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DID THE TUNISIAN COMMERCIAL BANKS RESPECT THE PRUDENTIAL RULES?

Tijani Amara

Mohamed Mabrouki

Abstract:

The evolution of the banking regulatory environment in recent years raises many questions about the effectiveness of prudential measures and the relevance of the legal system in this new landscape. The Cooke ratio, replaced in 2003 by the Mc Donough ratio, has since become an international benchmark for banks. Banks that are less risky and comply with prudential standards are solvent. Thus, with their compliance with prudential standards, Tunisian commercial banks are relatively safe from risks. From a sample of 10 commercial banks between 2007 and 2015, we studied the impact of compliance with prudential standards on the solvency of the banking institution. To do this, we based on the studies of Kefi and Maraghni (2011). Indeed, we have made estimates on panel data, these results show that the ratio of liquidity, interest rate risk ratio and Return on assets have positive and significant effects on the risk coverage ratio.

Keywords:

Commercial Banking, Banking Risk, Risk Coverage Ratio, Prudential Regulation, Solvency, Panel Data

1. Introduction

The banking sector has always been considering one of the most vital sectors for the economy. Its importance as "vitality" of economic activity lies in the collection of deposits and the provision of credit to states and individuals, households and businesses is indisputable. It is particularly important for the stability of financial systems. It must always be robust, resilient and healthy for effective intermediation of financial resources.

Recent years have been marked by various fluctuations and disturbances in the monetary sphere, upheavals and changes, which alert the banking and financial environment in different countries of the world. Indeed, banks are very delicate institutions, in which the worst catastrophes are possible, with the most serious consequences. They are increasingly threatening by a variety of risks affecting their business and their position in the financial market.

As a result, the bank's management must pay the utmost attention to identifying the type as well as the degree of its exposure to the risk and tackling it effectively. It was with the aim of consolidating the stability and security of the financial system and reducing the negative effects of risk taking that the advent of prudential regulation came about. The aims of this prudential regulation are grouped in such a way as to guarantee a "healthy" and "prudent" banking activity, to strengthen the stability of the financial system and to build confidence in this system and to equalize the conditions of banking competition.

However, this prudential regulation cannot eliminate any risk for the bank since the latter must take risks to make a profit. However, it must at least prevent excessive risk taking. The determination of an "optimal" prudential regulation is thus the primary concern of the authorities. Optimality can only be assessing in the light of a well-defined system of constraints and an advantageous involvement in bank profitability.

However, compliance with prudential measures requires significant efforts on the part of banking institutions. On the one hand, they must develop sophisticated techniques to measure their credit and market risks. On the other hand, the generation of capital is essential to comply with these standards, which generates an "extra cost" for banks.

In addition, the concept of solvency is the ability of a financial institution to fulfill its obligations in the event of a cessation of activity or liquidation. It refers to the long-term

financial viability of a bank and its ability to cover long-term obligations. A bank is considering solvent if the total assets exceed the total liabilities. If the total assets are less than the total liabilities, the bank faces a risk of insolvency and "technically insolvent". Therefore, we have so far mentioned two essential notions: on the one hand the prudential regulation, which presents itself as a constraint but necessary for the control of the financial institutions and on the other, side the solvency of the banks. Based on these findings, we are interested in this article to demonstrate: to what extent the respect of prudential rules has an impact on the solvency of the banking establishment in particular in Tunisia.

Our methodology is based on a multivariate model testing the dependent variable namely the Risk Coverage Ratio (RCR) based on the independent variables, Interest Rate Risk Ratio (RTI), Market Risk Ratio (RM), Ratio of Credit Risk (RC), Liquidity Ratio (RL), Ratio Return On Assets (ROA) and Bank Volume (V). We test the robustness of our results by considering various statistical measures. To do this, we consider a sample composed of ten Tunisian commercial banks. The study period cover over nine years (2007-2015).

To this end, we first present the conceptual framework through which we discuss the purpose of banking regulation while putting into perspective its evolution from the first preventive measures to the current regulation defined by the Basel agreements. Then we conduct an empirical study testing the impact of the respect of the prudential norms on the solvency of banks in particular in Tunisia**.**

2. Regulating Banks: What and Why?

Prudential regulation is what is calling prudential supervision. Jezebel Soubeyran (2010) defines prudential regulation as "a set of devices implemented by the supervisory authorities of the banking and financial sphere". Regulation is a very important process that appears after a succession of proven crises stressed the need for supervision. In fact, regulation serves to strengthen the bank and eliminate instability, which can sometimes lead to the collapse of the economy.

According to Rochet (2008), prudential regulation is the shadow of banking regulation. Indeed, the effectiveness of banking regulation is manifesting in the ability to reduce risk.

Prudential regulation of banks sees its justification in two main objectives (Rochet 2003)

 Micro-prudential regulation : regulation aimed at maintaining sound, healthy and solvent credit institutions, ensuring the safeguarding of small depositors.

