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Examining the Relationships between Capital Ratio, Credit Risk, Capital Buffer and Prudential Regulation in Tunisian Banking

Hichem Maraghni[1*] Mohamed Tahar RAJHI[2]
1.Doctor at High Institute of Management, University of Gabes and Institute of Business Administration of Tunis (IAE Tunis), Tunisia
2.Professor of Finance at Faculty of Economics and Management, University of El Manar II, Director of IAE Tunis, Tunisia
*E mail of the Corresponding author : maraghni.h@voila.fr

Abstract
We try to examine the simultaneous effect between the variations of capital ratio and the level of credit risk-taking to a sample of Tunisian universal banks under regulation. To do this, we have estimated a structural model in double simultaneous equations with a panel data over a period from 1990 till 2012, then under both period between 1990/2000 and 2001/2012 by using 3SLS estimation. The standards regulatory terms aim to limiting the risk-taking of credit, liquidity, market and operational and supervise the banking activity by limiting their involvement in riskier activities. The results show first, that regulatory constraints on the requirement of bank capital in Tunisia exhibit no incidents on the behavior of credit risk incentive. This institutional pressure is negatively associated with the capital ratio level essentially over the period 2001-2012. In addition, we found that Capital Buffer is negatively related, in a significant degree, to the level of capital ratio of these banks. These findings were similar to those in the contributions of Dahl and Shrieves (1992) Godlewski (2005), Lindquist (2004), Dionne (2006), and Wedow Stolz (2009) and those more recently such as Jokipii and Milne (2010), Maurin and Toivinen (2012). However, the simultaneous effect between the change in the level of capital and incentives to the credit risk is negative and statistically significant over the entire period of analysis. The change in the level of capital has significant and rapid impact on the level of credit risk incentive. These banks modulate their capital ratio, primarily, based on the magnitude of the risk of insolvency of their credit portfolio.
Keywords: Bank regulation, Credit risk, Capital ratio, capital buffer, Basel II and III.

1. Introduction

We try to examine the simultaneous effect between changes in the regulatory capital ratio and a sample of the level of credit risk taking Tunisian universal banks under regulatory pressure on solvency enacted by Law No. 2001-65 of 10 July 2001 and amended by the 2006-19 from 02 May 2006. To achieve this goal we estimated a structural model double simultaneous equations and panel data over a period from 1990 to 2012 then on the two sub period between 1990 -2000 and 2001-2012 by the technique of 3SLS. This model was originally developed in the work of Shrieves and Dahl (1992), Aggrawal and Jacques (1998), Van Roy (2005), Koopman et al. (2005), Stolz et al (2007) to which we have introduced some changes, such as recently by Milne and Jokipii (2010), and Ben Hmida Bouri (2011) and Lin et al (2013) and on the basis of the review the theoretical and empirical literature consistent with our assumptions and issues in order to adapt to the Tunisian context.

The interest of this paper is certain. First, a first econometric interest that is manifested through the relevance of our sample (periods and data) compared to other previous work and the use of new estimation technique (3SLS) combined with the relevance our question deemed valid research. Next, the second interest of this paper is reflected by the results to which we arrived that can given some answers to qualified banking behavior theoretically ambiguous. Prudential management standards set by regulatory authorities intended to limit the risk (credit, liquidity, market, operational, ... etc.) and limit their involvement in riskier activities. This legal intervention proves essential to ensure the strength and sustainability of the banking system. Indeed, to limit their risk of bankruptcy, safeguard the interests of depositors and guarantee the stability of the financial system. Banks have long been subject to various prudential regulations based on several mechanisms, the aim is usually to impose on them minimum capital. The capital requirements play a fundamental role in banking regulation which explains the one hand, the importance of their capital levels to ensure the stability and competitiveness of the bank and on the other hand, their role in terms of incentives to excessive risk-taking behavior, particularly the credit risk that most threatens the banking industry (DeCoussergue 2002). Indeed, if a bank has a high amount of capital then it has more to lose if it fails and is therefore encouraged to engage in less risky activities. The articulation of this paper will focus on the following methodology: we start by introducing and indicating its purpose and interest, then in the first section we will outline the variables and context of our study and the formulation of hypothesis tested and the econometric specification of the model chosen. Some specifications tests will be presented at the end of this first section. The statistical description of the data, the correlation matrix of the variables and the expected signs of the model parameters will be subject to the second section. Throughout the third section we presented and analyzed most of the results of the estimates of the relationship between changes in the capital ratio and changes in the credit risk level.

2. Definition of the variables tested assumptions and econometric specification

2.1. Presentation of variables, assumptions and analytical framework

The two equations (III.5.1) and (III.5.2), simultaneously express the relationship between the level of change in capital and the behavior of banks in terms of credit risk (both endogenous variables). These are based on the desired target levels of capital and credit risk as a suitable battery explanatory proxies (exogenous variables) that will be defined and presented below. It should be noted that the choice of exogenous variables is closely related to the review of the theoretical and empirical literature and inspired from previous contributions made through comparable models specified by Agrawal and Jacques (1998), Heid et al. (2004) Godlewski (2005), Van Roy (2005) and Lin and al. (2013). Indeed, these latter were required account and introduced the majority of these variables in their models that treat almost the same question.

We are just going to present the definitions of six new variables (endogenous and exogenous) included in the equations (III.5.1) and (III.5.2) The rest of variables will be briefly presented in the table (III.1). In fact, we define successively CRRISK, BUFFER, (REG x ΔCRRISK) (ΔCAR x REG) (BUFFER x ΔCAR) and (BUFFER x CRRISK). Having set these variables, our empirical strategy is eventually to advance hypothesis and built based on the definitions in the following.

CRRISK: This variable expresses the level of credit risk taken, introduced into our model as endogenous variable through a first variation (ΔCRRISK) between (t) and (t-1) and as an exogenous variable (t - 1) to reflect the main source of bank risk. Indeed, it is an indicator that captures the danger from the balance sheet and off-balance from quantitative information on institutions and bank loan portfolios, namely counterparty risk. It is measured by the ratio of provisions for bad and doubtful debts and the amount of financing to the economy according to the following formula:

CRRISK = *Provisions for doubtful and bad loans (litigious) / Total lending to the economy*

By incorporating this variable into its work, Kwan (2004) pointed out that this is a measure that expresses the bank's ability to absorb losses and reflects the level of risky assets in a portfolio of bank assets arguing that banks with more capital are considered less risky and therefore are more reserves on their NPL. As Bouri and Ben Hmida (2011) and Saadawi (2010), who also introduced this variable in their work, we used this definition in our study. These authors showed that the allocation of bank portfolio credit risk is carried out in the light of regulatory standards that set the level of prudential capital requirements, as enacted by the Basel agreements I, II and III internationally. They also insist that the banking portfolio aims to ensure the regularity of bank value in the medium term and to optimize the level of allocated capital under credit risk constraint.

On the regulatory front, institutions whose portfolio is considered relatively risky (with a level of high credit risk) will be forced to hold a level of capital larger buffer. Otherwise, these banks will be more likely to be found with minimum capital ratios below the required regulatory standard, which is likely to favor an increase in the probability of bankruptcy and are unable to cope with the costs associated with this delicate financial situation. Several authors have noted that the extent of the bank's credit risk is not an easy task. Moreover, many measures of credit risk variable were adopted in the literature, however, we have recorded no consensus or compromise on a standard measure that is the most appropriate and most relevant. Given the purpose of this paper, which aims to quantify the change in credit risk level under the regulatory policy following a change in capital profile of the ten Tunisian banks on a history of twenty-three years, this measure of risk credit has been focused on the existing literature. Therefore we are concerned about the ratio of provisions for outstanding CDL and the economy to assess this variable. Indeed, in the ancient and recent literature, several authors have used this ratio to capture the risk of asset, it lists as examples the work of McManus and Rosen (1991), Berger (1995), Gorton and Rosen (1995), DeYoung and Roland (2001) Speed Limit (2004), which resulted a positive relationship between (ΔCRRISK) and (ΔCAR) while Godlewski (2005) and Van Roy did not detect any significant relationship between these two variables, against Milne and Jokipii (2010) and Lin et al (2013) resulted in a positive impact of these two endogenous proxies in a model similar to the one we chose. Cane and Quagliariello (2006) and Bouri ben Hmida (2011), for against, detected a negative impact between these two components.

The correlation matrix teaches that ΔCRRISK variable is negatively correlated with ΔCAR and we record a negative correlation coefficient of the order of (-0.2220). The expected impact of this variable seems controversial in the theoretical and empirical literature anterior and can be either negative or positive: ΔCRRISK based ΔCAR and vice versa. It remains to consider its sign in the results of our estimate for the ten selected banks and periods of planned analysis. Based on the above arguments, we propose to test the following hypothesis: Hypothesis 1 (H1): The change in the level of credit risk taken is correlated with the change in the capital ratio level but the sign of this effect appears even qualified.

