

Bank Capital Ratio, Prudential Regulation and Liquidity Risk Taking: Behavior of Tunisian Banks in a Simultaneous Approach

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Abstract

We analyze in this article the simultaneous incidence which connects the variations of the ratio of capital and the level of the risk-taking of liquidity, under the regulatory pressure regarding bank liquidity and solvency. To reach this goal, we used a model with two simultaneous equations developed by Aggarwal and Jacques (1998) and inspired from the contribution of Dietsch and Tillov (2014), in datum of panel during period 1990-2012 by using the technique of estimation of 3SLS on ten Tunisian universal banks. Our results show that the institutional conditions show a negative association with the change of the level of solvency of these establishments. Every variation of the level of the risk of liquidity implies no adjustment of the level of the ratio of the capital. This behavior leads to predict the existence of a certain carelessness towards this risk supported by the intervention of the Central Bank of Tunisia to insure a balance of finance at the level of the short-term operations of the interbank availability. On the other hand, our results testify of the importance of the pillows of liquidity to keep a minimum level of liquidity which is going to serve to protect these establishments, lenders or borrowers on the interbank market, counter possible shocks at the level of their availability. Besides, the results show the existence of a certain instability at the level of the banking behavior in an environment regulated regarding risk of liquidity.

Keywords: bank prudential regulation, liquidity risk, solvency risk, capital buffer, simultaneous approach

1. Introduction

The objective of this article is to encircle the simultaneous incidence which binds the variations of the ratio of capital and the level of the risk-taking of liquidity, under the statutory pressure regarding liquidity and regarding solvency on the Tunisian banks. To reach this goal, we used a model in two simultaneous equations developed by Shrieves and Dahl (1992), Son Lai et al. (2012), and inspired of the contribution of Dietsch and Tillov (2014), using a panel over a period going from 1990 till 2012 by the technique of 3SLS. In the literature, Goodhart (2008) indicated that the liquidity and the solvency are both inseparable pillars in the banking profession, often impossible to distinguish them one of the other one. Indeed, a not liquid bank can quickly become insolvent and conversely. Particularly, in times of crisis, the variations of the liquidity are immediately translated by modifications of the structure of the stockholders' equity of credit institutions. However, Pagès (2001), considered that the shocks of liquidity can be transformed into shocks of solvency and quite changes at the levels of the stockholders' equity of banks can reduce, even block their access to the financing if they are perceived as a threat for their level of solvency.

The results show that the institutional conditions show a negative association with the change of the level of solvency of these establishments. Every variation of the level of the risk of liquidity implies no adjustment of the level of the ratio of the capital. This behavior leads to predict the existence of a certain carelessness negligence towards this risk supported by the intervention of the Central Bank of Tunisia to insure a balance of finance at the level of the short-term operations of the interbank availability. On the other hand, many empirical works testify of the importance of the pillows of liquidity to keep a minimum level of liquidity which is going to serve to protect these establishments, lenders or borrowers on the interbank market, counter possible shocks in Level of their availability. Besides, other contributions show the existence of a certain instability at the level of the banking behavior in an environment regulated regarding risk of liquidity.

The present paper is organized as follows: in the first section, we are going to present the main part of the reserved variables, to formulate the underlying hypotheses and to develop the econometric specification of the reserved model. Two tests of preliminary specifications will also be the object of this section. In the second section, we expose the statistical description of the data, the matrix of correlation of the various variables as well as the signs expected from the parameters of the model. Before our conclusion, we analyze, in the third section, the results of the estimation of the model.

2. Variables, Hypotheses and Econometric Specification

2.1 Definition of Proxies and the Main Hypotheses

LIQRISK: Measures the risk of liquidity of the bank. Introduced under endogenous shape in the equation (5.2) by a first variation between two exercises (t) and ($t-1$) noted (Δ LIQRISK). It is about a ratio which indicates the part of the availability collected in the short term which can be honored in case of banking problem from the liquid assets. A high value of this ratio reveals a healthy management of the risk of liquidity and thus a lesser vulnerability at the risks of liquidity. According to Descamps and Soichot (2002), Darmon (1998), the risk of liquidity is essentially connected to three elements: a) the intrinsic risk of balance sheet which materializes by the notion of transformation, b) the attitude of the economic agents towards the establishment which reflects the reliable notion and c) the institutional context in which the establishment evolves in particular the general liquidity of the market. These authors noted that one of the banking specificities lies in the transformation of short resources in more distant term. According to the prudent approach, the criterion of liquidity most frequently measured in the national banking regulations by the cash ratio is defined by the relationship between current assets and current liabilities. In our study and seen the absence of precise information on these confidential sizes, we are going to choose a simpler approach by reporting the competitions to the economy in the deposits of the clientele.

$$LIQRISK = \text{Domestic Loans} / \text{Deposits}$$

Rochet (2008) considered that in the light of the recent events, a banking regulations basing only on a device of adequacy of stockholders' equity seem insufficient. The turbulences on the money market revealed that certain banks had preserved very few liquid assets to deal with a lack of the level of very short-term liquidity. The Agreement of Basel II adjusts exactly the device of adequacy of stockholders' equity compared with the risk generally, but, it does not evoke the question of the constitution of reserves to cover needs for liquidity. Indeed a good solvency is translated by a level of ratio of comfortable capital, this is synonymic of a level of liquidity or comfortable availability, when the customers pay off their credits, a level of liquidity will be guaranteed and available at the level of the bank and, consequently, we attend a reduction in its risk of liquidity. By referring to these arguments we can move forward the following hypothesis: hypothesis (H1) - the relation between the variation of the level of the ratio of capital and the level of the risk of liquidity shows a negative association.