 Macro-prudential regulation : regulation aimed at safeguarding the banking system as a whole, ensuring the smooth functioning of the banking industry and resolving the banking and financial system crises.

These two objectives stem from two problems facing the banking system: the first is the inability of individual depositors to control bankers' use of their deposits, while the second presents the risk of contagion resulting from systemic crisis. Both issues highlight the need to regulate banking institutions.

2.1. The inability of individual depositors to monitor banks

According to Modigliani et al (1958) in the absence of conflicts of interest and in the presence of complete markets, there is no need for financial intermediaries. However, information asymmetry among small depositors (lenders) and firms (borrowers) makes depositors powerless to discriminate against good from bad investments.

The information theory states that one of the most important reasons for banks is the fact that they have an informational advantage over depositors in terms of monitoring. This advantage also suggests that depositors lose information in order to estimate the level of risk of the bank's assets.

The main purpose of prudential regulation of banks is therefore the protection of depositors, particularly in the event of bankruptcy. We should therefore ask why specifically regulate financial institutions compared to non-financial institutions. The explanation remains, in part, in the peculiarity of the kind of creditors of financial institutions.

Indeed, the peculiarity of the financial structure of a bank unlike a non-financial enterprise is that a large part of its debt is spread between a very large numbers of small depositors. These small depositors commonly have neither the information nor the expertise necessary to oversee and control a financial institution.

Dewatripont et al (1993) point out that: "If small depositors deposited their money in non-financial firms while financial sector debt was held by large depositors, we would have to consider the regulation of the non-financial sector rather than of the financial sector ".

As a result, it is necessary to create a representative of the depositors who protects their interests and guarantees the control of the bank they finance. This shows the implementation

of a deposit guarantee system and prudential regulation guaranteeing this depositors protection role. The inability of depositors to monitor the activities of banks adds to the risk of contagion to the financial and banking system. The need to prevent this risk and to promote the stability of the banking system as a whole therefore gives rise to the second reason for the prudential regulation of banks.

2.2. The risk of contagion or systemic risk

The identification of systemic risk involves defining the systemic crisis. In a systemic crisis, the financial sector is disrupting that it can no longer perform these functions effectively. According to Mishkin (1999), a financial crisis "occurs when the shocks of the financial system interfere with information flows, so that the financial system can no longer do its job of channeling funds to those who have opportunities to productive investment ". In practice, a systemic crisis occurs after the financial system has experienced some kind of shock, which is then amplifying as it spreads through the financial system. Shocks can be spatial in nature; this is justified when a single bank fails due to mismanagement or fraud or systematic, when a recession strikes all banks at the same time. Mishkin (1999) identifies four basic sources of shocks :

- the deterioration of the balance sheets of the financial sector;
- the increase of interest rates;
- the increase of uncertainty and;
- The deterioration of non-financial balance sheets.

After presenting the systemic crisis, we will define the systemic risk. Several concepts have been proposing by international institutions as well as by economists:

The definitions presented by international financial institutions are quite global. The European Central Bank (ECB) in its 2004 annual report defines systemic risk as "The risk that an institution's inability to meet its obligations in the future will lead other institutions to be unable to meet their obligations. Such a failure can cause significant liquidity or credit problems and, as a result, could threaten stability or confidence in the markets. «In its annual report of 2010, describes the same concept as: "the risk that the financial instability becomes such that it prevents the good functioning of the financial system to the point of negatively impacting the growth and the wellbeing".

De-Bandt et al (2000) find that any notion of systemic financial risk should include widespread events in the banking and financial sectors and payment and settlement systems. The effects of contagion are during the concept, which also includes simultaneous instances of financial instability following global shocks. According to these authors, several rigorous models of contagion within the banking and payment system have been suggesting, but there is no general theoretical framework. In addition, Lehar (2005) defines systemic financial risk as the potential for the occurrence of an event that involves the simultaneous bankruptcy of a number of financial institutions.

For Adrian et al (2010), systemic financial risk is linking to the dysfunction of an institution that spreads widely and disrupts the supply of credit and capital to the economy of real assets. This definition is similar to that presented by Acharya et al (2009), which defines systemic risk as the joint failure of financial institutions and capital markets that significantly shorten the supply of capital to the real market.

Patro et al (2013) describe systemic risk as a situation in which the entire financial system is simultaneously distressed, with a consequent credit and liquidity crisis. Systemic risk can have a significant influence on the financial markets and the real economy, reducing the supply of capital and exacerbating capital losses. In addition, Patro et al. (2013) consider systemic risk as the probability of a severe decline in the financial system caused by a strong and general event, it gathers at the break-up of a financial institution, which negatively influences not only the financial markets, but also on the economy as a whole.

Based on the comparison of systemic risk definitions already, we can draw the following conclusions:

- Systemic risk concerns a large part of the financial system or a large number of financial institutions. It is considering disruptive to the performance of the financial system and its functions, such as financial intermediation.
- The transmission of disturbance between interconnected elements of the system, this can have à negative impact on the real economy.
- In the literature, the definitions of systemic risk began to appear in the mid-1990s, but their "creation" increased sharply after the outbreak of the global financial crisis.

