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The impact of regulatory capital pressure on profitability and risk: Evidence from Tunisian banks

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The impact of regulatory capital pressure on profitability and risk: Evidence from Tunisian banks

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Abstract

This thesis makes four different contributions to the conventional wisdom dealing with the effect or regulatory pressure on bank profitability and risk. Firstly, this thesis examines the impact regulatory capital on the profitability and risk using a sample of ten listed Tunisian banks from 2005-2020. Secondly, it contributes to the literature receiving scant attention from researchers which have investigated the nonlinear impact of regulatory pressure on bank profitability and risk. Thirdly, it analyzes other determinants of bank profitability and risk. Finally, our analysis uses both static and dynamic methodology to test for the persistence of bank profitability and risk as well as make sure that our results are not biased by endogeneity.

Keywords: Banking, Regulatory capital, Basel Accord, Profitability, Risk, 2SLS
Jel classification: G21, C23, G29

Résumé

Cette mémoire apporte quatre contributions différentes sur le sujet de la pression réglementaire sur la rentabilité et le risque des banques. Dans un premier temps, nous examinons l'impact du ratio de solvabilité réglementaire sur la rentabilité et le risque à l'aide d'un échantillon de dix banques tunisiennes cotées de 2005 à 2020. Deuxièmement, nous contribuons à la littérature qui retient peu l'attention des chercheurs étudiant la relation non linéaire entre la pression réglementaire et la rentabilité et risque des banques. Troisièmement, nous analysons les autres déterminants de la rentabilité et du risque des banques Tunisiennes. Enfin, notre analyse utilise à la fois une méthodologie statique et une méthodologie dynamique pour tester l'effet de persistance de la rentabilité et du risque ainsi que pour s'assurer que nos résultats ne sont pas biaisés par un problème d'endogénéité.

Mots clés: Banking, Regulatory capital, Basel Accord, Profitability, Risk, 2SLS
Jel classification: G21, C23, G29

To my beloved parents and sisters.

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List of abbreviations

CAR - Capital Adequacy Ratio
CBT – Central Bank of Tunsian
CET1 – Core Equity Tier-1
CRI - Capital Regulatory Index
DMB – Deposit Money Banks
EAD - Exposure-At-Default
G-SIBs - Global Systemically Important Banks
IRB – Internal Based Approaches
IRRBB - Interest Rate Risk in the Banking Book
LGD – Loss Given Default
MENA - Middle East and North Africa
NPLs – Non-performing loans
OECD - Organisation for Economic Co-operation and Development
PD – Probability of Default
QAT –Qualitative Asset Transformation
ROA – Return on Assets
ROAA – Return on Average Assets
ROE- Return On Equity
SA - Standard Approach
SAP - Structural Adjustment Program
SCRA - Standardized Credit Risk Assessment Approach
SOB - State-Owned Banks
SOE – State-Owned Entreprise
WAEMU - West African Economic and Monetary Union

INTRODUCTION

"Regulation- a tough environment getting even tougher"
Bugrov, Dietz and Poppensienker, 2016

I Background of the Study

The banking sector is known to be one of the most supervised and regulated sectors in the world (Santos, 2001). This much attention addressed towards the banking sector stems from the undeniably vital role banks play as financial intermediaries and promoters of economic growth. They are able to ensure their intermediation role through optimal capital allocation and savings mobilization (Seven and Yetkiner, 2016).

In a world where markets are complete as envisioned by *Arrow and Debreu*, there are no transaction costs which justify the existence of banks as financial intermediaries and debt holders and investors are able to efficiently allocate their risk exposure by their own merit (Santos, 2001). More recent work explained the existence of banks by the services they provide to their clients. In this context, banks provide their clients with liquidity (borrowers) and efficient risk allocation (depositors). Hence, we can conclude that banks play an important role in a financial market and any market frictions can have an impact on the whole financial system.

Nonetheless, banks tend to follow the logic of *"heads, I win, tails*, you lose" or what is referred to in the economic jargon as "moral hazard". According to the moral hazard hypothesis, banks engage in excessive risk taking for their personal gain and on the expense of their creditors.

Regulation is often a reaction to market failure usually induced by excessive risk taking. The existence of market friction such as information asymmetry imposes the intervention of regulatory bodies. Consequently, regulators have implemented reforms aimed to increase bank owners' "skin in the game" through higher capital requirements and tougher supervision.

Regulatory authorities push two justifications for capital regulation. First, depositors do not have the ability to monitor banks' risk allocation. Second, banks are not willing to increase capital unless constrained.

This being said, there is opposing arguments in theoretical and empirical literature alike on the relationship between stringent or lax regulation on financial stability. More stringent capital requirements may help strengthen the capitalization of banks but can also cause excessive risk taking when managers are forced to offset additional costs imposed by equity financing and other forms of long term debt by increasing their risky asset portfolio. In contrast, relaxing capital requirement may also be an incentive for managers to increase bank risk.

In Africa, the banking system is considered to be the backbone of the economy albeit major weaknesses that have caused a series of banking crises in the continent. These weaknesses have shed light on the fragility of the banking sector in Africa (Ozili, 2018). The crises in Africa are usually instigated by excessive dependence on oil import, exchange rate volatility and structural and institutional failures (Beck and Cull, 2013).

In Tunisia, the banking sector remains the most important sector of the financial system and the bedrock of economic growth mainly due to the country's financial system being bank-based rather than market based. Based on these grounds, the banking sector is considered a major source of risk which can be propagated to the overall financial system. Indeed, the Tunisian banking sector suffers from big problems such as inefficiency, low profitability and a hefty stock of NPLs (Fendri and Neifar, 2020). These major weaknesses have been deepened by the deterioration of major economic indicators and socio-political unrest since the Arab spring which emerged in 2011 (Kalfaoui and Ben Saada, 2015). According to Kalfaoui and Ben Saada (2015), Tunisian banks were always geared towards speculation and profit maximization rather than their primary mission as a lending channel.

Therefore, the Tunisian banking sector provides an interesting context to study the impact of bank regulatory capital on bank profitability and risk. The Tunisian sector has undergone a restructuring wave which started in early 1987. The changes were intended to foster competition in the banking sector, mobilize savings and enhance resource management.

II Rationale and contribution of the research

The debate between bank managers and regulators about regulatory intervention cast doubts on the impact of regulatory capital on bank behavior (Corcoran, 2010; Jakovljevi et al., 2015; Manlagnit, 2015). The questions whether capital should be regulated and whether the current regulation is effective in mitigating bank risk (Persaud, 2009; Gopinath, 2010; Hanson et al., 2011) or whether banks should be able to freely set their optimal capital level (Miller, 1995; Calomiris and Berry, 2004; Aiyar et al., 2015) are still being investigated. One way of going about this nexus is to assess the response of the regulated entities to risk-weighted capitals.

The expected response from banks when faced with more stringent regulation is to either adjust their balance sheet risk or to increase their capital. However, the strategically response of banks is not as simple as one might think. Banks that chose to raise new equity to comply with regulatory capital may see their profits deplete due to the costly nature of equity financing compared to leverage (Myers, 1977; Myers and Majluf, 1984). Banks can offset high equity costs by passing on this cost to borrowers through charging higher interest rates (King, 2010). However, higher interest rates affect borrowers' ability to pay back the amounts borrowed and in turn increase borrowers default and ultimately bank instability (Martynova, 2015). Hence, the effect of capital requirements on bank risk and profitability remains ambiguous.

In addition, Empirical studies investigating the effect of regulatory capital often focus on developed nations. Scant attention has been paid to developing nations in Africa and Asia. Our thesis seeks to close down the gap in research about the impact of regulatory capital on bank profitability and risk by investigating the effect of regulatory pressure in a developing nation. Given these disparities between developing and developed nations, we are uncertain if the impact of regulatory requirements on bank behavior has been the same for both. We chose the Tunisian banking sector because it has been understudied and since banks are still at the heart of the financial system. Thus, regulators are interested to know the impact of more regulatory pressure through bank capital on bank behavior mainly in terms of profitability and risk. In addition, the Tunisian stock exchange is much smaller and less active than markets in developed nations which can provide more insight on bank-based systems.

The contribution of our thesis to the relevant literature is fourfold: First, very few empirical studies have investigated the simultaneous effect of regulatory capital ratios on bank profitability and risk. We seek to fill the literature gap by analyzing bank behavior in response to capital constraints. Second, the majority of studies that tackled our research question have focused on testing its impact on developing countries and mainly the U.S. and some European countries leaving a gap to fill in developing countries. Also international capital standard did not distinguish between market-based and bank-based market systems or any particularity of each country. Third, to our knowledge very few papers have investigated to potential non-linear effect of capital requirements on bank profitability and risk. Disregarding this relationship can infer very misleading conclusions about the real effect of capital requirements and increase the social costs inflicted by them. Last, we also investigate the impact of bank specific characteristics and macro-economic and political conditions on bank profitability and risks using both static and dynamic methodology to make sure that our results are not biased by endogeneity.

III Research aims, questions and objectives

The problem we seek an answer for is: Does bank regulation have a negative impact on bank profitability? Does it boosts banks stability by mitigating their risks? Or does it have no impact at all on profitability or risk?

The principal research aims are:

To investigate the impact of more stringent capital requirements on Tunisian banks; To examine if the relationship can take other forms other than the proven linear relationship; To provide a more comprehensive view on the profitability-capital and risk-capital nexus.

Based on theses research aims, this study attempts to answer the following research questions:

1. What is impact of bank regulatory capital on the profitability of Tunisian banks?
2. What is impact of bank regulatory capital on the risk of Tunisian banks?
3. Is the impact of bank regulatory capital linear or can it take a "U-shape" form?

IV Organization of the Thesis

Considering our research objectives, the remainder of the thesis is structured in the following manner. Chapter 1 presents and defines our key concepts and offers a clear view on the concepts we seek to investigate. It also reviews theoretical and empirical literature that have investigated the impact of regulatory capital on bank behavior. Chapter 2 presents the research methodology and data used for the study as well as discusses our final results. The thesis concludes with the general conclusions in which we have summarized the main ideas, findings and proposals, drawn from the theoretical and practical research.

Chapter 1

CONCEPTUAL AND THEORETICAL FRAMEWORK

CHAPTER INTRODUCTION

The objective of the first chapter is to determine the conceptual framework of our variable of interest. In order to assess the relationship between regulatory capital pressure and bank profitability and risk taking, it is important to clarify the concept of bank capital, risk and stability which is done in Section 1 below. The section also provides a summary of the main functions of bank capital.

Common misconception about the definition of certain concepts remains a source of controversy in research papers. This chapter is essential to every thesis because it clarifies the direction we seek to follow to be able to provide answers to our research question. Concepts may have different interpretations and definitions depending on the area of research. Bank capital remains one of the most controversial topics in research dealing with bank behavior. The topic has been the center of extensive discussion between bank managers and regulatory bodies.

It is also useful to trace briefly the history of the Basel international capital requirements and national capital regulation. Thus, Section 2 reviews the history of capital requirements and bank capital ratios and discusses some of the limitations of the international standards. Section 2 also details the important role of regulation and the growing debate between bank managers and regulators on the effectiveness of regulatory capital requirements and the social costs of capital requirements.

Without pretending to be exhaustive, Section 3 provides an overview and an analysis of the various theories that attempted to explain and predict banks' response to capital requirements. The section also provides an overview of empirical evidence about the issue.

The scope of this thesis is limited to bank capital requirements and its impact on bank profitability and risk ; other tools of prudential regulation such as liquidity requirements are not discussed.

I CONCEPTUAL FRAMEWORK

In this section we present conceptual framework of our variables of interest. We seek to understand the potential effect of higher capital requirements on bank profitability and risk. But first we need to define what we consider as bank capital and regulatory capital. We also need to define what we mean by bank stability and risk. This step is very crucial because it is relevant to our discussion and improves readers' understanding of our research questions.

I.1 Conceptual framework of bank capital

In this subsection we will begin by presenting different definitions of bank capital provided by the economic and financial literature. We will also and provide a summary of the main functions of bank capital.

I.1.1 Definition of bank capital

There are many definitions of bank capital in the relevant literature. We refer to the bank's economic capital as the value of shareholder equity that banks use in order to absorb losses. In the event of liquidation, capital owners have the lowest priority to be reimbursed. There is a broad list of what qualifies as capital, however bank equity capital mainly consists of retained earnings and common equity.

Some scholars define bank's capital as the equity value of a bank equated to the present value of its future net earnings. Others refer to banks capital as the owners' net worth in a bank and it includes the pay in capital and all additions to the capital resources of the bank.

All of the above definitions agree on the principal that banks' capital belongs to shareholders and is associated with voting rights and control. The regulatory definition of capital has broadened the concept of what can be considered as capital and included other types of liability such as hybrids in the definition of capital. The rationale behind is that these liabilities rank below deposit liabilities in terms of priority and thus can serve to absorb losses and protect depositors' funds.

Aside from the opposing views on what qualifies as bank capital, measuring capital is as complex. The book value of capital indicate the historical accounting value of a bank's balance sheet items which takes into account simply the asset and liability items that a bank reports at a specific point in time. Hence, balance sheet capital is the difference between the assets side and the liabilities side. If the liabilities exceed a bank's assets, capital can play as a buffer to sustain bank unexpected losses and allow banks to continue operations (Berger et al., 1995; Valencia, 2016). Thus, the book value of capital neglects banks' off–balance sheet items.

The method valuating banks' asset and liability items is very important because the book value of capital can be very different from its "real" value. If, for example, a loan's book value is recorded on the asset side of the bank's balance sheet as worth $1000 but is actually worthless— because the borrower can no longer pay back the amount borrowed—the real value of capital can be overstated. This is also the case for securities whose value on the market has fallen but the book value is still the same. These situations have triggered a longstanding debate over the pitfalls of using historical costs in accounting practices to value banks' assets in favor of mark-to-market accounting.

Another accounting practice that can change the value of capital is the creation of loan loss reserves. Loan loss reserves reduce shareholders' equity because they are deducted from the income that otherwise could have gone to shareholders' pockets. Recent changes in accounting practices modified how banks account for loan loss reserves in favor of forward looking loan loss reserves which in turn would reduce shareholders' equity even more.

On the other hand, the market value of capital reports the value of the bank's capital as appraised by the stock market and thus reflects the market's expectation of the future return prospects of the bank. This measure of capital can be biased since markets are not perfect and investors do not have all the information to correctly value a bank's capital.

Notwithstanding, all these definitions and measures of capital share a common ground: They do not mention risk nor are they constrained by rules and laws.

We rely on the definition of Maisel (1983) to define capital adequacy: "Capital is adequate either when it reduces the chances of future insolvency of an institution to some predetermine level of alternately when the premium paid by the banks to an insurer is 'fair', that is, when it fully covers the risks borne by the insurer. Such risks, in turn, depend upon the risk in the portfolio selected by the bank, on its capital and on term of the insurance with respect to when insolvency will be determined and when loss will be paid."

Based on these grounds, regulatory capital should be proportional to banks' risk. In practice, regulatory capital or capital requirements (we use these terms interchangeably) consists of capital that banks are required to hold in order to comply with the regulation in force. It is usually measured in the form of a ratio whereby the nominator consists of Tier 1 and Tier 2 capital segmented according to their subordination and maturity while the denominator is the unweighted or risk-weighted assets.

In practice, however, most regulatory capital ratios are risk-weighted even if it's difficult to accurately measure the actual risk profile for each bank. Tier 1 capital is considered the safest and the most liquid form of capital and has superior capacity to sustain unexpected losses without disrupting operations whereas Tier 2 capital en-

compasses less safe instruments.
To sum up, capital adequacy represents the amount of capital resources needed by banks for their operations, consistent with the amount of risks and risk assets it is assuming. It refers to the level of capital necessary for a bank as determined by the regulatory and supervisory authorities to ensure financial health and soundness of the financial system.
Table 1.1 summarized types of regulatory capital that satisfy the Tier 1 and Tier 2 definitions of regulatory capital.

Table 1.1: Types of regulatory capital

Instrument	Characteristics
Equity capital	Equity capital is the bank's core capital and consists of common stock and retained earnings. This form of capital is the most liquid and the most secure.
Disclosed reserves	Some of the retained earnings and other surplus may be redirected into published reserves. They hold the same characteristics of equity capital.
Preferred stock	Cumulative preferred stock encompasses hybrid instruments that can be converted into equity when a trigger event occurs. This form of capital share a common ground with debt instruments whereby they pay fixed dividends. In terms of priority, Cumulative preferred stock has priority over equity capital.
Revaluation reserves	Revaluation reserves stem from revaluating bank assets. The term is a purely accounting term and it's a difficult task to calculate their value in the event of liquidation.
Undisclosed reserves	Undisclosed reserves consist of earnings that did not appear in the retained earnings of a bank. This form of capital can be accepted by some regulators.
Loan provisions	Loan provisions consist of cash that to a bank can use to offset losses on bad loans.
Subordinated term debt	Subordinated term debt consists of long term debt of more than 5 years. To be able to be eligible to be considered in the numerator of the regulatory ratio, subordinated term debt must comply with the regulatory guidelines. In terms of priority, these instruments have priority over all the other equity forms listed before.

I.2 The functions of bank capital

An important function of bank capital is to provide a cushion to absorb banks' unexpected losses so that depositors —in case of a bank-run — or tax-payers —in case of a bailout —do not have to bear the consequences of these situations. This is known as the ex-post facto of bank capital. Indeed, in term of priority, bank capital has priority over all other senior debt to absorb losses.
The ex-ante function of bank capital, as equally important as the first function, is that capital encourages better risk management provided that bank managers do not act against the interest of shareholders for their personal gain. Based on the aforementioned argument, capital incentivizes banks to improve their risk management which in turn reduces the moral hazard and too-big-to fail situations where losses can be passed on to other parties. Bank managers find fewer incentives to take on excessive risks when shareholders' are more likely to take the hit since these losses are deducted from their "skin in the game". Thus, regulatory capital aims to increase shareholders' skin in the game which in turn would reduce banks' excessive risk taking incentives.
Bank capital also supports the banks' lending activity. The bank business model depends on leverage to finance most of its illiquid assets. However, in a situation of liquidity crunch, bank capital supports the bank lending activity. Based on these grounds, banks with higher capital are able to grant more loans to the economy. Regulators also advocate for higher capital because it will lower the responsibilities of governments to bail out failed banks as a lender of last resort.

