

Determinants of Liquidity Risk: Evidence from Tunisian Banks

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Abstract—

This paper examines the determinants of liquidity risk in the Tunisian banking sector over the period 2000-2012. Using panel data and bank specific factors including loan portfolios quality, capital adequacy, management quality, bank size, bank's business model and profitability, we find evidence for the channel of depositors' demand which suggests a positive relationship between credit risk and liquidity risk. However, this holds only for banks which are already facing an important deterioration of loan portfolios' quality. Also, our findings show a negative relationship between bank liquidity and management efficiency. In addition, we find that banks which rely mostly on traditional banking activities, mainly lending activity, have lower liquidity risk. Finally, our findings highlight the importance of taking into account the heterogeneity among banks in terms of management efficiency and business model when computing the required liquidity.

Keywords— Liquidity risk, credit risk, bank management efficiency, bank business model.

I. INTRODUCTION

The recent financial crisis has shown shortcomings in the liquidity management by financial institutions which has led to the creation of Basel III new regulatory framework regarding banks' liquidity ([1]). Bank liquidity risk has received great attention from policymakers, researchers and practitioners after the 2007-2008 financial crisis. The main reason behind this attention is that a liquidity shortage at one so called "too big to fail" banking institution can lead to systemic contagion and financial instability. Also, a bank with an appropriate liquidity level will be able to meet its obligations, even in difficult times as bank runs. From this perspective, a "comfortable" liquidity level decreases the risks of failure which may reduce the funding costs and improve the profitability ([2]).

Reference [3] defines liquidity risk as the likelihood that the demand for cash by the customers of banks exceeds the bank's ready supply of cash. The authors emphasize the stochastic nature of the demand for cash. For instance, institutional depositors might unexpectedly draw their time deposits before maturity, or clients having lines of credit might draw unexpectedly large portions of their credit lines.

Assuring a better bank liquidity risk management has been a focus of regulatory and supervision institutions and international financial stability institutions. One recent regulatory reform have been provided by the Basel III framework which addresses the vulnerabilities that caused the financial crisis by strengthening bank capital and liquidity standards with the aim of having a more resilient banking sector ([4]).

In Tunisia, liquidity risk problems appeared due to extreme loan-to-deposit ratios. The decline in funding liquidity led to an important distress in the interbank market. Thus, the Central Bank of Tunisia (CBT) has provided successive liquidity support through short-term loans to banks in order to ensure the banking stability. Notwithstanding, banks liquidity remains a serious issue in Tunisia. According to the annual report on banking supervision¹ of the CBT, 13 resident banks, which represent 62% of the total number of resident banks operating in Tunisia, have not complied with the prudential norm related to liquidity ratio in 2014. In 2015, The CBT imposed penalty payments on 7 banks for non-compliance with the prudential regulation on banks' liquidity. Further, it required 4 banks to present a plan in order to restore compliance with this prudential regulation. Consequently, this situation of banks' liquidity in Tunisia has highlighted the importance of appropriate bank liquidity risk management.

In this context, the objective of this paper is to analyze the determinants of the liquidity risk in the Tunisian banking sector considering bank specific factors over the period 2000-2012. These bank specific factors include capital adequacy, banks loan portfolios quality, management quality, bank size bank's business model and profitability.

The research contributes to the related literature on banks liquidity which is an up-to-date topic being of concern to regulators, researchers and practitioners, thorough analyzing the determinants of the situation of the liquidity in the Tunisian banking sector in the aim of insuring its stability and facing the remaining challenges taking into consideration a series of bank specific factors.

The remainder of the paper is organized as follow. Section 2 reviews the theoretical and empirical literature on the determinants of bank liquidity risk and formulates the hypotheses. Section 3 describes the data and presents the

¹In 2012, 14 resident banks, which represent 67% of the total number of resident banks operating in Tunisia, and one off-shore bank, have not complied with the prudential norm related to liquidity ratio. In 2013, 16 resident banks and one off-shore bank, have not complied with the prudential norm related to liquidity ratio.

methodology used in this paper. Section 4 provides the summary statistics. Section 5 shows the empirical results. Finally section 6 summarizes our concluding remarks.

II. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The literature which analyzes the determinants of bank liquidity risk in developing economies is relatively scarce. In general, the empirical researches on this topic are focused mostly on the case of the advanced economies ([5]). Reference [6] shows how a sample of European and North American banks manage bank liquidity risk, over the period 2002-2009. The authors examine whether banks have incentives to take more risks in a crisis period and if they follow similar strategies. Their findings provide important insights for regulators, suggesting that banks have a collective behavior in the pre-crisis period, which is reflected in a global decrease of liquidity indicators and that collective risk taking incentives are present mainly among the largest banks.

