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Topic :

THE RELATIONSHIP BETWEEN INCOME DIVERSIFICATION, BANK RISK AND PERFORMANCE DURING CRISES : EVIDENCE FROM THE TUNISIAN BANKING SECTOR

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ABSTRACT

In this thesis, we focus on studying the relationship between income diversification (non-interest income), bank risk, and performance during crises (financial and health crises). Therefore, empirical analysis is performed using 11 Tunisian-listed banks spanning from 2005 to 2021. Our analysis leads to the following main results. Income diversification increases bank performance and reduces risk in general. Adding to this, only trading income has a positive impact on bank performance. Meanwhile, all the components of non-interest income have a negative impact on bank risk. Dealing with the crisis period, our results prove that shifting toward non-interest income during the financial crisis didn't impact bank risk and performance. However, during the COVID-19 pandemic, the risk decreases when banks increase the share of non-interest revenue. Moreover, with the decomposition of non-interest income sources during this period all three components have a negative impact on bank risk. Thus, Tunisian banks must be aware of the importance of investing in different channels beyond their core activities that generate non-interest income since they increase performance and allow them to become more stable even during the health crisis.

Keywords: Income diversification, non-interest income, non-interest income components, Bank Performance, Bank Risk, Financial Crisis, Health Crisis (COVID-19 pandemic).

RÉSUMÉ

Dans cette étude, nous nous focalisons sur l'étude de la relation entre la diversification de revenus (revenus hors intérêts), le risque bancaire et la performance durant les crises (crises financières et sanitaires). Une analyse empirique est effectuée en utilisant 11 banques cotées en Tunisie pour la periode 2005-2021. Notre analyse conduit aux principaux résultats suivants. La diversification de revenus augmente la performance des banques et réduit le risqué en général. De plus, seuls les revenus de trading ont un impact positif sur la performance. En revanche, toutes les composantes de revenus hors intérêts ont un impact négatif sur le risque bancaire. En ce qui concerne la période de crise, nos résultats prouvent que la diversification de revenues pendant la crise financière n'a pas d'impact sur le risque et la performance des banques. Cependant, pendant la pandémie de COVID-19, le risque diminue lorsque les banques se tournent vers les revenus hors intérêts. De plus, avec la décomposition des sources de revenus hors intérêts durant cette période, les trois composantes ont un impact négatif sur le risque bancaire. Ainsi, les banques tunisiennes doivent être conscientes de l'importance d'investir dans différents canaux, au-delà de leurs activités principales, qui génèrent des revenus hors intérêts, car ils augmentent la performance et leur permettent de devenir plus stables même pendant la crise sanitaire.

Les Mots Clés : Diversification de revenues**,** Revenu hors intérêts , composantes de Revenu hors intérêts, Performance bancaire ; Risque bancaire , Crise financière, Crise sanitaire (pandémie de COVID-19).

ABBREVIATIONS

AG: asset growth.

ATM: Automated Teller Machine.

CAR: Capital Adequacy Ratio.

CBT: Central Bank of Tunisia.

COMSH: The share of the commission.

CPSH: The share of income stemming from the commercial portfolio.

CTI: The cost-to-income ratio.

EU: European Union.

GDP: Gross Domestic Product.

HII: Herfindahl-Hirschman Index.

IPSH: The share of income stemming from the investment portfolio.

MENA: Moyen-Orient et de l'Afrique du Nord.

MMR: Money Market Rate.

NIM: Net Interest Margin.

NNII: The Share of Non-Interest Income.

NOI: Net Operating Income.

ROA: Return on Assets.

ROE: Return on Equity.

US: United States.

VIF: Variance Inflation Factor.

SUMMARY

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INTRODUCTION

Over the past two decades, it has been widely recognized that the banking sector is at the center of the economy. It plays a fundamental role in strengthening and boosting its growth.

Banks' core business is intermediation, in which they provide a secure link between borrowers and lenders. Indeed, they exist to mitigate the problems that may exist between these two agents. These problems may arise due to both asymmetric information and contract costs.

The worldwide financial systems have undergone profound changes through a process of deregulation, market opening, and technological and IT developments. These changes had the direct impact of intensifying competition that has gradually taken place. Therefore, to gain a competitive edge and to satisfy their customer's needs, which are becoming more demanding and vigilant, banks have diversified their activities and operate in new fields. This strategy is also adopted by banks to enhance profitability and minimize risk. Indeed, when banks diversify their activities, they generate non-interest revenue.

In response to the new banking environment, Tunisian banks had also diversified their sources of revenue by adopting a combined strategy based on multiple income structures of both interest and non-interest income.

In the literature, income diversification follows the portfolio theory concept, which is based on the assumption that individuals (or firms) can maximize their return and minimize their risk by diversifying their portfolios into different financial assets. Under this assumption, several scholars are motivated to study the relationship between income diversification and bank performance/risk. Indeed, the empirical studies dealing with this topic showed mixed results. A large stand of studies proved that income diversification enhances bank performance and reduces risk. Adding to this, they assumed that this strategy can create economies of scope and provide cross-selling of different products among the based ones (Hamdi et al. 2017; Sanya and Wolfe, 2011; etc). In contrast, another stand found a negative impact of this strategy (Stiroh,2004; Deyong et Roland,2001; Mercieca et al. 2007; Abedifar et al. 2018; etc).

Moreover, the series of crises that are raised motivated, on the one hand, regulators and supervisors, and on the other hand, researchers to further study how to forecast and prevent failures or, simultaneously, how to reduce their impacts. Empirical studies are mostly interested

in studying the impact of income diversification on bank performance and risk during crises in developed countries. Nonetheless, there is an ongoing debate concerning this issue. Some authors found a positive relationship between income diversification and bank stability during crises. Diversifying into non-interest income is an economical buffer to absorb the adverse effect of shocks (Simoensa and Vander Venneta,2021). Despite these benefits of diversification, other scholars proved that shifting toward non-interest revenue during crises can impact negatively bank performance and positively risk. According to Williams (2016), the banking sector can be severely weakened by the occurrence of different crises and macroeconomic shocks. Yet, the combined interaction between the share of non-interest income and crises can result in an appreciation in this circumstance.

Regarding all these considerations, it is interesting to conduct a study developed in the context of the Tunisian banking sector. Thus, we attempt to answer these questions:

> *Does the income diversification strategy beneficial for the Tunisian banking sector?*
>
> *Which is the impact of shifting toward non-interest revenue on bank performance and risk during crises period, particularly the financial and health crises?*

Hence, to reach our aim, empirical analysis is performed using 11 Tunisian listed banks. Our data covers 187 in total, for 17 years starting from 2005 to 2021. We used an impulse response function to study the impact of a shock of non-interest income on bank performance and risk. Adding to this, we used a GLS estimator in which we introduced a dummy variable related to each type of crisis and interaction terms between dummy variables and non-interest income as in Kim et al. (2020) methodology.

Therefore, our study is outlined as follows:

The first chapter highlights the importance of this topic, by providing theoretical background and a literature review. **The second chapter** deal with our empirical analysis, where we will present the features of the Tunisian banking sector. Then, we will describe our data and methodology and we will present our empirical interpretations. Lastly, we will end with a conclusion containing our main results.

CHAPTER 1: INCOME DIVERSIFICATION, BANK RISK AND PERFORMANCE: THEORETICAL BACKGROUND AND LITERATURE REVIEW

I. Introduction

Deposit and loan services have traditionally been the main sources of income for banks. However, the global banking sector has seen significant development in its operating models during the past three decades. Due to market competition, globalization, deregulation, and technological innovation, banks in both developed and developing countries were obliged to expand their traditional activities and shift their principal sources of income from interest-based business (Meslier et al. 2014). Therefore, diversification is seen as the most relevant strategy used by banks to run their business, by performing new sources of revenue that provide non-interest income such as trading securities, brokerage, bank assurance, investment provision, and underwriting services.

In this vein, several researchers were motivated to investigate the role of income diversification on bank risk and performance, using different methodologies and taking into consideration different periods, normal and crisis periods. The major findings in banking assumed that diversification aims to reduce bank risk and enhance its performance. Nonetheless, the financial crisis give rise to serious concerns and proved that diversification can expose banks to support higher risk than lower risk (Alouane et al. 2021). Therefore, the literature shows mixed standpoints and results concerning this topic.

Before going further in this study, we devote the present chapter to introduce different concepts related to diversification strategy, risk, and bank performance. Adding to this, we will review theoretical explanations and empirical findings investigating the link between income diversification, bank risk, and performance. Lastly, we will develop our hypothesis based on the previous results.

II. Diversification strategies in the banking sector and Non-interest income's share

To survive and sustain profitability in a competitive environment, banks have implemented different diversification strategies. Some of these strategies tend to help banks to opt for a diversified business model based on non-traditional activities and fee-based business rather than focusing on the traditional lending and deposit model. These changes in the banking model, impact risk and performance.

In the flowing section, we will present the concept of diversification in general and then we will concentrate on the diversification of the bank's revenues, especially the non-interest income. Finally, we will treat the performance and risk concepts in the banking sector and their determinants.

II.1 Bank Diversification

II.1.1 Definition and different forms

Diversification is a risk management strategy that incorporates a wide range of investments into a portfolio[1]. It is seen as the most important topic in the finance literature (Yilmaz et al. 2012). However, there is no consensus on the exact definition of the concept of diversification among researchers (Mulwa et al. 2015). It has numerous definitions, thus, what is required is a complete definition that is theoretically solid as well as managerially valid (Ojo, 2009).

In finance, diversification refers to minimizing risk by investing in a wide range of assets. Thus, if asset prices do not rise and fall in perfect synchronization, a well-diversified portfolio will be less risky than the weighted average risk of its component.

Generally, the historical context of diversification can be traced back to a well-known proverbial: "Don't put all your eggs in one basket."

According to Tam Le et al. (2022), diversification is the process through which a community, business, or individual aims to broaden its area of production or activity in order to lower the risks related to over-specialization. It is seen as a risk mitigation technique that is widely employed in investment management.

Ghort (1962) explained the concept of diversification based on the idea of the "heterogeneity of outputs". Where he noted that if two products are offered independently, their cross-elasticity of demand is low and consequently in the short term, the required inputs used in the production and distribution of one product may not be transferred to the other product.

For a commercial bank, diversification can be defended as follow: "a diversification strategy means a broadening of income sources, expansion of business scope, and extension of operating activities" (Qu,2020).

[1]According to www.investopidia.com

Moreover, Baele et al. (2007) assumed that banks can be diversified by combining into a conglomerate form such activities as commercial banking, insurance, securities, and other financial activities. Or creating a conglomerate of several banks across a bank holding company or banking groups (Khaloul and Hallara, 2010).

In the same context, three dimensions of diversification in banking can be seen; geographic expansion, diversification among financial products and services, and a combination of geographic and business line diversification (Mercieca et al. 2007).

In the literature, other types of bank diversification exist such as income diversification (Gambacorta et al. 2014; Kiweu, 2012) and international diversification (Lin, 2010). Additionally, Berger et al. (2010) argued that diversification can be viewed in four dimensions: deposit, loan, geographic, and asset. However, according to Mulwa et al. (2015), the key and common diversification approaches in the banking sector are:

- Income diversification: is known also as activities diversification. This type of diversification is manifested when banks diversify their sources of income rather than relying on a single one as the net interest income. Banks try to increase other new income sources through the expansion into new financial business lines (Qu,2020).
- Credit diversification: it involves the diversification of credit lines (loan portfolios), among various companies and sectors.
- Geographic diversification: is about the expansion of banks' activities across different markets. In other words, it is seen as spreading assets among several locations with different economic environments and different models of returns (Messlier et al. 2015; Berger et DeYoung,2001). This type of diversification is used to spread the risk of being excessive concentrate in any one market. While, when banks penetrated new markets they supported "learning costs" because of the lack of information related to this market (Berger et DeYoung, 2001).
- Asset diversification: in order to reduce portfolio risk, banks try to diversify their assets through different classes of assets. It can be defined also, as the distribution strategy used by banks to distribute their earning assets over lending and non-lending asset (Goetz et al. 2013).

II.1.2 Basic theoretical theories behind diversification

In the literature, several theories explain the motivation behind diversification, such theories present one of these two components which are; managerial and prescriptive components. The managerial one tends to explain the managerial behavior behind the decision of choosing the diversification strategy. Concerning the second component, it gives an idea about the expected gain resulting from the diversification (Mulwa et al. 2015).

Adding to the fundamental theory of diversification which is the **Modern Portfolio Theory**, Montgomery (1994), recognized the existence of other theoretical motivations behind the use of the diversification strategy, which are the search for market power (**Market power theory**) and the use of resources to reach a competitive advantage (**Resource-based view theory**).

However, some financial theories and many researchers pointed out that banks may suffer many problems or face regulatory or supervisory conflicts directly related to their choice to diversify or not**.** Adding to this, diversification benefits explained by portfolio theory can be eliminated by the occurrence of the **agency problem** and **asymmetric information** (Qu, Z. 2020).

Modern Portfolio Theory:

The Modern Portfolio Theory was fathered by Markowitz (1952) when he introduced the Mean-Variance model which is considered the first mathematical model dealing with the issue of assets allocation and portfolio optimization. Since that, portfolio theory has evolved enormously throughout the years. This theory assumed that for a well-diversified portfolio and for the same level of expected return, this portfolio presents a low level of risk compared to the undiversified portfolio. Therefore, using diversification leads to maximizing profitability and reducing risk.

In the banking industry, this theory is the basic and the most used one. It explains the diversification of banks' activities (Qu,2020). Based on this theory, concentrated revenue sources impact negatively the volatility of banks' revenue. Thus, an income diversification strategy could provide a "coinsurance effect" (Tong, 2012). Mooney and shim (2015), supposed that for a well-diversified bank, the "coinsurance effect" can reduce the volatility of its future cash flow.

Market power theory:

This theory was pioneered by Porter (1980). The argument behind this theory is on the company's position among the competitors, using different strategies. The most used one is diversification; it helps firms to overcome competition. By penetrating new markets using diversification, firms can reach a competitive power in the market. This is regarding their position in another market (Mulwa et al. 2015). In line with the banking sector, based on this theory banks have a tendency to focus more on revenue diversification as their market power grows (Zouaoui and Zoghlami, 2020). In sum, market power theory stipulates diversification as a way to improve the performance of firms in a specific industry at a particular time.

Resource-Based View Theory (RBV):

The idea of this theory was begun by Edith Penrose in 1959. This theory presented a firm as a set of resources. The RBV strategy takes into account the circumstances in which a company's resources, produce high returns over extended periods. Resource integration is an important concern for banks involved in a diversification strategy. Indeed, diversified firms can increase their effectiveness through internal capital market accessibility and by reallocating internal resources to more profitable and efficient businesses. Whereas focused activity firms are only able to configure their resources using external capital markets.

According to Mulwa et al. (2015) "The RBV theory not only provides a prescription for improving a firm's financial performance but also recommends diversification by building on the resource capacities to enter new markets or what Wernerfelt calls the sequential entry strategy.

Agency theory:

Agency theory assumes that the separation between owners and managers leads to divergent interests that eventually result in higher agency costs. Instead of increasing the cash payout to shareholders, managers typically spend extra cash flow to improve income, which tends to damage banks' performance and reduce value for shareholders.

According to Jensen and Meckling, (1976) managers with available free cash flow can increase the range of their business to achieve personal gains. Adding to this, bank structure will be more complex due to the diversification of their activities. This complexity can lead to the occurrence

of significant agency problems. In the same context, Laeven and Levine, (2007) assumed that diversification can intensify agency problems.

Asymmetric information:

In the banking sector, the process of diversification leads to an increase in asymmetric information (Krishnaswami and Subramaniam,1999). Therefore, because of the large number of customers, banks may be unable to recover adequate information. As a consequence, banks may fail to get rid of potential risky borrowers, which could affect the banks' risk forecasting and their operational strategies, resulting in an increase in financial instability (Hakimi et al. 2012). Additionally, Liu and Qi (2003) pointed out that diversified companies have inadequate and insufficient lines of information generation and transmission to management, which decreases the quality of bank decisions and results in inefficiency and loss of value.

II.2 Income diversification: Net interest income versus non-interest income

Banks are engaged in a wide range of business activities, including retail and corporate banking, wealth management, capital market, and insurance. Based on how it is generated, they divided their income sources into two categories: net interest income and non-interest income.

II.2.1 Net interest income

As a financial intermediary between lenders and borrowers, banks earn what we call the net interest income. In other words, the net interest income is generated from the difference between interest receives on loans given to borrowers and the interest it pays to lenders.

II.2.2 Non-interest income

Non-interest income is called also non-banking financial services. Is any revenue that banks receive from sources other than their primary intermediation activities (accepting deposits and extending loans).

According to Haubrich and Young (2019), non-interest income is defined as “income generated by banks from sources unrelated to the collection of interest payments.”

These incomes are generated from non-traditional activities such as brokerage, commission, trading for securities, underwriting services, and wealth management.

