International Journal of Economics and Business Administration
Volume XIV, Issue 1, 2026

pp. 119-141

Assessing Prudential Compliance and Solvency in Tunisian Commercial Banks

Submitted 20/12/25, 1st revision 25/01/26, 2nd revision 16/02/26, accepted 15/03/26

Nourhene Dhahri[1]

Abstract:

Purpose: *This study investigates the effect of bank risk ratios—credit risk, market risk, interest rate risk, and liquidity risk—as well as internal factors such as profitability and bank size—on the solvency of Tunisian banks, measured by the Risk Coverage Ratio (RCR).*
Design/methodology/approach: *The study uses a sample of 10 Tunisian banks over the period 2010–2023. An econometric analysis is conducted using the Generalized Method of Moments (System GMM) to examine the relationship between bank risk indicators, internal bank characteristics, and solvency.*
Findings: *The results show that market risk and interest rate risk positively contribute to bank solvency, while liquidity risk negatively affects it. Credit risk does not have a statistically significant impact on solvency in this context. Additionally, larger banks tend to have better risk coverage, whereas profitability shows a negative effect on solvency.*
Practical implications: *The findings emphasize the importance of integrated risk management and the implementation of appropriate prudential policies to strengthen the resilience and stability of the Tunisian banking sector.*
Originality value: *This study provides empirical evidence on the combined effects of multiple bank risk ratios and internal bank characteristics on solvency in the Tunisian banking sector using a System GMM approach over a recent and extended period (2010–2023).*

Keywords: *Tunisian banks, bank solvency, banking risk, liquidity, GMM, risk coverage, bank size, profitability.*

JEL Codes: *G21, G28, G32, G33, C23.*

Paper type: *Research article.*

[1]*Dr., ISAEG, Tunisia, e-mail: nourhendhahri1@gmail.com;*

1. Introduction

The banking sector has long been recognized as one of the fundamental pillars of any functioning economy. Its essential role in mobilizing savings, providing credit to individuals, businesses, and governments, and ensuring the stability of financial systems makes it indispensable to sustainable economic development. A robust and sound banking system is therefore necessary to guarantee efficient financial intermediation. The absence or weakness of these conditions can lead not only to systemic crises but also to severe repercussions for the real economy.

Banks serve as the driving force of economic activity. By collecting deposits and granting loans, they circulate funds within the economy, maintaining its momentum. Moreover, banks play a central role in money creation and payment systems, reinforcing their strategic importance in financial intermediation.

In recent years, the global financial landscape has undergone considerable fluctuations and disruptions. Economic and geopolitical instability, coupled with technological transformation, has amplified the complexity of risks faced by financial institutions.

Banks are increasingly exposed to a variety of risks—credit, market, liquidity, and operational—that may endanger both their profitability and solvency. Consequently, bank management must remain vigilant in identifying, assessing, and mitigating these risks effectively to preserve institutional stability.

Against this backdrop, prudential regulation has emerged as a crucial mechanism for ensuring the soundness and resilience of the financial system. It provides a framework aimed at preventing excessive risk-taking and maintaining the solvency of banks. Over the past two decades, prudential standards have evolved significantly, particularly through the Basel Accords. These frameworks emphasize risk-sensitive capital requirements, liquidity coverage, and supervisory review processes, all designed to strengthen banks' ability to absorb shocks.

Prudential regulation combines both preventive and corrective approaches. It seeks to reduce the likelihood of bank failures while establishing effective intervention mechanisms for distressed institutions. Its objectives are to promote sound and prudent banking practices, reinforce confidence in the financial system, and ensure fair competition among financial institutions.

Nevertheless, prudential regulation cannot completely eliminate risk. Since banking is inherently linked to risk-taking, the objective is not to suppress it entirely but to control it within acceptable limits. Compliance with these standards also involves substantial costs. Banks must invest in advanced risk management systems and maintain higher capital buffers, which may generate both direct financial costs and opportunity costs in terms of reduced lending capacity.

Solvency, in this context, refers to a bank's ability to meet its long-term obligations and continue operating without financial distress. It reflects an institution's financial strength and capacity to cover its liabilities. A bank is considered solvent when its total assets exceed its total liabilities; conversely, when liabilities surpass assets, the bank faces the risk of insolvency. Recent financial episodes, such as the collapse of regional banks in the United States and tensions in the European banking sector in 2023, have reaffirmed the importance of solvency management for maintaining systemic stability.

This research aims to analyze the relationship between prudential standards and bank solvency, focusing particularly on the Tunisian banking sector. Using a multivariate analytical model, the study evaluates the impact of several prudential indicators—interest rate risk ratio, market risk ratio, credit risk ratio, liquidity ratio, return on assets (ROA), and bank size—on the risk coverage ratio (RCR), which serves as a proxy for solvency. The empirical analysis is based on data from ten Tunisian commercial banks over a nine-year period.

Ultimately, this study contributes to the ongoing debate on the effectiveness of prudential regulation in enhancing financial stability while maintaining banks' operational efficiency and profitability, especially in emerging economies such as Tunisia.

2. Why Regulate Banks

Prudential regulation occupies a central role in maintaining financial stability. It encompasses the set of rules, procedures, and mechanisms established by supervisory authorities—such as central banks, regulatory bodies, and international institutions—to ensure the soundness of the banking system and sustain public confidence. As Jezebel Soubeyran (2004) notes, it represents a supervisory framework designed to prevent imbalances that could undermine the financial system as a whole.

Historically, the recurrence of banking crises has highlighted the need for strict oversight of financial activities. Regulation thus emerged as a response to excessive risk-taking and systemic fragility. Its fundamental objective is to strengthen the resilience of financial institutions, preserve solvency, and prevent large-scale economic disruption.

According to Baicu (2012), the primary purpose of banking regulation is to achieve and maintain financial stability through a coherent set of rules governing the conduct of institutions. It seeks to protect depositors, investors, and the broader economy by fostering an environment of trust and reliability within the financial sector.

Rochet (2008) further argues that prudential regulation is a natural extension of banking regulation, as it aims to limit excessive risk-taking. Its effectiveness

depends on the ability of supervisory authorities to balance safety with efficiency—ensuring optimal resource allocation while minimizing the probability of bank failures.