Before the crisis, the definitions put more emphasis on the contagion effect and the extent of this phenomenon. However, after the outbreak of the crisis, in addition to the significant scale

of the phenomenon, increased attention was giving to the disruptions in the functions of the financial system. This results in flaws and has a negative impact on the real economy, which in turn has been rarely emphasizing before the crisis.

2.3. Preventive measures: Limits and problem of moral alea

To mitigate the problems of individual depositors' incapacity and systemic risk, preventive measures were put in place: the introduction of the deposit insurance system and the installation of the lender of last resort.

The first formal national bank deposit insurance system was introducing in the United States in 1934 to prevent major bank rushes that contributed to the Great Depression. Other countries, even those in which the banking crisis had accompanying the depression, did not follow this trend, and it was not until after the post-war period that deposit insurance began to spread outside the United States. The 1980s saw an acceleration in the spread of deposit insurance, with most OECD countries and an increasing number of developing countries adopting some form of explicit depositor protection. In 1994, deposit insurance became the norm for the new single banking market of the European Union Garcia (1999). More recently, the IMF has approved a limited form of deposit insurance in its code of practice (FolkertsLandau and Lindgren, 1997).

Despite its growing popularity among policymakers, the desirability of deposit insurance remains a controversial issue among economists. In the classic work of Diamond and Dybvig (1983), deposit insurance is an optimal policy in a model where bank stability is threatening by self-fulfilling races. If the draws result from imperfect information from some depositors, suspensions may prevent withdrawals, but at the cost of leaving some depositors in need of liquidity in some states of the world (Chari and Jagannathan, 1988).

The objectives of setting up a deposit guarantee agency are three: (Venard 2001)

 Firstly, such an institution can reassure depositors and thus make the bank deposit an optimal contract against illiquidity by dissuading "counterfeiters" to provoke a race at the counters.

 On the other hand, a deposit guarantee scheme minimizes the effects of a risk information asymmetry of the bank. Deposit insurance protects small savers against rushes by depositors with inside information.

 Finally, the third argument put forward to justify deposit insurance is that it ensures more equality in competition.

In fact, large and / or nationalized banks have an advantage linked to their image as "safe" banks, which makes it easier for them to attract deposits. The insurance system must allow other banks to not be disadvantaged.

The second element of the preventive measure is the intervention of a lender of last resort. This function, providing by the central bank, is much broader in the modern economy, where it is extending to market liquidity, than formerly, where it was limited to the liquidity of banks.

The theoretical foundations of the doctrine of the lender of last resort were first establishing by Thornton in (1802) and then by Bagehot in (1873), who elaborated and refined them. This doctrine is basing on four pillars:

(1) The central bank, acting as lender of last resort, should prevent temporarily illiquid but solvent banks from failing. This type of loan is by nature short-term.

(2) The central bank should lend freely, but charge a penalty rate.

(3) The central bank should accommodate anyone with a good guarantee, valued at pre-panic prices.

(4) The central bank must prepare to lend freely in advance.

The central bank as a lender of last resort is presuming to lend only to illiquid but solvent banks (Fischer, 1999, Freixas et al., 2000, Wood and Roche, 2004). In the wake of a run on a bank, the central bank provides the bank with a credit to pay depositors without having to liquidate the assets of the bank.

However, these preventive measures, deposit insurance and the lender of last resort, present a real problem: the problem of moral hazard.

Although deposit insurance and lender of last resort can be seeing as a tool for stopping or minimizing bank movements, it is also a source of moral hazard for excessive risk taking, which can lead to bank failures.

Arrow (1971) was among the first to talk about the risk of moral hazard as an unavoidable risk caused by a change in the lessee's incentives.

Moral hazard is a situation where some agents take excessive risks because they do not feel the cost of risk. In other words, a moral hazard occurs because some agents know that the potential costs of taking additional risks will be borne by other agents and / or the government Demirgüç-Kunt et al (2002) conclude that moral hazard issues are basing on the conclusion that explicit deposit insurance tends to increase the probability of bank instability. Laeven (2002) observed that the cost of deposit insurance has some power in predicting bank failures, which he interpreted as evidence of the view that deposit insurance creates a moral hazard for deposit insurance.

The moral hazard arises after the money has been disbursed to the borrower and arises from the fact that the borrower may have an incentive to violate loan terms by investing in "immoral projects" that are unacceptable to the borrower. Borrower because the extent that they have a great chance of gain for the borrower, they also have a great possibility of failure that will have the most detrimental effect on the lender. It is the lack of knowledge of the lender about the activities of the borrower.

2.4. The regulations defined by the Basel agreements

The Basel Committee is the world's leading standard-setting body for the prudential regulation of banks and a forum for cooperation in banking supervision. According to Sylvie (2005), "The Basel Committee on Banking Supervision was established in 1974 by the governors of central banks and banking regulators and supervisors of the major industrialized countries (G-10).

