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Topic:

The Determinants of Non-Performing Loans in Tunisia

Presented and defended by :

MDIMAGH Meriam

Supervised by :

Mrs. Olfa BENOUDA

Student belonging to :

ARAB TUNISIAN BANK

ABSTRACT

The purpose of this study is to investigate the macroeconomic and microeconomic factors that contribute to non-performing loans (NPLs) in Tunisia. We discovered that, over the last sixteen years, the demand for credit in its various forms has grown exponentially, resulting in significant over-indebtedness and a real risk of destabilization. This research's empirical validation is based on a sample of ten Tunisian banks observed between 2006 and 2021. The estimation of a dynamic panel model using the GMM method allowed us to discover that macroeconomic factors such as economic growth and inflation levels, as well as microeconomic factors such as management quality, play a significant role in the increase of household bad debts in Tunisia.

Keywords: non-performing loans, Macroeconomic determinants, Bank specific determinants, Dynamic panel data.

JEL Classification: G14[1], G21[2], G32[3]

[1] G14: Information and Market Efficiency
[2] G21: Banks
[3] G32: Financing policy*Financial risk and risk management*Capital and ownership

DEDICATIONS

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SUMMARY

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GENERAL INTRODUCTION

Banks face numerous risks, such as credit risk, market risk, and operational risk. The risk of default by the counterparty to whom the loan is granted is referred to as the bank's credit risk. It is a significant issue for banks and regulatory agencies. Through financial literature, non-performing loans (NPLs) represent the bank's ex-post credit risk, while loan loss provisioning (LLP) represents the bank's ex-ante credit risk.

Exploring the factors that underpin ex-post credit risk is critical for financial authorities that seek stability and effective management for the banking sector. Hence, NPLs can be used to alert the beginning of a banking crisis, according to Louzis et al (2012), and Abid et al (2013).

Assimilating the level of NPLs, several researchers dealing with the determinants of NPLs assumed that macroeconomic or bank-specific factors were explanatory determinants. Salas and Saurina (2002), on the other hand, have combined macroeconomic and microeconomic variables in their attempts to explain the NPLs of Spanish Commercial and Savings Banks from 1985 to 1997. Their findings suggest that bank-specific determinants should be regarded as advanced warnings for future NPLs.

Notably, the majority of empirical studies looked into the impact of macroeconomic variables on NPLs. While studying household NPLs in a group of European countries, Rinaldi and Sanchis-Arellano (2006) discovered empirical evidence that discretionary expenses, monetary conditions, and unemployment all have a significant impact on NPLs.

Literature has indicated that certain bank characteristics are associated with loan problems. Berger and DeYoung (1997) highlight the link between banks' characteristics, efficiency ratios, and NPLs. They believe that potential mechanisms are worth developing. They specifically claimed that "bad management," "skimping," and "moral hazard" are all factors that promote bad loans. Berger and DeYoung (1997) and Williams (2004) discovered that a reduction in cost efficiency usually leads to an increase in future NPLs using a sample of US commercial banks from 1985 to 1994.

Similarly, Berge and Boye found that NPLs are substantially related to both real interest rates (RLR) and unemployment in a study of the Nordic banking system from 1993 to 2005 (Berge, 2007). Cifter (2009), Boss (2009), Nkusu (2011), and Segoviano (2006) are among the other studies which focused on the macroeconomic determinants of NPLs. For example, Boss et al.

investigated the relationship between credit risks and the business cycle when dealing with the major Austrian corporate sectors (Boss, 2009).

Podpiera and Weill discovered a negative link between cost efficiency and NPLs while studying the link between efficiency and bad loans in the Czech banking industry from 1994 to 2005 (Podpiera J. a., 2008). In China's banking system, some researchers, have demonstrated that incentive contracts have a positive impact on NPL management (K.Ng, 2013).

In Tunisia's case, it is classified among the countries characterized by relatively high credit risk, with a rate of 13.3% in 2021. Many international organizations and rating agencies such as Fitch Ratings, state that Tunisian banks have a not-so-reassuring and sometimes ineffective management risk strategy, which leads to the deterioration of credit institutions' profitability and the fragility of the Tunisian banking system.

It is in this context that the theme of this research work is defined. Our problem is to investigate the macroeconomic and bank-specific factors that can affect and influence non-performing loans at the credit institution level for a sample of Tunisian banks. Several works have focused on assessing credit risk ex-ante, from the perspective of borrowers or individual credit transactions. However, we are interested in loan ex-post losses.

As a result, the current study has two primary goals. The first goal is to gain theoretical knowledge of NPLs, we suggest knowing the component that explains the quality of the bank's loans to supervise them. The second goal is to examine Tunisian reality, because previous studies have primarily focused on developed countries, leading us to question Tunisia's case in such an unstable financial environment. Indeed, identifying the determinants of the risk in Tunisian banks will allow us to assess the effectiveness of credit policies in the banks. As a result, this research can help other developing countries take the necessary steps to clean up their banking sectors.

Thus, this study aims first of all to explore the factors that influence NPLs, specifically the macroeconomic and bank-specific variables that influence NPLs using the Tunisian banking system as a model. The former is referred to as systematic factors, while the latter is referred to as idiosyncratic factors. As a result, we intend to take into account both the economic setting and the major banking characteristics influencing NPLs.

On a methodological extent, we attempted to create an empirical model following (Abid, 2013) and (Louzis D. P, 2012) that included both macroeconomic and bank-specific variables. The current study employs a panel data set of ten Tunisian banks from 2006 to 2021.

Ergo, this dissertation is organized as follows. The first chapter examines a review of credit risk management and banking concepts including financial and non-financial risks. The second chapter then inspects the non-performing loans concept, context, and definition of the possible determinants of NPLs. It also displays the hypotheses of the link that these variables have with non-performing loans. Finally, the third chapter presents the econometric model used and discusses, the data, methodology, empirical results, and findings related to the theoretical section on the determinants of bad debts.

FIRST CHAPTER

CREDIT RISK MANAGEMENT AND BANKING RISK CONCEPTS

CHAPTER I: CREDIT RISK MANAGEMENT AND BANKING RISK CONCEPTS:

Introduction

It is unattainable for a bank not to take risks in its operations, especially as the economy grows. However, the risk varies from bank to bank, depending on the bank's management. Risks have multiplied with the development of various banking activities, particularly risks related to granted credits or insolvency risks, putting the banking business and its efficiency at risk.

Credit risk is a risk associated with the banking industry, it is the risk of loss associated with a borrower's failure to repay its debts (bonds, bank loans, trade receivables, etc.). This risk is divided into three categories: default risk, which arises when the borrower fails or delays in paying the principal and/or interest on its debt, recovery rate risk in the event of default, and credit portfolio quality risk.

Because all credit is an anticipation of future revenues, regulatory authorities and the bank's management bodies, including executives and account managers, are focused on credit risk. As a result, any credit that does not generate revenue results in a loss for the bank.

Thus, the goal of this first chapter is to present the main risks associated with banking activity, then we will focus on credit risk and the impact it can have on the bank's results, and finally the importance of credit management while imposing standards and prudential regulations to follow.

To this end, this chapter is divided into two sections as follows, the first section examines banking risks concepts and classification. Then, the second section discusses credit risk management and prudential regulations on the subject.

SECTION 1: BANKING RISKS CONCEPTS

I. BANKING RISKS DEFINITION

A risk can be defined as an uncertain but possible event that could result in some losses. The risk stems from uncertainty, specifically the ambiguity about the discrepancy from the preferred outcome. It is viewed as a concept that arises when a decision maker can identify potential trends and even their likelihood but fails to predict which of these developments will occur (Tileagă.C, 2013).

In the financial sphere as a whole, but especially in the banking system, risk only entails negative deviations from the presumed or desired outcomes and is affiliated with the likelihood of a loss, whereas favorable deviations are regarded as opportunities. The risk associated with banking activity occurs in any operations, transactions, or decisions that have an uncertain outcome. Because all of their banking operations involve some level of uncertainty, all of their banking operations contribute to a bank's overall risk.

In the literature, banking risks are specifically associated with financial risks. Given the nature of their activities, banks are the first and most affected by deteriorating economic and financial conditions in the countries in which they operate.

A Banking risk is defined as an event that occurs during the course of banking operations and harms these activities through asset quality deterioration, reduced profits, or even loss registration, all of which have an impact on the bank's functionality. Banking risk can arise from either internal or external influences, and given the potential for unanticipated costs, risk management activities are of particular interest to banks, (Cocri·, 2009).

Banking risk encompasses both financial and bank-specific risk categories as well as non-financial risks that affect all entities no matter their area of activity.

II. BANKING RISKS CLASSIFICATION

When compared to other types of businesses, the banking industry is significantly more vulnerable to risks, particularly in this ever-changing competitive environment. Banks are no longer simply accepting deposits and making loans. Instead, they work in a rapidly evolving industry with high-profit pressure, which drives them to develop more and more value-added services to offer and to better satisfy customers. Risks have become much more complex as a single activity can involve multiple risks.

1. Financial risks

1.1.Credit risk

While financial institutions have encountered difficulties for a range of causes over the years, the main source of serious banking problems remains the loose lending standards for debtors and counterparties, poor portfolio risk management, or inability to pay attention to shifts in the economy or other scenarios that ultimately led to a worsening in the credit standing of a bank's counterparties.

Credit risk is the risk that a bank borrower will struggle to meet its commitment according to the terms set. Credit risk management aims to maximize a bank's risk-adjusted rate of return by limiting credit risk exposure. Banks should manage both their portfolio's total credit risk and the risk inherent in individual credits or transactions. They should also consider the relationship between credit risk and other risks. Credit risk management is a critical part of a comprehensive risk management strategy and is essential to any financial organization's success.

For most banks, loans are the most significant and obvious source of credit risk. Therefore, the possibility of a loss due to a borrower's failure to repay a loan or meet contractual obligations is referred to as credit risk. It traditionally entails the chance that a lender will not receive the owed principal and interest, resulting in a disruption in cash flows and increased collection costs. Excess cash flows can be written to provide additional credit risk protection. When a lender faces increased credit risk, it can be mitigated by offering a higher coupon rate, which results in higher cash flows.

Although it is impossible to predict who will fail to meet their obligations, properly assessing and managing credit risk can reduce the severity of a loss. Interest payments from a debt obligation's borrower or issuer are a lender's or investor's reward for taking on credit risk.

However, other sources of credit risk exist throughout a bank's operations, including in the banking and trading books, and both on and off the balance sheet. Banks are increasingly exposed to credit risk in financial instruments other than loans, such as acceptances, interbank transactions, trade financing, foreign exchange transactions, financial futures, swaps, bonds, equities, options, and the extension and settlement of commitments and guarantees.

1.2.Market risk

The systematic or unavoidable risk is associated with market factors that affect all businesses and cannot be eliminated through diversification. War, unexpected inflation, negative

international events, political events, interest rate risk, inflation risk, and other factors all contribute to it (Fisher D.E, 1991). Market risk, in other words, is the likelihood of a danger associated with uncertainty in a financial institution's portfolio (investment in a variety of securities) income as a result of a change or fluctuation in the market condition regarding factors such as asset price, interest rate, market liquidity, and so on (Dowd, 1998).

Market risk is defined by the Basel Committee as "*the risk of loss on on-balance-sheet and off-balance-sheet positions as a result of changes in market prices, including risks related to interest rate instruments and trading book securities*."

Therefore, the Market risk is primarily caused by a bank's activities in capital markets. It's because equity markets, commodity prices, interest rates, and credit spreads are all unpredictable. Banks are more vulnerable if they are heavily involved in capital market investing or sales and trading.

1.3.Liquidity risk

Liquidity risk refers to a bank's ability to access cash to meet funding commitments. Among the commitments is to allow customers to withdraw their deposits. Failure to provide cash to customers on time can have a domino effect. If a bank delays providing cash to customers for a day, other depositors may hurry and withdraw their deposits as they lose confidence in the bank. This further decreases the bank's ability to provide funds, resulting in a bank run.

Banks face liquidity problems due to an overreliance on short-term funding sources, a balance sheet concentrated in illiquid assets, and customer lack of trust in the bank. Mismanaging asset-liability duration can also cause funding issues. When a bank has a sizable number of short-term liabilities but insufficient short-term assets, this occurs. If a bank's assets are entirely or primarily tethered to long-term loans or investments, the bank may suffer from an asset-liability duration mismatch.

There are rules in place to help with liquidity problems. They provide a requirement that banks hold sufficient liquid assets on hand to survive a certain period of time even if no other resources are injected.

1.4.Solvency risk

When the value of all of a bank's assets, regardless of maturity, is less than the value of all of its liabilities, the bank is insolvent. This risk refers to a lack of equity capital to absorb the bank's potential losses, which could lead to insolvency and the bank's inability to honor its

obligations to depositors and other creditors.

In general, this risk is caused not only by a lack of capital, but also by the occurrence of one or more risks that the bank could not prevent. Banks' exposure to this type of risk can jeopardize their operations, so the goal sought by financial institutions is to try to adjust capital to risks in order to cope with this type of insolvency risk.

2. Non-Financial risks

2.1.Operational risk

In the banking industry, operational risk is not a novel concept. Since the beginning of banking, there have been risks associated with operational mistakes caused by factors such as processing errors, internal and external fraud, law suits, and business disruptions. One of the major challenges in systematically managing these types of risks, as this article will discuss, is that operational losses can be quite diverse in nature and highly unpredictable in their overall financial impact.

The Basel Committee on Banking Supervision established the following definition as part of the revised Basel framework: *"Operational risk is defined as the risk of loss resulting from inadequate or failed internal processes, people, and systems or from external events. This definition includes legal risk, but excludes strategic and reputational risk."* (Bank for International Settlements)

To mitigate various aspects of operational risk, historically, banks have depended on suitable internal operations, operational audits, insurance coverage, and other risk management techniques. These tools remain critical; however, the banking industry's increasing complexity, Numerous vast and highly circulated operational losses in recent years, as well as a changing regulatory capital regime, have led both banks and banking regulators to perceive operational risk management as an evolving discipline. The application of quantitative notions similar to those used to asses credit and market risks to operational risk measurement is especially remarkable.

Because of its broadness, the definition of operational risk is constantly evolving. Before delving into the definition, it is essential to comprehend that operational risk exists in all aspects of an organization's operations. As a byproduct, some of the early practitioners classified operational risk as any risk origin that is not covered by market or credit risk. However, this definition of operational risk includes several other risks that banks manage and does not lend itself to the management of operational risk per se.

2.2.Strategic risks

These risks, unlike the previous ones, are not discussed by the Basel Committee. They are primarily related to decisions made by the bank's decision-making bodies that may result in an unanticipated economic loss.

These strategic decisions can take various forms, including decisions to restructure, reduce staff, hire, establish regional operations (including the opening and closing of branches, bank subsidiaries, and so on), internationalize, form alliances or partnerships, merge and acquire, outsource, and diversify (investments in new banking products, businesses, markets, equipment, projects, assets, etc.). Thus, strategic risks encompass all events that may jeopardize the achievement of strategic objectives.

Strategic risks may also be associated with commercial risks arising from potential staff departure to competitors, the concentration of activities on a single product or a limited number of clients, or reputational risk to the bank. If these risks materialize, the bank's image and reputation will be harmed, affecting its profitability. These risks necessitate special handling, and their management is not part of the balance sheet management tasks.

SECTION 2: CREDIT RISK MANAGEMENT AND PRUDENTIAL REGULATION

Credit institutions must constantly assess their risk and profit positions. Apart from expected performance and the goal of optimizing the risk-profit relationship, risk management has no meaning. Risk management should be sought as some profitability indicators to be kept within certain constraints (Nagy, 2013).

Risk management is one of the most important sources of surplus value creation at a bank, with the primary goal of preventing or avoiding bankruptcy and financial difficulties.

I. CREDIT RISK MANAGEMENT

1. Credit risk management definition

Banks are an important part of the financial market, and their actions can have instant consequences for their country's financial health. The world has witnessed a number of crises that began with banks and dispersed to the entire financial sector, most notably the 2008 economic downturn. The need for a viable risk management system in banks, as well as a secure banking sector, is now more pressing than ever.

As a result, risk management entails the following actions: risk detection and analysis, risk eradication and risk monitoring, risk assessment and risk-taking, and finally risk financing via risk coverage or risk transfer.

Ergo, the bank's risk tactic is founded on a series of risk policy principles that encompass all of the bank's risk-management guidelines. Banks must be aware of the risks associated with their daily operations as well as the achievement of their strategic objectives. Banks believe that effective risk management is critical to achieving strategic goals and consistently providing quality benefits to shareholders. In this context, a significant risk-management plan establishes a method for identifying, assessing, tracking and controlling these risks in order to maintain them at reasonable levels based on the bank's risk aversion and capacity to cover these risks.

Credit risk management in a bank thus entails operations designed to reduce the risk of toxic debt exposure and its occurrence. Lending activities are an important part of a commercial bank's products and services. According to a study on a banking risk analysis, because loans are the largest and most visible source of credit risk, this aspect of risk management typically accounts for more than 70% of a bank's balance sheet (Van Greuning, 2009). Credit risk is thus

a major threat that must be effectively managed and investigated. Banks should screen and monitor loan applicants to ensure that only the most creditworthy borrowers are funded.

2. Credit risk management techniques

In order to inquire about the credit risk management techniques in the banking industry, a study was conducted on the credit management highway to success and proposed several models used by banks in their efforts to improve credit management (Abedi, 2002). Credit scoring models, linear probability models, linear discriminant models, risk-adjusted return on capital, option pricing theory models, and Neural networks (Saunders, 2008).

For instance, **Credit scoring models** are among the techniques used to assess borrowers' creditworthiness. The mathematical or statistical process of converting data about prospective applicant characteristics on delinquencies and defaults is referred to as credit scoring (Mester, 1997). The credit scoring model produces a scorecard that enables you to examine historical data on previous loan performance to determine which borrower characteristics are useful in predicting whether the loan performed well. A well-designed model should assign a high percentage of high scores to borrowers whose loans are likely to perform well, and vice versa.

