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Review

The effects of liquidity risk and credit risk on bank stability: Evidence from the MENA region

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Abstract

The global financial crisis has induced a series of failures of most conventional banks. This study investigates the main sources of banking fragility. We use a sample of 49 banks operating in the MENA region over the period 2006−2013 to analyze the relationship between credit risk and liquidity risk and its impact on bank stability. Our results show that credit risk and liquidity risk do not have an economically meaningful reciprocal contemporaneous or time-lagged relationship. However, both risks separately influence bank stability and their interaction contributes to bank instability. These findings provide bank managers with more understanding of bank risk and serve as an underpinning for recent regulatory efforts aimed at strengthening the joint risk management of liquidity and credit risks.

JEL Classification: F3; G21; O16; 053

Keywords: Credit risk; Liquidity risk; Bank stability; MENA region

1. Introduction

The recent financial crisis has led to bank failures that have had a negative impact on the real economy. Therefore, a particular attention to the consequences of financial instability on the economy has been established (Agnello & Sousa, 2012). Furthermore, in an environment characterized by market imperfections, it is imperative to protect the depositors against bank failures (Dewatripont & Tirole, 1994). Consequently, the banking system needs to identify the sources of banking fragility. On the other hand, banks are exposed to several financial risks. According to Cecchetti and Schoenholtz (2011), these financial risks include the chance that depositors will suddenly withdraw their deposits (liquidity risk), borrowers will not repay their loans on time (credit risk), interest rates will change (interest rate risk), the bank's computer systems will fail or their buildings will burn down (operational risk). Nevertheless, among these risks, credit and liquidity risks are not only the most important risks that banks face, but they are also directly linked to what banks do and why banks fail.

What is the relationship between liquidity and credit risk in banks? The classic theories of the microeconomics of banking support the view that liquidity and credit risks are closely linked. Both industrial organization models of banking, such as the Monti-Klein framework and the financial intermediation perspective in a Diamond and Dybvig (1983) or Bryant (1980) setting, show that a bank's asset and liability structures are closely connected, particularly, with regard to the fund withdrawals and borrower defaults. In their financial intermediation, banks create liquidity in the economy, either from their balance sheets by generally financing risky projects using the deposits of their clients, or from off-balance sheets, by

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opening credit lines (Holmstrom & Tirole, 1998; Kashyap et al., 2002). Based on these models, a body of literature has recently evolved focusing on the interaction between liquidity and credit risks and their implications on the banking stability (Acharya & Mora, 2013; Acharya & Viswanathan, 2011; Acharya, Shin, & Yorulmazer, 2010; Cai & Thakor, 2008; Gatev, Schuermann, & Strahan, 2009; Goldstein & Pauzner, 2005; Gorton & Metrick, 2011; He & Xiong, 2012a,b; Imbierowicz & Rauch, 2014; Wagner, 2007).

Anecdotal evidence from bank failures during the global financial crisis further supports these theoretical and empirical results. According to official reports of the FDIC[1] and OCC,[2] the majority of commercial bank failures during the recent financial crisis is caused by the joint occurrence of liquidity and credit risks. Dermine (1986) find that as liquidity risk is seen as a profit-lowering cost, a loan default increases this liquidity risk because of the lowered cash inflow and depreciations it triggers. Therefore, according to the literature, liquidity and credit risks are positively correlated. However, during the crisis, banks moved from a risk of withdrawal of deposits, or even from bank runs, to a risk of drying up other funding sources, specifically the interbank market (Borio, 2010; Huang & Ratnovski, 2011). On the other hand, due to the information asymmetries in the loan market, banks were exposed to credit risk (Heider et al., 2009). Therefore, a mutual reinforcement between credit and liquidity risks resulting in bank failures has been witnessed.

In this context, the liquidity problems, even self-reinforcing between credit and liquidity risks, appear to have played a major role in the amplification of banking failures. In light of these facts, it seems important to consider the influence of interdependence between liquidity and credit risks on the soundness of banks. Moreover, authors like (Acharya & Mora, 2013; Acharya, Mehran, & Thakor, 2016; Brunnermeier, Crocket, Goodhart, Persaud, & Shin, 2009; Calomiris, Heider, & Hoerova, 2015; Distinguin, Roulet, & Tarazi, 2013; He & Xiong, 2012c; Imbierowicz & Rauch, 2014; Vazquez & Federico, 2015) suggest that liquidity and credit risks can be jointly regulated. Tirole (2011) and Acharya, Shin, and Yorulmazer (2011) propose to explicitly regulate liquidity. Yet, when banks are heavily dependent on the interbank market, increasing capital requirements can be interpreted as a prudential measure of both insolvency and liquidity risks.

Even if He and Xiong (2012c), Hieider et al. (2009), and Acharya and Viswanathan (2011) have already showed that credit and liquidity risks simultaneously interact and influence the stability of banks, this empirical work examine, in addition, how credit and liquidity risks affect banking stability. One can mention the contribution of Imbierowicz and Rauch (2014), which from a sample of US commercial banks, show that credit and liquidity risks jointly influence the soundness of banks and Vazquez and Federico (2015) which on the basis of a set of European and American banks, conclude that a simultaneous exposure to credit and liquidity risks amplifies the difficulties of the banks during the crisis. Nevertheless, this paper provides a complementary approach by empirically analyzing the issue above in the banking system of the MENA region.