The Basel Committee has published two interdependent standards: the Basel Core Principles for Effective Banking Supervision and the Basel Capital Accord. The main function of the Basel Committee is "to fill the gaps in international surveillance in pursuit of two fundamental principles: that no foreign banking institution should escape supervision; And that the control should be adequate. »

The development of markets and the globalization of financial activities give systemic risk an international dimension. The Basel Committee has therefore emphasized the necessary cooperation between the monetary authorities of home and host payers in order to exercise effective control over international banking groups.

Basically, the work of the Basel Committee resulting in the July 1998 update of the international solvency ratio, known as the Cooke ratio. Subsequently, other issues were

considering by the Committee as market risk, off-balance sheet offsetting, internal control or the quality of financial information. At the end of the 1990s, the Basel Committee undertook a far-reaching reform of the international solvency ratio, known as Basel II or the Mac Donough ratio. The new ratio entered into force on 1 January 2007 for the EU Member States. The standards adopted by the Basel Committee apply to all banks with an international activity, regardless of their country of origin.

Bradley et al 2005 state that each credit institution includes in its terms and conditions a "risk premium" proportionate to the borrower's assessment of default risk. If the actual losses incurred by a bank on its commitments are lower than these expected losses, the institution benefits and the operation generates an increased profit. On the other hand, if the actual losses exceed the expected losses, the institution's loan portfolio does not generate sufficient cash flow for the bank to honor its own commitment. Without sufficient own funds, she is insolvent and risks bankruptcy.

The Cooke ratio, established in 1988 by the Basel Committee, recommends to banks with an international dimension, regardless of the country in which they are established, a minimum standard of capital according to the credit risks incurred. . The ratio is calculating as (Bradley et al 2005)

$$COOKE\ Ratio = Total\ \frac{Total\ Equity}{Credit\ Risk} \geq 8\ \%$$

The first Basel agreements officially had two objectives:

(1) Ensuring the "safety and soundness" stability of the international banking system

(2) Eliminate distortions of competition because some banks.

With the increase in bank capital, the Cooke ratio has helped to enhance the security and profitability of the international banking system.

A new ratio, known as the Mc Dnough or Basel II ratio, will come into effect at the end of 2006. This new agreement is not simply about replacing the old standard with a new, more refined one. The approach is qualitative and aims to achieve a better match between equity and risk. It is basing on the complementarily of internal control and external audit of credit institutions. It is basing also on three types of obligations classified as "pillars": minimum capital requirements, supervision by the prudential authorities, and market discipline. (Bradley et al 2005)

The calculation of the new ratio is basing on the same logic as in the initial device. It is a question of bringing back the own funds to the assumed risks and to require the credit institutions that they proportionate their risky commitments to the amount of the own funds which they hold and which, in the last analysis, ensure their solvency. The capital requirement is, in fact, determined based on the following ratio:

$$\textbf{Mc Dnough Ratio} = \frac{Total\ Equity}{Credit\ Risk + Market\ Risk + Operational\ Risk} \geq 8\,\%$$

The techniques used by banks to reduce their risks are considering more and can reduce the capital requirements.

Finally, a new range of risks qualified as operational risk must also be covering by equity. Operational risk is defining as the risk of direct or indirect losses due to the inadequacy or failure of internal procedures, personnel and systems, or external events.

The second pillar consists of a process of individual and qualitative review by the controller. Prudential supervisors will ensure that each institution has satisfactory procedures in place to assess its risks and the corresponding equity. They will therefore judge whether the banks correctly assess their capital requirements in relation to the level of risk they have set themselves.

Basel II Pillar 2 focuses on the supervisory review process, which can be summarizing into four principles key: (Hull 2007)

(1) Banks must put in place processes to assess the adequacy of their capital at risk and maintain this level

(2) Regulators need to assess banks' capital adequacy strategies. Supervision also focuses on the ability of financial institutions to control and ensure compliance of the ratios used. If this is not the case, the regulators must respond appropriately.

(3) Banks must hold capital above the regulatory minimum and regulators must have the ability to impose on banks a "cushion" of capital above this minimum level.

(4) Regulators need to intervene early to avoid that own funds fall below their minimum level and must demand rapid measures to restore and maintain own funds above the minimum level.

The purpose of the new agreement is to improve financial transparency so that investors and market players can better evaluate banks.

These are therefore subject to market discipline is called upon to implement effective financial communication in several areas. They will therefore publish full-year information on the nature, volume and methods of managing their risks, the capital structure and the adequacy of their equity (Bradley et al 2005).

As a direct result of the global financial crisis, the Basel Committee agreed in July 2009 on a modified regulatory framework for the trading book, which includes exposures arising from securities that a bank has and intends to hold. This modified regulatory framework is normally referring to the Basel III, which focuses on strengthening the regulation of trade exposures (Niemeyer 2016).