Linear probability models use past data as inputs into a model, such as accounting ratios, to explain repayment history. To forecast new loan probabilities, the relative importance of the factors used to explain past repayment performance is used. Based on their observed characteristics, linear discriminant models categorize borrowers as low or high default risk. It generates a score that distinguishes good from bad loans.

Risk-adjusted return on capital models assesses whether or not the bank is providing sufficient risk remuneration and whether or not the bank is providing value added to shareholders through its participation in business.

Models of **option pricing theory** begin with the assertion that a borrower's limited liability is analogous to a put option written on the borrower's assets with a strike price equal to the outstanding debt value. The borrower may default if the value of its assets falls below the value of its outstanding debt in the future. This model calculates the likelihood of a firm defaulting based on a prediction of the firm's asset price volatility, which is typically based on the observed volatility of the firm's equity prices.

Neural networks are artificial intelligence algorithms that use the experience to learn the relationship between borrower characteristics and the likelihood of default and to determine which characteristics are not important in predicting default. This method is more flexible than

standard statistical techniques because no assumptions are made about the functional form of the relationship between characteristics and default probability, or about the distribution of variables, model errors, or correlation among the characteristics.

II. PRUDENTIAL SUPERVISION

1. International prudential regulation

The Basel Committee, established in 1974 by the ten major industrialized countries, is responsible for strengthening the global financial system's soundness, as well as the effectiveness of prudential supervision and cooperation among banking regulators. It now brings together supervisors from 28 different countries or jurisdictions (Argentina, Australia, Belgium, Brazil, Canada, China, European Union, France, Germany, Hong Kong, India, Indonesia, Italy, Japan, Luxembourg, Mexico, Netherlands, Russia, Saudi Arabia, Singapore, South Africa, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States).

This committee creates rules, recommendations, and best practices that serve as the standard in the field of banking supervision known as the Basel Accords. These Accords, issued by the Basel Committee on Bank Supervision, are the most well-known international regulation. Basel III is currently in use as the successor to Basel II in preparation to implement Basel IV.

Since the creation of the Basel Committee, because of multiple crises that hit the banking system the committee concluded that the credit risk required more focus. The Committee's first large-scale project resulted in the publication, in 1988, of an agreement on an international solvency ratio known as the "Cooke ratio," after its instigator.

The Committee's first large-scale project resulted in the publication, in 1988, of an agreement on an international solvency ratio known as the "Cooke ratio," after its instigator.

Equation 1: The Solvency Ratio

$$Ratio\ Cooke\ or\ solvency\ ratio = \frac{Equity}{weighted\ risks} = \frac{Equity}{Credit\ risk + Market\ risk} > 8\%$$

This ratio is at the heart of the "Basel 1" agreements and is a fundamental component of banking regulation: each risk must include a certain amount of capital to ensure market security and minimize systemic risks by avoiding the "domino effect". This ratio used to only consider the credit risk until the Barings scandal in 1995 that drove The Basel Committee to amend the Cooke ratio in 1996 and take into account market risks and open the possibility of using internal models to calculate regulatory capital for these risks.

In view of the fact of the complex changes in the banking business, the Basel committee required a thorough review of the regulatory framework that the 1988 Basel accord was deemed insufficient since its conception of the banking risks was too narrow, as it is limited to credit risk and market risks, and the measure of risk was insufficiently refined in view of the fact of the uniform weighting of companies at 100%, even if they had all the guarantees and were well rated, whereas certain OECD countries, even though weighted at 0%, could prove risky. Also, Basel I had a rigid weighting grid that does not take into account risk reduction techniques based on guarantees.

The Committee decided then to propose Basel II. In the context of credit risk management, Basel II's overreaching goal was adequate bank capitalization and best practice risk management to strengthen the banking system's stability via "three pillars": minimum capital requirements, supervisory review, and market discipline (Crouhy, et al. 2006).

The first pillar added on the Cooke Ratio by the McDonough Ratio by including the operational risk to the weighted risks that must be covered by the bank's equity:

Equation 2: The McDonough Ratio

$$McDonough\ Ratio = \frac{Regulatory\ capital\ (Tier\ 1 + Tier\ 2 + Tier\ 3)}{Credit\ risk + Market\ risk + Operational\ risk} \geq 8\%$$

The Basel II regulatory capital consists of:

- Tier 1 capital is the primary regulatory measure of a bank's financial strength. It is made up of core capital (common stock and disclosed reserves), as well as non-redeemable, non-cumulative preferred stock. Banks are required to hold 4% of Tier 1 capital, with a minimum core capital ratio of 2%.
- Tier 2 capital is regarded as the second most reliable form of capital by regulators. It consists of capital that is redeemable at a future date or that is difficult to value such as undisclosed reserves, revaluation reserves, general provisions, hybrid instruments, and subordinated term debt are all included (with a minimum maturity of five years).
- Tier 3 capital is made up of subordinated debt. This capital may only be used by a bank to cover market risk.

As for the risk-weighted assets, they are all of the bank's assets that are weighted for credit risk according to a formula determined by the regulator (e.g., commercial loans are 100% weighted, residential mortgages are 50% weighted, some other assets are 20% weighted, and so on).

Credit risk management plans should be implemented in tandem with sound practices for assessing asset quality, adequacy of provisions and reserves, and credit risk disclosure, according to Basel II. It also mandates full disclosure of credit history, independent credit analysis, legal consideration, sharing credit information among agents, and prompt problem resolution.

To better assess credit risk and broaden the scope of risks, Basel II put forward the standard approach which gives the possibility of measuring the risk of the counterparty by the ratings allocated by the rating agencies, and the internal systems which are more elaborate as they are based on the banks' own data and must be authorized by the supervisors.

As for Basel III, right after the subprime mortgage meltdown and global financial crisis of 2007-2008, it was determined that the risk-mitigation measures of Basel I and II were insufficient, and the committee began work on Basel III. It was launched in 2009 and was supposed to start in 2015, but the deadline has been pushed back several times and is now set for January 1, 2023, in the wake of the global COVID-19 pandemic, though certain provisions are already in effect in some countries. Basel III increased the Tier 1 capital requirement from 4% to 6%, while also requiring banks to maintain additional buffers, raising the total capital requirement up to 13%.

Basel III also introduced new leverage and liquidity requirements aimed at protecting banks from excessive and risky lending while ensuring adequate liquidity during times of financial stress. It specifically established a leverage ratio for so-called "globally systemically important banks." The ratio is calculated as Tier 1 capital divided by total assets of the bank, with a minimum ratio requirement of 3%.

Equation 3: The Leverage Ratio

$$Leverage\ ratio = \frac{Tier\ 1\ Capital}{Total\ exposure} \geq 3\%$$

Furthermore, Basel III established several liquidity-related rules. The liquidity coverage ratio, for example, requires banks to maintain a "sufficient reserve of high-quality liquid assets (HQLA) to allow them to survive a period of significant liquidity stress lasting 30 calendar days." HQLA refers to assets that can be quickly converted into cash with no significant loss in value.

Equation 4: The Liquidity Coverage Ratio

$$Liquidity\ Coverage\ Ratio = \frac{High\ quality\ liquid\ assets}{Total\ net\ liquidity\ outflows\ over\ 30\ days} \geq 100\%$$

Another liquidity-related provision is the net stable funding (NSF) ratio, which compares the bank's "available stable funding" (basically capital and liabilities with a time horizon of more than one year) with the amount of stable funding that it is required to hold based on its assets' liquidity, outstanding maturities, and risk level. The NSF ratio of a bank must be at least 100%. This rule's goal is to create "incentives for banks to fund their activities with more stable sources of funding on an ongoing basis" rather than load up their balance sheets with "relatively cheap and abundant short-term wholesale funding."

Equation 5: The Net Stable Funding Ratio

$$NSFR = \frac{Available\ amount\ of\ stable\ funding}{Required\ amount\ of\ stable\ funding} \geq 100\%$$

Basel III should result in a more secure financial system while only slightly limiting future economic growth. The impact on investors is likely to be varied, but Basel III should result in safer markets for bond investors and more stability for stock market investors. A better understanding of Basel III regulations will help investors understand the financial sector in the future, as well as form macroeconomic opinions on the stability of the international financial system and the global economy.

Many countries have already adhered to their Basel III operations. However, most developing countries, are still working to implement it. In such cases, central banks play an important role in issuing nationwide control policies, guiding banks in their implementation, and monitoring banks' performance.

2. National prudential regulation

Since 1987, the Tunisian banking and financial system has undergone various structural and cyclical changes, including the implementation of a structural adjustment plan aimed at shifting the economy away from bank financing and toward financial market financing, as well as the improvement and modernization of banking activity to create an efficient and competitive system.

At this stage, and in this unstable international environment marked by crises, the Tunisian banking system may be the victim of these external shocks, making it fragile, prompting supervisory authorities to implement measures that may appear to be the perfect solution at the time but later negatively impact the system.

As the global banking landscape has evolved, the restructuring of the Tunisian banking system has become a necessity in this global movement. As a result, the Tunisian banking system implemented multiple measures brought about by these global-scale changes.

The purpose of these measures was mainly the liberalization of the banking activity in Tunisia which was justified by the administration of a set of prudential rules that must prevail in terms of risk division and coverage, as well as a loans classification system based on increasing degrees of insolvency.

These prudential rules were established by Circular N° 91-24 of 17/12/91, which was later modified through the circulars N° 99-04 of 19/03/99, N° 2012-09 of 29/06/12, N°2021-01of 11/01/21 and N°2022-02 of 04/03/22.

By way of these circulars, the CBT targeted all risk management measures as the division and coverage of risks, the monitoring of commitments and asset classification, the accounting of interest and revenue, the creation and reversal of provisions, the provisioning of overdrafts and the arrangement rescheduling or consolidation of loans.

And through the banking circular N°. 2022-02 for the purpose of redefining the establishment of provisions for both classes of performing loans as in class 0 and 1, by following the guidelines of the Basel III accord and creating collective provisions calculated following a methodology prescribed in the circular.

As for following international regulations, The CBT has been engaged, since 2014, in a process of prudential reforms aiming at the convergence towards the Basel standards through the implementation of the Basel liquidity ratio LCR, capital requirements to cover operational risk and market risks, and the publication of a circular putting the responsibility of Banks and Financial Institutions to develop internal rating systems of counterparties.

The years 2019-2020 have been devoted to the completion of pillars 1 and 2 of Basel 2 through the progress in the project of the revision of the approach of calculation of the credit risk, the project of the passage of the prudential framework of the equity capital from a social basis to a consolidated basis, the implementation of an internal economic capital assessment and allocation process "ICAAP", the implementation of a process for measuring and managing the overall interest rate risk in the banking book "IRRBB", and the revision of the supervision process in order to fully comply with the 29 Basel core principles for effective supervision.

As for the Covid-19 pandemic framework, the CBT has continued to work for the completion of Basel II's 1st Pillar, starting with a project for supervision on a consolidated basis: The project

of implementation of supervision on a consolidated basis is a structuring project which is inserted within the framework of the five-year action plan of the banking supervision "2016-2020".

The implementation of supervision on a consolidated basis **aims to** adequately monitor the risk profile of banks and financial institutions that develop subsidiaries or associated institutions on a national and international scale. It also takes into account all the risks incurred by the entities belonging to the group in order to contain the risk of contagion. It establishes prudential rules adapted to the size and complexity of the activities carried out within the groups to preserve their financial soundness. And finally, aims to strengthen the role of the CBT as a supervisor in the case where a bank or financial institution under Tunisian law has subsidiaries located abroad that are supervised by foreign supervisory authorities.

These choices have been made by reference to international regulations and taking into account the specificities of the Tunisian context. In light of this, a circular on the definition of the prudential scope of consolidation and the methods of consolidation under prudential scope is being finalized.

As for the IFRS, the migration of Tunisia to these standards in this difficult context related to the health crisis represents a major challenge and is a structuring project for the financial system.

According to the national prudential regulations for credit risk management, credit institutions must have a procedure for selecting credit risks as well as a system for measuring these risks that allows them to centrally identify their balance sheet and off-balance-sheet risks, understand the different categories of risk levels based on qualitative and quantitative information, make global breakdowns of their commitments and identify individuals with ties to the credit institution.

Concerning the non-performing loans problem in Tunisia intensified by the global pandemic, the Central Bank published on March 1st 2022, the banking circular N°. 2022-01 that was addressed to banks and financial institutions, in order to highlight the importance of the prevention and resolution of non-performing loans.

The said circular provides, in particular, the obligation for banks and financial institutions to:

1. Systematically assess the viability of the debtors' situation throughout the life cycle of the loan through an economic and financial analysis based on:

- Their certified financial statements for the last three years and the certified consolidated financial statements in the case of business groups must include at least an analysis of the following two financial indicators: Financial expense coverage ratio (EBITDA/Financial expense) and leverage ratio (Debt/EBITDA).
- Their business plans, cash flow projections, current global debt level and solvency assessment. These plans must be reviewed by a Chartered Accountant, registered with the national accountants' Order, for debtors with a global commitment to the financial system that exceeds 25 million dinars.

2. For public or private sector debtors (large exposures) with a commitment to the financial sector totaling more than 100 million dinars, require an annual report on the governance, activity, performance, liquidity, solvency, and, if applicable, the relationships between the entities of the business group. A chartered accountant licensed by the Order of Chartered Accountants of Tunisia is required to review this report.
3. Within a period of not more than five years beginning in 2022, lower the percentage of gross non-performing commitments to less than 7% for commitments on an individual basis and 10% when accounting for commitments transferred to their collecting subsidiaries.
4. To remove from their balance accounts any receivables with a classification of 4 that have been outstanding for five years or longer and satisfy the requirements for write-off set forth by the applicable tax legislation.

SECOND CHAPTER

NON-PERFORMING LOANS CONCEPT, CONTEXT, AND DETERMINANTS

CHAPTER II: NON-PERFORMING LOANS CONCEPT, CONTEXT, AND DETERMINANTS

Introduction

As aforementioned in the first chapter, credit risk is a risk associated with the banking industry, it is the risk of loss associated with a borrower's failure to repay its debts. This risk is divided into three categories: default risk, which occurs when a borrower fails to pay the principal and/or interest on its debt, recovery risk in the event of default, and risk of deterioration in the credit portfolio's quality.

In consequence, credit risk is approximated in the financial literature by the amount or rate of non-performing loans (NPLs). Non-performing loans are an indicator of asset quality and provide insight into the effectiveness of banks' credit policies.

In this context, the goal of this work is to investigate the factors that explain the quality of the bank's loans in order to supervise them. This chapter is divided into two sections. In the first section, we introduce the concept of non-performing loans by providing some definitions for it, and a few related theories. We then emphasize its significance by presenting the NPLs' evolution in Tunisia and a sample of similar countries. In the second section, given the abundance of recent empirical work aimed at studying the determinants of credit risk, will include a summary of the empirical literature review while studying each determinant as well as the hypothesis related to these variables.

SECTION 1: NON-PERFORMING LOANS CONCEPT

I. NON-PERFORMING LOANS DEFINITION AND RELATED THEORIES

1. Non-performing loans definition

A non-performing loan (NPL) is one for which the borrower is in default and has missed delivering the required principal and interest payments on a regular basis for a set period of time. Non-performing loans occur when borrowers are unable to continue making loan payments because they either run out of money or find themselves in challenging circumstances.

The widely accepted threshold for classifying a loan as nonperforming, according to the BCBS, is when loan obligations are more than 90 days past due. Multilateral organizations define non-performance in a similar way. The BCBS defines default as follows: "*a default is considered to have occurred with regard to a particular obligor when either or both of the following events have occurred: I the bank considers that the obligor is unlikely to pay its credit obligations to the banking group in full, without recourse by the bank to actions such as realizing security; and (ii) the obligor is past due on any material credit obligation for more than 90 days* (Basel Committee on Banking Supervision)." The IMF's Financial Soundness Indicators (FSIs), which are widely used for cross-country comparison, also define a loan as nonperforming if the principal or interest is more than 90 days past due.

The criteria would present difficulties for balloon payment loans or overdraft-type credits based solely on the number of days past due. Additionally, even if the loan is not yet past due, information indicating that the borrower is likely to default may be available. A loan is considered nonperforming when the likelihood of full repayment is low, or when the loan is in default or is highly likely to default. The number of days past due, as well as the borrower's overall financial performance/creditworthiness, are thus criteria for determining whether a loan is nonperforming, and are sometimes combined with collateral assessment.

However, it should be noted that in order to establish a specific number of days as a criterion for classifying a loan as nonperforming, countries must carefully evaluate local practices and characteristics, which may differ from portfolio to portfolio. Even when counting days past due, there can be discrepancies because borrowers are usually given grace periods, and the first day past due is not always the first day the payment was due.

The following scenarios are examples of how a loan can become non-performing, according to the International Monetary Fund (IMF):

- Principal and interest loan installments are at least 90 days overdue, and the lender has lost faith in the borrowers' ability to pay back their debt. In this instance, the lender records the loan as a bad debt in its books of accounts.
- Changes in the Loan Agreement shall result in the capitalization, refinancing, or postponement of interest payments for a period of ninety (90) days. If less than 90 days have passed since the principal and interest payments were due, and there are grounds for skepticism that the borrower will fail to repay the outstanding loan in full.

When explaining NPLs we immediately think of ex-post credit risk and banks' exposure to this risk. Credit risk is inherent in the banking industry because making loans always carries the risk that they will not be repaid which will then turn them into non-performing loans.

2. Related theories on NPLs

NPLs have become one of the main worries for both banks and regulatory bodies as a result of the recent financial crisis and recession. At this time, it is important to mention the most important NPL studies that have been published. The effect of macroeconomic factors on NPL levels has been researched by numerous writers, including (Anjom, 2016), (Turan, 2014), (Çeliku, 2003), (Clichici, 2014), (Kurumi, 2017), and (Hanifan, 2017). They demonstrate a connection between macroeconomic issues and particular bank characteristics for NPLs in developing nations.