I.3 Conceptual framework of bank risk and stability

This subsection aims to provide concept definition of bank risk and stability. This is very important since our thesis seeks to gauge the impact of regulatory pressure on bank risk. The concept of risk and stability are very different yet very close. We will also present how empirical wisdom has measured stability and risk in the literature.

I.3.1 The concept of bank stability and risk

Preserving financial stability is one of the main objectives of a country's regulatory bodies, decision-makers, and central banks across the globe. The issue of financial stability has become one of the most discussed issues in the financial literature. Bank risk is considered among the major factors affecting financial stability.
In general, there is no commonly accepted definition for the concept of financial stability, since a set of measures are required to sustain a stable financial system (Van den End, 2006). However, there have been some efforts to define financial stability. For example, Davis (2001) and Padoa-Schioppa (2003) define financial stability in terms

of the ability of the financial system to absorb external shocks, which leads to the absence of negative shocks on the real economy. Similarly, Swamy (2014) defines bank stability as the bank's ability to manage its operations under hostile events, such as policy changes within a liberalization era of the financial industry. Thus, it reflects the bank's capacity to be solvent under unfavorable economic conditions through their capital and reserve accounts. Allen and Wood (2006) also define financial stability as a state of affairs in which shocks or any other distress are unlikely to occur.

Houben, Kakes, and Schinasi (2004) define financial stability by the well-functional role of banks in the financial system which refers to its primary function such as risk management and resource allocation.

Based on the above arguments, financial stability occurs when banks can absorb economic shocks and can smoothly fulfill their principal functions. Therefore, the concept of financial stability illustrates the condition where the financial intermediation functions are performed smoothly thus building confidence among stakeholders (Jahn and Kick, 2011; Makkar and Singh, 2013).

The banking sector is considered stable when it is helps assisting rather than preventing economic performance and diluting the financial imbalances (Schinasi, 2004; Kasman Carvallo, 2014).

Boyd and Runkle (1993) document that the specific factors of the banking-sector (e.g. loans size, capital adequacy and deposit size) are considered as the main indicators of financial stability. Similarly, Lin and Yang (2016) concluded that strong bank elements, such as liquidity, asset quality, capital adequacy, profitability and management efficiency in addition to the favorable economic environment, will reinforce financial stability. De Nicolo (2001) postulates that if banks are unable to utilize assets to generate revenue, they cannot remain stable in the long run. Geoff (2009) posits that a sound banking sector leads to a stable financial system, and as a result, to economic growth.

Moody's measures banks' stability through their ability to honor their obligations to debt holders including depositors and other creditors. This measure is referred to as the financial strength rating. They use qualitative and quantitative information to assess bank stability. This rating system is thought to be more accurate than just using information from banks' balance sheets (Demirgüç-Kunt et al, 2008).

All in all, we can conclude that bank stability ensures the health of the financial system, which is one of the major duties of the regulatory bodies in any economy (Mirzae, Moore and Liu, 2013; Shijaku, 2017; Almahadin, 2020).

On the other hand, risk taking can be defined as the willingness of banks to take extensive risk for higher return (Buch, et al., 2014). Excessive risk taking can lead to substantial losses that can wipe out a bank's capital. Hence we can see how bank risk taking can be measured by its insolvency risk. Additionally, high-risk taking can badly affect the performance of the institutions when returns are not up to the expectations of the investors.

Jiménez et al., (2013) documented in their study on Spanish banks that the stability of the banking institutions can be affected by high risk taking. Bolton, Mehran, and Shapiro (2015) highlighted that excessive risk-taking of financial institutions affects depositors, taxpayers, creditors and financial system as a whole. In addition, shareholders give preference to extensive risk taking due to limited liability, moral hazard issues, and convex pay-off systems.

Therefore, shareholders of the banks have strong inducements to undertake extensive risky investments for their profit maximization goals (Mollah, Hassan, Al Farooque, Mobarek, 2017). In sum, we can see how bank risk taking is linked to insolvency risk which can result in financial instability.

Insolvency risk has been widely used in the empirical banking literature as a proxy for financial stability (Schaeck et al., 2009; Laeven and Levine, 2009; Berger et al., 2009; Demirguc-Kunt and Huizinga, 2010; Houston et al., 2010; Lepetit and Strobel, 2013).

I.3.2 Empirical measures of risk and stability

The previous subsection attempted to present the link between bank insolvency risk (or risk taking) and financial stability. This subsection is designed to introduce the empirical method we chose to account for bank instability and risk taking.

As we have mentioned before, stable banks need to be solvent in order to remain a going concern entity. Excessive risk taking can, however, lead to substantial losses which in turn deplete banks' capital. We refer to this bank situation as balance-sheet insolvent. Hence we can see how insolvency can lead to the instability and fragility of the financial system. This is arguably more dangerous when the affected banks are considered "too big to fail" or "too big to save".

Thus, empirical literature has used several measures that can proxy for stability and insolvency risk. However, one measure stands out and has been used extensively in bank risk and stability literature (Boyd and Runkle, 1993; Laeven and Levine, 2009; Uhde and Heimeshoff, 2009; Lee and Chin, 2013; Hoque et al., 2015).

The z-score was built on the work of Roy (1952) and afterward enhanced through the work of Boyd and Graham (1986), Hannan and Hanweck (1988), and Boyd, Graham, and Hewitt (1993) and has since become wildly used as an estimate of bank stability and solvency in the banking and financial stability related literature. Z-score is also one of the indicators used by the World Bank in their Global Financial Development Database to measure bank stability.

Not to be confused by the z-score developed by Altman (1968) as a set of financial and economic ratios used to predict corporate finance distress.

According to Roy (1952), the z-score measures the distance to default. It is calculated by the total of return on assets ratio and the capital asset ratio divided by the standard deviation of asset returns. A bank default occurs when incurred losses exceed equity.

$$E > -\Pi$$

The probability of default can be written as proba (-ROA< CAR) where ROA is calculated as the net income (π) to total assets and CAR is calculated as Equity over Total assets. When net income is normally distributed, the inverse of the probability of default is as follows:

$$Z - score_{it} = \frac{ROA_{it} + CAR_{it}}{\sigma ROA_{it}}$$

Note that σ(ROA) is the standard deviation of ROA. Hence, we can conclude that the Z-score is the inverse probability of default. The basic idea behind the measure is to compute how much variability in bank profits (σ(ROA)) can be absorbed by its own equity (E) before becoming insolvent. The z-score measure assumes that when capital level falls to zero a bank is declared insolvent. A higher level of Z-score indicates that the bank is low-risk meaning that the bank has to go through several drops of its profits to fall into insolvency. Likewise, a low level of Z-score indicates that the bank is high-risk.

The study of Chiaramonte et al. (2015) show that the use of Z-score to predict bank distress is documented to be "at least as good" and as reliable as other approaches that require more data such as the approaches that include CAMELS variables even when used during a crisis period. Lepetit and Strobel (2013) argue that Z-score plays an important role in the assessment of both individual bank risk as well as overall financial stability.

The major advantage for the use z-score to predict bank stability is the simplicity in its computation and that it solely relies on bank publicly available accounting data. However, being an accounting-based measure can also be its own shortcoming.

II BANK CAPITAL REGULATION

In this section we will present the role capital regulation plays in curbing bank risk taking incentives. We also discuss the social costs of capital regulation and we explain the reasons banks are opposed to capital requirements. Lastly, we present the international and national regulatory standards for bank capital requirements.

II.1 The role of capital regulation

The global banking sector has undergone significant structural and regulatory changes since the 1980s. Banks were taken in liberalization movement activities initiated by the rule of "3D" which stands for Deregulation, disintermediation and decompartmentalization, favored by the abolition of geographical boundaries.

Right after the Great Financial Crisis of 2007-2008, economist and regulatory bodies alike were questioning the factors that led to the upheaval of the financial system in countries considered to be the most strict in terms of compliance with the Basel capital standards and the Basel Core Principles for Effective Bank Supervision (BCPs) and more skepticism grew on the effectiveness of existing regulations. The crisis shed light on the weaknesses of the regulation (at that time) and spawned a controversial debate over inadequate bank capital believed to be the source behind the proliferation of the financial distress. The crisis had also damaged banks reputation and triggered the loss of confidence toward the financial system as a whole.

Banks' business model is established on the grounds that they finance "illiquid assets" with "liquid resources" or what is commonly referred to as qualitative asset transformation (QAT). This business model makes them particularly vulnerable to the loss of confidence by depositors. Therefore, bank capital plays an important role in preserving and boosting market confidence in banks. According to Chishty (2011), Capital adequacy is important for a bank to maintain depositors' confidence.

Regulatory intervention is justified on the ground that banks, if left alone, maintain capital ratios lower than the socially optimal level (Rime, 2001). Bank managers, responsible for deciding the capital structure of the bank, are not incentivized to choose to raise capital over debt due to mainly three reasons eloquently summarized by Aiyar et al. (2015): First, if managers act against the interest of shareholders and are able to extract personal gains from keeping a high default risk, they are more likely to opt for leverage since the probability of default rises when the bank is more and more leveraged up. Second, the social costs of a banking crisis (e.g. tightening of the credit supply, disruption of the payment system) are not internalized by the bank's stakeholders. Hence, bank managers receive no incentives to keep a prudent management of risk. Third, the presence of safety nets that protect creditors interests creates incentives for bank managers and shareholder whose interests are now aligned with

the managers to “game these safety nets” by keeping a high default risk.
This situation is more dangerous when depositors are not able to monitor the risk portfolio of banks due to asymmetry of information and high costs of monitoring. This is the reason why some countries have given explicit deposit insurance schemes to protect the interest of depositors since bank depositors are not protected by the standard covenants of debt contracts.
In this case, regulators can enforce remedial covenants, such as restricting asset growth and certain activities or enforcing the raise of additional capital, which constrain the actions of banks. Because regulatory enforcements impose substantial costs on banks, they provide a vital incentive for banks to limit risk-taking. (Higher capital requirements may represent entry barriers for newcomers, who would restrict competition and allow existing banks to accumulate power, resulting in a more prudent and less-risky behavior).The absence of a risk management culture, the existence of a destructive competition and information asymmetry, all these factors represent the characteristics of a risky and constantly changing environment for banks. Thus, prudential regulations have been required to deal with this risky environment. The best-known regulatory instrument is capital adequacy.
Before regulatory minimum capital were put in place, it was socially unjustifiable to have substantial capital because leverage is a cheaper alternative and bank owners bear negative externalities in the case of bank failure (Aiyar et al., 2015). Another explanation as to why banks are reluctant to raise more capital is the opportunity for excessive risk taking provided by the deposit insurance schemes. Deposit insurance schemes diminish depositors’ incentives to monitor and discipline banks. Indeed, uninsured creditors lose the incentive to monitor banks since they expect to have a safety net and be fully reimbursed in the event of bank failure by insurance deposit schemes. Bank managers can also act against the interest of shareholders and maintain high default risk by taking on risky assets when they are being rewarded with compensation plans that values short term profits.
Capital requirements, although they receive constant criticism, appear to be a prerequisite for a sound and stable banking sector. When properly designed, they curb bank incentives to engage in excessive risk taking because they can substitute supervision and oversight of bank risk management.
More stringent regulatory capital can curb bank risk-taking incentives in at least two ways. First, higher capital will incentives banks to enhance the screening and monitoring of their customers (Coval and Thakor, 2005; Mehran and Thakor? 2010). Second, higher capital also reduces bank managers and shareholders preference for risky assets (Calomiris and Kahn, 1991). However, higher capital can also have adverse effect on bank risk taking through two potential channels. First, if higher capital dilutes ownership, the more “skin in the game” hypothesis no longer holds since the negative

externalities of bank default does not greatly affect shareholders' wealth (Besanko and Kanatas, 1996). Second, more equity-funding will result in lower return to shareholders. This may push bank managers to take excessive risks in order to bring back up the profitability that shareholders are used to get (DellAriccia et alk., 2014). This is particularly true even more for larger banks than smaller banks since the too-big-to-fail status offers a potential bailout in case of failure or any other distress (Berger and Bouwman, 2013).

II.2 Basel standards for capital regulation

The Basel framework has been adopted by all OECD countries and is still being implemented gradually in developing countries who seek a risk based and cautious approach to bank regulation.

To date, the Basel framework has come up with three major adaptations of the Basel regulations. These adaptations include Basel I (1988), Basel II (2004), and Basel III (2010). These agreements aim to boost recapitalization and improve bank asset quality. In addition, they define the main objectives of bank capital as well as the minimum capital that must be held by credit institutions.

These international capital standards are reinforced by three pillars. Pillar I defines the regulatory rules, Pillar II provides scope for supervisory discretion, whereas Pillar III seeks to foster market discipline.

Historically, Basel I framework is considered the first initiative to define and regulate capital. Regulators in the U.K. and U.S. in 1981 pioneered the concept of capital requirement and introduced risk-weighted capitals. This has triggered their acceptance and adoption by most countries around the world.

The Basel I framework was a response to the international debt crisis in Latin America in 1988. That same year, the Basel Committee on Banking and Supervision (BCBS) introduced the first set of minimum capital requirements for banks with the aim of promoting a sound and stable international banking system. Although the framework was intended at first for international banks, they were widely adopted by most banking regulators in developed and developing nations (Goodhart 2011).

The Basel III framework proposed in 2009 and currently being implemented, aims to increase the quality and quantity of capital. Basel III has been widely adopted in high-income member countries of the Organisation for Economic Co-operation and Development (OECD), with developing nations taking a more cautious approach. Selective adoption of this complex framework is appropriate in settings with limited supervisory capacity.

II.2.1 Basel I

Basel I is the first international agreement and the first Basel Accord which was initially aimed at international banks and included the following:

- **The definition of capital** in which capital is composed of core capital and supplementary capital;
- **A simple risk-weighted asset (RWA) approach** to categorize bank assets and off-balance sheets into four risk levels, respectively: 0% - zero risk, 20% low risk, 50% medium risk and 100% high risk ;
- **The capital adequacy ratio**, which refers to a mandatory minimum that banks are required to maintain at all times at 8% for the ratio that includes core and supplementary capital to risk-weighted assets and 4% for the ratio of core capital to risk-weighted assets.

Under Basel I, capital consisted of two items based on their "quality" in terms of loss-absorption: Tier 1, with the best loss-absorption capacity comprising mainly of shareholders' equity and Tier 2 capital subordinate to deposits.

The primary objective of the now known as Basel I framework was to set an international agreement to maintain a minimum level of capital to promote bank solvency. For bank managers this meant that an increase in their asset portfolio had to be accompanied by an increase in capital to maintain the 8% minimum at all costs.

When Basel I was first introduced in 1988, the banking industry was not as developed as it is now. Back then, financial transitions were conducted smoothly and rules were implemented and revamped rapidly without causing disruption to the operation of the existing banks. Regulation was simple and ambiguous which opened the door for bank to adopt their own interpretation to sidestep the regulation in force. Ingenious and devious financial products (e.g. Credit Default Swaps) and services came to existence which caused the global financial crisis of 2007.

For brevity, the pitfalls of the Basel I framework can be summarized by the following:

- *The lack of risk sensitivity*: The Basel I framework assigned four risk levels yet allowing for great variation within each risk level. For instance a highly leveraged small firm had to respect the same regulatory capital of 8% as a large corporation with an AAA-rating since they both fall under the 100% risk bracket. This categorization of risk unintentionally encouraged banks to adopt an arbitrage approach in which banks preference for high quality but low expected returns was shifted to low quality assets with high expected returns. This had turned regulatory capital to an uninformative tool about the real risk exposure for each bank regardless of their size (Ferguson, 2003).

- *A "one-size-fits all" approach*: The minimum requirements were the same no matter the size, the leverage, the risk management or risk level, of the bank.

- *A gap in the coverage of risk sources*: Basel I only included credit risk in the denominator of the ratio disregarding other equally important sources of risk. The 1996 Amendment brought change to the risk weighted ratio by including market risk in the denominator. Yet, the ratio still hadn't covered other sources of risk (e.g. operational risk, strategic risk, reputation risk *e*tc).

- *An uninformed and arbitrary ratio*: The 8% minimum requirement was not based on any solvency target but rather it was a figure capable of being met by banks in G10 countries without any disruption of their activities.

- *Lack of recognition of new financial instruments*: The first adaption of the Basel framework failed to adequately assess the actual risks that accompanied the use of new financial instruments and risk mitigation techniques.

The shortcoming of Basel I had created a jurisdiction gap whereby regulatory capital no longer can assess the potential risk profile of banks. Furthermore, the regulatory capital was based on book values rather than market values disregarding the different accounting practices in each country which hampered the objective of harmonizing capital standards. The international Basel Committee on Bank Supervision took this as an opportunity to revamp to a new adaptation which is now referred to as Basel II published in 2004. The second adaptation of the Basel framework sought to sever with the primitive capital adequacy ratio brought by Basel I and addresses the new financial climate. This included dropping the one-size-fits-all approach for better alignment with the risk specification of each institution (Attik, 2011). Despite harsh criticism towards the first adaptation of the Basel Accord, the average ratio of risk weighted assets in the G10 countries jumped from 9.3% in the year it was introduced to 11.2% in 1996 (Jackson, 1999).

II.2.2 Basel II

The Basel II Accord replaced Basel I and was set forth with the objectives of being elastic and reflective of the sophistication of bank operations.
The new framework provided a new definition of regulatory capital which included the expansion from two to three tiers; (2) allowed banks to choose one of two methodologies to measure their credit risk ; and (3) included operational risk.
The new adaptation was built on three mutually reinforcing pillars: (1) **minimum capital requirements**; (2) **supervisory oversight on behalf of national regulators**; and (3) **stronger market discipline** in the form of information disclosure on capital, risk exposures, and risk assessment processes.