Since non-interest income is a "heterogeneous category" that includes a wide range of activities, it is divided into four major components (Kevin J, 2004):

- Fiduciary income: revenue generated from the fiduciary activities of banks such as managing investment for a third party;
- Service charge: revenue generated from deposit accounts such as ATMs;
- Trading revenue: is derived primarily from the trade of cash instruments etc;
- Fees and other income: including all the other existent fees such as commission, credit commitment fees, etc.

II.3 Bank performance and risk

The financial theory emphasizes two essential criteria in the context of portfolio management, namely, performance and risk, which are inseparable.

In this sub-section, we will present the definition of performance; its types of measurement and the instruments that allow us to analyze the performance of a bank. Then, we will analyze the concept of risk while presenting its definitions and types.

II.3.1 Performance: definition, measures, and determinants

II.3.1.1 Definition and measures

In order to preserve sustainability in a competitive environment, banks try to improve their performance. Thus, this topic has been extensively studied in many countries, it appears as a key concept in the financial and managerial literature. The results of all these studies show that a bank's performance depends on numerous factors which are institutional, regulatory, managerial, and macroeconomic factors.

In the management area, performance is defined as the outcome of all a company's efforts. These efforts focus on applying best practices most efficiently at the lowest possible cost to generate better results that satisfy client expectations.

In the banking sector, according to Ayadi and Ellouze (2015) performance can be defended as all that can enhance the torque value for the money. In other terms, it is referred to the capacity of attaining objectives while reducing costs. Moreover, performance is based on two different concepts which are efficiency and effectiveness. The first concept is related to the management

of means used to attain a fixed objective, and the second one is related to the ability to achieve a predefined objective.

To measure performance, several studies used the same two proxies which are the return on equity (ROE) and the return on assets (ROA). The return on assets is defended as the measure of using the assets in order to earn profit.

$$ROA = \frac{netincome}{total\ assets} \qquad ROE = \frac{net\ income}{total\ equity}$$

II.3.1.2 Determinants

In the literature, usually, performance determinants are split into two main groups; internal (bank-specific) factors and external(macroeconomic) factors. Several studies try to explain the impact of these factors on the performance of banks. However, these studies show contradictory results.

- Internal determinants:

Internal factors are related to the microeconomic determinants, which are unique to each bank. They give an idea about the global situation of a bank including its financial health. Internal factors are derived from bank accounts. There are many determinants, but the most studied ones in the financial literature are the flowing:

Size: is proxied by the logarithm of total assets. This factor is studied by several authors; however, no consensus can be reached about the results that were obtained. Several studies showed a positive relationship between size and performance (Mercieca et al. 2007, Goddard et al. 2004). Adding to this, large bank benefits from economies of scale, and this will enhance their performance. Yet, greater size could affect negatively the performance of banks mainly because of bureaucracy (Athanasoglou et al. 2008). Naouili et al. 2015 assumed also that size affects negatively the performance of banks and in this case, banks can deal with the problem of diseconomies of scale.

In the context of Tunisian banks, Ben naceur and Goaied (2008) studied the determinants of Tunisian bank performance from 1980 to 2000, they found also a negative relationship between size and bank performance.

Capitalization: called also capital ratio or capital adequacy ratio, it is measured by the ratio of equity to total assets. The link between capital ratio and bank performance was studied by several authors. De Jonghe (2010) assumed that the capital adequacy ratio can be seen as a signal of bank solvency. This result is following the findings of Naouili et al. (2015), who studied the determinants of Tunisian banking performance, they assumed that "having a high own capital is a positive signal sent to the market on the solvency of the bank. Consequently, such banks are able of reducing their financing costs".Moreover, a well-capitalized bank will have a lower cost of debt, since it requires less external financing than a slightly capitalized bank. Thus, this will increase performance (Naceur and Goaied, 2001; Liu et Wilson, 2010; Goddard et al. 2004; Abreu and Mendes, 2001, etc.).

Ownership structure: the impact of ownership structure on performance was studied by several authors. In this context, Micco et al. (2004) showed that in developing countries there is a strong relationship between bank ownership and bank performance, contrary to in developed countries. Adding to this, they found that public-owned banks in emerging countries typically exhibit less profitability, higher overhead expenses, and higher non-performing loans. In contrast, foreign-owned banks used in their sample of emerging nations exhibit stronger profitability and lower overhead costs.

In a political context, Micco et al. (2007) studied the impact of ownership structure on bank performance using a sample of 179 countries from the period 1995-2002. They assumed that compared to their private counterparties, state-owned banks are characterized by low profitability. Furthermore, they argued that the performance gap between public and private ones widens during the election period. Dietrich and Wanzenried (2014) have also studied the determinants of banking profitability where they have highlighted the negative effect of privatization on bank performance.

Efficiency: is measured by the ratio of cost to the outcome or it can be also measured using parametric methods (SFA) and non-parametric methods (DEA) (Naouili et al. 2015). Many authors studied the impact of cost efficiency on bank performance and they found that cost efficiency improves bank performance. Accordingly, Goddard et al. (2013) assumed that cost

efficiency is the most important determinant of performance than others such as concentration or market share.

Liquidity: The ability of banks to meet short-term financial obligations without having to sell investments or fixed assets prematurely is indicated by their amount of liquid assets, which can be quickly converted into cash when needed. (Shim, 2013).

As they are the first who studied the determinants of the EU bank performance, Molyneux and Thornton (1992), found a negative relationship between liquidity and performance.

Asset quality: Among several authors, Trujillo-Ponce, (2013) assumed that the relationship between the quality of a bank's assets exists. likewise, when the doubtful assets increase bank should allocate a significant proportion of its gross margin to provisions to cover losses generated from these credits. Therefore, bank performance will decrease. Thus, there is a positive relationship between asset quality and performance.

- External determinants:

The external determinants are related to the macroeconomic and legal environment, within which banks can operate. The most studied determinants in the literature are the following:

Inflation: the issue of the relation between inflation and bank performance was introduced firstly by Revelle, (1979), who noticed that the impact of inflation on bank performance is related to the growth rate of operating expenses and wages. In other words, according to this author, there is a negative relationship between inflation and performance when operating expenses increased faster than inflation and vice versa. Flowing this research, several authors are interested to study this issue where they found a positive relationship between bank performance and inflation (such as Molyneux and Thornton (1992), Dietrich and Wanzenried (2014), and Athanasoglou et al. (2008)). When studying the determinants of EU bank performance Patria et al. (2015) assumed that a higher inflation rate leads to arise in loan interest rate which increases performance.

Nonetheless, other authors have yielded opposite founding, (as Ben Naceur and Kandil, 2009; Afanasieff et al. 2002). According to these authors, inflation can decrease the demand for credit due to the increase of uncertainty in the future, thus bank performance will decrease. Adding to this when the inflation rate is not fully anticipated, performance will decline due to the increase in financing costs.

GDP growth: a majority of authors who studied the external factors that impact performance found a positive relationship between the development of the economic activity, which is measured by the growth of the domestic product (GDP), and bank performance (as Dietrich and Wanzenried (2014); Naouili et al. (2015), Goddard et al. (2004), etc.). As it is known that in a period of economic growth, investments and consumption increase, which in turn led to an increase in credits and customers deposits, ultimately, bank performance will increase also.

Market concentration: in order to explain the impact of market concentration on bank performance two main theories are proposed which are the market power hypothesis and the efficient structure theory. These two theories explain the positive relationship between the degree of market concentration and bank performance. However, the results of empirical studies dealing with this issue are mixed. On one hand, authors such as Bourke (1989), Molyneux and Thornton (1992) and Maudos and de Guevara (2004) assumed that the degree of industry concentration impact positively performance. On the other hand, others as García-Herrero et al. (2009), Pasiouras and Kosmidou, (2007) and Staikouras and Wood (2004) found that the relationship between market concentration and performance is negative or either cannot exist.

II.3.2 Risk: definition and different types

II.3.2.1 Definition

The concept of "Risk" in the banking industry has been extensively studied by several researchers (Ghosh, (2012); Bessis (2002)). Yet, there is no common definition of this concept. Risk can be defended as the potential loss that could happen due to the occurrence of antagonistic events in the future. Adding to this, the risk in the banking industry is characterized by two dimensions; which are uncertainty (concerning the probability of occurrence of the adverse event) and intensity (concerning losses, if the risk arises).

Risk is primarily a group of features; it cannot be considered as an individual or an isolated event. A few of a sequence of transactions that are carried out could result in losses for the bank, but they are all risky (Ghosh, 2012). According to Bessis, (2002) risk can be also defended as "adverse impacts on the profitability of several distinct sources of uncertainty".

II.3.2.2 Types of risks

Risk in banking can be divided into two major categories: financial risk and nonfinancial risk. Financial risk immediately causes loss to a bank (impacts directly the financial position of a

bank). The types of risks which are considered financial risks are; credit, market, and operational risks. Although, nonfinancial risk indirectly affects banks. These risks mainly are; reputation, legal, political, and technology risks. Unlike non-financial risks which are frequently non-quantifiable, financial risk can be measured numerically. A brief summary of a few significant banking risk categories as under:

- ***Credit risk:***

According to the Basel Committee on Banking Supervision (BCBS)[2], credit risk is defended as "the potential that a bank borrower or counterparty will fail to meet its obligations under agreed terms". it is considered one of the most important risks among others. This is due to the fact that this risk can easily lead to bank failure.

Credit risk refers to the likelihood that a borrower cannot honor its commitment on time because of a decline in its ability to repay or failure to comply with the contract (Bessis, 2002; Afriyie and Akotey, 2013). Credit risk is dependent on four factors which are:

Default risk (PD):	The default risk refers to the probability that a customer will default within one year. This probability is called the probability of default. The values of this probability are between 0 and 1. Default risk is evaluated internally through rating systems and expert human judgments and also externally through rating agencies.
Maturity:	This is the average time remaining on the commitment. The risk and uncertainty rise depending on the longer period of the commitment.
Loss given default (LGD):	The loss given default is the final loss supported by the bank once all recovery procedures have been completed. The value of LGD is zero when there is no loss. Meanwhile, if the loss covers the total exposure amount the value of LGD is 100%. The loss given default can be determined using the recovery rate**:** **LGD = 1- recovery rate**

[2] Principles for the Management of Credit Risk, BCBS, September 2000.

Exposure risk (EAD):	The exposure at the time of default is the outstanding credit owned by the borrower at the time of the default. In other words, it is the anticipated risk on the commitment as a result of the debtor's default.

- ***Market risk:***

Market risk is the risk of loss that may result from fluctuations in the prices of financial instruments that composed a portfolio. This risk can be related to the interest rate, stock prices, the exchange rate, commodities prices, etc. In the literature, Bessis, (2002) defended the market risk as the negative deviation in the market value of the trading portfolio because of market flotation over the required period to execute the transaction.

- ***Liquidity risk:***

Liquidity risk (or even illiquidity risk) refers to a bank's inability to satisfy, at a given time, its commitments or its maturities by the mobilization of its assets. Due to the excessive withdrawing deposits faced by banks, or even issues of refinancing obligation, the liquidity risk is raised (Saunders and Cornett (2008)). Moreover, liquidity risk results from the mismatching risk. Alternatively, it arises from the difference between the maturities of assets and liabilities.

- ***Operational risk:***

Operational risk can result from failure in internal procedures, persons, or systems. Unlike other types of risks like market and credit risk, operational risk mostly results from internal bank activities.

Adding to the internal source, operational risk can be emerging from unpredictable external events (such as terrorist attacks, or natural disasters). Unlike legal risk, operational risk does not take into consideration strategic and reputation risks.

- ***Legal risk:***

This risk results from banks' failure to comply with regulatory requirements. Even it can emerge from the negligence of procedures, legal constraints, and ethical standards. When operating in e-banking services, banks may be exposed to legal risks related to the divulgation of customers' information and privacy concerns (Sokolov, 2007).

❖ ***Interest rate risk:***

The interest rate risk refers to a financial consequence of adverse changes in interest rate. According to it sense, the evolution of rates can impact positively or negatively the interest margin or the market value of the bank.

- Impact on the interest margin: it is a short-term impact. Indeed, if the bank is a net borrower in a period of declining rate, its interest margin will be improved. However, if the interest rate increases its interest margin is negatively affected.
- Impact on the economic value: it is a long-term impact. Indeed, the variation of rates results in a modification of the discounted value of future flows. Thus, will impact the discounted value of the balance sheet position.

❖ ***Solvency risk:***

Solvency risk occurs when a bank is unable to have sufficient capital to absorb its potential losses. It results from the inadequacy of the bank's available capital and the risks taken by the bank.

❖ ***Reputation risk:***

Reputation risk occurs when customers, investors, and other involved parties will take a negative perception of the bank. This risk can impact negatively the bank's capacity to maintain existing or even to develop a new business line.

III. Previous studies and development of hypotheses

The issue of non-interest activities in the banking industry has been well-studied by several researchers. They especially, focused on the impact of shifting towards non-traditional activities, that generate non-interest sources of revenue, on bank performance and risk. Some of them investigated the link between revenue diversification, bank performance, and risk in a crisis period; financial and the most recent pandemic crisis (Covid-19).

Nonetheless, empirical findings in the literature show an ongoing debate concerning this topic. Some authors proved that non-interest income is beneficial for banks as it can enhance performance while it reduces risk. Another vein in the literature assumed that there are no diversification benefits concerning this issue, and they even proved the insignificant relationship between non-interest income, bank performance, and risk.

Therefore, in the flowing section, we will review the existing literature dealing with this topic. We will start by presenting the international context, then will move to the Tunisian banking industry. Adding to this we will present the empirical studies that take into account the impact of crises. Progressively, our hypothesis will be developed.

III.1 Non-interest income, bank risk, and performance: relationship

To study the impact of revenue diversification on both bank risk and performance, numerous research has been done. In this context, Balea et al. (2007) used panel data of 255 listed banks from 17 European countries from 1989-2004. Their founding proved that the franchise value of these banks increased when banks highly relay on the share of the non-interest income.

Adding to this, revenue diversification reduces the idiosyncratic risk. By running a panel regression, Chiorazzo et al. (2008) highlighted the benefit of shifting toward a non-traditional source of revenue for 85 Italian banks. They demonstrated that income diversity has a positive impact on the risk-adjusted return.

Elsas et al. (2010) used a sample of 9 countries which are the USA, Canada, Australia, UK, Germany, France, Spain, Italy, and Switzerland from 1996 to 2003. Their empirical founding signifies that revenue diversification improves bank profitability as well as market values. Moreover, they showed that the benefits of income diversity overcome costs in the banking industry.

Using the systems Generalized Method of Moments estimator (System-GMM), Sanya and Wolfe (2011) focused on studying the link between revenue diversification, bank risk, and performance for 11 emerging economies. They argued that diversification benefits exist in emerging nations. In other words, diversification increases performance while it reduces risk. Based on their data, the authors supported the idea that these benefits are important for banks in which their risk exposure is moderated.

Against this background, Pennathur et al. (2012) studied this issue for the Indian banks where they used two-panel data (public and private banks) over the period of 2000-2009. Their studies demonstrate that fee-based income is beneficial for the public sector, as it reduces risk. However, for the Indian private sector banks (domestic and foreign), diversification increases risk.

In the same years, Nguyen et al. (2012b) used panel data covering 4 Asian countries (Bangladesh, India, Pakistan, and Sri Lanka) during 1998-2008. Based on the Generalized Methods of Moments (GMM) they concluded that the most financially stable and profitable banks are those that shift toward non-interest income. Another research on this topic focused on the Japanese banking sector and confirmed the positive impact of revenue diversification on the value of these banks. Yet, there is no evidence of his positive impact on risk. Nonetheless, findings proved that increasing fee-income share (as a component of non-interest income) reduces systematic risk, idiosyncratic risk, and even total risk (Sawada, 2013). These results are confirmed by Trivedi (2015) in the context of Indian banks over the period of 2005-2011.

Examining the added value of relaying on the non-traditional source of revenue on Asian banks, Lee et al. (2014) used panel data from 44 Asian countries (for 967 banks). By applying a dynamic Generalized method of moments (GMM), they found that a non-interest source of revenue improves performance and reduces the risk for middle- or low-income countries. In contrast, this benefit of diversification cannot exist in the case of high-income countries.

Based on a sample of 39 Philippine banks from the period of 1999-2005, Meslier et al. (2014) proved that non-interest income, especially the income generated from trading activities, improves performance and reduces risk. This benefit is justified by the weak correlation between trading income and traditional banking activities.

Nguyen and Hong (2017) used a GARCH (0,1) in their study, where they pointed out that Vietnam's commercial banks profit greatly from income diversification. As it increases performance and reduces risk.

Githaiga et al. (2019) used a sample of 31 commercial banks in Kenya over the period of 2008-2017. Their findings revealed that income diversification increases the financial performance of these banks.

Among several scholars, Uddin et al. (2021) recently treated this issue in the context of the Bangladesh banking sector. Their experimental results, based on the use of one step system GMM, indicated that income diversification (as well as asset diversification) has a positive impact on profitability.

As it is considered the first investigation dealing with this topic in the MENA countries, Ammar and Boughrara (2019) used a two-step system GMM based on 275 countries. Their results

showed that shifting toward non-interest income especially trading generating business contributes the most to enhancing bank performance and stability.