BUFFER: This is a variable that has been introduced in equation (III.5.1) of our model in order to explain the variation in the level of regulatory capital ratio (ΔCAR) depending on the specific buffer fund and to

measure the distance taken by banks against the risk of non-compliance with the prudential regulation of capital as mentioned by Bouaiss (2005). This variable is calculated from the formula of the risk coverage ratio, defined as the difference between the capital ratio (CAR) and the regulatory minimum ratio required (Min REG), Tunisia (Min REG equal to 5% from 1990 to 2000 then (Min REG equal to 8% over the period 2001-2012.) For Heid, and Slotz Porath (2004) and Fonseca and Gonzalez (2009), it is an absolute safety stock capital held by the bank, it is also a combined measure of equity and default risk This variable is calculated using the following formula.:
Buffer = CAR - Min REG

We have chosen this explanatory variable because it reflects the observed change in the amount of bank capital held in addition to that required by the regulator. We adopt this measure of capital since we assume that banks will manage their own funds in order to avoid, or reduce, the costs and penalties associated with disobedience to regulatory standards. This argument was also advanced by Lindquist (2004) Repullo and Suarez (2004), Nier and Baumann (2006) and more recently by Maurin and Toivanen (2012). Several contributions have introduced this variable to account for the procyclical nature of the regulatory environment including Carpenter et al. (2002), Krainer (2002) and Heid (2007) or to detect the relationship between bank credit risk, regulatory pressure and behavior of solvency ratios, for example the work of Illing and Paulin (2004) Koopman et al. (2005), Stolz (2007). The results of the contributions of Ayoso et al. (2004), Lindquist (2004) and Wedow and Stolz (2009), have shown the effect of countercyclical buffer own funds (Capital Buffer), respectively, for samples of banks in Spain, Norway and banks in Germany.

Recently, Fonseca and Gonzalez (2009), Jokipii and Milne (2010) and Ben Hmida Bouri (2011) and Lin et al (2013) and announced the countercyclical behavior of this variable, particularly in the credit risk level respectively in Switzerland , Tunisia and the United States when they studied the relationship between the capital reserve (Capital Buffer), capital, risk, performance and efficiency. Referring to the theory commonly called "Buffer Theory", it is expected that adjustments to the capital levels with the levels of credit risk of the decision will be positively correlated where a finding of the existence of relatively high equity buffer or safety, as they will be negatively related when the situation is symmetrical. Under this approach, banks have higher capital ratios to the required regulatory standard (well capitalized) show capital reserves fund more comfortable. However, for banks that are close to the required level of regulatory capital, the relationship could be short-term negative. In fact, any increase in regulatory capital requirements (ΔCAR) results in a decrease in the level of capital reserve stock (BUFFER) and conversely, an increase of the own funds buffer results in a degradation of the capital ratio. Thus, for information about the low levels of values (BUFFER) and (ΔCAR) for our sample, we make the second hypothesis to be tested as follows: Hypothesis 2 (H2): The level of own funds buffer is negatively correlated with the change in the level of capital. A negative relationship is expected between (ΔCAR) and (BUFFER).

CAR: This is the solvency ratio or adequacy of regulatory capital ratio, also called "McDonough". This is the ratio between the prudential net equity of the bank (bases (Tier 1) and supplementary (Tier 2)) and the weighted bank assets or adjusted for different risk classes. This ratio can't be calculated directly from the financial statements, it is usually issued by banks in their annual reports. Also, it has been introduced as the first change between two years.. The ratio (CAR) is variable which measures the solvency of the bank, it has become very popular, as evidenced by Powell (2004) since its adoption by international regulatory authorities. The value of this ratio should be above 8% since the beginning of 2000. It was used by Jacques and Nigro (1997) Aggrawal and Jacques (1998) and Heid et al (2005), Milne and Jokipii (2010) and Lin et al. (2013), to identify the simultaneous effect between capital and counterparty risk measured by (RWA / TA). These authors point out that a high level of this ratio indicates a risk of default or lower credit. Therefore, based on this argument, the sign for the variable (ΔCAR) in our model (III.5) will be negative depending on the credit risk (ΔCRRISK). The feedback effect is expected to be seen with an unexpected sign controversial results in the literature on the relationship (hypothesis H1). The ratio is calculated from the formula is as follows:
CAR = Capital (Tier 1 + Tier 2) / Risk Weighted Assets

The following hypothesis can be conveyed to be tested in the light of the definition of this variable: Hypothesis 3 (H3): The change in the level of the bank's capital ratio exhibits a significantly negative effect on risk-taking behavior credit.

REG: Introduced to the levels of contributions Heid et al. (2005), Van Roy (2005), Nashane et Gosh (2004), Cannata and Quagliariello (2006) and Matejašák and Teplý (2009) and more recently in the work of Milne and Jokipii (2010) and Bouri and Ben Hmida (2011). This is an exogenous variable which is among the explanatory variables in equation (III.5.2), our econometric model on the level of credit risk, as useful to capture the effect of regulatory pressure equity through composite control variables in accordance with the guidelines of the Basel II and III Agreement and the applicable laws of texts governing credit institutions in Tunisia. This variable can have two possible values is (MinREG σCARi +) - curry, t, or null. Several authors, such as Calem and Rob (1996) and Godlewski (2005) support the idea that the effect of the latter on the credit risk level to be determined in the estimation results. In the same sense, Blum (1999) and Heid et al (2006) noted in their work that the effect of bank regulation behavior incentives for default risk-taking led to controversial results. One notes: Min REG is the regulatory minimum required for solvency, σCAR is the standard deviation of the capital ratio denoted CAR. For a bank (i) and towards the end of a year (t) variable regulatory pressure (REG) is defined as follows:

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

Several contributions confirm the essential role of regulation and banking supervision in the credit risk prevention. All these previous findings allow us to build the fourth hypothesis about the institutional variable effect (as defined in the work of Darine (2008)), or the impact of (REG (i,t-1) behavioral risk-taking bank credit (ΔCRRISKi,t), as follows: Hypothesis 4 (H4): Regulatory pressure has an unexpected effect on the behavior of Tunisian banks' credit risk.

(REG x ΔCAR) and (ΔCRRISK x REG): These two composite variables that expresses one hand, the product of the variable reflecting regulatory constraints and the variable measuring the level of capital and Furthermore, the product of the credit risk level and that relating to regulatory pressure. These two variables were included respectively in equations (III.5.1) and (III.5.2) in our model such that appear in the works of Aggrawal and Jaques (1998) Quagliariello (2008), Albertazzi and Gambacorta (2009) and particularly for Bouri and Ben Hmida (2011) in the Tunisian context (time series model). Rather composite variables that will be used to quantify the impact of regulation on capital ratio. Inspired by the work of Van Roy (2005), Milne and Jokipii (2010), Maurin and Toivanen (2012) and Lin et al. (2013), we can consider that regulatory pressure can affect the speed of adjustment of the bank's solvency ratio. This interaction term defined as the product of the two variables could detect more rigorously the impact of prudential constraint on the change in the capital level of our model. The expected sign of these composite variables is expected to be positive for the product (REG ΔCAR x) relative to ΔCAR (λ8> 0) by against that of (REG (i,t-1) x ΔCRRISK (i, t-1)) seems unpredictable until analysis level, as indicated by several theorists, among others, Shrieves and Dahl (1992), and Nigro Jacques (1997), and Eisenbeis Kwan (1997) and Altunbas et al. (2007). In light of this definition and the references we deem necessary to advance the hypothesis to be tested as follows: Hypothesis 5 (H5): Regulatory pressure is positively associated with the change in the level of capital ratio and anticipates an unexpected effect the behavior of banks' solvency when thine account its incitement to additional credit risk.

(BUFFER x ΔCAR) and (BUFFER x CRRISK): In the same way, and according to the same logic of composite variables, we introduce these two composite variables to quantify the impact of the reserve capital on changes in the level of default risk. This measure was inspired mainly work Heid, and Slotz Porath (2004) for German banks, Maurin and Toivanen (2012) for European banks and His Lea et al. (2010) for banking institutions in Canada. Through these variables we examine whether the banks, when they have relatively low capital buffer stocks, adjust the counterparty risk level faster compared to the opposite situation. To implement these concepts, and referring to the contributions of Bouri and Ben Hmida (2011) on a sample of Tunisian banks, Hwang and Lin and Xie (2013) in the context of US banks, we insert these proxy in equation (III.5.2) explaining the behavior of incitement to credit risk taken in relation to the capital buffer.

Furthermore, Calem and Rob (1996) and Rime (2001) highlighted in the literature on bank behavior under the regulations, the theory of buffer capital called "Buffer Theory" envisages that when a credit institution approaching the minimum regulatory capital adequacy ratio, then it is supposed to have more incentive to improve the level of equity and to avoid the costs and penalties caused by under-capitalization. These authors reported also that banks with low capital levels trying to rebuild an adequate capital reserve stock by increasing their level of capital and simultaneously reducing their incentive to excess credit risk. The sixth hypothesis can be formulated as follows: Hypothesis 6 (H6): Composite measures specific buffer funds negatively influence the level of counterparty risk. To avoid the problem of redundancy and repetition, we decided not to reproduce the definitions with too much detail of some variables, we decided to combine the necessary information related to such exogenous variables and the underlying assumptions in the table (III.1) following.