Reference [7] analyzes the interconnection between banks liquidity risk and bank specific factors in the Euro area. The aim of here research is to provide a better understanding of what are the determinants of the two new indicators recommended by the Basel Committee, namely the liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR). Here findings show that banks with bigger size, lower capitalization, lower assets quality and higher specialization in lending activities have higher liquidity risk exposure.

The literature on liquidity risk in developing countries is less developed despite the existence of a series of recent studies. Reference [8], for instance, tries to examine the liquidity determinants of commercial banks in Poland. Here findings show that liquidity tends to decrease with bank size. This means that large banks tend to hold less liquid assets, relying on a liquidity assistance of the lender of last resort in case of distress, while small and medium sized banks hold more liquid assets. Also, the author shows that the inflation and increases in capital adequacy positively affect bank liquidity.

Reference [5] applies OLS regression analysis to examine the impact of bank-specific factors on commercial banks liquidity in Central and Eastern European countries (CEE) over the period 2004-2011. Their findings show that the internal factors that have the most influence on the overall liquidity of the examined banks are bank capitalization, depreciation of loans portfolios and profitability. However, the effect of these variables depends on the local macroeconomic environment particularities of the CEE countries as the impact of these factors on the overall liquidity of the examined banks has been positive in some countries and negative in others.

A. *Liquidity risk and bank's loan quality*

Two major research strands concerning the microeconomics of banking namely the classic financial intermediation theory ([9], [10], [11], [12]) and the industrial organization approach to banking, which is represented by the Monti-Klein model, provide explanations regarding how banks work and their major risk and return sources are given ([13]).

Both strands of literature argue that there is a relationship between liquidity and credit risk. The Monti-Klein framework and its extensions (e.g. [14]) suggest that borrower defaults and sudden fund withdrawals lower bank profitability. Banks maximize their profits by maximizing the spread between deposit and loan rates, given an exogenous main refinancing rate and stochastic borrower defaults and fund withdrawals. A credit default increases liquidity risk because of the decreased cash inflow ([15]). Thus, liquidity risk and credit risk should thus be positively associated. This relationship is suggested also by the theoretical financial intermediation literature ([9], [10]).

A new body of literature that focuses on the financial crisis of 2007/2008 supports also the positive relation between liquidity and credit risk ([16], [17], [18]). These studies argue that if too many distressed economic projects are financed with credits, banks cannot meet the depositors' demand. In case of further value deterioration of these assets, more and more depositors will claim back their money. Thus, higher credit risk will lead to higher liquidity risk through the channel of depositor demand.

Reference [17] suggests that in the recent financial crisis perceived credit risk in the form of subprime loans has led to a substantial increase in refinancing rates and funding haircuts in the interbank market. They show how perceived credit risk can cause liquidity risk in banks.

In contrast, many authors ([19], [20], [21], [22], [23]) support a negative relationship between credit risk and liquidity risk in banks. This negative relationship holds only when certain assumptions and economic features are met ([13]). However, their studies mostly focus on specific aspects of liquidity (such as certain assets or deposits), very specific credit risk features (such as loan commitments) or only examine very specific economic circumstances. Nevertheless, as it is argued by [13], we would expect that during good economic conditions as well as in crisis, the positive relationship between liquidity risk and credit risk should be prevalent. Reference [5], in what concerns the relationship between banks' assets quality and the overall liquidity of commercial banks in Central and Eastern European countries (CEE) over the period 2004-2011, shows that the increase in impair loans negatively affects the overall liquidity of the banks.

Reference [5] argues that credit risk impacts liquidity risk through the channel of depositors demand. The authors explain that if banks grant loans to many distressed economic projects, banks' asset value will deteriorate. The consequence is that depositors will claim back their money leading to a liquidity problem.

Concerning the effect of non-performing loans (NPLs) on bank liquidity, we would expect that a decrease in the loan portfolio's quality, due to an increase in the ratio of non-performing loans to total loans, will negatively impact the overall liquidity of a bank. The theoretical financial intermediation literature ([9], [10]) argues that liquidity risk and credit risk are positively correlated. This positive relationship between the two major banking risks can be explained by the fact that when loan default increases, bank liquidity decreases because of the lowered cash inflow and the depreciations it causes ([15]). Reference [13] investigates the relationship between liquidity risk and credit risk using a sample of US banks over the period 1998-2010. Their results show that credit risk does not significantly influence

liquidity risk. This is because liquid assets turn illiquid. More recently, [24] argues that a rising share of NPLs in bank loan portfolios leads to greater risks affecting both bank liquidity and profitability.