In a study of 20 banks listed on the Indonesia Stock Exchange (IDX) between Q1 2005 and Q4 2014, (Hanifan, 2017) found that the ratio of operations expenses to operating income and return on equity (ROE), as well as GDP growth and inflation, have a significant positive relationship with NPLs.

In the same context, the Granger-causality approaches were used to examine a sample of 278 banks in nine transition nations from 1995 to 2002 and investigate the associations between NPLs, loan quality, cost-effectiveness, and bank capital (Rossi, 2005). They discovered that declines in cost-effectiveness typically occur after increases in NPLs.

Other studies found that there was a negative correlation between NPLs and economic growth and that it is the leading economic variable that affects the NPLs ratios in their study of banks operating in the countries of Central, Eastern, and Southeast Europe (Jakubik, 2013).

On another note, in order to ascertain the connection between NPLs and bank balance sheet effects, a study found that, in the majority of situations, banking profitability occurred before

or concurrently with public debt crises (Erdogdu, 2015). The pressure of increased credit risk must be overcome by banks, and the ratio of non-performing loans is trending upward.

However, Credit expansion is a reliable sign of stability in the banking industry. Consequently, interest in credit growth rates is shared by central banks, academics, and investors (Jakubik P., 2015).

In addition, as a whole, NPLs constitute a significant input risk. Additionally, it is recognized as a harbinger of impending losses for the banking sector (Vouldis, 2016). According to this perspective, lowering the number of NPLs is a requirement for the economy to become better. Resources are locked up in unprofitable industries if non-performing loans are continued and constantly renewed, which impedes economic progress and reduces economic efficiency (Jolevska, 2015).

Bank credit trends also allow the forecasting of future economic conditions, where an increase in credit supply may precipitate subsequent financial or economic crises, whereas a significant decrease in credit may result in a contraction of economic activities (Awdeh, 2017).

In order to investigate the role of regulatory and risk management strategies in the reduction of NPLs, Erdinç and Gurov used GMM estimation methods on a panel data of banks from the Eurozone and emerging European countries from 2000 to 2011 to examine theses banks' compliance with the Basel Accord, Internal Ratings Based Approach (IRB). According to their findings, implementing the IRB had a major influence on the decrease of NPLs. Furthermore, they claim that the countries in the Eurozone adopted the IRB approach more than the emerging European countries, resulting in a significant increase in the level of NPLs. (Erdinç, 2016)

In a current study led by Abid et al., they have adopted dynamic panel data using GMM estimated on 16 Tunisian banks from 2003 to 2012 in an attempt to address the determinants of NPLs in the Tunisian banking sector. Their results indicate that macroeconomic variables, specifically the real GDP growth rate, inflation rate, and RLR, have an impact on the level of NPLs. As for the bank-specific variables, such as ROE and Inefficiency when included in the model, they gain additional explanatory power. These variables support the hypothesis that these indicators are related to management quality. (Abid, 2013)

As a result, their findings are important in terms of establishing regulatory policies. Furthermore, it was demonstrated that performance and inefficiency measures are considered key indicators of future NPLs. According to this study, authorities should assert the management's performance in order to mitigate potential increases in NPLs. Also, in order to

prevent future financial instability, regulators should consider risk management systems and bank procedures.

Therefore, national and international authorities, recommend the implementation of a rigorous governance policy. They also recommend resolving management issues at banks in order to decrease NPLs which are a risk factor in the financial system.

Understandably, as a conclusion to this study, these relationships can be applied for the purposes of forecasting and stress testing for both banks and regulators.

II. AN OVERVIEW OF THE INTERNATIONAL AND TUNISIAN CONTEXT

1. The international context

The COVID-19 pandemic has originated an economic crisis on a scale never seen before. According to the OECD 2020 Economic Outlook, both the pandemic's outlook and the path to economic recovery are highly uncertain. The OECD warned that it could have been a global recession bigger than the Great Depression if it wasn't for the measures taken to limit contagion, prevent subsequent waves of the virus, and support national economies. Nonetheless, the persistent uncertainty about the severity of the crisis and the prospects for economic recovery raised concerns about the banking sector's potential reaction.

Banking systems were better capitalized and liquid at the start of the COVID-19 crisis than in previous crises. However, flaws are visible in a number of areas. A number of banks continue to suffer from low valuations, low profitability, and high levels of non-performing assets, particularly in some parts of the world. Regardless of the crisis, weaknesses such as low interest margins may be exacerbated by the low-interest rate environment and flat yield curves that will likely continue in many jurisdictions (Patalano, 2020). Furthermore, a prolonged and severe disruption could result in a significant increase in NPLs due to increased defaults, forcing banks to increase their LLPs and deductions. Particularly, the decline in asset quality and earnings potentials may limit banks' ability to absorb greater loan losses.

NPL accumulation is a common feature of financial crises. Recent examples include multiple European countries, as well as the United States, following the GFC. The risk of a vicious circle of low asset quality, low bank profit, pressure on capital levels, and constrained lending, all of which have a negative impact on growth, can exacerbate the NPL problem, highlighting the importance of NPLs for macroeconomic and financial stability. Significant realized losses by banks on NPLs, combined with high leverage and weak economic conditions, may require the use of resolution instruments and possibly government-backed solutions in many cases.

Notably, following the Global Financial Crisis, several European jurisdictions implemented solutions to repair balance sheets impacted by high levels of NPLs. Over the period 2014-2019, EUR 700 billion in NPLs were sold in Europe to a slew of distraught asset managers and investment banks (Deloitte, 2019). Because of these factors, it is critical to understand the macro and micro determinants of NPLs under various scenarios.

After the introduction of the Basel III accords with higher minimum capital and liquidity requirements, many OECD countries' banking institutions have become more resilient. In contrast to the situation before the GFC, banks' regulatory capital and liquidity ratios registered a new peak at the end of 2019. The greatest increase has been seen in European banks, with its' ratio rising to nearly 19% in 2019. Furthermore, in 2019, the liquidity coverage ratio in all banking systems studied exceeded 100%. As a result of the COVID-19 pandemic's onset, banks may depend on their powerful loss-absorbing abilities to deal with higher credit provisions and draws on credit lines dedicated to borrowers.

Nonetheless, the COVID-19 crisis poses risks to certain banks' capital, despite the fact that they began the crisis with higher capital ratios than before the GFC and amidst significant policy interventions intended for mitigating the current crisis' economic ramifications. For banks with a regulatory capital ratio that is marginally higher than the regulatory standards, capital base reduction due to rising loan losses that are not covered by reserves may necessitate capital buffer replenishment. Banks with remaining capital buffers must address any major obstacles to using such buffers to prevent the risk of bank deleveraging, which could limit credit intermediation to the real economy during the recovery.

There are still vulnerabilities in a number of areas. Profit declined significantly since the GFC and persists low. Banks all over the world saw the highest drop in ROE in 2019 compared to 2007. Bank profitability plummeted which implies that banks entered the crisis with less revenues to cover losses than in the past. The low-interest rate environment, which is expected to persist following major central banks' unprecedented monetary policy actions since the beginning of 2020, may also exacerbate low-interest margins. Furthermore, **credit losses are expected to rise** as banks are increasingly confronted with late or skipped mortgage payments and an increasing number of defaults. A sluggish economic recovery or the early termination of support measures, coupled with increased risks in the non-financial private sector, could jeopardize the path for banks with relatively high loan loss provisioning requirements, exacerbating the negative impact of COVID-19 on their profitability.

Furthermore, despite ongoing efforts to enhance asset quality and the implementation of NPL resolution ploys, the NPL ratio of banks in emerging markets and certain European economies has risen significantly above pre-GFC levels. These excessive levels of bank NPLs imply that banks are entering a crisis weighed down by a big amount of poor-quality loans, which could create more difficulties. Following the GFC, persistently high NPL ratios were a source of concern in several European economies, and the pandemic resurrected the NPL issue.

While the COVID-19 pandemic hasted changes in the banking sector, it also increased ambiguity and reduced profit objectives, delaying transformation plans.

Therefore, high and persistent NPL ratios will stymie economic recovery by undermining the banking system's soundness and ability to lend to the real economy. Higher NPL ratios tend to depress bank lending, widen lending spreads, and slow real GDP growth. Simultaneously, it was revealed that macroeconomic factors, particularly GDP growth and the unemployment rate, have a strong and robust impact on the NPL ratio of eurozone banks.

2. The Tunisian context

Tunisia's financial intermediation is predominantly young. Founded in the aftermath of independence in 1956, its major transformations have occurred in the last 30 years. The banking industry has a significant impact on the economy. Matter of fact, it helped accelerate wealth creation by meddling in the financing of various sectors of the economy such as construction, agriculture, communication, transportation, tourism, and so on.

Its physiognomy has not changed significantly since 2017. The number of banks and financial institutions licensed in Tunisia remains at 42, with 23 resident banks, 7 non-resident banks, 8 leasing institutions, 2 factoring companies, and 2 investment banks. Resident banks hold over 90% of the credits, assets, and deposits of every financial institution.

However, State-owned banks continue to dominate and control half of the market, stifling economic growth because the government controls the market. Shares in public structures are held by state banks. They give them loans, but this prevents them from allocating savings to more attractive investments. This causes a rise in financing rates, which have not performed well in recent years.

Therefore, Tunisia's banking system, like that of most developing countries, is critical to economic growth. It is regarded as a barometer of the overall state of the economy. This system has proceeded to evolve as a result of environmental changes such as capital market reformulation, bank restructuring, and portfolio sanitation of non-performing loans.

NPLs have always had a negative impact on the performance of the banking system. According to the International monetary fund's report on Tunisia (February 2021), Improved banking sector monitoring would aid in the detection of emerging problems and potential threats to financial stability, such as exposure of state-owned banks to troubled state-owned enterprises or a concentration of credit risk in certain sectors.

Unfortunately, the financial performance and efficiency of public banks appear to be significantly lower than that of other banks. Indeed, the stress test results show that the three largest public banks have an average solvency ratio of 9%, an average official NPL ratio of around 15%, an average provisioning ratio of less than 50%, and an average ROE of around 6%. These figures are significantly lower than comparable private bank averages.

Or as highlighted previously the importance of strengthening banking sector regulation and supervision, as well as implementing measures to increase competition in the financial sector. The restructuring of state-owned banks would be a critical component of this. Furthermore, there is a need to review bankruptcy procedures and act quickly to address the high NPLs.

In fact, in January 2021, the CBT announced a new methodology for calculating collective provisions aimed at addressing potential financial stability concerns raised by debt repayment moratoria. In 2020, the CBT conducted stress testing on banks to assess the potential impact on credit risk, and staff recommended additional stress testing as the pandemic lingers. It also praised the CBT's plans to conduct an asset quality audit in 2021. The authorities recently relaxed tax write-off conditions for fully provisioned NPLs in order to improve NPL management. Staff recommended that, despite repayment moratoriums, NPLs be transparently recorded and urged authorities to address remaining structural issues related to NPLs. Finally, once the recovery is underway, the CBT should develop a strategy and communication plan for phasing out Covid-related measures.

According to the CBT's report for 2021, In contrast to the end of 2020, the banking sector's financial base has been consolidated by the end of 2021. Indeed, the solvency and Tier 1 ratios have increased to 13.6% and 10.6%, respectively, from 12.9% and 10.1% at the end of 2020, thanks to the CBT's risk coverage and dividend distribution measures.

Furthermore, the loan portfolio's quality improved slightly in 2021, due mainly to exceptional measures taken to support economic agents. As a result, the share of NPLs in total loans was 13.3% at the end of 2021, close to 13.6% at the end of 2020.

Table 1: NPLs ratio in Tunisia

	2016	2017	2018	2019	2020	2021
Tunisia	15,40%	13,40%	13,40%	13,40%	13,60%	13,30%

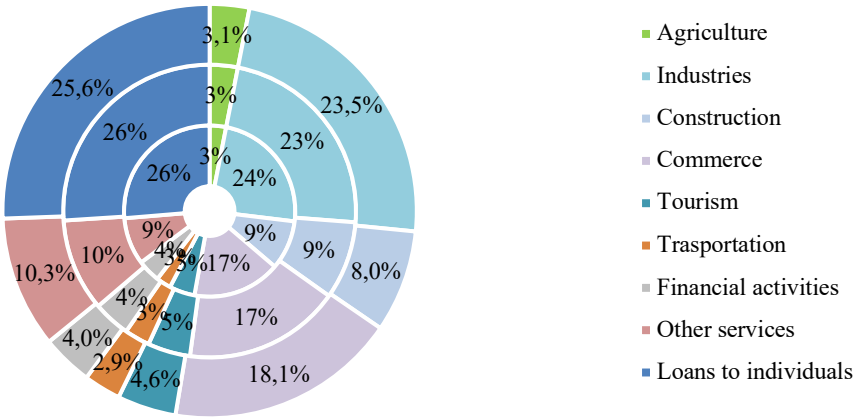
Source: Created by the author based on The CBT's annual report 2021

Moreover, the portfolio's loan quality improved slightly in 2021. This outcome is due to the exceptional measures put in place to assist economic agents. Thus, non-performing loans accounted for 13.3% of total liabilities at the end of 2021, up from 13.6% in 2020.

The sectoral breakdown of NPLs reveals a slight increase in its concentration index at the end of December 2021, with individuals receiving the highest number of classified loans by 25,6% in 2021, followed by loans to industries and commerce receiving 23,5% and 18,1% in 2021, respectively. These three industries account for more than 67% of all non-performing loans in Tunisia's banking system.

Figure 1: non-performing loans to total loans per sector from 2019 to 2021

Internal loop 2019 – Central loop 2020 – External loop 2021



Source: Created by the author based on The CBT's annual report 2021

The Tunisian banking sector struggles from a number of shortcomings, primarily due to former regime damage and the national economy's vulnerability following the crisis, which impedes its capability of raising funds for beneficial projects. As a result, this sector, which is categorized by misallocation of resources, adds to Tunisia's poor economic performance.

The January 2011 revolution had a significant impact on this sector, resulting in the accumulation of huge Non-Performing Loans. Banks, concerned with their profitability, raise their interest margins, increasing the likelihood of borrowers' default and limiting their capacity to repay debt service. Nowadays, the Tunisian banking sector endures a very important NPLs

rate, mostly in public banks, reaching its highest level of 15.6% in 2016 which then reached 14,3% in 2022 but continue to be a critical level. The primary causes of this alarming ratio are the Tunisian banking sector's poor portfolio and risk management, as well as the market's intense competition.

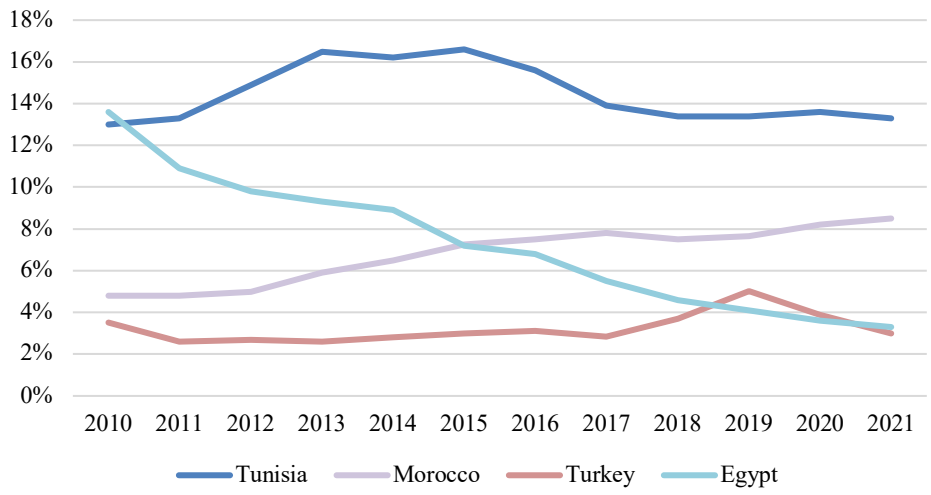
Tunisia's Government debt accounted for 79.7 % of the country's Nominal GDP in Dec 2021, compared with the ratio of 81.5 % in the previous month., which is well above the emerging market debt burden benchmark of 70% of GDP.

It was not so much the health crisis that hit developing countries like Tunisia hard at the start of the pandemic in spring 2020. While Europe and the United States dealt with the health consequences of the pandemic, the global economic impact devastated Tunisia. In fact, the real GDP contracted by an unprecedented 9.2%, the largest drop since independence. Tourism and transportation have collapsed, and manufacturing in export-oriented sectors has declined.

3. Comparing NPLs

To understand the importance of NPLs in Tunisia, we decided to compare the Tunisian NPLs ratio to that of three other countries which have a comparable banking system to that of Tunisia such as Morocco, Egypt, and Turkey.

Figure 2: Comparing NPLs



Source: Created by the author based on The World Bank's database (2021)

The graph above depicts the evolution of the non-performing loan to total loan ratio in these countries. At first glance, Turkey has had the lowest ratio among the selected countries since 2010, while Tunisia has the highest non-performing loans among the Southern Mediterranean countries.

For **Tunisia**, the curve has an upward trend from 2011 to 2015, followed by a continuous decrease since 2016 as a result of the transfer and deletion of various volumes of NPLs over the years as part of the public banks' restructuring program.

Individually and collectively, the three public banks presented organized and viable approaches to reducing NPLs to sustainable levels at the end of the restructuring program by improving the regulatory framework for write-offs and bad loan waivers. To that end, these banks were asked to refresh their plans for the resolution of NPLs in light of the two laws that went into effect on June 6, 2018, making it easier to write off and waive claims.