The rules of the Capital Requirements Directive 4 (CRD 4) applying Basel III in Europe can be summarizing in four main points (Hache 2012):

- The increase in capital requirements
- The introduction of a countercyclical capital buffer
- The introduction of a leverage ratio
- The introduction of two liquidity ratios

3. The impact of compliance with prudential standards on the solvency of Tunisian banks: an empirical study

This section first proposes to describe and justify the methodological choices we have made to test hypotheses. Thus, we first present the methodological framework of the research represented by the sample of the study and the description of the different variables while formulating the hypotheses of the research. Then we present the descriptive statistics, the tests and the interpretation of the results obtained.

3.1. The methodological aspects

The sample

The objective of this study is to determine the impact of compliance with prudential standards on the solvency of Tunisian banks. To do this, we chose a sample of 10 (universal) commercial banks.

Based on this sample, we collected the data according to their availability in the "bank scope" data source over a period of nine years from 2007 to 2015, thus a panel of 90 observations.

The choice of this period is very important because it allows us to study and identify the likely impact of the Tunisian revolution on the activity and solvency of banks. The regressions are performing using the STATA software.

Measurement of variables and assumptions of the study

In the context of this research, we use variables whose choice was guiding by empirical studies and the availability of more or less recent data on compliance with prudential standards (risk coverage ratio) on the solvency of commercial banks. In what follows, we will present the variables to be explaining and the explanatory variables.

The dependent variables

Risk coverage ratio

The risk hedge ratio is a regulatory ratio also known as the "Mc Donough" ratio. It is a solvency ratio or capital adequacy ratio. It is the ratio between the prudential own funds of the bank (basic and complementary) and the weighted or adjusted bank assets for different risk classes. As noted by Powell (2004), this ratio is a significant expression of the bank's capital level and has been applying by most international banking systems since its adoption in Basel II.

This is the ratio between basic prudential (Tier 1) and complementary (Tier 2) net primary and adjusted bank assets according to the different risk classes. This ratio cannot be calculating directly from the financial statements. The ratio is usually issuing by the banks in their annual reports. According to the regulatory management standard in force in Tunisia, the value of this ratio must not be less than 10% since the beginning of 2016 in Tunisia (against 8% previously). The formula for calculating this ratio is:

$$RCR = \frac{\text{Net prudential own funds (party 1 + party 2)}}{\text{Risk} - \text{adjusted assets (Credit risk . Market risk. Operational Risk}}$$

Independent variables

In light of the results of studies developed by recent empirical work, we have identified a set of explanatory variables. In what follows, we will expose these variables.

Interest rate risk ratio

This ratio is the determining variable for interest rate risk. It is the ratio between the net banking income and the total balance sheet. The formula for this ratio is as follows:

$$RTI = \frac{Net\ Banking\ Income}{Total\ Balance\ Sheet}$$

H1: Interest rate risk is a determinant of the risk coverage ratio

Market risk ratio

The market risk ratio is the ratio between the market capitalization (number of securities admitted to listing * share price) and the total balance sheet

The concept of market capitalization is using as a synonym for the market value of the business. For Ménard (2011), the market value is defining as "value resulting, for a given good or service, from the confrontation of supply and demand in a given market under normal conditions of competition". The formula for this ratio is:

$$RM = \frac{Market\ Capitalization}{Total\ Balance\ Sheet}$$

***H2** : Le risque de marché est un facteur explicatif du ratio de couverture de risque*

The liquidity ratio

It is the ability of a company or an individual to repay these debts in the short term. Indeed, banks that have enough cash and can easily raise funds to deal with deposit withdrawals or demand for credit, in this case, we can say that these banks are profitable and require less capital. In addition, the liquidity deficit can negatively affect the bank's strength (Salhi 2014).

According to the prudential approach, the liquidity criterion most frequently used in national banking regulations is the liquidity ratio defined by the ratio between the realizable assets and the liabilities payable. According to Tunisian regulations, this ratio must be greater than 100%. The formula for this ratio is:

$$RL = \frac{Assets\ realizable}{Liabilities\ payable}$$

***H3** : Le risque de liquidité est un déterminant du ratio de couverture de risque*

Credit risk ratio

This ratio is the determining variable for credit risk. This indicator captures the balance sheet and off-balance risk of quantitative information on institutions and bank loan portfolios. It measure by the ratio of the required reserves (including the agios to be reserved) and the amount of financing to the economy according to the following formula (Maraghni 2015):

$$RC = \frac{Required\ provisions\ (including\ the\ agios\ to\ reserve)}{Total\ loans\ to\ the\ economy}$$

Kwan (2004) has included this variable in his work. He pointed out that this measure expresses the bank's ability to absorb losses and reflects the level of risky assets in a portfolio of bank assets. He considers that banks with more capital are considering less risky and therefore have more reserves on their non-performing loans.