Based on the aforementioned theoretical developments, we formulate and test the following hypothesis:

Hypothesis I: An increase in non-performing loans negatively impacts bank liquidity.

B. Liquidity risk and bank management quality

Many studies have analyzed the relationship between bank liquidity and bank management quality as it is proxied by banks' cost efficiency. This indicator has been considered in the related empirical literature as one proxy for the performance of bank managers.

A lower operating cost relative to bank operating incomes reflects efficient bank management. Well managed banks are able to attract deposits at a lower rate ([5]). This will enable banks to provide more loans. At the same time, the liquidity level will improve. However, when a bad managed bank faces difficulties to attract deposits, it will need to pay additional interest rate to attract funding in the form of deposits. This will negatively impact their loaning operations and their overall liquidity will decrease.

Based on the theoretical developments regarding the relationship between liquidity risk and bank management skills, we formulate and test the following hypothesis:

Hypothesis II: An increase in the ratio of operating costs to operating incomes negatively impacts bank liquidity.

C. Liquidity risk and bank's capitalization

Reference [25] examines the relationship between capital and liquidity creation among Czech banks. They carry out a series of Granger-causality tests, over the period 2000-2010. Their results support the idea that the requirements of Basel III can lead to the drop of liquidity creation, but on the other hand that greater liquidity creation can decrease banks' solvency. This situation leads to a trade-off between the benefits of financial stability guaranteed by stronger capital requirements and the benefits of greater liquidity creation.

Reference [5] argues that bank capitalization and liquidity are negatively correlated. The main reason behind this negative relationship between bank capitalization and liquidity is that banks' shareholders who are employing a high amount of equity will put a great pressure on the management of the bank in order to enhance the profitability. To do so, bank management is forced to make more profitable investment or to grant more loans with high interest rate. This strategy can be followed through the transformation of a share of their liquid assets, which generate zero to low return, into illiquid assets taking the form of long term loans as well as long term investments generating higher return. Reference [26], for instance, suggest that liquid assets bring low returns. The authors examine the relationship between bank capitalization and the overall liquidity of commercial banks in Central and Eastern European countries (CEE) over the period 2004-2011. They show that the measures adopted by the regulatory and supervision authorities, both at national and European level, in the aim of preventing the negative impact of the global financial turmoil and the internal macroeconomic downturn, had a positive effect on the overall liquidity of the banks.

Regarding the impact of bank capitalization on the overall liquidity of banks operating in the Tunisian banking sector, we would expect that an increase in capital ratio will negatively affect bank liquidity. Using the aforementioned theoretical developments regarding the relationship between liquidity risk and bank capitalization, we formulate and test the following hypothesis:

Hypothesis III: An increase in bank capitalization negatively impacts bank liquidity.

D. Liquidity risk and bank size

The literature on bank liquidity has examined the so called "Too big to fail" hypothesis which relates bank liquidity level to bank size. The related literature argues that bank size is negatively correlated with liquidity ([8]). The so called "Too big to fail" banks tend to hold less liquid assets. This is because large financial institutions expect liquidity assistance of the lender of last resort in case of liquidity shortage. However, small banks have higher liquidity ratios.

Reference [5] argues that, while large banks may attract more deposits from additional clients through the crowding-in effect which has positive impact on the overall liquidity, the opposite impact may also exist when, in long boom periods, large banks tend to apply higher interest rates for loans and lower interest rates for deposits leading a part of their clients to relocate toward smaller banks which are more costumers friendly. This relocation of clients, and therefore their deposits, toward smaller banks will negatively affect large banks' overall liquidity.

Reference [1] argues that bank liquidity is negatively correlated with bank size. The authors state that banks with small scale might take less advantage of the availability of wholesale funding or central bank funding than larger banks. Also, [1] argues that due to their "too-big-to-fail" status, big banks might respond to the moral hazard incentives by taking excessive risks. One example of excessive risk taking by large banks would be to engage in severe transformation ratio loans-to-deposits which leads to a drop of bank liquidity.

Based on the theoretical developments regarding the relationship between liquidity risk and bank size, we formulate and test the following hypothesis:

Hypothesis IV: Bank size negatively impacts bank liquidity.

E. Liquidity risk and bank profitability

Reference [5] argues that banks with high profitability tend to have more liquidity than other banks which are registering lesser returns. This is because the additional returns are not always distributed in the first year they are

obtained. This leads to an increase in retained earnings of the bank which positively impacts its liquidity level. However, lower returns or losses negatively impact the banks' retained earnings, leading therefore to a decrease of the overall liquidity.