- *The minimum required of own funds remained unchanged*, at 8%, with at least 4% in the form of Tier 1 capital and 2% in the form of common equity. However, this time, risk-weighted assets included three risks: credit risk, market risk and operational risk. Basel II added Tier 3 to the numerator of the regulatory ratio to help banks meet the required minimum of 8%. Tier 3 encompasses short-term subordinated debt with a maturity of at least two years provided they are approved by the supervisory authority.

- *The supervisory process for bank activity* included mainly the rapid intervention to avoid capital deplete, credit risk assessment approaches subject to approval of national regulators and improving bank-supervisor dialogue.

- *Market discipline* focused on information asymmetry by requiring regular reporting requirements every six month for national banks and quarterly for international banks to the Central Bank and published to the general public stating, in great detail, the ownership structure, risk exposures, capital adequacy to the risk profile and so on of each institution.

Moreover, Basel II Accord also included the expansion of risk weights range and the diversification of credit risk management instruments and derivatives such as Credit Default Swaps (CDSs) and credit linked notes. It also allowed banks to develop and use their in-house models to compute their specific risk parameters of their portfolios. The number of risk categories exploded for large sized banks jumping from less than 10 categories to over 200,000 (Haldane, 2011).
In addition, the framework permitted the assessments from authorized external credit assessment institutions of a bank risk portfolio.
Basel II authorized two approaches to assess a bank's risk weights. The standardized approach, also commonly referred to as the standard approach (SA) and the Internal Rating Based – (IRB) approach. The standardized approach is similar to the risk buckets proposed under Basel I. Yet, this time, the number of risk buckets increased substantially from the four categories under Basel I. This approach also allowed the use of financial instruments to mitigate the risk portfolio of banks and in turn reduce their capital requirements.
The internal Rating Based – (IRB) approach permitted banks to develop their own rating systems to asset their credit risk. This approach is subject to the approval of regulators and include two methodologies: The Foundation Internal Rating Based approach (Foundation IRB) and the Advanced Internal Rating Based approach (Advanced IRB). Whereas in the first methodology banks will only need to compute the probability of default (PD) of their borrowers, in the second methodology banks need to determine, in addition to the probability of default, their own loss given default

(LGD) and exposure-at-default (EAD) levels.
Even though the IRB approaches were designed to be more elastic and risk sensitive, it unintentionally contributed to the substantial increase in complexity of the computation of the regulatory capital ratio. Furthermore, supervisory authorities were no longer able to monitor financial institutions properly given the new complexity and the differences between the three methodologies.
The global crisis of 2007 exposed the shortcoming of Basel II framework. We briefly enumerate some of the main shortcomings of Basel II below:

- *False Sense of Security*: Bank managers took comfort from the compliance with the Basel II framework. At that time, the general opinion was that all financial institutions that complied with the Basel standards will be immune to any distress and that a "well-designed" regulatory framework can protect from any systemic meltdown.

- *Overreliance on credit-rating agencies*: The use of credit-rating agencies to assess risk have been shown to be problematic since, in the time leading up to the crisis, they failed to determine the risk level of ingenious and innovative financial instruments. Moreover, there has been evidence that riskier firms tend to forgo ratings to lower their cost of borrowing (Danielsson et al., 2001).

- *Greater complexity of credit risk measurement*: The complexity of the new credit risk assessment methodologies increased the opacity of operations and risk management of banks. In turn, regulators found it not only challenging but also costly to confirm the accuracy of computation of the reported risk-weighted asset ratios (Haldane, 2011). These pitfalls weakened the effectiveness of supervisors (Pillar 2) and market discipline (Pillar III). The global financial crisis exposed the quality of information provided to supervisory authorities in order to effectively monitor them and the attitude of banks concerning information disclosure (World Bank, 2012).

- *Social costs of capital requirements*: Regulatory capital ratios aimed to promote bank soundness and stability but did not take into account the social cost of said regulation. Several studies have shown that more stringent capital requirements cut credit supply to households and firms in need of financing. The social costs of the Basel framework may be extended to also include opportunity costs and reduction of profitability born by financial institutions.

One of the key pitfalls of the first two Basel Accords was they were more focused on the stability of each stand-alone bank than on the overall stability of the financial system. The global financial crisis revealed the danger of systemic risk whereby the failure of one bank can unleash a chain reaction. The failure of Lehman Brothers prompted reforms to the Basel II framework to what is known today as Basel III.

II.2.3 Basel III

Basel III emerged post-crisis and is the third and the latest advancement of the Basel Accords and is an international regulatory standard set by the BCBS on capital adequacy. The latest adaptation of the Basel framework included a new leverage ratio, capital buffer, two new liquidity risk ratios and stability oriented stress testing. The new reforms aimed to boost the resilience of financial institutions by making sure they are maintaining a capital sufficient to absorb losses in case of emergence of another crisis.

The Basel III reforms were agreed by the G-20 in November 2010 and later issued by the Basel Committee on Banking Supervision in December 2010 (BCBS, 2010). The key aims of these reforms is to improve the quality and quantity of bank capital, to increase their loss-absorption capacity and improve bank disclosure. The Basel III reforms were designed to control the causes of the global financial crisis.

Basel III introduced new rules which included a new and stricter definition of capital designed to increase consistency, transparency and quality of the capital base and the introduction of new liquidity standard (BCBS, 2010).

Basel III divides capital into two types: Tier 1 Capital and Tier 2 Capital. Tier 1 capital is further divided into Common Equity Tier 1 Capital (CET1) and Additional Tier 1 Capital. Common equity has been the focus of Basel III because it is the "the most loss-absorbing form of capital".

Basel III made no changes to the minimum capital ratio but a capital conservation buffer of 2.5% was added to the 8% minimum capital requirement bringing the minimum total capital required to 10.5%. Global systemically important banks (G-SIBs) were also subject to additional capital requirements which range from 1% to 2.5% depending on the risk bracket. The newest installment has also called for changes in the quality of the regulatory capital. These changes included raising the 4% Tier 1 capital to 6% and imposing a minimum level of the common equity capital set at 4.5% of risk-weighted assets.

Furthermore, Basel III introduced a new leverage ratio, a substitute to the risk- based Basel II framework. This new leverage ratio is set at 3% and imposes more restrictions on bank activities.

Table 1.2 below summarized the key changes made the three adaptations of the Basel framework in regards to the capital requirements. Basel III increases capital requirements for securities financing activities, repurchase agreements and counterparty credit risk arising from derivatives.

Additionally, the new Basel Accord has formulated ways of reducing systemic risk and the cyclical effects of Basel II. For instance, it introduces a countercyclical capital buffer and capital conservation, and discusses "through the- cycle" provisioning.

Table 1.2: Basel III capital requirements compared to Basel I and Basel II

	Basel I	Basel II	Basel III
Quantity of Capital			
Minimum Total Capital	8%	8%	8%
Countercyclical Buffer	-	-	0-2.5%
Global Systemically Important Banks (G-SIB) Surcharge	-	-	1-2.5%
Minimum Total Capital Plus Conservation Buffer, Countercyclical Buffer, and G-SIB Charge	8%	8%	11.5-15.5%
Leverage Ratio	-	-	3%
Quality of Capital			
Minimum Common Equity capital (CET1)	-	-	4.5%
Minimum Tier 1 Capital	4%	4%	6%
Hybrid Capital Instruments with Incentive to Redeem	Eligible	Eligible	Not eligible

Basel III is poised to have a significant impact on the world's financial systems and economies. However, it was essentially criticized for the complexity in the calculations of the capital requirements due to the excessive parameterization of risk variables which gave reason for banks to arbitrage away regulatory capital. Another shortcoming for Basel III is that it still relies on risk-weighted assets even after failing during the global financial crisis (Wolf, 2014).

II.3 Capital regulation in Tunisia

In the early 1980s, acute macro-economic difficulties exacerbated the deep-seated inefficiencies characterizing the Tunisian banking sector. Regulatory authorities, in response to the ticking time bomb, launched the Tunisian's structural adjustment effort of the late 1980s and early 1990s. The Structural Adjustment Program (SAP) aimed to liberalize the economy both externally and internally and the financial sector under the auspices of the IMF.

These reforms endeavored to mobilize domestic savings, bolster efficient resource allocation, favor healthy competition and strengthen the banking sector's soundness. The reforms were implemented gradually and tackled different problems of the financial and economic system. The initial phase of the reforms involved essentially the liberalization of interest rates and credit allocation decisions to commercial banks, the promotion of the stock market, opening banks' capital to foreign investors and strengthening prudential regulation and supervision. In this line, the Basel prudential standards were officially adopted in Tunisia in 1991. According to Tunisian banking law, banks were required to abide by the Basel risk-weighted adequacy ratio set at

8% by 1999. In 1992, the Central Bank of Tunisia (CBT) called for the pumping of additional capital into undercapitalized banks. The estimated capital flow injection amounted to 1.5% of GDP for equity and an extra 1.5% of GDP for provisions (Laeven and Valencia, 2008). The capital pumped in the system did not only enhance the solvency of banks but also changed the structural organization of these banks leading to a more diversified ownership structure. Indeed, Tunisian banks went from a majority government ownership to a near equal ownership shared between the government and domestic and foreign private shareholders. The privatization of Tunisian public banks strengthened competition and ultimately led to improvements in the services provided alongside the modernization of the payment system.

Prudential standards were strengthened by the Law No. 2001–65 of 10 July 2001 on credit institutions, as amended and supplemented by Law No. 2006–19 of 2 May 2006. The law tackled the use of banks' own funds as well as other soundness measures such as the solvency ratio, liquidity ratios amongst others. Moreover, the reform of the 10 July 2001 introduced the concept of universal banking and banished the distinction between deposit, investment and development banks.

Since 2011, the CBT launched a program of banking regulation reforms intended to complete the transition to Basel standards. The reform included establishing collective provisions to cover latent risks and the gradual increase of the minimum solvency ratio to 9% by the end of 2013 and then to 10% by the end of 2014. Additionally, the CBT introduced Tier 1 ratio of 6% by the end of 2013 and 7% by the end of 2014.

In 2015, the CBT announced the elaboration and implementation of their five-year plan for banking supervision in 2016-2020. The plan seeks to bring the Tunisian banking prudential framework in line with Basel II and III standards. The plan encompassed the introduction of operational risk and market risk in the calculation of capital requirements which were effectively implemented in 2016 and 2018 respectively. Additionally, the five year plan urged banks to develop their own internal rating systems for counterparties in 2016.

The year 2016 marked the implementation of Law No. 2016-48 of 11 July 2016 which aimed to strengthen the financial system and improve credit flow into the real economy. The reforms started with a partial recapitalization of the three state banks (BH Bank, BNA Bank and STB Bank) whose stock of impaired loans constituted a growing burden and an alarming threat to their solvency. The law brought changes to the previous banking law including the revision of the supervision and oversight regime. A series of measures were set out to ensure further stabilization of the banking sector including allowing the closing down of banks if necessary and the establishment of a new deposit guarantee fund whereby depositors are protected via guarantee deposits of up to 60,000 Tunisian Dinars. In 2018, the CBT issued circular No. 2018-06 on capital adequacy standards in which they sought to ensure that banks were in compliance with

the minimum capital requirements and that they provided adequate coverage of market risks to hedge against foreign exchange risks and their outstanding Treasury bonds in their balance sheets. The circular also sought to set a single reference framework for capital adequacy standards. The circular provided additional reforms in order to meet with the Basel requirements. In that line, complementary equity was split into two components: Tier 1 and Tier 2, new capital requirements for counterpart risk on over-the-counter derivative instruments were imposed and prudential standards specific to Islamic banks were established. The circular also was one of the first regulatory texts that explicitly recognized the notion of the trading portfolio. In the same year, the BCT worked on finalizing pillar 2 relative to Basel II standards whereby banks were required to transition from a company base equity prudential framework to a consolidated base. For the years 2019-2020, The CBT continued to apply structural reforms aimed to fully comply with pillars 1 and 2 of Basel II and Basel III standards through the advancement in the project of the revision of the credit risk calculation approach, the establishment of an Internal Capital Adequacy Assessment Process to measure and manage the Interest Rate Risk in the Banking Book (IRRBB), the elaboration of an internal evaluation process for economic capital allocation "ICAAP" and the review of the supervision process in order to fully comply with the 29 fundamental principles of Basel for effective supervision. As part of review for credit risk calculation approach, the BCT has chosen not to retain the internal ratings approach and to use a standard approach dubbed the Standardized Credit Risk Assessment Approach (SCRA), which excludes the use of external ratings. The rationale for this decision was that SCRA is more adapted to the economic and financial reality of the Tunisian financial system whereby the use of external ratings is relatively scarce. The CBT also argues that the use internal ratings approach has its own limitations due to the complexity of the models used which are likely to undermine the credibility of risk-weighted assets estimates and consequently affect the confidence of stakeholders.
More recently, The CBT has taken, like all of the regulatory authorities around the world, a set of measures aimed to limit the negative impact of the COVID-19 pandemic on the economy, preserving financial stability and adapting the supervision process to the new economic context while allowing banks and financial institutions to support economic agents during this difficult period. The set of measures included the adjustment of the components of the minimum capital requirement ratio to take account of the rescheduling of deadlines which will be excluded from the numerator of the ratio and subjecting banks to perform a stress test to assess their resilience capacity over a 3-year horizon (2020, 2021 and 2022).

III Theoretical and empirical review

The following section should not be mistaken for a thorough review of the literature relating to the effect of regulatory capital requirements. We do not attempt to include all relevant theories to our research question or all points of view nor do we want to review all theoretical and empirical wisdom in great detail. Rather, we summarize what we regard as some of the most important theoretical and empirical perspectives, and integrate them within a coherent framework, in order to present a summary helpful to any student or practitioner wanting to know more about our research question.

III.1 Theoretical review of regulatory pressure and bank behavior

Although the Basel framework has become the blueprint of financial regulation and has been accepted as the primary regulatory framework around the world, theoretical literature remains torn about the effect of regulatory pressure on bank profitability and risk.

Below, We discuss theories that have addressed the issue of how regulatory pressure is predicted to affect bank profitability and risk. These theories fall into four groups. These groupings are provided for expositional convenience only and should not be interpreted as competing theories. Rather, these theories focus on different aspects of banks' response to regulatory pressure.

III.1.1 Theoretical wisdom on capital requirement and bank risk

When investigating the impact of regulatory capital on bank behavior, some aspects of behavioral finance should be factored in. These factors include the presence of the problem of moral hazard, agency problems between managers and bank owners as well as between bank managers and bank owners against other creditors, and capital buffers.

The Portfolio selection model and the Expected Income effect

Kahane (1977), Koehn and Santomero (1980), and Kim and Santomero (1988) have used the mean-variance framework to model bank portfolio selection in order to understand the dynamics between the introduction of more stringent capital requirements and bank risk taking incentives. They show that when banks are faced with more stringent capital requirements they expect a reduction in their profits. This is commonly referred to as the *"expected income effect"*. Under this theory, banks engage in excessive risk taking in order to remain profitable. Thereby, capital requirements encourage bank risk taking. Hence, this theory challenges the ability of capital requirements to curb bank excessive risk taking (Koehn and Santomero, 1980; Kim and Santomero, 1988; Rochet, 1992). If anything, when bank owners consider raising capital to be expensive they will choose a higher point on the efficiency frontier which entails higher return but also higher risks. This can lead to an increase in the default risk of banks when they engage in excessive risk taking in which an increase in capital can no longer offset. For regulatory policy, the theory argues that capital regulation can have an adverse effect opposite to what regulatory bodies and policy-makers would desire. Their reasoning was that when banks are pressured to raise capital they do that by substituting leverage with risky assets. This means that banks would have incentives to raise their portfolio risk exposure when confronted with involuntary regulatory induced increases in capital (Merton, 1972; Kahane, 1977; Koehn and Santomero, 1980; Kim and Santomero, 1988). Kahane (1977) argues that capital requirements cannot curb bank risk taking unless regulation also tackles the composition of banks' portfolio. In sum, the mean-variance framework predicts a positive association between capital adequacy and asset risk.

The option pricing framework and moral hazard

The option pricing framework posit that unregulated banks have incentives to increase their risk exposure and take part in excessive portfolio asset and leverage risks in the hopes of securing better profitability and maximizing their shareholders equity value (Benston et al., 1986; Furlong and Keeley, 1989; Keeley and Furlong, 1990; Merton, 1977; Black et al., 1978; Kareken and Wallace, 1978; Dothan and Williams, 1980; Marcus and Shaked, 1984; Diamond and Dybvig, 1986; Benston et al., 1986). The theory posits that banks can maximize shareholder equity value by maximizing the option value of the deposit insurance through higher risky assets and leverage.

The problem that arises from this particular bank behavior is that banks can increase shareholder value at the expense of their depositors through exploiting the deposit insurance subsidy induced by the flat-rate deposit insurance pricing. Thus, banks can use deposits to take in more risks while at the same time not having to pay a default risk premium induced by the higher risk exposure.

The option pricing framework posit that the relationship between capital and risk can be positive or negative depending on the marginal benefits that a bank can get from issuing deposit liabilities and the costs of asset risk and leverage that comes with more risk exposure.

In this context, a negative relationship between capital and risk can be observed when banks exploit the deposit insurance subsidy to extract marginal benefits. Thus, we expect to see lower capital is associated with higher risk exposure. This situation is referred to as the "moral hazard" hypothesis. On the other hand, a positive relationship between capital and risk can be observed when banks expect higher costs to entail with

higher risk exposure. In sum, we can conclude that according to the option pricing framework bank behavior is driven by the marginal gains or costs a bank can expect to support when taking in more risks.
However, the moral hazard advocates argue that regulatory pressure should limit moral hazard incentives due to the mandatory minimum level of capital relative to their risky assets increases. Capital requirements can restrict this bank behavior by forcing shareholders to take part in the losses previously borne by depositors thus diminishing the value of the deposit insurance put option. Notwithstanding the contribution of theory of options valuation applied by Merton (1977) to the conventional wisdom, this framework was criticized for ignoring the presence of a very important aspect of the financial system which is market friction. In particular, information asymmetry was not taken into account in the option pricing theory (Dewatripont and Tirole, 1994).