The rationale for prudential regulation can be understood through two complementary dimensions (Rochet, 2003; Basel Committee on Banking Supervision, 2023):

- Microprudential regulation focuses on the stability and solvency of individual institutions. Its objective is to ensure that each bank operates prudently and maintains adequate capital to safeguard depositors.
- Macroprudential regulation adopts a systemic perspective, seeking to preserve the stability of the financial system as a whole. It aims to prevent systemic crises, mitigate contagion effects, and sustain the continuous financing of the real economy.

These two dimensions address fundamental structural challenges inherent to the banking sector. On one hand, individual depositors lack the ability to assess banks' financial soundness, creating an information asymmetry between institutions and the public. On the other hand, the risk of contagion means that the failure of a single institution can endanger the entire system. These realities justify regulatory intervention to monitor, discipline, and stabilize the sector.

In the current environment—characterized by financial digitalization, the rise of fintech, and the growing interconnectedness of markets—prudential regulation remains a critical policy priority. Recent analyses by the Bank for International Settlements (BIS, 2024) and the International Monetary Fund (IMF, 2025) emphasize that well-designed regulatory frameworks not only curb excessive risk-taking but also enhance system resilience, enabling banks to continue supporting sustainable economic growth even during periods of uncertainty.

2.1 The Inability of Individual Depositors

According to Modigliani *et al.* (1958), in a world without conflicts of interest and with perfectly efficient markets, financial intermediaries would be unnecessary. However, in reality, information asymmetry between small depositors (lenders) and firms (borrowers) prevents depositors from distinguishing between sound and risky investment opportunities. This asymmetry makes it impossible for most savers to assess the quality of the banks' portfolios or the level of risk associated with their funds.

Moreover, depositors generally prefer short-term investments, whereas firms typically seek medium- to long-term financing to support their productive activities. These mismatched preferences between savers (agents with a financing surplus) and

firms (agents with a financing deficit) explain the essential role of banks as intermediaries in transforming savings into long-term investments.

Information theory suggests that one of the key reasons banks exist is their informational advantage over individual depositors. Banks possess superior monitoring capabilities, allowing them to evaluate and control credit risk more effectively. Nevertheless, this advantage also implies that depositors lose visibility over how their savings are used, which further limits their ability to evaluate the bank's financial soundness.

The primary goal of prudential regulation is therefore to protect depositors—particularly small and uninformed ones—in the event of bank failure. A relevant question arises: why should financial institutions be regulated more strictly than non-financial firms? The answer lies partly in the nature of banks' liabilities. Unlike non-financial companies, a large portion of a bank's debt is held by a vast number of small depositors who typically lack both the information and expertise required to monitor the institution's risk-taking behavior.

As Dewatripont *et al.* (1993) observed, "if small depositors placed their money in non-financial firms, while the debt of the financial sector were held by large and sophisticated investors, then it would be the non-financial sector that required regulation rather than the financial one." Consequently, a regulatory framework must act as a collective representative of depositors, ensuring their protection and monitoring how banks manage their funds. This justification underpins the establishment of deposit insurance schemes and prudential supervision systems designed to safeguard depositor interests.

While this reasoning primarily applies to traditional commercial banks that rely heavily on deposit collection, it can also extend—though to a lesser degree—to other financial institutions such as investment banks, which are more dependent on capital markets for funding. Although their investors tend to be more informed than retail depositors, the complexity of modern financial instruments and the speed of transactions make it equally necessary to have regulatory oversight to prevent excessive risk-taking and ensure transparency.

Ultimately, the inability of depositors to effectively monitor bank activities, combined with the potential for contagion across interconnected institutions, forms the basis of the prudential regulatory framework aimed at preserving financial stability.

2.2 Systemic Risk or Contagion Risk

A second—and arguably more critical—objective of prudential regulation is to maintain the stability of the overall financial system. To understand systemic risk, it is first necessary to define what constitutes a systemic crisis. According to Mishkin

(1999), a financial crisis occurs "when disruptions in the financial system impede the flow of information, preventing it from efficiently channeling funds to those with productive investment opportunities." In such situations, the financial sector becomes unable to perform its fundamental intermediation functions.

Systemic crises typically arise following an initial shock that propagates throughout the financial system. These shocks may be idiosyncratic—originating from the failure or mismanagement of a single institution—or systemic, when economic downturns or market stress simultaneously affect a large number of banks. Mishkin (1999) identifies four main sources of systemic shocks:

- Deterioration of financial institutions' balance sheets,
- Rising interest rates,
- Increasing uncertainty, and
- Weakening of non-financial sector balance sheets.

Several international institutions have proposed complementary definitions of systemic risk. The European Central Bank (ECB, 2004) defines it as "the risk that the inability of one institution to meet its obligations will cause other institutions to default, leading to liquidity or credit problems and threatening confidence in financial markets." In a more recent statement, the ECB (2010) expanded this definition, referring to systemic risk as "the risk that financial instability becomes so widespread that it disrupts the functioning of the financial system and adversely affects economic growth and welfare."

Similarly, the Bank for International Settlements (BIS, 1994) describes systemic risk as "the risk that the failure of one market participant to meet its contractual obligations may cause other participants to default, leading to a chain reaction of financial distress."

Economic literature offers diverse perspectives on the phenomenon. Summers (2003) argues that there is no single universal definition of systemic financial risk. De Bandt and Hartmann (2000) suggest that systemic risk encompasses widespread distress in banking, financial, and payment systems, where contagion effects play a central role. Lehar (2005) views systemic risk as the potential for simultaneous failure of several financial institutions.

Adrian and Brunnermeier (2010) link systemic risk to the distress of a single institution that spreads throughout the financial system, disrupting credit and capital flows to the real economy. Similarly, Bhattacharya *et al.* (2009) define it as the joint failure of financial institutions and markets that sharply reduces capital supply to the real sector. Abdymomunov (2013) interprets it as the risk of a negative shock affecting both the financial system and the real economy, often triggered by macroeconomic disruptions or failures within interconnected institutions.

Patro *et al.* (2013) further describe systemic risk as a situation where the entire financial system experiences simultaneous stress, leading to credit and liquidity shortages that magnify economic losses.

From a comparative perspective, three key insights emerge from these definitions:

- Scope: Systemic risk affects a significant portion of the financial system or a large number of institutions, undermining its ability to perform intermediation functions.
- Transmission: It involves the propagation of shocks through interconnected financial entities, which can have serious repercussions on the real economy.
- Evolution: While the concept gained attention in the 1990s, its importance intensified after the 2008 global financial crisis and was reinforced by more recent episodes of market instability, including the 2023 banking turbulence in the United States and Europe.

