PSTR model is the rejection of linearity. However, the fundamental objective of this approach is to define the optimal threshold of the transition variable that can affect the dependent variable. By defining this threshold, we can discuss the effect within two regimes: below the threshold and above the threshold. Results are given in Table 6.

From Table 6, we notice that the threshold of liquidity risk that may affect bank stability in the is 109.34% for banks in the Middle East and 83.95% for banks in North Africa. We note that bank stability is more sensitive to liquidity risk in North Africa rather in the Middle East. Reaching only the threshold of 83.95%, liquidity risk affects bank stability. However, banks in the Middle East can sustain this risk until a threshold of 109.34%. Hence, banks in the North Africa are invited to well hedge and manage liquidity risk to ensure banking stability.

4.3. Findings of the PSTR Regression

Results of the PSTR regression are displayed in Table 7. This table shows that below the defined threshold, liquidity risk does not exert any significant effect on bank stability for the two regions Middle East and North Africa. It should also be noted that there is not any significant effect of liquidity risk on bank stability in the Middle East banks either below or above the optimal threshold. However, surpassing the threshold of 83.95%, the effect of liquidity risk becomes negative and significant in the North African banks. The coefficient of liquidity risk is negative and significant at the level of 1%. This means that Bank stability in the North Africa is more sensitive to an increase in the LDR. An increase of the LTD ratio significantly decreases bank stability measured by ZROA. Banks and policymakers in this region are invited to control this ratio. Also, they are invited to maintain a ratio below 83.95% to ensure bank stability. The negative effect of liquidity risk on bank stability is in line with Hakimi and Zaghdoudi (2017), Djebali and Zaghdoudi (2020).

Results indicate that well capitalized banks are more stable. The coefficient of the capital adequacy ratio is positive and significant for both Middle East and North Africa regions. When equity increases, the cost of capital decreases and hence improves the level of profitability that ensures bank stability. Furthermore, an increase in the bank capital may raise expected costs and financial distress. A higher level of capital reduces the incentives of shareholders to adopt speculative behavior and excessive risks. Capital may positively affect bank profitability and bank stability through monitoring channels. To avoid losses, shareholders have more incentive to monitor and require higher efficiency which positively turns on bank profitability. This finding is in line with the works of Bourke (1989), Molyneux and Thornton (1992), Goddard et al. (2004), Berger (1995) and Mehran and Thakor (2011).

Empirical findings indicate that bank diversification (NII) is found to be without any significant effect for the Middle East banks, while; it significantly increases bank stability in North Africa. More bank diversification lowers bank risks and enhances bank profitability. This result is convergent to Hamdi et al. (2017). We also found that more bank competition measured by Lerner index negatively and significantly affects bank stability in the Middle East region. More competitive banking system may favour speculative behaviour and bank risk-taking that affect bank stability.

The global financial crisis of 2008 is found to be negatively and significantly associated with bank stability in the Middle East region. In the period of crisis, the ability of borrowers to fulfil their commitments is reduced. It results in a deterioration of the quality of loans portfolios and an increase of the level of NPLs, one of the most serious concerns that affect bank profitability and bank stability. This result is in line with the works of Hamdi et al. (2017), Hakimi et al. (2020) and Zaiane and Moussa (2021).

Concerning the effect of macroeconomic conditions, we found that the inflation does not exert any significant effect. However, more economic growth leads to more bank stability in the Middle East banks. High level of growth increases the probability of borrowers to pay their loans. This reduces the level of NPLs, increases bank

Table 4: Test of linearity

Ransition variables	Middle East		North Africa	
Tests	Statistics	P-value	Statistics	P-value
Lagrange multiplier Wald Test	34.241	0.000***	17.430	0.0453**
Lagrange multiplier F-Test	2.753	0.005***	2.508	0.0355**
Likelihood-ratio Test	70.930	0.000***	19.235	0.0373**

*** and ** indicate significance levels respectively at 1% and 5%

Table 5: Test of the number of regimes

Transition variables is LDR		Middle East		North Africa	
Hypotheses	Tests	Statistics	P-value	Statistics	P-value
1. H_0 : r=0;H_1 : r=1	LRT	41.992	0.002***	40.497	0.009***
	F	104.927	0.000***	3.226	0.000***
2. H_0 : r=1;H_1 : r=2	LRT	22.763	0.073*	61.581	0.040**
	F	103.313	0.000***	4.134	0.000***