The theory of limited liability under option pricing theory

Under the theory of limited liability shareholders' payoff resembles that of a call option whereby the value of the option is equal to the bank's asset value. This call option has a limited downside risk equal to shareholders' paid equity and an unlimited upside gains. Shareholders will urge managers to maximize the bank's total assets while using as little capital as possible. Since banks are largely financed through deposits characterized with flat and low interest rates, banks can increase their equity market value. Under this theory, capital requirements reduces shareholders' limited liability which in turn would reduce their risk appetite.

The risk aversion theory

The utility maximizing mean-variance framework provides another vision of the relationship between capital and risk. In this framework, the relationship is driven by banks' risk aversion. Banks with low risk aversion will choose to finance their assets with capital rather than leverage (Kim and Santomero, 1988)). On the other hand, when bank managers are not risk averse they tend to use leverage more than capital and take part in excessive risk taking hoping for higher return. According to this theory, managers' compensation plans are usually tied to short term return in order to align managers' interests with that of shareholders. These short-term plans encourage excessive risk taking. Under this theory, bank capital requirements may not have any significant effect on bank risk taking since that decision depends on the bank manager's own risk aversion.

The theory of bankruptcy costs avoidance

The theory of Bankruptcy cost avoidance introduced by Orgler and Taggart (1983) sought to explain the reason why the optimal level of capital that banks hold will be in excess of the regulatory minimum. This relationship depends on the tradeoff between tax rewards from deposit financing and costs of leverage in terms of bankruptcy costs, higher reserve requirements and diseconomies of scale that stems from the production of deposit services. Empirical evidence show that this theory is true for banks holding capital in excess of the regulatory minimum and not for undercapitalized banks. This theory argues that banks will reduce their risky asset portfolio to reduce their bankruptcy costs which increases with higher leverage.
All in All, the theory suggests that banks will increase their capital when they increase their risk exposure.

The buffer theory

Similarly to the aforementioned theory, the buffer theory predicts that a bank holding capital levels just above the regulatory minimum may reduce its risk exposure or increase capital level as a protection against the violation of the regulatory minimum capital requirements (Marcus, 1984; Milne and Whalley, 2001; Milne, 2004). This allows them to avoid costs arising from a supervisory intervention in case of a breach of the capital requirements.
This theory is however challenged by the *"gambling for resurrection"* hypothesis where banks holding capital levels below the minimum required may increase the risk of their asset portfolio in hopes to garner higher return to increase their capital and comply with the regulation in force.

The agency theory

The relationship between capital and risk can be explained by the dichotomy between the risk preferences between bank managers and shareholders. Thus, the Agency theory can be useful to bring insight to the puzzle. The first to use the theory of agency to explain the relationship between our key variables were Saunders et al. (1990). Indeed, bank managers may find incentives to limit bank risk exposure below the level desired by the owners. This is explained by the view that managers have more to lose than owners in the event of bank failure since they are compensated with risky fixed claims on the bank and hold industry specific human capital. As a consequence, managers whose banks hold excessive risk exposure may offset their marginal cost, in terms of their incremental disutility due to the increase in risk exposure by issuing less debt. In sum, this theory predicts that capital requirements are welcomed by bank managers. Under this theory, bank managers do not resist to higher capital requirements since higher capital will increase the resilience of the bank.

The theory of the disciplinary role of debt

Another strand of literature focused on the disciplinary role of debt on bank managers. Equity-capital does not confer the same control rights as that of creditors. Under this theory, banks can choose their capital structure factoring in the disciplinary benefits that debt has resulting in higher proportion of debt-financing relative to equity. Debt holders are informed about the real outcomes of bank investment otherwise only known by bank managers all while reducing banks cost of funding (Diamond, 1984; Ramakrishnan and Thakor, 1984; Calomiris and Kahn, 1991).
These control rights make it harder for bank managers to serve their own interests in keeping a high default rate by taking excessive risk and create incentives for them to improve their job performance resulting in efficiency gains.
However, safety nets induced by explicit and implicit guaranties of depositors, such as deposit insurance, weaken the disciplinary role of debt by removing depositors and creditors' incentives to monitor bank managers. Indeed, uninsured creditors face greater risks than insured creditors since they have no safety net to rely on in the event of bank failure if bank capital depletes and they no longer can be reimbursed. Thereby, uninsured creditors are incentivized to monitor bank risk management and increase the cost of debt to reflect the bank's risk portfolio.
In sum, this theory claims that the disciplinary role of debt reduces agency costs and reinforces the supervision and monitoring of bank managers. Mehran and Mollineaux (2012) documented that block holders are able to monitor bank managers and subsequently reduce agency costs. On the other hand, Calomiris Kahn (1991) show that since demand deposits work on the basis of *"first come first serve"*, early depositors who are able to withdraw all of their deposits — in response to rumors about bank problems or from having access to private information — have higher payoffs and more chances to get back money deposited in the bank before all the funds are exhausted than late comers. Consequently, information about the bank's health and financial condition becomes valuable which in turn increases the incentives to monitor and audit banks. Under this theory, capital requirements weaken the disciplinary role of debt since it decreases the level of leverage.
However, The concept of "market discipline" has become so popular that Basel committee included it as the third pillar in the second adaptation of the framework.

III.1.2 Theoretical wisdom on capital requirements and profitability

A large body of theoretical literature sought to shed light on the relationship between capital regulation and profitability of banks. This is explained by the important effect of profitability on the willingness of bank owners and managers to comply with regulation. Indeed, banks would seize their activities if they fail to create shareholder value. Hence the question to be asked is: How does the level of mandatory capital affect bank profitability?

According to conventional wisdom in banking, more stringent capital requirements are associated with lower profitability (Berger, 1995). This is in line with models of perfect marks with no asymmetry of information between a bank and its investors.

The theory of irrelevancy of Modigliani-Miller

If markets are perfect and complete as envisioned by Arrow and Debreu, the theory of irrelevancy of Modigliani and Miller (1958) applies. Under this theory, there is no asymmetry of information and it is reasonable to assume that depositors have access to all information.

The Capital structure theory posits that debt and equity are irrelevant to the firm's value. Hence, according to this theory, capital has a neutral effect on bank cash flows and in turn profits. This theory was later challenged by many others for the simplicity of its assumptions about the world which includes no tax advantages and no bankruptcy costs. Miller (1995) argues that nothing prevents a reduction of the cost of capital with higher levels of capital and Jensen and Meckling (1976) have shown that information is not equally distributed and that depositors are generally less informed about the bank risky portfolio compared to shareholders. Under this theory, capital requirements will have no effect on banks' profitability.

Even though this theory has been criticized for its unrealistic representation of reality, it is still considered the starting point of several other theories. The trade-off theory, for instance, used the irrelevancy theory as a starting point.

The trade-off theory

The trade-off theory posits that regulatory capital will reduce bank profitability due to higher costs of capital compared to leverage. However, this effect is coupled with a decrease in risks which in turn would lower the costs of insolvency demanded by shareholders to compensate higher default risk. The trade-off theory argues that, in equilibrium, banks will chose an optimal level of capital which allows them to offset costs and benefits which in turn would imply a neutral effect at the margin. However, the aforementioned theory was criticized due to the fact that banks are, generally, pressured to hold a capital level in excess of their optimal level as required by binding capital requirements imposed by regulators which in turn would result in additional costs imposed on banks (Miller, 1995; Buser et al, 1981).

The agency theory

This theory provides rationale on why the relationship between capital requirements and profitability could be of a negative sign. Jensen and Meckling (1976) argue that equity financing may induce agency costs which in turn would deplete profits. This theory claims that bank managers will seek to increase bank capital, even if it is economically unjustified, in order to convince owners that they are acting on their best interest. This behavior reduces bank profits because equity financing is more expensive than leverage.

On the other hand, this theory also argues that managers may be reluctant to use debt in order to avoid debtholders monitoring and avoid the disciplinary role of debt. Leverage offers an insurance to shareholders that managers are making efficient decisions in order to be able to honor their liabilities to debtholders (Hart and Moore 1995). Notwithstanding, others argue that bank debt is different from firm debt due to the fact that bank debt is, in the most part, held by small uninsured depositors with high asymmetry of information this would lead to difficulties in monitoring bank managers and their decisions when it comes to investment (Dewatripont and Tirole 1994). Hence, the disciplinary role of debt is hindered by the aforementioned arguments. To sum up, this theory predicts that bank managers will use capital to increase their personal gains at the expense of bank owners. Hence, capital requirements will reduce banks' profitability because it entails agency costs.

The signaling theory

If regulatory capital compels banks to raise equity capital in order to meet with capital requirement then banks may have to bear an adverse selection cost as a result of information asymmetry. Myers and Majluf (1984) introduced the signaling theory to describe the reaction of the market after a firm announces equity offerings. They document that when banks or any other firm resort to external equity, outside investors will not be able to accurately value the bank's future earnings prospects due to information asymmetry. This information asymmetry causes adverse selection. This phenomenon can be witnessed in the stock market after a firm announces equity offerings which are generally followed by a drop in its share prices forcing them to raise capital at prices well below fair value. Consequently, the equity value of existing shareholders is diluted because of the aforementioned adverse selection costs. The theory attempted to explain why banks are discouraged to announce equity offerings. Capital requirements impose adverse selection costs not just when banks are below the minimum requirements but also include adjustment costs to a new minimum.

The moral hazard theory

Another theory suggests a positive impact of capital on banks' value. This can be explained by two channels that are related to moral hazard behaviors, including the risk premium required by debt holders and monitoring efforts exerted by the bank (De Bandt et al., 2014). Due to limited liability, shareholders' losses are limited to the paid in capital. Hence, this provides an incentive to take excessive risks at the expense of other stakeholders in the bank. Debt holders anticipate this behavior and require a premium to finance banks, thus debt holders' market discipline forces banks to maintain a positive amount of capital (Calomiris and Kahn 1991). More capital may hinder the willingness of shareholders to take excessive risks. In contrast, debt holders require a lower premium in the case of better-capitalized banks. Consequently, higher capital requirements imply lower debt costs, thus ultimately increasing bank profitability. Under the second channel, higher capital internalizes potential losses derived from a lack of monitoring. Thus, banks are encouraged to monitor when the capital ratio increases. A study by Holmstrom and Tirole (1997) develops a model where the monitoring effort of the banks depends on its capital ratio.

Later, a dynamic model proposed by Mehran and Thakor (2011) suggested that detaining capital is costly but the marginal cost differs across banks. Under a direct effect, higher payments extracted from borrowers because of the stronger monitoring effects imply higher margins for the bank. A direct effect comes from a supplementary incentive to monitoring because more capital increases the probability of survival, which improves future returns on the bank's investment. Berger and Bouwman (2013) indicate that a greater level of capital in the US small banks is associated with a higher probability of survival and greater market share both during financial crises and normal times. The same results are obtainable for large banks but only during financial crises episodes. Several empirical studies further report a positive relationship between capitalization and bank profitability (Berger 1995a; Goddard et al. 2004; Pervan et al. 2015; Saona 2016; Tan 2017). Others also suggest that banks with higher capital attract more loans and deposits, thus enhancing their performance (Calomiris and Mason 2003; Kim et al. 2005).

In summary, several theories acknowledge the benefits brought by the introduction of regulatory capitals to have some disciplinary effect on banks' risk taking behavior whereas other theories argue against them. Hence, we reach to empirical wisdom in hope for an answer to our puzzle.

III.2 Empirical review of regulatory pressure and bank behavior

In light of nearly seven decades of regulatory capital ratios, one might anticipate that empirical wisdom would yield considerable agreement on the effect of capital requirements and bank risk and profitability. However, similarly to theoretical wisdom, empirical investigation failed to provide a consensus about the nexus.

III.2.1 Relationship between capital regulation and risk

The relationship between capital and risk has been largely discussed. No consensus has been yet reached on the impact of capital on risk. Several empirical evidence support the 'skin in the game" hypothesis whereby banks' reduce their risk taking when faced with higher capital requirements (Acharya et al., 2016; Barth and Seckinger, 2018; Gornall and Strebulaev, 2018) whereas others have documented the contrary (Hovakimian and Kane, 2000; Bhattacharya, 2013).

De Jonghe and Öztekin (2015), using a cross-sectional sample encompassing 64 countries and covering the 1994 to 2010 period, showed that banks in countries with more stringent regulation tend to adjust their capital in response to regulatory pressure more rapidly than banks in countries with more relaxed regulation. They find that when banks are faced with higher capital requirement the response is, in general, by deleveraging through internal capital management and not by selling assets which may result in an economic downturn. Similarly, Shrieves and Dahl (1992) explored the question of the adjustment of bank capital to risk levels using simultaneous equation framework on a sample of U.S. commercial banks between 1984 and 1986 and found that undercapitalized banks tend to adjust their capital to regulatory standards at a higher rate compared to well-capitalized banks. They document a positive association between capital and risk consistent with the theories of capital structure and Agency theory. If anything, they find that regulatory pressure accounts for little of the relationship compared to managers' and bank owners' private incentives. Notwithstanding the result presented above, they find that regulatory pressure was at least effective on banks that held low capital levels. All in all, they find that banks, when faced with regulatory pressure to increase capital, banks respond by increasing their risk exposure. This finding corroborates the positive capital-risk hypothesis which implies that capital requirements increase bank risk taking. Similarly, Hovakimian and Kane (2000) analyzed the effect of an increase in capital requirements on the risk behavior of U.S. commercial banks. They find that regulatory capital ratios do not curb bank risk-taking incentives. On the contrary, they find that capital requirements increase the risk-taking incentives of poor-capitalized banks more than well-capitalized banks. Similarly, Bhattacharya (2013) attempted to compare the change in the risk taking behavior of U.S. before and after the implementation of capital requirements in 1980. The author argues that, contrary to what regulatory and supervisory authorities would expect, capital requirements increased bank risk-taking. He explains that since binding capital requirements reduced the lending activity of banks by more than a half, banks had no other way than to increase their risky asset portfolio to generate income in order to keep shareholders happy. He documents that non-performing loans increased 2.5 times since capital requirements came into effect.

Other studies documented the success of capital requirement in limiting bank excessive risk taking. Rime (2001), using a sample of Swiss banks during the period 1989 to 1995, found that regulatory pressure had a positive impact on bank capital due to harsh consequences if banks fail to comply with the Swiss capital requirement which may lead to bank closure and takeover.

Hendrickson and Nichols (2001) argue that we cannot lump financial regulation in one basket. They claim that certain types of regulations (e.g. deposit insurance schemes) increased bank risk taking whereas other types of regulation (e.g. capital requirements, lending and deposit rate regulations) decreased bank risk taking incentives and improved bank stability. They compare legislation between Canada and the U.S. and find that capital requirements were effective to mitigate bank risk. Thus, they support the view that regulatory pressure contributed to limit bank risk taking. Barth et al. (2004) support the argument of Hendrickson and Nichols (2001). They argue that it is misleading to focus on the effects of specific regulation (e.g. restrictions of bank trading activities) while disregarding other regulatory factors (e.g. the power of regulators or the degree of government ownership). Barth et al. (2004) use the capital regulatory index (CRI) which compiles quantitative and qualitative characteristics of capital stringency. They find that regulation and its impact differs across countries, regions and income groups. They also find that regulatory capital stringency helped reduce non-performing loans which confirms that regulatory capital were effective in mitigating bank credit risk. However, they find that regulatory stringency did not reduce bank risk when it is defined as the likelihood of bank crises. This confirms our view that different definitions of concepts can yield to different results.

Other studies have shown capital stringency is less effective when certain aspects of markets are present. Agoraki et al. (2011) and Lee and Lu (2015), argue that regulatory regulation only reduces bank risk for banks with relatively small market powers. For banks with strong market power, the effectiveness of such regulation can be minimal or, in extreme cases, reversed (Agoraki et al., 2011). On a similar note, Behr et al. (2010) defends the view that the effectiveness of capital regulation depends on market concentration. They argue that to be able to achieve the desired effect of regulatory capital, markets concentration has to be low. Similarly, Laeven and Levine (2009) reveal that the effectiveness of capital requirements depends on bank ownership concentration. They explain that the more concentrated ownership is, the higher are banks incentives to take on higher risks to offset utility losses imposed by capital requirements.

Camara et al. (2013) argues that the different responses to higher capital requirements are ascribed to the differences in capital levels among banks. Well-capitalized banks, with capital ratios above the minimum required) adjust their risk and capital in the same direction whereas poorly capitalized banks (below the minimum required) reduce their risky assets portfolio to comply with regulatory capital ratios. Further investigation into the sub-samples, the authors find that strongly undercapitalized banks (with regulatory ratios below 4%) engage in excessive risk taking. They explain that this is due to the persistence of past poor profitability and past poor-quality investments in which managers try to offset with even more risk taking. Other studies have shown no evidence on the effectiveness of regulatory capital pressure to reduce bank risk. Delis et al. (2012) find that capital requirements had no effects on bank risk. They document that the influence of capital requirements were heterogeneous across banks. This heterogeneity is the result of bank specific characteristics as well as macro-economic conditions. That is why we take into consideration these aspects in our empirical investigation. The authors argue that regulatory capital was not successful in reducing bank risk. On a similar note, Agoraki et al. (2011) find that capital constrains were not effective to curb the risk taking incentives of banks with higher market power. Dautovic (2019) argue that large banks respond to higher capital requirements by increasing their risky assets portfolio. Bitar et al. (2018) using a sample of 1,992 banks from 39 OECD countries between 1999 and 2013, investigated the effectiveness of imposing higher capital requirements by supervisory bodies on bank risk, efficiency and profitability. They find that imposing minimum capital ratios has a positive association with bank efficiency and profitability. However, they find that risk-based capital ratios were not effective in reducing bank risk. This raises questions about the aim of the Basel framework to harmonize of the calculation methods of capital. They also find that the new reforms of Basel III in which banks are required to hold higher liquidity ratios and higher capital ratios may impede highly liquid banks' efficiency and profitability.