Table III.1. Some explanatory variables used in the model (III.5) and their underlying assumptions to be tested.

Variables	Formula	Theorical references	Hypothesis
SIZE	***SIZE = Ln (Total assets)***	Matejašák and Teply (2009), Shrieves and Dahl (1992), Godlewski (2004), Murinde and Yassen (2004), Hassan and Hussain (2006), Saadaoui (2010), Lin and al. (2013)	H7: the size of the bank presents a negative relation with the variation of the level ratio of the capital and simultaneously has a negative effect on the variation of the level of the risk of counterparty.
ROA	***ROA = Net benefit/ Total Assets***	Rime (2001), Heid and al (2004), Matejašák and Teplý (2007), Van Roy (2005), Nashane and Ghosh (2001), Godlewski (2005) , Milne and Jokipii (2010), Son Lai and Soumare (2010), Bouri and Ben Hmida (2011).	H8: the relation expected between the level of capitalization and the quality of assets in terms of yield is positive.
LLOSS	***LLOSS = NPL / Total loans***	Rime (2001), Cannat and Quagliariello (2006), Jacques and Negro (1998), Saadaoui (2010), Bouri and Ben Hmida (2006), Matejašák and Teplý (2009).	H9: the relation between the ratio of the not performing loans and the variation of the level of the credit is expected with a positive sign
SPREAD	***SPREAD = Net Interest Margin / Total Assets***	Godlewski (2004), Van Roy (2005), Jabnoun (2005), Saadaoui (2010), Son Lai and Soumare (2010), Rajhi e and Gassouma (2011) , Lin and al. (2013).	H10: the part of the net margin of banking interest is positively correlated to the level of the ratio of capital and negatively connected with the level of the risk of default.

Source : Done by auteur.

2.2. Econometric model specification and partial adjustment

For a long time, Altman (1968) emphasized that in addition to their traditional utility assessment of financial and economic performance of credit institutions, financial ratios are considered internal static streamlining tools necessary for predicting difficulties . Lev (1969) ruled on the use of the industry average as the value "target" and firms adjust their financial ratios according to a partial adjustment model, subsequently improved with the calculation of adjustments by the work durations Peles and Scheneller (1989). This partial adjustment model takes the econometric form $y(t) - y(t-1) = \lambda (y^*(t) - y(t-1))$, where $y(t)$ and $y(t-1)$ are financial ratios, respectively (t) and (t-1), $y^*(t)$ is the financial ratio "target" or "desired" unobservable in (t) and λ measures the partial adjustment speed momentum to reach the target value. Lintner (1977) also used this type of model in the context of the adjustment of the target level of dividends banking firms. The contributions from Chen and Anima ((1994) and Kouings and Roodhooft (1997) showed that we could estimate the partial adjustment speed over time of financial ratios by introducing a non-parametric approach to study their dynamic behavior and test their convergence values "objectives". It is in the context of this econometric specification partial adjustment that fits our contribution through two simultaneous equations model originally developed by Shrieves and Dahl (1992) and taken up by Jacques and Nigro (1997), Aggarwal and Jacques (1998), Ediz, Michael and Perraudin (1998), Rime (2000) Saadawi (2010), and Ben Hmida Bouri (2011) and Lin et al. (2013), and several other authors to study the relationship between the level of capitalization ratio and the level of risk ratio in general banking firms. Knowing that we are going to focus on the credit risk level in this work, a review of the theoretical literature shows that these two endogenous variables are connected and behave in a simultaneously. In other words, two possible situations: a) Each change in the level of capitalization ratio can result in an adjustment of the level of incitement to credit risk taking and b) Any possible changes in the level of risk credit may encourage the institution to adjust its funding ratio to a desired target value to hedge against this risk.

Target values or objectives of the capital ratio (CAR *) as well as the credit risk level (CRRISK *) as credit institutions authorized as a bank wishing to obtain, is a linear function of several exogenous variables that explain the decision framework of their attorneys. In the long term, these banks want to achieve optimal degrees following ratios partial adjustment. Specifically, Dahl and Shrieves (1992) is clear that these firms are able to instantly reach the "target" levels and therefore they do partially, hence the use of the parameters (λ) and (γ) related this adjustment knowing that their values vary between zero and unity. During each year (t) and for each bank (i), the optimal level change in the ratio of capital and the level of credit risk ratio will be motivated by the

difference between CAR and CAR * t-1 and simultaneously between CRRISK* and CRRISK t-1.
Resulting in both equations (III.1) and (III.2) following by

$$\Delta \mathbf{CAR_{i,t}} = \lambda\ (\mathbf{CAR^* - CAR_{t-1}}) \qquad \textbf{(III.1)}$$

$$\Delta \mathbf{CRRISK_{i,t}} = \gamma\ (\mathbf{CRRISK^* - CRRISK_{t-1}}) \qquad \textbf{(III.2)}$$

Taking into account the explanatory variables (exogenous) as described and recorded in the works of Jacques and Nigro (1997), Aggarwal and Jacques (1998), in two simultaneous equations, respectively (And) and (St), we get the econometric specifications bases (III.3) and (III.4) which set out mathematically as:

$$\Delta \mathbf{CAR_{i,t}} = \lambda\ (\mathbf{CAR^* - CAR_{t-1}}) + \mathbf{Et} \qquad \textbf{(III.3)}$$

$$\Delta \mathbf{CRRISK_{i,t}} = \gamma\ (\mathbf{CRRISK^* - CRRISK_{t-1}}) + \mathbf{St} \qquad \textbf{(III.4)}$$

Our model estimated is written in the form of two simultaneous equations (III.5.1) and (III.5.2) in the following system:

$$\textbf{(III.5)} \quad \begin{cases} \Delta \mathbf{CAR}_{i,t} = \lambda_0 + \lambda_1 \mathbf{ROA}_{i,t} + \lambda_2 \mathbf{SIZE}_{i,t} + \lambda_3 \mathbf{SPREAD}_{i,t} + \lambda_4 \Delta\mathbf{CRRISK}_{i,t} \\ \quad + \lambda_5 \mathbf{CAR}_{(i,t-1)} + \lambda_6 \mathbf{BUFFER}_{i,t} + \lambda_7 (\mathbf{REG}_{(i,t-1)}\ \mathbf{X}\ \Delta\mathbf{CRRISK}_{(i,t-1)}) \\ \quad + \lambda_8 (\mathbf{REG}_{i,t}\ \mathbf{X}\ \Delta\mathbf{CAR}_{i,t}) + \boldsymbol{\mu}_{i,t} \qquad \textbf{(III.5.1)} \\ \Delta \mathbf{CRRISK}_{i,t} = \gamma_0 + \gamma_1 \mathbf{SIZE}_{i,t} + \gamma_2 \mathbf{LLOSS}_{i,t} + \gamma_3 \mathbf{SPREAD}_{i,t} + \gamma_4 \Delta\mathbf{CAR}_{i,t} \\ \quad + \gamma_5 \mathbf{CRRISK}_{(i,t-1)} + \gamma_6 \mathbf{REG}_{(i,t-1)} + \gamma_7 (\mathbf{BUFFER}_{(i,t-1)}\ \mathbf{X}\ \Delta\mathbf{CAR}_{(i,t-1)}) \\ \quad + \gamma_8 (\mathbf{BUFFER}_{i,t}\ \mathbf{X}\ \mathbf{CRRISK}_{i,t}) + \boldsymbol{\eta}_{i,t} \qquad \textbf{(III.5.2)} \end{cases}$$

With, µi, t and ηi, t respectively express terms residues capitalization level equations and credit risk level for establishing (i) and during the year (t). We also note lj (j = 1 ... .8) and γk (k = 1 ... ..8) model parameters assigned to the different variables (λ0) and (γ0) as the respective constants of the two simultaneous equations model (III.5).

2.3. Preliminary tests of specification and choice of estimation technique

In their contributions similar to ours, Ayuso et al. (2004), and Wedow Stolz (2005) Jokipii and Milne (2008), Jokipii and Milne (2010) and Fonseca and Gonzalez (2010) use the estimator (3SLS) when they analyzed the determinants of excess capital (capital buffer) simultaneous equation to explain the behavior of banking companies in terms of capitalization, credit risk taking under regulatory pressure. As claimed by Arrelano and Bover (1995) estimation technique (3SLS) considered more robust than by the least squares (2SLS). Indeed, it can overcome the endogeneity problem by replacing the endogenous variables by instruments such as the lagged values of these variables. We will use the estimator (3SLS) taking values delayed level of capital and credit risk.