The continuously increasing research on this topic motivated several scholars and practitioners to deeply study this issue. Instead of the added value of income diversification (as it is presented previously) several empirical studies reported the negative side of diversification.

To begin with, Deyong et Roland (2001) investigated the link between revenue diversification and bank risk in 472 U.S commercial banks during the period of 1988-1995. Their results proved that non-interest income increases risk. In their study, they suggested three main explanations for this result. First, unlike the majority of fee-based activities, most bank loans are based on a strong relationship with their customers. Indeed, it is costly to move away from a lending relationship for both borrowers and lenders due to switching costs and information costs. However, because of the strong competition, low information costs, and less consistent demand in some of the product markets, some fee-based activities may be volatile over time. Therefore, even with credit risk and interest rate risk, interest income from loans is relatively less fluctuate than non-interest income. Second, to offer fee-based services and intermediation-based products banks require the use of different combinations of inputs. Therefore, a lending relationship is based on variable input, which is interest expense. While, diversification into non-traditional activities, that generating non-interest income, may lead banks to increase their fixed charges such as labor input to develop the required skills and face competition. Thus, an increase in the ratio of fixed to variable costs is most often followed by a decrease in net banking income and an increase in operating risk. Third, regulators do not require banks to maintain an additional level of capital to manage risks. Consequently, banks try to exploit this advantage to increase their return to equity by taking more risks in non-traditional activities.

Adding to this, Stiroh (2004) studied this relationship in the US banking sector. He proved that shifting towards non-interest income in particular the trading revenue increases risk and reduces the risk-adjusted profits. According to this author, because of the significant volatility of trading revenue, non-interest income is more volatile than net interest income.

Stiroh and Rumble (2006) shed light on the “dark side” of revenue diversification. They argued that the volatility of the non-interest income offset the benefits provided by diversification.

Using a sample of 755 small European banks, Mercieca et al. (2007) proved that diversification into non-interest income does not help to strengthen the solidity and safety of European banks,

since, it results in an inefficient trade-off between risk and return. Adding to this, the insolvency risk is increased (Lepetit et al. 2008).

In the Australian context, Delpachitra and Lester (2013), supported also the negative impact of revenue diversification as it decreased profitability. Thus, these banks should concentrate on their traditional business and reduce their reliance on non-interest activities.

Paltrinieri et al. (2020) studied this issue in the field of Islamic banking. They used panel data of 47 Islamic and 154 conventional banks, they found that income diversification for Islamic banks has an insignificant impact on risk-adjusted profitability.

As we already mentioned, the link between non-interest income, bank performance, and risk has been well-studied in developed and emerging countries. Yet, the empirical results in the literature are mixed. In the context of the Tunisian banking sector, the issue of revenue diversification is not well-developed in the literature.

Since Tunisia underwent significant financial changes at the start of the 1990s, including the execution of structural adjustment programs, trade liberalization, and the ratification of numerous accords and trade agreements, it makes for Tunisian banking industry an interesting case study (Hamdi, 2013). Therefore, Mnasri et e Abaoub (2010) used panel data of Tunisian commercial banks over the period of 1997-2006. They proved that diversification has no direct benefit within or across business lines. Adding to this, the reliance on non-interest income reduces the performance of Tunisian commercial banks. Concerning the risk side, the authors didn't prove any significant link between diversification and systematic risk (even total risk).

Moreover, Ayedi and Ellouze (2015) studied the determinants of banking performance, they assumed that the share of non-interest income has no impact on bank performance. In the same vein, Hamdi et al. (2017), focused on the Tunisian context. By the use of 20 Tunisian banks over the period of 2005-2012, they pointed out that performance is one of the different determinants of non-interest income. In addition, their empirical results proved that non-interest income impact positively performance and negatively and significantly correlated with risk. Similarly, Belguith and Bellouma (2017) used a sample of 11 Tunisian banks over the period of 2001-2014 to examine the impact of revenue diversification on bank stability and performance. They demonstrated that income structure diversity provides a greater trade-off between the expected level and variance of bank performance.

In line with previous results that highlighted the added value of income diversification for emerging countries and based on the traditional portfolio theory, we can assume that this strategy of diversification tends to bring benefits to Tunisian banks. Other explanations that can enhance this assumption are the trend of the Tunisian banking sector to diversify its activities to gain a competitive advantage in which they take into consideration the development of technologies and environmental requirements as the behavior of their customers.

Adding to this, the size of this industry is characterized by small and medium banks that can benefit from diversification as it can improve their performance and reduce their risk.

Therefore, our first hypothesis is as under:

H1: Shifting toward non-interest income increases performance and reduces the risk for the Tunisian banking industry.

III.2 Non- interest income, bank risk, and performance during crises

Throughout their operations, banks are frequently confronting many types of risks that can adversely affect their activities (Hunjra et al. 2020). During the period of crisis, the banking sector faced several pressures. The profitability of traditional banking activities, such as business lending, would decline due to the declining level of deposits and rising level of non-performing loans in banks' balance sheets. Thus, adopting a new banking model, relying on functional diversification, can help banks to enhance their profitability and reduce their costs.

In the Tunisian context, according to financial experts, the revolution as well as the recent pandemic crisis put Tunisian banks under pressure. This sector is operating in a competitive and unstable environment that necessitates both digitalization and innovation. Adding to the core banking intermediation revenues, these banks requires also the adoption of new sources of income to sustain their performance and minimize their risk exposure.

In this line, several studies focused on investigating the impact of crises on the relationship between revenue diversification, bank performance, and risk. There are numerous empirical results highlight the positive side of this relationship where the non-interest activities are

perceived as a hedge to attenuate the influence of a sudden financial shock (Ammar and Boughrara, 2019).

Besides, other authors proved the adverse results. Where they supported the idea that the reliance on non-interest income leads these banks to be vulnerable to different macroeconomic and market shocks.

Therefore, we will present the literature dealing with this topic. Due to the specific source and different consequences of crises, we will treat each type of crisis separately.

III.2.1 Global financial crisis: an overview

By the end of 2008, most of the equity of banks around the world has been destroyed due to the occurrence of the subprime crisis in 2007. However, this crisis had a non-uniform impact on the performance of these banks (Dietrich and Wanzenried, 2011). This impact depends on the business model adopted by each bank.

In response to the crisis, several authors have been motivated to investigate the impact of non-interest income, especially on bank performance and risk during the financial crisis.

For this reason, Vallascaset al. (2012) studied the link between income diversification and bank performance during the financial crisis. Based on 145 Italian banks, findings demonstrate that as a result of the recent financial crisis, diversified banks showed the highest performance decline. Jointly, they proved that this decline is associated with each type of income diversity studied. However, traditional banking that relied heavily on deposit-based funding and loan were characterized by performance-enhancing during times of turmoil.

By performing a multi-period logit model, DeYoung and Torna (2013) assumed that different non-interest streams have inconsistent impacts on the failure of US banks during the financial crisis. Their main findings suggest that the likelihood of bank failure during this crisis was reduced by fee-for-business revenue like loan services, insurance sales, and security brokerage. In contrast, other sources of non-interest income as investment banking, and venture capital increased the likelihood of bank failure.

Park et al. (2019) investigated the impact of income diversification on bank risk and return during the period of the financial crisis. By the use of panel data of US holding companies, they pointed out that non-interest income positively impacts bank risk and return during this period.

Moreover, they proved that bank instability during the destressed period is not generated by non-interest revenue.

In the context of the Chinese banking sector, Cheng et al. (2020) studied the impact of the business model on bank risk during and after the financial crisis. Therefore, to address this issue they used panel data of 180 commercial banks from 2004-2016. Their main empirical results proved that during and after the financial crisis increasing the share of non-interest income leads to an increase in insolvency risk as well as the volatility of ROA.

Based on a sample of commercial banks in the OECD[3] countries, Kim et al. (2020) proved the existence of a non-linear relationship between diversification and financial stability. In addition, during the financial crisis diversification lead to an increase in the volatility of financial stability. Based on these results, the authors argued that banks should focus on traditional intermediation activities instead of diversifying their activities.

Moudud-Ul-Huq et al. (2020), used the generalized method of moments estimator (GMM) to evaluate the impact of revenue diversification in the context of emerging countries. They used two data; 32 commercial banks in Bangladesh and 16 commercial banks in South Africa. Their main results provided concrete evidence that portfolio diversification can be a tool for emerging economies to reduce risk and boost bank performance.

Investigating the same issue, Nguyen et al. (2020) focused on a group of commercial banks in 28 countries[4] during 1993-2013. By performing the dynamic GMM estimator, they demonstrated the existence of an inverse relationship between traditional and non-traditional banking profit. Adding to this, the diversification benefits are observed only in the period before the financial crisis. In contrast, the post-crisis period is characterized by a negative effect of non-traditional activities on the risk-adjusted return.

Yang et al. (2020) studied the impact of income diversification on the systematic risk of US commercial banks from 2000 to 2013. This period contains two subsamples related to the

[3]The Organization for Economic Co-operation and Development (OECD), where the government of 38 countries collaborate to develop policy standards to promote sustainable economic growth. These countries are: Austria, Australia, Belgium, Canada, Chile, Colombia, Costa Rica, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, The united Kingdom and the United States.

[4]Classified as financially liberalized countries which are Argentina, Brazil, Canada, Chile, Colombia, Denmark, Finland, France, Germany, Hong Kong, Indonesia, Ireland, Italy, Japan, Korea, Malaysia, Mexico, Norway, Peru, Philippines, Portugal, Spain, Sweden, Taiwan, Thailand, Venezuela, United Kingdom, and the United States

financial crisis (2007-2008) and the European debt crisis (2010-2013). Using a CoVAR[5] to measure the systematic risk, the authors assumed that during the crisis period revenue diversification impact positively the systematic risk.

The financial crisis, whose starting points are part of the chain of failure of the financial sector in a developed country, has progressively reached emerging and underdeveloped countries, particularly Tunisia, through a variety of mechanisms and transmission lines. As a consequence, it is very important, from the point of view of real activity, that this crisis had a negative spillover impact (Ben salem, 2018).

Based on the previous results, we can formulate our second hypothesis:

H2: Shifting toward non-interest income decreases (increases) performance (risk) for the Tunisian banking industry during the financial crisis.

III.2.2 Pandemic crisis (COVID -19): an overview

Since the global financial crisis of 2007–2009, the COVID-19 pandemic is one of the worst economic crises. The outbreak of this global pandemic has not only affected the human health of individuals. It has also threatened the economy as a whole, creating stress on the international financial markets (Goldstein et al. 2021). As a financial institution, the banking sector around the world has experienced an immediate exogenous shock (Elnahass et al. 2021).

The economic downturn brought on by COVID-19 affects bank profitability, decreases bank revenue, and results in losses due to defaulted debtors. Moreover, it leads to tightened credit standards and decreased demand for various types of loans (Li et al. 2021). Therefore, banks must take several measures to deal with the COVID-19 epidemic, such as strengthening their risk provision or reorganizing their sources of income.

As is highlighted by the financial theory, that diversification has several benefits as it can reduce risk. Therefore, income diversification can be a good strategy to reduce the negative impact of this health crisis on the banking sector. In this context, Simoensa and Vander Venneta (2021) provided an empirical analysis of how diversity affected the European bank market valuations

[5]Defined" as the change in the value at risk of the financial system conditional on an institution being under distress relative to its median state" (Adrian and Brunnermeier, American economic review, Vol. 106 No. 7 July 2016).

during the first month of the Covid-19 outbreak in multiple aspects. They found that functional diversity, especially the reliance on non-interest income is an economical buffer to absorb the adverse pandemic shock.

Studying the same issue, Li et al. (2021) assumed that the use of non-interest income as a source of revenue had a positive impact on bank performance and a negative impact on risk during the COVID-19 pandemic. Their results are supported by Kozak and Wierzbowska (2022), who highlighted the diversification benefits of the reliance on non-interest income during the period when the rapid spread of this pandemic impacted negatively the world economy.

By performing a dynamic panel regression Ochenge (2022) investigated the relationship between revenue diversification and bank performance. For this reason, the author used data from 30 commercial banks in Kenya. His empirical results are also the same as proved by Li et al. (2021), Kozak and Wierzbowska (2022).

Unfortunately, despite these three works presented above the literature addressing this issue is so restrictive. Therefore, based on these results we expect that for the Tunisian banking sector non-interest income impact increased bank performance and reduced risk.

Thus, our third hypothesis is formulated as under:

H3: Shifting toward non-interest income increased performance and decreased risk for the Tunisian banking industry during the COVID-19 pandemic.

IV. Conclusion

The technological innovations, financial liberalization, and deregulation are accompanied by the increasing demand for new innovative and different financial products and services leading banks to adopt a new business model and diversify their business activities from different non-core business activities. In addition, it seems that the diversification strategy impacts the risk-performance differently.

In this chapter, we discussed the concepts of income diversification, performance as well as risk in the banking industry. Then, we presented a review of the literature dealing with the relationship between income diversification and performance and banking risk in normal periods and periods of crisis. We found authors asserting the existence of a positive relationship between these variables. Others rather defended the negative impact of diversification on profitability and banking risk. Finally, other authors proved that the impact is insignificant and that it is dependent on other variables specific to the banking sector.

Following this discrepancy in the economic literature, we decide, in the next chapter to focus on the Tunisian context and empirically examine the relationship between income diversification, performance and risk of Tunisian banks during crises.

CHAPTER 2: DATA, METHODOLOGY AND EMPIRICAL FINDINGS

I. Introduction

Nowadays, banks have become increasingly challenged by several factors such as competition, globalization and technological development. Faced with this situation, banks expanded their activities beyond their traditional business model.

The banking activity involves a variety of risks that can affect the performance and even the stability of the banking sector. For this purpose, banks are obliged to measure and manage all these risks. For this reason, to address this problem banks need to focus their strategic choices by picking the right combination of these activities while taking into account the risk/return trade-off.

In this regard, income diversification has been considered an interesting topic by several authors. Many scholars highlighted the positive impact of income diversification on both bank performance and stability. Whereas, others proved its negative impact.

Therefore, to study this topic in the context of Tunisian Banks we will devote this chapter to empirically studying the relationship between income diversification, bank performance and risk in general and in crises period.

Thus, this chapter is structured as follows. In the first section, we will present the features of the Tunisian banking sector. We will describe our data and present our methodology in the second section. Adding to this we will analyze the descriptive statistics and provide the preliminary tests. After dealing with these analyses, we will present and discuss our empirical findings. Lastly, we will end this chapter with a general conclusion by reviewing the results of our research.

II. Tunisian banking sector: an overview

The banking industry is considered as the main pillar of the Tunisian economy, which contributes to its development and ensures its performance. During the past two de decades, the Tunisian banking system has experienced significant improvements thanks to a comprehensive program of modernization of financial institutions introduced by the Central Bank of Tunisian. In the following section, we will start by overviewing the structure of the Tunisian banking sector. We will then focus on its current features and the main indicators that we will use in our empirical analyses.

II.1 The structure of the Tunisian banking sector

Headed by the central bank of Tunisia (CBT) which was created in 1958, the Tunisian banking sector is made up of 23 resident banks, 7 non-resident banks, 8 leasing companies, 2 factoring companies and 2 investment banks. The banking system is characterized by an important bank branch network. Currently, 1,999 branches are spread throughout the Tunisian territory.

The Tunisian banking sector is characterized by the domination of resident banks in terms of both weight and numbers. Indeed, these banks have 92.7% of the total assets of the sector.

The three state-owned banks which are BNA, STB and BH bank are the largest ones, in which they representing 36.5% of banking assets, 40.3% of banking credits and 29.9% of banking deposits[6].

II.2 Features of the Tunisian banking sector

Since the revolution of 2011, the Tunisian economy suffer from several shortcomings, resulting from political instability. The banking system's liquidity and stability were severely impacted by this revolution, which forced the CBT to modify its monetary policy and initiate new reforms. Nonetheless, the Tunisian economy is still vulnerable making it poorly prepared to absorb the ongoing shock like the one brought on by the pandemic crisis of COVID-19.

Amidst this context, Tunisia has experienced a deep decline in economic growth due to the decrease in both supply and demand. As is presented in the following figure (fig.1) we can see that the real GDP dropped to attain 8.7% in 2020 which is considered as a deeper decline compared to the financial crisis (2007-2008) and the revolution of 2011. Adding to this, developments in macroeconomic conditions were mitigated in 2021. Economic activity has faced up significant rigidities impeding recovery in growth. Indeed, the real GDP has rebounded modestly by 3.1% in 2021.