Other scholars have documented that the relationship between regulatory capital and bank risk taking can be nonlinear. Dias (2021), using a sample of over 1,800 banks in 135 countries, finds that risk-taking and capital requirements follow an inverse "U" shaped relationship, this implies that a rise in capital ratios entails less risk-taking by banks at first which is then followed by an increase in risk taking. He also finds that more stringent monitoring has a negative impact on efficiency which in turn would lead to more risk taking.

An important thing to note is that all the abode studies have used different proxies for bank risk. Laeven and Levine (2009) have used Z-score to investigate the relationship between regulatory capital and bank risk whereas Agoraki et al. (2011), Lee and Lu (2015) and Behr et al. (2010) all have used non-performing loan to account for bank risk. Alam (2014) have used the loan loss reserves ratio. Lee and Hsieh (2013) document that the effect of capital regulation on bank risk varies with risk measurements.

III.2.2 Relationship between capital regulation and profitability

Empirical evidence on the effect of regulatory capital on bank profitability find no conclusive evidence on the matter. Several studies show that regulatory compliance seemed to improve bank profits (Coccorese and Girardone 2017; Berger and Bouwman, 2013; Bitar et al., 2016 ; Kundid, 2021; Swamy, 2018) while other studies find that, on the contrary, regulatory capital diminish bank profitability (Goddard et al., 2010; Chishty 2011). Other studies find that regulatory pressure had no effective impact on bank profitability (Ngo, 2006).

Berger (1995) is one of the most cited papers relating to the capital-profitability nexus. He employs a two-equation reduced form framework with three lags and control variables for a sample of US banks in the mid-to-late 1980s. His evidence show a causality in both directions between earnings and capital. The positive causality from earnings on capital is explained by the hypothesis that banks retain some of their marginal earnings to increase capital. He argues that the positive capital-profitability nexus can be explained by two separate hypotheses: the bankruptcy cost hypothesis and the signaling hypothesis. Under the former, banks increase their earnings as the cost of uninsured debt decreases, since banks that were previously undercapitalized raise their capital levels closer to equilibrium levels. The signaling hypothesis posits that bank management signals private information that prospects are good by increasing capital. That can be due to higher revenues, lower costs or reduced risk.

Coccorese and Girardone (2017) revealed a positive association between capital and profitability measured by return on assets using a global sample comprising of 4 414 banks operating in 77 countries for the period 2000 to 2013. They argue that by issuing new capital bank signal positive private information about the bank soundness and prospects. In the U.S., Berger and Bouwman (2013) analyzed the implications of higher capital on bank performance using a sample of U.S. based banks during the financial crises. They document a positive relationship between capital and bank profitability. They find that the effect remains positive even after controlling for bank size.

In Europe, Goddard (2004) investigated the determinants of European banks' profitability using cross sectional data during 1990s. The results showed that capital requirements improved bank profitability. On the same line, Kundid (2021) investigated the relationship of our key variables using a sample of 24 commercial banks from the Croatian banking sector between 2011 and 2016. They use Return on Assets, Return on Equity and net interest margin as estimates for bank profitability. They document a positive and strong association between regulatory capital and profitability consistent with the capital buffer theory when using Return on Assets and net interest margin as bank profitability indicators. However, the relationship does not hold with Return on Equity as a profitability indicator.

In Asia, Swamy (2018), using a sample of Indian commercial banks between 2002-2011, examined the effect of new capital regulations under Basel III proposals on Indian banks profitability. They find that an increase in the ratio of capital to risk weighted assets had a positive impact on banks profitability. They also find that the impact on profitability is greater for public sector banks than private banks. Similarly, Le and Nguyen (2020) examine the relationship between capital and bank profitability using a quantile regression approach on a sample of 30 Vietnamese banks between 2007–2019. They find a positive association between capital and profitability. Notably, they find an inverted U-shaped relationship with the bank capital ratio. The relationship is more significant for highly-profitable banks than for less-profitable ones. The author suggest that supervisory bodies need to cautiously prepare for the increase in capital requirements and take into account the impact of such moves on bank profitability.

Bitar et al. (2016) documented that regulatory capital is positively related to bank profitability using a sample of 168 banks from the Middle East and North Africa (MENA) region covering the period 1999-2013. They highlight the important role of introducing and developing a bank risk management framework to help banks strengthen their soundness. Furthermore, they find that too-big-to-fail banks react to higher capital requirements by limiting their exposure to credit risk and enhancing their risk management processes which in turn would lead to lower inefficiency costs and ultimately to higher profits. Haron (2004) measured the impact of some of the determinants of profitability. They find that regulatory capital is positively correlated with bank profitability.

Notwithstanding, several other studies have shown that regulatory requirements have imposed substantial costs and in turn reduced the profitability of banks. In this line, Goddard et al. (2010), using a sample that covers eight European countries between 1992–2007 found a negative relationship between capital requirements and profitability. This finding is explained by the managers' "over-cautiousness" when it comes to selecting profitable investment leading to high opportunity costs which in turn would reduce profitability. Similarly, Tran et al., (2016) investigated the interrelationships among liquidity creation, bank profitability and capital requirements using an unbalanced quarterly panel data of all U.S. banks between 1996 to 2013. They document

a non-linear relationship between regulatory capital and profitability which depends on the bank's level of capitalization. They showcase a negative association between regulatory capital and profitability for undercapitalized banks and a positive association for well-capitalized banks. In sum, they reveal that the implication of a change in mandatory capital has different implication depending on the initial level of capital that a bank holds.
Chishty (2011) investigated the relationship between capital adequacy and profitability in the Indian context from 1996 to 2006. They report a negative relationship between the two variables. Moreover, under a market with cutthroat competition, Indian banks are forced to diversify their sources of income in a context of tighter interest margins. In Africa, Madugu et al. (2019) argue that capital requirements reduced bank profitability in Ghana. Conversely, Ozili (2016), using a sample of 18 African countries from 2004 to 2013 find that regulatory capital has a greater positive externalities on listed banks compared to non-listed banks. Particularly, they show that the impact on listed banks is the greatest when they have a capital ratio of at least 20%. Naceur (2006) studied the effects of capital regulations on cost of intermediation and profitability in the Egyptian context. The author argues that capital adequacy ratio positively contributed to banks' profitability. The results supported the hypothesis that capital regulations improved the profitability of banks. The same result was further corroborated by Naceur and Kandil (2009) who also investigated the impact of regulatory requirements on bank profitability in Egypt. They analyzed the puzzle using a sample comprising of 28 banks from Egypt between 1989 to 2004. Profitability is then estimated by two variables; return on assets (ROA) and return on equity (ROE). Capital is estimated through three measures of capital regulation, a dummy variable to account for change in regulation and another dummy variable to account for the short-run dynamics of such change. They show that capital adequacy is positively related to profitability measured by ROA. This is explained by the argument that banks that hold an adequate level of capital have lower cost of funding and cost of insolvency which in turn would result into higher profitability. The positive relationship does not hold when using ROE as proxy for profitability. This means that unexpected losses were absorbed by the increase in interest margin yielding to a neutral effect on shareholder value. Furthermore, they find that the aforementioned positive impact is not sustainable over time as the coefficient for the long-term dummy variable is not statistically significant for both estimates of profitability.
Ajayi et al. (2019) assessed the impact of capital rerquirements on the profitability of eight Deposit Money Banks (DMB's) of Nigeria for the year 2017. They use the Capital adequacy ratio (CAR) as an estimate for bank capital and Return On Assets (ROA) as an estimate for bank profitability. They find a strong and positive association between capital and the profitability of Deposit Money Banks (DMB's) of

Nigeria. They recommend that policymakers should focus on capital adequacy but also monitoring and evaluating its implications on the banking industry in Nigeria.

Up until now we have discussed empirical evidence that suggest that capital regulation can either improve or diminish bank profitability. Another strand of literature reported that regulatory requirement had no significant impact on bank profitability. Ngo (2006) investigated the relationship between regulatory capital and profitability. The results showed no significant relationship between capital and profitability. Similarly, De Bandt et al. (2018) used a sample of 25 French banks for the period 2007-2014 to investigate the effect of higher capital requirements on bank profitability. They report that French banks were unfazed by higher capital restrictions.

III.2.3 Relationship between capital regulation and profitability and risk

There is scant attention paid to investigating the influence of capital on bank profitability and risk taken together. In this part, we would like to review research that focused on both aspects.

Lee and Hsieh (2013) examines the relationship between bank capital and profit and risk simultaneously using two-step system GMM dynamic panel data techniques through a sample of 2,276 Asian banks over the period 1994-2008 to find that an increase in capital tend to have a positive impact on profit and a negative impact on risk. Disparity of the impact is however witnesses when comparing income classes in different countries. Moreover, they document that Middle Eastern countries had the highest impact of capital on profitability. The authors explained this result by the proliferation of Islamic banking practices which puts restrictions on excessive risk-taking. This finding was corroborated by Bitar et al. (2016) who also documented a positive association of regulatory capital on profitability and risk using a sample of 68 banks from the Middle East and North Africa (MENA) region between 1999 and 2013. They also find that GCC countries have benefitted from the oil boom and close ties with the western world which helped tremendously in keeping up with the global standards of capital requirements compared to the other MENA countries. Moreover, they find that the aforementioned relationship is greater for too-big-to-fail banks, well-governed banks and banks in transition during the Arab spring. In Asia, Lee et al., (2015) analyzed the Chinese context through a sample gathering 171 Chinese commercial bank between 1997 and 2011. They investigated the influence of capital requirements on bank risk during three sub-periods: before China entered the World Trade Organization, transition period that lasted 5 years, and after opening up to foreign investment. They document a positive association between capital requirements and profitability supporting the expected bankruptcy cost hypothesis and the signaling hypothesis. Furthermore, they find that capital requirements contributed to reduce bank risk taking incentives. Similarly, Nguyen and Le (2016) examined the impact of bank capital on profitability and the credit risk of 30 Vietnamese commercial banks over the period 2000 to 2014. They find evidence suggesting that higher levels of capital is associated with higher profitability and reduced credit risk. These findings are in line with the moral hazard theory.

Ayaydin and Karakaya (2014) investigated the impact of regulatory capital on the profitability and risk using data from 23 Turkish Commercial Banks between 2003 and 2011. They find that more stringent capital requirements are associated with higher profitability proxied by interest income and ROA but an adverse effect on profitability measured by ROE. Moreover, they find that higher capital regulation has a positive impact on risk when using the variance of ROA to account for bank risk but a negative impact on risk when using the variance of ROE. Hence, they argue that their finding is in line with 'regulatory hypotheses' in which an increase in banks capital is usually followed by an increase in their risky asset portfolio. The findings are also inline with the 'moral hazard hypothesis' whereby banks exploit the deposit insurance schemes benefitting from the existing flat rate.

In Africa Kanga et al., (2020) used a simultaneous equation model to analyze simultaneous relationship among bank capital, risk and profitability using a sample of banks from all West African Economic and Monetary Union (WAEMU) over the period 2000 to 2014. They document a positive association between capital and profitability. They also reveal a positive association between capital and risk in line with the regulatory hypothesis. They recommend that policymakers do not impose uniform capital regulation bearing in mind the heterogeneity of the region and to not adopt a 'one size fits all' approach when it comes to capital requirements. They also argue that policymakers need to also take into account bank profitability and risk appetite when it comes to fixing the adequate capital ratio.

CHAPTER CONCLUSION

Higher bank capital contributes to financial stability: it provides a cushion for absorbing losses during a crisis or other bank distress and may also improve screening and monitoring by banks as it tends to curb risk-taking because shareholders have more skin in the game. However, bank managers usually oppose to proposals of higher capital requirements on the grounds that their profitability is jeopardized by the social costs induced by capital requirements. Although there has been made a series of studies to analyze the impact of capital requirements and its implications on bank behavior, none of these studies have been conclusive.

Theoretical wisdom provides evidence on why regulatory capital can curb bank excessive risk taking. The option pricing framework posit that bank owners exploit the insurance deposit schemes, which are fixed at a flat rate, to engage in excessive risk taking. The theory of bankruptcy costs postulate that banks maintain capital ratios well above the require minimum to reduce their bankruptcy costs. However, the buffer theory claims that banks keep a buffer to protect against violations of regulatory minimum capital requirements. Theoretical wisdom also predicts that capital requirements will negatively affect bank profitability. The agency theory posits that regulatory capital ratios force banks reduce leverage which reduces the benefits of the disciplinary role of debt. The trade-off theory postulates that banks face opportunity costs by using capital instead of debt to finance their assets.

Empirical evidence is torn about the effect of regulatory capital on bank behavior. Several studies have documented the positive impact of capital requirements on bank profitability (Berger and Bouwman, 2013; Ozili, 2016; Bitar et al., 2018; Le and Nguyen, 2020) whereas others have reported the adverse effect of regulatory requirements on bank profitability (Madugu et al., 2019; Chishty, 2011; Goddard, 2010). On the relationship of regulatory capital and bank risk, several studies have shown that capital requirements reduced bank risk (Raz abd Jahera, 2018) while other document that they were not effective to curb bank risk taking (Bitar et al., 2018; Zhang et al., 2008) or shown that regulatory pressure have had no significant effect on bank risk (Bougatef and Mgadmi, 2016) and questioned whether regulatory pressure is able to discipline banks ex-ante (Rajan, 2018).

Chapter 2

IMPACT OF REGULATORY CAPITAL ON BANK RISK AND PROFITABILITY

CHAPTER INTRODUCTION

In this chapter, we will present the methodology we followed in order to provide answers to our research questions. Bank stability and profitability does not just depend on the regulatory capital but also several other variables. These other variables can either be specific to each bank or capture macro-economic conditions.
We focus on the Tunisian context to investigate the impact of regulatory capital on bank profitability and stability. Our sample consists of 10 listed banks in the Tunisian stock exchange and covers the period stretching from 2005 to 2020.
We start by presenting our dependent and independent variables after running a significance test in order to retain only the significant variables interacting with our dependent variables. Then we specify our two empirical models with Return on Average Assets (ROAA) and Z-score as our dependent variables. We also list our data sources; provide descriptive statistics of our variables; and discuss our regression results.
We conduct our empirical analysis by first investigating the linear impact on bank profitability and stability to fill the existing gap in the banking literature. Then, we look to find if the impact of regulatory capital can be non-linear meaning that the impact can be positive at first up to a certain threshold then it becomes negative. This is commonly referred to as a "U-shaped" relationship. We also test whether profitability and stability showcase a persistent effect by using a dynamic methodology which includes one-period lagged values of our dependent variables.
Last, this chapter concludes with a summary of our key findings and their implications

on the literature investigating the impact of capital requirements on bank behavior as well as regulatory and supervisory authorities who seek to assess the social costs and positive externalities of stringent capital requirements.

I Tunisia's economic and financial outlook

The Tunisian economy has witnessed great change since the Arab spring revolution that started in early 2011. Subsequently, Major economic indicators crashed and unemployment soared. The long-standing vulnerabilities were exasperated by Covid-19. Tunisia spending to relief economic pressure and to support affected sectors and population reached 4.3% of GDP. The Central Bank of Tunisia (CBT) reduced its policy rates twice and implemented accommodative regulatory actions.
Economists and financial analysts still consider Tunisia's downside side risk to be very important. In October 2021, Moody's downgraded Tunisia's government foreign and local currency and the Central Bank of Tunisia (CBT) to Caa1 from B3 and maintained the negative outlook. This downgrade is explained by the failure of the government to put into place reforms and the sustainability of its external debt especially faced with high financing requirements.
Even after more than a decade passing, the Tunisian economy still hasn't fully recovered from the impact of the political turmoil. This recovery is further delayed by Covid-19. Real GDP contracted by 8.8% in 2020 after an increase of 1% the year before, due to the restrictions of the financial conditions aimed to reduce inflation. (World Bank, 2020)
The pandemic hit the Tourism and Transport sector while the manufacturing sector experienced a slowdown. In particular, the transport sector was reported to have collapsed by 60%. The World Bank projects a slow rebound in 2021 provided that key reforms and unbalances are addressed promptly. Unemployment slightly declined going from 15.5% in 2018 to 14.9% in 2018 just to jump back up in 2020 to 16.2% due the closing down of 5% of firms.

The fiscal deficit soared in 2020 to reach 11.5% of GDP essentially due to low tax intake and a huge civil service salary bill among the highest in the world reaching 17.6% in 2020 and consuming 75% of total tax revenues of 2020. This situation was further worsened by the State-Owned Enterprises (SOEs) characterized by low efficiency and profitability, crippling debt and lack of transparency. These loss making and fund absorbing SOEs that benefit from government guaranties are responsible for deteriorating the fiscal deficit even further draining up to 40% of GDP in the end of 2020 in which 15% of these loans are covered by government guaranties. The SOEs also drain funding from the banking sector especially state-owned banks where the stock of loans to SOEs reached a staggering 17% of GDP in 2019 with a stock of

accumulated arrears.
The financial sector is said to withstand the sanitary crisis mainly due to the central bank's accommodative actions and the relaxing of an array of regulatory requirements. However, it is too soon to tell whether the financial sector weathered the crisis since the impact of the government relief and easing measures as well as the effect on the industries are yet to be observed.
Even before the crisis, Tunisian banks were struggling with longstanding vulnerabilities especially high level of non-performing loans, outstanding loan obligations with the SOE sector, liquidity squeeze and meager capital buffers. State-Owned Banks (SOBs) are estimated to be the most vulnerable.
Recently, Bank loans to SOEs grew to 9% of total bank loans essentially due to government guarantees further deepening credit concentration and rendering the banking sector highly exposed to sovereign risk.
National savings continued its decline to reach 8.8% of GDP in 2019 mainly due to the constant drop in private savings and the erosion of public savings. Private investment also continued its steady decline to reflect excessive government regulation and inherited bureaucracy.
As of December 2020, the Tunisian financial sector numbered 42 banks and financial establishments, of which 23 are resident banks, 8 Leasing companies, 2 factoring companies, 2 merchant banks and 7 non-resident banks. Currently, all Tunisian banks operate as Universal Banks.
As mentioned in Chapter 2, Tunisian banks are required to respect two minimum capital requirements: The "Mc Donough" ratio of 10% and the Tier 1 ratio of 7%. Both ratios experienced steady upward trend from 2016 and peaked in 2020 with 13.20% on average for the Mc Donough ratio and 10.8% for the Tier 1 ratio. The increase in both ratios is ascribed to the decision of suspending dividend payout in 2019 to increase the resilience of the banking sector (CBT, 2020) Figure 2.1 shows the average level of compliance for Tunisian banks between 2015 and 2020. We can see that Tunisian banks, on average, were complying with both Tier 1, set at 7% and the solvency ratio, set at 10%.