The systems of simultaneous equations can be estimated using various methods. The methods that impose fewer conditions and are the most used are: two-stage least squares method or the 2SLS method of least squares or triple (3SLS) and technical apparently called independent equations (SUR). In our case the estimators (3SLS) have the same properties as the Ordinary Least Square: unbiased and minimum variance, we obtain the most significant coefficients and more robust estimation results. As in most of the empirical work, and if we refer to the work of Bouri and Ben Hmida (2011), we note that in the presence of a linear multi-equation model, it sometimes happens that an endogenous variable an equation appears as an explanatory variable in another equation. This dual status of certain variables calls for a specific treatment systems incorporating several equations with that characteristic. In this paper, the econometric model processing (III.5) simultaneous equations raises three issues: the identifiability conditions of the model, the endogeneity of these variables and the estimation technique used. As indicated Bourbonnais (2004), for a simultaneous equations model is identifiable, it must meet the conditions of order and rank conditions. Order conditions are met for a particular measurement in the equation where the number of exogenous variables included in the equation is at least equal to the number of endogenous variables it contains. The estimation method chosen is that of (3SLS). The condition identifiablité and endogeneity test will be carried out under pre tested to estimate in what follows.

α. Verification of the model identification conditions

Before the estimation of simultaneous equations model, Bourbonnais (2004) points out that it is necessary to check two identification conditions: conditions of order and rank conditions. The rank condition is a necessary and sufficient condition, but it is difficult to implement in practice. Still, according to Bourbonnais (2003), rank conditions are more difficult to explain intuitively but it is extremely rare that a practical system that meets the conditions of order does not meet the rank conditions. There econometric tests on the validity of rank conditions of this type of model structure. They are usually made prior to estimation.

Indeed, Donald Gragg test and the test of Anderson and Rubin checks the acceptance or rejection of the null hypothesis based on "H0 = The model is identified as". In addition, the Sargan test on identification, believes the null hypothesis which states that the identification instruments are uncorrelated. In our case, we will limit ourselves to verify the order conditions that determine equation equation. Three cases of identification may be encountered:

Case 1: The model is identified as if an equation of the model is as identifiable;
Case 2: The model is just identified if all equations are identifiable just;
Case 3: The model is On-identified if the model equations are either identifiable fair or on-identifiable.

The implementation of this test is carried out as follows: First we will define the following instruments: g is the number of endogenous variables in the model (the number of equations); k is the number of exogenous variables of the model; g 'is the number of endogenous variables in an equation; and k is the number of exogenous variables in an equation. Then we will present the conditions of the model identification as follows:

Identification Conditions	Comment
$g-1 > g-g' + k - k'$	identified
$g-1 = g-g' + k - k'$	Just identified
$g-1 < g-g' + k - k'$	under identified

Referring to our model (III.5), we notice that it contains two endogenous variables that are ΔCARi, t and ΔCRRISKi,t so (g = 2) (that is the number of equations to estimate). For each facility (i) and year (t) specification includes, in addition to the constant, fifteen exogenous variables (ROA i,t, SIZEi,t, SPREADi,t ; ΔCRRISKi,t; CAR (i, t-1) REG (i, t-1), LLOSS i, t, ΔCARi,t, BUFFER i, t, (REG (i, t-1) x ΔCRRISK (i, t-1)), (i REG, tx ΔCAR i, t), CRRISK (i, t-1), (BUFFER (i, t-1) x ΔCAR (i, t-1)), and (i BUFFER, tx CRRISK i, t)) thus we obtain (k = 15). In the first equation (III.5.1) the number of endogenous variable (g '= 1), while the exogenous variables (k = 8). We can then write : Equation (III.5.1) [2-1] = 1 <[(2-1) + (15-8)] = 8 In the second equation, the number of endogenous variable g '= 1 while the exogenous variables is k' = 8. We obtain therefore : Equation (III.5.2) [2-1] = 1 <[(2-1) + (15-8)] = 8. With these results we can conclude that the two equations (III.5.1) and (III.5.2) are over-identified which demonstrates that our model itself is over-identified. We can therefore estimate its parameters by the least squares dual method (2SLS), or even, the least squares method triples (3SLS).

β. Endogeneity Durbin-Wu-Haussman and Davidson and Mckinnon

Generally, several authors use tested Durbin-Wu-Haussman and Davidson and McKinnon (1993) in order to detect the presence of endogeneity problem between the variables of the model and the terms of residues. Double steps, we will first proceed to the regression of each of the endogenous variables on all exogenous variables suspected. Then we take these residues and introduce them to the level of the basic specification (model (III.5)). This is the test similar to that Breusch-Pagan and / or Cook-Weisberg (heteroscedasticity test) which is interpreted in terms of the Wald statistic (Chi Deux). We will finally realize the Fisher test on the attached significance of residues. We reject the null hypothesis that the coefficients associated with residues are zero for changes in capital levels and changes in the credit risk level. In other words we will test the endogeneity of the variable (ΔCARi, t) and subsequently that of the variable (ΔCRRISKi, t) according to the terms of the respective errors. Most of the results of the test endogeneity applied to our model is successively grouped in tables (III.2) and (III.3) include:

Table III.2. Results of endogeneity test (ΔCARi,t) first equation

Endogenious Variable: $\Delta CAR_{i,t}$	**T-Student**	**P > |t| (P-value)**
ROA	-	0.0000
SIZE	-	0.0000
SPREAD	-	0.0000
CAR(1)	-	0.0000
BUFFER	-	0.0000
REG x ΔCRRISK (1)	-	0.0000
REG x ΔCAR	-	0.0000
LLOSS	-	0.0000
CRRISK (1)	-	0.0000
REG(1)	-	0.0000
BUFFER x ΔCAR (1)	-	0.0000
BUFFER x CRRISK	-	0.0000
Resid $\mu_{i,t}$	-	0.0000
Intercept λ_0	-	0.0000
N	*217*	
Fischer F (11,205)*	*103.30*	
Prob > F	*0.0000*	
R^2	*84.70%*	

**Statistic Ficher : F(q, n-k-1), N : number of observation,*

R^2 determination coefficient

The results of the regression of the endogenous variable equation (III.5.1) (ΔCARi, t) according to the different exogenous variables of the model are (ROAI, t, SIZEi, t, SPREADi, t, ΔCRRISKi, t AS (i, t-1), REG (i, t-1), LLOSSi, t, ΔCARi, t, BUFFERi, t, (REG (i, t-1) x ΔCRRISK (i, t-1)) (governed ΔCARi tx, t), CRRISK (i, t-1), (BUFFER (i, t-1) x ΔCAR (i, t-1))), and (i BUFFER, tx CRRISKi, t) in addition to the constant (λ0) to the residue (μi, t) of the first equation, reveal a Fisher statistic F (11.205) equal to (103.30) with a Prob> F = 0.0000, significant at a confidence interval 99%, higher than the critical value read directly from Fisher's table for a number of observations equal to 216 and over the period 1990 to 2012.
For these variables, the t-Student are not significant with P-Value> | t | = 0.0000. We can conclude that light from these results that the equation of the term residue (III.5.1) relating to the capitalization is insignificant so there was no problem of endogeneity.

Table III.3. Endogeneity test de la 2nd equation $\Delta CRRISK_{i,t}$

Endogenious Variable: $\Delta CRRISK_{i,t}$	**T-Student**	**P > |t| (P-value)**
ROA	-	0.0000
SIZE	-	0.0000
SPREAD	-	0.0000
CAR(1)	-	0.0000
BUFFER	-	0.0000
REG x ΔCRRISK (1)	-	0.0000
REG x ΔCAR	-	0.0000
LLOSS	-	0.0000
CRRISK (1)	-	0.0000
REG(1)	-	0.0000
BUFFER x ΔCAR (1)	-	0.0000
BUFFER x CRRISK	-	0.0000
Résidue $\eta_{i,t}$	-	0.0000
Intercept γ_0	-	0.0000
N	*216*	
Fischer F (11,204)*	*839.34*	
Prob > F	*0.0000*	
R^2	*69.07%*	

**Statistic Ficher : F(q, n-k-1), N : number of observation,*
R^2 determination coefficient

The results in Table (III.3) show that regression of the variable (ΔCRRISKi, t) on the set of exogenous variables and the constant (γ0) of our model (III.5) namely (i ROA, t, SIZEi, t, SPREADi, t, ΔCRRISKi, t, CP (i, t-1), REG (i, t-1), LLOSSi, t, ΔCARi, t, BUFFER i, t, (REG (i, t-1) x ΔCRRISK (i, t-1)), (REGI, tx ΔCARi, t), CRRISK (i, t-1), (BUFFER (i, t-1) x ΔCAR (i, t-1)) and (i BUFFER, tx CRRISK i, t)) from the error term η i, t of equation (III.5.2)) have for a number of observations equal to 204 for the whole period work (1990 -2012), a statistical Fisher F (11.204) equal to 839.34 with Prob> F = 0.0000 to a low of 1%, higher than the critical value read immediately on Fisher's table. According to these results endogeneity tests listed in the tables (III.2) and (III.3) we see that for the endogenous variables (ΔCARi, t) and (ΔCRRISKi, t), t-Student are not significant with P-value> | t | = 0.0000. We can conclude that the residue (ηi, t) in equation (III.5.2) on the change in the level of credit risk-taking is not significant, therefore, there is no endogeneity problem in the specification used. After checking the identification requirements of simultaneous equations as our model followed by the verification of the absence of endogeneity problem for both endogenous variables ΔCARi, and ΔCRRISKi t, t, it should now indicate that we will made an estimate of the model in three periods, the first from 1990 to 2012 the second period runs from 1990 to 2000 and the third period covers the years 2001 to 2012. Methodologically, this time slicing is likely to enable us to see the impact of the behavior of the ten banks in our sample in terms of credit risk taken with respect to the change in capital ratio together under regulatory pressure effect in force in Tunisia. In the next section we will present our data through a statistical description, especially we will outline the correlation matrix between the variables and their expected signs in the estimate made by the econometric software Stata.