Concerning the upward trend, it is explained by the difficulties The Tunisian economy faced in 2011 as a result of political insecurity, a difficult social climate, a lack of investors, and a significant decline in the tourism sector. Indeed, an examination of the period preceding the revolution reveals that non-performing loans were significant and stable, then fell by 13.3% in 2011. This indicator increased rapidly from 13,3% (2011) to 14,9% (2012), 16,5% (2013), 16,2% (2014), and 16,6% (2015). (2015). Following a particularly restrictive political and social environment, the economy has experienced a slowdown in economic growth since 2011, resulting in an increase in the percentage of NPLs in the banking sector.

Morocco, Turkey, and Egypt have all had nearly constant NPLs ratios over the last five years, but none are as significant as Tunisia's, despite Tunisia having the smaller population in this sample.

According to the graph, **Morocco** has the second lowest level of non-performing loans among the Southern Mediterranean countries and in North Africa right after Egypt, Morocco has the most organized financial system among these countries.

As for **Egypt**, according to its central bank, the non-performing loan ratio reached 2.5% of the total loans at the 10 largest banks operating in the Egyptian market, whilst reaching 2% at the top five banks. It also stated that banks allocated funds to cover 96.4% of total non-performing loans in September 2020. At the same time, these provisions covered 100% of NPLs within Egypt's top ten banks and five largest banks. These indicators explain the rapid decline in the Egyptian banking system since 2011.

In regards to **Turkish** NPL ratios, from 2011 to 2019, the ratios doubled, rising from 2.7% to 5.4%. Despite strong loan growth, the NPL volume nearly remained flat in 2020. This is primarily due to the Banking Regulatory Supervisory Agency's extended forbearance measures,

extensive loan restructurings for operationally viable companies, and protective measures implemented by the Turkish government in response to the COVID-19 economic downturn.

As a result, the situation in Tunisia is particularly more complicated than the other countries in this sample. This level, which was the highest in the southern Mediterranean countries, is primarily due to Tunisian banks' hesitancy in making loans and their lax lending policies.

SECTION 2: DETERMINANTS OF NON-PERFORMING LOANS

Despite policymakers' efforts in terms of information gathering, guarantees, assistance, governance, evaluation, and risk management, banks are experiencing an increase in non-performing loans. NPLs are considered 'financial pollution' because they have a number of negative consequences (Makri, 2014).

As a result, an important part of banking literature has been dedicated to the explanation of NPLs either by traditional or classic determinants such as financial ratios because of their quantifiability and obtainability.

However, traditional financial analysis has some limitations. Banks are critical to economic development. They are the most involved in financing the economy and providing necessary funds for investment. A large number of studies have reported strong evidence of the positive effects of bank lending on economic growth (Levine R, 2000). In the same vein, (Fakih, 2017) and (Arayssi, 2020) discuss the beneficial effects of bank lending on economic growth.

For that reason, understanding the determinants of non-performing loans is critical for the macroeconomic and financial system's stability. A large number of studies have looked into credit risk factors, particularly in the aftermath of the global economic crisis.

Some studies looked at a single type of potential determinant, while others looked at the interaction of systemic factors and idiosyncratic influences. According to Reinhart (2010), NPLs can signal the start of a banking crisis.

Therefore, banks and credit institutions do not operate in a closed system, they are inevitably influenced and constrained by macroeconomic and market conditions. Dai Xiaomin (2005) added nonfinancial ratios and macroeconomic factors to the discriminate model and neural network model of credit ratings. Empirical results showed that by incorporating industry-relative ratios and non-financial ratios into traditional models based solely on financial ratios, total classified accuracy and predictive power would be significantly improved, and the neural network approach outperformed the discriminate model in classified accuracy. Khemraj (2009) found that both bank-specific and macroeconomic factors impact the loan portfolios of commercial banks in Guyana. Guy (2011) used a series of bank idiosyncratic variables and macroeconomic factors to explain non-performing loans. On these grounds, both bank-specific variables and macroeconomic variables are determinants to influence the situation of bank loans.

I. BANK-SPECIFIC FACTORS:

In contrast to macroeconomic determinants, distinctive characteristics of the banking industry and individual bank policy choices have a decisive influence on the increase in NPLs. A subset of the literature has looked into the relationship between bank-specific factors and NPLs. Keeton (2003) discovered a strong link between credit expansion and impaired assets. The findings revealed that rapid credit growth was associated with lower credit standards, which contributed to higher loan losses.

Ergo, NPL determinants should not be sought solely in macroeconomic variables that are exogenous to the banking industry. The characteristics of the banking sector and each bank's policy choices, particularly in terms of efforts to improve efficiency and risk management, are expected to influence the evolution of NPLs. A body of literature investigates the relationship between bank-specific factors and NPLs.

1. The return on equity:

Since equity is the crucial buffer that can ensure the absorption of losses, high profitability can recover the equity so that the bank can cope with possible losses. ROE is a useful metric that is commonly used to assess the performance of banks. Furthermore, it is used as a proxy for the quality of bank management in the literature.

Equation 6: The Return on Equity

$$Return\ on\ equity = \frac{Profits_{it}}{Total\ equity_{it}}$$

Profitability in terms of flows ensures that the sustainability of profits and the severity of risks incurred are considered. Because one of the causes of the bad loan provision ratio is poor risk management.

It corresponds to a minor assessment of loan projects and collateral, as well as a lack of borrowers' control. Bank profitability has a negative effect on NPLs, according to studies by Fofack (2005), Seuraj (2012), and Louzis D. P (2012).

Indeed, a positive relationship between bank profitability and the increase in NPLs is likely as in the model of Rajan (1994). In this model, Rajan sought to explain the correlation between credit supply and demand. In fact, credit policy is not only determined by the bank's profit maximization, but also by the short-term reputation of bank management. Therefore, the manager can manipulate earnings while using a liberal credit policy and trying to increase his

profitability while inflating his current profits at the expense of profits non-performing loans. As a result, past earnings can be positively related to bad loans.

In order to investigate whether there is a causal relationship between loan quality and bank profitability, Berger and DeYoung (1997) tested two specific hypotheses, namely:

- The “Bad Management” Hypothesis demonstrates the existence of a negative relationship between performance and NPLs. By analogy with the 'bad management' hypothesis, it may be justified on the grounds that past performance can be used as a proxy for management quality.

In this context, it is presumed that past earnings may be positively related to future NPLs thus it leads to the second hypothesis concerning banks’ performance:

- The ‘Procyclical credit policy’ hypothesis: there exists a negative link between performance and future increases in NPLs.

In fact, the relationship between lagging performance indicators and troubled loans has remained vague. Thereby, it is maintained in the context of lending activities that poor performance may indicate lower skill quality, which sounds similar to the 'bad management' hypothesis. This indicates a negative relationship between previous earnings and problem loans:

RoE Hypothesis: *The RoE has a negative association with NPLs.*

2. Bank size:

According to previous studies, bank size is considered an internal factor that may affect the level of NPLs. The effect of this internal determinant changes over time. As stated by Salas (2002) large banks tend to diversify more, lowering NPL levels. Furthermore, because they have more resources to absorb losses and can maintain high loan loss provisions, these banks are not more sensitive to shocks. However as claimed by Abid, Ouertani, & Zouari-Ghorbel, the possibility of defaults can be increased when the size and loan portfolios increase (Abid, 2013). This was also supported by the findings of Hu, Li, and Chiu, who demonstrated that large banks have more resources and experience dealing with bad borrowers (Hu .J.L, 2004). Small banks, on the other hand, may be more vulnerable to the problem of non-performing loans due to a lack of experience in evaluating the quality of borrowers.

Equation 7: The Bank Size ratio

$$Size_{it} = \frac{Total\ Assets_{it}}{\sum_{i=1}^{n} Total\ Assets_{it}}$$

The Size of a bank is essentially considered in the analysis of its diversification. Diversification is the allocation of resources in a way that minimizes exposure to risk toward assets. Therefore, these factors such as bank diversification opportunities and bank size are considered to have an impact on NPLs.

This seems to be accurate, according to Louzis et al (2012) and Mabvure T J (2012), because diversification reduces credit risk. Using bank size as an approximation for diversification opportunities, the authors discovered a negative relationship between bank size and NPLs in this sphere ((Salas, 2002), (Hu .J.L, 2004), and (Rajan, 1994)). According to these authors, larger banks provide more diversification opportunities. Non-interest income, on the other hand, can be used as a proxy for diversification opportunities because it represents a portion of total income. This is correct because it reflects the fact that banks rely on sources of income other than loan making, i.e., on diversified sources of income. In terms of the US banking system, research has not shown that diversification reduces risk. According to Stiroh (2004) non-interest income growth was fine-tuned with net interest income during the 1990s. Based on this, we propose the following hypothesis:

- The 'Diversification' hypothesis: There is a negative relationship between bank size and NPLs.

The relationship between those factors and NPLs is ambiguous. According to Hu .J.L (2004), large banks allow managers to evaluate loans and devote more resources. In fact, according to Salas and Saurina (2002), bank size is negatively associated with a high volume of NPLs:

Size Hypothesis: *The Bank's size has a negative association with NPLs.*

3. The efficiency of banks

Berger and Deyoung (1997), Louzis et al (2012), and others are unlikely to consider NPL determinants exclusively among macroeconomic factors because they are found to be exogenous to the banking industry. Indeed, each bank's policy decisions, such as the emphasis on improving efficiency and risk management, as well as the characteristics of the banking sector, are expected to influence the evolution of NPLs. These authors with Sabbah (2013) investigated the relationship between loan quality and cost efficiency and discovered a link

between NPLs and bank-specific factors. In fact, Berger and Deyoung (1997) accredit the NPLs level to bad management, skimping, and moral hazard.

Operating efficiency is defined as the cost function that assumes that bank income increases, or the cost function that assumes that income decreases at all levels of output (Daley, 2009). Moreover, it is measured as operating expenses divided by operating income.

Equation 8: The Inefficiency Ratio

$$Operational\ Efficiency_{it} = \frac{Operating\ Expenses_{it}}{Operating\ Income_{it}}$$

When a bank performs all of its business operations at a low cost, it is said to be doing its job efficiently. Berger and DeYoung (1997) deduced that a decrease in commercial bank cost efficiency in the United States will indeed affect the rise in future loan defaults. Managers who are unable to control operating expenses and loan portfolio management face this problem. Nevertheless, when efficient banks are studied in another study, an increase in cost efficiency is followed by a slog of loan defaults, leading to the following hypothesis:

- The 'Skimping' hypothesis: a high level of efficiency leads to an increase in NPLs. i.e., a rise in loan defaults occurred when banks decided to spend less money on underwriting and take a closer look at loans in the short run, despite the risk of future loan performance problems.

With reference to Louzis et Al (2012) and Abid et Al's (2013) work on the determinants of household NPLs in Tunisia, they set forth the following hypothesis, its purpose is to test the flow of causality between bank's inefficiency and NPL:

- The "Bad management hypothesis": a high level of NPL is justified by inefficient skills in credit scoring, bad control of borrowers, and lack of collateral according to Podpiera and Weil, 2008.

Ekanayake and Azeez (2015) studied the factors that affected the NPLs in the banking sector of Sri Lanka for the period between 1999 and 2012 and concluded that NPLs have a positive correlation with the efficiency of the bank. Benthem (2017) examined the relationship between operating efficiency and NPLs in commercial banks, and the result indicates that operating efficiency increases the higher level of NPLs, which proposes that management conducts affect NPLs. Fiordelisiet al. (2011) examined the various factors that increased the risk level in the EU banks and concluded that decreasing efficiency increases the risk level of banks in the

future. Furthermore, the efficiency factors have an influence on NPLs in the Greek banking sector (Louzis D. P, 2012).

Efficiency Hypothesis: *The Bank's efficiency has a positive association with NPLs.*

4. Solvency ratio:

The solvency ratio is used to determine the minimum amount of common equity banks must maintain on their balance sheets. It is also known as the risk-based capital ratio which is calculated by taking the regulatory capital divided by the risk-weighted assets.

Equation 9: The Solvency Ratio

$$Solvency\ ratio = \frac{Regulatory\ capital}{Risk\ weighted\ assets}$$

Over the course of 2017, the banking industry had rapid growth in lending activity, which saw a double-digit increase of 12%, the highest rate since 2010. This occurred amid persistent economic hardship, a virtual halt in the drive to boost dinar deposits (8.3%), and a dramatic tightening of bank liquidity.

Indicators of the sector's financial soundness also improved, as evidenced by a 2-percentage-point drop in non-performing loans to below 14%, a stabilization of the provisioning rate for these claims at about 57%, and an increase in the overall solvency ratio of the banking industry of 0.6 percentage points to about 12% as a result of the sector's improved profitability.

As for the Tunisian banking sector, the minimum level of the solvency ratio should be below 10% and the Tier 1 ratio should be at 7%, according to the CBT's Circular No. 2018-06. However, market risks are included in the risk-weighted assets. Interest rate risk, title risk, change risk, and settlement risk are all covered by these additional capital needs.

Berger and De Young (1997), Khemraji and Pasha (2004), Chase et al (2005), Dicks and Arellano (2006), Greenidge and Grosvenor (2009), Misra and Dhal (2010), Louzis, Vouldis and Metaxas (2010)) explain this behavior as a lack of equity capital, which forces credit institutions to engage in risky behavior. Which lead these researchers to deduct this hypothesis:

- The 'Moral hazard' hypothesis': The low capitalization of banks contributes to an increase in the number of NPLs. A bank with insufficient capital may experience a high volume of NPLs. Managers' moral hazard incentive leads to excessive risk and an increase in the volume of NPLs (Salas, 2002).

Previous research has found a negative relationship between non-performing loans and the solvency ratio, which the moral hazard hypothesis may help to explain. Indeed, credit institutions, particularly banks, make large amounts of loans to finance risky projects. These institutions do not use control and supervision mechanisms, nor do they choose their clients. This situation almost certainly results in the accumulation of NPLs. When confronted with this situation, economic agents take excessive risks.

Therefore, this ratio which estimates the risk-taking attitude of banks has a negative and significant explanatory power for NPLs

Solvency Hypothesis: *The Bank's solvency ratio has a negative association with NPLs.*

II. MACROECONOMIC FACTORS

Banks operate in a macroeconomic environment that has a significant impact on both bank profitability and bank risk. Banking literature has specified some macroeconomic specifics to model return/risk.

To be more specific, Abidi et al. contend that there is strong evidence that loan quality in Tunisian banking is sensitive to the economic cycle. Using a dynamic panel model, they deduced that macroeconomic factors such as economic growth and inflation levels play an important role in the rise of non-performing loans among Tunisian households.

Referring to more literature on NPLs, most studies used the RLR, the gross domestic product, the sovereign debt and the inflation rate as the crucial macroeconomic determinants of NPLs.

1. The inflation rate

During economic expansion, borrowers are able to pay back loans. Consequently, the likelihood of default and the amount of NPLs decline ((Abid, 2013), (Louzis D. P, 2012) and (Messai, 2013)). In the same sphere, a decrease in inflation is correlated with an improvement in household finances. Consequently, it has a favorable effect on timely and consistent debt repayment ((Abid, 2013) and (Demirguc-Kunt, 1998)).

On this note, research has proven the positive link between the rate of inflation and NPLs. For instance, Fofack (2005) maintains that inflation expectations cause people in some Sub-Saharan African countries to make bad loans. Accordingly, Fofack (2005) considers inflation to be one of the primary causes of commercial banks' rapid loss of own funds, resulting in increased credit risk.

Consistently, Nkusu (2011) and Klein (2013) examined the effect of inflation on credit quality. Inflationary effects, according to Klein (2013), can be ambiguous. A high level of inflation can affect NPLs and, as a result, the banking system's stability because an increase in the price level reduces households' real income if their wages are sticky. When inflation rises, businesses and households may be unable to pay their bank debts because they are unable to meet their obligations.

Indeed, when inflation is volatile, properly assessing credit risk (NPLs) becomes more difficult. Furthermore, a significant and rapid drop in the inflation rate can result in a drop in nominal income, which has a negative impact on liquidity and solvency. Fisher (1933) dubbed this phenomenon "debt-deflation," or the debt trap that follows deflation.

Therefore, the following hypothesis is to be studied an Increase in the level of the inflation rate can therefore impact the bank's solvency and increase the volume of NPLs:

Inflation rate Hypothesis: *The Inflation rate has a positive association with NPLs.*

Other macroeconomic variables can provide supplementary information about the impact of macroeconomic conditions on households such as interest rates.

2. The real lending rates

According to previous research, Gonzalez Hermosillo et al (1997) and Minsky (1982) stated that there is a positive relationship between the real interest rate and NPLs. This conclusion is supported by the fact that borrowers who are granted loans at variable rates are unable to meet their obligations whenever the interest rate rises, according to Jimenez and Saurina, (2005) and Fofack, (2005).

Also, in compliance to Flouzart and De Boissieu (2004), in models of over-indebtedness, inflation and interest rates are among the factors that not only lead to loan non-payment but can also cause insolvency crises. As a result, our hypothesis consists in:

Interest rate Hypothesis: *There is a positive relationship between the interest rate and NPLs.*

3. The gross domestic product growth

The literature has extensively studied the relationship between the macroeconomic environment and credit quality, which links the business cycle with the stability of the banking system. According to Fernandez de Lis et al (2000), Salas and Saurina (2002), Fofac (2005), and Jimenez et al (2006), the evolution of NPLs exhibits cyclical behavior. As a result, when the economy is in an expansionary phase, the volume of NPLs is low. This situation is explained

by the fact that non-financial economic agents have enough income and revenue to honor their commitments within the recommended time frame. When the expansion phase continues, financial institutions continue to extend credit regardless of the borrowers' creditworthiness. Furthermore, if there is a recession, economic agents who have bank loans may be unable to repay them.

Thus, the effect of the macroeconomic environment can be measured by the real GDP growth rate. When the economy experiences rapid growth, it affects borrowers' income as well as their ability to borrow.