H4: *Credit risk is an indicator for the risk coverage ratio*

Return on Assets

This ratio indicates the net return of all the assets constituted by the bank and one can write:

ROA = Margin Profit × Asset turnover

$$\mathbf{ROA} = \frac{\text{Net result}}{\text{Net banking income}} \mathbf{X} \frac{\text{Net banking income}}{\text{Total balance sheet}}$$

This is the most used ratio to evaluate the performance of a credit institution.

This ratio shows the average net income rate generated on all activities carried by the bank. A low ratio means low profitability. (Salhi 2014). It is expressing in the form of the report:

$$\mathbf{ROA} = \frac{\text{Net income}}{\text{Total assets}}$$

H5: The return on assets ratio is an explanatory factor for the risk coverage ratio

Volume

The natural log of total balance is using as an indicator of the volume of the bank.

V = ln (Total Balance Sheet)

H6: The volume of the bank's business is a determining risk coverage ratio

Table 1

Abbreviation of used variables

Variables used	Abréviation	Masure
Risk coverage ratio	RCR	Prudential net capital / risk-adjusted assets
Ratio of interest risk	RIT	Net banking income / total balance sheet
Market risk ratio	RM	market capitalization / total balance sheet
Liquidity risk ratio	RL	Assets realizable / liabilities payable
Credit risk ratio	RC	Required provisions (including agios to reserve) / total credits granted or (loan / total assets).
Return on Assents	ROA	Operating résulta / total assents

Volume	V	V = Ln (total balance sheet)

The model to be tested

Our model can be written in the following form:

$$RCR = \alpha_0 + \alpha_1\ RIT_{i,t} + \alpha_2\ MR_{i,t} + \alpha_3\ LR_{i,t} + \alpha_4\ CR_{i,t} + \alpha_5 ROA_{i,t} + \alpha_6\ V_{i,t} + \varepsilon_{i,t}$$

With:

i : it is an individual dimension that indicates the number of commercial banks (i = 1, 2, 3, ... 10).

t: it is a temporal dimension that represents the study period (t = 2007, 2008, 2009, ... 2015).

〖 RCR〗 _ (i, t): Represents the risk-opening ratio.

〖 RTI〗 _ (i, t): Represents the interest rate ratio for bank i in year t

〖 RM〗 _ (i, t): Designates the market ratio for bank i to year t

〖 RL〗 _ (i, t): Represents the liquidity ratio for bank i in year t

〖 RC〗 _ (i, t): Represents the credit ratio for bank i to year t

〖 ROA〗 _ (i, t): Refers to the return on assets for bank i in year t

V_ (i, t): This is the volume for bank i in year t

ε_ (i, t): Designates the error term

3.2. The estimation method

The homogeneity test

When considering a sample of panel data, the first thing that needs to be looking for is the heterogeneous or homogeneous precision of the data generation process.

Econometrically, this amounts to checking the equivalence of the coefficients of the model explored in the individual dimension. Economically, the homogeneity tests return to specify if it is reasonable to suppose that the theoretical model studied is the same for all the countries, or conversely if there are specificities of each country. The assumptions of this test are as follows:

H0: The coefficients of the variables are different from zero

H1: The coefficients of the variables are not different from zero

The Hausman test

The Haussman specification test (1978), also known as the Wu-Hausman test or the Durbin-Wu-Hausman test, is a general test that can be appliying to many econometric specification problems. Nevertheless, its most common application is that of the individual effect specification tests in Panel.

It thus serves to discriminate fixed and random effects; the general idea of the Haussman test is both simple and general. The Haussmann test considers the possible presence of a correlation or a specification of default. Its statistical test applied to the specification of individual effects is as follows:

$$H = (\beta MCG - \beta LSDV)\,[Var\,(\beta MCG - \beta LSDV)] - 1\,(\beta MCG - \beta LSDV)$$

- $\beta MCG - \beta LSDV$ sont les estimateurs d'effets fixes et d'effets variables sur le modèle
- $V\,(\beta MCG - \beta LSDV$ is the matrix variance - covariance of the estimated coefficients.

The assumptions of this test are:

H0: fixed effect model

H1: random effect model

If **H0** is greater than 5% value of the threshold table, we reject the hypothetical null value, if H is less than the theoretical threshold, then we accept Ho.

4. Presentation and interpretation of results

To test the validity of our model, we proceeded first to a descriptive analysis

4.1. Descriptive analysis

Before presenting our results, we present the descriptive statistics concerning the dependent variables (variables to be explaining) and the independent variables (explanatory variables) which appear in the following table (for more details see appendix n ° 1):

Table 2

Descriptive statistics of dependent and independent variables

Variables	Observation number	Average	Standard deviation	Min	Max
RCR	90	0.1067943	0.0072149	0.0885624	0.1231456
RTI	90	0.2402797	0.0714454	0.130104	0.451472
RM	90	0.1410998	0.106597	0.0143171	0.4637158
RL	90	1.128967	0.2211704	0.1100568	1.850458
RC	90	0.4457335	0.3631959	0.010028	0.992772
ROA	90	0.0056996	0.0197336	-0.118428	0.0323592
V	90	21.97744	0.456769	21.038	22.71

As we have already mentioned, the dependent variable considered is the regulatory ratio: the risk coverage ratio (RCR). According to this table, we can see that the risk coverage ratio of our sample takes an average of (0.106) and a low dispersion of (0.007). We can also see that the ratio varies between (0.088) and (0.123).