3. Description of descriptive and statistical data

A description of the data sources will be exhibited prior to the presentation of the results.

3.1. Description data

Our panel consists of ten Tunisian commercial banks (universal) over a period of twenty three years which runs between 1990 and 2012. To build our database we first collected the financial statements of these institutions, all listed on the BVMT, are: balance sheets, income statements, statements of treasuries flows, off-balance sheet commitments and notes to the financial statements. The sources of these documents were essentially the recent reports of APBEFT, BCT and other statistics on bank financial statements collected from the ADB. Internal reports on the situations of some banks in our sample, as well as reports of Fitch-rating and Maxula Stock Exchange is part of our sources of financial data in our database. Not to mention the reports on regulatory oversight in Tunisia and other banking statistics on their own websites to each institution. All these sources have been fundamentally useful for the construction of our official database. Many data were the subject of a preliminary calculation either ratios or by calculations of change between two periods (t) and (t-1) or the product of two variables as composite or interactive proxies to take into account possible effects due to the nonlinearity. The list of selected schools as well as information on some relevant financial ratios at 30 June 2013 are presented in the table (III.4).

Table III.4. Bank sample informations

Banks	**Social nomination**	**Informations at 30/06/2013**			
		CAR	**CRRISK**	**BUFFER**	**Prob. F**
ATTIJARI	Attijari Bank	9,24%	22,74 %	1,24%	0,92%
AB	Amen Bank	13,15%	23,70%	5,15%	0,18%
ATB	Arab Tunisian Bank	14,39%	27,41%	6,39%	0,12%
BIAT	Banque Internationale Arabe de Tunisie	11,92%	26,71%	3,92%	0,12%
BH	Banque de l'Habitat	10,23%	19,11%	2,23%	0,14%
BNA	Banque Nationale Agricole	11,41%	23,11%	3,41%	0,16%
BT	Banque de Tunisie	21.84%	53,37%	13,84%	0,11%
STB	Société Tunisienne de Banque	9.02%	18,67%	1,02%	0,18%
UBCI	Union Bancaire pour le Commerce et l'Industrie	10.51%	21,45	2,51%	0,33%
UIB	Union Internationale des Banques	9.27%	19,60%	1,27%	0,14%

Source: Calculated by the author (Buffer and Prob f) and reports from the APBFT 2013 and report on the supervision BCT 2013, (CAR) capital ratio (Prob.F): Probability bankruptcy (Prob.F = 1 / 2IR^2) IR is IR risk index = [E (ROA) CAR +] / σ (ROA) with E (ROA) and σ (ROA) are respectively the mean and the standard deviation of the return on assets (ROA) and (CAR) is the capital ratio. (BUFFER) excess equity in% "misleading" or "capital buffer" (CAR - Min Reg (8% in 2013)) (= CRRISK Provisions for doubtful loans and litigeuses / Total lending to the economy) and (CAR = FPNP / AAR), respectively the ratio of regulatory capital and credit risk ratio.

If we refer to the table (III.4) We note that the regulatory capital ratio of the ten banks included in our panel, comply with the prudential standard solvency June 30, 2013. In fact, these ratios broken down between (9.02%) and (21.84%) while the standard is required (8%). Furthermore, the ratio of credit risk as measured by the share of provisions for bad and doubtful debts in the amount of lending to the economy, posted the wrong values expressed provisioning policy Tunisian banks partly explained the law which limited the tax deduction of provisions to a certain percentage of annual profits. Indeed, these provisioning rates are relatively low and considered insufficient given the somewhat conservative valuation of collateral on these claims and do not respect the prudential standard fixed (70%).

The values of specific buffer funds (%) show that by the middle of fiscal 2013, the ten banks, subject to our sample hold sufficient "cushion" or reserve stock of capital (Capital Buffer). Indeed, these positive values, vary between (1.02%) and (13.84%). This reserve shows the ability of these institutions to avoid, or to meet the costs and penalties associated with potential non-compliance with regulatory standards for solvency. Bankruptcy probability calculated in the table (III.4) shows that the banks in question in this paper are far from beings threatened by such a situation. Indeed, the probability displayed low values which lie between (0.11%) and (0.92%). According to Avery and Berger (1991), a more student own capital ratio, is associated with a lower probability of bankruptcy. However, Gennotte and Pyle (1991) and Santos (1999) showed that the strengthening of capital requirements leads to riskier asset choices which reduces the positive effects of the capital increase and therefore results in a lower failure probability of banking firms. These authors stressed that the strengthening of capital requirements should therefore not be a substitute for the monitoring and credit risk control.

3.2. Data processing and properties of Descriptive Statistics

Table III.5. Descriptive Statistics

Variables	(N)	Mean	Standard Dev.	Min.	Max.
ΔCAR	230	0.00351	0.01747	-0.097418	0.070737
ΔCRRISK	230	0.182811	0.108022	0.14941	0.493293
ROA	230	0.005444	0.011517	-0.103505	0.035006
SIZE	230	14.81109	0.53435	12.4643	16.8847
SPREAD	230	0.03631	0.021089	0.00935	0.12913
CAR(1)	230	0.08256	0.03097	-0.01098	0.17482
BUFFER	230	-0.016011	0.030021	-0.094818	0.090985
REG x ΔCRRISK (1)	230	-0.000451	0.002765	-0.016535	0.015103
REG x ΔCAR	230	0.000970	0.000906	-0.001293	0.002901
LLOSS	230	0.227565	0.060468	0.12	0.32
CRRISK (1)	230	0,58038	0,451900	0,000395	0 ,207632
REG(1)	230	0.015944	0.018618	0	0.177708
BUFFER x ΔCAR (1)	230	-0.000162	0.000926	-0.008864	0.002069
BUFFER x CRRISK	230	0.001891	0.008587	-0.022489	0.070082

Source: Calculated by the Stata 11. N: Number of observations over the analysis period (1990-2012). Min: minimum value observed. Max: The maximum value observed. The sample includes 10 Tunisian universal banks. The variables were defined above. (1) Variable calculated by (t-1), Δ: the variation of the variable between (t) and (t-1)

To answer our question, we use annual data available on the financial statements of the ten Tunisian universal banks from 1990 to 2012. During this period we have identified two regulatory regimes requirement for bank capitalization which we to encourage them to make the time cut into two the first time between 1990 and 2000 when the minimum regulatory capital required was more than (5%) and the second period, which runs from 2001 until 2012 where it has a ratio higher prudential capital (8%). The results of the statistical treatment of the sample in the table (III.5) show that for the 230 observations, the average credit risk ratio was (18.28%) with a maximum value (49.32%). The volume of own buffer funds show a negative average of about (-1.60%) with a standard deviation equal to (3.002%). In general the 23 years these banks do not have enough "capital stock" This situation is explained by the weak solvency ratio of these banks mostly below the average required regulatory especially during the first period under analysis as noted in our database.

3.3. Correlation Matrix

Variables	Formula	Theorical references	Hypothesis
SIZE	*SIZE = Ln (Total assets)*	Matejašák and Teply (2009), Shrieves and Dahl (1992), Godlewski (2004), Murinde and Yassen (2004), Hassan and Hussain (2006), Saadaoui (2010), Lin and al. (2013)	H7: the size of the bank presents a negative relation with the variation of the level ratio of the capital and simultaneously has a negative effect on the variation of the level of the risk of counterparty.
ROA	*ROA = Net benefit/ Total Assets*	Rime (2001), Heid and al (2004), Matejašák and Teplý (2007), Van Roy (2005), Nashane and Ghosh (2001), Godlewski (2005) , Milne and Jokipii (2010), Son Lai and Soumare (2010), Bouri and Ben Hmida (2011).	H8: the relation expected between the level of capitalization and the quality of assets in terms of yield is positive.
LLOSS	*LLOSS = NPL / Total loans*	Rime (2001), Cannat and Quagliariello (2006), Jacques and Negro (1998), Saadaoui (2010), Bouri and Ben Hmida (2006), Matejašák and Teplý (2009).	H9: the relation between the ratio of the not performing loans and the variation of the level of the credit is expected with a positive sign
SPREAD	*SPREAD = Net Interest Margin / Total Assets*	Godlewski (2004), Van Roy (2005), Jabnoun (2005), Saadaoui (2010), Son Lai and Soumare (2010), Rajhi e and Gassouma (2011) , Lin and al. (2013).	H10: the part of the net margin of banking interest is positively correlated to the level of the ratio of capital and negatively connected with the level of the risk of default.