According to most econometric analyses, real GDP growth has been the primary driver of nonperforming loan ratios over the last decade. As a result, a decline in global economic activity remains the most significant risk to bank asset quality. Simultaneously, economic activity cannot fully explain the evolution of non-performing loans across countries and over time. Indeed, empirical findings indicate that additional factors may have a negative impact on asset quality in countries with specific vulnerabilities. As a result, we consider the following hypothesis:

GDP Hypothesis: *the real GDP growth has a negative impact on the number of NPLs.*

Meanwhile, the study of Ouhibi et al. (2017) shows a positive and significant association between the sovereign debt and NPLs.

4. Sovereign debt

Following the recent financial crisis and the subsequent sovereign debt events, the interconnections between sovereign debt crises and banking crises were recognized. Reinhart and Rogoff (2010) provide extensive empirical evidence that banking crises frequently precede or coincide with sovereign debt crises[4]. Nonetheless, they also note that "A causal chain from sovereign debt crisis to banking crisis [...] cannot be dismissed lightly,". In fact, the latter temporal sequence has occurred in almost every country that entered the economic crisis caused by the pandemic while in a precarious sovereign debt position.

Equation 10: Sovereign Debt Ratio

$$Debt_t = \frac{Central\ Government\ Debt_t}{Nominal\ GDP_t}$$

[4] The mechanisms at work include either the taking over of massive debt on the part of the government which undermines its solvency or the collapse of the currency which inflates foreign currency debt.

Two channels of transmission of a sovereign debt crisis to the banking system have been identified. First, deterioration in public finances places a "ceiling" on market evaluations of national banks' credibility, causing banks to struggle for liquidity (Reinhart and Rogoff, 2010). In light of this, banks must reduce lending, preventing debtors from refinancing their debts. Furthermore, an increase in public debt may necessitate fiscal measures, particularly cuts in social spending and the wage component of government consumption (Perotti, 1996).

As of April 2022, according to the monthly public debt brochure released by the Ministry of Finance, Tunisia's outstanding public debt reached 107.8 billion dinars at the end of 2021, representing 85.5% of GDP. The outstanding debt has risen by nearly 16% since 2020 (93 billion dinars, or 77.8% of GDP) and nearly 30% since 2019 (83.3 billion dinars, or 68% of GDP). To be specific, external debt accounts for 62.8% of total outstanding debt, this increase is essentially due to the sharp increase of the US Dollar in which most of Tunisia’s debt is denominated.

As a result of this negative shock to household income, several outstanding loans became unserviceable, while second-order effects in corporate loans may occur due to decreased demand. As a result, the following hypothesis can be advanced:

Sovereign debt Hypothesis: *Rising sovereign debt leads to an increase in NPLs.*

THIRD CHAPTER

DATA, METHODOLOGY, AND EMPIRICAL RESULTS

CHAPTER III: DATA, METHODOLOGY, AND EMPIRICAL RESULTS

Introduction

Non-performing loans have been the subject of extensive theoretical reflections as well as numerous empirical studies, some of which were discussed in the previous chapter. The numerous and recent works dealing with bank crises and bank failures assert that the deterioration of asset quality and the emergence of classified loans are indicators of insolvency, which can lead to bankruptcy. A high rate of non-performing loans appears to be a key indicator for assessing the financial fragility of the banking sector.

According to financial literature, there is no critical threshold for the banking sector to declare bankruptcy. Gonzalez Hermosillo et al. (1997), on the other hand, use a safe floor of 6-8% of the non-performing loan rate. Above this threshold, efforts should be made to reduce the emergence of NPLs.

To keep high NPL rates under control, it is critical to investigate the causes of loan non-repayment. In fact, determining the factors that explain NPLs is advantageous for the bank to understand what it needs to do internally to mitigate this rate, as well as for regulatory bodies to take appropriate measures to control them.

Some Tunisian banks, which have a relatively high rate of nonperforming loans when compared to other developing countries, want to limit the growth of classified loans. This observation makes us wonder about the causes of the emergence of bad debts and the causes of bank disparities.

In this context, this chapter begins with an examination of the sample, then the empirical determinants of NPLs in the Tunisian banking sector, followed by a summary of the key hypothesis and a presentation of our model. Before proceeding with the estimation in the second section, an exploratory statistical study of the data is required to ensure an unbiased regression as well as a presentation of the panel models. As a result, we will present the approach we took and the estimation technique we used (GMM). We will then conclude with a presentation and validation of the model's estimation, as well as a detailed interpretation of the obtained results.

SECTION 1: THE RESEARCH DESIGN

Despite bank efforts to keep the NPL rate under control, it is still rising. Furthermore, when compared to other countries, this rate remains relatively high. This is due to the unfavorable economic environment and management issues at the banks. The overall rate, however, conceals differences between said banks. This section is dedicated to the variable analysis of NPLs for further investigation. Furthermore, empirical literature was prioritized in the determination of the variables, but also the availability of data for the sample played role in the process of variable and study period determination.

I. THE SAMPLE

In order to identify the determinants of non-performing loans in the Tunisian banking sector, we conducted empirical research on a sample of both private and public banks. Our sample consists of the main banks listed on the Tunis Stock Exchange for information accessibility.

Hence, our data set includes 10 traditional banks. Our information is gathered by hand from the Professional Association of Tunisian Banks, the World Bank for macroeconomic indicators, and individual financial statements. We will study the determinants of NPLs in These Tunisian banks from 2006 to 2021. The banks in our sample are listed in the table below.

Table 2: List of the banks in our sample

	Bank	Acronym	Ownership
1	Amen Bank	AB	Private
2	Arab Tunisian Bank	ATB	Private
3	Attijari Bank	ATTIJARI	Private
4	BH Bank	BH	Public
5	Banque Internationale Arabe de Tunisie	BIAT	Private
6	Banque Nationale Agricole	BNA	Public
7	Banque de Tunisie	BT	Private
8	Société Tunisienne de Banque	STB	Public
9	Union Bancaire pour le Commerce et l'Industrie	UBCI	Private
10	Union Internationale des Banques	UIB	Private

Source: By the author

II. VARIABLES DESCRIPTION

The choice of the endogenous variable and the exogenous variables is an essential step for the use of an econometric model of the determinants of NPLs. The literature review provides a range of determinants of NPLs. Referring to previous empirical work (e.g. Lobna. A et al (2013), Louzis et al, 2012), we define the variables used in our econometric model. The table

below lists the main variables used in this paper along with the source of the data.

Table 3: Presentation of the variables

Variables			***Sources***
Dependent variable	Non-performing loans ratio		BVMT / CMF
Explanatory variables	Bank-specific variables	Return on Equity Bank size Inefficiency Ratio Solvency Ratio	 CMF BVMT
	Macroeconomic variables	Inflation Ratio RLR GDP Growth Sovereign debt	INS/BCT BVMT WB

Source: By the author

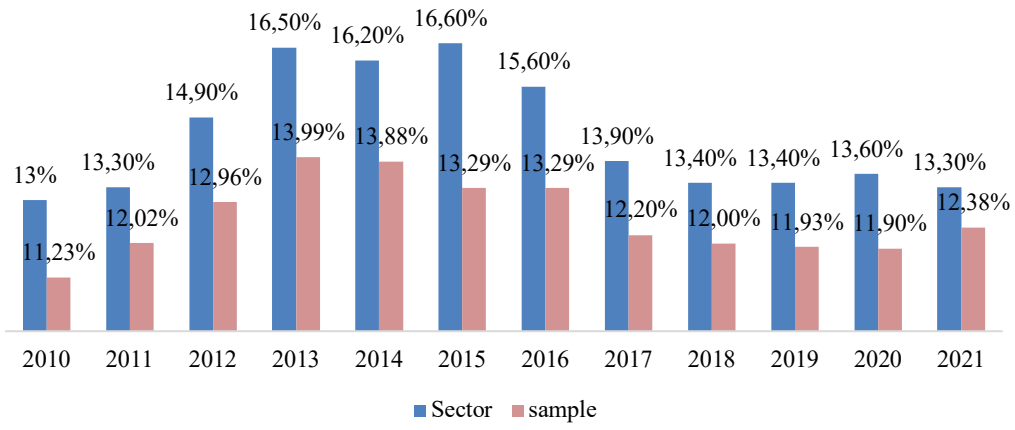
1. Dependent variables

In order to examine the key determinants of non-performing loans in Tunisia, we employ the non-performing loan ratio developed by Kumar and Kabra (2010), Nkusu (2011), Louzis et al (2012) and, more recently, Abid et al (2013).

In the context of our research, the ratio of NPLs will be on an annual basis. We should note that we will not use the sector's aggregate ratio, but rather a ratio specific to each bank: $\boldsymbol{NPL_{it}}$, where $\boldsymbol{i = 1,..,10}$ represents the number of individuals observed i.e., the number of banks in our sample and $\boldsymbol{t = 1,\ldots,16}$ represents the observation dates i.e., from 2006 to 2021.

To demonstrate the representativeness of our sample, we compared the average ratio of NPLs in the sector to that of our sample. This comparison revealed a striking similarity between the two ratios: the two series exhibit the same trend from 2010 to 2021. The graph below depicts the evolution of the NPLs ratio in the Tunisian banking sector and our sample.

Figure 3: Comparing the sector and our sample's NPL levels



Source: By the author

Furthermore, the portfolio's loan quality improved slightly in 2021. This outcome is due to the exceptional measures put in place to assist economic agents. As a result, the share of non-performing loans in total liabilities stood at 13.3% at the end of 2021, compared to 13.6% at the end of 2020.

2. Independent variables

We have two types of explanatory variables, according to the literature review:

NPL = f (Macroeconomic variables, bank-specific variables)

After researching the major determinants behind NPL in developing market economies we decided that the explanatory variables should be composed of macroeconomic and bank-specific variables as described previously.

2.1.Macroeconomic variables:

There are four macroeconomic variables and they are observed at an annual frequency. The specificity of these variables is that they vary only over time: they are common to all individuals (banks) in the sample. These variables are quantitative and expressed as a percentage.
Data for these variables were collected from the World Bank Data website, the Central Bank of Tunisia website, and the Ministry of Finance website.

2.1.1. GDP Growth:

We chose the variable Gross Domestic Product to control the macroeconomic conditions (GDP). Indeed, GDP is an economic indicator that reflects the country's level of domestic economic production. It enables us to quantify a country's wealth over a given time period.
Because these are activities that do not have a consistent growth rate over time, the GDP growth rate allows for the detection of periods of recession or economic growth. Tunisia's GDP growth rate in 2021 is 3.34%. The World Bank website is used to collect data on economic conditions. Later in the analysis, this variable will be introduced in a one-period lag.

2.1.2. Inflation rate:

As we previously mentioned, Fofack (2005) stated that inflationary pressures cause people to make bad loans in some African countries. He also sees inflation as one of the primary causes of commercial banks' rapid loss of own funds, implying increased credit risk.

Therefore, as our second macroeconomic variable we will study the inflation’s relationship with NPLs and whether or not it has a positive association with the increase of bad loans.

2.1.3. Real Lending Rate:

Following, Abid et al. (2013), Louzis et al. (2012) and according to multiple studies, there exists a positive relationship between the real interest rate and NPLs. This conclusion is supported by the fact that borrowers who are granted loans at variable rates are unable to meet their obligations whenever the interest rate rises.

The real interest rate is calculated by deflating the average money market interest rate by the year-on-year consumer price index.

2.1.4. Debt:

As a fourth macroeconomic variable, following the lead of multiple other studies, we will study the increase in public debt and its effect on NPL levels. According to Louzis et al. (2012), these variables are linked positively meaning rising sovereign debt leads to an increase in NPLs.

2.2.Bank-specific variables:

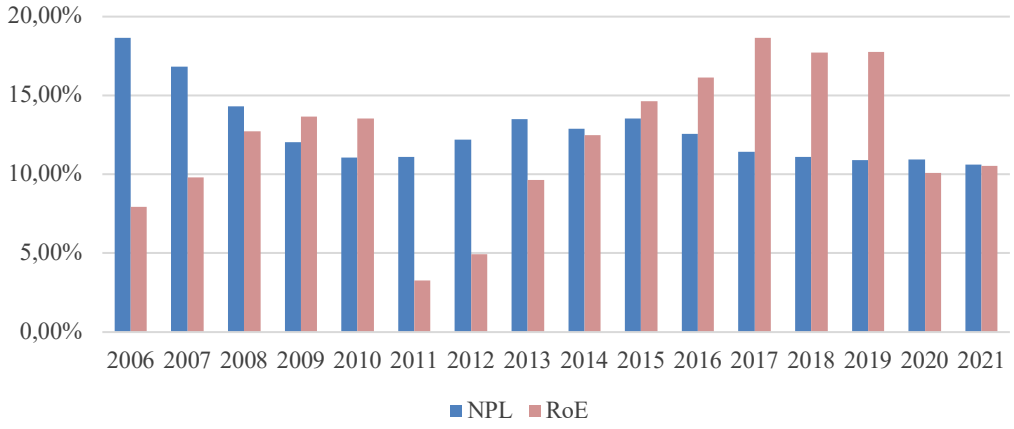
As for the bank-specific factors they differ from one bank to another, therefore we used several variables, which are outlined below:

2.2.1. Return on equity:

Several authors propose using various indicators to evaluate profitability, including the Return on Equity metric. In fact, this measure primarily reflects short-term profitability or management efficiency and provides direct information on how the allocation of specific resources leads to the realization of current profits. This ratio assesses the ability of shareholder capital to generate net profits. As a result, it reflects financial profitability as well as the efficiency with which the company uses its equity.

ROE also has a strong explanatory power of financial performance (Carton and Hofer, 2006) and provides information that is of particular interest to investors, as it highlights the return on their investments. The graph below depicts the evolution of the two variables for our sample of banks in order to determine the nature of the relationship that may exist between profitability and NPLs.

Figure 4: Comparing our sample's NPLs and RoE



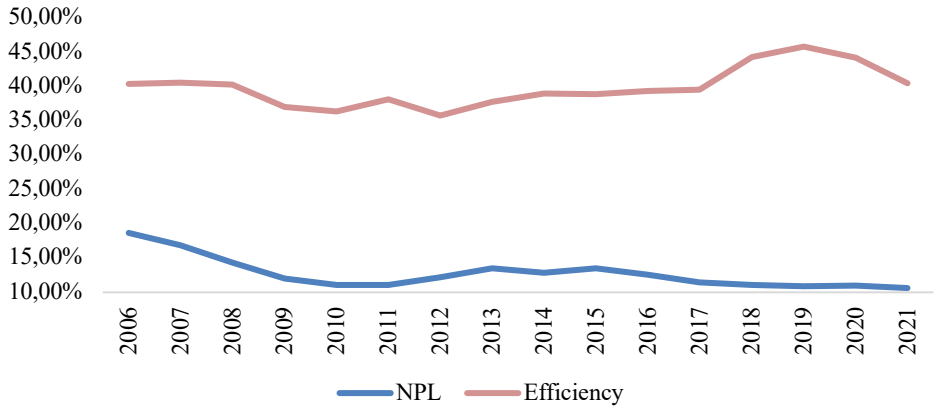
Source: By the author

According to this graph, a decrease in the NPL rate is accompanied by an increase in bank profitability, and vice versa. Thus, ROE appears to be a determinant of our variable of interest, with a negative relationship.

2.2.2. Inefficiency ratio:

The overall evaluation of a financial institution is regarded as a complex process that necessitates the consideration of several criteria in the complex financial analysis processes. The majority of studies assess management quality, predicts risk, and determines performance using the concept of efficiency.

Figure 5: comparing our sample's NPLs and Efficiency rates



Source: By the author

After computing each of our samples' operational inefficiency according to the studies of Daley and Matthews (2009) as we previously stated, the sample's efficiency ratio shows a negative relationship with NPL rate i.e., a positive relationship between efficiency and NPL as shown by the graph above.

2.2.3. Size:

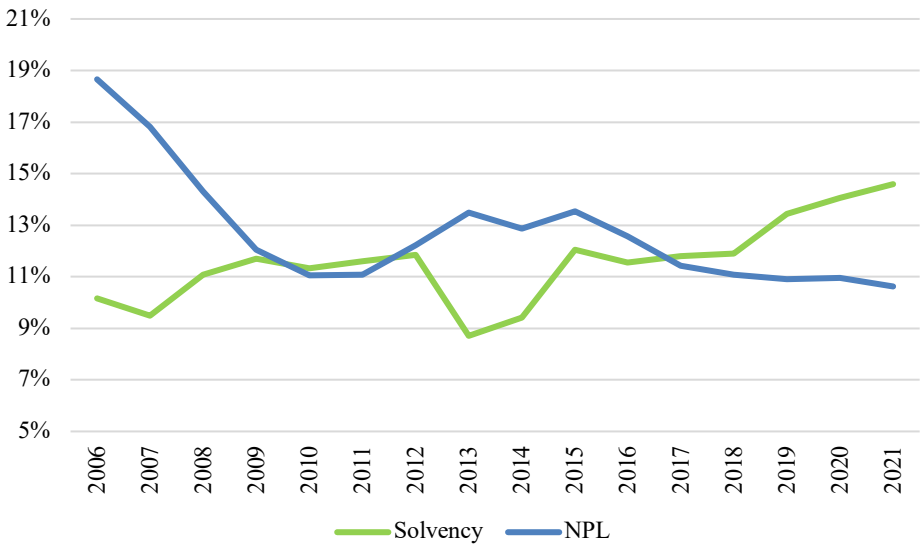
Size is another factor that contributes to non-performing loans (SIZE). According to previous research, it can be approximated by various measures.

For this study, we use the Louzis et al (2012) measure, which divides the total assets of bank i in year t by the total assets of all banks in the sample in all years. This variable is considered as a control variable.

2.2.4. Solvency:

The solvency ratio is our fourth bank-specific variable. Indeed, a bank's solvency is defined by its ability to meet the demands of its depositors at any given time. Furthermore, it is now well established that supervisory authorities are responsible for controlling banks' ability to meet their obligations.