Before 2008, research largely emphasized contagion effects—the rapid spread of distress from one institution to others. Post-crisis, however, scholars and regulators have placed greater focus on the functional disruptions of the financial system and their real economic impacts. This evolution has broadened the concept of systemic risk from a narrow contagion perspective to a multidimensional framework encompassing confidence erosion, correlated exposures, market bubbles, and feedback loops.

In summary, systemic risk embodies the collective vulnerability of the financial system to shocks that can impair both market confidence and economic performance. Prudential regulation therefore serves not only to protect individual banks but also to prevent the propagation of crises that could endanger the entire economy.

3. Preventive Measures and the Challenge of Moral Hazard

To mitigate the challenges stemming from individual depositors' inability to monitor banks and from systemic risk, regulators have historically implemented two major preventive mechanisms: deposit insurance and the lender of last resort function. Deposit insurance systems were first introduced in the United States in 1934 to curb bank runs that had intensified during the Great Depression.

Over the following decades—particularly after World War II and more markedly during the 1980s—many OECD and developing countries adopted similar schemes to protect small savers and strengthen confidence in banking systems (Garcia, 1999).

The International Monetary Fund later endorsed limited forms of deposit insurance as part of sound prudential practices (Folkerts-Landau and Lindgren, 1997).

Economically, deposit insurance aims to guarantee depositors the recovery of their funds even in the event of bank failure, thereby maintaining confidence and preventing self-fulfilling runs (Diamond and Dybvig, 1983). It also reduces information asymmetry by protecting uninformed savers against panics triggered by privileged depositors, while promoting fair competition between small and large banks (Venard, 2001).

However, while deposit insurance stabilizes the financial system, it cannot fully eliminate the risk of bank runs or depositor panic. Complementing this mechanism, the lender of last resort—a function assigned to central banks—ensures liquidity provision during crises. Rooted in the works of Thornton (1802) and Bagehot (1873), this doctrine emphasizes that central banks should lend freely, against good collateral, at a penalty rate, and primarily to solvent but illiquid institutions. Such interventions aim to prevent liquidity shortages from turning into solvency crises, thereby preserving systemic stability (Freixas *et al.,* 2000; Marini, 2003).

Nevertheless, both mechanisms—while crucial for financial stability—introduce a significant moral hazard problem. By guaranteeing deposits and providing emergency liquidity, authorities may unintentionally encourage banks to take on excessive risks, assuming that potential losses will be absorbed by regulators or the public sector.

Arrow (1971) first conceptualized moral hazard as a distortion in incentives caused by risk-sharing arrangements, and subsequent studies confirmed its relevance in banking. Demirgüç-Kunt and Detragiache (2002) and Laeven (2002) found that explicit deposit insurance tends to increase the likelihood of banking instability, as it weakens market discipline and emboldens risky behavior.

In essence, while deposit insurance and the lender of last resort serve as indispensable safety nets for maintaining confidence and preventing systemic collapse, they also create perverse incentives that may compromise prudential behavior. Thus, the effectiveness of these preventive measures depends on how well regulation balances protection with accountability, ensuring that financial stability is maintained without encouraging excessive risk-taking.

4. Regulation Defined by the Basel Accords

The Basel Committee on Banking Supervision (BCBS) is recognized as the leading international body responsible for setting prudential banking standards and serves as a forum for cooperation in banking oversight. Its main objective is to strengthen regulation, supervision, and banking practices globally to enhance financial stability (Bank for International Settlements, 2023).

Sylvie (2005) explains that the BCBS was established in 1974 by central bank governors and banking supervisory authorities from major industrialized countries

(G-10) following the failure of the German bank Herstatt. Its mission was to improve global financial stability by enhancing supervisory quality and providing a forum for ongoing cooperation among member countries. The committee functions through approximately thirty technical working groups, with members drawn exclusively from regulatory agencies, finance ministries, and central banks of 13 advanced economies.

The Basel Committee on Banking Supervision (BCBS) has developed two cornerstone frameworks: the Core Principles for Effective Banking Supervision and the Basel Capital Accord. The Committee's main objective is to close gaps in international oversight, ensuring that no foreign bank operates outside regulatory supervision while maintaining adequate oversight standards.

Although it does not possess formal supranational authority, the BCBS functions as a forum where regulators can establish and share best practices (Grynberg *et al.,* 2005). Its initiatives aim to prevent banking crises through global coordination and the establishment of prudential norms, which led to the introduction of the Cooke Ratio in 1988. This ratio set minimum capital requirements for internationally active banks, linking regulatory equity to the credit risk of their assets (Bradley *et al.,* 2005):

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

Despite its contributions, Basel I revealed several limitations over time. Technological and financial developments rendered the 1988 risk framework increasingly outdated, with rigid risk weights penalizing certain assets, while banks' credit risk mitigation efforts were not fully recognized. Additionally, new risks, especially operational risk, were emerging. To address these issues, Basel II, or the MacDonough Ratio, was introduced and implemented in 2006, emphasizing a more qualitative approach to align capital requirements with actual risks. Basel II relies on three pillars: minimum capital requirements, supervisory review, and market discipline (Bradley et al., 2005). The first pillar maintains the principle of capital proportional to risk:

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

Credit risk can be assessed using the standardized approach, based on external ratings, or the internal ratings-based (IRB) approach, which allows banks to use internal models approved by regulators. Operational risk, defined as "the risk of direct or indirect losses arising from inadequate or failed internal processes, personnel, systems, or external events," can be calculated using the basic indicator approach, standardized approach, or advanced measurement approach.

Capital allocation typically considers 85% for credit risk, 5% for market risk, and 15% for operational risk.

Pillar 2 focuses on qualitative supervisory review, ensuring banks maintain sufficient capital and proper risk evaluation procedures, while regulators can require additional capital buffers (Hull, 2007).

Pillar 3 strengthens market discipline through enhanced transparency, requiring banks to disclose semi-annual information on risk exposure, capital structure, and capital adequacy. However, Basel II did not fully address issues such as insufficient capital buffers, excessive leverage, rapid credit growth, systemic interdependencies, procyclical effects of rating downgrades, liquidity risk, and complexity of financial instruments, which contributed to the 2007–2008 financial crisis (Niemeyer, 2016).