***Source**: Calculated using Stata 11. Values of correlation coefficients and their signs for each (i) and year (t) Over the entire period from 1990 to 2012. The variables are: ROA: the ratio of return on assets, SIZE: the natural logarithm of total assets, SPREAD: the ratio of net interest margin on total assets, LLOSS: the ratio of non-performing loans to total loans and REG: variable regulatory pressure as selected by Van Roy (2005) Godlewski (2005), and Matejašák Teplý (2009) and Lin et al. (2013). BUFFER: excess capital "buffer" or capital buffer, ΔCRRISK and ΔCAR represent the endogenous variables in our model: changes in credit risk levels and changes in the level of capital ratio.*

Most of the results derived from the correlation matrix between the different variables used in this specification may be presented through the following:

The correlation coefficient between the variable-specific buffer fund (BUFFER) and the change in the level of capital ratio (ΔCAR) is negative in the order of (-0.2355). As expected on the assumption underlying these two variables, the parameter (λ6) in the model (III.5) is expected to be negative.

The change in credit risk level is negatively associated with the change in the ratio of regulatory capital with a correlation coefficient equal to (-0.2220). our first hypothesis states that the impact can not be identified on the basis of the literature in effect. The parameters (λ4) and (γ4) respectively have negative signs in the simultaneous equations (III.5.1) and (III.5.2).

As the composite variables in the first equation (III.5.1) we store the correlation coefficients all negative one hand, between (REG (i, t-1)) x ΔCRRISK (i, t-1)) and (ΔCAR) and the other between (REG (i, t-1) x ΔCAR (i, t-1)) and (ΔCAR) with respective values of about (-0.0856) and (-0.0053). According to our assumptions built above the parameter (λ8) is expected with a positive association while the parameter (λ7) is provided having an unexpected sign.

In addition, the parameters (γ7) and (γ8) are assumed negative beings in accordance with the sixth assumption. It fact, according to the correlation matrix of the coefficients are in the order of (-0.0352) and (-0.7861), on one side, between (BUFFER (i, t-1) x ΔCAR (i, t 1)) and (ΔCRRISK) and the other side, between (BUFFER CRRISK x) and (ΔCRRISK). These negative signs were expected between the two exogenous variables products and changes in the level of credit risk taken in the second equation (III.5.2).

The correlation coefficients between the variable size and level of credit risk changes and between the latter and the variable regulatory pressure appearing in equation (III.5.2) are equal to (0.0256 respectively) and (0.1075). For cons, the parameter (γ1) on the effect size is supposed to have a negative sign as expected under the assumption (H7), while the parameter (γ6) for the variable regulatory pressure is assumed to have a unexpected effect on default risk-taking behavior. The following table (III.7) we will try to expose the various early signs of the model parameters (III.5) to estimate.

Table III.7. Expected Signs of coefficients in the model (III.5)

Variables	**Parameters**	**Expected Signs**	
		$\Delta CAR_{i,t}$	**$\Delta CRRISK_{i,t}$**
$\Delta CAR_{i,t}$	γ_4		-
$\Delta CRRISK_{i,t}$	λ_4	?	
$ROA_{i,t}$	λ_1	+	
$SIZE_{i,t}$	λ_2 et γ_1	-	-
$SPREAD_{i,t}$	λ_3 et γ_3	+	-
$CAR_{(i,t-1)}$	λ_5	-	
$BUFFER_{i,t}$	λ_6	-	
$REG_{(i,t-1)}$ x $\Delta CRRISK_{(i,t-1)}$	λ_7	?	
$REG_{i,t}$ x $\Delta CAR_{i,t}$	λ_8	+	
$LLOSS_{i,t}$	γ_2		+
$CRRISK_{(i,t-1)}$	γ_5		-
$REG_{(i,t-1)}$	γ_6		?
$BUFFER_{(i,t-1)}$ x $\Delta CAR_{(i,t-1)}$	γ_7		-
$BUFFER_{i,t}$ x $CRRISK_{i,t}$	γ_8		-

The mark (?) Means that the expected sign of this variable parameter can be either positive or negative (theoretical controversy about the impact of this variable). Counters (i) and (t) represent bank and year. The coefficients lj 1.2 ... 1.2 ... 8 and γk .8: are the model parameters. The variables are: ROA: the profitability ratio of assets, SIZE: the natural logarithm of total assets, SPREAD: the ratio of net interest margin on total assets, LLOSS: the ratio of non-performing loans to total loans and REG: Variable regulatory pressure. BUFFER: excess capital "deceiving" or cushion of equity, and ΔCRRISK ΔCAR represent the endogenous variables in our model: changes in credit risk levels and changes in the level of capital ratio. Products (REG (i, t-1) x ΔCRRISK (i, t-1)), (REG i tx ΔCAR i, t), (BUFFER (i, t-1) x ΔCAR (i, t-1)) and (i BUFFER, tx CRRISKi, t) composite variables are useful to detect the effect of regulatory pressure and the impact of own funds buffer respectively ΔCRRISK and ΔCAR.

The anticipation signs of the different parameters of our model, grouped in the table (III.7), was carried out on the basis of assumptions made at the beginning of this paper that are also built at the lights of the definition of variables and the synthesis of the literature review. This approach was inspired by the work of Heid et al. (2004), and of Matejašák Teplý (2009) and Hassan and Hussain (2004).

4. Estimation results of simultaneous relationship between the change in the capital ratio and the change in credit risk

The summary of the results of the estimation technique (3SLS), model (III.5) is erected in the table (III.8) as follows:

Table III.8. Estimation Results

Periode	**Total periode : 1990 - 2012**		**periode 1 : 1990 - 2000**		**periode 2 : 2001 - 2012**	
endogenous variables	**Δ CAR**	**ΔCRRISK**	**Δ CAR**	**ΔCRRISK**	**Δ CAR**	**ΔCRRISK**
exogenous variables						
ROA	0.08737 (1.33)		-0.27780 (1.84)*		-0.27742 (3.97)***	
SIZE	0.00625 (4.73)***	0.035944 (1.92)*	0.0040 (2.03)**	-0.01693 (0.50)	0.002139 (1.27)	0.01028 (1.06)
SPREAD	0.000122 (0.30)	-0.02081 (3.95)***	0.1137 (1.12)	-2.03112 (1.23)	-0.02131 (0.81)	-0.02052 (10.31)***
$CAR_{(i,t-1)}$	-0.5718 (19.29)***		-0.7985 (19.85)***		-0.43968 (9.30)***	
$CRRISK_{(i,t-1)}$		-0.07760 (1.82)*		-0.27571 (4.41)***		-0.1358 (2.54)**
$REG_{(i,t-1)}$		0.5375 (1.23)		-0.02316 (0.02)		-0.06879 (0.31)
LLOSS		0.768 (4.62)***		4.06259 (7.74)***		0.3260 (2.85)**
BUFFER	-0.6115 (13.35)***		-0.7691 (13.78)***		-0.49703 (8.06)***	
ΔCRRISK	-0.00788 (1.75)*		0.001548 (0.35)		-0.010371 (0.60)	
Δ CAR		-0.98057 (1.72)*		-1.1616 (1.35)		0.97285 (2.72)**
$REG_{(i,t-1)}$ x $\Delta CRRISK_{(i,t-1)}$	-0.24300 (1.14)		0.11021 (0.54)		-2.28210 (3.67)***	
$REG_{i,t}$ x $\Delta CAR_{i,t}$	1.5241 (1.57)		-1.6034 (1.22)		2.2733 (1.97)**	
$BUFFER_{(i,t-1)}$ x $\Delta CAR_{(i,t-1)}$		10.577 (1.23)		11.56612 (0.71)		2.36244 (0.49)
$BUFFER_{i,t}$ x $CRRISK_{i,t}$		-16.6896 (16.80)***		-13.8396 (10.52)***		-16.8116 (10.58)***
Intercept	-0.01194 (1.27)	-0.4641 (2.70)**	-0.00192 (0.12)	-0.9598 (3.12)**	0.01174 (0.82)	-0.14313 (1.57)
N	209	209	95	95	114	114
R^2	74.82%	63.65%	84.60%	74.62%	71.29%	64.08%
χ^2	630.06***	385.10***	521.49***	293.60***	289.48***	215.65***

** : significant at 10%, ** : significant at 5%, *** : significant at 1%. N : Number of observation. R^2 : détermination coefficient χ^2: chi-deux statistics (test of Wald), Technic 3SLS. (Stata 11).*

Our methodology is to review the results of the estimation of our model focusing on the effects exerted by the explanatory variables, especially regulatory pressure and clean buffer funds on those endogenous (ΔCAR) and (ΔCRRISK) bearing over the entire period and for the two sub marked period.