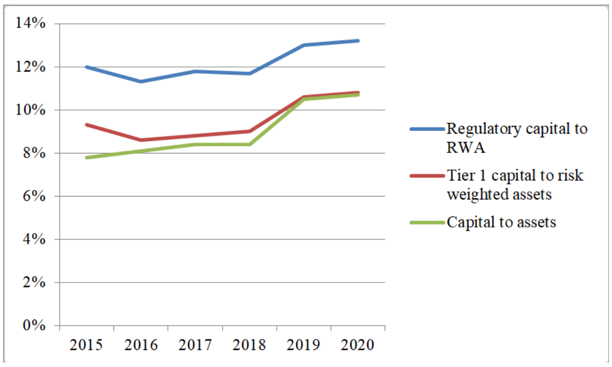

Figure 2.1: Tunisian banks compliance over the period 2015-2020

Bank loans to the economy increased by 6.8% in 2020 against 3.7% the year before. However, Banks Interest margin grew by only 1.5% in 2020 against 31.4% the previous year, due to deferred payment of interest rates and a decrease in the monetary market rate. Net commissions also witnessed a decline in growth of only 3.3% in 2020 compared to 22.3% in 2019, due to the support measures imposed by the CBT regarding monetic operations while revenues stemming from security investment grew by 9.7% in 2020 against 22.9% in 2019. Consequently, the net operating income increased by 1.7% in 2020 against 13.3% the previous year.
Despite the economic and political unrest throughout the overall period, Tunisian banks managed to remain profitable and peaked in 2018 in which ROA and ROE reached 1.20% and 13.50% respectively. Both indicators witnessed a slight drop in 2019 to record 1.10% for ROA and 13.30% for ROE. Net interest margin reached 55.10% of net banking product in 2019 an increased from the 51.9% recorded the previous year. This figure reached 54% in September 2020.
The liquidity ratio Loan to Deposit (LTD) implemented in 2018, reached 117% in 2020 against 120% in 2019.
Non-performing loans peaked in 2015 reaching a record high of 16.6% of total loans. Tunisian banks effort to reduce their stock of impaired loans can be witnessed through the steady decline of the NPLs ratio which reached its lowest point in 2020 with 13.10%. Provisions to total loans were kept above 55% throughout the whole period and peaked in 2020 reaching 58.2%. However, Fitch ratings predict that Tunisian banks' asset quality to deteriorate further following the expiry of the CBT support measures by the end of 2021.

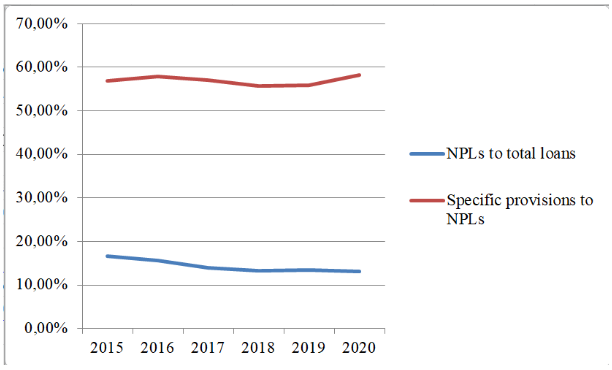

Figure 2.2: Tunisian banks asset quality over the period 2015-2020

Figure 2.2 displays Tunisian banks asset quality and coverage through the years. We can see a declining trend with NPLs reaching their lowest rate in 2020. This can be ascribed to accommodative approach of the Central Bank of Tunisia to help businesses withstand the negative shocks of Covid-19. We can also see that Tunisian banks loan loss reserves keep climbing especially in 2020. This can be explained by the pro-active attitude of Tunisian banks to prepare for the aftermath of Covid-19.
We expect Tunisian banks' asset quality metrics to weaken due to the expiry of the loan deferral scheme on 30 September and of other borrower support measures by end-2021
The Liquid assets to short term Liabilities were kept under 100% from 2015 to 2018. The ratio then jumped up to reach 134% in 2019 and 178.5% in 2020. The LTD ratio, which was officially implemented at the end of 2018, witnessed a steady drop from 135% on average in 2017 to 130.7% the following year to reach 120% in 2019. However, this figure is only an estimated average of all Tunisian banks. The Central bank has revealed that, in 2019, six banks recorded an LTD ratio that exceeded 130%. In 2020, the LTD ratio reached 117%.

II Definition of variables and hypothesis development

In our analysis, we use a list of determinants to the banking industry and also explore alternative explanations specific to the banking activity. We use several control variables to reduce the effect of omitted variable bias.
There are two separate hypotheses for each independent variable since we seek to test the impact of regulatory capital requirements on our dependent variables.

II.1 Dependent variables

First pair of hypotheses will test if risk-weighted capital positively or negatively affects the profitability and risk (stability) of Tunisian commercial banks. Following the findings of empirical research presented in Chapter 1, we have no prediction on the sign of the relationship due to the aforementioned opposing views of bank managers and regulatory authorities. Indeed, bank managers claim that stringent capital requirements reduce bank profitability and may increase bank risk-taking incentives whereas regulatory authorities believe that they curb bank excessive risk taking.

II.1.1 Bank profitability

Profit maximization is the principal target of every firm (Adeusi, Kolapo, and Aluko (2014). According to the expected income effect theory, capital requirements reduce bank profitability.
Return on Assets (ROA) has been widely used to measure a firm's financial profitability. Indeed, ROA has been wildly used in the empirical literature to proxy for profitability (Afriyie and Akotey, 2013; Albulescu, 2015; Alper Anbar, 2011; Kosmidou et al., 2012; Petria et al., 2015; Tee, 2017, Madugu et al., 2019). Rivard and Thomas (1997) posit that ROA is a better proxy for profitability than ROE since the latter can be biased by high equity multipliers. Hassan and Bashir (2003) find that ROA is generally low for banks and managers use high levels of leverage to hike up the value of the ROE. Hassan and Bashir (2003) argue that ROA is the most preferred profitability indicator by the majority of regulators.
Following Chen et al. (2018), we use the return on average assets (ROAA) to proxy for bank profitability. Hence, we compute ROAA as the ratio of net income to average total assets. This ratio indicates the asset intensity of each bank. A high ROAA signifies that the bank has a higher asset intensity and vice versa.

$$ROAA = \frac{Netincome}{AverageAssets}$$

II.1.2 Bank stability and risk

As we have mentioned before, existing research that focused on bank stability generally used Z-score as a measure for bank stability and risk taking (Boyd and Runkle, 1993; Laeven and Levine, 2009; Uhde and Heimeshoff, 2009; Lee and Chin, 2013; Hoque and al., 2015; Fernandez et al., 2016; Ashraf, 2017; Chen et al., 2017).
In chapter 1 we have developed theoretical and empirical rationale behind using Z-score as a proxy for bank risk taking and stability. The basic idea behind the measure is to compute how much variability in bank profits (σROA) can be absorbed by its own equity (E) before becoming insolvent. The Z-score measure assumes that when

capital level falls to zero a bank is declared insolvent.
Z-score is a measure of bank stability and an inverse measure of bank risk taking. Several papers multiply Z-score by 1 to get an appropriate measure of the banks risk-taking (Ashraf, 2017; Mourouzidou-Damtsa et al., 2017). We keep the value given by the Z-score measure but provide the inverse interpretation for the relationship between regulatory capital and bank risk.
A higher level of Z-score indicates that the bank is considered a low-risk bank meaning that the bank has to go through several drops of its profits to fall into insolvency. Likewise, a low level of Z-score indicates that the bank is high-risk. Z-score is computed as follows:

$$Z - score_{it} = \frac{ROA_{it} + CAR_{it}}{\sigma ROA_{it}}$$

where ROAit is the return on assets, σROAit is the standard deviation of ROA, and CARit is the ratio of total equity to total assets.
The value given after computing our Z-score for each bank can be highly skewed. Therefore, we use the natural logarithm of Z-score. We will refer to the natural logarithm of banking z-score as a Z-score in the remaining of this thesis. We also compute the standard deviation of ROA using 3-year rolling windows. By using the 3-year rolling window scale instead of the full sample period we allow time variation of the standard deviation and give a more accurate estimation of bank risk in each year (Beck et at., 2013).
A higher Z-score indicates more stability, thus less risk-taking in a bank and vice versa. Profits are not required to be normally distributed to be a valid probability measure. A higher ratio also means that a larger negative return is required to render the bank insolvent. Therefore, as an empirical risk measure, z-score is highly suitable as bankruptcy will occur when the equity capital of a bank is depleted.

II.2 Independent variables

Our independent variables include our key regulatory capital proxies and a set of control variables.

II.2.1 Regulatory capital

As we mentioned before in the literature review chapter, theoretical and empirical literature are torn on the influence of capital requirements on bank performance, risk and stability (Boudriga et al., 2009; Osei-Assibey and Asenso, 2015).
Regulatory authorities are not lenient when it comes to minimum capital requirements because they believe they safeguard depositors' interest, serve as a buffer to absorb losses and withstand negative shocks and ultimately promote the overall stability and efficiency of the financial system. The idea that capital adequacy ratio based on risk weighted assets can reduce banks' incentives to engage in risk taking behavior stems from the fact that when

banks are faced with more stringent capital adequacy ratios or when they are close to no longer respecting the regulatory requirements they are forced to either raise more capital or shrink their risky asset portfolio. However, bankers are opposed to the idea of more stringent capital requirements because they believe that raising capital instead of leverage is rather costly and has a direct impact on their profitability.
Several empirical researches sought to bring more light to the nexus. One strand of research documented a positive impact of capital requirements on performance. Ozili (2017) document a positive relationship between capital requirements and profitability in a sample of commercial banks in Africa. In Asia, Lee and Hsieh (2013) find a positive impact of capital requirements on bank performance. Other researches document the opposite view.
Abba et al. (2013) also revealed a negative association of capital adequacy and bank risk portfolio on a sample of Nigerian banks. These findings are consistent with the works of Al-Sabbagh and Magableh (2004).
Other studies found that the relationship can take both signs depending on a certain level. They find that raising capital is positively correlated with performance up to a point dubbed the optimal level then becomes negative afterward.
We use the Basel minimum capital adequacy ratio as a proxy for regulatory requirements. The ratio is calculated by summing Tier 1 and Tier 2 capital and dividing by the risk-weighted assets (RWA). Several empirical studies have also used the ratio of capital to the risk-weighted to account for regulatory imposed capital (Hosna et al. (2009), Li and Zou (2014), Shingjergji (2014), Adjeitsey (2015), Afriyie and Akotey (2013)).
We follow the methodology of Le and Nguyen (2020)) whereby they use the square value of bank regulatory capital to test if the relationship is non-linear and increases profits up to a threshold before dropping after. This is commonly referred to as “U-shape” form. If regulatory capital is indeed nonlinear and follows a “U-shape” form, this reveals serious implications of regulation decisions on bank behavior.
Bank managers claim that capital regulation reduces bank profitability due to social costs. Hence, by using the square value of the regulatory capital ratio we seek to see if the coefficient can change value if capital requirements increase up to a threshold.
We therefore develop the following two hypotheses below:

- Hypothesis 1: Regulatory capital has a negative impact on bank profitability

- Hypothesis 2: Regulatory capital follows a “U-shape” form

- Hypothesis 3: Regulatory capital has a positive impact on bank stability (negative impact on bank risk)

II.2.2 Bank specific characteristics

Bank specific characteristics are unique to each bank in the sample. We believe that bank specific characteristics greatly influence bank profitability and risk taking incentives.

- Size

A large body of theoretical and empirical wisdom was interested in investigating the relationship between size and profitability. Several hypotheses were put forth to explain the potential positive relationship between the two. Large banks benefit from economies of scale and scope thus tend to generate higher returns compared to smaller banks.
For the link between bank risk (stability) and regulatory capital, theoretical wisdom put forth two opposing theories. The "agency theory" developed by Jensen and Meckling (1976) predicts that bank managers and owners interest do not align. Managers will try to grow the size of the bank in order to build an empire and extract private compensation (Murphy, 1985; Jensen, 1986); Gabaix and Landier, 2008). The "stewardship theory" suggests that managers see their personal benefit increase when the company grows and thus their interest aligns with that of the bank. However, this theory assumes that managers are trustworthy (Donaldson and Davis, 1991; Davis et al., 1997).
De Haan and Poghosyan (2012) provide evidence on the positive relationship between size and stability using return volatility as a measure of instability.
In our model we use the number of operating branches to account for bank size. The rationale for using this proxy for bank size is that by using the natural logarithm of total assets we fall into multicollinearity problems when two or more explanatory variables are highly correlated and render our estimation spurious. Large banks, at least in the Tunisian context, tend to open more branches.
We therefore develop the following two hypotheses below:

- Hypothesis 1: Size has a positive impact on bank profitability

- Hypothesis 2: Size has a positive impact on bank stability (negative impact on bank risk)

- Net interest margin

The majority of bank profits stem from their loan making activity. This is especially true for traditional banks that follow the traditional bank business model such as the case of Tunisian banks. Based on these grounds, we expect to see a positive and strong relationship between the net interest margin and profitability of Tunisian banks.
We use the ratio of net interest margin to total loans to measure Tunisian banks' interest-based activity. This ratio only appears in the profitability model since we have already included a proxy for bank profitability that is the Return On Average Assets (ROAA) in our risk (stability) model.
We therefore develop the following hypothesis:

- Hypothesis: Net interest margin has a positive impact on bank profitability

- Liquidity Risk

One of the major roles performed by banks in the economy is liquidity creation (Berger and Bouwman, 2009). Liquidity creation consists of transforming liquid liabilities mainly from depositors' funds into illiquid assets such as long term loans to their borrowers. A structural mismatch between the two can exasperate the negative externalities in the case of bank distress. According to the Liquidity Asset Theory, banks need to set aside a sizeable portion of liquid assets in the form of cash and other short term liquid assets in order to hedge against potential and unforeseen demand of liquidity. Hence, we can understand how holding sufficient amount of liquid assets reduce bank risk and strengthen their solvency.

Berger and Bouwman (2009) show that the majority of failed banks during the global financial crisis had troubles managing their liquidity risk. Also, when a large number of depositors seek to withdraw funds at once and the bank is short on liquidity and defaults on its payments, in this case a bank is considered "cash-flow insolvent". Hence banks are advised to actively manage their liquidity risk and ensure against liquidity shocks. This is the reason why the Basel frame work in its third adaptation focused on liquidity risks. However, if banks are overly cautious about liquidity risk and in turn substantially reduce their loan making activity this may hurt their profitability and stability in the long-run.

Empirical wisdom is torn on the relationship between liquidity risk and profitability. Several studies report a positive relationship between liquidity risk and profitability. In particular, Molyneux and Thornton (1992) and Laeven, and Levine (2003) argued that banks holding a subsequent amount of liquid assets are less likely to generate interest income and are penalized with lower profitability. This finding has been empirically confirmed by several other studies (Shen et al., 2001; Demirgüç-Kunt et al., 2003; Naceur and Kandil, 2009; Chen et al., 2018). Others document a negative relationship between liquidity risk and bank profitability (Lee and Kim, 2013; Bassey and Moses, 2015).

To proxy for bank liquidity risk, we follow Carsemar et al. (2021) and use the ratio of Loan to Deposits (LTD). This ratio measures how much loans are being financed by depositors' funds and can predict the potential liquidity risk a bank can face in a situation of a bank-run. Banks with fewer illiquid assets in terms of loans are better able to meet their depositors' withdrawal needs than loaned up banks.

Because we believe that the effect of liquidity risk can take some time to affect bank stability and profitability we use the one-period lagged LTD. Using lagged values of independent variables is also empirically justified because it can reduce the possible impact of reverse causality in our empirical models.

We therefore develop the following two hypotheses below:

- Hypothesis 1: Liquidity risk has a positive impact on bank profitability

- Hypothesis 2: Liquidity risk has a negative impact on bank stability (positive impact on bank risk)

- Cost efficiency

In order to improve their profitability, banks need to use the available funds efficiently in order to generate added value to their shareholders and safeguard depositors' funds. For that, banks need to recruit the most skilled staff and equip them with the latest technology and tools. Bank costs can be split into operating costs which considered the outcome of the bank management and other costs such as depreciation and tax among others.

We believe that efficiency can affect bank performance, risk and stability with variant degrees. The most impact should be seen in relation to bank profitability because costs directly affect profits. Efficient banks are able to reduce their operating costs by optimizing the use of their assets and hence improve their profitability. Athanasoglou et al., (2008) find that operating expenses are a major factor that drives bank profits. They find that for Greek banks, operating expenses that are supposed to be shared between customers and the bank are weighing down banks' profits. They explain that in a competitive market, banks are not able to "overcharge" their customers. Conversely, inefficient banks tend to see their profits shrink due to inadequate use of the funds available.