In response, Basel III was developed to further enhance bank resilience. Following the interim Basel 2.5 framework in 2009, which tightened capital requirements for trading book exposures and introduced stressed Value at Risk (VaR) calculations, Basel III was formally adopted in December 2010 with minor adjustments in 2011.

The framework aims to improve the quality and quantity of bank capital, capture risks more effectively, introduce capital buffers, reduce procyclicality, mitigate systemic risk, ensure minimum liquidity, limit maturity mismatches, control leverage, and strengthen regulation of trading exposures (Niemeyer, 2016). Under the CRD IV Directive in Europe, Basel III introduces:

- ✓ ***Higher Capital Requirements***: The minimum capital ratio rises to 10.5%, including a countercyclical buffer, with stricter criteria for eligible capital instruments (Hache, 2012).
- ✓ ***Countercyclical Capital Buffer***: Banks must hold 0–2.5% additional capital when credit growth is deemed excessive, moderating credit cycles.
- ✓ ***Leverage Ratio***: This ratio aims to limit excessive leverage in the banking sector.

$$\textbf{Leverage Ratio} = \frac{\textbf{Capital}}{\textbf{Exposure}}$$

- ✓ ***Liquidity Ratios:*** The Liquidity Coverage Ratio (LCR) ensures banks maintain sufficient liquid assets to cover net cash outflows over a 30-day stress period:

$$\textbf{LCR} = \frac{\textbf{Liquid assets}}{\textbf{Outflows during 30 days of stress} - \textbf{Inflows during 30 days of stress}} \geq 100\%$$

While the Net Stable Funding Ratio (NSFR) mitigates maturity transformation risk by requiring stable funding over a one-year horizon:

$$NSFR = \frac{\textbf{Available Stable Funding (1 year)}}{\textbf{Required Stable Funding (1 year)}} > 100\%$$

Overall, these reforms are designed to enhance banks' capital adequacy, leverage management, and liquidity oversight, thereby supporting the stability of the financial system (Niemeyer, 2016).

5. The Influence of Prudential Standards on the Financial Solvency of Tunisian Banks: An Empirical Study

This study aims to examine the impact of compliance with prudential regulations on the solvency of Tunisian banks. To achieve this, we first outline the methodological choices adopted to test our hypotheses, providing a detailed description of the study sample and the variables employed. We then present the research hypotheses that guide our analysis. Finally, we report the descriptive statistics, the conducted tests, and the interpretation of the results, highlighting the key insights derived from this empirical investigation.

5.1 Methodology and Sample

The aim of this research is to assess the impact of compliance with prudential regulations on the solvency of Tunisian banks. The study focuses on a sample of ten universal commercial banks, namely: Amen Bank (AB), Banque de Tunisie (BT), Société Tunisienne de Banque (STB), Attijari Bank, Banque Internationale Arabe de Tunisie (BIAT), Banque Nationale Agricole (BNA), Union des Banques du Commerce et de l'Industrie (UBCI), Arab Tunisian Bank (ATB), Banque de l'Habitat (BH), and Union Internationale des Banques (UIB).

Data were extracted from the annual reports of these banks over a thirteen-year period, from 2010 to 2023, forming a balanced panel of 140 bank-year observations. This dataset provides a comprehensive and reliable source for analyzing the relationship between adherence to prudential standards and the solvency of financial institutions.

To examine these relationships, statistical analyses were conducted, including regression models using STATA software, enabling the evaluation of the effect of prudential regulations on banks' solvency performance.

5.2 Definition of Variables and Study Hypotheses

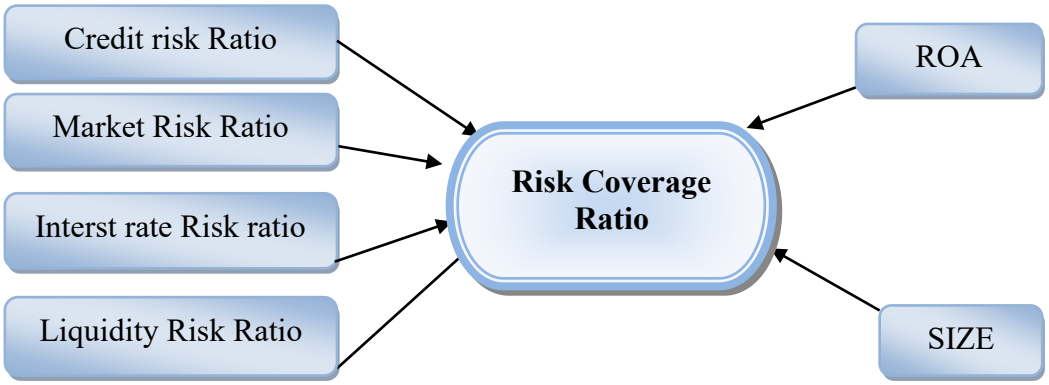
In the following paragraphs, we present the variables used in this study, which are categorized into three groups: dependent variables, independent variables, and control variables.

The main dependent variable is the Risk Coverage Ratio (RCR), which reflects the solvency and regulatory capital adequacy of Tunisian banks. This ratio measures the extent to which a bank's capital covers different types of banking risks.

The independent variables include the primary indicators of banking risk: interest rate risk, market risk ratio, liquidity risk ratio, and credit risk ratio. These variables allow for an assessment of banks' exposure to various risk types and their impact on solvency as measured by the RCR.

Finally, the control variables comprise bank profitability, measured by ROA (Return on Assets), and bank size, measured by total assets. These variables account for the influence of both performance and the scale of the bank on its solvency.
Figure 1 illustrates the conceptual framework of the study, showing how compliance with prudential regulations and different types of risks affect bank solvency, while controlling for bank size and profitability.

Figure 1. *Research Framework*



Source: *Own study.*

Dependent Variable:

- ✓ **Risk Coverage Ratio**

The primary measure of bank solvency in this study is the Risk Coverage Ratio (RCR), also known as the McDonough ratio, which serves as a key regulatory indicator of capital adequacy. It is defined as the ratio between a bank's regulatory capital—including Tier 1 (core capital) and Tier 2 (supplementary capital) —and its risk-weighted assets across various risk types, including credit, market, and operational risks. This ratio reflects a bank's capacity to absorb potential losses arising from its risk exposures, thereby indicating its level of capitalization and financial strength (Powell, 2004).