***, ** and * indicate significance levels respectively at 1%, 5% and 10%

Table 6: Results of threshold values

	Middle East	North Africa
	LDR→ZROA	*LDR→ZROA*
γ	5.000	5.000
C	109.34%	83.95%
AIC	−6.301	−1.078
BIC	−5.307	−0.437

Table 7: Results of the PSTR model estimation

Variables	Middle East		North Africa	
	Coeff	T-Stat	Coeff	T-Stat
BS	−0.187	−0.934	0.658	0.890
CAR	0.064	5.922***	0.245	5.130***
NIM	0.007	0.128	0.152	1.389
NII	0.009	0.043	0.635	3.433***
CONC	0.004	0.543	−0.020	−0.371
LERN	−0.857	−2.346**	−1.830	−0.622
CRISIS	−0.015	−3.037***	0.446	0.948
GDPG	0.531	7.529***	0.038	0.626
INF	−0.010	−0.831	−0.031	−0.305
CCOR	0.098	0.801	0.017	2.013**
POLIS	0.005	0.063	0.144	0.282
LDR <Threshold	0.026	0.452	0.041	0.132
LDR >Threshold	0.485	0.255	−0.709	−5.809***
γ	5.000		5.000	
C	109.34%		83.95%	
AIC	−6.301		−1.078	
BIC	−5.307		−0.437	
Obs	838		234	

ZROA is the dependent variable and LDR is the transition variable, *** and ** indicate significance levels respectively at 1% and 5%

profitability and stability. This results in line with Boussaada (2021). As institutional quality, we found that more control of corruption significantly increases bank stability in North Africa. The coefficient of control of corruption is positive and significant at the level of 5%. An increase of 1% in the control of corruption increases bank stability by 1.7%. More control of corruption improves the decision-making and reduces the probability of bad loans. Thus, the ratio of NPLs decreases and the profitability and the stability of banks will be increased.

5. ROBUSTNESS CHECK

To check whether the results of the effect of liquidity risk on bank stability are robust, we conduct a robustness test. In this step, we used a second measure of bank stability that was commonly used. We used the ZROE instead of the ZROA. We test the same three steps such as the test of linearity, the test of the number of regimes and the threshold values. The test of linearity confirms once again the non-linearity between liquidity risk and bank stability. The test of the number of regimes indicates exists at least two functions of transition and the model has one threshold. The threshold values of liquidity risk are respectively 121.92% for the Middle East banks and 95.68% for the North African banks. Results of the robustness check are given in Table 8.

Form Table 8, we note that the same conclusion was drawn: bank stability is more sensitive to liquidity risk in North Africa rather in the Middle East. Achieving only the threshold of 95.68% of

Table 8: Results of the PSTR model estimation

Variables	Middle East		North Africa	
	Coeff	T-Stat	Coeff	T-Stat
BS	−0.331	−1.741*	−0.253	−0.370
CAR	0.026	2.273**	0.241	2.384**
NIM	0.256	5.080***	0.106	0.445
NII	0.286	1.389	0.473	1.910*
CONC	−0.002	−0.217	−0.289	−2.180**
LERN	−1.295	−3.717***	2.001	0.666
CRISIS	−0.032	−6.911***	0.318	0.452
GDPG	0.345	4.848***	0.066	0.347
INFL	0.013	1.144	−0.007	−0.062*
CCOR	−0.286	−3.820***	0.552	0.574
POLIS	0.071	0.624	0.390	1.043
LDR <Threshold	0.026	0.512	1.457	2.488**
LDR >Threshold	−0.167	−3.438***	−1.383	−3.025***
γ	5.000		5.000	
C	121.92%		95.68%	
AIC	−6.315		−2.223	
BIC	−5.322		−1.582	
Obs	838		234	

***, ** and * indicate significance levels respectively at 1%, 5% and 10%

loans LDR, liquidity risk affects bank stability in the North African banks. While; it can go until 121.92% to have a significant effect of LDR on ZROE.