We examine the influence of liquidity and credit risks on bank stability employing an extended sample period since the recent financial crisis. One of the issues behind the motivation of this paper is examining the relationship between liquidity risk and credit risk and also how two categories of risk influence bank stability. In a first step, we investigate whether there is a reciprocal relationship between liquidity risk and credit risk, and if this relationship is positive or negative. On the light of this first result, we test, in a second step, if liquidity and credit risks individually and/or jointly contribute to bank instability.

The scarcity of studies that analyze the impact of liquidity and credit risks on banking stability in the Middle East and North Africa (MENA) countries during the recent financial crisis begs the issue about their behavior. Most studies employed credit risk and/or liquidity risk as the determinants of bank stability, but the emphasis has not been on cyclical effects of these risks. Thus, we have chosen the MENA region for several reasons. First, credit growth rates in the MENA countries have been more volatile, which may raise concerns about the stability of the financial system, and in particular, a higher credit growth is often followed by the financial crisis (Crowley, 2008). Second, the MENA countries attract bankers and investors worldwide. This strategic position makes the MENA region more susceptible to political instability and thus to economic and financial instability. Third, the MENA region is facing numerous changes, such as the commercial banks, which operate alongside and compete with their Islamic counterparts, the opening up of certain markets to foreign competition and the increased role of bank lending. Therefore, it is necessary to analyze the effect of credit and liquidity risks on banking stability in the MENA region.

In view of the crucial role played by banks in the economies of the MENA region, it is important to maintain their stability. Despite the ongoing debate on the importance of the relationship between risk and stability, there are no empirical studies that have examined the impact of credit and liquidity risks on bank stability in the MENA region. Our study differs from the previous studies because as far as we know, no existing studies have employed the Z-score rather than the commonly used the default probability variable as the dependent variable in the literature. However, we define bank stability is equal to the mean of return on assets plus the capital asset ratio (equity capital/total assets) divided by the standard deviation of asset returns, this definition is a better proxy to capture the bank stability.

The present paper's modest contribution lies in providing bankers with some tools whereby bank stability can be more effectively managed through staff monitoring of the credit and liquidity risks involved factors. Indeed, bank managers may take advantage of recognizing the defects and try to re-conduct

[1] Federal Deposit Insurance Corporation.
[2] Office of the Comptroller of the Currency.

the credit and liquidity risks management strategies for preventing a similar financial crisis in the future.

In this context, this paper is structured as follows. Section 2 presents a brief overview of the literature. Section 3 outlines the econometric modeling approach and describes the used data. Section 4 reports and discusses the empirical results. Section 5 concludes this paper and offers some policy implications.

2. Literature review

2.1. The reciprocal relationship between liquidity risk and credit risk

According to Dermine (1986), liquidity risk is seen as a profit-lowering cost. A loan default augments liquidity risk because of the lowered cash inflow and depreciations it triggers. Based on the theory financial intermediation (Bryant, 1980; Diamond & Dybvig, 1983) and the industrial organization approach to banking, which features in the Monti-Klein model of banking organizations (Prisman, Slovin, & Sushka, 1986), there is a relationship between liquidity and credit risk. According to Samartin (2003) and Iyer and Puri (2012), based on these models, show that risky bank assets trigger bank shocks. Based on these models, liquidity and credit risk should be positively related and jointly contribute to bank instability.

Diamond and Rajan (2005) show that there is a positive relationship between liquidity and credit risks. They clarify that if too many economic projects are funded with loans the bank cannot meet the demand of the depositors. Thus, these depositors will claim back their money if these assets deteriorate in value. This implies that liquidity and credit risks increase simultaneously.

The bank will use all the loans and reduce the overall liquidity. The result is that higher credit risk accompanies higher liquidity risk by depositors' demand. Financial companies raise debts that must be constantly renewed and used to finance assets as more debts in the banking system provide a higher « bank-run » risk (Acharya & Viswanathan, 2011). Nikomara, Taghavi, and Diman (2013) study the relationship between credit and liquidity risks for Iranian banks. The proposed study includes all the private and government banks over the period 2005—2012. They conclude that there is a positive and significant relationship between credit and liquidity risks.

On their part, Ejoh, Okpa, and Inyang (2014) examine the relationship and the effects of credit and liquidity risks on the default probability of Nigerian banks. The study includes the First Bank of Nigeria Plc and adopts the design of experimental research where questionnaires are destined to a sample of eighty respondents. They find that there is a positive relationship between liquidity risk and credit risk.

Imbierowicz and Rauch (2014) test the relationship between liquidity risk and credit risk in the US banks. Their study includes a sample of all commercial banks in the United States during the period 1998—2010. They show that a positive relationship between liquidity risk and credit risk, but no reciprocal relationship between both risks.