According to Tunisian regulations, the minimum required value of this ratio has been set at 10% since 2016, up from 8% previously, in order to enhance the stability of the national banking sector. The RCR is widely used in banking literature as a measure of bank solvency and financial resilience (Obeid, 2021; Berger and Bouwman, 2013; Jokipii and Milne, 2011; Anginer and Demirgüç-Kunt, 2014; Li, 2020). These studies demonstrate that higher capital requirements reduce the likelihood of bank failure and improve the ability to absorb shocks.

The ratio is calculated as follows:

$$\boldsymbol{RiskCov} = \frac{\text{Net Regulatory Capital (Tier 1 + Tier 2)}}{\text{Risk} - \text{Weighted Assets (Credit Risk, Market Risk, Operational Risk)}}$$

A higher risk coverage ratio indicates stronger financial stability and lower exposure to potential risks, whereas a lower ratio signals increased vulnerability to potential losses.

This ratio has been employed in numerous studies, including those by Jacques and Nigro (1997), Aggrawal and Jacques (1998), Heid *et al.* (2005), Milne and Jokipii (2010), and Lin *et al.* (2013). These authors note that a higher level of this ratio is associated with a lower probability of default or reduced credit risk.

Independent Variables (Explanatory) :

- ✓ **Credit Risk Ratio**

The credit risk ratio is a key indicator that assesses the extent to which a bank is exposed to potential losses arising from borrower defaults. It reflects the bank's capacity to absorb losses stemming from counterparty risk, both on- and off-balance sheet.

According to Maraghni and Rajhi (2015), this ratio falls within the framework of prudential regulatory mechanisms, which aim to require banks to hold sufficient capital to cover such risks. Similarly, Maraghni (2016) emphasizes that capital requirements serve as a critical lever for bank risk-taking, although their expected effect on credit risk is not necessarily immediate or automatic.

The ratio is measured as the provisions for doubtful and non-performing loans divided by the total loans extended to the economy, as follows:

$$\boldsymbol{CREDIT\_Risk} = \frac{\text{Required Provisions, including reserves}}{\text{Total Loans to the Economy}}$$

In this study, the ratio is widely recognized in the literature (McManus and Rosen, 1991; Berger, 1995; Gorton and Rosen, 1995; DeYoung and Roland, 2001; Speed

Limit, 2004). Empirical findings, however, remain mixed: some studies observe a positive relationship between credit risk (CREDIT_RISK) and the risk coverage ratio (RISKCOV) (Milne and Jokipii, 2010; Lin *et al.,* 2013), others find no significant relationship (Godlewski, 2005; Van Roy), while some report a negative effect (Cane and Quagliariello, 2006; Bouri and Ben Hmida, 2011; Maraghni and Rajhi, 2015).
Hypothesis 1 (H1): Credit risk has a significant impact on the risk coverage ratio.

- ✓ **Market Risk Ratio**

The market risk ratio (MR) measures a bank's market valuation relative to the size of its balance sheet. It is calculated by dividing the market capitalization—the total number of shares outstanding multiplied by the share price—by the total assets. This ratio reflects how the market perceives the bank's financial soundness, expected profitability, and overall risk profile (Kwan and Furlong, 2005; Jordan *et al.,* 2011; BIS, 2018).

Market capitalization represents the value assigned by investors within a competitive and transparent market framework, as it emerges from the interaction of supply and demand, in line with economic theory (Ménard, 2011).

Theoretically, this ratio is related to the concept of "charter value," where a high valuation indicates strong investor confidence and may incentivize the bank to limit its risk-taking in order to preserve this strategic value (Kwan and Furlong, 2005). Empirical evidence suggests that market value of equity is a relevant indicator for understanding market perceptions of banking risk and anticipating potential vulnerabilities (Jordan *et al.,* 2011; BIS, 2018).

The ratio is calculated as follows:

$$\boldsymbol{MAR\_Risk} = \text{Market Capitalization}/\textit{Total Assets}$$

Hypothesis 2 (H2): Market risk significantly affects the risk coverage ratio (RCR).

Ratio de Risque d'Intérêt (RTI) :

- ✓ **Interest Rate Risk Ratio**

The interest rate risk ratio (INT_Risk) assesses a bank's exposure to fluctuations in interest rates by measuring the sensitivity of its intermediation income (net interest income) to such variations relative to the size of its balance sheet:

$$\boldsymbol{INT\_Risk} = \text{Realizable Assets} / \text{Total Assets}$$

This ratio evaluates the extent to which banking income is affected by interest rate changes, and consequently, its potential impact on profitability and solvency.

The INT-Risk reflects the bank's ability to generate net interest income and its potential vulnerability to interest rate shocks, particularly due to maturity mismatches between assets and liabilities (maturity gap), as highlighted by Rokhmawati (2019). A high ratio indicates that the bank relies heavily on interest margins for profitability and may be more susceptible to rate fluctuations if its asset-liability management is not effectively optimized.

Hypothesis 3 (H3): Interest rate risk has a significant impact on the risk coverage ratio (RCR).

- ✓ **Liquidity Risk Ratio**

The liquidity risk ratio indicates the proportion of short-term liquid assets that can be mobilized in the event of a banking problem. A high value of this ratio reflects effective liquidity risk management and, consequently, lower vulnerability to this type of risk (Maraghni and Bouheni, 2016).

According to Descamps and Soichot (2002) and Darmon (1998), liquidity risk is mainly associated with three factors:

a) the intrinsic risk of the balance sheet, reflected in the concept of transformation;
b) the behavior of economic agents towards the institution, reflecting the notion of reliability;
c) the institutional environment in which the bank operates, particularly the overall market liquidity.

These authors highlight that a specific feature of banking lies in transforming short-term resources into longer-term uses. From a prudential perspective, the liquidity criterion is often measured in national banking regulations by the cash ratio, defined as the ratio of liquid assets to current liabilities:

$$\boldsymbol{LIQ\_Risk} = \text{Realizable Assets} / \text{Total Assets}$$

This measure has been widely used in the literature to assess liquidity risk management across different banks and contexts, for example, Houben and Kakes (2009), Allen and Gale (2000), Garcia and Nguyen (2013), Maraghni and Bouheni (2015), and Bougatef and Mgadmi (2016).

Hypothesis 4 (H4): Liquidity risk has a significant impact on the risk coverage ratio (RCR).