4.1. Relationship between return on assets (ROA) and the change in capital ratio (ΔCAR)

On referring to the table (III.8), the estimation results show that the two periods under SP1 (1990-2000) and SP2 (2001-2012), the ratio of return on assets is negatively statistically significant in its relationship with the change in the capital ratio. In fact, the parameter (λ1) takes negative values on the order of (-0.27742) and (-0.27780) on SP1 and SP2, and significant at a probability threshold greater than 1% and 10% respectively. This result contradicts with most results found by Heid et al. (2006), and Matejašák Teplý (2009), Saadawi (2010), Milne and Jokipii (2010), and Ben Hmida Bouri (2011) and recently by Lin et al (2013), in addition, when we take account of other explanatory variables to specify our model the relationship between these components changes behavior. Most theorists have argued that purpose by the fact that the quality of the portfolio of assets whose banking firms has is presumed vary in the same direction as the change in the regulatory solvency ratio for a fraction of the equity will be constituted by deferred profit. Indeed, banks that store large profits short of year (t-1) will have to postpone most interesting results, which translates into a significant level of capital or capital ratio at the beginning of the year (t). As an indicator that examines the effectiveness of the use of available assets and its ability to generate profits from the assets of the bank, these results exhibit a negative association between solvency and economic efficiency away. An increase in the level of capital results in an increase in the ratio of bank capital which means a decrease in the ratio (ROA).

If we refer to the work of Guidara (2010) and Repullo and Suarez (2004), then a part it will be one of the performance measures will be included in the bank's equity. They estimated that this association can be either positive or negative. In fact, if the bank increases its capital levels by deducting unallocated profits instead of issuing new shares, then the relationship can be positive. By cons, and as for Rime (2001), these authors stated that in case of information asymmetry in the market, the signals transmitted by the disclosure of information on earnings, this relationship becomes negative. In other words, the relationship with the market value of the firm is likely to be negative. This inverse relationship can be interpreted by the fact that improving the quality of the asset portfolio of banks in our sample is at the expense of a reduction in the level of their credit ratings. The banks in our sample use other means to finance their capital level rise other than retained earnings or profits will be mainly distributed to shareholders instead of the built-in potential increases in their capital levels. An improved ratio (ROA) of a proportion of 1% is explained by a decrease of 22.77% of its level of capital ratio. The hypothesis (H8) is not verified.

4.2. Impact of effect 'size' on the variation of the ratio of capital and changes in the credit risk level

The variable (SIZE) is calculated natural logarithm of the bank's assets. If therefore increases the bank tends to be stronger and the principle of "Too Big To Fail" applies. The hypothesis (H7) Advanced, appears to be validated against the results obtained from the estimation of our specification. According to this hypothesis we expect a negative association between changes in the level of capital ratio and simultaneously a negative effect on the change in the credit risk level. The "size" effect on the behavior (ΔCAR) er (ΔCRRISK) detected through the parameters signs (λ2) and (γ1) in both equations (III.5.1) and (III.5.2), demonstrates the the existence of a positive and statistically significant relationship respectively with a threshold of 1% and 10% on the total period beginning in 1990 and ending in 2012 and for the ten universal banks adopted in our panel. The t-Student these coefficients are successively in the order of (4.73) and (1.92). A negative correlation between the variable (SIZE) and variable (ΔCAR) has been detected for a coefficient equal to (-0.2433) against a positive correlation coefficient equal to (0.0256) between this variable and the credit risk. This result was not observed by Matejašák and Teply (2009), Shrieves and Dahl (1992) Godlewski (2004) Murinde and Yassen (2004), Hassan and Hussain (2006) Saadawi (2010). They have found against negative size effect on the level of capital ratio. Furthermore, Milne and Jokipii (2010) and Lin et al. (2013) detected a significant and negative impact of the variable (SIZE) on the level of risk (ΔCRRISK).

Remember that Shrieves and Dahl (1992), insist that size could have an effect on capital ratios and risk levels for several reasons, particularly the investment opportunities of the bank, these properties features and easy access on interbank markets to refinance. As stated earlier, Tunisian banks are all homogeneous size and qualified even small, relative to African banks, European or American firms. Also, the amount of capital held by the ten banks selected in our sample is small compared to that provided by foreign banks. The effect of size on the level of capital ratio is positive and statistically significant for the total period and the first sub-period (SP1) for our work. On the level of credit risk taken, the results in the table (III.8) reveal that there is a significant positive relationship between bank size (SIZE) and the change in credit risk level (ΔCRRISK). The ten institutions identified in this econometric study fail to lower their levels of credit risk taken once their size is improving through the increase in the volume of their asset portfolio, this is likely to be commented on by lack of diversification that characterizes their activities. This contradicts the one found by Aggarwal and Jacques (1998), Heid et al. (2004) and Murinde and Yaseen (2004). While these findings join those found in the works of Awdeh et al (2011), Al-Zubi et al. (2008) and Guidara et al. (2012). So we have a positive effect between size and the level of credit risk and a positive association between effect size and the level of solvency of the banking firm. The parameters λ2> 0 and γ1> 0, so the seventh hypothesis is not verified.

4.3. Relationship between the ratio of non-performing loans and credit risk-taking behavior

The results of the estimate by the 3SLS method of our model with two simultaneous equations in the table (III.8), shows that there is a positive and statistically significant relationship between the ratio of non-performing loans (LLOSS) and the behavior of credit risk (ΔCRRISK) of the ten banks object of our empirical work. The ninth hypothesis states that the relationship between the variable and the LLOSS ΔCRRISK variable is expected with a positive sign (γ2> 0). The correlation coefficient between these two variables is positive it amounts to (0.0280). Of the three periods in our estimation we have achieved significant results. In fact, the parameter (γ2) is equal to (0.768), significant at a 99% confidence interval using a Student-t of about (4.62) over the total period, and equal to (4.06259) and (0.3260), respectively, SP1 and SP2 to respective threshold of 1% and 5% for p-value equal to (7.74) and (2.85). This positive association was marked at the results estimates made by

Rime (2001), Van Roy (2005), Al Zubi et al. (2008), Darine (2008), and Matejašák Teplý (2009), Milne and Jokipii (2010), Saadawi (2010), Awdeh et al. (2011), and Toivinen Maurin (2012) and Lin et al. (2013), among LLOSS and the change in the overall risk of the bank and particularly the risk of default that most threatens the business and the banking industry. Our results are consistent with those found in previous contributions, including those Cannata and Quagliariello (2006) and Aggarwal and Jacques (1998). The banks holding bad qualities loans are assumed to engaged in riskier activities. In the context of panel Tunisian banks Bouri and Ben Hmida (2011) found that the incitement to credit risk taking increases significantly with the increased distribution of bad loans (bad and doubtful debts) especially during the from 2000 until August 2007. In sum, we can confirm that hypothesis (H9) advanced at the beginning of this paper seems to be validated.

4.4. Link between the net interest margin ratio, the change in capital ratio and credit risk taking

According to the hypothesis (H10), we expect the share of net bank interest margin (SPREAD) in total assets is positively related with the level of capital ratio and negatively associated with the level of credit risk. The correlation coefficients are approximately (-0.0525) and (-0.1203) with (ΔCAR) and endogenous (ΔCRRISK) and settings (λ3) and (γ3) Model (III.5) should behave in this same direction. The estimation results show a negative impact of this variable and statistically significant credit risk-taking behavior during the overall period of our work (1990-2012) with a coefficient equal to (-0.02080) for a range of 99% confidence interval and P-value of the order of (3.95). Also, the variable SP2 (SPRAD) exhibits a negative and statistically significant effect on the risk of default of the level of our panel having a t-Student who is around (10.31) at the 1%, the coefficient (γ3) equal to (-0.02052). Moreover, the variable in question does not have a statistically significant effect sue the level of capital ratio over the three periods of analysis. Thus, the level of solvency of these banks can not be explained by income from its intermediation function in terms of interests. Indeed, it is a variable in the selected work Godlewski (2004), Van Roy (2005), Jabnoun (2005) Saadaoui (2010), The Lai et al. (2010), and Gassouma Rajhi (2011) and Lin et al. (2013), their results show that an increase in the level of capital can positively simulate the ratio of net margin through an increase in the cost of capital and an additional incentive to take risk défaut.Le result concerning the opposite effect of this variable on incitement to credit risk taking has been supported by the work of Saadawi (2010), Awdeh et al (2011) and Maurin and Toivinen (2012). These authors reported that when banks distribute more credits This is likely to increase their volume of interest received in parallel with their growing commitments in this risky business. In case of default by the borrower is way the intermediation margin deteriorate, the free resources collected in depot forms are paid what makes this margin unable to cover the cost of credit risk. One of the desired technical to absorb the increased credit risk level is the revision of rates and borrowing costs deemed granted to customers which can not be solvent. The tenth hypothesis underlying the effect of this variable appears approved.

4.5. Impact of "Capital Buffer" on the change in equity ratio

The impact of own funds on the buffer level of capital ratio is negative and statistically significant. Indeed, the estimation results confirm our second hypothesis, the sign of the parameter (λ6) is negative as expected on the total period from 1990 to 2012 for all ten banks in our panel, also on the other two periods. The buffer capital adjustment coefficients relative to capital level amounted to (-0.6115) (-0.7691) and (-0.49703) with t-Student (13.35), (13.78) and (8.06) all statistically significant at the 1% respectively over the three periods of analysis.