The choice of our independent variables is guiding mainly by empirical studies that highlight the determinants of the risk hedge ratio of commercial banks.

In light of the statistics obtained, we can see that the interest rate risk ratio (RTI) of commercial banks in our sample over the period 2007 to 2015 is about (0.240) and varies between (0.130) and (0.451), with a dispersion of (0.071).

The results also indicate that the market ratio (RM) is on average around (0.141). It varies between (0.014) and (0.463) with a dispersion of (0.106).

The variable liquidity ratio (RL) averages a share of (1,128) with a minimum of (0.110) and a maximum of (1.850) and a dispersion of (0.221).

We can also see that the Credit Risk Ratio (CR) variable has an average of approximately (0.445). It varies between (0.010) and (0.992) with a dispersion of (0.363).

On average, the asset return variable (ROA) is of the order of (0.005) with a negative minimum of (-0.118), a maximum of (0.032) and a dispersion of (0.019).

The last variable, the one we proposed in the model, is volume (V). It has an average of (21.97) and varies between (21.03) and (22.71), with a dispersion of (0.456).

4.2. The matrix correlation

In order to examine the possible correlation that might exist between the different exogenous variables, we determine the correlation matrix of the independent variables. The correlation coefficient indicates the magnitude of the linear relationship between two variables and varies between 1 and -1. The closer it gets to 1 in absolute value, the stronger the correlation. The closer he gets to 0, the weaker he is. Table (3) shows the correlation matrix.

Table 3

Matrix correlation

	RCR	RTI	RM	RL	RC	ROA	V
RCR	1.0000						
RTI	0.2558	1.0000					
RM	0.3063	-0.0355	1.0000				
RL	-0.0177	0.1124	0.0685	1.0000			
RC	-0.2441	0.3762	-0.0776	0.1859	1.0000		
ROA	0.1128	-0.2754	0.1743	-0.4807	-0.1354	1.0000	
V	-0.1331	-0.3796	-0.3393	-0.0817	-0.2062	-0.0119	1.0000

The study of this matrix makes it possible to detect the existence or not of a problem of multi-colinearity. From this table, we note that the correlations between the independent variables are small, and all the Pearson correlation coefficients between these variables are less than 0.6, that is, there is not one problem of multi-collinearity.

4.3. Multi co linearity

The variance inflation factor of the variables is at most 2.55. They are less than five so, there is no problem of multi-co linearity in the analyzes presented (Gujarati, 2005).

Table 4

Variance inflation factor (VIF)

Variable	VIF	1/VIF
ROA	1.49	0.672243
RTI	1.45	0.691381
V	1.39	0.717325
RL	1.39	0.721191
RM	1.24	0.808118
RC	1.22	0.819779
Mean VIF	1.36	

4.4. Results and interprétations

We recall that the problem of our study is to determine to what extent the explanatory variables can have an impact on the risk coverage ratio in commercial banks. In what follows, we will analyze the impact of seven six factors: the interest rate risk ratio (RTI), the liquidity

risk ratio (RL), the market risk ratio (RM), the ratio credit risk (RO), return on assets (ROA), size (TA) and volume (V) on risk coverage ratio (RCR).

Table 5

the results of the model estimation

Variable to explain Explanatory variables	RCR Coefficients	 p>|t|
Observation number	90	
Constant	0.0744129	0.042
RTI	0.0306015***	0.029
RM	-0.003401	0.690
RL	0.0032797*	0.100
RC	-0.0008307	0.581
ROA	0.0927578***	0.000
V	0.000985	0.544
R^2	0.0925	-
Test of Fischer		
Prob>F	-	0.0000
F(9,74)	-	22.99
Test of Breusch Pagan		
Prob>chi2	-	0.0000
Chi2 (1)	-	109.58
Test of Hausman		
Prob>chi2	-	0.1617
Chi2 (6)	-	9.22

*** significant at the level of 1%,
** significant at the level of 5%,
* significant at the level of 10%

According to table (4), the homogeneity tests (Fischer test and Breusch and pagan test), we notice that the probability of these tests is less than (0.05) which confirms the existence of a problem heterogeneity. Therefore, the application of the least squares method (MCO) is biased. (See Annex 6)

To choose between the fixed effect model and the one with random effects, we performed the Hausman test. The results of the Hausman test presented in Table (4) show the random effect model, since the probability of this test is greater than (0.05). (See Annex 7)

Empirical results from this model show an explanatory variable (RL) that is statistically significant at the 10% level. The RTI and ROA variables are statistically significant at the 1% threshold, while the variables (RM, RC, and V) have no significant effect.