Les Variables de contrôle :

- ✓ **Return on Assets (ROA)**

ROA (Return on Assets) measures how efficiently a bank utilizes its assets to generate net income while complying with regulatory capital requirements. It is

calculated as net operating income divided by total assets. This ratio serves as a key indicator of overall bank performance and its ability to maintain adequate solvency levels. Empirical studies, including those by Maraghni and Rajhi (2015), Maraghni and Bouheni (2015), Bougatef and Mgadmi (2016), and Ghenimi et al. (2017), have investigated the relationship between profitability and banking solvency in various contexts.

$$\mathbf{ROA} = \mathbf{net\ beneft / Total\ Assets}$$

- ✓ **Bank Size (SIZE)**

The size of a bank reflects the scale of its resources and total assets. It can influence both its solvency and risk-taking behavior, as larger banks often benefit from economies of scale, better risk diversification, and easier access to capital to meet prudential requirements. Bank size is typically measured as the natural logarithm of total assets:

$$\mathbf{Size} = \mathbf{ln\ (Total\ Assets)}$$

This variable is widely employed in the banking regulation and solvency literature (Bougatef and Mgadmi, 2016; Ghenimi *et al.,* 2017; Hunjra *et al.,* 2020; Li, 2020) to examine how a bank's size moderates the impact of prudential regulations on its solvency ratio and its capacity to absorb risks.

Table 1. *Variable definitions and measurements*

variables	**Measures**
Ratio de couverture de risque	Fonds propres nets prudentiels / actifs ajustés aux risques
Credit Risk Ratio	Required Provisions (including the agio to reserve) /Total loans to the economy
Market Risk Ratio	Market Capitalization / (Total Assets
Interest Rate Risk Ratio	Net Banking Income / Total Assets
Liquidity Risk Ratio	Realizable Assets / Payable Liabilities
ROA (return on asset)	Net benefits /Total Assets
Size of the Bank	Ln (Total Assets)

Source: *Table made by authors based on the literature review*

5.3 Empirical Analysis

Descriptive Analysis :

Before interpreting our empirical results, we provide a comprehensive overview of the variables used in this study, including both the dependent (explained) and independent (explanatory) variables. The descriptive statistics summarized in the table present detailed information for each variable, including the mean, standard deviation, as well as the minimum and maximums values.

Table 2. *Descriptive Statistics*

Variable	Obs	Mean	Std. Dev.	Min	Max
RiskCov	140	.11	.01	.09	.12
CREDIT_Risk	140	.1	.03	.05	.15
MAR_Risk	140	.08	.01	.06	.1
INT_Risk	140	.22	.06	.13	.37
LIQ_Risk	140	1.05	.01	1.03	1.07
ROA	140	.01	0	.01	.01
SIZE	140	21.74	.13	21.4	21.9

Source: *Author's calculations based on data from the banks' annual reports.*

The descriptive statistics presented in the table indicate that the Risk Coverage Ratio (RiskCov) averages 11% with a standard deviation of 1%, ranging from 9% to 12%, reflecting a relatively uniform application of prudential standards. Credit risk (CREDIT Risk) has a mean of 10% and a standard deviation of 3%, indicating moderate differences in credit management across banks.

Market risk (MAR Risk) is stable, with an average of 8% and a low standard deviation of 1%, whereas interest rate risk (INT Risk) exhibits greater variability (mean 22%, standard deviation 6%), signaling heterogeneous exposures to rate fluctuations. Liquidity risk (LIQ Risk) remains relatively constant (mean 1.05, standard deviation 0.01), indicating well-managed liquidity.

Return on assets (ROA) is low and stable (1%), and bank size (SIZE) is homogeneous, with a mean of 21.74 and a standard deviation of 0.13, confirming that the sampled institutions are large and comparable. Overall, these results reveal prudential and structural homogeneity among Tunisian banks, while highlighting the variability in interest rate risk as a potential factor affecting their solvency.

Correlation analysis :

After examining the variables used in the econometric model, the correlation matrix presented in Table 3 below illustrates the nature and degree of association among the different variables.

Table 3. *Correlation Matrix*

Variables	RiskCov	CREDITRisk	MARRisk	INTRisk	LIQRisk	ROA	SIZE
RiskCov	1.00						
CREDIT_ Risk	0.10	1.00					
MARRisk	0.09	0.79	1.00				
INTRisk	0.45	0.52	0.22	1.00			
LIQRisk	-0.12	0.03	-0.04	-0.26	1.00		
ROA	0.08	-0.05	0.27	0.04	-0.57	1.00	
SIZE	-0.05	0.56	0.49	-0.15	0.53	-0.25	1.00

Source: *Author's calculations based on data from the banks' annual reports.*

The correlation matrix indicates that no correlation exceeds 0.80, suggesting that multicollinearity is not a concern for this sample and allowing the simultaneous inclusion of explanatory variables in the regression model. The Risk Coverage Ratio (RiskCov) is moderately correlated with interest rate risk (INT_Risk, 0.45), weakly correlated with credit risk (CREDIT_Risk, 0.10) and market risk (MAR_Risk, 0.09), and slightly negatively correlated with liquidity risk (LIQ_Risk, –0.12), implying that solvency is primarily influenced by interest rate risk.

Credit risk is strongly correlated with market risk (0.79) and moderately with interest rate risk (0.52), while market risk is positively associated with bank size (SIZE, 0.49). Interest rate risk shows a negative correlation with liquidity (–0.26), and liquidity risk is negatively related to profitability (ROA, –0.57).

Finally, bank size is positively correlated with several risk measures (CREDIT_Risk 0.56; MAR_Risk 0.49; LIQ_Risk 0.53) but slightly negatively with profitability (ROA, –0.25).

Overall, these results confirm the absence of problematic multicollinearity and highlight significant, albeit moderate, relationships between risks, solvency, and bank performance, providing a suitable framework for analyzing the impact of prudential regulations.

5.4 Test of Multicollinearity

The results of the multicollinearity analysis, presented in Table 4, indicate that all variables included in the model have VIF values below the critical threshold of 10, suggesting that multicollinearity is not a significant issue.

Table 4. *Multicollinearity Test*

	VIF	1/VIF
CREDIT Risk	8.979	.111
MAR Risk	4.912	.204
SIZE	3.51	.285
INT Risk	2.849	.351
LIQ Risk	2.29	.437
ROA	2.172	.46
Mean VIF	4.119	.