REGL: it is an exogenous variable among the explanatory variables in the equation (5.2) of our econometric model, corresponding to the incidence of the level of risk of liquidity on the change of the level of the ratio of capital under statutory conditions by means of the variables of composite controls. According to the texts of laws and to the circulars which govern the profession of credit institutions in Tunisia, the banking regulations regarding liquidity rest essentially on articles 13, 14 and 15 of circular no 91-24 of 17.12.1991 replaced by the circular to banks no 93-08 of 30.07.1993, then by the circular to banks no 99-04 of 19.03.1999 and finally, by the circular no 2001-04 of 16.02.2001. Indeed these articles stipulate that "banks have to respect permanently a cash ratio which cannot be lower 100% calculated by the relationship between the current assets and the current liabilities" and that "banks have to send to the BCT a monthly statement of the cash ratio for the deadline not exceeding 25 days as from the expiration of the month considered". In fact when Heid et al. (2005), Van Roy (2005), Cannata and Quagliariello (2006) and Matejasák and Teplý (2009) and more recently Milné and Jokipii (2010) and Lin et al. (2013), handled the statutory pressure regarding solvency, they used the regulations in force, that is the international solvency ratio equal to 8 %. In our case and to express the regulations regarding liquidity, logically we chose the standard of liquidity, that is the 100 % ratio. This variable can take two possible values, is $[\text{Min REGL} + \text{LIQRISK}_i - \text{LIQRISK}_i, t]$, is zero.

Flaunet (2010), Deloitte (2010) and Cecchetti (2010) found that the reaction of banks regarding liquidity under the statutory conditions shows a positive trend and sometimes negative. As for Trichet (2010), Tahiry (2010) and Weber (2010), by ruling on the effect of the banking regulations (Directives of the BIS) on the behavior regarding risk-taking of liquidity and defect, during crisis situations, they ended in results debated on behalf of the banking firms. Min REGL it is the required minimum regarding liquidity in Tunisia 100% equal, it is the ratio of current assets on current liabilities. We note (LIQRISK) the standard deviation of the cash ratio of the

noted bank (LIQRISK). For a bank (i) and towards the end of one year (t) the variable statutory pressure regarding liquidity (REGL) is defined in the following way:

$$REGL_{i,t} = [Min_{REGL} + \sigma (LIQRISK_i)] - LIQRISK_{i,t} \text{ if } LIQRISK_{i,t} \leq Min_{REGL} + \sigma (LIQRISK) \\ REGL_{i,t} = 0 \text{ if } LIQRISK_{i,t} > Min_{REGL} + \sigma (LIQRISK)$$

Previous contributions underlined the fundamental role of the banking legal and regulatory environment in the management of the risk of liquidity in spite of their rarity. The second hypothesis translates the incidence of the institutional component (REGL) there (t-1) on the behavior of taking risk of liquidity of the bank ($\Delta LIQRISK$) one year later (t). The second hypothesis can be built in the following way: hypothesis 2 (H2) - The statutory pressure presents an unforeseen effect on the behavior of the Tunisian banks regarding risk-taking of liquidity.

(REGX $\Delta LIQRISK$): it is an interactive variable, introduced to detect the incidence of the statutory conditions regarding solvency on the speed of adjustment of the ratio of capital together with the variation of the level of the liquidity risk. This variable was used in the works of Hassen and Hussain (2006). Indeed, the statutory pressure regarding solvency (REG) was defined by Van Roy (2005), Matejasák and Teplý (2009) and Saadaoui (2010). We call back that the variable regulatory pressure (REG) is defined as follows:

$$REG_{i,t} = [Min_{REG} + \sigma CAR_i] - CAR_{i,t} \text{ if } CAR_{i,t} \leq Min_{REG} + \sigma CAR_i \\ REG_{i,t} = 0 \text{ if } CAR_{i,t} > Min_{REG} + \sigma CAR_i$$

(BUFFER X LIQRISK): it is a term of interaction defined as the product of the variable reflecting the reserve of stockholders' equity and that of the level of risk of liquidity. It is the variable which was included in the equations explaining the variations of the behavior of the risk-taking of liquidity. We examine if banks, when they have low stocks buffers of stockholders' equity, adjust the latter and the risks more quickly compared with the opposite situation. According to Tirole (2010), the weight of risk associated with liquid assets means that banks can increase their reserves of stockholders' equity by the liquidation of assets. Consequently, the banks who hold more liquid assets have generally a low level of pillow of stockholders' equity and also can be inclined to increase their levels of risk.

According to Dietsch and Tillov (2014), to put in reserve of the capital allows a bank to absorb the possible losses. The amount of the capital which a bank has to hold, compared with its assets, should be sufficient to cover the unexpected losses and remain solvent and especially to have some liquid in times of crisis. The more the capital put in reserve will be raised, the less is the incentive in the risk-taking and particularly that of the liquidity. Normally, banks can accumulate stockholders' equity buffers by preserving their profits and undistributed profits, what means the reduction of the discretionary distributions of the results. These activities include the reduction of the payments of dividends, shares buyback and payments of bonuses to the staffs. This variable was introduced by Bouri and BenHmida (2011), which supposed a negative association with the behavior of the risk-taking of liquidity. We present the fourth hypothesis in the following way: hypothesis 4 (H4) - the interactive or composite variable (BUFFER X LIQRISK) is negatively bound with the level of the liquidity risk of the bank.

2.2 Econometric Specification of the Model

To explain the link between the level of solvency and the incentive to the taking of the risk of liquidity in a simultaneous way, as for Bouri and Ben Hmida (2011), a model with double equation will be specified. The objective is to estimate this model and to take into account the simultaneity between its variables. To do it, our analysis is made through a model of partial adjustment developed initially by Shrieves and Dahl (1992) and Jacques and Nigro (1997). We are going to follow their initiatives by basing us on the first-rate differentiation to eliminate the serial correlations due to the effect of the endogénéité of specific variables as indicate it Arellano and Bond (1991). The first works on this subject quantified the particular simultaneity between the level of the ratio of capital and that of the risk. By analogy, and by way of meticulous empirical investigation, we are going to emphasize the risk of liquidity. This choice is based on the contribution of Godlewski (2005).