Bank profitability might also proxy for the quality of the management of banks ([27]). From this perspective, a bad performance would signal lower quality of bank managers' skills in terms of their capability to raise funding in the form of deposits at reasonable cost which impedes banks' liquidity.

Using the aforementioned theoretical developments regarding the relationship between liquidity risk and bank profitability, we formulate and test the following hypothesis:

Hypothesis V: An increase in bank profitability positively impacts bank liquidity.

F. Liquidity risk and bank's business model

It has been argued by the empirical literature on bank liquidity that business models of banks do have a significant effect on bank liquidity. The two business models that have been discussed by the related literature are: (1) assets management and investment banking, and (2) interest business. Reference [1] suggests that banks which rely on traditional banking activities, mainly those focusing on the lending and deposits taking business have a higher liquidity level than banks with higher share of non-interest income over total income (eg: asset management, investment banking activities). The main reason behind this is that banks focusing on traditional banking activities are able to collect more deposits to fund their lending activities. The empirical related literature has proxied banks' business model through the ratio on non-interest income over total income. A bank with a higher share of this ratio would indicate that it has an investment based business model, whoever, a lower ratio indicates that the bank has an interest based business model.

Based on the theoretical developments regarding the relationship between liquidity risk and bank's business model, we formulate and test the following hypothesis:

Hypothesis VI: The ratio of non-interest income over total income is negatively related to bank liquidity.

III. DATA AND METHODOLOGY

The sample in this paper is composed of the ten largest banks operating in the Tunisian banking sector and holding more than 85% of the total assets of the banking sector. The period of analysis is 2000-2012. We use in this study two datasets containing bank-specific factors and macroeconomic variables. The dataset containing bank-specific factors has been drawn from the Thomson Reuters Eikon database. The macroeconomic variables have been obtained from the National Institute of Statistics.

The empirical literature has used many indicators for bank liquidity. Reference [5] has employed as proxy for liquidity the ratio of loans to total assets. This indicator presents the advantage of being easy to be calculated for all banks included in the sample. Reference [8] uses the most popular indicator for bank liquidity which is computed as the ratio of liquid assets to total assets. Reference [26] considers as a proxy for the liquidity the loans to customer deposits ratio.

In this paper, as we are focusing on the determinants of bank liquidity in Tunisia during the period 2000-2012 and as the new regulation on bank liquidity was introduced in late 2014, we use as indicator of bank liquidity the ratio of weighted current assets over weighted current liabilities as it is defined in the regulation set by the Central Bank of Tunisia (Circular of CBT to banks n°91-24 of 17 December 1991, modified by the circular n° 2001-04 of 16 February 2001). Table I below shows how the bank liquidity ratio is measured based on the regulation set by the Central Bank of Tunisia.

In order to explain the evolution of liquidity of banks operating in the Tunisian banking sector, a set of bank specific factors is used, namely, bank capitalization, loan portfolio quality, management quality, profitability, bank's business model and bank size. The choice of these explanatory variables is motivated by the fact that they are under the control of the bank's management and being influenced by each bank's strategy, so one could analyze how these internal factors affect the overall bank liquidity.

Loan portfolio quality is proxied through the ratio of non-performing loans (NPL) which is calculated as the ratio of bank nonperforming loans to total gross loans. Based on the most commonly used definition, NPLs are defined as the sum of total loans (in principal and/or interests) past due 90 days or more, divided by total (gross) loans. A decline in NPLs suggests an improvement in the bank asset quality. However, when NPLs ratio increases the loan portfolio quality deteriorates.

Bank management quality is measured in this study using the ratio of operating expenses divided by operating incomes to proxy for bank managers' skills. A low value of this ratio indicates that bank managers have good skills in terms of controlling and monitoring their operating expenses (following [27]). Other indicators have been used as proxies of bank management quality in the empirical literature. Reference [5], for instance, use as proxy for bank management quality the ratio of interest expenses to total deposits. A low value of this ratio reflects the capability of the bank management to attract more deposits at lower costs.