[6] Supervision report (CBT 2020)

Source: annual reports CBT

Figure 1:Evolution of the real GDP between 2007-2021

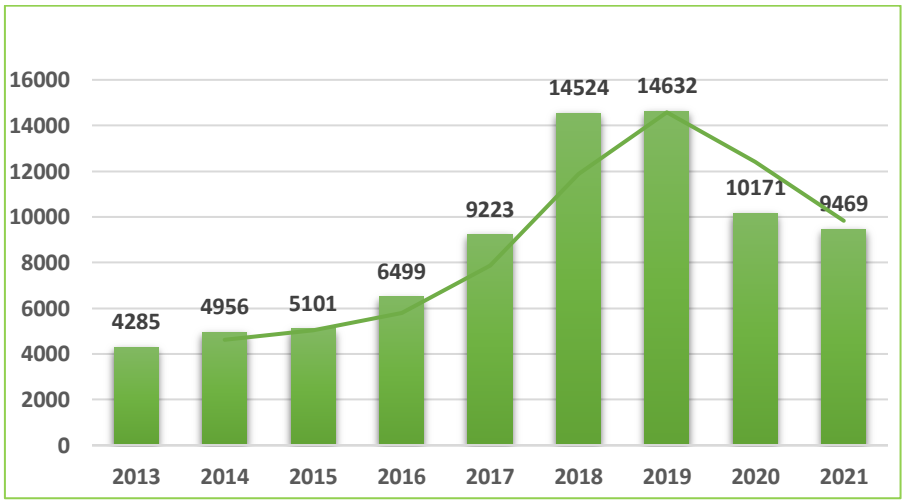
Adding to this, the unemployment rate increased in 2020 to attain 17.4% against 14.6% in 2019. Unfortunately, the economic recovery in 2021, has been insufficient to recover the losses caused by the health crisis and the unemployment rate remained at 16.2%.

Similarly, this pandemic has led to an increase in the level of public debt where it has reached a value of 77.8% of GDP in 2020 compared to 68% in 2019. Even in 2021, the level of this debt continued its increase where it presented 79.2% of GDP.

Moreover, the budget deficit has widened further in 2020 to attain 9.4% of GDP against 3.6% in 2019 as a result of lower tax revenue and higher public expenditure. In contrast, in 2021 the budget deficit decreased to attain 7.5% of GDP as a result of some savings expenditure and the increase of tax revenue by 12%.

Dealing with the context of the liquidity of the Tunisian banks, we can see in the following figure (fig.2) that banks' liquidity needs have increased consistently between 2013 and 2019. However, banks' liquidity needs decreased in 2020 and 2021. We can note that banks' liquidity needs decreased by 4461 MTD between 2019 and 2020 due to the return in Banknotes and Coins in Circulation (BMC) and the intervention of the CBT to mitigate the impact of the COVID-19 in the banking sector, especially in view of the default risk of some vulnerable companies. In this vein, the CBT has implemented a one-month refinancing operation and

widened the range of assets eligible for refinancing. This operation allowed the injection, from May to December 2020, an additional liquidity envelope of an average amount of 244 MTD[7]. In 2021, banks' liquidity needs decreased by 702 MDT to reach a value of 9469 MDT. This improvement is mainly due to the important return of cash to bank coffers, also to the increase in labor income and rebound in tourist recipients.

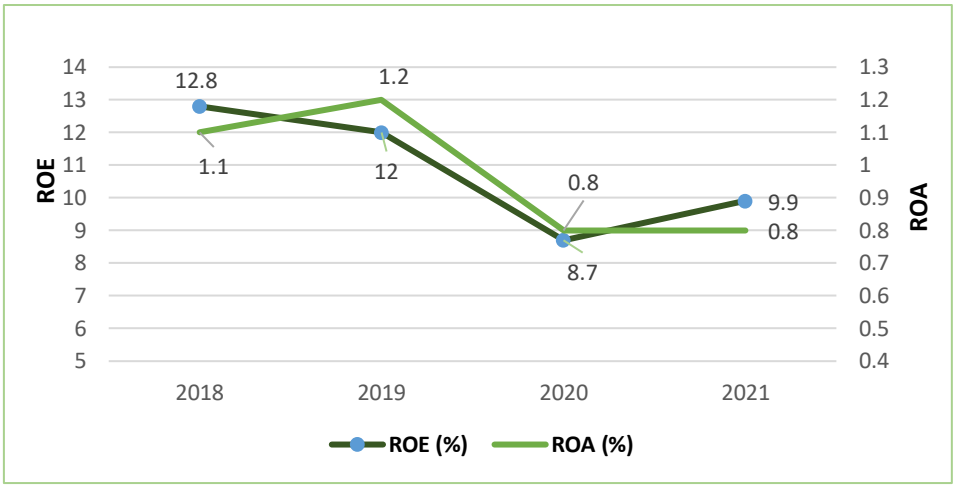


Source: annual report CBT 2020 and 2021

Figure 2: Banks 'liquidity need between 2013 and 2021

Moreover, in 2020 banks' profitability indicators (ROA and ROE) decreased (fig.3). The ROA dropped to attain 0.8% compared to 1.2% in 2019. Similarly, the ROE declined to attain 8.7% compared to 12% in 2019. This decline in profitability is due to the economic recession generated by the health crisis which has led to a decline in the net result of the banking sector. However, by the end of 2021, banks' profitability indicators improved. The ROE increased to reach 9.9% compared to the previous year and the ROA remained at its previous level of 0.8%.

[7] Annual report CBT 2020.



Source: supervision report of 2020 and annual report CBT 2021

Figure 3:Evolution of the ROA and ROE between 2018 and 2021

Concerning the operating activity of the Tunisian banking sector, we can note that the pace of progression of the Net operating income has shown a significant decline in 2020. Either an evolution just of 1.5% compared to 25.09% in 2019 (fig.4). This decline is generated by the decrease in the pace of the progression of the net interest margin which is because of the decrease in interest received related to the postponement of the maturities of credits and also the drop in the money market rate (MMR). And by the remarkable decrease in the pace of evolution of the net commission. However, by the end of 2021, the net operating income increased by 12.3% compared to the previous year. This improvement is related to the resumption of the activity and the return of the repricing of some banking services to their normal level.

In the same vein, according to the structure of the net operating income (fig.5), we can note that income revenue is roughly equally divided between interest and non-interest income. In 2021, the structure of the net operating income was characterized by a drop in the share of the interest margin by 3% and an increase of 2% in the income generated from the investment portfolio, compared to 2020.

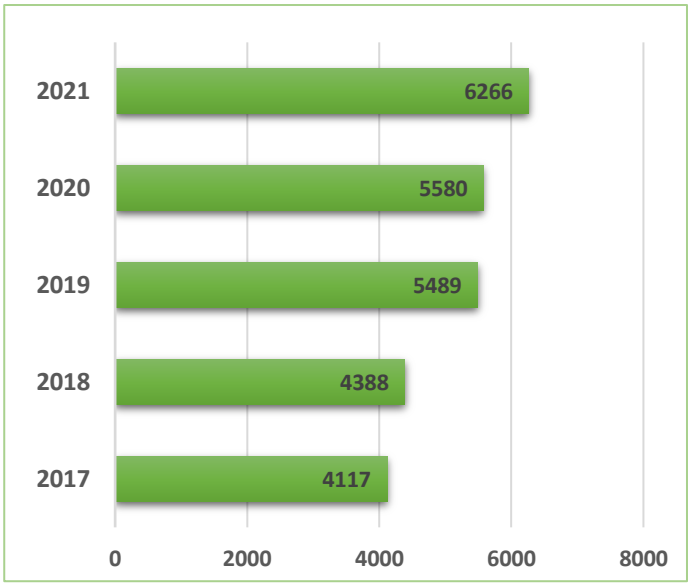


Figure 4:The NOI's evolution between 2017-2021

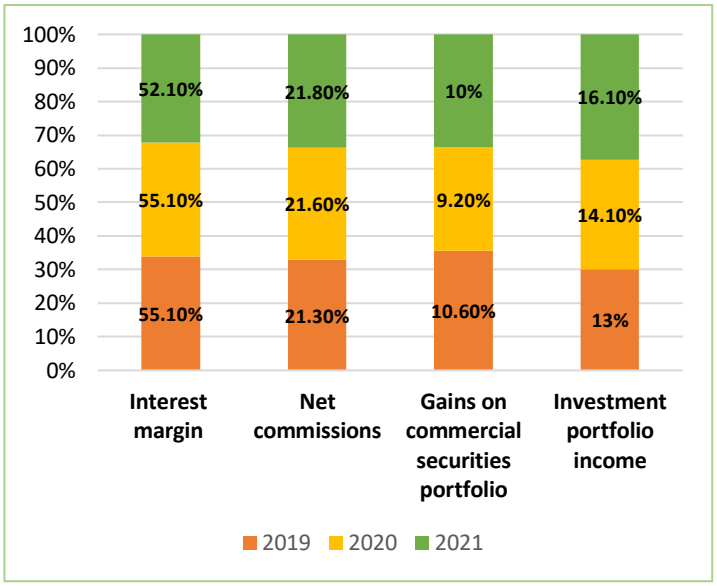
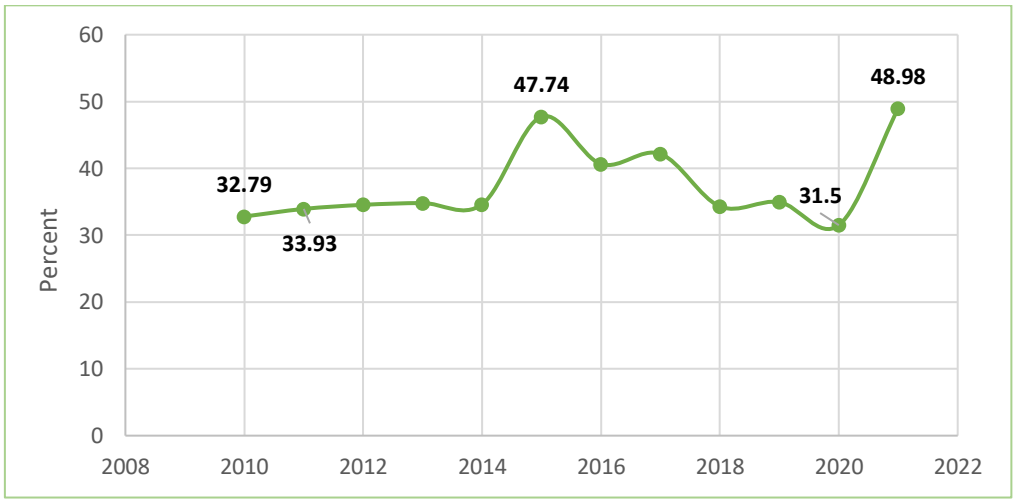


Figure 5: The NOI's structure between 2019-2021

Studying the tendency of non-interest income's share to total income, the following figure (fig.6) shows that non-interest income to total income significantly increased in 2021 by 17.48% after a deeper decline in 2020.



Source: The world bank[8]

Figure 6: Non-interest income to total income between 2010-2021.

[8] https://fred.stlouisfed.org/series/DDEI03TNA156NWDB.

III. Data and methodology

Before we start our analysis, we will present in this section our data and the methodology that we will follow in our study.

III.1 Data description and sources

For this study, empirical analysis is performed using 11 Tunisian-listed banks (see table 1). In our work, we selected only the listed banks due to the accessibility of information. However, we have excluded Wifak International Bank from our data which has just begun its activity in 2015 after its transformation from the company "El Wifak Leasing" into a universal bank specializing in Islamic banking. Our data covers 187 in total, for 17 years starting from 2005 to 2021. It is collected from the balance sheets and income statements of listed banks. The macroeconomic data is sourced from the world bank and the Central bank of Tunisia (CBT).

Table 1: List of Listed Tunisian Banks retained in our study

Acronym	**Banks**	**Ownership structure**	**Net operating income (2021)** (in millions of dinars)
BIAT	Banque Internationale Arabe de Tunisie	Private	1015
BNA	Banque Nationale Agricole	Public	829
STB	Société Tunisienne de Banque	Public	649
BH	BH Bank	Public	569
ATTIJARI	Attijari Bank	Private	523
AM	Amen Bank	Private	455
UIB	Union Internationale des Banques	Private	443
BT	Banque de Tunisie	Private	377
ATB	Arab Tunisian Bank	Private	298
UBCI	Union Bancaire pour le Commerce et l'Industrie	Private	263
BTE	Bank of Tunisia and Emirate	Private	63

Source: IlBoursa.com

III.1.1 Variables definition

Based on the previous empirical studies we present the variables that we use to test our hypotheses. These variables are dependent variables, independent variables and control variables.

III.1.1.1 Dependent variables

The main purpose of this empirical analysis is to study the link between income diversification, bank performance and risk. For this reason, we use two main measures for performance and risk which are considered as our main dependent variables.

The return on assets (ROA) is the measure of bank performance that is used by several authors. It is calculated as follows:

$$\boldsymbol{ROA} = \frac{Net\ income}{Total\ assets}$$

To measure bank stability, we employ the Z-score, based on the existing studies (Kevin J, 2004, Stiroh and Rumble 2006, Mercieca et al. 2007, Ammar and Boughrara, 2019). It is defined as" the number of standard deviations by which a bank's return on assets has to fall for the bank to become insolvent" (Köhler, 2015). Thus, it is used as a risk proxy. Indeed, a higher value of the Z-score denotes greater bank stability and in turn a low level of bank risk.

The Z-score is calculated as follows:

$$\boldsymbol{Z - score} = \frac{ROA + capital}{\sigma ROA}$$

Where:

Capital is the ratio of total equity to total assets.

σROA is the standard deviation of ROA.

III.1.1.2 Independent variables

To measure the level of income diversity, especially the share of non-interest income we use the ratio of the non-interest income to total operating income (as Baele et al. 2007, Cheng et al. 2020, Ochenge 2022, Alouane et al. 2021, etc). In the literature, there is another indicator used

widely by several authors to assess the issue of income diversification which is the Herfindahl-Hirschman Index (HHI). However, this index takes into account the two sources of revenue which are net interest and non-interest revenue. For this reason, our choice is justified by the fact that the non-interest income ratio best fulfills our objectives because it allows us to capture the immediate impact of diversification. Therefore, ***the share of non-interest income*** is as follows:

$$\boldsymbol{NNII} = \frac{Non - Interest\ Income}{Net\ Operating\ Income}$$

In addition, a detailed analysis of the different product lines gives an in-depth breakdown of the contribution of each activity to the bank's profitability and stability. Therefore, we split the non-interest income into its main components which are net commissions and trading commissions (which include gains from the commercial portfolio and the investment portfolio). Thus, we use additional diversification ratios which are:

The Commission share ratio

$$\boldsymbol{COMSH} = \frac{Net\ Commissions}{Net\ operating\ income}$$

The Trading share ratio

To capture the impact of trading revenue as a component of non-interest income, we incorporate two ratios which are presented as follows:

$$\boldsymbol{CPSH} = \frac{Commercial\ potfolio'\ profit}{Net\ operating\ \ Income}$$

$$\boldsymbol{IPSH} = \frac{Investment\ potfolio'\ profit}{Net\ operating\ Income}$$

III.1.1.3 Control variables

In our study, we use three categories of control variables which are bank-specific variables, macroeconomic variables and dummy variables. Bank-specific and macroeconomic variables have a significant impact on the profitability and stability of the banking sector.

- Bank-specific variables

Taking into consideration the bank's core activity which is the intermediation activity we use the ratio of the net interest income to the total asset ***(NIM)***. In our study, this variable cannot be employed to measure bank performance as it is only useful for monitoring the profitability of traditional or interest-generating activities.

$$\boldsymbol{NIM} = \frac{Net\ interest\ income}{Total\ assets}$$

We introduced also ***the capital adequacy ratio (CAP)*** which is measured by the total equity to total assets. Several studies proved that bank capitalization has a positive impact on bank's performance (Naceur and Goaied, 2001; Liu et Wilson, 2010; Goddard et al. 2004; Abreu and Mendes, 2001, etc). Therefore, a well-capitalized bank can deal with the costs of a future bank failure (Ayadi and Ellouze 2015). In the context of Tunisian banks, Dhouibi (2015) proved that the capital structure impacted positively banks 'performance.

The capital ratio is presented as follows:

$$\boldsymbol{CAP} = \frac{Total\ equity}{Total\ assets}$$

Moreover, we use ***the bank size*** as our third control variable. It is commonly used to capture potential economies or diseconomies of scale in the banking sector. Banks are more stable and their idiosyncratic risk is reduced when the bank size is increased (Ammar and Boughrara, 2019). While increasing the size of banks may enhance their performance, a negative impact

could emerge as larger and complex banks tend to aggressively opt for diversification strategies. This variable is measured by the natural logarithm of banks' total assets which is presented as follows:

$$\boldsymbol{SIZE = Ln(Total\ assets)}$$

To measure bank efficiency, we use **the cost-to-income ratio (CTI)** which is defined as the ratio of operating costs to the net operating income (Ammar and Boughrara, 2019). This ratio gives an idea of the efficiency of the bank' management as it reflects managers' capability to minimize the banks' costs by improving the quality of fees, commissions-based-business and trading activities. Thus, to enhance banks' efficiency and profitability, managing operating costs is the appropriate way (Karakaya and Er, 2013). A lower value of this ratio indicates a high bank efficiency.