Indeed, further to statutory requirements on the capital, every increase of the ratio of capital is translated by an improvement of the level of solvency which can improve the level of banking liquidity. Rime (2001) considered that the process of discretionary adjustment is fundamental to maintain the level of the constant capital. In our analysis, we included the risk of liquidity as a particular component of the level of the global risk of the bank. This inclusion emanates from the relation which exists between the level of the risk of liquidity and the level of the risk of solvency which is profoundly discussed in the previous literature, in particular the contributions of Merton (1974), Kim and Sundaresan (1993), Shimko and Van Deventer (1993), Longstaff and Schwartz (1995) Leland (1998), Jarrow and Turnbull (1997) and Duffee (1999). Our model can have the following form:

$$\Delta CAR_{i,t} = \psi (CAR^* - CAR_{t-1}) \quad (1)$$

$$\Delta LIQRISK_{i,t} = \theta (LIQRISK^* - LIQRISK_{t-1}) \quad (2)$$

ΔCAR^* and $\Delta LIQRISK^*$, two endogenous variables, represents respectively target measures of the level of ratio of capital and the level of the risk of liquidity. The bank (i) wishes to reach these target levels for every period (t) as indicates it Peltzman (1970), Marcus (1983), Wall and Peterson (1987) during exposure of a model of partial adjustment to model the behavior of risk-taking generally and the level of the capital for banking institutions. By analogy, in this frame of analysis, the variations of the capital and the risk of liquidity are relatively proportional in the difference between one target value and the value in the previous period (t-1). We note by (Xt) and (Yt) all the exogenous factors which can determine both reserved endogenous variables respectively. The terms (Ψ) and (θ) represent the discretionary speeds of adjustment of both ratios towards their targets, these coefficients ventilate between zero and the unit. We obtain the following basic specifications:

$$\Delta CAR_{i,t} = \psi (CAR^* - CAR_{t-1}) + X_t \quad (3)$$

$$\Delta LIQRISK_{i,t} = \theta (LIQRISK^* - LIQRISK_{t-1}) + Y_t \quad (4)$$

We can write our model under the shape of both simultaneous equations (5.1 and 5.2) according to the following system:

$$\begin{aligned} \Delta CAR_{i,t} = & \psi_0 + \psi_1 ROA_{i,t} + \psi_2 SIZE_{i,t} + \psi_3 SPREAD_{i,t} + \psi_4 \Delta LIQRISK_{i,t} \\ & + \psi_5 CAR_{(i,t-1)} + \psi_6 BUFFER_{i,t} + \psi_7 (REG_{(i,t-1)} X \Delta LIQRISK_{(i,t-1)}) \\ & + \psi_8 (REG_{i,t} X \Delta CAR_{i,t}) + \phi_{i,t} \end{aligned} \quad (5.1)$$

$$\begin{aligned} \Delta LIQRISK_{i,t} = & \theta_0 + \theta_1 SIZE_{i,t} + \theta_2 LLOSS_{i,t} + \theta_3 SPREAD_{i,t} + \theta_4 \Delta CAR_{i,t} \\ & + \theta_5 LIQRISK_{(i,t-1)} + \theta_6 REGL_{(i,t-1)} + \theta_7 (BUFFER_{(i,t-1)} X \Delta CAR_{(i,t-1)}) \\ & + \theta_8 (BUFFER_{i,t} X LIQRISK_{i,t}) + \Gamma_{i,t} \end{aligned} \quad (5.2)$$

Knowing that ψ_i ($i=1, \dots, 8$) and θ_k ($k=1, \dots, 8$), are the parameters of the model relative to the various reserved variables and (ψ_0) and (θ_0) represent the respective constants in both simultaneous equations (5.1 and 5.2). With ($\phi_{i,t}$) and ($\Gamma_{i,t}$) who indicate respectively the residues of the relative equations at the level of the ratio of capital (ΔCAR) and the level of the risk of liquidity for every bank (i) and year (t).

2.3 Exploratory Tests of Specification and Method of Estimation

All the estimators of simultaneous equations try to manage the fact that the hazards of the structural equations are correlated to any endogenous variable appearing in the equation. This correlation returns the not convergent estimators MCO. We saw that 3SLS solves this problem by replacing the defective regressors by instruments. The technique of estimation considered the most suitable and the most strong is the one. Three Stage Last Square, chosen to realize our estimation.

2.3.1 Tests of Durbin-Wu-Haussman and Davidson and Mckinnon

With the aim of detecting the presence of the problem of endogénéité between the variables of the model and the terms of residues in both equations, the test of Fisher joined by residues seems the most appropriate. At first, we are going to make the regression of each of the endogenous variables on all the suspected exogenous variables. Then, we resume these residues and we introduce them at the level of the basic specification (5). This test comes true in double stage such as explained by Durbin-Wu-Haussman and of Davidson and Mckinnon (1993). Indeed, we are going to test the endogénéité of the variable ($\Delta CAR_{i,t}$) and afterward that of the variable ($\Delta LIQRISK_{i,t}$) according to the respective terms of errors $\phi_{i,t}$ and $\Gamma_{i,t}$. The main part of the results of the test of endogénéité made on our model is included in the following Table 1:

Table 1. Endogeneity tests results (1st and 2nd equation)

Endogenous Variable: $\Delta CAR_{i,t}$	T-Student	(P-value)	Endogenous Variable: $\Delta LIQRISK_{i,t}$	T-Student	(P-value)
Residue : $\phi_{i,t}$	-	0.000	Residue : $\Gamma_{i,t}$	-	0.000
Intercept: ψ_0	-	0.000	Intercept : θ_0	-	0.000
N	230		N	230	
Fischer F (5,220)*	47.62***		Fischer F (7,220)*	23.54***	
R ²	31.35		R ²	12.78	

Note. *** Fisher significative at 1%: F(q, n-k-1), N : Number of observation, R²: (global significativity).