On average, each increase in the level of the stock of capital (Capital Buffer) results in a decrease in the level of capital ratio of around 61% over the entire period and for the ten institutions. This type of reservation so exhibits a cyclical character. This adjustment could be explained by the cyclical movement in capital requirements, higher level of capital in the event of a bank in good conditions and proliferation of distribution of credits, resulting in a decrease in reserves of stock equity which aims to allow to absorb unexpected losses and thus reduce the risk of insolvency. To align the regulatory standard solvency ratio required, this reaction is described as normal because, as indicated Illing and Paulin (2004) and Goodhart and Persaud (2008) the required capital increase when economic conditions s proves to be good and the "capital buffer" would be exhausted when the financial situation deteriorated and regulators are concerned that such cyclicality of capital is a source of procyclicality which is likely to upset the stability of the financial system and banking. The average displayed on the 23 years, the amount of buffer capital is negative in the range of (-1.60%), banks in our panel practically hold very volatile capital reserve amounts (standard deviation of 3%) improving the level of solvency of these institutions is justified by fit through an average of 49% (2001 and 2012) to amortization of built capital cushion to deal with credit risk. Bouri and Ben Hmida (2011) found that the Tunisian banking system generated a risk coverage ratio below the regulatory standard of 8% between 1994 and 2000 to improve and eventually exceed that required regulatory threshold when the Credit risk also had an upward trend that is to say in a situation of rapid economic growth. Through these findings, the authors showed that these banks were in the process of adjusting their hedging ratios to monitor developments especially the risk of insolvency of their customers. In addition, the passage of regulatory ratio of 5% to 8% from December 31, 1999 resulted in a remarkable decrease in BUFFER variable that has a negative sign between December 1999 and April 2004, to resume its increase from May 2004 and we record important values Buffer Capital in 2013 (see Table III.4).

Our results corroborate those found by Ayuso (2004). In fact it has detected a significant association between the negatively cousin of capital and economic cycle that results in a change in the level of capital the bank, which is more important in a recession that in case of expansion. This author also noted that this "cushion" is likely to reduce the volatility of the capital charge. This could explain why some banks keep an extra level of capital in case of expansion for use in a recession. However, these outcomes in response to higher capital cushion in a recession that is due to the reduction in the level of appropriations activities (fuck the capital level) were confirmed by other contributions such as those of Lindquist (2004) and Wedow and Stolz (2009), Guidara et al (2010), who spotted that under regulatory pressure, the capital cushion will decrease in financial recession and therefore it will compensate for the reduction of loans. In our context, the hypothesis (H2) is checked the level of own funds buffer is negatively associated with changes in the level of capital ratio.

4.6. Relationship between composite variables, changes in the level of capital and incitement to credit risk taking

If we start by analyzing the effect of both variables related to regulatory pressure ie (REG (i, t-1) x ΔCRRISK (i, t-1)) and (i REG, tx ΔCAR i, t) on the change in the capital ratio level (ΔCAR), while the results show that these two composites have a statistically significant impact on the capitalization of banks chosen solely on the SP2 period (2001-2012). Indeed, on the one hand, regulatory pressure coupled with ex ante credit risk-taking behavior is (REG (i, t-1) x ΔCRRISK (i, t-1)) exhibit a negative coefficient the order of ($\lambda 7$ = - 2.28210) significant at a confidence interval of 99% and displays a T-Student equal to (3.67). The sign of this impact was not identifiable in accordance with the results of previous studies that have shown controversial outcomes. On the other hand, on the same SP2, the impact of the composite variable (REG i, tx ΔCAR i, t) has a positive impact on the solvency of banks retained. The parameter ($\lambda 8$) is positive and is close to the value of (2.2733) with a p-value of (1.97), statistically significant at greater than 5% probability. This sign was provided even if the correlation coefficient between two variables was negative (-0.0856). These results join those found by Jacques and Agrawal (1998), Milne and Jokipii (2010), and Toivinen Maurin (2012) and Lin et al (2013). The reaction of these institutions to the regulatory requirements is clearly the decline in the level of incentive to take credit risk on SP2, moreover it is the essential justification for the introduction of prudential regulation at banking systems. When combined with the level of capital ratio, regulatory pressure becomes a stimulus to additional credit risk-taking because in parallel with an improvement in the level of capital, banks are encouraged to take additional credit risk and to engage in riskier activities especially credit distribution business. It is remarkable that the variable regulatory pressure (REG (t-1)) shows no impact on the level of credit risk taken on the three periods of analysis. Once solvency ratios complies with prudential management standard required, the banks studied exhibited no reaction in terms of incitement to global risk taking and even especially credit risk.

Regarding the composite variable (BUFFER x CRRISK), the results of the estimation of our panel shows that it is negatively associated and shows a statistically significant coefficient at the 99% confidence interval for the three periods. Indeed, the parameter ($\gamma 8$) takes the negative value, as expected, in the order of (-16.6896) between 1990 and 2012 with a T-Student about (16.80). An increase in own buffer funds (associated credit risk) pushes banks to adjust their incentives for risk-taking. This result reaffirms the evidences found by Lindquist (2004), which dealt with the determinants of capital in particular cousin of the level of counterparty risk-taking banks in Norway. Main results show a negative relationship between capital cushion and default risk for these firms. This supports the hypothesis that specific buffer funds are considered a hedge against the costs associated with regulatory discipline. Yet when Nier and Baumann (2006) attempted to quantify the risk of default of the impact on the level of capital cushion, they conveyed the results which show that these two variables are inversely related and that the government guarantees reduce the cushion capital in banks. Returning to our results, we can say that composite measures specific buffer funds with institutional variable regulatory pressure, negatively influences the level of credit risk taking and together the level of equity. The hypothesis (H6) has been approved and we join the most current results of Lin, Xie and Hwang (2013).

4.7. Link between the change in the level of capital and credit risk-taking behavior

The main objective of this paper is based on the quantification of the impact of simultaneous bank behavior in terms of credit risk-taking following a change in the level of the ratio of capital under regulatory pressure. Initially, the assumptions (H1) and (H3) constructed specify, first, that the effect of the level of credit risk-taking shows off a sign on the unexpected change in the level of capital ratio, and secondly, that the change in the level of the bank's capital ratio is negatively associated with the behavior of credit risk-taking of banks. Thus the parameter ($\gamma 4$) is provided with a negative sign in equation (III.5.2), for against that of the parameter ($\lambda 4$) appearing in equation (III.5.1), seems to have a sign not yet decided in the empirical and theoretical literature earlier. The results in the table (III.8) allow us to say that the impact of the change in a change ΔCAR capital ratio on the behavior of the ΔCRRISK credit risk taking is negative and statistically significant at an interval of 10% confidence, a T-Student of about (1.72). In fact, an average 1% change in the level of solvency of banks in our sample about 23 years, resulting in a significant average decrease of around 98 pp of the level of credit risk between 1990 -2012, against 97 pp over the period 2001-2012. However, each change in default risk level of 1% results in an inverse variation of 0.7% in the level of capital ratio. The adjustment of the level of risk compared to the level of capital occurs more rapidly and more important than the opposite. The behavior of the banks' counterparty risk taken shows a negative and statistically significant association with the change in the solvency level at a confidence level greater than 10% with a p-value of the order of (1.75) and only on the aggregate period of our panel. These results certify those found by Bouri and Ben Hmida (2011) on the same Tunisian banking sector. Validating the hypothesis (H3) is maintained while reaction (ΔCRRISK) to (ΔCAR) has been illuminated.

5. Conclusions

The main objective of this paper was to quantify the simultaneous impact of changes in capital ratio on the default risk-taking behavior, under regulatory pressure, by estimating a two-equation model that encompasses several variables characterizing capital and the risk of bank credit, developed since 1992 by Dahl and Shrieves and recently enhanced by Lin et al (2013), to be applied to a sample of ten local banks using panel data over a 23 year period 1990 to 2012 divided by the following two sub-periods, the estimate was made according to the technique (3SLS). Through the results, we can conclude first that the regulatory constraints on the requirement of bank capital in Tunisia exhibit no incidents on the behavior of credit risk taken by against this institutional pressure is negatively associated the hedging ratio essentially over the period 2001-2012. In addition, we found that the stock of capital reserves (Capital Buffer) and is negatively related to a significant degree on the level of capital ratio of these banks. These findings were similar to those in the few contributions that have dealt with this subject, namely those Lindquist (2004), Ayoso (2004), and Wedow Stolz (2009) and those more recently Jokipii and Milne (2010) and Maurin and Toivinen (2012). However, the simultaneous effect between the change in the level of capital and incentives to the credit risk taken by these banks is negative and statistically significant over the entire period of analysis. The change in the level of capital results in a significant and rapid impact on the incentive to take counterparty risk and the level of provisioning. These banks modulate their capital ratios primarily based on the magnitude of the risk of insolvency of their customers. The conclusions reached seem to give a partial answer to our research question. We consider relevant to pursue our empirical investigations to detect the impact of liquidity risk level on the behavior of the ratio of regulatory pressure on capital.

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