Louati, Abida, and Boujelbene (2015) examine and compare the behavior of Islamic and conventional banks in relation to the ratio of the capital adequacy. The authors use data from 12 MENA and South East Asian countries over the period 2005—2012. They show that there is a significant negative relationship between liquidity ratio and credit risk of conventional banks. Laidroo (2016) study the differences in foreign-owned banks' loan growth and its determinants in comparison with privately-owned domestic banks. Their study includes a sample of the Central and Eastern European (CEE) bank-level data during the period 2004—2012. These authors find that bank capital remains an important loan growth determinant for domestic private banks during the non-crisis periods, whereas bank liquidity is of greater importance to domestic private banks during the crisis periods. Based on the theoretical and empirical studies discussed above, our hypotheses concerning the relationship between liquidity and credit risks are:

H1. There is an interdependency between credit risk and liquidity risk.

H2. Liquidity and credit risks have a positive relationship, i.e. liquidity and credit risk jointly increase or decrease.

2.2. The influence of liquidity risk and credit risk on bank stability

A body of empirical literature such as Rashid and Jabeen (2016) examine the bank-specific, financial and macroeconomic determinants of the performance of Islamic and conventional banks in Pakistan over the period 2006—2012. They find that operating efficiency, overheads and reserves are significant determinants of conventional banks' performance, whereas deposits, operating efficiency, and market concentration are significant determinants of Islamic one. They also conclude a impact of GDP and the lending interest rate on performance for Islamic and conventional banks.

Meyer and Pfifer (1970), Martin (1977), Espahbodi (1991), and Kolari, Glennon, Shin, and Caputo (2002) show that banks' default risk is mainly driven by low capitalization, low earnings, over-exposure to certain categories of loans and excessive loan defaults. Cole and White (2012), and DeYoung and Torna (2013) find that excessive investment banking activities, low equity, heavy concentration and bad macroeconomic conditions in the banks' immediate vicinity in commercial real estate loans increase banks' PDs during the financial crisis. They found that credit risk plays an important part in the bank stability, but largely ignores liquidity risk.

Nevertheless, as stressed by Acharya et al. (2016), Bouwman (2013), and Calomiris et al. (2015), the banking regulatory tools may be substitutable. On the basis of a theoretical model characterized by asset substitution and managerial pursuit of private benefits problems, Acharya et al. (2016) suggest an optimal capital regulation of banks. For them, to deal with these two problems, the optimal regulatory of capital requires a capital charge on two levels. On the first level, the minimum capital which will face the asset substitution problem reduces the leverage. However, they undermine market discipline. On the second level, the callable capital will eliminate this alteration. However, it should be invested in risk-free assets (cash). Thus, the authors showed that with these capital requirements at two levels, the banking system is more stable.

Brunnermeier et al. (2009) suggest that the increase of capital requirements can simultaneously manage the liquidity and solvency risks of banks. Following Ratnovski (2013), banks' refinancing problems may be due to solvency problems. This induces that the simultaneous combination of liquidity and transparency requirements on solvency would solve the problem of refinancing of banks.

On the other hand, Calomiris et al. (2015) develop a theory on banking liquidity requirement where they show that banks should be regulated on the side of the assets instead of that of the capital. For them, banks should hold more liquid assets that would enable them to face liquidity risk and better manage and monitor the risks to which they are exposed. However, the interaction between credit and liquidity risks influences the stability of banks.

More recently, Hassan et al. (2016) argue that a capital adequacy ratio of the banks leads to decrease substantially given the stress scenarios of banks in Turkey over the period January 2006 to October 2014.

Berger and Bouwman (2009) empirically show that the 2007 banking crisis was preceded by a substantial creation of liquidity of US banks. Vazquez and Federico (2015) analyze the relationship between the structure of liquidity and the leverage practiced by banks and the impact on their stability during the financial crisis. They showed that banks with a low liquidity structure (risk level of high liquidity) and a high leverage before the crisis were most at risk of bankruptcy. Demirguç-Kunt and Huizinga (2010) find that the dependence of banks on the interbank market increases the probability of their bankruptcy.

Ozsuca and Akbostanci (2016) examine the bank-specific characteristics of risk-taking behavior of the Turkish banking sector as well as the existence of risk-taking channel of monetary policy in Turkey over the period 2002–2012. The authors conclude that large, liquid and well-capitalized banks are less prone to risk-taking.

Extending the model of Leland (1994) and Leland and Toft (1996), He and Xiong (2012c) show that, in the context of corporate debt renewal, the deterioration of the market liquidity leads to an interaction between liquidity and credit risks which are characterized by an increase of the risk premium of liquidity and credit. This interaction leads to the increase of business failure risk. Berger and Bouwman (2013) test the role of the regulatory capital in improving the resilience of banks during the crisis, and find that capital reduces the probability of bank failure.

Imbierowicz and Rauch (2014) analyze the relationship between liquidity and credit risks, and their impact on the soundness of 4300 US commercial banks over the period 1998–2010, including 254 failures banks during the crisis. The results show that credit and liquidity risks jointly influence the banks' default probability. Moreover, Ejoh et al. (2014) examine the effects of credit and liquidity risks on Nigerian banks' default probability. The study include the First Bank of Nigeria Plc and the Pearson's correlation reveal that there is a joint influence of liquidity and credit risks on the banking default probability.