Source: *Author's calculations based on data from the banks' annual reports.*

The variance inflation factor (VIF) analysis shows that Credit Risk has the highest VIF (8.979), followed by Market Risk (4.912), indicating that these variables are relatively more correlated with the other predictors. The remaining variables—Size (3.51), Interest Rate Risk (2.849), Liquidity Risk (2.29), and ROA (2.172) —exhibit moderate VIF values. With a mean VIF of 4.119, it can be concluded that the model

does not suffer from significant multicollinearity, and the estimated coefficients are reliable.

5.5 Econometric Model Specification

The econometric model proposed in this study is specified as follows:

$$RiskCov_{i,t} = \alpha_0 + \alpha_1\ CREDIT\_Risk_{i,t} + \alpha_2\ MAR\_Risk_{i,t} + \alpha_3\ INT\_Risk_{i,t} + \alpha_4 LIQ\_Risk_{i,t} + \alpha_5 ROA_{i,t} + \alpha_6\ SIZE_{i,t} + \varepsilon_{i,t}$$

where:

* (i) denotes the bank index ((i = 1, 2, ..., 10))
* (t) denotes the time index corresponding to the study year ((t = 2010, ..., 2023))

$RiskCov_{i,t}$ is the risk coverage ratio of bank (i) in year (t)
$CREDIT\_Risk_{i,t}$ is the credit risk ratio of bank (i) in year (t)
$MAR_Risk_{i,t}$is the market risk ratio of bank (i) in year (t)
$INT\_Risk_{i,t}$ is the interest rate risk ratio of bank (i) in year (t)
$LIQ\_Risk_{i,t}$ is the liquidity risk ratio of bank (i) in year (t)
$ROA_{i,t}$ is the return on assets of bank (i) in year (t)
$SIZE_{i,t}$is the size of the bank (logarithm of total assets) for bank (i) in year (t)
$\varepsilon_{i,t}$ is the error term capturing unobserved factors

This model allows for the simultaneous examination of the effects of various risk dimensions and bank performance on the risk coverage ratio.

6. Results and Discussions

Table 5 presents the impact of various types of bank risks and control variables on the solvency of Tunisian banks, measured by the Risk Coverage Ratio (RiskCov). To estimate these effects, we employed the Generalized Method of Moments (GMM), specifically the System GMM (SGMM), which is suitable for addressing endogeneity issues and the unobserved heterogeneity of banks (Arellano and Bond, 1991; Arellano and Bover, 1995).

To ensure model robustness, diagnostic tests were conducted. The Arellano-Bond test indicates no first-order autocorrelation (AR(1), p = 0.204) and no second-order autocorrelation (AR(2), p = 0.653), while the Sargan test confirms the validity of the instruments (p = 0.7984), well above the 5% significance threshold.

The empirical results show that market risk (MAR_Risk) has a positive and significant effect (β = 0.364; p = 0.023), suggesting that higher market valuation encourages banks to strengthen their risk coverage, thus confirming hypothesis H2. Interest rate risk (INT_Risk) also exhibits a positive and significant impact (β =

0.079; p = 0.018), indicating that effective management of interest rate exposure contributes to improved solvency, validating hypothesis H3. In contrast, liquidity risk (LIQ_Risk) negatively and significantly affects the Risk Coverage Ratio (β = –0.491; p = 0.027), highlighting banks' vulnerability in case of insufficient liquidity (H4 validated). Credit risk (CREDIT_Risk), although negative, is not significant (β = –0.215; p = 0.148), suggesting that its effect on solvency remains limited in this context and partially qualifying hypothesis H1.

Regarding control variables, profitability (ROA) shows a negative and significant effect (β = –1.494; p = 0.035), whereas bank size (SIZE) has a positive but marginally significant effect (β = 0.036; p = 0.093), indicating that larger banks may benefit from economies of scale and better diversification, enhancing their solvency. The constant term is not significant, implying that the variation in solvency is primarily explained by the variables included in the model.

Table 5. *Results of Generalized Method of Moments (GMM) in system*

RiskCov	Coef.	St.Err.	t-value	p-value
L	-.001	.274	-0.01	.996
CREDIT_Risk	-.215	.149	-1.45	.148
MAR_Risk	.364	.16	2.28	.023**
INT_Risk	.079	.033	2.37	.018**
LIQ_Risk	-.491	.223	-2.20	.027**
ROA	-1.494	.707	-2.11	.035**
SIZE	.036	.022	1.68	.093*
Constant	-.181	.289	-0.63	.531
AR1	1.270			
p-value	0.204			
AR2	-1.921			
p-value	0.055			
Number of obs	130			
Sargan	1.476058			
p-value	0,7984			

Note: ****, ** and * indicate level of significance at 1%, 5% and 10% respectively*
Source: *Author's calculations based on data from the banks' annual reports.*

7. Conclusion

This empirical study examined the impact of various types of bank risks — credit, market, interest rate, and liquidity — as well as control variables, namely profitability and bank size, on the Risk Coverage Ratio (RCR) of Tunisian banks. The findings reveal several key insights.

Firstly, market risk and interest rate risk have a positive and significant effect on the RCR, suggesting that banks tend to strengthen their solvency when exposed to market fluctuations or interest rate variations. In contrast, liquidity risk negatively affects the RCR, highlighting banks' vulnerability to insufficient liquidity and

emphasizing the importance of proactive liquidity risk management. Credit risk, although negative, is not significant, indicating that its impact on solvency remains limited in the Tunisian context.

Regarding the control variables, profitability (ROA) shows a negative and significant effect, which may reflect trade-offs between profitability and prudence in risk management. Bank size (SIZE) exhibits a positive but marginally significant effect, suggesting that larger banks benefit from economies of scale and better diversification, enhancing their ability to absorb risks.

Overall, these results underscore the importance of integrated risk management and appropriate prudential regulation to safeguard bank solvency against various risks. They also highlight the need for Tunisian banks to strengthen their liquidity frameworks to reduce vulnerability and ensure sustainable financial stability.

References:

Abdymomunov, A. 2013. Joint systemic risk in the financial sector. Journal of Financial Stability, 9(3), 434-445.

Adrian, T., Brunnermeier, M.K. 2010. CoVaR. Federal Reserve Bank of New York Staff Report, (348).