According to the results found further to the regression of $(\Delta \text{CAR}_{i,t})$ in the equation (5.1) on the various exogenous variables ($\text{ROA}_{i,t}$, $\text{SIZE}_{i,t}$, $\text{SPREAD}_{i,t}$, $\Delta \text{LIQRISK}_{i,t}$, $\text{CAR}_{i,t-1}$, $\text{REGL}_{i,t-1}$, $\text{LLOSS}_{i,t}$, $\Delta \text{CAR}_{i,t}$, $\text{BUFFER}_{i,t}$, $(\text{REG}_{i,t-1} \times \Delta \text{LIQRISK}_{i,t-1})$, $(\text{REG}_{i,t} \times \Delta \text{CAR}_{i,t})$, $\text{LIQRISK}_{i,t-1}$, $(\text{BUFFER}_{i,t-1} \times \Delta \text{CAR}_{i,t-1})$), and $(\text{BUFFER}_{i,t} \times \text{LIQRISK}_{i,t})$ besides the constant (ψ_0) on residues ($\phi_{i,t}$), we notice a statistics of Fisher F (5,220) of the order of (47.62) significant in a threshold of probability upper to 1 % and which is more than critical value on the table of Fisher. We can conclude that the term of residue concerning the level of ratio of capital is not significant: there is thus absence of problem of endogénéité. In the same table (1), the results reveal that the regression of the variable $(\Delta \text{LIQRISK}_{i,t})$ on all the exogenous variables and on constant (θ_0) compared with the term of error ($\Gamma_{i,t}$) in the equation (5.2), show a statistics of Fisher F (7,220) equal to 23.54 significant in an interval of 99 % confidence. For a number of observation equal to 230 and over all the period from 1990 to 2012, this value is superior to that criticize on the table of Fisher. Also, we can conclude that the relative residue the variation of the level of the risk-taking of liquidity is not significant, consequently there is absence of problem of endogénéité in the reserved specification.

2.3.2 Conditions of Model Identification

Usually made beforehand in the estimation, the check of the conditions of identifiability of the model is necessary as indicated by Bourbonnais (2004). For our specification, we are going to examine these conditions of order are determined equation by equation in the following way: the number of the exogenous variables of the model, (g') the number of the endogenous variables appearing in an equation and (k') is (g) the number of the endogenous variables of the model, (k) the number of the exogenous variables appearing in an equation. So the conditions of identification of the model amount through the following three situations:

1st situation: if $g - 1 > g' + k - k'$, then the equation is under identified;

2nd situation: if $g - 1 = g' + k - k'$, then the equation is just identified;

3rd situation: if $g - 1 < g' + k - k'$, then the equation is under identified.

Our model in two simultaneous equations (5.1 and 5.2), contains two endogenous variables (ΔCAR) and ($\Delta \text{LIQRISK}$), thus (g) equal in (2). Besides the constant, we have fifteen exogenous variables: (ROA , SIZE , SPREAD , $\Delta \text{LIQRISK}$, CAR , REGL , LLOSS , ΔCAR , BUFFER , $(\text{REG} \times \Delta \text{LIQRISK})$, $(\text{REG} \times \Delta \text{CAR})$, LIQRISK , $(\text{BUFFER} \times \Delta \text{CAR})$, et $(\text{BUFFER} \times \text{LIQRISK})$), thus (k) equal to (15). In the first equation (5.1) the number of endogenous variables and (g') is equal in (1) and the number of exogenous variables amounts to eight (k' equal to 8). This enumeration, applicable time on the equation (5.2), gives the same results. We can verify:

Equation (5.1)	$[2 - 1] = 1 < [(2 - 1) + (15 - 8)] = 8$
Equation (5.2)	$[2 - 1] = 1 < [(2 - 1) + (15 - 8)] = 8$

In the light of these results, we can say that both equations (5.1 and 5.2) are on identified, what shows that our model, too, is on identified. We can conclude that it is possible to estimate the model (IV.5) by the technique of the Triple Lesser Squares (3SLS). After the verification of the absence of the problem of endogénéité for both endogenous variables (ΔCAR) and ($\Delta \text{LIQRISK}$) as well as the conditions of identification of both equations, it is important to make an estimation of the model retained over the period going of 1990 to 2012. Compared with the results found in the matrix of correlation where all the coefficients are lower than (0.7), we judge that the "VIF" test between the various variables is not necessary. We notice the absence of the problem of multicollinearity between the reserved variables.

3. Description of the Data and the Descriptive Statistics

In this section, we shall present our data through a statistical description, the matrix of correlation between variables as well as their signs hoped in the model estimated by the software (Stata 11.) over a period of 23 years for ten universal Tunisian banks.

3.1. Sources (Springs) and Description of the Data

To build our database, we began by collecting financial statements of the Tunisian banks, worth knowing balance sheets, states of results, cash flow statements, commitments except balance sheets and notes in financial statements. Our sample is established by ten universal commercial banks during period from 1990 till 2012. The sources of these documents are the reports of the APBEFT, the BCT, Fitch-rating and Maxula Bourse, as well as the other statistics identified with the BAD. Reports on the statutory supervision in Tunisia and other banking statistics available on web sites appropriate to every establishment were the object of the source of our data. Several variables made the object of a calculation either by ratios or by calculations of variation between two

exercises (t) and (t-1) or still the product of two variables in the form of composite variables (interactive). The list of the reserved banking institutions as well as the information on some significant ratios on June 30th, 2013 are exposed in the Table 2.