The cost-to-income ratio is presented as follows:

$$\boldsymbol{CTI} = \frac{Operating\ Costs}{Net\ Operating\ Income}$$

As another bank-specific variable, we introduce **Asset growth (AG).** This variable captures the impact of rapid growth on banks' strategic choices (Lee et al. 2014). Banks with greater asset growth may be inclined to seek non-traditional revenue sources. Adding to this, asset growth can be seen as a proxy of growth through acquisition (Sanya and Wolf, 2011; (Mercieca et al, 2007; Stiroh and Rumble 2006).

This ratio is presented as follows:

$$\mathbf{AG} = \frac{\boldsymbol{TA_t - TA_{t-1}}}{\boldsymbol{TA_{t-1}}}$$

Where; TA is the total assets.

- Macroeconomic variables

The Gross Domestic Product (GDP)

It is an external determinant of macroeconomic conditions. In upturns, high economic growth facilitates credit expansion and may motivate managers to undertake risky aggressive strategies. In downturns, when real GDP growth is decreasing and when loan demand reduces, investors will be discouraged to invest in the domestic markets and financial instability will increase (Nguyen et al. 2012). The GDP growth is expected to have a positive impact on banks' performance based on the literature related to the association between economic growth and financial sector performance.

The inflation rate (INF)

The inflation rate is presented as a measure of macroeconomic conditions. Inflation and bank performance relationship depend on whether the inflation is anticipated or unanticipated. On the one hand, banks can timely adjust interest rates, which consequently results in revenues that grow faster than costs, with a positive impact on profitability. On the other hand, banks may be slow in adjusting their interest rates resulting in a faster rise in bank costs than bank revenues. This will consequently impact negatively bank profitability and increase its insolvency risk. Thus, we cannot determine in advance the impact of inflation on bank performance.

Dummy variables

To address the issue of the impact of the share of non-interest income on both bank risk and performance during different types of crises we use two dummy variables:

The first one is **DF (dummy financial crisis)** is used to capture the impact of the subprime crisis. It takes a value of 1 for the years 2007, 2008 and 2009. And it takes a value of 0 otherwise.

The second one is **DC (dummy health crisis, the Covid-19 pandemic)** is used to capture the impact of Covid-19. It takes a value of 1 for the years 2020 and 2021, and it takes a value of 0 otherwise.

III.2 Methodology

As we mentioned in the first chapter we aim to study the impact of income diversification on both bank risk and performance during crises period, especially during the financial crisis (subprime) and the health crisis (Covid-19). For this purpose, our empirical work will proceed in two main parts. On the one hand, we will use the impulse-response function of the panel vector autoregressive (PVAR) to forecast the impact of a shock of the share of the non-interest income (as it is our measure of income diversification) on bank risk and performance.

On the other hand, we will use panel regression models in which we will start by testing the effect of shifting toward non-interest income on bank risk and performance in general over the period of our study. Adding to this, we will test the impact of each component of the non-interest income. Dealing with the issue of crises we will use dummy variables indicating the crisis period (subprime and covid-19) and we will use interaction terms between our measure of diversification and the dummy variables (following Saunders et al. 2016). Moreover, we will test the impact of each component of the non-interest income on bank risk and performance during the most recent crisis which is Covid-19.

Therefore, our basic model is presented as follows:

$$\mathbf{Y_{it}} = \boldsymbol{\alpha} + \boldsymbol{\beta}\, \boldsymbol{DIV_{it}} + \sum \boldsymbol{\delta_k}\, \boldsymbol{X_{it}} + \boldsymbol{\varepsilon_{it}} \quad \textbf{(A)}$$

Where:

Y_{it}: is the vector of our dependent variables which are bank performance (ROA) and bank risk (Z-Score) for the bank i and the year t.

DIV_{it}: is the vector of our dependent variables which are the share of the non-interest income (NNII) and the share of the non-interest income components (commission (COMSH), and trading revenue CPSH, IPSH).

X_{it}: is the vector of our control variables including bank-specific variables such as NIM, Size, AG, CAR and CTI. It includes also macroeconomic variables such as GDP and INF.

ε_{it}: is the error term.

Based on this model we will split the second part of our methodology into four main steps in which we will run 10 regressions in total, which are presented as follows:

Step1: the non-interest income' impact on bank performance and risk

$$\mathbf{ROA_{it}} = \alpha + \beta\, NNII_{it} + \delta_1 NIM_{it} + \delta_2 CAR_{it} + \delta_3 AG_{it} + \delta_4 Size_{it} + \delta_5 CTI_{it} + \delta_6 GDP_t + \delta_7 INF_t + \varepsilon_{it} \quad \mathbf{(1)}$$

$$\mathbf{Z\text{-}Score_{it}} = \alpha + \beta\, NNII_{it} + \delta_1 NIM_{it} + \delta_2 CAR_{it} + \delta_3 AG_{it} + \delta_4 Size_{it} + \delta_5 CTI_{it} + \delta_6 GDP_t + \delta_7 INF_t + \varepsilon_{it} \quad \mathbf{(2)}$$

Step2: the non-interest income components' impact on bank performance and risk

$$\mathbf{ROA_{it}} = \alpha + \beta_1\, COMSH_{it} + \beta_2 CPSH_{it} + \beta_3 IPSH_{it} + \delta_1 NIM_{it} + \delta_2 CAR_{it} + \delta_3 AG_{it} + \delta_4 Size_{it} + \delta_5 CTI_{it} + \delta_6 GDP_t + \delta_7 INF_t + \varepsilon_{it} \quad \mathbf{(3)}$$

$$\mathbf{Z\text{-}Score_{it}} = \alpha + \beta_1\, COMSH_{it} + \beta_2 CPSH_{it} + \beta_3 IPSH_{it} + \delta_1 NIM_{it} + \delta_2 CAR_{it} + \delta_3 AG_{it} + \delta_4 Size_{it} + \delta_5 CTI_{it} + \delta_6 GDP_t + \delta_7 INF_t + \varepsilon_{it} \quad \mathbf{(4)}$$

Step3: the non-interest income' impact on bank performance and risk, during crises

$$\mathbf{ROA_{it}} = \alpha + \beta\, NNII_{it} + \beta_1 NNII_{it} * DF(NNII_{it} * DC) + \beta_2 DF(DC) + \delta_1 NIM_{it} + \delta_2 CAR_{it} + \delta_3 AG_{it} + \delta_4 Size_{it} + \delta_5 CTI_{it} + \delta_6 GDP_t + \delta_7 INF_t + \varepsilon_{it} \quad \mathbf{(5)\ (7)}$$

$$\mathbf{Z\text{-}Score_{it}} = \alpha + \beta\, NNII_{it} + \beta_1 NNII_{it} * DF(NNII_{it} * DC) + \beta_2 DF(DC) + \delta_1 NIM_{it} + \delta_2 CAR_{it} + \delta_3 AG_{it} + \delta_4 Size_{it} + \delta_5 CTI_{it} + \delta_6 GDP_t + \delta_7 INF_t + \varepsilon_{it} \quad \mathbf{(6)\ (8)}$$

Step4: the non-interest income components' impact on bank performance and risk, during the COVID-19 crisis

$$\mathbf{ROA_{it}} = \alpha + \beta_1\, COMSH_{it} + \beta_2 CPSH_{it} + \beta_3 IPSH_{it} + \beta_4 COMSH_{it} * DC + \beta_5 CPSH_{it} * DC + \beta_6 IPSH_{it} * DC + DC + \delta_1 NIM_{it} + \delta_2 CAR_{it} + \delta_3 AG_{it} + \delta_4 Size_{it} + \delta_5 CTI_{it} + \delta_6 GDP_t + \delta_7 INF_t + \varepsilon_{it} \quad \mathbf{(9)}$$

$$\text{Z-Score}_{it} = \alpha + \beta_1 COMSH_{it} + \beta_2 CPSH_{it} + \beta_3 IPSH_{it} + \beta_4 COMSH_{it} * DC + \beta_5 CPSH_{it} * DC + \beta_6 IPSH_{it} * DC + DC + \delta_1 NIM_{it} + \delta_2 CAR_{it} + \delta_3 AG_{it} + \delta_4 Size_{it} + \delta_5 CTI_{it} + \delta_6 GDP_t + \delta_7 INF_t + \varepsilon_{it} \quad (10)$$

IV. Descriptive statistics and preliminary tests

Before applying any estimation method, a detailed analysis of the properties of the series is essential. Therefore, before starting our empirical study it is essential to study the general behavior of each of our variables by presenting the descriptive statistics and the study of the correlation between the variables. In addition, a set of preliminary tests is presented to assess the validity of our models.

IV.1 Descriptive statistics

The descriptive statistics of all the variables for the 11 Tunisian banks during the study period are illustrated in the following table (table 2). We present the number of observations, the mean, the standard deviation, the minimum and the maximum of each of the dependent and independent variables.

Table 2:Descriptive statistics

	Variables	Obs	Mean	Std. Dev	Min	Max
Dependent variables	ROA	187	0.009	0.01	-0.08	0.026
	Z-Score	187	0.22	0.16	-0.05	0.61
Independent variables	NNII	187	0.45	0.11	0.17	0.79
	COMSH	187	0.23	0.06	0.19	0.40
	CPSH	187	0.14	0.10	0.0003	0.55
	IPSH	187	0.08	0.06	0.0015	0.32
Control variables	NIM	187	0.024	0.007	0.008	0.041
	CAR	187	0.1	0.06	-0.016	0.49
	Size	187	6.64	0.35	5.42	7.28
	CTI	187	0.48	0.12	0.24	0.85
	AG	187	0.09	0.07	-0.08	0.36
	GDP	187	0.021	0.033	-0.086	0.067
	INF	187	0.048	0.013	0.021	0.073

- The ROA has an average of 0.9% with a minimum value of -8% (ATTIJARI BK 2007) and a maximum value of 2.6% (BT 2008) and a standard deviation of 1%.

  Thus, this measure highlights the disparities that exist between the listed Tunisian banks included in our study, which includes both low and high-performance banks.

  By analyzing the average value of ROA of each listed Tunisian bank used in our sample during the period of our study (fig.7) we can notice that the highest average value is 2.12% which belongs to BT. However, BTE shows the lowest average value of 0.35%.

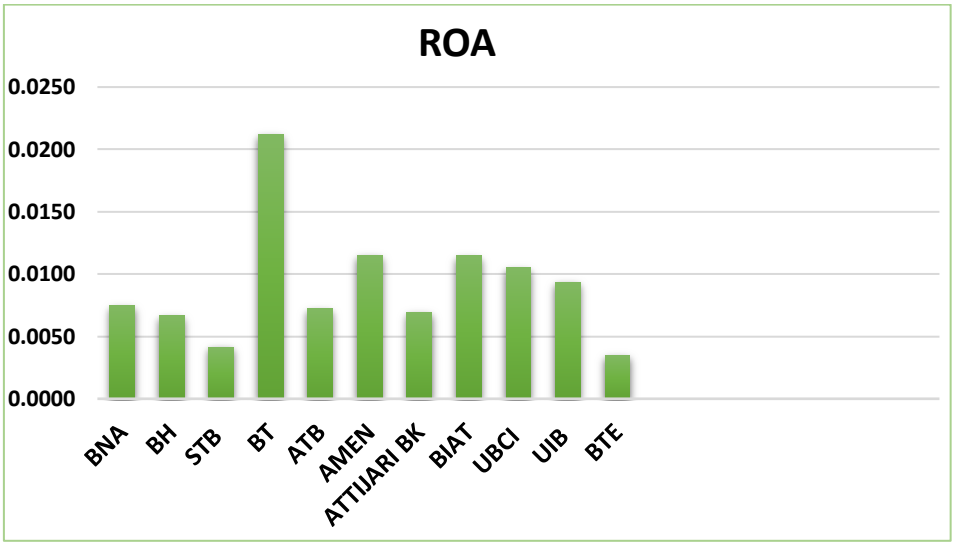


Figure 7: ROA of the listed Tunisian banks (the average during 2005-2021)

- The Z-Score has an average value of 22% with a minimum value of -50% (STB 2013) and a maximum value of 61% (AMEN 2021). It has also a high value of standard deviation, 16%, indicating that our sample includes banks with a high level of instability.

  We studied also the average value of the Z-Score of each listed Tunisian bank in our sample (fig.8). We can notice that BT has the highest average value of 51% and ATTIJARI BK has the lowest average value of 3.32% during the period of our study.

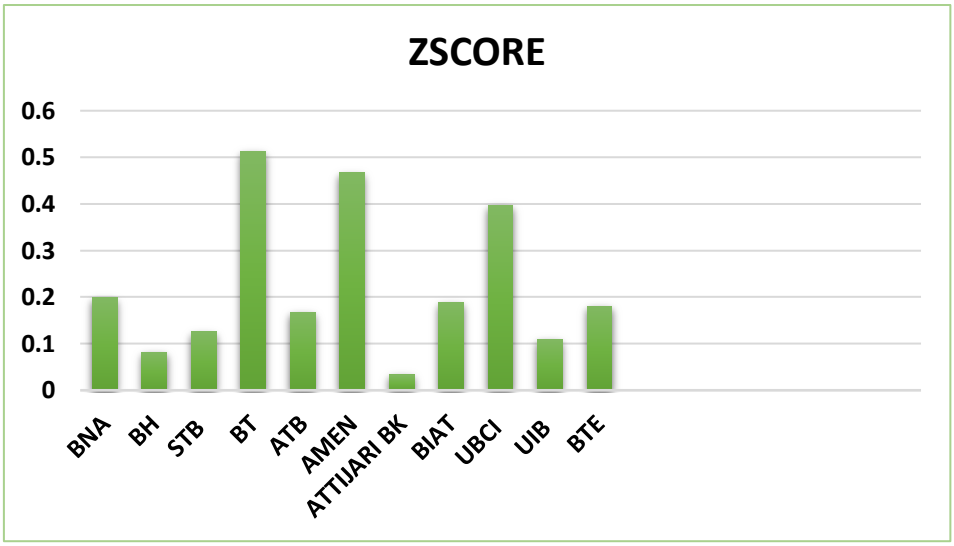


Figure 8: Z-SCORE of the listed Tunisian banks (the average during 2005-2021)

- Dealing with the share of the non-interest income it reported an average of 45% with a range from 17% (BTE 2005) to 79% (ATB 2006) and a standard deviation of 11%. The highest average value which is 67.34% belongs to ATB, and the lowest average value which is 37.26% belongs to BNA.

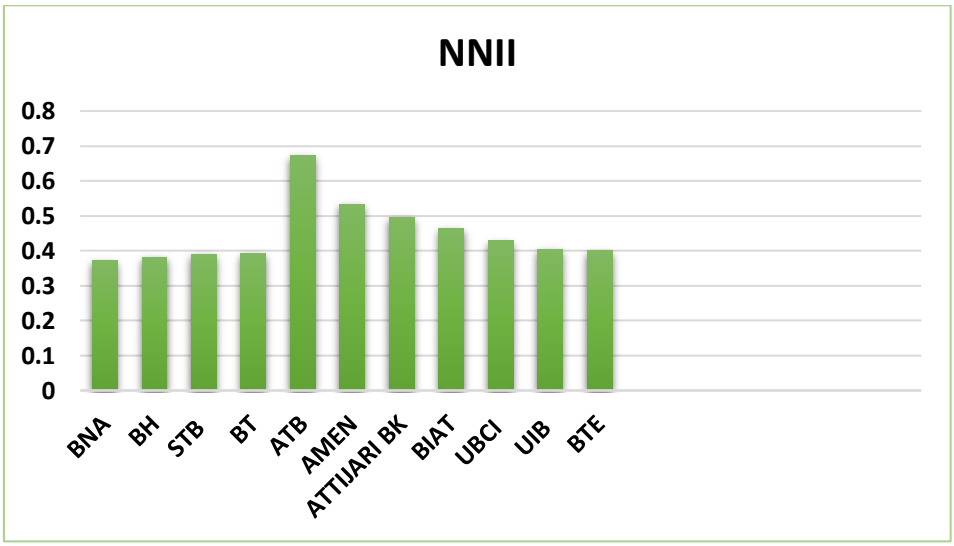


Figure 9:The share of the non-interest income (NNII) of the listed Tunisian banks (the average during 2005-2021)

- Concerning the three components of non-interest income, we can notice that commissions have the highest average value of 23% compared to the gain generated

from the commercial portfolio (CPSH) and the gain generated from the investment portfolio (IPSH). This value proved that banks' income structure is based on bank services and fee-based activities.

Studying the average value of the share of these three components of each listed Tunisian bank used in our analysis (fig.10), we can notice that the non-interest income structure of the UIB is based on the share of the commissions in which she has the highest average value of 29%. However, she has the lowest average value of gains generated from the investment portfolio (3.8%). Adding to this, ATB has the highest average value of gains generated from the commercial portfolio (35%). Yet, the lowest average value belongs to BTE (5.7%).