Allen, F., Gale, D. 2000. Financial contagion. Journal of Political Economy, 108(1), 1-33.

Anginer, D., Demirgüç-Kunt, A. 2014. Bank capital and systemic stability. Journal of Financial Stability, 13, 1-12.

Anginer, D., Demirgüç-Kunt, A. 2014. Bank capital and systemic stability. World Bank Policy Research Working Paper No. 6948. World Bank.

Bank for International Settlements (BIS). 1994. 94th Annual Report. Basel: BIS.

Bank for International Settlements (BIS). 2018. Annual economic report 2018. BIS.

Bank for International Settlements (BIS). 2019. Basel III: Finalising post-crisis reforms. Basel Committee on Banking Supervision.

Banque Centrale de Tunisie (BCT). 2016. Circulaire aux banques n°2016-02 relative au ratio de solvabilité. Tunis: BCT.

Berger, A.N., Bouwman, C.H.S. 2013. How does capital affect bank performance during financial crises? Journal of Financial Economics, 109(1), 146-176.

Bhattacharya, S., Boot, A.W.A., Thakor, A.V. 1998. The economics of bank regulation. Journal of Money, Credit, and Banking, 30(4), 745-770.

Bougatef, K., Mgadmi, N. 2016. The impact of liquidity on bank profitability: Evidence from MENA countries. International Journal of Business and Finance Research, 10(5), 79-94.

Bougatef, K., Mgadmi, N. 2016. The impact of prudential regulation on bank capital and risk-taking: The case of MENA countries. The Spanish Review of Financial Economics, 14(2), 51-56.

De Bandt, O., Hartmann, P. 2000. Systemic risk: A survey. In: C. Goodhart, G. Illing (Eds.), Financial crises, contagion, and the lender of last resort (pp. 1-42). Oxford University Press.

Demirgüç-Kunt, A., Detragiache, E. 2002. Does deposit insurance increase banking system stability? An empirical investigation. Journal of Monetary Economics, 49, 1373-1406.

Dewatripont, M., Tirole, J. 1993. The prudential regulation of banks. Cambridge, MA: MIT Press.

European Central Bank. 2004. The European Central Bank and financial stability. Frankfurt am Main: ECB.

European Central Bank. 2010. Euro system financial stability review. Frankfurt am Main: ECB.

Folkerts-Landau, D., Lindgren, C.J. 1998. Toward a framework for financial stability. Washington, International Monetary Fund.

Freixas, X., Giannini, C., Hoggarth, G., Soussa, F. 2000. Lender of last resort: What have we learned since Bagehot? Journal of Financial Services Research, 18, 63-84.

Garcia, G. 1999. Deposit insurance: A survey of actual and best practices. IMF Working Paper No. 99/54.

Garcia, M.T., Nguyen, J. 2013. Bank liquidity and financial stability. Journal of Banking Regulation, 14(2), 100-115.

Hache, F. 2012. Bale III en 5 questions : des clefs pour comprendre la réforme. Finance Watch, Square de Meeûs 38/40, 1000 Bruxelles.

Houben, A., Kakes, J. 2009. Liquidity risk management and supervision. Journal of Financial Stability, 5(3), 237-249.

Hull, J. 2007. Gestion des risques et institutions financières. Paris: Pearson Education France.

Jokipii, T., Milne, A. 2011. Bank capital buffer and risk adjustment decisions. Journal of Financial Stability, 7(3), 165-178.

Jordan, D.J., Clark, E., Smith, T. 2011. Explaining bank market-to-book ratios: Evidence from 2006-2009. Journal of Banking & Finance, 35(5), 1234-1245.

Kwan, S.H., Furlong, F.T. 2005. Market-to-book, charter value, and bank risk-taking. BIS Working Paper No. 165. Bank for International Settlements.

Laeven, L. 2002. Bank risk and deposit insurance. World Bank Economic Review, 16, 109-137.

Lehar, A. 2005. Measuring systemic risk: A risk management approach. Journal of Banking & Finance, 29(10), 2577-2603.

Li, L. 2020. Regulation of leverage ratio, credit expansion and credit risk of commercial banks. Open Journal of Social Sciences, 8(04), 376.

Li, X. 2020. Capital regulation and bank risk-taking: Evidence from emerging markets. Emerging Markets Review, 45, 100729.

Ménard, C. 2011. Économie industrielle et concurrence : Théories et applications. Paris: Éditions La Découverte.

Maraghni, H., Bouheni, F.B. 2015. Bank capital ratio, prudential regulation and liquidity risk taking: Behavior of Tunisian banks in a simultaneous approach. International Journal of Economics and Finance, 7(6), 263-278.

Maraghni, H., Rajhi, M.T. 2015. Examining the relationships between capital ratio, credit risk, capital buffer and prudential regulation in Tunisian banking. European Journal of Business and Management, 7(9), 106-122.

Modigliani, F., Miller, M.H. 1958. The cost of capital, corporation finance and the theory of investment. American Economic Review, 48(3), 261-297.

Mishkin, F.S. 1999. Global financial instability: Framework, events, issues. The Journal of Economic Perspectives, 13(4), 3-20.

Niemeyer, J. 2016. Basel III – what and why? Sveriges Riksbank Economic Review.

Obeid, H. 2021. The effect of capital adequacy on the financial stability of banks: Evidence from MENA countries. International Journal of Finance & Banking Studies, 10 (1), 10-25.

Patro, D., Qi, M., Sun, X. 2013. A simple indicator of systemic risk. Journal of Financial Stability, 9(1), 105-116.

Powell, A. 2004. Basel II and developing countries: Sailing through the sea of standards. World Bank Policy Research Working Paper No. 3387. World Bank.

Rochet, J.C. 2003. Réglementation prudentielle et discipline de marché. Revue d'économie financière, 73, 201-212.

Rochet, J.C. 2008. Le futur de la réglementation bancaire. Working Paper de l'Université de Toulouse, Working Paper No. 2 - 12/2008.

Rokhmawati, R. 2019. The impact of interest rate risk on bank performance. International Journal of Economics and Financial Issues, 9(1), 48-55.

Summers, L.H. 2003. International financial crises: Causes, prevention, and cures. American Economic Review, 93(2), 1-16.

Venard, N. 2001. Gestion des risques bancaires et réglementation prudentielle. Revue d'économie financière, 28, 49-62.