Figure 6: Comparing our sample's NPLs and Solvency ratios



Source: By the author

Effective regulation and supervision are required to ensure the proper operation of banks and the preservation of financial stability. This regulation in Tunisia is based on the Cooke Ratio, which was defined during the Basel I agreements. The guiding principle of this international solvency ratio is to require a level of equity proportional to the credit risks to which a bank is exposed because it must meet its obligations to its creditors at all times. In other words, the more risk a bank takes on, the more capital it must build up to cushion any losses on banking operations and to prevent the bank from failing. For the banks in our sample, their solvency ratio is above the required standards as shown in the figure above. The decline recorded in 2013 is explained, according to the BCT, by the decline in the equity capital of banks.

Previous studies, have used the solvency ratio as an explanatory variable for credit risk. In the case of the Tunisian banking sector, the previous graph shows a negative relationship between the two variables.

3. Hypothesis summary

As we mentioned beforehand and based on existing literature, our current study will seek confirmation or refutation of the following hypotheses:

Table 4: Hypotheses summary

Variables	Hypothesis tested	Association with NPLs
Bank-specific		
Return on equity	Bad management (-)	(-)
	Procyclical credit policy (+)	(+)
Inefficiency	Bad management (+)	(+)
	Skimping (-)	(+)
Size	Diversification (-)	(-)
Solvency ratio	Moral Hazard (-)	(-)
Macroeconomic variables		
Inflation rate		(+)
Real lending rate		(+)
GDP Growth		(-)
Debt		(+)

Source: By the author

III. THE MODEL

1. Presentation of the analysis method:

In order to study the determinants of NPLs, we use a model that is consistent with the literature and inspired by empirical work dealing with the same issue. We will estimate our model using the generalized method of moments on a sample of ten Tunisian banks listed on the stock exchange for yearly observations ranging from 2006 to 2021.

We will use a dynamic specification of the regression model to empirically test the impact of other factors that cannot be directly observed. In the regression equation, we add the lagged dependent variable to the other explanatory variables based on the research of Williams et al. 2009. The regression model will then be estimated as follows:

Equation 11: the model

$$NPL_{it} = \alpha + \beta_1 NPL_{it-1} + \beta_2 Size_{it} + \beta_3 Efficiency_{it} + \beta_4 RoE_{it} + \beta_5 Solvency_{it} + \beta_6 Inflation_{it-1} + \beta_7 RLR_{it} + \beta_8 \Delta GDP_{it-1} + \beta_9 Debt_{it} + \varepsilon_{i,t}$$

With:

$\boldsymbol{NPL_{it}}$**:** Non-performing loans

$\boldsymbol{NPL_{it-1}}$**:** Non-performing loans of the bank $\boldsymbol{i}$ at the end of the year ***t-1***

$\boldsymbol{Size_{it}}$**:** the size of the bank

$\boldsymbol{Efficiency_{it}}$**:** The operational efficiency of the banks

$\boldsymbol{RoE_{it}}$**:** the bank's return on equity

$\boldsymbol{Solvency_{it}}$**:** the solvency ratio of the banks

$\boldsymbol{Stockprice_{it}}$**:** the bank's change in its stock price per year

$\boldsymbol{Inflation_{it}}$**:** Tunisia's inflation rate

$\boldsymbol{RLR_{it}}$**:** the real lending rates

$\Delta\boldsymbol{GDP_{it-1}}$**:** the growth in the Tunisian gross domestic product lagged by a period

$\boldsymbol{Debt_{it}}$**:** Tunisia's sovereign debt ratio

$\boldsymbol{\varepsilon_{it}}$**:** The idiosyncratic error terms

$\boldsymbol{\alpha, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_9}$: Coefficients to be estimated

2. Specification of the research model:

In this paper, we estimate our model using panel data. This method increases the degrees of freedom and large sample properties of the best estimators while reducing endogeneity issues.

Indeed, linear regression on panel data combines both time and individual dimensions. The former is concerned with the variations of variables over time, whereas the latter is concerned with individual heterogeneity. Longitudinal data allows the analysis of individual heterogeneity while accounting for the dynamic behavior of variables over time. This method generates an endogeneity problem for our model, which will be resolved using the generalized method of moments of a dynamic panel.

Ordinary least squares (OLS) estimation or sophisticated panel data regression methods (such as random effects or fixed effects) fail to detect sources of endogeneity in our model. The impertinence of traditional methods lends itself to the use of the dynamic panel estimator. We use GMM in this framework, which was developed by Arellano and Bond (1991) and improved by Arellano and Bover (1995) and Blundell and Bond (1999). This technique addresses the issues of simultaneity bias, reverse causality, omitted variables, and individual and temporal effects control. Furthermore, including one or more lagged dependent variables among the explanatory variables allows us to correct the variables' endogeneity bias.

The following are some of the benefits of using the GMM method:

- Solving the problem of endogenous institutional variables: according to Green (2008), we can use as instrumental variables all regression variables that are uncorrelated with the residual term (including lagged variables and differential variables).
- Multicollinearity reduction or avoidance in the model: Multicollinearity will be eliminated by introducing the lagged dependent variable.
- Omission of time-fixed variables: The use of this method results in the elimination of many variables that are fixed over time.

In terms of how we approach our work, we go through various estimations to justify the use of GMM. First, we use a "pooled" regression, which does not account for any effect. We then proceed to the estimation using fixed-effects and random-effects models. The former assumes that the relationships between the dependent variable and the explanatory variables are the same for individuals and that it has a residual structure that validates the standard OLS assumptions. The latter, on the other hand, considers individual specificity as random. To account for individual heterogeneity, it is decomposed into a fixed term (α) and an individual-specific term (u_i). To solve the endogeneity problem, the choice between these two models will be based on the Hausman specification test. The use of the OLS method necessitates the absence of heteroscedasticity and autocorrelation of errors. As a result, we run the Breusch Pagan test, which measures the stability of the error variance over time, as well as the Wooldrige autocorrelation test of the error terms.

When faced with problems that traditional estimation methods cannot solve, we will then estimate using the GMM. The instruments allow us to isolate the endogenous regressor variations that are correlated with the error term. For instrument validity, we use the Sargan overidentification test, and the Arellano-Bond test, which looks at residual autocorrelation.

SECTION 2: FINDINGS AND DISCUSSIONS

The goal of this section is to investigate the factors that contribute to non-performing loans in the Tunisian banking sector. As a result, we will begin by presenting the preliminary tests on the sample. Then, we will introduce the panel models and the GMM estimations that were used, and we will conclude by stating the various results as well as the discussions.

I. DESCRIPTIVE STATISTICS AND SPECIFICATION TESTS

1. Descriptive statistics

The descriptive statistics will follow two steps. First, we will present the summary statistics. Second, we will display the correlation matrix that shows the possible correlations between our exogenous and endogenous variables.

1.1.Summary statistics

The following table describes our variables for the 10 Tunisian banks over the study period. It shows the descriptive statistics for the continuous variables used in our empirical study.

Table 5: Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
NPL	160	.1272766	.0723303	.05	.447
Size	160	.0987566	.0364179	.0345464	.1779158
Inefficiency	160	.3986114	.0778914	.2514368	.5831556
RoE	160	.1422106	.4286005	- .21885	.45568
Solvency	160	.1154531	.0391497	-.062	.221
Inflation	160	.0462991	.0125457	.0296694	.0730759
RLR	160	.0113689	.0161776	-.0134111	.0375898
GDPGrowth	160	.0204839	.0338478	-.0873498	.0670952
Debt	160	.5464375	.1373615	.388	.797

Source: Stata Output, Appendix (1)

Between 2006 and 2021, the banks in our sample had an average **NPL** rate of 12.72%. This rate was recorded in a difficult economic environment with a maximum NPL rate of 44% and a minimum of 5%.

Concerning the **inefficiency** rate, according to our computations, it registered a 39.86% mean, a 7.789% standard deviation, and a value interval between 25.14% and 58.31%.

Since the bank **size** rate evaluated in the table is determined relatively to the sample as an approximate measure for diversification opportunities, it indicates an average of 9.87% in an interval of [3.45%; 17.79%] which suggests a diversified sample with a 3.64% standard

deviation.

The **RoE** averaged 14.22% with an important standard deviation of 42.86%. This is due to a large difference between the minimum (-21.88%), and the maximum (45.56%). Thus, our sample includes both performant and non-performant banks.

The **solvency** ratio recorded an average of 11.54%, which is higher than the regulatory ratio. This high ratio can be explained huge interval between -6.2% and 22.1% rates published by the banks in the sample.

The **inflation** rate averaged 4.629% with a range from 2.96% to 7.3% and a standard deviation of 1.254%. This large difference between the min and the max could be explained by the upward trend of inflation these last years

Regarding the **RLR**, the rate has a mean value of 1.136% with a range from -1.341% to 3.758%. It also registered a low standard deviation of 1.617% which means that the sample's data is quite clustered around the mean value.

The **GDP** growth rate reported a mean value of 2.048% with a range from -8.73% to, 6.71%. These statistics are related to the Tunisian economic context which has been in deterioration since the revolution. Hence, this could explain the high standard deviation of 3.384%.

As for the sovereign **debt,** because of the rapid increase of Tunisia's public debt, the variable registered a 54.64% mean value and a 13.73% standard deviation which indicates that our sample's data is more spread out around the mean value.

1.2.Correlation Matrix

Table 6: Correlation Matrix

	NPL	SIZE	EFF	RoE	SOL	INF	RLR	GDP	Debt
NPL	**1.0000**								
SIZE	0.2073	**1.0000**							
EFF	0.2864	0.1795	**1.0000**						
RoE	0.0217	0.0627	0.0412	**1.0000**					
SOL	-0.4717	-0.0921	0.0363	-0.2413	**1.0000**				
INF	-0.1600	-0.0003	0.2325	0.0924	0.1848	**1.0000**			
RLR	0.0117	0.0009	0.1457	0.0568	0.1208	0.2104	**1.0000**		
GDP	0.1571	0.0005	-0.1191	-0.0057	-0.2034	-0.2554	-0.1731	**1.0000**	
Debt	-0.1311	0.0005	0.2667	0.0080	0.2872	0.7351	0.4728	-0.4501	**1.0000**

Source: Stata Output, Appendix (2)

According to the correlation Matrix between the variable of interest the NPL and the explanatory variables, the **solvency** ratio, **Inflation**, and Sovereign **debt** all have a negative relationship with NPLs. However, economic conditions as measured by the **GDP** growth rate show a positive relationship with NPLs, which contradicts our expectations and necessitates further investigation. Similarly, based on the correlation between the **inefficiency** ratio, the **RoE**, and NPLs, we can conclude that the correlation matrix confirms the RoE hypothesis of procyclical credit policy as well as the inefficiency hypothesis of Bad Management.

Further, concerning the **RLR** the results confirm our previous hypothesis of the existence of a positive relationship with the NPL. But the **size**-NPL correlation is inconsistent with our previous statement therefore it requires other tests.

Regarding the multicollinearity problem, according to Gujarati (2003), it can be detected if the bivariate correlation coefficients between the different independent variables exceed 80%. Therefore, we can conclude that the multicollinearity between our explanatory variables is not an issue in this study.

2. Specification tests

2.1. Testing for multicollinearity issue: VIF

Multicollinearity is an econometric issue that can cause estimation biases. Hence, to test it we will apply the variance inflation factor. Following James et al. (2013) book "…a VIF value that exceeds 5 or 10 indicates a problematic amount of collinearity". Therefore, according to the table, our independent variables reported a mean value of 1.55. Hence, there is no multicollinearity issue and our variables are accepted.

Table 7: Test for multicollinearity

Variable	VIF	1/VIF
Debt	2.77	0.361353
Inflation	2.41	0.415512
GDPGrowth	1.49	0.672925
RLR	1.31	0.763440
Solvency	1.19	0.840486
Efficiency	1.12	0.891660
RoE	1.09	0.916035
Size	1.06	0.945076
Mean VIF	**1.55**	

Source: Stata Output)

2.2.Testing for stationarity: LLC test

After testing the multicollinearity issue, we will make sure that they do not contain unit roots and that our distribution will be stable over time. To do so, we will apply the Levin-Lin-Chu test, in which the first hypothesis suggests the presence of unit roots.

Hypotheses:

H_0: There are unit roots

H_1: variables are stationary

Table 8: The results of the Levin-Lin-Chu tests

Levin-Lin-Chu test				
	Without trend		With trend	
	Value	P-Value	Value	P-Value
NPL	-8,5329	0,0000	-4,4650	0,0000
Size	-1,1968	**0,1157**	-1,8397	0,0329
Efficiency	-2,0872	0,0184	-1,9131	0,0279
RoE	-5,3366	0,0000	-5,8329	0,0000
Solvency	-1,1447	**0,1262**	-2,4196	0,0078
Inflation	-3,5921	0,0002	-4,7979	0,0000
RLR	-6,8240	0,0000	-7,5984	0,0000
GDP	-9,7732	0,0000	-12,397	0,0000
Debt	5,7006	**1,0000**	-4,7408	0,0000

Source: Stata Output, Appendices (3-12)

Test results: This table shows that all of our variables are stationary because according to the LLC test with a trend it shows an all-over p-value greater than 5%.

2.3.Testing for homoscedasticity: Breusch-Pagan

The Breusch-Pagan test in statistics is a Chi-squared test of heteroscedasticity for linear regressions. Breusch and Pagan (1979) introduced this test while Cook and Weisberg (1983) had independently developed it to present the (Cook–Weisberg test). Indeed, to apply the ordinary least squares (OLS) regression the assumption of homoscedasticity should be verified.

In other words, the variance of the error term has to be constant. Otherwise, the OLS estimation is biased and cannot provide reliable predictions. To test the econometric assumption of homoscedasticity we apply the Breusch-Pagan test, where the null hypothesis is **homoscedasticity**. This hypothesis is rejected if the P-value of the test is less than an appropriate threshold (Generally 5%).

Based on the Lagrange multiplier test, the Breusch-Pagan tests verify whether the variance of the error term is constant or it depends on the independent variables. Given the assumption of the non-dependency between the independent variables and the variance of the error term (unobserved), we can estimate the error terms variance through the average of the squared residuals (observed). Hence, the homoscedasticity assumption is applied and the variance is constant. However, if the independency hypothesis is not held to be true, the variance of the error term is a linear function of the independent variables. Therefore, we examine it by regressing the squared residuals on the independent variables.

Hypotheses:

H_0: The variance of the Error term is constant

H_1: The variances of the Error term are not equal

Test results: The null hypothesis of the Breusch-Pagan / Cook-Weisberg test for heteroskedasticity, states that there is constant variance among the residuals or that the variance of the error term is constant. The Chi-Square test statistic of the test is 19.18 and the p-value that corresponds to the Chi-Square test statistic is 0.0000. Since this value is less than 0.05, we can reject the null hypothesis and conclude that **heteroscedasticity is present in the data**.

2.4.Testing for heterogeneity: F-test

For the panel data, testing the individual and temporal effects should be out of the question. Indeed, the error term of our model is divided into an idiosyncratic error term ($u_{i,t}$) and an individual effect (a_i). This individual effect reflects a time or bank unobserved heterogeneity.

The F-test is a test that verifies the existence of fixed effects under the assumption of independently identically distributed (i.i.d.) errors. It assumes that all the a_i are equal to zero. Hence, there is no unobserved heterogeneity.

Hypotheses:

H_0: There are no individual effects ($a_i = 0$)

H_1: The error term includes individual or temporal effects ($a_i \neq 0$)

Test results: Our model's regression reports a P-value = 0.0034, therefore the null hypothesis is rejected, which means that **individual effects are present**, so the composite error terms are correlated, so the i.i.d. condition is violated.

2.5.Testing for autocorrelation: Wooldridge

To establish whether or not the residuals are serially correlated over time, we conducted the Wooldridge test for autocorrelation. The null hypothesis supposes the inexistence of first-order serial, that is, autocorrelation exists.

To test the assumption of no autocorrelation, we will use the Wooldridge test. When serial correlation is not detected and solved it would produce inefficient estimates.

Hypotheses:

H_0: No first-order correlation

H_1: there exists a first-order correlation

Test results: Our results show that our model suffers from **first-order correlation**, hence there is a correlation between individuals when the probability is less than 5%. Thus, the results of the classical methods' estimates are all biased.

Conclusion

Individual effect tests, in addition to the Wooldridge and Breusch-Pagan tests, have revealed that the classical regressions are inefficient. Individual heteroskedasticity and autocorrelation problems do not validate the OLS conditions and cannot solve the problems associated with endogeneity.

II. PANEL MODELS

Panel data offers a significant advantage in that the variables observed have two dimensions. In fact, they allow us to track the evolution of relationships over time (the temporal dimension) and highlight the heterogeneity among individuals (individual variability). In panel data, two specifications must be considered: the fixed effect model and the compound or random error model.

1. Fixed effect model:

The fixed effects model assumes that the relationships between the dependent variable to be explained and the explanatory variables are the same for all individuals. Individual effects are, in fact, represented by constants (hence the name fixed effects model). The estimated model is then written:

Equation 12: Fixed effect model

$$Y_{it} = \alpha_i + aY_{it-1} + \sum_{i=1}^{n} \beta_{it} X_{it} + \mu_{it}$$

$$i = 1, \dots, n \; and \; t = 1, \dots, T$$

With:

- $\boldsymbol{\alpha_i}$: the individual fixed effect, it represents the individual specificity
- $\boldsymbol{Y_{it}}$: NPL_{it}
- $\boldsymbol{X_{it}}$: The set of explanatory variables
- $\boldsymbol{n}$: The number of variables in the model
- $\boldsymbol{\mu_{it}}$: the error term with the following statistical properties: $E\mu_{it} = 0$; $V\mu_{it} = \sigma^2$ and $cov(\mu_{it}, \mu_{js}) = 0 \; if \; i \neq j \; and \; t \neq s$

The fixed-effects model provides unbiased estimators but is inefficient in the case of random heterogeneity. When estimating the model's various parameters, the individual dimension is not used. Given the fixed effect model's limitations, a new specification is required to improve efficiency. The fixed effect model estimates are presented in the appendices.