The role of banks as liquidity providers is very important during the financial crisis (Acharya & Mora, 2013). They provide evidence that banks which failed during the recent financial crisis suffered from liquidity shortages right before the actual default. The study shows that banks which failed or nearly failed attract deposits by offering high interest rates. Indirectly, the results indicate that the joint presence (occurrence) of the liquidity and credit risks could push banks into default. Based on the empirical and theoretical studies, our third hypothesis is as follows:

H3. Liquidity risk and credit risk jointly contribute to the banking instability.

3. Econometric modeling and data

3.1. Econometric modeling

We use some complementary methods to assess the effect of credit and liquidity risks on the banking stability. We first investigate the relationship between credit and liquidity risks. This analysis addresses the problem that the direction of influence is not clear and has received a great deal of attention during the past years (Imbierowicz & Rauch, 2014). To account for possible reciprocal or lagged relationships between the variables, we employ a simultaneous-equation approach and PVAR model. Second, we check for the effect of liquidity and credit risks on the banking stability by employing the generalized method of moment (GMM).

3.1.1. Two-stage least squares (2SLS)

To examine the causal relationship between credit and liquidity risks, we use the simultaneous equation approach:

$$CR_{i,t} = C + \beta_1 CR_{i,t-1} + \beta_2 LR_{i,t} + \sum_{j=1}^{J} \beta_j Bank_{i,t}^{j} + \sum_{l=1}^{L} \beta_l Macro_t^{l} + \mathscr{E}_{i,t} \quad (1)$$

$$LR_{i,t} = C + \beta_1 LR_{i,t-1} + \beta_2 CR_{i,t} + \sum_{p=1}^{P} \beta_p Bank_{i,t}^{p} + \sum_{q=1}^{Q} \beta_q Macro_t^{q} + \mathscr{E}_{i,t} \quad (2)$$

where $i = 1, \ldots N$ denotes the bank and $t = 1, \ldots \ldots .T$ denotes the time period.

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CR_{it} and LR_{it} represent, respectively, the credit risk and liquidity risk of bank i at time t. $Bank^{j}_{i,t}$ and $Bank^{p}_{i,t}$ represent the bank-specific control variables, namely the size of the bank, the return on assets (ROA), the return on equity (ROE), the capital adequacy ratio (CAR), the net interest margin (NIM), the liquidity gaps, the asset growth, the income diversity, the crisis, and the efficiency. $Macro^{j}_{t}$ represents the real GDP growth, and the inflation rate. These variables have been established by the researches on credit risk and liquidity risk, such as Akhtar, Ali, and Sadaqat (2011), Anam, Bin Hasan, Huda, Uddin, and Hossain (2012), Berger and DeYoung (1997), Bonfim (2009), Eklund, Larsen, and Bernhardsen (2001), Iqbal (2012), Kabir, Worthington, and Rakesh (2015), Louzis, Vouldis, and Metaxas (2012), Misman, Bhatti, Lou, Samsudin, and Abd Rahman (2015), Muharam and Kurnia (2012), Munteanu (2012), Tan (2015), and Zhang, Cai, Dickinson, and Kutan (2016).

3.1.2. Panel vector auto-regression model

As the direction of influence is not clear and with regard to a possible lagged relationship we employ a panel vector autoregression (PVAR) model developed by Love and Zicchino (2006) to investigate the causal relationship between credit risk and liquidity risk. The PVAR is that it accounts for individual bank specificity in the level of the variables by introducing fixed effects (u_i). The model is written as:

$$y_{i,t} = u_{i,t} + \Theta(L)y_{i,t} + \mathscr{E}_{i,t} \qquad (3)$$

where $\Theta(L)$ is the lag operator and $y_{i,t}$ is a vector of variables.

3.1.3. Modeling Z-score

This paper follows the empirical specification proposed by Imbierowicz and Rauch (2014), which can be expressed as follows:

$$\begin{aligned} z - score_{it} = {} & \beta_0 + \beta_1 Z - score_{it-1} + \beta_2 liquidity\ risk_{it} \\ & + \beta_3 credit\ risk_{it} + \beta_4 liquidity\ risk{*}credit\ risk_{it} \\ & + \beta_5 size_{it} + \beta_6 ROA_{it} + \beta_7 CAR_{it} \\ & + \beta_8 loan\ growth_{it} + \beta_9 efficiency_{it} \\ & + \beta_{10} income\ diversity_{it} + \beta_{11} Inf_t + \beta_{12} GDP_t \\ & + \beta_{13} crisis_{it} + \xi_{it} \end{aligned} \qquad (4)$$

where i represents the bank (in our study, we have 49 conventional banks); t represents the time (our time frame is 2006–2013); $Z - score_{it}$ stands for the bank stability at time t; $Zscore_{it-1}$ is the first lagged dependent variable which captures the persistence in bank stability over time. β_0 is the parameter to be estimated; the ROA represents the return on asset, CAR is the capital adequacy ratio, Inf is the inflation rate, and GDP is the real GDP growth, and crisis to check the possible pressure in the 2007 financial crisis period; and ξ is the error term. β_2, β_3, β_4, β_5, β_6, β_7, β_8, β_9, β_{10}, β_{11}, β_{12}, *and* β_{13} are coefficients to be estimated using one-step dynamic panel estimation performed by the general method of moments (GMM) developed by Blundell and Bond (1998). Actually, these variables have been established by the papers on banking risk and bank stability, such as Cole and Gunther (1995), Acharya and Viswanathan (2011), Cole and White (2012), and He and Xiong (2012b) for the accounting variables, and Thomson (1992) and Aubuchon and Wheelock (2010) for the macroeconomic variables.