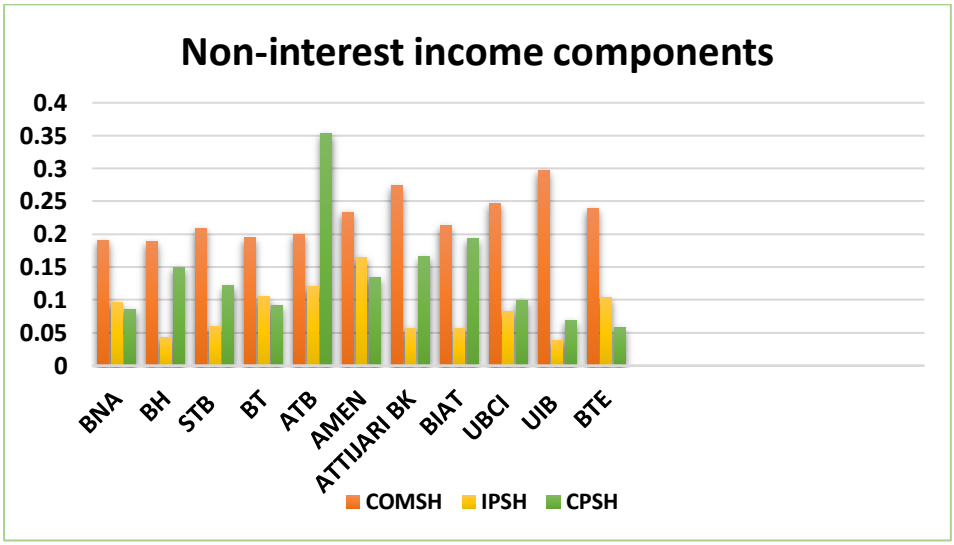


Figure 10:The share of the non-interest income components of the listed Tunisian banks (the average during 2005-2021)

- Concerning the net interest margin (NIM) has an average of 2.4% with a minimum of 0.08% (ATB 2006) and a maximum of 4.1% (UBCI 2020). It has also a low level of standard deviation of 0.7%.
- On average, the capital adequacy ratio of the 11 listed banks presents 10%. The minimum is -1.6% (STB 2013) and the maximum is 49% (BTE 2005).
- Regarding the cost-income ratio (CTI), it reported an average value of 48%, with a value of a standard deviation of 12% and a range from 24% (BT 2010) and 85% (UIB 2007).

- As for the bank's assets growth (AG), it has an average value of 9% with a value of standard deviation of 7%. The minimum value is -8% (UBCI 2019) and the maximum value is 36% (BTE 2007).
- Regarding the macroeconomic factors, we found that the GDP rate presents an average value of 2.1%, with a minimum value equal to -8.6% in 2020 due to the pandemic crisis (COVID-19) and a maximum value equal to 6.7% in 2007. Adding to this, the inflation rate has an average value of 4.8% with a range from 2.1% in 2005 and 7.3% in 2018.

IV.2 Correlation analyses

In order to study the correlation between our dependent and independent variables, we present the correlation matrix (tab.3). Our two dependent variables which are ROA and Z-Score are positively and significantly correlated. This proved that performant banks are more stable. The share of non-interest income is positively and significantly correlated to bank performance and stability. Regarding the different components of non-interest income, we can document that COMSH is negatively and significantly correlated with both bank performance and stability. In contrast, CPSH is non-significant correlated to both performance and stability. The IPSH is positively and significantly correlated to bank stability. Moreover, NIM is positively and significantly correlated to both bank performance and risk. Thus, intermediation activity enhances bank performance as well as bank stability. We can also notice that size, AG and CAR are positively and significantly correlated to bank performance. Concerning macroeconomic factors, they are not significantly correlated to bank performance and stability.

Table 3:Correlation Matrix

Variables	ROA	Z-SCORE	NNII	NIM	COMSH	IPSH	CPSH	SIZE	Asset growth	CAR	cti	GDP	INF
ROA	**1**												
Z-SCORE	**0,437****	**1**											
NNII	**0.015****	**0.052****	**1**										
NIM	**0,266****	**0,215****	**-0,739****	**1**									
COMSH	**-0,302****	**-0,219****	**0,283****	-0,113	**1**								
IPSH	0,125	**0,386****	**0,342****	**-0,199****	-0,105	**1**							
CPSH	0,072	-0,142	**0,700****	**-0,605****	**-0,174****	**-0,228****	**1**						
SIZE	**0,163****	-0,088	**0,177****	-0,048	**-0,185****	**0,180****	**0,175****	**1**					
AG	**0,275****	0,019	0,010	-0,107	-0,141	-0,097	**0,152****	-0,126	**1**				
CAR	**0,267****	**0,454****	**-0,250****	**0,204****	**-0,373****	**0,213****	**-0,205****	**-0,555****	0,134	**1**			
CTI	**-0,538****	**-0,448****	0,106	-0,111	**0,532****	-0,128	-0,093	**-0,377****	**-0,158****	**-0,228****	**1**		
GDP	-0,027	-0,027	-0,096	-0,049	-0,051	**-0,292****	0,116	**-0,279****	**0,250****	0,006	0,029	**1**	
INF	0,039	-0,003	0,123	0,120	0,022	**0,368****	-0,120	**0,316****	**-0,270****	-0,059	-0,042	**-0,152****	**1**

** represent statistical significance at 5%.

IV.3 Preliminary tests

IV.3.1Multicollinearity test

The Variance Inflation Factor (VIF) is used to detect the issue of multicollinearity. In general, the inflation factor of the variance of each variable must be less than the critical value of 10. In addition, the tolerance, defined as 1/VIF, is used by researchers to check the degree of collinearity. A tolerance value less than 0.1, or a VIF value more than 10, means that the variable is considered as a linear combination of another independent variable. Indeed, all the variables used in our regressions have a VIF value of less than 10. Therefore, there is no multicollinearity issue.

IV.3.2Stationarity test

To test the stationarity of the variables used in our analyses we use the most common test in panel data which is the Levin-Lin-Chu test in which the null hypothesis suggests the presence of unit roots.

The hypotheses to be tested are:

H0: There are unit roots

H1: Variables are stationary

Table 4:The results of the Levin-Lin-Chu test (Unit root test)

Variables	t-statistic	P-value
ROA	-19.70	0.0000
Z-Score	-9.83	0.0000
NNII	-3.21	0.0006
COMSH	-1.94	0.0256
CPSH	-1.57	0.0574
IPSH	-4.32	0.0000
NIM	-4.74	0.0000
CAR	-4.33	0.0000
Size	-5.88	0.0000
CTI	-3.26	0.0005
AG	-5.01	0.0000
GDP	-2.83	0.0023
INF	-2.03	0.0209

Therefore, according to the results presented in the table above (tab.4), all our variables are stationary where the p-value is less than 5% except for the CPSH which is stationary at a 10% level of significance.

IV.3.3 Homoscedasticity test (Breush-Pagan test)

To detect possible heteroscedasticity of errors, we use the Breush-Pagan test, in which the null hypothesis is the variance of the error term is constant.

The hypotheses to be tested are:

H0: The variance of the error term is constant (homoscedasticity)

H1: The variance of the error term is equal (heteroscedasticity)

Table 5:The results of the Breush-Pagan test

Regressions	Breush-Pagan value	P-value
1	227.42	0.0000
2	13.65	0.0002
3	230.95	0.0000
4	14.92	0.0001
5	233.19	0.0000
6	12.76	0.0004
7	173.19	0.0000
8	4.06	0.0439
9	250.32	0.0000
10	6.85	0.0089

According to the results of Breush-Pagan value test, our 10 regressions reported a p-value less than 5%. Hence, a problem of heteroscedasticity is presented and the GLS is considered the appropriate estimation to deal with this issue.

IV.3.4 Autocorrelation test

To test serial correlation, we use the test of Wooldridge. If the serial correlation is not detected and resolved, it would result in inefficient estimates.

The hypotheses to be tested are:

H0: The errors are not autocorrelated

H1: The errors are autocorrelated

Table 6:The results of Wooldridge test

Regressions	Wooldridge value	P-value
1	6.77	0.0264
2	41.50	0.0001
3	6.07	0.0334
4	42.14	0.0001
5	6.28	0.0310
6	21.79	0.0009
7	5.51	0.0407
8	27.46	0.0004
9	4.72	0.0549
10	44.51	0.0001

According to the table above (tab.6), we reject the null hypothesis of the Wooldridge test since the p-values of our regressions are less than 5%. Thus, our regressions suffer from an autocorrelation problem.

IV.3.5 Hausman test

Since we are using panel data, both random and fixed effects models can be employed. Therefore, we will run the Hausman test (Hausman 1978), which is also known as the Wu-Hausman test. It is a statistical test used in econometrics to choose between fixed or random individual effects in the panel data. While the random effects model considers that the variation across individuals is assumed to be random and uncorrelated with the regresses included in the model, the fixed effects model does not. This makes it possible to choose between the fixed

effects model and the random effects model. If the Hausman test has a p-value less than 5% hence we reject the null hypothesis and the fixed effect model is appropriate.

The hypotheses to be tested are:

H0: The random effect model is more appropriate than the fixed effect model

H1: The fixed effect model is more appropriate than the random effect model

Table 7:The results of the Hausman test

Regressions	P-value	Random or fixed
1	0.5376	Random effects
2	0.9461	Random effects
3	0.0899	Fixed effects
4	0.9320	Random effects
5	0.6137	Random effects
6	0.9997	Random effects
7	0.5457	Random effects
8	0.8997	Random effects
9	0.2498	Random effects
10	0.0000	Fixed effects

The results of the Hausman test are presented in the table above (tab.7). For all our regressions the random effects model is an appropriate model except regressions 3 and 10 where the fixed effect model is more appropriate than the random effects.

V. Empirical findings and discussion

In the following section, we will present the results of our empirical analysis in which we will study the impact of shifting towards non-interest income on bank risk and performance during different crises period. In this research work, we will choose to work on the financial crisis as well as the health crisis. Adding to this, we will present the results of the impact of each component of the non-interest income on bank risk and performance. This breakdown into detailed categories of non-interest income allows us to understand in depth the impact of each category.

V.1 Impulse-response function of non-interest income on bank risk and performance

In order to study the response of bank risk and performance to shocks on non-interest income (NNII) we consider constructing an impulse-response function. Therefore, to ensure that the impulse-response function is not biased, all of our variables should pass the unit root test. Indeed, we already run the unit root test and we found that all of our variables are stationary at level. Adding to this, it is necessary to determine the optimal lag order. For this reason, we refer to the three selection criteria of Andrews and Lu (2001) which are:

- Akaike information criterion (AIC), *Akaike (1969).*
- Bayesian information criterion (BIC), *Schwarz (1978), Akaike (1977).*
- Hannan-Quinn information criterion ((HQIC), *Hannan et Quinn (1979).*

Therefore, the optimal lag is one (p=1) as it minimizes the three used criteria.

The following figure (fig.11) shows the impulse response function of the non-interest income shock and its impact on bank stability and performance in general. The upper and lower lines represent the 95% confidence level. The impulse response function shows that a shock on the share of non-interest income (NNII) has a negative immediate impact on the Z-Score during the first period, meaning that risk increases in this period. In contrast, after one period the stability of the Tunisian banks increases to reach their maximum. During the third period, the Z-Score decreases slightly but fails to regain its long-term equilibrium level during the 10 periods.

In the same vein, we can observe that a shock on NNII results in an instantaneous and positive effect on the ROA. Consequently, the ROA decreases and then progressively converges to zero in the fifth period.

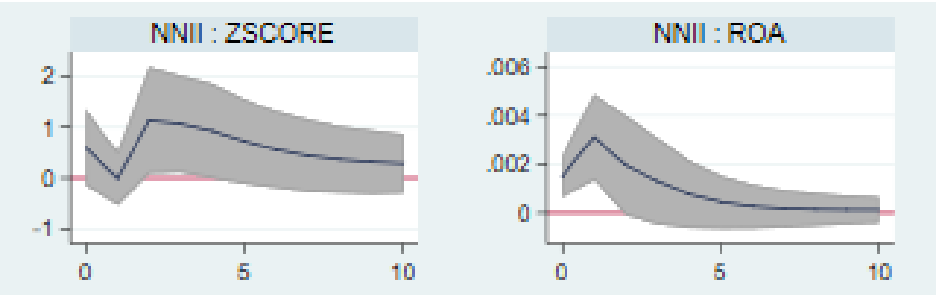


Figure 11: Impulse response function of NNII on Z-SCORE and ROA

V.2 Non-interest income, bank risk and performance; nexus

We will start our interpretation by analyzing the impact of non-interest income on bank risk and performance in general following the first step. The results of the first two regressions are presented in the following table (tab.8).

Table 8: Results related to the share of non-interest income on bank performance and risk

Variables	ROA (1)	Z-Score (2)
NNII	0.05***	0.35***
	(0.008)	(0.04)
NIM	0.915***	3.96***
	(0.131)	(0.862)
CAR	0.045**	1.477***
	(0.016)	(0.079)
Size	0.004	-0.031
	(0.003)	(0.02)
CTI	-0.034***	0.069*
	(0.006)	(0.041)
AG	0.033***	0.0035
	(0.008)	(0.033)
GDP	0.01	-0.095
	(0.019)	(0.079)
INF	-0.072	-0.044
	(0.058)	(0.257)
Constant	-0.052**	-0.004
	(0.023)	(0.141)

( )represent statistical significance at 1%. (**) represent statistical significance at 5%.*

(***) represent statistical significance at 10%

Results show that the share of non-interest revenue has a positive and significant impact on both bank performance (measured by the ROA) and stability (measured by Z-SCORE). Meaning that improving the reliance on non-interest-generating activities by 1% generates an increase in bank performance by 5% and a decrease in bank risk by 35%. Thus, these findings are coherent with several studies as those of Hamdi et al. (2017), Belguith and Bellouma (2017), Meslier et al. (2014) and Alouane et al. (2021) and confirm our first hypothesis. As non-interest

income is part of operating income, Tunisian banks benefit from their diversification strategy. In addition, they can make better use of the competencies of their labor force. As a result, fixed expenses will be spread over several product categories, which will increase the profit margin and strengthen the bank's profitability.

As we expected, the net interest margin (NIM) has a positive and highly significant impact, at a level of 1%, on both bank performance and stability. These results proved that the reliance on intermediation activities is still dominated by the Tunisian banking sector, as it represents their principal core business. Indeed, bank credits form the main source of income for Tunisian banks. Thus, the interest margin represents the most important part with an average of 55% of the total net operating income during the period between 2005 and 2021. Therefore, these results can prove also that diversification into net interest and non-interest income enhances bank performance and stability.

The capital adequacy ratio presented a positive and significant impact on both bank performance and stability (and in turn a negative impact on risk) for a level of 5%. Despite the challenging economic environment, Tunisian banks continued to strengthen their capital to support their activities and satisfy the prudential requirements introduced by the CBT. Indeed, a high level of capitalization helps banks to reduce recourse to external financing which will increase their costs since external financing has become expensive with the current situation of the Tunisian banks. Moreover, as it is argued by Hamdi et al. (2017) that capital reflects the bank's ability to deal with unexpected losses. Therefore, the strength and quality of capital will impact the level of bank performance. In the same vein, Naceur and Goaid, (2001) pointed out that banks that can enhance their capital are considered the most performing ones. Adding to this, well-capitalized banks are more stable and can absorb potential economic shocks.

The cost-to-income ratio has a negative significant impact on bank performance, which are in line with the findings of Nisar et al. (2018). Meaning that to enhance bank performance, Tunisian banks should reduce their operating costs. In contrast, it has a positive significant impact on bank stability and in turn, it reduces bank risk.

Concerning the macroeconomic factors, the GDP rate displays a positive and non-significant impact on bank performance. It has also a negative and non-significant impact on bank stability.

According to these results, the share of non-interest revenue has a positive and significant impact on both bank performance and stability during the period of our study.

V.3 Non-interest income components, bank risk and performance; nexus

After dealing with the share of non-interest generating business as a hole in the first step, we will devote this part to find out which effect dominates. Therefore, we will base our work on the second step in which we will replace the non-interest income share with the three different components of the non-interest income (COMSH, IPSH, and CPSH).

Table 9:Results related to the share of non-interest income components on bank performance and risk

Variables	ROA (3)	Z-Score (4)
COMSH	0.002 (0.022)	0.648*** (0.078)
IPSH	0.036* (0.019)	0.239*** (0.069)
CPSH	0.0436*** (0.014)	0.276*** (0.052)
NIM	0.438* (0.23)	3.967*** (0.85)
CAR	0.037 (0.024)	1.638*** (0.088)
Size	0.015** (0.001)	-0.027 (0.022)
CTI	-0.036*** (0.013)	0.005 (0.046)
AG	0.027*** (0.009)	0.018 (0.032)
GDP	0.027 (0.021)	-0.09 (0.078)
INF	-0.119* (0.071)	0.092 (0.256)
Constant	-0.095** (0.042)	-0.069 (0.151)

(*) represent statistical significance at 1%. (**) represent statistical significance at 5%.