Efficiency can affect bank risk and stability when banks invest in the best tools and skills to improve their screening and monitoring of risks. Berger and DeYoung (1997) put forth the *"bad management"* hypothesis whereby management inefficiency can affect bank risk. In this context, managerial quality refers to the process of screening and monitoring borrowers' quality, collateral valuation, underwriting and credit scoring (Louzis et al. 2012). Other studies also confirm the negative link between bad management and risk (Louzis et al. (2012); Dimitrios et al. (2016)). These studies use cost efficiency as a proxy for bad management. Other works find no significant relationship between the two (Podpiera and Weill, 2008)

Berger and DeYoung (1997) also put forth the "bad luck" hypothesis whereby external events, not related to management, may reduce cost efficiency. This hypothesis was later confirmed by the work of Rossi et al. (2009).

We use the ratio of operating costs which consists mainly of labor costs to total operating income to account for bank inefficiency. We expect the relationship to be negative because the higher is bank inefficiency the lesser profits a bank can generate.

We therefore develop the following two hypotheses below:

- Hypothesis 1: cost-efficiency has a positive impact on bank profitability

- Hypothesis 2: cost-efficiency has a positive impact on bank stability (negative impact on bank risk)

- Lending policy

Lending policy refers to the bank strategic choices when it comes to their growth and development. Keeton and Morris (1987) pioneered in investigating the impact of a bank rapid credit growth. They document an important association between rapid credit growth and bank risk. This finding was later confirmed by the studies of Kwan and Eisenbeis (1997) and Konstantakis et al. (2016). On a similar note, several studies showed that rapid credit growth is associated with higher levels of risk (Salas and Saurina, 2002; Makri et al., 2014; Konstantakis et al., 2016; Radivojevic and Jovovic, 2017; Peric and Konjusak, 2017).

In our models, we use asset growth to proxy for bank lending policy. We therefore develop the following two hypotheses below:

- Hypothesis 1: Asset growth has a positive impact on bank profitability
- Hypothesis 2: Asset growth has a positive impact on bank stability (negative impact on bank risk)

- Credit risk

Asset quality refers to the quality of a bank's asset portfolio. Due to the lack of data on bank asset portfolio quality, we focus on the quality of the loan portfolio of our sample banks. The quality of a bank loan portfolio is generally measured by the NPLs level. However, NPLs are only considered an ex-post consequence of credit risk. According to new IFRS accounting standards, Loan loss reserves should be deducted from banks Profit and Loss account to account for potential default risk. Based on these grounds, we use the ratio of Loan Loss Reserves (LLR) in our profitability model since loan loss reserves are deducted from bank profits and directly impact bank profitability. On the other hand, we use the ratio of NPLs to total loans (NPL) to account for asset quality in our stability model because we believe that NPLs have a stronger impact on the overall risk and stability of a bank. We include the first lag of LLR and NPL to reduce endogeniety bias.
We therefore develop the following two hypotheses below:

- Hypothesis 1: Credit risk has a negative impact on bank profitability

- Hypothesis 2: Credit risk has a negative impact on bank stability (positive impact on bank risk)

- Diversification

Banks have branched out of the traditional business model to include other sources of income. The objective was at first to find additional sources of income to survive in an environment of cutthroat competition but slowly banks have noticed the positive impact of diversification on mitigating their risk exposure (De Jonghe, 2010).
Non-traditional income includes commissions and other market trading income. In crisis periods, diversification is thought to help reduce bank risks by generating income from other sources of revenue other than their traditional interest-based activity. Yet, several studies have shown that diversification during and post-financial crisis did not improve bank stability but actually contributed to bank instability (Maudos, 2017; Shim, 2019). This is explained by Ibragimov et al., (2011) who show that diversification can mitigate the individual bank risk exposure at first but it increases the effect of joint bank failure. Consequently, the individual benefit of diversification on bank risk is more than offset by systemic risk and in turn diversification can have an adverse impact on bank stability.
Diversification can also have positive externalities on bank profitability. Through diversification, banks can access new sources of revenue which in turn would lead to more profits

(Kohler, 2015). Li et al., (2021) posit that diversification improved bank profitability even during the COVID-19 health crisis.
In the Tunisian context, we expect diversification to have a positive effect on bank profitability and a negative effect on bank risk (positive effect on bank stability). We account for diversification using two different ratios in each model. For our profitability model, we use the ratio of non-interest income to total operating income (DIVER). This ratio provides information about the bank's income structure but also showcases the weight of non-traditional income. For our risk model, we use the ratio of net commissions to payroll and benefits expenditure (COMOP) to account for diversification. This is because banks are more likely sustain their normal activity if they are able to meet their short term financial obligations including payroll and benefits.
We therefore develop the following two hypotheses below:

- Hypothesis 1: Diversification has a positive impact on bank profitability

- Hypothesis 2: Diversification has a positive impact on bank stability (negative impact on bank risk)

II.2.3 Macroeconomic conditions

Bank profitability and risk is not solely influenced by bank specific characteristics but also macroeconomic conditions. Macroeconomic conditions encompass external factors that could influence bank profitability and risk taking (stability).

- Political instability

Political instability risk refers to unstable political regimes. Political instability is the leading cause to the slowdown of economic growth due to its negative externalities on investment and human capital (Uddin et al., 2017). Gosh (2016) analyzed the effect of the Arab spring on the banking sector and found that the Arab spring reduced bank profitability and increased its risk. Rezgallah et al., (2019) document a direct negative association between political instability and bank risk taking. We use the score of political stability provided by the world Bank multiplied by (-1) to assess the impact of political instability on bank profitability and stability.
We expect political instability to negatively affect bank profitability and stability. We therefore develop the following two hypotheses below:

- Hypothesis 1: Political instability has a negative impact on bank profitability

- Hypothesis 2: Political instability has a negative impact on bank stability (positive impact on bank risk)

- Business Cycle

Business cycle is thought to be a major factor that influences bank performance, risk and stability. Hence, we are led to think that bank profitability may perhaps be procyclical. Bank lending is directly affected by demand which is affected by the economic situation of the country. In a downturn, banks are reluctant to provide loans to customers because of the increased risk. Add to that the deterioration in quality of their current loan portfolio which requires additional provisions which in turn reduce banks' profits. Conversely, in an upturn characterized with a positive GDP growth and a boost in the income streams, borrowers' ability to honor their debt servicing increases and banks are able to reduce their NPLs levels (Khemraj and Pasha, 2009; Nkusu, 2011; Nguyen, 2017) and grant more loans. A substantial empirical studies also corroborated the inverse relationship between economic growth and bank risk (Castro, 2013; Abid et al., 2014; Ghosh, 2015; Reddy, 2015; Roy, 2014; Kjosevski and Petkovski, 2017). In the same vein, Louzis et al. (2012) show that when the economy is in its expansion cycle, consumers and firms alike are able to generate a stream of income to pay out their debt service. They also find that towards the end of the expansion cycle, banks tend to grant loans to bad borrowers and when the crisis kicks in, NPLs level increases.

We use real GDP per capita growth rate to account for the business cycle. Real GDP growth is generally used to measure economic growth and to assess the business cycle (Nkusu 2011; Zhang et al. 2016; Al-Khazali and Mirzaei, 2017; Jiménez and Saurina 2006; Makri et al. 2014; Salas and Saurina 2002).

We therefore develop the following two hypotheses below:

- Hypothesis 1: Real GDP growth has a positive impact on bank profitability

- Hypothesis 2: Real GDP growth has a positive impact on bank stability (negative impact on bank risk)

- Inflation

In general, inflation is supposed to have a positive effect on bank profitability. This is because when banks are able to anticipate the inflation rate, they are able to adjust their interest rates accordingly. Conversely, inflation can hurt bank profitability if they fail to adjust their interest rates.

Empirical literature is torn about impact of inflation on bank risk and profitability. The earlier work of Salas and Saurina (2002) and Rinaldi and Sanchis-Arellano (2006) were focused on the impact of inflation on bank risk. They found that low inflation was associated with better financial conditions for borrowers which strengthened their debt servicing ability. Several recent studies also corroborated the aforementioned findings (Klein, 2013; Ghosh, 2017). Another strand of literature posit, on the contrary, that high inflation can actually strengthen borrowers' ability to pay back the amounts borrowed since inflation depreciate the real value of their debt service burden (Nkusu, 2011; Klein, 2013). However, based on the aforementioned argument, high inflation cuts down borrowers' real income rendering it more difficult to honor their outstanding debt obligations (Klein (2013); Us (2017)). Other researches find no statistically significant relationship between inflation and bank credit risk (Peric and Konjusak, 2017).

We therefore develop the following two hypotheses below:

- Hypothesis 1: Inflation has a positive impact on bank profitability

- Hypothesis 2: Inflation has a negative impact on bank stability (positive impact on bank risk)

Table 2.1: Main variable definitions

Variable	Proxy	Description
Dependent variables		
Profitability	ROAA	This ratio indicates the asset intensity of each bank. A high ROAA signifies that the bank has a higher asset intensity and vice versa .
Stability	Z-score	A higher Z-score indicates more stability, thus less risk-taking in a bank and vice versa.
Independent variables		
Bank specific characteristics		
Size	Number of operating branches	The number of operating branches is highly gives an idea about the bank's size.
Liquidity risk	Loan-to-Deposits ratio (LTD)	An increase in this ratio infers a decrease in liquid assets.
Credit risk	NPLs to total loans ratio (NPL) and LLR to NPLs ratio	An increase in this ratio infers a decrease in bank asset quality.
Cost efficiency	Cost-to-income (CTI)	An increase in this ratio infers a decrease in bank efficiency.
Lending policy	Asset Growth (AG)	An increase in this ratio generally infers an increase in lending activities.
Diversification	Non-interest income to operating income ratio	An increase in this ratio infers that the bank is branching out of their traditional lending activities.
Macro-economic conditions		
Political instability	Score of political instability by the World Bank Group	The score measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism.
Business cycle	Yearly real GDP growth per capita	This ratio informs about the business cycle of the country at one point in time.
Inflation	Yearly inflation rate	This ratio informs about the increase in prices of goods and services

III Econometric specification and methodology

Econometric specification presents the empirical models we seek to investigate and methodology describes the sample and data sources, the post-estimation tests and estimation techniques that we have used in our quest.

III.1 Econometric specification

In order to test the aforementioned hypotheses, we construct the following two models to investigate the relationship between regulatory capital and ROAA and Z-score along with other control variables. Since this study uses panel data, we will present two statistical methods: Fixed effect OLS and GLS.
First off, model (1) will be written as follows:

$$\begin{aligned} ROAA_{it} = \alpha + \beta_1 CAP_{it} + \beta_2 CTI_{it} + \beta_3 SIZE_{it} + \beta_4 AG_{it} + \beta_5 LLR_{it-1} \\ +\beta_6 LTD_{it-1} + \beta_7 RENDC_{it} + \beta_8 DIVER_{it} + \beta_9 POL_t \\ +\beta_{10} INF_t + \beta_{11} GDP_t + \epsilon_{it} \end{aligned} \quad (2.1)$$

Where $ROAA_{it}$ is Return on Average Assets, CAP_{it} is the regulatory capital, CTI_{it} is the cost to income ratio, $SIZE_{it}$ is the number of operating branches, AG_{it} is the asset growth rate, LLR_{it-1} is the lagged ratio of loan loss reserves over NPLs, LTD_{it-1} is the lagged value of loan to deposit ratio, $RENDC_{it}$ is the net interest margin ratio, $DIVER_{it}$ is the ratio of non-interest income to operating income, POL_t is the political instability score, INF_t is the inflation ratio and GDP_t is the real growth rate of GDP per capita, whereas ε_{it} is the disturbance term.

However, after we added the regulatory capital squared to test whether the relationship is nonlinear our first model will be written as follows:

$$\begin{aligned} ROAA_{it} = \alpha + \beta_1 CAP_{it} + \beta_2 CAP_{it}^2 + \beta_3 CTI_{it} + \beta_4 SIZE_{it} + \beta_5 AG_{it} + \beta_6 LLR_{it-1} \\ +\beta_7 LTD_{it-1} + \beta_8 RENDC_{it} + \beta_9 DIVER_{it} + \beta_{10} POL_t \\ +\beta_{11} INF_t + \beta_{12} GDP_t + \epsilon_{it} \end{aligned} \quad (2.2)$$

Our second model will be written as follows:

$$\begin{aligned} Z - score_{it} = \alpha + \beta_1 CAP_{it} + \beta_3 GCP_{it} + \beta_4 CTI_{it} + \beta_5 SIZE_{it} + \beta_6 AG_{it} \\ +\beta_7 NPL_{it-1} + \beta_8 LTD_{it-1} + \beta_9 ROAA_{it} + \beta_{10} COMOP_{it} + \\ \beta_{11} POL_t + \beta_{12} INF_t + \beta_{13} GDP_t + \epsilon_{it} \end{aligned} \quad (2.3)$$

Where and $Z\text{-score}_{it}$ is our stability proxy, CAP_{it} is the regulatory capital, GCP_{it} is the growth rate of bank capital, LTD_{it-1} is the lagged value of loan to deposit ratio, $NPL_{it-1}$is the lagged value of NPLs to total loans, $ROAA_{it}$ is Return on Average Assets, $SIZE_{it}$ is the number of operating branches, CTI_{it} is the cost to income ratio, AG_{it} is the asset growth rate, $COMOP_{it}$ is the ratio of net commissions over operating income, POL_t is the political instability score, INF_t is the inflation ratio and GDP_t is the real growth rate of GDP per capital, whereas ε_{it} is the disturbance term.

III.2 Methodology

In this subsection we start by detailing our data sources and final sample. We follow that by reporting the results of our specification tests and post-estimation tests of our empirical models. Last, we report the estimation technique that helps us avoid certain violations of the Ordinary Least Squares (OLS) technique.
In order to circumvent omitted variables bias we follow the Stanley and Doucouliagos (2012) general-to-specific approach. The method consists of predetermining a set of relevant control variables that can potentially influence our variables of interest and are backed by empirical literature then dropping all the non-statistically significant variables except the variable with a substantial empirical literature documenting their significant effect on our variables of interest. This method allows only significant variables remain in our models. This explains why some variables are not included in one model but are in the other model.

III.2.1 Sample selection and data sources

We start with a sample encompassing the 11 banks listed in the Tunisian stock exchange. However, we decided to exclude one bank due to extreme underperformance which may cause a problem of outliers. We use a final sample of 10 Tunisian banks listed in the Tunisian stock exchange relevant to the period 2005-2020. The rationale behind our sample choice is that these 10 banks provide 80% of financing to the economy. Thus the type of data used for this study is a balanced panel dataset. Our sample period covers periods of boom and bust of the Tunisian economy and growth in banks' balance sheets.
Our data is hand-collected from different but complementary sources from Bank annual reports, statistics provided by the Financial Market Council (CMF) and the annual reports of Association Professionnelle Tunisienne des Banques et des Etablissements Financiers (APTBEF). We also used data provided by the CBT to further enhance the quality of our data.

III.2.2 Multicollinearity test

In order to not end up with spurious regressions, we start by detecting and solving any potential multicollinearity between our regressors. We test for multicollinearity by inspecting our correlation matrix and confirming the result by using the Variance Inflation Factor (VIF). The rule of thumb for this test is that if the result shows a mean VIF smaller than 6 and individual VIF smaller than 10 we can affirm that there is no multicollinearity problems. The first VIF test is for our profitability measure while the second test is for the stability measure.

Table 2.2: Variance inflation factor for Model (1)

	VIF	1/VIF
POL	2.625	.381
RENDC	2.468	.405
SIZE	2.377	.421
LLLR	2.146	.466
INF	1.855	.539
CAP	1.852	.54
CTI	1.848	.541
DIVER	1.748	.572
GDP	1.433	.698
LLTD	1.318	.759
AG	1.254	.797
Mean VIF	1.902	.

Table 2.3: Variance inflation factor for Model (2)

	VIF	1/VIF
SIZE	3.363	.297
ROAA	3.274	.305
CTI	3.181	.314
POL	2.648	.378
COMOP	2.114	.473
CAP	2.029	.493
LNPL	1.658	.603
GDP	1.529	.654
INF	1.453	.688
AG	1.324	.755
LLTD	1.312	.762
GCP	1.053	.949
Mean VIF	2.078	.

We also look to confirm the results produced by the VIF test through inspecting our correlation matrix. We follow the same method recommended by Wooldridge (2015) in which he considers the existence of multicollinearity if the correlation coefficient between two variables is greater than 0.7. All the correlation coefficients are less than 0.7 suggesting a low chance of multicollinearity bias in our estimations.

Table 2.4: Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) CAP	1.000													
(2) GCP	-0.012	1.000												
(3) LTD	0.113	-0.012	1.000											
(4) NPL	-0.457	0.097	-0.014	1.000										
(5) BRANCH	0.060	-0.050	-0.272	-0.158	1.000									
(6) CTI	-0.544	-0.036	-0.197	0.347	-0.100	1.000								
(7) AG	0.102	0.046	0.178	-0.056	0.087	-0.214	1.000							
(8) COMOP	0.353	0.062	0.008	-0.253	0.066	-0.562	0.220	1.000						
(9) POL	-0.107	0.060	-0.102	0.250	-0.520	0.099	0.162	-0.143	1.000					
(10) LLR	0.349	-0.032	0.080	-0.706	-0.038	-0.218	-0.063	0.184	-0.363	1.000				
(11) RENDC	0.350	-0.042	-0.062	-0.217	0.258	-0.333	-0.051	0.064	-0.081	0.064	1.000			
(12) DIVER	0.078	0.003	-0.424	-0.236	0.164	0.071	-0.250	0.209	-0.356	0.197	-0.034	1.000		
(13) GDPC	-0.240	0.147	0.072	0.229	-0.349	0.098	0.187	-0.029	0.367	-0.199	-0.305	-0.132	1.000	
(14) INFGDP	0.184	-0.030	0.060	-0.189	0.310	-0.113	-0.032	0.064	-0.401	0.120	0.553	0.115	-0.234	1.000

III.2.3 Specification tests: Random effect vs. Fixed effect

According to Brooks (2014), fixed effect models assign a different and time invariant intercept for each cross-section. Similarly, random effects models also assign a time invariant intercept for each cross-section however this time around these interecets derive from a common mean value.
The choice of the fixed effect estimation is based on the outcome of the Hausman specification test. If the P-value of the Hausman specification test is statistically significant then fixed effects model is more appropriate, otherwise random effects model is more appropriate.