Table 2. Informations about bank sample

Banks	Social nomination	Informations at 30/06/2013			
		RISK	CRRISK	LIQRISK	CAR
ATTIJARI	Attijari Bank	7,372	22,74 %	105.20%	9,24%
AB	Amen Bank	16,666	23,70%	106.70%	13,15%
ATB	Arab Tunisian Bank	20,412	27,41%	107.30%	14,39%
BIAT	Banque Internationale Arabe de Tunisie	20,412	26,71%	105.90%	11,92%
BH	Banque de l'Habitat	18,898	19,11%	133.50%	10,23%
BNA	Banque Nationale Agricole	17,677	23,11%	118.40%	11,41%
BT	Banque de Tunisie	21,320	53,37%	123.50%	21.84%
STB	Société Tunisienne de Banque	16,666	18,67%	116.30%	9.02%
UBCI	Union Bancaire pour le Commerce et l'Industrie	12,309	21,45%	106.50%	10.51%
UIB	Union Internationale des Banques	18,898	19,60%	113.50%	9.27%

Source: by auteurs. CAR: capital ratio, RISK: global Risk index ($IR = [E(ROA) + CAR] / \sigma(ROA)$) with $E(ROA)$ and $\sigma(ROA)$ respectively mean and variance of return on assets, CRRISK: credit risk ratio (Provisions NPL / Total credit), LIQRISK: liquidity risk ratio (domestic loans/ deposits).

3.2 Descriptive Statistics

Table 3. Statistical properties of the variables

Variables	(N)	Mean	S. Devi.	Min.	Max.
ΔCAR	230	0.00351	0.01747	-0.097418	0.070737
$\Delta LIQRISK$	230	0.163008	0.141872	-0.71	0.70713
$CAR(1)$	230	0.08256	0.03097	-0.01098	0.17482
$LIQRISK(1)$	230	0.76883	0.133258	-0.69009	1.71307
BUFFER	230	-0.016011	0.030021	-0.094818	0.090985
REGL(1)	230	0.214738	0.239997	0	0.78155
$REG \times \Delta LIQRISK(1)$	230	-0.00176	0.344682	-0.421821	0.109696
$REG \times \Delta CAR$	230	0.000970	0.000906	-0.001293	0.002901
$BUFFER \times \Delta CAR(1)$	230	-0.000162	0.000926	-0.008864	0.002069
$BUFFER \times LIQRISK$	230	-0.000734	0.007650	-0.497924	0.463119

Source: calculation made by the software Stata 11. N: number of observations over the period of analysis (on 1990-2012). Min: minimal value observed. Max: maximal Value observed. The sample includes 10 Tunisian universal banks., (1): variable calculated there (t-1), Δ : mean the variation of the variable between (t) and (t-1).

The statistical description of the data obtained in the picture(board) (3) shows that the variation of the level of the risk of liquidity of ten reserved banks posts(shows) an average of 16.30 % with a standard deviation equal in (14.18 %). This endogenous variable ventilates between a minimal and maximal value respectively of the order of (71 %) and (70 %). The levels of liquidity to these banks differ from one year to the next: it is the nature of the banking profession which explains this variation of the level of liquidity which seems to be very volatile over the period of 23 years. As for the variable relative to the statutory pressure (REGL), we register(record) an average value for 230 observations of the order of 21.47 % with a standard deviation about 24 %. As defined higher, this variable is superior zero, its shows values between 0 and 78.15 % for ten banks of our panel. The Table 4. According to, present the various levels of correlation between the endogenous and exogenous variables of our model (5). It is about the matrix of correlation realized by the software STATA 11.

3.3 The Matrix of Correlation

Table 4.

Variables	Δ CAR	Δ LIQRISK	ROA	SIZE	SPREAD	CAR(1)	BUFFER
Δ CAR	1						
Δ LIQRISK	0.2902	1					
ROA	0.3585	-0.0798	1				
SIZE	-0.2433	-0.0167	-0.0590	1			
SPREAD	-0.0525	-0.0410	-0.0277	-0.0577	1		
CAR(1)	-0.4596	-0.1167	0.1366	0.2339	0.0020	1	
BUFFER	-0.2355	-0.1127	-0.4533	0.1765	0.0612	-0.6393	1
REG x Δ LIQRISK (1)	0.0252	0.2777	-0.04559	-0.0544	-0.0138	-0.0588	0.0523
REG x Δ CAR	0.1634	-0.2912	-0.0930	0.2898	0.0876	-0.0856	0.6927
LLOSS	0.2344	0.0650	0.0400	-0.6270	0.0080	0.2344	-0.1947
LIQRISK (1)	-0.0398	0.1254	-0.0405	0.0217	-0.0328	0.0850	-0.0134
REGL(1)	0.1116	0.2018	0.1524	-0.3341	-0.0088	-0.2646	-0.0935
BUFFER x Δ CAR (1)	-0.0248	-0.0532	-0.0474	0.0144	0.0076	-0.0577	0.0887
BUFFER x LIQRISK	-0.2858	-0.6018	0.0917	0.0699	0.0004	0.0915	0.1576

Table 4. Continued

Variables	REG x Δ LIQRISK (1)	REG x Δ CAR	LLOSS	LIQRISK (1)	REG(1)	BUFFER x Δ CAR (1)	BUFFER X LIQRISK
Δ CAR							
Δ LIQRISK							
ROA							
SIZE							
SPREAD							
CAR(1)							
BUFFER							
REG x Δ LIQRISK (1)	1						
REG x Δ CAR	-0.2326	1					
LLOSS	0.0463	-0.2378	1				
LIQRISK (1)	0.5636	-0.2074	-0.0164	1			
REGL(1)	-0.1382	0.7006	0.5209	-0.1746	1		
BUFFER x Δ CAR (1)	-0.0962	0.0887	-0.0370	-0.2926	0.0223	1	
BUFFER x LIQRISK	-0.2956	0.2944	-0.1424	-0.1351	-0.1830	0.0320	1

Source: calculation made with Stata 11. Values of the coefficients of correlation and their signs for every establishment (i) and year (t). Over all the period from 1990 till 2012. REGL: the variable of the statutory pressure in terms of liquidity. BUFFER: the capital in reserve “buffer” of stockholders’ equity Δ LIQRISK: the variation of the level of the risk of liquidity Δ CAR, represents the variation of the level of the insolvency risk. REG x Δ LIQRISK, REG x Δ CAR, BUFFER x Δ CAR, BUFFER x LIQRISK are composites proxies in the model (IV.5).