Compared to the results in Table 6, there are no significant changes with regard to the effect of bank specifics, macroeconomic and financial environment and institutional context. Results of the robustness check confirm the positive effect of the bank capital, bank diversification, level of growth and control of corruption on bank stability. However, bank competition and financial crisis are found to be negatively and significantly associated with bank stability measured by ZROE.

6. CONCLUSION AND POLICY RECOMMENDATIONS

This paper aimed to investigate the non-linear relationship between liquidity risk and bank stability in the MENA region. To achieve this goal, we used a sample of 83 banks over the period 2005-2020 and we performed the PSTR model as an empirical approach.

The empirical results confirm that there is a threshold effect in the liquidity risk-stability relationship. When bank stability was measured by ZROA the threshold of liquidity risk that may affect bank stability is 109.34% for banks in the Middle East and 83.95% for banks in North Africa. However, when ZROE was used, the threshold values of liquidity risk are respectively 121.92% for the Middle East banks and 95.68% for the North African banks. From these thresholds, we note that bank stability is more sensitive to liquidity risk in North Africa rather than in the Middle East.

More specifically, we found that below these thresholds, the loan to-deposit-ratio does not exert any significant effect on bank stability in the Middle East; while it significantly increases the stability of banks in North African countries. Above, the same thresholds, the LDR significantly decrease bank stability for

the two sub-samples. We also found that bank stability is more sensitive to an increase in bank competition and the global financial crisis. However, bank capital, bank diversification, economic growth, and control of corruption enhance bank stability.

The results of this paper could have substantial implications. Firstly, by identifying these thresholds, policymakers and bankers will address and implement appropriate reforms to hedge liquidity risk. Second, to ensure bank stability, MENA banks should maintain the LTD ratio below the defined thresholds. Third, bank stability in this region could benefit from an improvement of bank capital, more bank activities diversification and stable macroeconomic; while more bank competition and financial crisis threaten bank stability.

REFERENCES

Amara, T., Mabrouki, T. (2019), Impact of liquidity and credit risks on the bank stability. MPRA Paper No. 95453.

Arif, A., Nauman, A. (2012), Liquidity risk and performance of banking system. Journal of Financial Regulation and Compliance, 20(2), 182-195.

Athanasoglou, P.P., Delis, M.D., Staikouras, C.K. (2006), Determinants of bank profitability in the South Eastern European region. Journal of Financial Decision Making, 2, 1-17.

Berger, A.N. (1995), The profit-structure relationship in banking-tests of market-power and efficient-structure hypotheses. Journal of Money Credit and Banking, 27, 404-431.

Bourke, P. (1989), Concentration and other determinants of bank profitability in Europe. North America and Australia. Journal of Banking and Finance, 13, 65-79.

Boussaada, R. (2021), Multiple large shareholders and bank stability: The case of MENA banks. Managerial Finance, 47(9), 1320-1336.

Cuong Ly, K. (2015), Liquidity risk, regulation and bank performance: Evidence from European banks. Global Economy and Finance Journal, 8(1), 11-33.

DeYoung, R., Jang, K.Y. (2016), Do banks actively manage their liquidity? Journal of Banking and Finance, 66, 143-161.

Djebali, N., Zaghdoudi, K. (2020), Threshold effects of liquidity risk and credit risk on bank stability in the MENA region. Journal of Policy Modeling, 42(5), 1049-1063.

Drehmann, M., Nikolaou, K. (2013), Funding liquidity risk: Definition and measurement. Journal of Banking and Finance, 37(7), 2173-2182.

Ghenimi, A., Chaibi, H., Omri, M.A.B. (2017), The effects of liquidity risk and credit risk on bank stability: Evidence from the MENA region. Borsa Istanbul Review, 17(4), 238-248.

Ghosh, S. (2020), Depositor discipline, financial crisis and macroprudential policies: Evidence from MENA banks. Journal of Islamic Accounting and Business Research, 11(8), 1531-1553.

Goddard, J., Molyneux, P., Wilson, J.O. (2004), The profitability of European banks: A cross-sectional and dynamic panel analysis. The Manchester School, 72(3), 363-381.

Goldfeld, SM., Quandt, RE. (1972), Nonlinear Methods in Econometrics. Amsterdam: North-Holland Publishing.

Goldfeld, S., Quandt, R. (1973), The estimation of structural shifts by switching regressions. In: Annals of Economic and Social Measurement. Vol. 2. Cambridge: NBER. p475-485.