Table I Definition of bank liquidity ratio

<i>Numerator: weighted current assets</i>	
<i>Assets</i>	<i>Weight</i>
<i>Cash</i>	<i>100%</i>
<i>Deposits at the Central Bank</i>	<i>100%</i>

<i>Deposits at the commercial banks</i>	100%
<i>Deposits at the Post</i>	100%
<i>Short-term discount portfolio</i>	100%
<i>Advance on time deposits, certificates of deposit and other financial products</i>	100%
<i>Debit accounts of customers</i>	7%
<i>Cash portfolio</i>	100%
<i>State securities</i>	100%
<i>Equity shares in listed companies</i>	100%
<i>Trading and investment securities</i>	100%
<i>Own shares of Credit institution, redeemed by itself, valued at market price</i>	100%
Denominator: weighted current liabilities	
Liabilities	Weight
<i>Loans from the Central Bank of Tunisia including the outstanding balance of debit accounts</i>	100%
<i>Loans from credit institutions including the balance due of current accounts</i>	100%
<i>Average daily credit balance required for banks' current accounts at the CBT</i>	100%
<i>Deposits from specialized financial institutions</i>	100%
<i>Current accounts</i>	60%
<i>Special savings accounts</i>	3%
<i>deposit accounts, certificates of deposit and other financial products</i>	13%
<i>Other amounts due to customers</i>	100%
<i>Certificates of deposit</i>	40%
<i>Accounts payable after receipt of funds</i>	100%

Bank capitalization is calculated as the ratio of net equity divided by total assets (balance sheet and off-balance) net weighted risks following the Circular of the CBT to banks n°1991-24 of 17 December 1991 concerning the division, risk hedging and monitoring of commitments. This Circular states that banks must ensure constantly a solvency ratio which cannot be less than 8%. This ratio was increased to 9% at end 2013 and to 10% the end of 2014.

Bank profitability is measured using return on assets which is defined as the ratio of net income to total assets (ROA). Other accounting-based indicators have been used in the literature to proxy for bank profitability including return on equity (ROE) and net interest margin defined as net interest income divided by total assets. Bank size is measured using the logarithm of bank total assets, following [28]. Reference [5] and [27] use, for instance, bank assets as a percentage of the total banking system as a proxy for bank size.

Bank's business model is proxied in this study using the ratio of non-interest income over total income, following [1]. This indicator reflects whether banks are focusing on the traditional banking activity which is financial intermediation by engaging in lending and deposits taking or on non-traditional banking activities like for instance assets management and investment banking. We also control for macroeconomic variables using information on economic growth and inflation. Table 2 presents the definition of the variables used in this study as well as their expected impact on bank liquidity.

Table 2 Variables definition

<i>Variables</i>	<i>Definition</i>	<i>Expected signs</i>
<i>Dependent variable</i>		
<i>Bank liquidity</i>	$LIQU_{it} = \frac{\text{Weighted Current assets}_{it}}{\text{Weighted Current Liabilities}_{it}}$	
<i>Explanatory variables</i>		
<i>Loan portfolio quality</i>	$NPL_{it} = \frac{\text{Non Performing Loans}_{it}}{\text{Total Loans}_{it}}$	(-)
<i>Bank management efficiency</i>	$EFF_{it} = \frac{\text{Operating Expenses}_{it}}{\text{Operating Incomes}_{it}}$	(-)
<i>Capitalization</i>	$CAR_{it} = \frac{\text{Owned Capital}_{it}}{\text{Risk-Weighted Assets}_{it}}$	(-)
<i>Profitability</i>	$ROA_{it} = \frac{\text{Net income}_{it}}{\text{Total assets}_{it}}$	(+)
<i>Size</i>	$SIZE_{it} = \text{Ln}(\text{Total Assets}_{it})$	(-)
<i>Business model</i>	$BMO_{it} = \frac{\text{Non-Interest income}_{it}}{\text{Total Income}_{it}}$	(-)

We use in this study a panel dataset on 10 Tunisian banks over 13 years (from 2000 to 2012). We regress bank liquidity on a set of bank specific factors including loan quality, bank capitalization, management efficiency, profitability, bank's business model which controls for the impact of banking activity diversification and bank size. We control also for macroeconomic condition by taking into account information on economic growth and inflation rate.

In a second part of the analysis we examine whether the impact of credit risk on liquidity risk varies with different levels of banks' loan portfolio quality. To do so, we sample banks which have poor quality of loan portfolios compared to the whole sample by sampling only those having a NPL ratio which is higher than the sample median. Then we regress bank liquidity on credit risk proxied by NPL ratio and on a set of other bank specific factors. This approach aims at testing whether an increase in credit risk leads to further increased liquidity risk in banks which are facing already a deteriorating loan portfolio quality. For robustness checks, we do the same regression for banks having a NPL ratio less than the sample median.

This analysis tries to examine whether credit risk impacts liquidity risk through the channel of depositors demand ([29]). From this channel's perspective, if banks grant loans to many distressed economic projects, banks' asset value will deteriorate and as a consequence of this depositors will claim back their money leading to a liquidity problem.