According to the matrix of correlation between the various variables held in our specification, we can indicate that the coefficient of correlation between (Δ CAR) and that of the level of the liquidity risk is positive at (0.2902). The hypothesis (H1) relative to these two variables plans a negative association, it is to say that the parameters (ψ_4 and θ_4) will be supposed with negative signs in our model (5). The composite variable ((REG) x (Δ LIQRISK)) shows a positive coefficient of correlation equal to (0.2777) compared with (Δ CAR) and the interactive component (BUFFER x LIQRISK) is negatively associated with the variation of the risk of liquidity (Δ LIQRISK) with a coefficient of correlation of the order of (-0.6018). Indeed, the parameter (ψ_7) is expected with a positive association whereas the parameter (θ_8) has a negative sign. The statutory pressure regarding liquidity (REGL) posts (shows) a positive correlation with the level of risk of liquidity, we register a coefficient of correlation about (0.2018). In consideration of the controversy in the literature handling the link between these two components, and according to the hypothesis (H2), the parameter (θ_6) can be either positive, or negative, thus the effect of this variable seems unforeseen.

3.4 Presentation of the Signs Expected from the Parameters

Table 5. Signs expected of model parameters

Variables	Parameters	Expected signs (IV.5)	
		Endogenous Variable (IV.5.1): $\Delta CAR_{i,t}$	Endogenous Variable (IV.5.2): $\Delta LIQRISK_{i,t}$
$\Delta CAR_{i,t}$	θ_4		-
$\Delta LIQRISK_{i,t}$	ψ_4	-	
$ROA_{i,t}$	ψ_1	+	
$SIZE_{i,t}$	ψ_2 et θ_1	-	-
$SPREAD_{i,t}$	ψ_3 et θ_3	+	-
$CAR_{(i,t-1)}$	ψ_5	-	
$BUFFER_{i,t}$	ψ_6	-	
$REG_{(i,t-1)} \times \Delta LIQRISK_{(i,t-1)}$	ψ_7	+	
$REG_{i,t} \times \Delta CAR_{i,t}$	ψ_8	+	
$LLOSS_{i,t}$	θ_2		+
$LIQRISK_{(i,t-1)}$	θ_5		-
$REGL_{(i,t-1)}$	θ_6		N/A
$BUFFER_{(i,t-1)} \times \Delta CAR_{(i,t-1)}$	θ_7		-
$BUFFER_{i,t} \times LIQRISK_{i,t}$	θ_8		-

Note. N/A means that the sign expected from the parameter of this variable can be positive or negative. The indications (i) and (t) represent respectively bank and exercise $\psi_1, 2, \dots, 8$ et $\theta_1, 2, \dots, 8$: the parameters of the model allocated to every variable are. REGL: the variable of the statutory pressure in terms of liquidity. BUFFER: the capital buffers or pillow of stockholders' equity $\Delta LIQRISK$: the variation of the level of the liquidity risk? ΔCAR , represents the variation of the level of insolvency risk. $REG \times \Delta LIQRISK$, $REG \times \Delta CAR$, $BUFFER \times \Delta CAR$, $BUFFER \times LIQRISK$ are the composite variables.

The signs were waited the various parameters of the model (5), are fixed so as to express our advanced hypotheses farther. These signs were also anticipated by Bouri and Ben Hmida (2011). Other similar works planned different signs to those mentioned in the table (5). The prediction of these incidences differs from a contribution to an other one according to the justified theoretical hypotheses and to the general context of these works. In the following section, we are going to present the results of the estimation of our model obtained in our panel over the period going of 1990 to 2012. Our approach concerning the interpretation of these results will put a particular accent on the incidence of the variation of the ratio of capital on the behavior of the risk-taking of liquidity of these banks under the specific statutory pressure.

4. Results of the Estimation

Table 6. Results of model (5) estimation (3SLS)

Period estimation:	1990-2012	
Endogenous variables	ΔCAR	$\Delta LIQRISK$
Exogenous Variables		
ROA	0.195915 (3.21)***	
$SIZE$	0.004954 (3.96)***	0.004459 (0.41)
$SPREAD$	0.000303 (0.76)	-0.003404 (1.07)
$CAR_{(i,t-1)}$	-0.59959 (20.74)***	
$LIQRISK_{(i,t-1)}$		0.023717 (0.65)
$REGL_{(i,t-1)}$		0.065365 (2.91)***
$LLOSS$		-0.28115 (2.67)***

BUFFER	-0.597183 (16.11)***	
<i>ALIQRISK</i>	-0.00511 (0.90)	
ΔCAR		0.49479 (1.58)
$REG_{(i,t-1)} \times \Delta LIQRISK_{(i,t-1)}$	-0.01004 (0.58)	
$REG_{i,t} \times \Delta CAR_{i,t}$	-0.2278 (5.54)***	
$BUFFER_{(i,t-1)} \times \Delta CAR_{(i,t-1)}$		-3.85966 (0.76)
$BUFFER_{i,t} \times LIQRISK_{i,t}$		-6.7137 (3.85)***
<i>Intercept</i>	0.00500 (0.54)	0.017481 (0.18)
<i>N</i>	230	230
<i>R</i> ²	75.76%	77.45%
χ^2	721.53***	789.10***

Note. Estimation made with the software Stata 11par the technique of 3SLS, *: significativité in 10 %, **: significativité in 5 %, ***: significativité in 1 %, N: number of observation. The statistics of Student in brackets. R^2 : coefficient of global significativité of the model χ^2 : statistics of chi -Deux.