3.2. Data sources and descriptive statistics

This paper considers MENA countries' banks. The banking annual reports are taken from the Bureau van Dijk Electronic banking database (Bankscope). The data on macroeconomic and country specific variables are obtained from the World Bank Development Indicators. The data panel includes 49 banks from 8 countries, namely Bahrain, Jordan, Qatar, Saudi Arabia, Turkey, UAE, Kuwait, and Yemen over the period 2006–2013. We choose this period because it includes the financial crisis period. In fact, this period is between the Lehman Brothers collapse which spurred the recent financial crisis and political uncertainty, and the end of these crises. Actually, the majority of commercial banks went bankrupt during the recent crisis. Imbierowicz and Rauch (2014) show that many banks were partly caused by the joint occurrence of liquidity and credit risks. This suggests that these categories of risk play an important role for banks and their stability.

The banking variables describe the internal and external variables which are considered to be explanatory variables. The dependent variable is measured using the Z-score. In this study, we use the Z-score as a measure of bank stability, which measures a bank's distance to insolvency. According to the approach proposed by Roy (1952), Blair and Heggestad (1978), and Boyd and Graham (1988), this variable is inversely related to the probability of default. It is denoted as follows:

$$Z = \frac{(u + k)}{\sigma}$$

where u: average performance of the bank's assets (ROA). The ROA is the return on asset, and the standard deviation of the ?? OA calculated moving averages eight periods.K: equity as a percentage of total assets.σ: standard deviation of ROA as a proxy for the volatility of returns.

A Z-score increase expresses a decrease of banks' probability of bankruptcy. For reasons of asymmetry, we use the log of the Z-score as in Laeven and Levine (2009) and Houston, Lin, Lin, and Ma (2010).

In short, Table 1 presents the different variables and their corresponding specific measures.

The descriptive statistics of the mean value and the standard deviation (Std. Dev.) of these different variables of banks operating in the MENA region are recorded below in Table 2.

Table 1
Description of the used variables.

Independent variables	Measures
Internal factors	
CAR	Capital to Asset
Credit risk	Impaired Loans/Gross Loans
ROE: return on equity	Net Income to equity
NIM	Net Interest Income to Earning Assets
Liquidity gaps	Logarithm of (Assets-Liabilities)
ROA: return on asset	Net Income/Total Assets
Size of the Bank	Logarithm of total Assets
Liquidity	Liquid assets to total Assets ratio
Loan growth	$\left(\frac{loant-loant-1}{loant-1}\right)$
Crisis dummy	1 in the financial crisis period, i.e. from 2007
Loan assets	net loans to total assets
Efficiency	Cost to income ratio
Income diversity	$\left\|1-\frac{net\ interest-income-other\ operating}{total\ operating\ income}\right\|$
External factors	
Inflation rate	Consumer Price Index
GDP	GDP Relative real Growth GDP

CAR Capital Adequacy Ratio, *ROA* Return On Assets, NIM Net Interest Margin, and *GDP* the real growth GDP.

The average of liquidity risk in banks is 0.090; the average of credit risk is 5.294, the average of income diversity is 3.172, the average of size is 4.029%, and the ROA is 1.459%. Indeed, the CAR is 11.719%. Regarding the interaction between liquidity and credit risks, the Z-score, the loan growth, the loan assets, the ROE, the NIM, the liquidity gaps, the inflation, and the GPD, there are 2.57, 4.461, 0.562, 10.992, 0.045, 3.143, 2.097, and 5.361 respectively. Finally, banks have the highest volatility in ROE, CAR, credit risk, GDP, ROA, credit risk*liquidity risk, income diversity, loan growth, Z-score, size, liquidity gaps, crisis, NIM, efficiency, loan assets, liquidity risk, and inflation inflows by 27.95, 13.429, 9.815, 5.087, 2.533, 2.286, 1.339, 1.251, 1.096, 0.845, 0.842, 0.221, 0.434, 0.154, 0.134, 0.091, and 0.071 respectively.

Table 2
Descriptive statistics of variables.

	Obs	Mean	Std. dev.
Liquidity	392	0.090	0.091
Credit risk	392	5.294	9.815
Credit risk*liquidity risk	392	0.628	2.286
ROA	392	1.459	2.533
Z-score	392	2.57	1.096
Size	392	4.029	0.845
CAR	392	11.719	13.429
Loan growth	392	4.461	1.251
Income diversity	392	3.172	1.339
Efficiency	392	1.55	0.134
Crisis	392	0.25	0.433
Loan assets	392	0.562	0.154
ROE	392	10.992	27.95
NIM	392	0.045	0.221
Liquidity gaps	392	3.143	0.842
inflation	392	2.097	0.071
GDP	392	5.361	5.087

Notes: Std. dev. is standard deviation, CAR is Capital Adequacy Ratio, ROA is Return On Assets, NIM is Net Interest Margin.