We use the specification test of Hausman to find which of the fixed effects or random effect is the appropriate estimation method. The result of the Hausman test provides a p-value of 0.9439 which is greater than the 5% threshold. This implies that we cannot reject the null hypothesis. Thus the appropriate estimation is random effects method.

To avoid any multicollinearity problems we have done a Pearson correlation analysis. The findings suggest that there are no multicollinearity problems between the chosen explanatory variables. Also, in order to avoid endogeneity issue that may arise from a reverse causality problem in the sense that it might be the case that bank liquidity impacts credit risk, we use the lag of NPL variable as regressor instead of the current.

IV. SUMMARY STATISTICS

Table 3 below describes the overview of the bank-specific variables used in this study. We divide the total sample into two subsamples, namely, banks with high liquidity risk and banks with low liquidity risk. We use as threshold, the sample median of the liquidity ratio. Table 3 shows that banks characterized by high liquidity risk have lower Z-score value which means that they are less stable than banks with low liquidity risk. Also, liquidity risky banks have higher credit risk measured using NPL ratio and lower loan and deposit growth rates than banks which have a liquidity ratio below the sample median. Moreover, banks showing high liquidity risk display lower profitability ratio measured using return on assets (ROA), have lower capitalization ratio, are cost inefficient, are relying on interest income source and finally, have lower size.

Table 3 Overview Of The Variables Used In This Study

	Banks with high liquidity risk	Banks with low liquidity risk	Total sample
Number of observations	65	65	130
Z-score	2.47 (1.17)	3.32 (0.23)	2.90 (0.94)
Liquidity ratio	98.38 (14.24)	122.2 (23.87)	110.3 (22.94)
NPL	22.42 (10.89)	12.7 (5.39)	17.60 (9.83)
Loangrowth	9.61 (8.67)	12.21 (10.11)	10.91 (9.47)
Depositgrowth	9.12 (8.0)	11.16 (8.70)	10.14 (8.389)
ROA	0.64 (1.79)	1.45 (0.93)	1.05 (1.48)
Capital ratio	9.76 (2.61)	11.88 (3.48)	10.82 (3.24)
Costinefficiency ratio	41.02 (8.32)	38.55 (6.23)	39.78 (7.43)
NNI	25.44 (5.63)	26.82 (8.05)	26.13 (6.95)
Total assets	2947.0 (1722.7)	3602.918 (1752.1)	3274.9 (1761.7)

Note: The table shows a descriptive overview of the data for two subsamples, namely, banks with high liquidity risk and banks with low liquidity risk. We use as threshold, the sample median of the liquidity ratio. The table provides variables means. The standard deviations are shown in parentheses below each variable. Z-score is defined as the logarithm of the ratio of the summation of return on assets and capital ratio divided by the standard deviation of return on assets. NPL ratio is calculated as nonperforming loans divided by total loans. Loan growth is the annual growth rate of total loans. Deposit growth is the annual change in total deposits. ROA is return on assets. Capital ratio is calculated as owned capital divided by risk weighted assets. Cost inefficiency ratio is defined as operating expenses divided by operation income. NNI ratio is calculated as non interest income divided by total income. Totals assets are displayed in millions. Liquidity ratio is defined as currents weighted assets over current weighted liabilities. The period of analysis in this section is 2000-2012.

Table 4 presents the pairwise correlation between the variables used in this study. For the dependent variable, the results show that bank liquidity is significantly and negatively correlated with problem loans. This is what should be expected as a decrease of loan portfolio's quality due to an increase in NPL ratio, will negatively affect the overall bank liquidity. Bank liquidity has a significant and positive correlation with bank size. This is what should not be expected as large banks tend to hold less liquid assets as they expect liquidity support from the lender of last resort in case of liquidity shortage. This positive correlation between bank size and bank liquidity can be explained by the crowding-in effect which allows large banks to attract additional clients and therefore more deposits leading to an increase in the overall liquidity of the bank. However, bank liquidity is not significantly correlated with bank capitalization, bank management efficiency, activity diversification and bank profitability. The obtained results suggest that there are not multicollinearity problems between the selected explanatory variables.

Table 4 Pairwise correlation between variables

	LIQU	CAR	NPL	EFF	ROA	SIZE	BMO
LIQU	1.00						
CAR	-0.01 (0.90)	1.00					
NPL	-0.23 (0.008)	-0.40 (0.00)	1.00				
EFF	0.02 (0.80)	-0.26 (0.002)	0.48 (0.00)	1.00			
ROA	-0.07 (0.38)	0.06 (0.45)	-0.006 (0.94)	-0.001 (0.99)	1.00		
SIZE	0.95 (0.00)	-0.02 (0.81)	-0.17 (0.04)	0.13 (0.11)	-0.05 (0.55)	1.00	
BMO	-0.08 (0.35)	0.04 (0.62)	-0.12 (0.15)	-0.11 (0.20)	-0.15 (0.08)	-0.03 (0.65)	1.00

Note: values in parentheses represent the significance level of correlations. A value of 0.05 or lesser means that there is a high likelihood that the two variables have a significant non zero relationship.