4.1 Relation between the Variation of the Level of Capital and the Variation of Liquidity Risk

The reaction of ten banks regarding adjustment of the solvency ratio compared with their behavior of risk-taking of liquidity seems statistically not significant. Indeed, the results (profits) of the estimation obtained in the table (6) show that the coefficients (θ_4) and (ψ_4) respectively in the equations (5.1 and 5.2), show values of the order of ((-0.00511 and 0.49479) and which are statistically not significant with respective t-Student about ((0.90 and 1.58). Our first hypothesis specifies that the relation enters the variation of the level of the ratio of capital (ΔCAR) and the level of the risk of liquidity ($\Delta LIQRISK$) shows a negative association. The theory “of absorption of the risks” bases on the classic role of the banking firms regarding transformation (processing) and regarding absorption of the risks. Allen and Mange (2004), among the partisans of this theory, moved forward the argument which considers that a high level of liquidity exposes banks to considerable risks, in particular massive withdrawal of funds by the depositors. The more the capital is raised as well as the level of risk is decreased, thus the most capitalized banks are more inclined to create liquid assets. Few works were interested in the interaction between the level of the ratio of capital of banks and their behavior of risk-taking of liquidity.

Berger and Bouwman (2009) showed that the theoretical literature rests on two ways to explain the reaction of the level of the liquidity risk of a bank according to its ratio of capital. Indeed, a first way, supported by Bhattacharya and Thakor (1993) and Repullo (2004), is due to the fact that stockholders' equity absorbs the unexpected losses of the banking firm, which is likely to strengthen its capacity to create more liquidity and consequently more incentive in the risk-taking. The second sends back to the works of Diamond and Rajan (2001) and Bervas (2008), which considered that the fragility of the balance sheet of banking institutions establishes a condition of their activity of creation of liquidity and thus their behavior of risk-taking of liquidity. The current situation of the banking liquidity is summarized according to central Bank of Tunisia (BCT) in the following way: the Bank noticed the progress registered at the level of funds injected in the banking system, carrying the global volume of refinancing in more than 5 billion dinars in 2013 against 962 million dinars on average of 2010. The BCT tried to support the reasons at the origin of the increase of the needs for banks in liquidity which is a logical result in the economic and financial evolutions which knew the country since January, 2011. Besides, among the factors which affected the banking liquidity, the first one holds the evolution of bills and active money held by the households to insure their running costs but also for motives of precaution. The latter passed from 5,8 billion dinars in 2010 to more than 7,6 billions at present, what engendered an additional withdrawal about 1,8 billion dinars with the banking counters. This evolution is partially natural, in the sense where it follows an increase of household incomes and where it was amplified by the uncertainty and the concern which accompanied the transition. According to the BCT, the second factor which had impacted negatively on the banking liquidity is in particular the important reduction in the assets of foreign exchange reserve which passed of 13 billion dinars at the end of 2010 in approximately 11,4 billion dinars at present, that

is a 1,6 billion dinar reduction in the banking liquidity.

The third factor which contributed to the contraction of the banking liquidity is the slowing down observed in the execution of the state budget, as soon as the public spending can supply liquid assets to the banking system if the political and economic conditions improve. This will lead to the improvement of the performances of the outside sector, to the return of the confidence to all the economic agents and to the positive evolution of the situation of liquidity in the banking sector. This lack of liquidity did not reach the level of the crises in the Tunisian banking sector which is widely supported by the authorities and particularly by the lender in the last resort (the BCT). All the banks of our sample respect practically the current prudent standard and the level of solvency of banks seems not to affect liquidity significantly. (H1) is thus accepted.

4.2 Impact of Regulations Conditions on the Behavior of Liquidity Risk-Taking

According to the results(profits) found further to the estimation of the model (5) in table (6), we register a positive and statistically significant incidence enter the statutory pressure regarding liquidity on the level of incentive(incitement) of risk-taking of liquidity for ten reserved banks and over the total period going of 1990 to 2012. Indeed, these results show a coefficient (06) positive which borders (0.065365), is T-Student equal to (2.92) significant in an interval of 99 % confidence. At first, the sign of this incidence between both variables (REGL) and (Δ LIQRISK) was not planned according to the second hypothesis. According to the results of some previous contributions, this impact was debated and seems not to be cut. As an example, Horv  th et al. (2012), by estimating the financial implications of the statutory requirements of Basel III on the banking sector in Czech Republic, noticed the existence of a negative link of causality enter the level of risk of liquidity (their capacity to create liquidity) and their respect for the standards of prudent management regarding liquidity. Besides, Destinguin et al. (2012) found, on a sample of European and American commercial banks, that an incentive in the risk-taking of liquidity by these banks is not of link with the recent statutory directives regarding liquidity.

We remind firstly that the risk of liquidity is the risk for the bank not to be able to face a moment given to its commitments by mobilizing its assets. In more important proportions, this risk little end in the bankruptcy of the bank further to a wave of panic which shows itself at the depositor's (bank run). Within the framework of our analysis, the liquidity of the Tunisian banks is relatively low. The BCT always brought to the banking system liquid assets which were necessary and supported all the public or private banks who dealt with major difficulties. Indeed, the cash ratios of the Tunisian banks remain very weak in reference to the international standards, but show recently values which respect the prudent standard (100%). These Tunisian banks tend to maximize the use of their resources in credits. The common feeling through the whole Tunisian banking system is that the BCT will always supply if need the necessary liquidity. This ratio testifies of a finance in balance, and a policy of healthy short-term allocation of resources.