González, A., Teräsvirta, T., Dick, V.D. (2005), "Panel Smooth Transmission Regression Models" SSE/EFI Working Paper Series in Economics and Finance: Stockholm School of Economics.

Granger, C.W.J., Teräsvirta, T. (1993), Modelling Nonlinear Economic Relationships. Oxford: Oxford University Press.

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

Hakimi, A, Boussaada, R., Hamdi, H. (2020), The interactional relationships between credit risk, liquidity risk and bank profitability in MENA region. Global Business Review, 23, 1-23.

Hamdi, H., Hakimi, A., Zaghdoudi, K. (2017), Diversification, bank performance and risk: Have Tunisian banks adopted the new business model? Financial Innovation, 3, 22.

Mehran, H., Thakor, A. (2011), Bank capital and value in the cross-section. The Review of Financial Studies, 24(4), 1019-1067.

Hansen, B.E. (1996), Inference when a nuisance parameter is not identified under the null hypothesis. Econometrica: Journal of the Econometric Society, 64, 413-430.

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

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

Jenkinson, N. (2008), Strengthening regimes for controlling liquidity risk: Some lessons from the recent turmoil. In: Bank of England Quarterly Bulletin. United Kingdom: Bank of England.

Kosmidou, K., Tanna, S., Pasiouras, F. (2005), Determinants of Profitability of Domestic UK Commercial Banks: Panel Evidence from the Period 1995-2002. In: Money Macro and Finance (MMF) Research Group Conference. Vol. 45.

Malik, A., Atiyas, I., Diwan, I. (2019), Crony capitalism in the Middle East: What do we know and why does it matter? In: Crony Capitalism in the Middle East: Business and Politics from Liberalization to the Arab Spring. Oxford: Oxford University Press.

Mamatzakis, E., Bermpei, T. (2014), What drives investment bank performance? The role of risk, liquidity and fees prior to and during the crisis. International Review of Financial Analysis, 35, 102-117.

Matey, J. (2021) Bank liquidity risk and bank credit risk: Implication on bank stability in Ghana. International Journal of Scientific Research in Multidisciplinary Studies, 7(4), 1-9.

Molyneux, P., Thornton, J. (1992), Determinants of European bank profitability: A note. Journal of Banking and Finance, 16, 1173-1178.

Olagunju, A., David, A.O., Samuel, O. (2012), Liquidity management and commercial banks' profitability in Nigeria. Research Journal of Finance and Accounting, 2(7-8), 24-38.

Peel, D.A., Speight, A.E. (1996), Is the US business cycle asymmetric? Some further evidence. Applied Economics, 28(4), 405-415.

Peel, D.A., Speight, A.E.H. (1998b), Threshold nonlinearities in output: Some international evidence. Applied Economics, 30(3), 323-333.

Peel, D.A., Speight, A.E.H. (2000), Threshold nonlinearities in unemployment rates: Further evidence for the UK and G3 economies. Applied Economics, 32, 705-715.

Quandt, R.E. (1958), The estimation of the parameters of a linear regression system obeying two separate regimes. Journal of the American Statistical Association, 53, 873-880.

Tabari, N., Ahmadi, A., Emami, A. (2013), The effect of liquidity risk on the performance of commercial banks. International Research Journal of Applied and Basic Sciences, 4(6), 1624-1631.

Terasvirta, T., Anderson, H.M. (1992), Characterizing nonlinearities in business cycles using smooth transition autoregressive models. Journal of Applied Econometrics, 7, S119-S136.

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

Tong, H. (1983), Threshold models in non-linear time series analysis. In: Lecture Notes in Statistics. Vol. 21. Berlin: Springer. Available from: https://www.springer.com/gp/book/9780387909189

Tong, H., Lim, K.S. (1980), Threshold autoregression, limit cycles and cyclical data. Journal of the Royal Statistical Society, Series B, 42,

245-292.
Zaghdoudi, K. (2019), The effects of risks on the stability of Tunisian conventional banks. Asian Economic and Financial Review, 9(3), 389-401.
Zaiane, S., Moussa, F.B. (2021), What drives banking profitability during financial crisis and political turmoil? Evidence from the MENA region. Global Journal of Emerging Market Economies, 13(3), 380-407.