V. EMPIRICAL RESULTS

In order to analyze the impact of bank specific factors on the liquidity variable for the banks included in our sample, we have employed a Random-Effects regression analysis. Table 5 shows the obtained results.

The results shown in Table 5 display a negative association between bank liquidity and non-performing loans ratio (NPL). This result indicates that an improvement of the loan portfolio's quality, due to a decrease in the ratio of non-performing loans to total loans, positively impacts the overall liquidity of banks. On the other hand, an increase in nonperforming loans, which means an increase in credit risk, would lead to a decrease in bank liquidity, which means an increase in liquidity risk. This positive relationship between the two major banking risks, namely credit risk and liquidity risk, can be explained by the fact that when the ratio of credit default increases, bank liquidity decreases because of the lowered cash inflow and the depreciations it causes ([15]). However, the coefficient of loan portfolio quality proxied by the ratio of non-performing loan is not significant which does not support our first hypothesis stating that an increase in NPLs negatively impacts bank liquidity.

The regression analysis results show a negative association between bank liquidity and capital adequacy ratio. This negative association between these two variables can be explained by the shareholders requirement of higher bank profitability when they are asked to increase their participation. To meet the shareholders desire, bank managers are constrained to invest in illiquid long term assets which have a higher return instead of holding liquid assets which provide zero to low returns. By following this investment strategy the overall bank liquidity decreases. However, the coefficient of bank capital ratio is not statistically significant which does not support our first hypothesis which states a presumed negative relationship between bank liquidity and bank capitalization.

Also, the regression analysis displays a negative relationship between bank liquidity and management efficiency which is strongly significant. This result supports our third hypothesis. Banks which are efficiently managed, having lower operating costs relative to operating incomes, are able to attract deposits at a lower rate. This will enable banks to grant more loans. At the same time, the bank liquidity level will increase. Nevertheless, bad managed bank, having higher operating costs relative to operating incomes, will face difficulties to attract customer deposits unless they pay additionally interest rate to attract funding in the form of deposits. This will have a negative impact on their loaning operations as well as on their overall liquidity.

The bank size coefficient is positive and significant. This is not what should be expected. This result does not support our fifth hypothesis which states that the so called "Too big to fail" banks tend to hold less liquid assets as they expect liquidity assistance of the lender of last resort in case of liquidity shortage.

The coefficient of the variable business model is negative and statistically significant. This variable reflects the level of banking activity diversification computed as non-interest income divided by total income. This finding indicates that banks relying on traditional banking activities, mainly those focusing on the lending and deposits taking business, have a

higher liquidity level than banks with higher share of non-interest income over total income (eg: asset management, investment banking activities). This can be explained by the fact that banks focusing on traditional banking activities are able to collect more deposits to fund their lending activities. This result supports our sixth hypothesis suggesting that the ratio of non-interest income over total income is negatively related to bank liquidity.

Table 5 Regression analysis results

Random-effects GLS regression			Number of obs = 130			
					Number of groups = 10	
R-sq:	within = 0.8970					
	between = 0.9711					
	overall = 0.9379					
LIQU	Coef.	Std. Err.	Z	Prob.	[95% Conf.	Interval]
NPL (t-1)	-0.33	0.47	-0.70	0.481	-1.25	0.592
CAR	-1.65	1.11	-1.49	0.137	-3.83	0.52
EFF	-2.31***	0.52	-4.42	0.000	-3.34	-1.28
ROA	2.12	2.04	1.04	0.297	-1.87	6.21
SIZE	182.6***	8.55	21.3	0.000	165.8	199.3
BMO	-1.20***	0.46	-2.60	0.009	-2.11	-0.29
GDP (t-1)	1.38	1.08	1.28	0.201	-0.74	3.51
INFLA (t-1)	-3.64	3.28	-1.11	0.267	-10.08	2.79
CONS	-1074.89	66.7	-16.1	0.000	-1205.7	-944.0

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is LIQU: Liquidity ratio which is defined as the ratio of weighted current assets over weighted current liabilities as it is defined in the regulation set by the Central Bank of Tunisia (Circular of CBT to banks n°91-24 of 17 December 1991, modified by the circular n° 2001-04 of 16 February 2001). NPL: nonperforming loans ratio is calculated as nonperforming loans divided by total gross loans. CAR: capital ratio is calculated as owned capital divided by risk weighted assets. EFF: Cost inefficiency ratio is defined as operating expenses divided by operation income. ROA is return on assets. Size is computed as the logarithm of bank's total assets. BMO: business model is measured by the ratio of non interest income divided by total income. GDP: is the gross domestic product annual growth. INFLA: is the annual inflation rate.