2. Random effect model:

The compound error model differs from the fixed effects model in that the individual effects are assumed to be random, whereas in the fixed effects model they are fixed. The specific constant term is composed of a fixed term and a random term specific to each individual to control the heterogeneity. The model's equation is as follows:

Equation 13: random effect model

$$Y_{it} = \beta_0 + aY_{it-1} + \sum_{i=1}^{n} \beta_{it} X_{it} + U_i + \varepsilon_{it}$$

With:

- $\boldsymbol{\beta_0}$: a fixed effect
- $\boldsymbol{U_i}$: A random term taking into account the unobservable individual heterogeneity with a zero mean and a constant variance σ_u^2.

Given the dynamic nature of the proposed specifications, appropriate tests should be used to avoid any potential correlation between exogenous or endogenous lagged variables and the error terms. The random effect model estimates are presented in the appendices.

3. Hausman test:

If the Wooldridge test revealed the existence of individual effects, we have to specify whether these effects are fixed or random. Hence, a test for the model specification is required.

The Hausman (1978) test is an individual effects specification test that addresses the endogeneity issue. It is a test based on the comparison of two estimators in which one proposed estimator of a parameter is simultaneously consistent and efficient under the null hypothesis and inconsistent under the alternative one.

In our study, we use this test to select the adequate estimation among the fixed and the random effects regressions. If the Hausman test has a P-value greater than 5% then our null hypothesis is accepted. Thus, the random effect is greater than the fixed effect estimation and vice-versa. The Hausman test seeks whether there is a correlation between the errors and the regressors. Hence, the null hypothesis is the non-correlation between them.

The following assumptions underpin this test:

Hypotheses:

H_0: The random effect provides consistent estimates or $E(U_i . X_{it}) = 0$

H_1: The fixed effect is more appropriate than the RE estimation or $E(U_i . X_{it}) \neq 0$

Test results:

Table 9: Hausman test

Chi-square test value	P-Value
9.09	0.4289

Source: Stata Output, Appendices (18)

Our model reported a p-value = 0.4289. Hence under the current specification, our initial hypothesis that the individual-level effects are adequately modeled by a **random-effects model** is resoundingly accepted.

The Hausman test is based on calculating the distance between the fixed and random effect estimators. This distance follows a chi-square under H_0. The calculated distance value is 10.18, with a p-value of 0.4289, allowing us to reject H_0, which is equivalent to accepting H_1 with a 5% risk level.

The estimators of the compound error model are biased, according to hypothesis H_1. Because there is a relationship between the explanatory variables and the error terms, we must employ Arellano and Bond's (1991) methodology, which will be developed in the following sections.

III. GMM ESTIMATION: THE ARELLANO BOND METHODOLOGY

After identifying the heteroskedasticity and autocorrelation issues, which were the implications of the estimation of the dynamic equation by the ordinary least squares method (OLS), we would use the generalized method of moments (GMM) to estimate our model using Stata software.

This methodology is developed by Arellano and Bond (1991), Arellano and Bover (1995) and Bundell and Bond (1998). Indeed, Arellano and Bond use the first-difference model by employing a large number of instruments and by taking into account the variance-covariance matrix of errors, which does not verify the OLS assumptions.

Through GMM, the endogeneity issues will be addressed by integrating the lagged dependent variable. Using instrumental variables, we can isolate the endogenous regressor variations that are correlated with the error term.

1. Presentation of the Arellano-Bond method

The approach of Arellano and Bond (1991) consists in putting the equation to be estimated in first difference, in order to eliminate the individual effect and to use as instruments the lagged values of Y and X. The equation to be estimated becomes:

Equation 14: Arellano-Bond model

$$\Delta Y_{it} = a'\Delta \mathrm{Y}_{it-1} + \beta'\Delta \mathrm{X}_{it} + \Delta \varepsilon_{it}$$

Before presenting the estimation results, it is necessary that the Sargan identification tests and the Arellano-Bond autocorrelation test be validated.

2. The Sargan over-identification test

The Sargan test of the overidentifying restrictions implied by an overidentified model. Recall that to be overidentified just means that you have more instruments than you have endogenous regressors. Therefore, the test's null hypothesis implies that all instruments are valid.

Hypotheses:

H_0: overidentifying restrictions are valid

H_1: overidentifying restrictions are not valid

Test results: Sargan's p-value must not be less < 5% and > 10%. The higher the p-value of the Sargan statistic the better. Since our p-value = 0.0530 > 5% it indicates that the group of instruments used in the analysis is valid.

Table 10: Sargan over-identification test

Variable	Coefficient	P-Value
NPL_{it-1}	0.9758	0.000
$Size_{it}$	-0.3461	0.116
$Efficiency_{it}$	0.0681	0.158
RoE_{it}	-0.0062	0.060
$Solvency_{it}$	-0.1721	0.006
$Inflation_{it}$	0.2316	0.186
RLR_{it}	0.0822	0.403
ΔGDP_{it-1}	-0.0658	0.193
$Debt_{it}$	-0.0421	0.035
Constant	0.0775	0.002
Sargan test	**0.4909**	

Source: Stata Output, Appendices (19)

3. Arellano and Bond's autocorrelation test (1991)

The Arellano–Bond estimator is a generalized method of moments estimator used to estimate dynamic models of panel data. It was proposed in 1991 by Manuel Arellano and Stephen Bond, based on the earlier work by Alok Bhargava and John Denis Sargan in 1983, for addressing certain endogeneity problems.

The Arellano–Bond test is a test of correlation based on the residuals of the estimation. Its goal is to see if the idiosyncratic error term is serially correlated. The test is run to look for first-differenced errors. If the error term in levels is serially uncorrelated, the error term in first differences must have a negative first-order serial correlation but no second-order or higher-order serial correlation. As a result, we should reject the null hypothesis that there is no first-order serial correlation in first differences (AR(1) test), but not the null hypothesis that there is no higher-order serial correlation in first differences (AR(2), AR(3),...).

If you do not reject the null hypothesis of the AR(1) test, it is possible that your idiosyncratic error term in levels is serially correlated. In the extreme case, the error term in levels takes a random walk, resulting in serially uncorrelated first-differenced errors.

Hypotheses:

H_0: No second order autocorrelation of the residuals

H_1: Negative autocorrelation of residuals of first order

Test results:

Table 11: Arellano-Bond test

Order	z	Prob > z
1	-2.3233	0.0202
2	1.6296	0.1032

Source: Stata Output, Appendices (20)

The results table gives us a probability of less than 5% for the AR effect (1), which confirms the existence of a first-order autocorrelation, justified by the presence of the lagged dependent variable. On the other hand, we obtained a probability greater than 5% for the AR effect (2), confirming the absence of residual second-order autocorrelation.

Based on the results of the tests performed, our estimate by the GMM method is robust and unbiased.

IV. MAIN RESULTS AND DISCUSSIONS

After performing the necessary regressions and following the model's validation, the results found must be interpreted. First, we discuss how economic conditions affect the level of NPLs. Then, we look at the bank-specific factors that influence asset quality.

1. Results analysis

We can present the estimation result, which revealed a relationship between the NPL (dependent variable) and the explanatory variables of our empirical model. The results of this regression are summarized in the table below.

Table 12: Arellano-Bond estimation

Variable	Coefficient	Std. Err.	z	P > |z|
NPL_{it-1}	**.9758686**	.0779483	12.52	0.000***
NPL_{it-2}	**-.2932332**	.0659148	-4.45	0.000***
$Size_{it}$	**-.3461178**	.2200338	-1.57	0.116
$Efficiency_{it}$	**.0681801**	.0483328	1.41	0.158
RoE_{it}	-.0062173	.0033041	-1.88	0.060*
$Solvency_{it}$	-.172114	.0631663	-2.72	0.006***
$Inflation_{it}$	.231657	.1749953	1.32	0.186
RLR_{it}	.0822823	.0983922	0.84	0.403
GDP_{it-1}	-.0658051	.0505606	-1.30	0.193
$Debt_{it}$	-.0421285	.0199555	-2.11	0.035**
Constant	.0775654	.0244794	3.17	0.002***
Prob > chi2	**0.0000**			

Source: Stata Output, Appendices (18)

, **, * means that the variables are significant at a specific level of confidence of respectively 10%, 5%, and 1%.*

Thus, we were able to identify eight explanatory factors for the NPLs that are significant at the 1%, 5% and 10% levels.

1.1.NPL and lagged NPL:

The integration of the lagged dependent variable is what distinguishes the GMM estimator. For a 95% confidence interval, the estimation yielded a one-period lag with an important positive coefficient of 0.9758.

As for the 2-period lag, the lagged dependent variable's coefficient is negative and statistically significant at 1%. The implication is that NPLs will likely decrease due to write-offs ((Sorge, 2006), (Roberto, 2012), and (Louzis D. P, 2012)) after increasing the previous year.

1.2.NPLs and Macroeconomic Variables:

1.2.1. NPLs and GDP Growth rate:

In terms of macroeconomic variables, the estimated coefficients are statistically significant and consistent with the previous theoretical arguments. In fact, the economy's slow growth has a negative impact on the NPL ratio. This result indicates a strong reliance on lenders' ability to repay their loans during the cycle phase. Specifically, an increase of one percentage point of **GDP** leads to a decrease of about 0.0658051 in the NPL ratio. Thus, the hypothesis that an economic downturn has a negative impact on NPLs has been confirmed.

The results show that the beta coefficient of annual GDP growth rate has an inverse relationship at the 0.05 (significance) level, implying a significant impact on NPL. As a result, economic growth improves business performance and increases payment capacity, resulting in a decrease in NPLs. Furthermore, during an economic downturn, the borrower's income and collateral value decrease, reducing the borrower's ability to pay. The findings are clearly consistent with the hypothesis and with the findings of Salas and Saurina (2002), and Fofack (2005).

1.2.2. NPLs and Inflation rate:

The inflation coefficient is a significant indicator of NPLs in the loan portfolio. This finding is consistent with previous findings from Rinaldi (2006) and Fofack (2005) studies. This can be explained by the fact that in Tunisia, a decrease in the inflation rate has a positive impact on household financial conditions and, as a result, loan repayment, explaining the positive relationship between inflation and NPLs.

The inflation rate depicts a **positive** relationship with loan portfolio quality these findings are supported by Rinaldi (2006) and Nkusu (2011), who found a significant and direct association between inflation and credit risk, this means that higher inflation can make debt servicing easier either by reducing the real value of outstanding loans or simply because it is associated with low unemployment. However, it can also weaken some borrowers' ability to service debt by reducing real income when wages are sticky.

1.2.3. NPLs and Real lending rate:

The RLR coefficients are positive, as expected. As a result, NPLs are vulnerable to changes in RLR. It is worth noting that the majority of credit types are loans with variable interest rates. This assumption holds true when lenders obtain loans at varying interest rates, which may increase the monthly repayment burden. As a result, it may result in an increase in payments, contributing to the growth of NPLs. Similarly, according to Louzis et al (2012) and Roberto and Ricardo (2012), consumer loans are difficult to repay because banks are likely to implement strict credit policies during recessions.

The coefficients for real lending rate (**RLR**) are **positive** as previously expected. Consequently, NPLs are sensitive to changes in RLR. It is worth signaling that most credit types are loans with floating rates. This assumption is valid when lenders get loans at varying rates, which may accentuate the monthly repayment burden. Consequently, it can lead to an increase in payments i.e., contributing to the higher growth of nonperforming loans. Similarly, according to Louzis et al (2012), Roberto and Ricardo (2012) and Sabbah (2013), loans for consumption are not easily paid back since banks are likely to adopt severe credit policies during recessions.

1.2.4. NPLs and sovereign debt:

As for the **sovereign debt**, the coefficient does not support our previously stated hypothesis. Rather the results show a **negative** coefficient which indicates a probable negative, but statistically significant at 5%, relationship with NPL levels. In spite of the fact that theoretically, a positive correlation between sovereign debt and NPL is confirmed by other studies, the results of our regression confirm the opposite.

Therefore, the expected hypothesis regarding sovereign debt is completely dismissed. According to a study conducted by Anita et al. (2022) on NPLs sensitivity to macroeconomic determinants in south Asian countries, the findings suggest that the sovereign debt coefficient of SAARC countries has a strong but negative association with NPLs at the 10% level. The rationale behind the outcome is that remodeling, innovation, and development in the financial

sector may reduce credit risk. Since innovation and development require massive government borrowing, it ultimately reduces non-performing loans. This result is consistent with (Anjom, 2016), and (Dimitrios, 2016), and contrast to that of (Louzis D. P, 2012) and (Makri, 2014).

1.3.NPLs and Bank-specific Variables:

1.3.1. NPLs and Efficiency rate:

The coefficient of the **inefficiency** index is **positive** and statistically significant. Hence, our empirical evidence provides support for the 'bad management' hypothesis. This result is compatible with the finding of Louzis et al (2012) and Berger and Deyoung (1997). It shows that Tunisian banks give loans with bad qualities and do not use sophisticated evaluation methods to detect in advance insolvent creditors.

Faced with this situation, Tunisian banks should consider valuation methods that distinguish between good and bad creditors, as well as credit risk management, given that the Tunisian banking sector is hampered by a non-negligible share of NPLs. Furthermore, this result demonstrates that Tunisian banks provide low-quality credit. They do not employ sophisticated valuation methods capable of predicting creditor insolvency and, as a result, the adoption of the Basel II accords.

The **Bad management hypothesis** implies that inefficient managers are less competent than others in making credit decisions. They take the risk of investing in unprofitable and even risky projects, which leads to inefficiency, and inefficiency leads to higher NPLs.

1.3.2. NPLs and Solvency ratio:

The solvency ratio, which measures banks' risk-taking attitude, has a negative and significant explanatory power for NPLs. As a result, our findings support the **moral hazard hypothesis** and are consistent with the findings of Abid et al (2013) and Sala and Saurina (2002). This could be explained by the fact that managers in low-capital banks face moral hazard incentives when taking on high-risk portfolios, which results in a growing level of NPLs in the Tunisian banking sector.

1.3.3. NPLs and RoE:

The performance indicator (ROE) for consumer loans is found to be significant at a 1% level and **negatively** related to NPLs. This result is consistent with the findings of Messai et al (2013) in European banks, Louzis et al (2012) in the Greek banking sector, and Podpierra and Weill (2008) in the Czech banking sector for the period 1994-2005, and Abid et al (2013) for the

Tunisian banking sector for the period 2003-2012 and it reflects the existence of a negative relationship between bank performance and non-performing loans. This interesting result confirms the hypothesis of "bad management".

This means that the efficiency with which banks grant credit to households is affected by the quality of management. These are quantitative modeling-based procedures. Poor performance can thus be interpreted as a lack of competence in lending activities. This is analogous to the Bad management hypothesis, which leads to a failure to monitor operating costs and loan quality, resulting in a capital loss.

Indeed, the bad management hypothesis has been empirically validated as lagged inefficiency and is positively related to NPLs. As a result, both performance and inefficiency may have explanatory power over NPLs and can be used as indicators of management quality.

1.3.4. NPLs and Bank size:

The result also shows a **negative** effect of **size** on the NPL. This finding is consistent with the hypothesis of diversification previously stated. Salas and Saurina (2002) found a negative relationship between bank size and NPLs in this line of research and argue that larger size allows for more diversification opportunities. Similar empirical evidence was also reported by Hu et al. (2004) and Rajan and Dhal (2003).

These results support our **diversification hypothesis**, smaller banks appear to have fewer problematic loans than larger banks. Because size allows for more diversification opportunities, a less concentrated portfolio may be the cause of the SIZE coefficients' negative sign.

Conclusion

The goal of this chapter was to conduct an empirical study to identify the factors that contribute to non-performing loans in Tunisia. We were able to demonstrate the impact of economic conditions through macroeconomic variables on the rate of non-performing loans through this study. Furthermore, we have identified certain bank-specific variables that can explain the differences in NPLs between banks and, among other things, the high level of classified loans. Profitability, solvency ratio, efficiency, and size are the most important. This connection is most likely explained by the Bad management hypothesis, which takes past performance as an indicator of management quality. According to the moral hazard hypothesis, undercapitalized banks make the riskiest loans, which could lead to an increase in bad loans. In terms of variation direction, these results confirm, relatively speaking, the theoretical hypotheses mentioned.

GENERAL CONCLUSION

This paper investigated both macroeconomic and bank-specific factors that explain non-performing loan rates in the Tunisian banking sector. To conclude this work, we summarize the main findings and discuss the significance and limitations of our research.

We presented the theoretical framework of credit risk in the first chapter. It is primarily related to information asymmetry between lenders and borrowers. In general, banks use risk management measures aimed at resolving informational issues to control credit risk. They cannot intervene in macroeconomic and environmental issues to mitigate credit risk. The empirical study selects a set of macroeconomic and bank-specific variables that can be used to reduce the high rates of non-performing loans.

To address our research question, we chose a sample of ten Tunisian banks from 2006 to 2021. Following a review of multiple empirical literatures, we identified several determinants of non-performing loans, including GDP growth rate, real lending rate, inflation rate, sovereign debt, profitability, solvency, bank efficiency, and bank size. Therefore, a dynamic panel model was used. First, we started with descriptive statistics and specification tests to ensure that we chose the appropriate methodology then we proceeded with our panel models. Hence, according to Hausman's test, the instrumental variables methodology of Arellano and Bond (1991) was employed to deal with the problem of correlation between the model variables and the error term. Later on, the Sargan test validated the instruments used, resulting in the robustness of the findings.

In terms of findings, we discovered that the level of non-performing loans in Tunisia is mainly explained by bank-specific factors. We discovered that economic conditions, particularly the inflation rate, the RLR, and the GDP growth rate, have a significant impact on the level of non-performing loans. Furthermore, bank-specific variables such as profitability, efficiency, solvency, and size have explanatory power, lending support to the "Bad management", the "Diversification" and the "Moral hazard" hypotheses.