4. Results and discussions

4.1. The relationship between credit risk and liquidity risk

In this subsection and before analyzing the effect of credit and liquidity risks on banking stability, it is first necessary to verify the existence or non-existence of a reciprocal relationship between credit and liquidity risks in order to find out if the two categories of risk contribute to banking instability. Therefore, it is very important to examine in Section 4.2 how banks are affected by this relationship in their risk structure. First, we briefly explain the methodology used in our analysis. We analyze the causal relationship between credit and liquidity risks using simultaneous equations. Finally, we examine the relationship between these risks using PVAR model.

4.1.1. The relationship between credit risk and liquidity risk - GMM estimation of simultaneous equations

In this subsection, firstly, we analyze the causal relationship between credit and liquidity risks using simultaneous equations.

Table 3 presents the results estimated by employing 2SLS regression in which credit risk is proxied by the ratio of non-performing loans to total loans and liquidity (inverse of liquidity risk) is proxied by the ratio of liquid assets to total assets. The Durbin-Wu-Hausman test was used to test for

Table 3
The relationship between credit risk and liquidity risk.

Independent variables	Credit risk (model 1)		Liquidity (model 2)	
	Coefficient	P-Value	Coefficient	P-Value
Constants	2.171548	0.874	−0.6388741	0.000***
Credit risk	–	–	−0.0022208	0.000***
Liquidity	−13.9669	0.61	–	–
size	−1.311478	0.005***	−0.0352721	0.290
ROE	–	–	0.0000907	0.895
ROA	−1.078122	0.000***	0.0025453	0.788
Loan assets	−1.640847	0.587	–	–
Income diversity	−5.781405	0.000***	–	–
Efficiency	−9.775005	0.002***	–	–
NIM	–	–	0.0120132	0.537
Liquidity gaps	–	–	0.030086	0.375
CAR	–	–	−0.0012873	0.108
Crisis	−1.402435	0.106	−0.0047443	0.662
Inflation rate	21.65592	0.000***	0.3716619	0.000***
GDP	−0.3604504	0.000***	−0.0011092	0.205
AR2 test	1.31	0.189	−0.20	0.841
Hansen J-test	28.21	0.104	25.89	0.170
DWH test	187.657	0.000	167.708	0.000

Notes: Hansen-test refers to the over-identification test for the restrictions in GMM estimation. AR (2) test is the test of the second-order autocorrelation in first differences. Durbin-Wu-Hausman test of the endogeneity. *, **, *** denote 10%, 5% and 1% significance levels, respectively.

endogeneity. The null hypothesis of the DWH endogeneity test means that an ordinary least squares (OLS) estimator of the same equation would yield consistent estimates. A rejection of the null hypothesis implies that the instrumental variables are required and the endogenous regressor effects on the estimates are meaningful. Second, the Hansen test was used to test the over-identifying restrictions. The null hypothesis of the over-identifying restrictions cannot be rejected. The third test is applied by AR (2) on residuals to show whether there is a correlation or not between the transformed error terms. These tests indicate that the instruments are valid.

The impact of credit risk on bank liquidity (inverse of liquidity risk) is significantly negative at 1% level, whereas the reverse causation is negative but insignificant. Therefore, from a statistical and economically point of view, the results show, firstly, that there is no statistically significant reciprocal relationship between liquidity and credit risks However, our results show that, in general no significant reciprocal relationship between credit and liquidity risks is detected. This confirms the results of Imbierowicz and Rauch (2014) who found no reciprocal relationship between credit and liquidity risks. This is explained by the investors that have incomplete preferences over portfolios (Easley & O'Hara, 2010), or due to companies that have to roll over maturing debt and face rising credit spreads when liquidity in the market has previously deteriorated (He & Xiong, 2012c). Hence, according to the overall results, we can conclude that there is a unidirectional causal relationship between credit and liquidity risks. Therefore, this suggests that the H1 and H2 of our study cannot be confirmed.

4.1.2. The relationship between credit risk and liquidity risk: PVAR model

In this subsection, we analyze the direct relationship between credit risk and liquidity risk. In addition to our analyses by simultaneous equations, we investigate the result of no meaningful relationship between credit risk and liquidity risk in further robustness tests. We replace our simultaneous equations regression by the PVAR model in a robustness test for our results. We detect no clear patterns of causal relationships between the variables which are statistically or economically meaningful.

Table 4 presents the results estimated by employing PVAR regression. In an addition robustness check, we find that the results of our previous analyses are confirmed: although some coefficients for liquidity risk and credit risk are statistically significant in the PVAR model suggesting that there is no reciprocal relationship between liquidity risk and credit risk. Therefore, our results indicate that there is no economically meaningful relationship between liquidity risk and credit risk.

Table 4
Main results of a 3-variables VAR model-robustness tests.

	Credit risk	Liquidity
Credit risk-1	1.751207 (21.1374)*	−0.002214 (−1.19336)***
Liquidity-1	−2.779373 (−0.33758)	1.619288 (8.78418)

Overall, the findings on the causal relationship between liquidity risk and credit risk do not indicate any considerable co-movement.