(***) represent statistical significance at 10%

As is presented in the table above (tab.9) the share of fees and commissions has no significant impact on bank performance. However, it reduces banks' risk as it has a positive significant impact on banks' stability. Concerning trading income, they have a positive significant impact on both bank performance and stability which are in line with previous empirical analyses of Lepetit et al. (2008), Nisar et al. (2018) and Meslier et al. (2014). This benefit can be explained by the weak correlation between trading income and traditional banking activities. Adding to this, the share of securities is positively correlated with bank stability, which can be explained by the fact that it reacts to different shocks than net-interest revenue (kholer, 2018). Thus, diversification through securities can increase stability and therefore reduces the risk for Tunisian banks. Consistent with the study of kholer, (2015) we can also notice that the highest contribution of bank stability is associated with the share of fees and commissions. Adding to this, Sawada, (2013) assumed that fee-income share reduces systematic risk, idiosyncratic risk, and even total risk. These results are expected since fees and commissions are the important components of the non-interest income of the Tunisian banks.

Adding to this, consistent with Ayadi and Ellouze (2014) size and asset growth have a positive significant impact on bank performance. Thus, economies of scale exist in the Tunisian banking sector. In other words, large banks can benefit from their sizes. Regarding, the inflation rate it has a negative significant impact on bank performance, meaning that a high level of inflation reduces the performance of the Tunisian banks.

V.4 Non-interest income, bank risk and performance during crises; nexus

After dealing with the impact of the share of non-interest-generating activities in general for the Tunisian banks, we will focus in this subsection on studying its impact on two different crises which are the financial crisis and the most recent one, the COVID-19 crisis.

Tableau 10:Results related to the share of non-interest income on bank performance and risk during crises

Variables	ROA		Z-Score		
	5	7	6	8	10
NNII	0.054*** (0.009)	0.055*** (0.008)	0.37*** (0.052)	0.40*** (0.048)	-
NNII*DF	-0.011 (0.012)	-	-0.059 (0.046)	-	-

NNII*DC	-	0.013 (0.023)	-	0.38*** (0.08)	-
DF	0.005 (0.005)	-	-0.038* (0.02)	-	-
DC	-	-0.013 (0.114)	-	-0.20*** (0.042)	-0.19*** (0.041)
COMSH	-	-	-	-	0.685*** (0.073)
IPSH	-	-	-	-	0.296*** (0.066)
CPSH	-	-	-	-	0.324*** (0.047)
COMSH*DC	-	-	-	-	0.034*** (0.108)
IPSH*DC	-	-	-	-	0.26*** (0.091)
CPSH*DC	-	-	-	-	0.698*** (0.161)
NIM	0.926*** (0.132)	1.021*** (0.14)	3.67*** (0.864)	5.438*** (0.90)	5.29*** (0.843)
CAR	0.042** (0.019)	0.054*** (0.172)	1.475** (0.08)	1.433*** (0.077)	1.58*** (0.08)
Size	0.004 (0.003)	0.006** (0.003)	-0.026 (0.021)	-0.029 (0.02)	-0.036* (0.02)
CTI	-0.034*** (0.006)	-0.03*** (0.007)	0.067* (0.04)	0.052 (0.042)	0.009 (0.043)
AG	0.033*** (0.008)	0.034*** (0.008)	-0.006 (0.033)	0.017 (0.031)	0.038 (0.029)
GDP	0.006 (0.019)	-0.021 (0.021)	-0.13* (0.078)	-0.022** (0.081)	-0.239*** (0.073)
INF	-0.06 (0.063)	-0.072 (0.057)	0.115 (0.26)	-0.015 (0.249)	0.083 (0.23)

Constant	-0.053** (0.023)	-0.073*** (0.024)	-0.039 (0.14)	-0.053 (0.144)	-0.049 (0.141)

(*) represent statistical significance at 1%. (**) represent statistical significance at 5%.

(***) represent statistical significance at 10%

As is presented in the table below (tab.10) that the financial crisis as well as the health crisis had no direct impact on the performance of the banking sector. However, they had a direct negative and significant effect on the stability of the Tunisian banking sector.

Concerning the impact of revenue diversification, we can notice that the share of non-interest revenue had a non-significant impact on bank performance and stability during the financial crisis, therefore we reject our second hypothesis.

Moreover, COVID-19 had an insignificant impact on bank performance. Indeed, to reduce the number of contaminations by the virus, the CBT took different measures in the favor of customers in the first quarter of 2020. Some monetary transactions become free as cash withdrawals from ATMs, electronic payments of small amounts, issuing of credit cards, and the postponement of credit maturities. By the end of 2020, all free transactions are cancellated and the number of transactions increased progressively in which the banking sector compensate the losses of the first quarter of the year. Therefore, we can explain this insignificant impact on bank performance by the compensation effect between the negative and positive implications of the propagation of this crisis, in the short and long term.

Meanwhile, the share of non-interest revenue had a positive significant impact on bank stability, which confirm our third hypothesis. Thus, during the health crisis, the Tunisian banks enhanced their share of non-interest income to decrease their risk. This can be explained by the fact that traditional activities decreased and this pandemic resulted in tightened credit standards and reduced demand for different types of loans (Li et al. 2021).

Since the share of non-interest income had a positive impact on bank stability during the COVID-19 crisis, we split the non-interest income into three components to study the effect of each component during this period. In this regard, we used an interaction term between the component and the dummy variables to capture the effect of this crisis. We can notice that all components had a positive impact at a level of 1% of significance.

VI. Conclusion

The banking system is an essential element that regulates economic activity in different countries. Banks or financial institutions have become necessary nowadays, given their important complicity in the implementation of monetary and budgetary policy and the growth of the economy.

Hence, a well-functioning banking system should be composed of profitable banks, as they contribute to the stability of the whole economy. Nonetheless, banks are exposed to different shocks as well as economic crises. Hence, to deal with these circumstances and reduce their impacts, banks should opt for well-studied strategies. In financial theories, diversification is an appropriate hedge strategy to reduce risk and enhance performance.

Dealing with this issue we used panel data of 11 listed Tunisian banks during the period of 2005-2021. We found that income diversification increases bank performance and reduces risk. Actually, combining both lending and non-interest income provides diversification benefits and consequently risk reduction. Hence, Tunisian banks should diversify more their income to enhance their performance and stability. Our results are in line with several previous analyses such as Kohler (2015), Lepetit et al (2007) Sanya and Wolfe (2011). We found also that all non-interest income components impact positively bank stability, especially, since fees and commissions are the most contributors to maintaining bank stability. Concerning bank performance, we found that trading income enhances bank performance.

Addressing the issue of shocks and crises, we used first an impulse response function in which we found that both stability and performance react immediately to the shock on non-interest income. Adding to this, we used a GLS regression to study the impact of income diversification in both financial and health crises. Our results proved that the financial crisis as well as the COVID-19 crisis didn't impact the share of non-interest income and performance associations. However, by the share of non-interest income, the stability of the Tunisian banking sector increased during COVID-19, and thus risk decreased.

Tunisian banks must be aware of the importance of investing in different channels beyond their core activities that generate non-interest income since they contribute to higher profits and allow them to become more stable even during the health crisis.

CONCLUSION

The banking system's role is very important, mainly when it is related to the economic growth and development of a nation.

In several countries, policymakers and banking supervisors have deregulated the area of bank diversification. Indeed, to increase competitiveness, they reduced barriers between commercial and investment banks, and security and insurance companies. Adding to this, they encouraged banks to diversify their activities.

In this vein, the Tunisian authorities encouraged banks to shift toward non-interest banking business through different reforms as the law of 2001 which is dealing with the concept of universal banks. With the emergence of this concept, the specialization of banks was reduced and Tunisian banks can operate in different fields and diversify their core business. Therefore, increasing the reliance on non-interest revenue is becoming an essential strategy for banks.

Different empirical research has addressed this strategy to the performance and risk of the banking sector. They studied the link between shifting toward non-interest income, bank performance, and risk. As is presented in the literature review in the first chapter we reviewed some studies in which they highlighted the added value of income diversification where it impacted positively performance and negatively risk. However, some other empirical investigations proved that income diversification decreased performance and increased risk.

As it is known that the banking sector is at the center of the financial world, making them more susceptible to changes in the sector and the economy as a whole. Indeed, the financial crisis as well as the pandemic crisis put pressure on all the economies in the world. These crises motivated several scholars to study the impact of shifting toward non-interest income during the crisis.

Therefore, this thesis dealt with the income diversification strategy and its impact on bank performance/risk in crises, in the context of the Tunisian banks. Our motivation is based on the absence of prior empirical works dealing with this topic for the Tunisian banking sector.

Thus, to address this issue we used a sample of 11 Tunisian-listed banks from 2005 to 2021. Our main results proved that income diversification improved bank performance and stability and thus reduced risk.

Adding to this, we found that all the different components of non-interest income had a positive and significant impact on bank stability and in turn a negative impact on risk. Yet, only trading income had a positive and significant effect on bank performance. Thus, trading income improves Tunisian banks' performance.

By studying the joint effect of income diversification and crises on bank performance and risk we proved by the use of an impulse-response function that both performance and risk react immediately to a shock of the share of non-interest income. Moreover, we chose to work on especially the financial crisis and the health crisis. By the use of a panel regression (GLS), our results revealed that the financial crisis had an insignificant impact on the share of non-interest income on both bank risk and performance. Concerning the COVID-19 pandemic, we found that increasing the reliance on non-interest income during this period impacted positively stability and in turn decreased risk. Meanwhile, it had an insignificant impact on bank performance.

Dealing with the decomposition of non-interest sources, in the period of the health crisis, we found that all three components are positively and significantly associated with bank stability. Meaning that all these components contributed to enhancing the stability of the Tunisian banking sector in this critical period.

On a whole, our main contribution can be summarized as follows:

- ✓ Tunisian banks should intensify the diversification of their income, and focus more on non-interest income, as it enhances their performance and reduces their risk.
- ✓ In order to gain a competitive edge and ameliorate their diversification strategy, Tunisian banks should accelerate their digital transformation and invest more in technology such as fintech.
- ✓ It is also necessary to look for skilled staff that can deal with different services and product that generates non-interest revenue.
- ✓ Increasing the reliance on income diversification doesn’t mean reducing the basic sources of revenue. Indeed, the combination of both lending and non-interest income provides diversification benefits and consequently risk reduction.

- ✓ Increasing the share of non-interest income in the COVID-19 period enhanced bank stability and in turn reduced bank risk.

It should be pointed out that our empirical analysis contains some limitations, that can be taken into consideration in future studies. In our work, we used annual data which makes our sample small. Thus, for future research, sub-annual data can be used, on the one hand, to extend the sample and, on the other hand, to investigate in depth the impact of the crisis, especially COVID-19.

Adding to this, our work contains two types of crises which are financial and the health crisis. Nonetheless, due to the lack of data concerning the financial statements for the year 2022 we were unable to include the Ukrainian war in our investigation.

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Appendices

Appendixes 1: **Stationarity test**

Levin-Lin-Chu unit-root test for ROA

Ho: Panels contain unit roots — Number of panels = 11
Ha: Panels are stationary — Number of periods = 17

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	-20.1988	
Adjusted t*	-19.7060	0.0000

Levin-Lin-Chu unit-root test for ZSCORE

Ho: Panels contain unit roots — Number of panels = 11
Ha: Panels are stationary — Number of periods = 17

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	-11.8521	
Adjusted t*	-9.8332	0.0000

```
Levin-Lin-Chu unit-root test for NNII
-------------------------------------

Ho: Panels contain unit roots               Number of panels  =     11
Ha: Panels are stationary                   Number of periods =     17

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       -5.9912
 Adjusted t*        -3.2162       0.0006
------------------------------------------------------------------------------
```

```
Levin-Lin-Chu unit-root test for NIM
------------------------------------

Ho: Panels contain unit roots               Number of panels  =     11
Ha: Panels are stationary                   Number of periods =     17

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       -8.0339
 Adjusted t*        -4.7491       0.0000
------------------------------------------------------------------------------
```

```
Levin-Lin-Chu unit-root test for CPSH
-------------------------------------

Ho: Panels contain unit roots               Number of panels  =     11
Ha: Panels are stationary                   Number of periods =     17

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       -5.0193
 Adjusted t*        -1.5773       0.0574
------------------------------------------------------------------------------
```

```
Levin-Lin-Chu unit-root test for IPSH
-------------------------------------

Ho: Panels contain unit roots               Number of panels  =     11
Ha: Panels are stationary                   Number of periods =     17

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        -7.7208
 Adjusted t*         -4.3236        0.0000
------------------------------------------------------------------------------
```

```
Levin-Lin-Chu unit-root test for COMSH
--------------------------------------

Ho: Panels contain unit roots               Number of panels  =     11
Ha: Panels are stationary                   Number of periods =     17

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        -4.6831
 Adjusted t*         -1.9498        0.0256
------------------------------------------------------------------------------
```

```
Levin-Lin-Chu unit-root test for cti
------------------------------------

Ho: Panels contain unit roots               Number of panels  =     11
Ha: Panels are stationary                   Number of periods =     17

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        -5.9961
 Adjusted t*         -3.2667        0.0005
------------------------------------------------------------------------------
```

```
Levin-Lin-Chu unit-root test for CAR
-------------------------------------

Ho: Panels contain unit roots               Number of panels  =     11
Ha: Panels are stationary                   Number of periods =     17

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        -7.6800
 Adjusted t*         -4.3384        0.0000
------------------------------------------------------------------------------
```

```
Levin-Lin-Chu unit-root test for Assetgrowth
---------------------------------------------

Ho: Panels contain unit roots               Number of panels  =     11
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        -9.0253
 Adjusted t*         -5.0180        0.0000
------------------------------------------------------------------------------
```

```
Levin-Lin-Chu unit-root test for SIZE
--------------------------------------

Ho: Panels contain unit roots               Number of panels  =     11
Ha: Panels are stationary                   Number of periods =     17

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        -6.4799
 Adjusted t*         -5.8898        0.0000
------------------------------------------------------------------------------
```

```
Levin-Lin-Chu unit-root test for INF
------------------------------------

Ho: Panels contain unit roots               Number of panels  =     11
Ha: Panels are stationary                   Number of periods =     17

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        -6.0252
 Adjusted t*         -2.0353        0.0209
------------------------------------------------------------------------------
```

```
Levin-Lin-Chu unit-root test for GDP
------------------------------------

Ho: Panels contain unit roots               Number of panels  =     11
Ha: Panels are stationary                   Number of periods =     17

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       -12.5455
 Adjusted t*         -2.8332        0.0023
------------------------------------------------------------------------------
```

Appendixes 2: **VIF test**

Variable	VIF	1/VIF
SIZE	3.23	0.309968
NNII	2.56	0.390570
NIM	2.50	0.399306
CAR	2.50	0.399374
cti	1.94	0.514912
INF	1.36	0.736213
GDP	1.27	0.787562
Assetgrowth	1.20	0.832929
Mean VIF	2.07	

Variable	VIF	1/VIF
SIZE	4.11	0.243583
CAR	3.73	0.267898
NIM	2.69	0.371271
CPSH	2.60	0.384472
IPSH	2.25	0.444204
cti	2.01	0.497291
COMSH	2.00	0.499443
INF	1.47	0.678258
GDP	1.35	0.742206
Assetgrowth	1.20	0.831096
Mean VIF	2.34	

Variable	VIF	1/VIF
SIZE	3.35	0.298380
CAR	2.61	0.382770
NNII	2.61	0.382875
NIM	2.53	0.394541
cti	1.98	0.505083
INF	1.55	0.646647
dummyfinNNII	1.55	0.646887
GDP	1.34	0.745486
Assetgrowth	1.24	0.808233
Mean VIF	2.08	

Variable	VIF	1/VIF
SIZE	3.39	0.295056
NNII	2.64	0.378131
CAR	2.60	0.385306
NIM	2.58	0.386978
cti	2.02	0.494675
dummycoNNII	1.53	0.653317
GDP	1.51	0.664131
INF	1.36	0.736102
Assetgrowth	1.20	0.832601
Mean VIF	2.09	

Variable	VIF	1/VIF
SIZE	3.56	0.281089
CAR	2.73	0.365765
NNII	2.68	0.373014
NIM	2.60	0.384142
cti	2.08	0.481703
GDP	1.62	0.618273
dummyfinNNII	1.57	0.635797
dummycoNNII	1.56	0.642116
INF	1.55	0.644500
Assetgrowth	1.24	0.806779
Mean VIF	2.12	

Variable	VIF	1/VIF
dummycoIPSH	5.29	0.188936
dummycocomsh	5.05	0.198047
SIZE	4.28	0.233824
dummycoCPSH	3.90	0.256370
CAR	3.86	0.259023
NIM	2.88	0.347729
IPSH	2.82	0.354122
CPSH	2.68	0.373426
COMSH	2.17	0.461261
cti	2.11	0.474591
GDP	1.56	0.642715
INF	1.52	0.659834
Assetgrowth	1.21	0.826060
Mean VIF	3.02	

Appendixes 3: **Breush -pagan test**

Model 1

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

         chi2(1)      =   227.42
         Prob > chi2  =   0.0000
```

Model 2

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

          chi2(1)      =    13.65
          Prob > chi2  =   0.0002
```

Model 3

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

          chi2(1)      =   230.95
          Prob > chi2  =   0.0000
```

Model 4

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

         chi2(1)      =    14.92
         Prob > chi2  =   0.0001
```

Model 5

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

          chi2(1)      =   233.19
          Prob > chi2  =   0.0000
```

Model 6

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

         chi2(1)      =    12.76
         Prob > chi2  =   0.0004
```

Model 7

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

         chi2(1)      =   173.19
         Prob > chi2  =   0.0000
```

Model 8

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

         chi2(1)      =     4.06
         Prob > chi2  =   0.0439
```

Model 9

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

         chi2(1)      =   250.32
         Prob > chi2  =   0.0000
```

Model 10

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

         chi2(1)      =     6.85
         Prob > chi2  =   0.0089
```

Appendixes 4: **Wooldridge test**

Model 1

```
Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,      10) =      6.770
          Prob > F =      0.0264
```

Model 2

```
Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,      10) =     41.502
          Prob > F =      0.0001
```

Model 3

```
Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,      10) =      6.075
          Prob > F =      0.0334
```

Model 4

```
Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,      10) =     42.145
          Prob > F =      0.0001
```

Model 5

```
Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,      10) =      6.288
          Prob > F =      0.0310
```

Model 6

```
Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,      10) =     21.798
          Prob > F =      0.0009
```

Model 7

```
Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,      10) =      5.516
          Prob > F =      0.0407
```

Model 8

```
Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,      10) =     27.461
          Prob > F =      0.0004
```

Model 9

```
Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,      10) =      4.721
          Prob > F =      0.0549
```

Model 10

```
Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,      10) =     44.517
          Prob > F =      0.0001
```

Appendixes 5: **Lag criteria**

lag	CD	J	J pvalue	MBIC	MAIC	MQIC
1	.990343	26.27251	.5035189	-94.61558	-27.72749	-54.67502
2	.9931087	13.04417	.7889423	-67.54789	-22.95583	-40.92085
3	.7518232	2.349436	.9846623	-37.9466	-15.65056	-24.63308
4	-.9226501	.	.	.	.	.