Indeed, we discover a positive relationship is significant at the 1% threshold between the risk coverage ratio (RCR) and the interest rate risk ratio (RTI), which confirms the hypothesis (H1) that stipulates that the interest rate ratio is a determinant of the banks' risk coverage ratio. Indeed, each fluctuation affects the interest rates will have effects on the risk coverage ratio. This result is consistent with the study conducted by kefi and Maraghni (2011).

On the other hand, we note that the coefficient of the market ratio variable is negative and statistically insignificant. This allows us to reject our research hypothesis (H2). In other words, market risk is not an explanatory factor for the risk coverage ratio. Kefi and Maraghni (2011) also confirm this result.

Regarding the liquidity ratio variable, we find that this ratio has a positive and statistically significant coefficient according to our hypothesis (H3). That is, liquidity risk is a determinant of the risk coverage ratio. This result is contradictory to that released by salhi et al (2012) who concluded that the liquidity risk has no effect on the solvency of the bank.

In addition, we find that the credit ratio has negative coefficient and has no significant effect on the risk coverage ratio. This result allows us to reject the hypothesis (H4). This means that the credit ratio is not an explanatory indicator of the risk coverage ratio. This result is confirmed by the study by kefi et al (2011).

In the same context of analysis, the results show that the return on assets ratio (ROA) is positively relating to the variation of the risk coverage ratio. Since the parameter (α_5) is equal to (0.0916026), positive and statistically significant at the 1% threshold, this result shows that the risk coverage ratio (solvency ratio) is explaining by the return on their assets (ROA) which validate our hypothesis (H5).

The same result has been confirming by several previous works, in particular Shrieves and Dahl (1992) and Jaques (1998), Rime (2001), Hassan, and Hussain (2004), maraghni and rajhi (2015). Most of them pointed out that the quality of the portfolio of assets, of which the banking companies are presuming varies in the same direction, as the variation of the regulatory solvency ratio for a fraction of the equity will consist of profits delaying.

Finally, we notice that the volume (V) has a positive and non-significant coefficient, which rejects the hypothesis **(H6)**. Therefore, the volume of the bank's activity is not a determinant of the solvency ratio. This result is in contradiction with that found by kefi and Maraghni (2011) which states that the volume is significant on risk coverage ratio.

It is interesting to inform that if the volume of the activities of the banks enlarged, then their risk taking becomes more and more important. The local banks are invited to consolidate their management systems to have a large volume of activity while being as prudent as possible.

4.5. Audit of prudential standards against the Risk Coverage Ratio

The following table presents the audit of prudential standards, in particular against the Risk Coverage Ratio, also known as the Mc Dnough Ratio, which is the ratio between prudential net capital and risk-adjusted assets. It must not be less than 10%. Our audit was basing on ten Tunisian commercial banks.

Table 10
Risk Coverage Ratio (RCR) (nine-year average)

Banque	AB	ATB	ATTIJARI BANK	BH	BIAT	BNA	BT	STB	UBCI	UIB
RCR	10.20	9.12	10.50	10.93	10.90	10.75	11.60	10.63	11.16	10.94

The credit risk ratio (solvency ratio) in 2007-2015 of credit institutions (AB, Attijari Bank, BH, BIAT, BNA, BT, STB, UBCI, UIB) is on average equal to 10.673%, higher than the prudential standard, which is of order 10%. So these banks respect prudential standards, they are less risky and solvent.

However, we note that one out of ten banks (ATB) do not comply with this standard, which could indicate a risk of insolvency.

5. Conclusion

In this research work, we tried to provide elements of the answers to our problem: the impact of the respect of the prudential norms on the solvency of the commercial banks Tunisian.

Based primarily on the review of previous empirical studies, we identified a set of variables that could influence the solvency ratio in commercial banks. Thus, we adopted an econometric model by considering the risk coverage ratio. Subsequently, we tried to test the

validity of our research hypotheses concerning the impact of each determinant on the risk coverage ratio. The results of the estimates showed a positive and significant relationship between these determinants (liquidity ratio, interest rate ratio and ROA).

To do this, we first tried to present the dependent variables and those that are independent of our model. We analyzed the impact of six variables (interest rate ratio, market ratio, liquidity ratio, credit ratio, and ROA and bank volume) on the risk coverage ratio.

The results showed that the variable liquidity ratio (LR) is statistically significant at the 10% threshold, while the two variables (ITR and ROA) are statistically significant at the 1% level. The other variables (RM, RC, and V) have no significant effect on the risk coverage ratio.

Despite its theoretical and methodological contributions, our study is not free of limits that open up new research perspectives. These limits include the existence of other variables that are in turn determining the solvency ratio such as the capitalization and size of the bank, the quality of the information available to the bank regarding the quality of its borrowers and the qualification of its staff.

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