4.2. The impact of liquidity risk and credit risk on bank stability: GMM method

To investigate the importance of liquidity and credit risks for banks, we examine how both risks jointly have an impact on bank stability. The absence of an economically meaningful relationship between the two categories of risk found in our prior analyses might be an indication of the absence of joint management of these risks in MENA banks. If this is true, we should find that a joint increase of liquidity and credit risks strongly contributes to banking instability, as stated in our hypothesis H3. Next to the results regarding the relationship between liquidity and credit risks presented above, we believe that there are other main theoretical reasons supporting this assumption. First, the body of literature on liquidity risk as well as the literature review on credit risk as presented above has established that each risk category separately has strong implications for banking stability. Second, the body of literature analyzing the relationship between liquidity and credit risks, also presented above, implies that the reciprocal relationship between these risks has strong implications for banking stability, too. Third, according to Imbierowicz and Rauch (2014), the failure of many banks during the recent financial crisis was partly caused by the joint occurrence of liquidity problems and too high credit risks. From a hypothetical perspective, we thus have strong reasons to test whether or not liquidity and credit risks separately and also jointly have a strong influence on banking stability. We present the results of the GMM according to the approach proposed by

Table 5
The impact of liquidity risk and credit risk on bank stability.

Independent variables	Coefficient	P-Value
Constants	−0.1026028	0.899
Z-score-1	0.3188109***	0.000
Liquidity	0.2319063**	0.0330
Credit risk	−0.0065155**	0.021
Credit risk*liquidity risk	−0.0111681*	0.083
ROA	0.0814033***	0.000
size	−0.235021***	0.000
CAR	0.0012011*	0.0682
Loan growth	−0.8768759***	0.000
Income diversity	1.196032***	0.000
Efficiency	−0.3300937	0.184
GDP	−0.0025844	0.627
Inflation rate	1.390656***	0.002
Crisis	−1.04121***	0.003
No. Obs.	343	343
AR (1)	−4.72	0.000
AR(2)	0.36	0.716
Hansen test	22.20	0.330

Hansen J-test refers to the overidentification test for the restrictions in GMM estimation. The AR2 is the Arellano Bond test for the existence of the second-order autocorrelation in first differences. *, **, *** denote 10%, 5% and 1% significance levels, respectively.

Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). Table 5 reports the results of the Hansen test for over-identifying restrictions and the AR (2) second-order serial correlation tests.

Table 5 presents the empirical results for banks and shows that the specification test AR (2) used for testing the serial correlation adopted for banks is also valid. The *p*-values for the AR (2) are higher than 0.10. Therefore, we do not reject the null hypothesis for banks. This implies that the empirical model has been correctly specified because there is no serial correlation (autocorrelation) in the transformed residuals, and the instruments used in the models are valid. In addition, using Hansen J-statistic tests to check the instrument validity, we notice that the *p*-values in the tests are greater than 0.1. Over identifying restrictions are valid and the model specification is correct. Therefore, these results indicate that the dynamic panel of banking stability model is a good specification. Moreover, the lagged dependent variable Z-score-1 is positive and significant at 1% level, which proves the dynamic character of the model specification (Tan, 2015). At this level, we validate the choice of a dynamic specification for our model. The results are presented in Table 5.

First, regarding the different categories of risk (credit risk and liquidity risk), which are negative with the banking stability amplify further the categories of risk increases bankruptcy. Indeed, higher credit risk raises bankruptcy. In other words, higher amount of credit risk is associated with larger probability of banking failures. Specifically, our result suggests that as credit risk increases, bank stability decrease. This result may be due to the fact that higher loan rates are caused by higher credit risk demand by consumers. On the other hand, liquidity risk (inverse of liquidity ratio) has a negative and statistically significant impact on banking stability. This result suggests that banks which are liquid are more stable. Liquid assets enable banks to overcome any urgent problem due to unexpected money withdrawal which may affect the overall banking stability if the bank is not holding sufficient liquid assets that could be transformed into cash immediately and at a low cost. Previous financial crisis is known to be liquidity crisis. After 2010, the banking regulators have taken steps to avoid this type of risk in the financial system. Therefore, this significant result is attributable to the mismanagement of liquidity risk by banks and regulators. However, high liquidity and credit risks decrease the banking stability, which confirms the findings of Imbierowicz and Rauch (2014).

Then, the effect of the interaction term (credit risk*liquidity risk) on the banking stability is found to be negative and significant at 10% level. This is not surprising because the two categories of risk jointly increase or decrease. Hence, this result suggests, first, that there is a joint and negative influence of the interaction between liquidity risk and credit risk on the banking stability and, secondly, reflects the fact that the negative impact of liquidity risk on the banking stability is growing together with the increasing credit risk and vice versa. The effect of liquidity risk is especially harmful to the stability of banks when the credit risk is high, and vice versa. In addition, banks with lower liquidity risk relative to the ones with higher liquidity risk charge higher banking stability as their credit risk increases. This makes sense, because sufficient liquidity enables these banks to maintain their stability. Furthermore, as the negative coefficient of the interaction term variable seems to decrease the banking stability during financial and economic crisis, as they are subject to the higher loan rates during financial crisis and therefore, to larger credit risks. A more direct channel of how liquidity and credit risk can jointly cause default is theoretically shown by He and Xiong (2012b). FDIC and OCC Material Reports showed that commercial bank failures during financial crisis have been caused by the joint occurrence of illiquidity and loan losses. Hence, suggesting that it might be an indication that the joint occurrence of liquidity risk and credit risk might have played a role in causing bank defaults during the financial crisis.