The positive and significant incidence of the statutory conditions on the variation of the risk-taking of liquidity testifies, not only a negligence of this risk, but also the stability of the cash ratio which does not consider the fatal effects of the increase of the risk of liquidity. These results are to be taken with caution because we do not possess more details of the characteristics of current assets (numerator of the ratio) and current liabilities (denominator of the ratio). Banks in Tunisia, so much assisted in liquidity by the Central Bank, do not care too much about the regulatory pressure as soon as the ratio is respected and register no imbalance at the level of their finances, then they manage their liquid assets in the day in the day and without greater caution. These results confirm those found by Darine (2008) and we have thus just enlightened the sense of the behavior of the Tunisian banks regarding risk of liquidity under regulatory pressure.

4.3 Relation between "Liquidity Buffer" and Liquidity Risk Taking

The interactive or composite variable (BUFFERX LIQRISK) is negatively connected with the level of the risk of liquidity of ten studied banks. Really, the results held in Table 6, show that this variable shows a negative and statistically significant association with the behavior of risk-taking of liquidity over 23 years. We register a coefficient (08) negative of the order of (-6.7137) with P-value equal to (3.58) significant in a threshold of probability upper to 1 %. The negative sign and the significativity of the weight associated with this composite variable show that when stockholders' equity buffers of safety increases, the incentive in the liquidity, what testifies of the existence of an effect of the regulatory requirement on the structure of the balance sheet(assessment) of these banks. This result confirms that found by Soumare et al. (2012) and that obtained, on the context of Tunisian banks, by Bouri and Ben Hmida (2011). The fourth hypothesis moved forward at the beginning of this paper is accepted, consequently. As underlined by Dietsch and Tillov (2014), banks preserve spontaneously a low level of reserves of liquidity (liquidity buffer) and cash ratios relative to the recent agreement of Basel III are necessary to avoid a crisis of banking liquidity. To reach this goal, establishments

have to hold a stock of transferable liquid assets and quality. This agreement fixes the quantitative and qualitative for the composition and the calibration of this “pillow of liquidity” through the ratio LCR. The latter obliges banks to maintain permanently a stock of assets considered as liquid and immediately available by the regulator allowing to face a shock of liquidity during a month. Consequently, the calibration of the reserves of liquidity rests on the respect for this short-term ratio which must be upper 100% on the horizon of 30 days. Ten Tunisian universal banks make appeal implicitly to their reserves of liquidity to face occasional massive retreats (withdrawals) by the depositors and avoid possible crises at the level of their availability through a balance balanced on the operations of finance and interbank, in the purpose to master-even to regulate the intensity of the risk of liquidity which threatens them, particularly in the short term.

4.4 Synthesis of the Results on the Liquidity Risk Behavior

Table 7. Summary of the results obtained on the behavior of banks in Tunisia: simultaneous relation between the ratio of capital and liquidity risk under regulatory pressures

Impact of REG on Δ CAR	Impact of REGL on Δ LIQRISK	Impact of Δ CAR on Δ LIQRISK	Impact of Δ LIQRISK on Δ CAR
-	+	0	0

Note. Source made by the authors. (+): positive Impact, (-): negative incidence and (0): no significant effect. REG: the statutory pressure in term of solvency, REGL: conditions statutory regarding liquidity Δ CAR: variation of the level of ratio of capital, Δ LIQRISK: variation of the level liquidity risk.

Table 7 summarizes the main part of the results of the estimations obtained in the term of the present article. The statutory pressure seems to influence only and positively the behavior of risk-taking of liquidity for ten Tunisian banks chosen in our panel. Besides, we notice that a significant incidence is detected only between the levels of ratio of capital and that of the credit risk considered the most dangerous in the banking activity in Tunisia. However, the legal and institutional conditions are positively associated and significantly with the discretionary adjustment of the ratio of capital of banking institutions over the last twenty three years detected respectively in two first specifications (5.1 and 5.2). The behavior of Tunisian commercial banks regarding ratio of capital conjugated with their risk-takings and under statutory pressure confirm the various results found in several previous contributions. It is about a not standard, unforeseen and flexible behavior according to the type of risk.

5. Conclusion

What is the incidence of a change at the level of the ratio of capital on the behavior of the incentive (incitement) in a risk-taking of additional liquidity under the prudent statutory conditions? In this article, we try to find elements of answer to this question, through the estimation of a model in two simultaneous equations by the technique of 3SLS, on a sample of ten universal Tunisian banks during period from 1990 till 2012. The obtained results show which institutional conditions concerning the adequacy of the statutory stockholders' equity, show a negative association with the change of the level of solvency of these establishments. In parallel, the statutory pressure (t-1), regarding liquidity, generates an impact anticipated the behavior of these banks in the form of a risk-taking of liquidity.

We also notice that every variation of the level of the liquidity risk involves no adjustment of the level of the ratio of the capital simultaneously (effect of return). This behavior leads to predict the existence of a certain carelessness towards this type of risk supported by the intervention of the Central bank of Tunisia to assure a balance of finance at the level of the short-term operations of the interbank availability. Besides, we put the accent on the effect of the reserves of liquidity (Buffer) on the risk inherent to these short-term transactions. ; Our results show a negative and significant link between these two components which testifies of the importance of these pillows of liquidity to keep a minimum level of liquidity. This is going to serve to protect these establishments, lenders or borrowers on the interbank market, the possible shocks at the level of their availability. The originality of this article is that it highlights not only the effect of the level of the capital on the capacity of banks to identify the risk of liquidity, but it also highlights the relation of causality inverse between these two endogenous variables. The obtained results confirm those obtained by previous works and which confirmed the existence of a certain instability at the level of the banking behavior in an environment regulated regarding liquidity risk.

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