As a result, our findings are particularly pertinent to the formulation of regulatory policies. As a consequence, it has been demonstrated that solvency, performance, and inefficiency measures are important predictors of future bad loans. In this regard, authorities should insist on managerial performance in order to mitigate potential NPL increases. Furthermore, in order to avoid future financial instability, regulators should consider risk management systems and bank procedures.

In addition, authorities should emphasize managerial performance in this regard in order to detect and mitigate potential increases in non-performing loans. Furthermore, in order to avoid future financial instabilities, they must consider the banks' risk management systems and procedures. Thus, enforcing strict governance policies and addressing management issues at each bank can help reduce non-performing loans, which are regarded as sources of vulnerability in the financial system.

Moreover, as a result of the excessive rate of non-performing loans in Tunisian banks, national authorities i.e., the Tunisian Central Bank, and the International Monetary Fund (IMF) recommend the implementation of a strict governance policy. They also recommend resolving management issues at banks in order to reduce non-performing loans, which are a source of vulnerability in the financial system.

Furthermore, the discovered relationships can be used by regulators and banks for forecasting and stress testing. Possible scenarios of the evolution of macroeconomic variables can be used in stress testing to assess the adequacy of loan loss provisions in the banking system. Accordingly, similar exercises could be carried out at the bank level to assess potential future problems, particularly for banks with poor performance indices.

Despite these important findings, our research can be **expanded** in a variety of ways. For example, it is best to investigate the determinants of non-performing loans by credit type (consumer, commercial, mortgage) such as the study conducted by Louzis et al. (2012) on the Greek Banking system. This can provide important insights. Additional research is required to better understand the interactions and relationships between various bank-specific factors and their impact on NPLs. For example, focusing on the roles of bank governance mechanisms and the potential impact of cultural factors on bank performance is intriguing. The research can be also expended by studying multiple models at a time by creating a model including only macroeconomic variables and then introducing bank-specific variables one by one to investigate their individual effect on NPLs.

Finally, while this study sheds light on the explanatory determinants of non-performing loans, it does have some **limitations**. Indeed, at the level of the variables retained, some information, such as the distribution of NPLs for each type of credit: consumer credit and housing credit, for example, could be relevant for determining the levels of NPLs. Another limitation is the lack of specific interest rates for each type of credit and each bank, which the CBT does not provide. On another note, data collection was difficult because we had to collect each variable from each bank's individual financial statements.

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APPENDICES

Appendix (1): Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
NPL	160	.1272766	.0723303	.05	.447
Size	160	.0987566	.0364179	.0345464	.1779158
Efficiency	160	.3986114	.0778914	.2514368	.5831556
RoE	160	.1422106	.4286005	-2.1885	4.5568
Solvency	160	.1154531	.0391497	-.062	.221
Inflation	160	.0462991	.0125457	.0296694	.0730759
RLR	160	.0113689	.0161776	-.0134111	.0375898
GDPGrowth	160	.0204839	.0338478	-.0873498	.0670952
Debt	160	.5464375	.1373615	.388	.797

Appendix (2): Correlation Matrix

	NPL	Size	Effici~y	RoE	Solvency	Inflat~n	RLR	GDPGro~h	Debt
NPL	1.0000								
Size	0.2073	1.0000							
Efficiency	0.2864	0.1795	1.0000						
RoE	0.0217	0.0627	0.0412	1.0000					
Solvency	-0.4717	-0.0921	0.0363	-0.2413	1.0000				
Inflation	-0.1600	-0.0003	0.2325	0.0924	0.1848	1.0000			
RLR	0.0117	0.0009	0.1457	0.0568	0.1208	0.2104	1.0000		
GDPGrowth	0.1571	0.0005	-0.1191	-0.0057	-0.2034	-0.2554	-0.1731	1.0000	
Debt	-0.1311	0.0005	0.2667	0.0080	0.2872	0.7351	0.4728	-0.4501	1.0000

Appendix (3): LLC test for RLR

```
. xtunitroot llc RLR, lags(0)

Levin-Lin-Chu unit-root test for RLR

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Not included

ADF regressions: 0 lags
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)

                     Statistic      p-value
 Unadjusted t         -9.8240
 Adjusted t*          -6.1014        0.0000

. xtunitroot llc RLR, trend lags(0)

Levin-Lin-Chu unit-root test for RLR

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included

ADF regressions: 0 lags
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)

                     Statistic      p-value
 Unadjusted t        -11.4666
 Adjusted t*          -7.5984        0.0000
```

Appendix (4): LLC test for Inflation

```
. xtunitroot llc Inflation , lags(0)

Levin-Lin-Chu unit-root test for Inflation
-----------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Not included

ADF regressions: 0 lags
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t        -5.4676
 Adjusted t*         -3.5921        0.0002
------------------------------------------------------------------------------

.  xtunitroot llc Inflation , trend lags(0)

Levin-Lin-Chu unit-root test for Inflation
-----------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included

ADF regressions: 0 lags
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t        -9.3109
 Adjusted t*         -4.7979        0.0000
------------------------------------------------------------------------------
```

Appendix (5): LLC test for GDP Growth lagged

```
. xtunitroot llc GDPGrowth , lags(1)

Levin-Lin-Chu unit-root test for GDPGrowth
-----------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Not included

ADF regressions: 1 lag
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t        -6.3960
 Adjusted t*         -1.4410        0.0748
------------------------------------------------------------------------------

. . xtunitroot llc GDPGrowth , trend lags(1)

Levin-Lin-Chu unit-root test for GDPGrowth
-----------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included

ADF regressions: 1 lag
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t       -10.5975
 Adjusted t*         -2.3915        0.0084
------------------------------------------------------------------------------
```

Appendix (6): LLC test for NPL lagged

```
. xtunitroot llc NPL , lags(1)

Levin-Lin-Chu unit-root test for NPL
------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Not included

ADF regressions: 1 lag
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t       -17.0528
 Adjusted t*        -15.6605        0.0000
------------------------------------------------------------------------------

. xtunitroot llc NPL , trend lags(1)

Levin-Lin-Chu unit-root test for NPL
------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included

ADF regressions: 1 lag
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t       -13.2154
 Adjusted t*        -10.1812        0.0000
------------------------------------------------------------------------------
```

Appendix (7): LLC test for NPL

```
. xtunitroot llc NPL, lags(0)

Levin-Lin-Chu unit-root test for NPL
------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Not included

ADF regressions: 0 lags
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t       -10.7722
 Adjusted t*         -8.5329        0.0000
------------------------------------------------------------------------------

. xtunitroot llc NPL, trend lags(0)

Levin-Lin-Chu unit-root test for NPL
------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included

ADF regressions: 0 lags
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t        -7.8545
 Adjusted t*         -4.4650        0.0000
------------------------------------------------------------------------------
```

Appendix (8): LLC test for SIZE

```
. xtunitroot llc Size, lags(0)

Levin-Lin-Chu unit-root test for Size
---------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Not included

ADF regressions: 0 lags
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t         -4.4575
 Adjusted t*          -1.1968        0.1157
------------------------------------------------------------------------------
```

```
. xtunitroot llc Size, trend lags(0)

Levin-Lin-Chu unit-root test for Size
---------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included

ADF regressions: 0 lags
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t         -5.3339
 Adjusted t*          -1.8397        0.0329
------------------------------------------------------------------------------
```

Appendix (9): LLC test for EFFICIENCY

```
. xtunitroot llc Efficiency , lags(0)

Levin-Lin-Chu unit-root test for Efficiency
---------------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Not included

ADF regressions: 0 lags
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t         -5.6199
 Adjusted t*          -2.0872        0.0184
------------------------------------------------------------------------------
```

```
. xtunitroot llc Efficiency, trend lags(0)

Levin-Lin-Chu unit-root test for Efficiency
---------------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included

ADF regressions: 0 lags
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t         -6.5198
 Adjusted t*          -1.9131        0.0279
------------------------------------------------------------------------------
```

Appendix (10): LLC test for ROE

```
. xtunitroot llc RoE , lags(0)

Levin-Lin-Chu unit-root test for RoE
------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Not included

ADF regressions: 0 lags
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t         -7.9734
 Adjusted t*          -5.3366        0.0000
------------------------------------------------------------------------------

. xtunitroot llc RoE, trend lags(0)

Levin-Lin-Chu unit-root test for RoE
------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included

ADF regressions: 0 lags
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t        -10.0967
 Adjusted t*          -5.8329        0.0000
------------------------------------------------------------------------------
```

Appendix (11): LLC test for SOLVENCY

```
. xtunitroot llc Solvency, lags(0)

Levin-Lin-Chu unit-root test for Solvency
-----------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Not included

ADF regressions: 0 lags
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t         -4.4146
 Adjusted t*          -1.1447        0.1262
------------------------------------------------------------------------------


. xtunitroot llc Solvency, trend lags(0)

Levin-Lin-Chu unit-root test for Solvency
-----------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included

ADF regressions: 0 lags
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t         -5.6875
 Adjusted t*          -2.4196        0.0078
------------------------------------------------------------------------------
```

Appendix (12): LLC test for DEBT

```
. xtunitroot llc Debt, lags(0)

Levin-Lin-Chu unit-root test for Debt
-------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Not included

ADF regressions: 0 lags
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t          2.2325
 Adjusted t*           5.7006        1.0000
------------------------------------------------------------------------------

. xtunitroot llc Debt, trend lags(0)

Levin-Lin-Chu unit-root test for Debt
-------------------------------------

Ho: Panels contain unit roots               Number of panels  =     10
Ha: Panels are stationary                   Number of periods =     16

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included

ADF regressions: 0 lags
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t         -7.5082
 Adjusted t*          -4.7408        0.0000
------------------------------------------------------------------------------
```

Appendix (13): Breusch-Pagan / Cook-Weisberg test

```
. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of NPL

         chi2(1)      =    19.18
         Prob > chi2  =   0.0000
```

Appendix (14): Wooldridge test

```
. xtserial NPL Size Efficiency RoE Solvency Inflation RLR GDPGrowth Debt

Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,       9) =     38.483
           Prob > F =      0.0002
```

Appendix (15): panel data setting

```
. tsset CodeBank Year
      panel variable:  CodeBank (strongly balanced)
       time variable:  Year, 2006 to 2021
               delta:  1 unit
```

Appendix (16): Fixed effect regression and F-test

```
Fixed-effects (within) regression               Number of obs     =       150
Group variable: CodeBank                        Number of groups  =        10

R-sq:                                           Obs per group:
     within  = 0.8635                                         min =        15
     between = 0.9300                                         avg =      15.0
     overall = 0.8969                                         max =        15

                                                F(9,131)          =     92.08
corr(u_i, Xb)  = 0.2862                         Prob > F          =    0.0000
```

NPL	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
NPL						
L1.	.7579824	.0348003	21.78	0.000	.6891392	.8268256
Size	-.2182122	.1717532	-1.27	0.206	-.5579811	.1215566
Efficiency	.0669489	.0482786	1.39	0.168	-.0285577	.1624555
RoE	-.0045317	.0036107	-1.26	0.212	-.0116745	.0026112
Solvency	-.2133659	.0574137	-3.72	0.000	-.326944	-.0997878
Inflation	.3334713	.1864081	1.79	0.076	-.0352884	.7022311
RLR	.1017082	.1021065	1.00	0.321	-.1002828	.3036991
GDPGrowth						
L1.	-.1269198	.0554242	-2.29	0.024	-.2365622	-.0172775
Debt	-.0435685	.0219572	-1.98	0.049	-.0870052	-.0001319
_cons	.0557526	.0211583	2.64	0.009	.0138964	.0976087
sigma_u	.01524558					
sigma_e	.01767686					
rho	.42655167	(fraction of variance due to u_i)				

```
F test that all u_i=0: F(9, 131) = 2.92                     Prob > F = 0.0034

. estimates store fixed
```

Appendix (17): Random effect

```
Random-effects GLS regression                   Number of obs     =       150
Group variable: CodeBank                        Number of groups  =        10

R-sq:                                           Obs per group:
     within  = 0.8598                                         min =        15
     between = 0.9814                                         avg =      15.0
     overall = 0.9265                                         max =        15

                                                Wald chi2(9)      =    1197.02
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =    0.0000
```

NPL	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
NPL						
L1.	.8021135	.0286691	27.98	0.000	.7459231	.8583039
Size	.0569466	.0666938	0.85	0.393	-.0737707	.187664
Efficiency	.0684776	.0305538	2.24	0.025	.0085932	.1283619
RoE	-.0035752	.0035968	-0.99	0.320	-.0106248	.0034744
Solvency	-.178224	.0529665	-3.36	0.001	-.2820364	-.0744115
Inflation	.3767537	.1865294	2.02	0.043	.0111628	.7423446
RLR	.0917923	.1032301	0.89	0.374	-.110535	.2941195
GDPGrowth						
L1.	-.1395082	.0537943	-2.59	0.010	-.244943	-.0340733
Debt	-.0476427	.0209582	-2.27	0.023	-.08872	-.0065654
_cons	.018621	.0136228	1.37	0.172	-.0080792	.0453213
sigma_u	.00635901					
sigma_e	.01767686					
rho	.11458206	(fraction of variance due to u_i)				

```
. estimates store random
```

Appendix (18): Hausman test

```
. hausman fixed random
```

	Coefficients (b) fixed	(B) random	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
NPL				
L1.	.7579824	.8021135	-.0441311	.0197267
Size	-.2182122	.0569466	-.2751589	.1582754
Efficiency	.0669489	.0684776	-.0015287	.0373803
RoE	-.0045317	-.0035752	-.0009564	.0003164
Solvency	-.2133659	-.178224	-.035142	.022156
Inflation	.3334713	.3767537	-.0432823	.
RLR	.1017082	.0917923	.0099159	.
GDPGrowth				
L1.	-.1269198	-.1395082	.0125883	.0133425
Debt	-.0435685	-.0476427	.0040742	.0065479

```
                b = consistent under Ho and Ha; obtained from xtreg
     B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(9) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =         9.09
                Prob>chi2 =       0.4289
                (V_b-V_B is not positive definite)
```

Appendix (19) : Sargan-Hansen test

```
Arellano-Bond dynamic panel-data estimation     Number of obs     =         130
Group variable: CodeBank                        Number of groups  =          10
Time variable: Year
                                                Obs per group:
                                                              min =          13
                                                              avg =          13
                                                              max =          13

Number of instruments =    103                  Wald chi2(10)     =      602.86
                                                Prob > chi2       =      0.0000
One-step results
```

NPL	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
NPL						
L1.	.9758686	.0779483	12.52	0.000	.8230926	1.128645
L2.	-.2932332	.0659148	-4.45	0.000	-.4224239	-.1640426
Size	-.3461178	.2200338	-1.57	0.116	-.7773762	.0851406
Efficiency	.0681801	.0483328	1.41	0.158	-.0265504	.1629105
RoE	-.0062173	.0033041	-1.88	0.060	-.0126933	.0002587
Solvency	-.172114	.0631663	-2.72	0.006	-.2959176	-.0483103
Inflation	.231657	.1749953	1.32	0.186	-.1113276	.5746416
RLR	.0822823	.0983922	0.84	0.403	-.1105629	.2751276
GDPGrowth						
L1.	-.0658051	.0505606	-1.30	0.193	-.1649021	.0332919
Debt	-.0421285	.0199555	-2.11	0.035	-.0812404	-.0030165
_cons	.0775654	.0244794	3.17	0.002	.0295866	.1255442

```
Instruments for differenced equation
        GMM-type: L(2/.).NPL
        Standard: D.Size D.Efficiency D.RoE D.Solvency D.Inflation D.RLR
                  LD.GDPGrowth D.Debt
Instruments for level equation
        Standard: _cons

. estat sargan
Sargan test of overidentifying restrictions
        H0: overidentifying restrictions are valid

        chi2(92)     =  91.64129
        Prob > chi2  =    0.4909
```

Appendix (20): Arellano-Bond test

```
. xtdpdsys NPL Size Efficiency RoE Solvency Inflation RLR l.GDPGrowth Debt, lags(2) vce(robust)

System dynamic panel-data estimation            Number of obs     =        140
Group variable: CodeBank                        Number of groups  =         10
Time variable: Year
                                                Obs per group:
                                                              min =         14
                                                              avg =         14
                                                              max =         14

Number of instruments =    117                  Wald chi2(9)      =    4939.68
                                                Prob > chi2       =     0.0000
One-step results
```

NPL	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
NPL						
L1.	1.027683	.1214617	8.46	0.000	.7896223	1.265743
L2.	-.3062864	.078472	-3.90	0.000	-.4600886	-.1524841
Size	.0119247	.1736773	0.07	0.945	-.3284766	.3523259
Efficiency	.0674077	.0383765	1.76	0.079	-.0078089	.1426244
RoE	-.0044412	.0027734	-1.60	0.109	-.009877	.0009945
Solvency	-.1520566	.0733899	-2.07	0.038	-.295898	-.0082151
Inflation	.3190374	.1621704	1.97	0.049	.0011892	.6368855
RLR	.0452227	.0757704	0.60	0.551	-.1032845	.1937299
GDPGrowth						
L1.	-.0791352	.0272744	-2.90	0.004	-.1325922	-.0256783
Debt	-.0404982	.0228415	-1.77	0.076	-.0852668	.0042704
_cons	.030579	.0126744	2.41	0.016	.0057377	.0554204

```
Instruments for differenced equation
        GMM-type: L(2/.).NPL
        Standard: D.Size D.Efficiency D.RoE D.Solvency D.Inflation D.RLR
                  LD.GDPGrowth D.Debt
Instruments for level equation
        GMM-type: LD.NPL
        Standard: _cons

. estat abond, artests(2)

Arellano-Bond test for zero autocorrelation in first-differenced errors
```

Order	z	Prob > z
1	-2.3233	0.0202
2	1.6296	0.1032

H0: no autocorrelation