However, it is interesting to note that banks with different overall levels of stability show different reactions to risks such as the appearance of liquidity and credit risks. These results confirm the findings of Ejoh et al. (2014), Imbierowicz and Rauch (2014), and Nikomaram et al. (2013).

According to Merton (1977), it can be shown that the banks supported by an explicit or implicit state guarantees greatly increase their risk-taking. These results imply that banks increase their credit risk and liquidity risk jointly to eliminate the risk of failure. Our results imply that a joint increase of liquidity risk and credit risk decreases the banking stability during a financial difficulty. We believe it is actually quite surprising that we find this effect for our banks. A large body of literature showed this idea (Akerlof & Romer, 1993; Ejoh et al., 2014; Imbierowicz & Rauch, 2014; Nikomaram et al., 2013). Coupling these empirical results with theoretical explanations for the reasoning behind the game for the resurrection should lead us to believe that troubled banks would also have engaged in this behavior during the recent financial crisis.

Concerning our control variables, Table 5 highlights the effects of *the return on assets* (ROA) on banking stability. The ROA has a positive and significant effect on banking stability at 1% level. In addition, the most profitable banks are more creditworthy. This result contradicts the one obtained by Srairi (2013), and Imbierowicz and Rauch (2014) who found a negative effect of the ROA on banking stability.

However, *the size* has a negative and significant effect on banking stability at 1% level. Thus, the bank's size decreases banking stability. This shows that larger banks have a greater risk of failure probability. Although, large banks are likely to increase the risk of their assets (De Jonghe, 2010; Stern & Feldman, 2004; Uhde & Heimeshoff, 2009). They diversify and better manage their risks (Boyd & Prescott, 1986; Salas & Saurina, 2002). This conforms the findings of Nguyen, Skully, and Perera (2012) and contradicts the one obtained by Imbierowicz and Rauch (2014).

The capital adequacy ratio (CAR) has a positive and significant effect on banking stability. In fact, capital plays a safety net role for banks in a time of crisis, thus, this reduces the risk of banking insolvency. This confirms the result of Imbierowicz and Rauch (2014) where capital on assets is negatively related to the probability of banking failure.

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Thereafter, it appears that *loan growth* has a negative effect on banking stability. Therefore, it may be interpreted as the ability of banks to attract new deposits, good managerial qualities and, a fortiori, a low probability of default. On the other hand, loan growth is an important channel of bank risk taking. Cornett et al. (2011) showed that banks that have stable resources during the crisis continue to lend, unlike those that do not. This confirms the result of Imbierowicz and Rauch (2014).

The income diversity has a positive and significant effect on banking stability at 1%. Increased income diversity means a better banking performance. This confirms the results of Srairi (2013).

The financial crisis is found to be negative and significant impact on banking stability. Hence, the financial crisis negatively affects the banking stability in the MENA region.

Furthermore, *efficiency* has a negative effect on banking stability, which implies that banks with lower managerial efficiency are more exposed to risks (Shehzad, Haan, & Scholtens, 2010). This confirms the work of (Srairi, 2013; Bourkhis & Nabi, 2013; Imbierowicz & Rauch, 2014).

The coefficient of *GDP growth* has a negative effect on banking stability. This helps reduce the risk of banking failure (Imbierowicz & Rauch, 2014). Finally, *the inflation rate* has a positive impact on banking stability, which confirms the study of Srairi (2013).

The above described results show that liquidity and credit risks jointly contribute to banking instability. These results are correct and validate our hypothesis H3. Therefore, the impact of a liquidity risk or credit risk on banking stability in the MENA region is very important.

5. Conclusion and policy implications

Liquidity and credit risks are the two most important factors for banking survival. This paper studies the effect of liquidity risk and credit risk on banking stability using a panel dataset of 49 banks operating in the MENA countries over the period 2006−2013. Moreover, we found that credit risk and liquidity risk do not have an economically meaningful reciprocal contemporaneous or time-lagged relationship, besides, each risk category has a significant impact on banking stability. We also documented that the interaction of the two risk categories has a significant impact on banking stability. Therefore, the estimation results showed the importance of credit and liquidity risks in understanding banking stability in the MENA region.

Our findings have several interesting policy implications. First, these findings provide several recommendations for bank management and bank supervisors in the MENA region. The financial crisis have shown that bank failures driven by credit risk in their portfolios, can cause a freeze of the market for liquidity. However, these results can give regulators, policymakers and bank management bodies' better insight into the stability and efficiency of banks and its behavior toward credit risk and liquidity risk. Second, our results imply that a joint management of liquidity and credit risks in a bank could substantially increase banking stability. Finally, our results support recent regulatory efforts mainly by Basel III framework which put more emphasis on the importance of the joint risk management of liquidity and credit risks.

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