Appendixes 6: **Regressions** (Fixed and random effect regressions)

Regression 1

```
Random-effects GLS regression                   Number of obs      =       176
Group variable: BANK                            Number of groups   =        11

R-sq:                                           Obs per group:
     within  = 0.3995                                         min =        16
     between = 0.9166                                         avg =      16.0
     overall = 0.5073                                         max =        16

                                                Wald chi2(8)       =    171.95
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000
```

ROA	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
NNII	.050223	.0084449	5.95	0.000	.0336714	.0667747
NIM	.9156758	.1310201	6.99	0.000	.6588811	1.172471
CAR	.0452522	.0169948	2.66	0.008	.0119429	.0785614
Assetgrowth	.0338801	.0087251	3.88	0.000	.0167791	.050981
SIZE	.00438	.0029707	1.47	0.140	-.0014424	.0102025
cti	-.0346972	.006774	-5.12	0.000	-.0479739	-.0214204
GDP	.0100971	.0191662	0.53	0.598	-.027468	.0476621
INF	-.0722848	.0587717	-1.23	0.219	-.1874752	.0429055
_cons	-.0527984	.0233081	-2.27	0.023	-.0984814	-.0071154

```
Test:   Ho:  difference in coefficients not systematic

               chi2(8) =  (b-B)'[(V_b-V_B)^(-1)](b-B)
                       =          6.99
             Prob>chi2 =        0.5376
```

Regression 2

```
Random-effects GLS regression                   Number of obs      =       176
Group variable: BANK                            Number of groups   =        11

R-sq:                                           Obs per group:
     within  = 0.8001                                         min =        16
     between = 0.1318                                         avg =      16.0
     overall = 0.2123                                         max =        16

                                                Wald chi2(8)       =    626.55
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000
```

ZSCORE	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
NNII	.356781	.0498555	7.16	0.000	.2590661	.454496
NIM	3.964867	.8628711	4.59	0.000	2.273671	5.656063
CAR	1.477821	.0799311	18.49	0.000	1.321159	1.634483
Assetgrowth	.0035701	.0331198	0.11	0.914	-.0613435	.0684838
SIZE	-.0310333	.0207209	-1.50	0.134	-.0716456	.009579
cti	.0693856	.0412339	1.68	0.092	-.0114313	.1502025
GDP	-.0956456	.0792445	-1.21	0.227	-.250962	.0596708
INF	-.0447687	.2575382	-0.17	0.862	-.5495342	.4599968
_cons	-.0044258	.1418071	-0.03	0.975	-.2823626	.2735109

```
Test:   Ho:  difference in coefficients not systematic

               chi2(8) =  (b-B)'[(V_b-V_B)^(-1)](b-B)
                       =          2.80
             Prob>chi2 =        0.9461
```

Regression 3

```
Fixed-effects (within) regression               Number of obs      =       176
Group variable: BANK                            Number of groups   =        11

R-sq:                                           Obs per group:
     within  = 0.4390                                         min =        16
     between = 0.3310                                         avg =      16.0
     overall = 0.3424                                         max =        16

                                                F(10,155)          =     12.13
corr(u_i, Xb)  = -0.5602                        Prob > F           =    0.0000
```

ROA	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
COMSH	.0026672	.0220825	0.12	0.904	-.0409543	.0462887
IPSH	.0366529	.0193332	1.90	0.060	-.0015376	.0748435
CPSH	.0436999	.0145871	3.00	0.003	.0148848	.072515
NIM	.4381563	.2381002	1.84	0.068	-.0321838	.9084964
CAR	.0374774	.0247953	1.51	0.133	-.011503	.0864577
Assetgrowth	.0276642	.0091502	3.02	0.003	.0095891	.0457393
SIZE	.0151644	.0062629	2.42	0.017	.0027927	.0275361
cti	-.0362629	.0130078	-2.79	0.006	-.0619584	-.0105674
GDP	.0278837	.0217859	1.28	0.202	-.015152	.0709194
INF	-.1196377	.0718009	-1.67	0.098	-.2614722	.0221968
_cons	-.0958507	.0420333	-2.28	0.024	-.1788828	-.0128186

```
Test:   Ho:   difference in coefficients not systematic

              chi2(10)  =  (b-B)'[(V_b-V_B)^(-1)](b-B)
                        =          16.36
             Prob>chi2  =         0.0899
```

Regression 4

```
Random-effects GLS regression                   Number of obs      =       176
Group variable: BANK                            Number of groups   =        11

R-sq:                                           Obs per group:
     within  = 0.8309                                         min =        16
     between = 0.1237                                         avg =      16.0
     overall = 0.2062                                         max =        16

                                                Wald chi2(10)      =    670.46
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000
```

ZSCORE	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
COMSH	.6480151	.078688	8.24	0.000	.4937895	.8022407
IPSH	.239845	.0690884	3.47	0.001	.1044342	.3752558
CPSH	.2767487	.0522226	5.30	0.000	.1743943	.379103
NIM	3.967545	.8503467	4.67	0.000	2.300896	5.634194
CAR	1.638647	.0888851	18.44	0.000	1.464436	1.812859
Assetgrowth	.0187527	.0329078	0.57	0.569	-.0457454	.0832508
SIZE	-.0270077	.0220572	-1.22	0.221	-.0702391	.0162237
cti	.0052842	.0464467	0.11	0.909	-.0857496	.096318
GDP	-.0948955	.0780112	-1.22	0.224	-.2477947	.0580037
INF	.0925476	.2566625	0.36	0.718	-.4105016	.5955968
_cons	-.0697407	.1513426	-0.46	0.645	-.3663667	.2268853

```
Test:   Ho:   difference in coefficients not systematic

              chi2(10)  =  (b-B)'[(V_b-V_B)^(-1)](b-B)
                        =          4.32
             Prob>chi2  =        0.9320
```

Regression 5

```
Random-effects GLS regression                   Number of obs      =       176
Group variable: BANK                            Number of groups   =        11

R-sq:                                           Obs per group:
     within  = 0.4049                                         min =        16
     between = 0.9125                                         avg =      16.0
     overall = 0.5107                                         max =        16

                                                Wald chi2(10)      =    172.20
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000
```

ROA	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
NNII	.0539394	.0093786	5.75	0.000	.0355577	.0723211
dummyfinNNII	-.0114076	.0126242	-0.90	0.366	-.0361505	.0133354
dummyfin	.0057832	.005563	1.04	0.299	-.0051201	.0166866
NIM	.9269228	.132905	6.97	0.000	.6664337	1.187412
CAR	.042023	.0178412	2.36	0.019	.007055	.076991
Assetgrowth	.0337996	.0088846	3.80	0.000	.016386	.0512131
SIZE	.0042236	.0030491	1.39	0.166	-.0017525	.0101996
cti	-.0348435	.0068667	-5.07	0.000	-.048302	-.0213851
GDP	.0069796	.0198465	0.35	0.725	-.0319189	.045878
INF	-.061646	.0630859	-0.98	0.328	-.185292	.0620001
_cons	-.0539829	.0238962	-2.26	0.024	-.1008186	-.0071472

```
Test:  Ho:  difference in coefficients not systematic

              chi2(10) =  (b-B)'[(V_b-V_B)^(-1)](b-B)
                       =          8.15
             Prob>chi2 =        0.6137
```

Regression 6

```
R-sq:                                           Obs per group:
     within  = 0.8079                                         min =        16
     between = 0.1324                                         avg =      16.0
     overall = 0.2140                                         max =        16

                                                Wald chi2(10)      =    659.58
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000
```

ZSCORE	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
NNII	.3737437	.0527224	7.09	0.000	.2704097	.4770777
NIM	3.672631	.8642032	4.25	0.000	1.978824	5.366438
CAR	1.475278	.0807245	18.28	0.000	1.317061	1.633495
Assetgrowth	-.0062236	.0331336	-0.19	0.851	-.0711642	.058717
SIZE	-.0269655	.0218651	-1.23	0.217	-.0698203	.0158893
cti	.0675768	.0407917	1.66	0.098	-.0123734	.1475269
DF	-.0389704	.0200665	-1.94	0.052	-.0003591	.0783
dummyfinNNII	-.0595416	.0460435	-1.29	0.196	-.1497853	.0307021
GDP	-.1303334	.0787889	-1.65	0.098	-.2847569	.02409
INF	.1158462	.2602564	0.45	0.656	-.3942469	.6259393
_cons	-.039926	.149238	-0.27	0.789	-.332427	.2525751

```
Test:  Ho:  difference in coefficients not systematic

              chi2(10) =  (b-B)'[(V_b-V_B)^(-1)](b-B)
                       =          1.13
             Prob>chi2 =        0.9997
```

Regression 7

```
Random-effects GLS regression                   Number of obs      =       176
Group variable: BANK                            Number of groups   =        11

R-sq:                                           Obs per group:
     within  = 0.4400                                         min =        16
     between = 0.9112                                         avg =      16.0
     overall = 0.5380                                         max =        16

                                                Wald chi2(10)      =    183.79
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000
```

ROA	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
NNII	.0551229	.0086967	6.34	0.000	.0380777	.0721682
dummycoNNII	.013291	.0231151	0.57	0.565	-.0320138	.0585958
dummycovid	-.0133913	.0114083	-1.17	0.240	-.0357512	.0089686
NIM	1.021286	.1406973	7.26	0.000	.7455248	1.297048
CAR	.0545203	.0172454	3.16	0.002	.0207199	.0883207
Assetgrowth	.0343617	.008536	4.03	0.000	.0176314	.051092
SIZE	.0066215	.0030712	2.16	0.031	.0006019	.012641
cti	-.0308214	.0070337	-4.38	0.000	-.0446072	-.0170356
GDP	-.0210972	.0211554	-1.00	0.319	-.062561	.0203667
INF	-.0720354	.0574929	-1.25	0.210	-.1847193	.0406485
cons	-.0738245	.0242215	-3.05	0.002	-.1212978	-.0263512

```
Test:  Ho:  difference in coefficients not systematic

             chi2(10) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                      =          8.86
            Prob>chi2 =        0.5457
```

Regression 8

```
Random-effects GLS regression                   Number of obs      =       176
Group variable: BANK                            Number of groups   =        11

R-sq:                                           Obs per group:
     within  = 0.8284                                         min =        16
     between = 0.1624                                         avg =      16.0
     overall = 0.2439                                         max =        16

                                                Wald chi2(10)      =    712.86
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000
```

ZSCORE	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
NNII	.4065935	.0488731	8.32	0.000	.310804	.5023831
dummycoNNII	.3803486	.0858573	4.43	0.000	.2120714	.5486258
dummycovid	-.2025086	.0422448	-4.79	0.000	-.2853069	-.1197103
NIM	5.438584	.9070403	6.00	0.000	3.660817	7.21635
CAR	1.433575	.0776809	18.45	0.000	1.281323	1.585827
Assetgrowth	.0170826	.0317826	0.54	0.591	-.0452101	.0793753
SIZE	-.0292535	.0207575	-1.41	0.159	-.0699375	.0114305
cti	.0522399	.0422	1.24	0.216	-.0304706	.1349504
GDP	-.2266772	.0816141	-2.78	0.005	-.3866378	-.0667165
INF	-.1503757	.2490418	-0.60	0.546	-.6384886	.3377372
_cons	-.0531113	.1449223	-0.37	0.714	-.3371538	.2309312

```
Test:  Ho:  difference in coefficients not systematic

             chi2(10) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                      =          4.87
            Prob>chi2 =        0.8997
```

Regression 9

```
Random-effects GLS regression                   Number of obs      =       176
Group variable: BANK                            Number of groups   =        11

R-sq:                                           Obs per group:
     within  = 0.4573                                         min =        16
     between = 0.9183                                         avg =      16.0
     overall = 0.5529                                         max =        16

                                                Wald chi2(14)      =    199.07
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000
```

ROA	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
COMSH	.0503784	.0151403	3.33	0.001	.0207039	.0800529
IPSH	.0661732	.0141972	4.66	0.000	.0383472	.0939992
CPSH	.0538989	.0090703	5.94	0.000	.0361213	.0716764
dummycovid	-.0122724	.0124447	-0.99	0.324	-.0366635	.0121187
dummycocomsh	-.0137561	.0323032	-0.43	0.670	-.0770692	.0495571
dummycoCPSH	.0657006	.0470945	1.40	0.163	-.0266029	.1580041
dummycoIPSH	.014711	.0277801	0.53	0.596	-.0397369	.069159
NIM	1.049415	.140851	7.45	0.000	.7733519	1.325478
CAR	.0403386	.0208515	1.93	0.053	-.0005296	.0812069
Assetgrowth	.035133	.0085192	4.12	0.000	.0184357	.0518303
SIZE	.0042511	.0033491	1.27	0.204	-.002313	.0108153
cti	-.0300159	.006875	-4.37	0.000	-.0434906	-.0165411
GDP	-.0258689	.0215518	-1.20	0.230	-.0681097	.016372
INF	-.0760732	.0602438	-1.26	0.207	-.1941489	.0420025
_cons	-.0571277	.0265526	-2.15	0.031	-.1091698	-.0050856

```
  Test:   Ho:   difference in coefficients not systematic

                chi2(14)  =  (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =          17.12
              Prob>chi2   =         0.2498
              (V_b-V_B is not positive definite)
```

Regression 10

```
Fixed-effects (within) regression               Number of obs      =       176
Group variable: BANK                            Number of groups   =        11

R-sq:                                           Obs per group:
     within  = 0.8581                                         min =        16
     between = 0.1293                                         avg =      16.0
     overall = 0.2144                                         max =        16

                                                F(14,151)          =     65.24
corr(u_i, Xb)  = -0.1038                        Prob > F           =    0.0000
```

ZSCORE	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
COMSH	.6853018	.0732848	9.35	0.000	.5405058	.8300979
IPSH	.2964965	.0661174	4.48	0.000	.1658618	.4271312
CPSH	.32484	.0474514	6.85	0.000	.2310857	.4185944
dummycovid	-.1987176	.0413311	-4.81	0.000	-.2803795	-.1170557
dummycocomsh	.3469868	.1089126	3.19	0.002	.1317974	.5621763
dummycoCPSH	.6989266	.1618127	4.32	0.000	.3792172	1.018636
dummycoIPSH	.2604368	.0914762	2.85	0.005	.0796982	.4411753
NIM	5.298202	.8435266	6.28	0.000	3.631563	6.964841
CAR	1.580752	.0805299	19.63	0.000	1.421641	1.739862
Assetgrowth	.0388471	.0290891	1.34	0.184	-.0186272	.0963213
SIZE	-.0367605	.020275	-1.81	0.072	-.0768199	.0032989
cti	.0091483	.0432026	0.21	0.833	-.0762115	.094508
GDP	-.2399246	.0737854	-3.25	0.001	-.3857097	-.0941395
INF	.0831532	.2301219	0.36	0.718	-.3715215	.5378278
_cons	-.0499008	.1412673	-0.35	0.724	-.3290167	.229215

```
  Test:   Ho:   difference in coefficients not systematic

                chi2(14)  =  (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =         201.17
              Prob>chi2   =         0.0000
```

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