However, bank profitability proxied by ROA and lagged macroeconomic variables namely economic growth and inflation rate do not seem to have a significant explanation power of the evolution of the liquidity indicator of Tunisian banks.

In order to examine whether the impact of credit risk on liquidity risk varies with different levels of banks' loan portfolio quality, we take into consideration in the regression banks which have poor quality of loan portfolios by sampling only those having a NPL ratio which is higher than the sample median. This is to test whether an increase in credit risk leads to further increased liquidity risk in banks which are facing already a deteriorating loan portfolio quality. This approach tries to examine whether credit risk impacts liquidity risk through the channel of depositors demand ([29]) which argues that if banks grant loans to many distressed economic projects, banks' asset value will deteriorate and as a consequence of this depositors will claim back their money leading to a liquidity problem.

The results provided in Table 6 show that among banks which are facing a deteriorating loan portfolios quality, a further increase in credit risk leads to an increase in liquidity risk. This result supports the channel of depositors demand ([29]) which relates liquidity risk to the depositors' claims to take back their money when banks are facing huge deterioration of loan portfolios' quality due to the excessive risk taking when they grant loans to many distressed economic projects.

When we consider only banks which have a NPL ratio higher than the sample median, the results for the other bank specific factors remain the same except for the coefficient of the variable business model which is still negative but no longer statistically significant. We do the same regression for banks having a NPL ratio less than the sample median. The results do not show a significant relationship between credit and liquidity risks.

Table 6 Regression Analysis Results (Robustness Checks)

Random-effects GLS regression			Number of obs = 62			
					Number of groups = 9	
R-sq:	within = 0.8417					
	between = 0.9672					
	overall = 0.9447					
LIQU	Coef.	Std. Err.	Z	Prob.	[95% Conf.	Interval]
NPL (t-1)	-0.72*	0.40	-1.78	0.075	-1.51	0.07
CAR	1.41	1.30	1.08	0.278	-1.14	3.98
EFF	-1.39***	0.52	-2.62	0.008	-2.42	-0.36
ROA	2.18	2.11	1.03	0.302	-1.96	6.33

SIZE	171.5***	7.15	23.9	0.000	157.5	185.5
BMO	-0.83	0.51	-1.62	0.106	-1.84	0.177
GDP (t-1)	2.40	1.69	1.42	0.157	-0.922	5.72
INFLA (t-1)	0.19	4.51	0.04	0.966	-8.64	9.03
CONS	-1070.8	55.49	-19.3	0.000	-1179.6	-962.1

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The variables definition is provided below the Table 5. This regression takes into consideration only banks facing deteriorating quality of their loan portfolios as it is proxied by a NPL ratio which is higher than the sample median.

VI. CONCLUSION

In this study we examine the determinants of liquidity risk in the Tunisian banking sector considering bank specific factors including banks' loan portfolios quality, management quality, capital adequacy, bank size, bank's business model and profitability over the period 2000-2012.

We find an evidence for the hypothesis suggesting a positive and significant relationship between bank loan portfolio's quality (low NPL ratio) and bank liquidity. However, this holds only for banks which are facing a deteriorating loan portfolios quality (with a NPL ratio higher than the sample median). Therefore, we find evidence for the channel of depositors demand ([29]) which relates liquidity risk to the depositors claims to take back their money when banks are facing huge deterioration of loan portfolios' quality due to the excessive risk taking when expand their lending activities to a lower quality of borrowers undertaking distressed economic projects.

We find also an evidence for the hypothesis suggesting a negative relationship between bank liquidity and management efficiency. This result indicates that banks which are efficiently managed are able to attract deposits at a lower rate leading therefore to an increase in their liquidity level. Also, our analysis shows that banks which rely mostly on traditional banking activities, mainly lending activity, have lower liquidity risk.

One policy implication of this analysis for banking supervision institutions is to reshape the methodology of computing the liquidity ratio in way that takes into consideration the heterogeneity among banks in terms of management efficiency and business model. One possible direction would be to set higher regulatory level of liquidity for banks with poor skills in terms of management efficiency as well as for those relying mostly on noninterest activities.

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