Table 2.5: Hausman (1978) specification test

	(1)	(3)	(5)
Chi-square test value	28.21	16.73	19.57
P-value	0.003	0.1601	0.075

The P-value provided by the Hausman test is less than 0.05 for regression 1 and less than 0.10 for regression 5 thus the null hypothesis is rejected and fixed effect model is preferred over the random-effects model. We fail to reject the null hypothesis for regression 3 hence random-effects model is preferred.

III.2.4 Heteroskedasticity test

Heteroskedasticity violates one of the important assumptions of OLS whereby the variance of the error term should be constant. By violating the homoscedasticity assumption our estimates could be inefficient and biased upward or downward.
We use Poi and Wiggins (2001) Likelihood ratio (LR) test for panel-level heteroskedasticity. The table below reports the result of our heteroskedasticity test for model 1 and model 2.

Table 2.6: Poi and Wigging (2001) Test for panel-level heteroskedasticity

	(1)	(3)	(5)
Likelihood-ratio test	64.42	64.87	117.17
Prob > chi2	0.000	0.000	0.000

The null hypothesis for this test is that the variance of the error terms is homoscedastic. This test is significant at the 1% level, therefore we can conclude that there is a presence of heteroskedasticity in both of our models.

III.2.5 Autocorrelation test

We also run the Wooldridge test which tests the first autocorrelation order in panel data (Drukker, 2003; Sanchez, 2012). The outcome of the Wooldridge test for autocorrelation in panel data is presented below.

Table 2.7: Wooldridge test for autocorrelation in panel data

	(1)	(3)	(5)
F(1, 9)	3.924	4.681	21.634
Prob > F	0.0789	0.0587	0.0225

We fail to reject the null hypothesis in the first model thus we can conclude that our model does not suffer from first order autocorrelation. However, we report the presence of first order autocorrelation in our second model.

III.2.6 Generalized method of moments

Consequently, the use of the Generalized Method of Moments estimation approach is justified in order to circumvent these two violations of the fundamental assumptions of the Ordinary Least Squares (OLS) method (Mwangi, Makau, Kosimbei, 2014). Hence in the following section we will include the estimation provided by the fixed effect OLS along with the GLS estimation however we will only carry out our discussion based on the GLS estimation.

IV Empirical results and discussion

In this subsection we provide a summary for our key variables and report the result of our regression along with a brief discussion of our results.

IV.1 Descriptive statistics

There are 160 observations from 10 Tunisian commercial banks listed in the stock exchange over 16 years. Table 2.8 below displays the descriptive statistics of the key variables included in the two models. As noted by several other studies, we witness some variations in the mean and standard deviation of the variables (Ashraf, 2017; Chen et al., 2017).
In particular, we notice that the mean values presented in Table 2.8 characterizing banks are generally larger than their median, which indicates that in our sample, smaller and medium sized banks outnumber large banks.
The financial stability of the Tunisian banking industry, measured by the Z-score, has

an average value of 3.51 with a standard deviation of 3.43 and a quite a significant gap between the minimum value of -16.12 and the maximum value of 10.08.

For our profitability variable, Tunisian banks performance does not stray away from the trend witnessed worldwide. Bank ROAA is positive but not very high. The average value of ROA is 1% with a maximum value of 4.4% a minimum value of –4.5%. This is in line with the average 1% ROA recorded in the banking industry worldwide (Borio et al., 2017; GarcíaMeca et al, 2015). The overall performance of the Tunisian banking industry is attributed to the interest margin charged on loans granted with an average value of 6.83%. Tunisian banks in our sample have an average regulatory capital ratio of 11.32%, much higher than the 10% minimum requirement of the CBT and the 8% minimum requirement of Basel committee. The median regulatory capital sits at 11.05%. Tunisian banks keep regulatory capital ratios in the range of 10.75% to 20.70% except for the year 2013 and 2014 in which a systemically important bank saw their equity drop to negative levels. This implies that Tunisian banks tend to keep a considerable buffer in order to absorb unexpected losses. This can be explained by the introduction of a more stringent minimum Tier 1 capital set at 7% coupled with a tighter supervision performed by the CBT after the adoption of a set of the Basel III recommendations. Banks' capital growth rate average value sits at 11.4% with a median of 8% and a standard deviation of 17.2%. This signals the presence of a high disparity between banks and overtime. However, a median of 8% gives insight on how much "skin in the game" shareholders are choosing to be.

In terms of cost efficiency, the ratio of operating costs to banking income is high averaging 47% and an equal value of the median with the maximum value reaching 77% of operating income signaling an efficiency problem for some Tunisian banks. The ratio of net commissions to operating expenses has an average value of 55% and a median of value of around 49%. The maximum value of the aforementioned ratio reached 91% showcasing a general trend among banks finance their rising operating expenses through commissions.

Further, the average bank has 130 operating branches with the minimum value of 39 branches and the maximum value of 207 branches.

Although Tunisian banks are still traditional in their income sources, most banks hold more diversified portfolios, with non-interest income accounting for around 46% on average of their total operating income and maximum value of reaching 77% of total operating income.

Tunisian banks' asset quality can be described as poor with a mean level of NPLs of 17% the highest in the region. Most central banks set 5% as an acceptable level of NPLs. Any figure higher than that is considered very risky. This if further concerning since the mean value of the ratio of loan loss reserves solely covers 51% of NPLs.

For liquidity risk, Tunisian banks mean LTD ratio sits at around 110% less than the regulatory level of 120%. However, other banks in other regions report an LTD of less than 80%.

Political instability has an average score of 49% and a standard deviation of 48%. This implies the the period studied is characterized with great political instability. The results

are in line with the economic and political reality of Tunisia which has witnessed substantial political changes since the Arab spring.
Inflation rate has a mean value of 5% and a standard deviation of 1%. This means that prices of products and services increase, on average, 5% a year.
The growth rate of real GDP per capita has a mean value of 1% and a standards deviation of 3%. This implies that during the period studied, the Tunisian business cycle went through periods of boom and bust.

Table 2.8: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	.25	Median	.75	Max
Z-score	160	3.51	3.43	-16.12	3.44	3.93	4.67	10.08
ROAA	160	0.01	.011	-0.05	0.00	0.01	0.02	0.04
CAP	160	0.11	0.04	-0.06	0.10	0.11	0.13	0.22
GCP	159	0.11	0.17	-0.32	0.01	0.08	0.17	0.99
CTI	160	0.47	0.11	0.25	0.39	0.47	0.53	0.84
SIZE	160	130.55	35.42	39	103.50	125.50	150	207
AG	150	0.08	0.07	-0.08	0.03	0.08	0.13	0.25
LLR	160	0.51	0.17	0.06	0.43	0.53	0.61	0.95
LTD	160	1.10	0.15	0.65	0.97	1.12	1.20	1.45
COMOP	160	0.51	0.15	0.24	0.40	0.49	0.61	0.91
RENDC	160	0.07	0.01	0.05	0.06	0.07	0.08	0.10
NPL	160	0.17	0.11	0.06	0.09	0.13	0.20	0.57
DIVER	160	0.46	0.12	0.22	0.37	0.44	0.51	0.77
INF	160	0.05	0.01	0.01	0.04	.044	0.06	0.08
GDP	160	0.01	0.03	-0.09	0.00	0.02	0.03	0.06
POL	160	0.49	0.48	-0.21	-0.04	0.68	0.89	1.14

IV.2 Results and discussion

In this subsection, we start by reporting the outcome of our first model on the impact of regulatory capital on bank profitability and provide a brief discussion of our results. Then, we report the outcome of our second model investigating the impact of regulatory capital on bank risk taking (stability) followed by a brief discussion of results.

IV.2.1 Regulatory capital and bank profitability

Table 2.9 displays our results of Model 1 in which ROAA is the dependent variable. The Fixed effect regressions are presented as a baseline specification from which we depart by examining the Generalized Least Squares (GLS) estimates. The Generalized Least Squares (GLS) controls for heteroskedasticity and autocorrelation. The heteroskedasticity and autocorrelation tests show that we suffer from heteroskedasticity but not autocorrelation. As mentioned before, we will solely interpret the results of the estimations produced by the GLS methodology. Hence, we will interpret the results provided by regression (2) and (4). The first two regressions seeks to provide empirical evidence on the impact of regulatory capital on bank profitability whereas the last two Regressions seeks to test the existence of a non-linear relationship between our variables of interest. Both regressions produce similar results for both signs and significance which can be summarized in table 2.9 below.

- ***Regulatory capital***

  For our first model, we evidence a positive impact of regulatory capital on bank profitability. This means that regulatory pressure did not curb bank profits. Interestingly, regulatory capital improves Tunisian banks' profitability. Our result confirm the findings of Baker and Wurgler (2013) who interpret these higher realized returns as proxying for higher expected returns ex ante and concluded that shareholders in higher-capital banks require higher returns.

  This can also be ascribed to the fact that since banks are constrained to increase capital commensurately with their risk weighted assets, they increase the monitoring and screening of their borrowers in order to select the most solvent borrowers who are able to pay back the principle borrowed with interest (Altunbas et al., 2007). This result was also documeneted by Naceur and Kandil (2009) whose findings show that shareholders incentives to monitor banks managers increase with capital requirements. Berger (2015) explains the positive association between capital requirements and bank profitability by the fact that well-capitalized banks face lower bankruptcy costs and benefit from reduced costs of borrowing which boosts their profitability.

Table 2.9: Estimation using OLS and GLS for ROAA

	(1)	(2)	(3)	(4)
	Fixed effects	GLS	Random effects	GLS
	ROAA	ROAA	ROAA	ROAA
CAP	.067***	.066***	.113***	.119***
	(.017)	(.013)	(.027)	(.023)
CAP2			-.304**	-.308***
			(.128)	(.111)
CTI	-.038***	-.032***	-.032***	-.033***
	(.01)	(.003)	(.006)	(.003)
SIZE	.032***	.013***	.013***	.012***
	(.005)	(.002)	(.003)	(.002)
AG	.019**	.009***	.024***	.008**
	(.009)	(.003)	(.008)	(.003)
LLLR	.002	.013***	.01***	.011***
	(.005)	(.003)	(.004)	(.003)
LLTD	-.024***	-.009***	-.012***	-.008***
	(.007)	(.002)	(.004)	(.002)
RENDC	.252***	.079**	.23***	.085**
	(.077)	(.036)	(.063)	(.036)
DIVER	-.058	.168***	.143**	.158***
	(.165)	(.042)	(.072)	(.042)
POL	-.001	-.002**	-.004***	-.002**
	(.002)	(.001)	(.002)	(.001)
INF	.028	.029	.037	.027
	(.041)	(.02)	(.042)	(.02)
GDP	.046***	.027***	.022	.023***
	(.016)	(.008)	(.016)	(.008)
cons	-.128***	-.057***	-.067***	-.055***
	(.026)	(.011)	(.016)	(.011)
Observations	150	150	150	150

Standard errors are in parentheses

*** p<.01, ** p<.05, * p<.1

Our result is in contrast with the expected income theory in which capital requirements are thought to reduce bank profitability. It is also in contrast with the empirical investigation of Goddard et al. (2010) in which they find that bank managers are "over-cautious" which reduce bank profitability since banks are supporting high opportunity costs. This finding

is also in contrast with that of Akbas (2012) and Curak et al. (2012) whose findings show that more stringent capital requirements are associated with diminishing profits due to the reduction of leverage effect and increased costs of funding.
The coefficient of regulatory capital squared (CAP2) in regression (4) is negative and significant. This finding confirms the view that stringent capital requirements help improve bank profitability up to a certain threshold. After that, an increase in capital is more likely to reduce bank profitability. This is commonly referred to as a "U-shape" form relationship. Le and Nguyen (2020) have also documented a U-shaped relationship between bank capital requirements and bank profitability.

- ***Cost efficiency***
  We find that the coefficient of the Cost to Income ratio (CTI) is negative and significant in the first model. This implies that cost inefficiency negatively impacts bank profitability. This outcome was expected since costs are directly deducted from the profit and loss account of the bank and hence reduce bank profits. This is consistent with the idea that efficient management provides bank with the opportunity to improve their profitability. Hence, as the conventional wisdom posits, efficient use of labor can only positively affect bank profits.
  Our findings are consistent with that of Bourke (1989) who finds that staff expenses reduce bank profits. They are also in line with the findings of Khediri and Ben-Khedhiri (2011) based on a sample of 10 Tunisian banks covering the period 1996-2005 and found that management efficiency positively influence bank profitability. However, our finding is in contrast with the study of Molyneux (1993) whose findings find a positive association between labor costs and bank profitability. He explains that in regulated sectors, profitable firms tend to have high payroll expenditure.

- ***Size***

  We find that size is positively correlated with profitability. Our findings are in line with the size-profitability hypothesis whereby larger banks benefit from economies of scale and scope which in turn lead to higher profitability. Our finding confirms the findings of Nguyen (2020) whereby large banks tend to be more profitable. Our findings is also in line with the findings of Zhang et al. (2008) who find that large bank benefit from investment opportunities, diversification and better access to capital markets.
  The positive association between size and bank profitability in the Tunisian context can be explained by the "stewardship theory" which suggests that managers' interest align with that of the bank owners. Based on this argument, bank profitability will benefit managers as well as bank owners (Donaldson and Davis (1991); Davis et al. (1997)).

- ***Lending policy***

  We use asset growth to proxy for bank growth strategy and lending policy. We document a positive relationship between asset growth and bank profits and stability. This can be explained by the fact that growth in assets translates to higher interest income which in turn leads to better profitability.

- ***Credit risk***

  Credit risk is proxied by the lag of Loan Loss Reserves (LLR) ratio and has a positive and significant coefficient. We expected the relationship to be negative since LLR are deducted from bank operating income. One possible explanation is that bank shareholders' expect to be compensated with higher return for the increased risk. In addition the risk-return hypothesis suggests that banks that engage in risk taking are rewarded with higher return. Our findings are consistent with that of Syafri (2012) and Madugu et al. (2019) whose findings show that credit risk positively impacts banks' profitability.

- ***Liquidity risk***

  We use the lag of Loan to Deposit (LTD) ratio to proxy for bank liquidity risk. The coefficient of our liquidity risk variable is negative and significant. This implies that liquidity risk negatively affects bank profitability. This can be explained by the fact that illiquid banks face higher costs of funding which in turn reduces their profitability. Based on these grounds, our findings are in line with the findings of Lee and Kim, (2013) and Bassey and Moses (2015) who also document a negative impact of liquidity risk on bank profitability. Our findings are in contrast with other studies that find a positive impact of liquidity risk on bank profitability (Molyneux and Thornton, 1992 ;and Laeven, and Levine, 2003; Shen et al., 2001; Demirgüç-Kunt et al., 2003; Naceur and Kandil, 2009; Chen et al., 2018)

- ***Net interest Margin***

  We find that the coefficient of the net interest margin ratio (RENDC) to be positive and significant. The sign of the coefficient is in line with the hypothesis we predicted. Tunisian banks' profitability is greatly influenced by their interest-based activity.

- ***Diversification***

  In the first model, the coefficient for our diversification variable is positive and statistically significant. This means that higher diversification entail higher return. This finding is in line with the findings of Ahamed (2017), Kohler (2015) and Li (2021) who documented a positive association between an increase in the share of non-interest income and bank profitability. However, our findings are in contrast with the findings of Lee et al. (2014) whose findings show that while diversification does have an impact on reducing bank risk it does not have a positive impact on bank profitability.

- ***Political instability***

  The coefficient of political instability variable is negative and significant in the first model. This variable measures the likelihood of political instability and/or politically-motivated violence, including terrorism. Our finding show that political instability negatively impacts bank profitability. Political instability negatively affects economic growth and foreign direct investment which in turn would lead to less lending and lower profits.

- ***Inflation***

  We document a non-significant relationship between inflation and bank profitability. Our findings are in line with that of Jokipii and Monnin (2013) who find no clear evidence of inflation on profitability. Our findings are in contrast with the findings of Syafri (2012) who document a negative association between inflation and bank profitability.

- ***Real GDP growth***

  We observe that the coefficient of real GDP per capita is positive and significant for our first model. This implies that economic growth stimulates bank profitability. This finding confirms earlier studies of Rupeika-Apoga et al. (2018) and Chand et al. (2021) that also document a positive relationship between economic growth and bank profitability.

IV.2.2 Regulatory capital and bank risk (stability)

In this subsection, we seek to explore the effect of regulatory capital on bank risk taking (stability). The GLS methodology which controls for heterskedastiy and first order autocorrelation requires a balanced sample. Yet, our sample is not balanced since we have used one-period lags of NPL and LTD and Asset Growth (AG) is computed by creating a missing value in the first year of every cross-section. To circumvent this limitation we have used rebalancing techniques performed via the STATA software to fill the missing values in our sample. Table 2.10 reports results of our second model with Z-score as our dependent variable.

- ***Regulatory capital***

  We find that the coefficient for regulatory capital is positive and significant in the second model too. We establish that regulatory capital exerts a positive effect on bank stability. This implies that regulatory capital boosts Tunisian banks' solvency. This result may be ascribed to the constant effort of Tunisia's regulatory bodies headed by the CBT to ensure the resilience of the Tunisian banking industry through recapitalization. Another explanation is that higher regulatory capital increase shareholders' "skin in the game" and in turn improves bank efficiency in terms of screening and monitoring of borrowers. Another possible explanation is that managers tend to work harder to offset the negative impact of the social costs of capital-financing by generating more profits through the expansion of their income sources and asset growth.

  The coefficient of capital growth rate (GCP) is negative and significant. This implies that regulatory capital can also take a "U-shape" form and increase bank risk taking and instability. This can also signal that regulatory capital is close to the threshold which would inverse the relationship between capital requirements and bank risk. We test the non-linearity hypothesis later in our robustness tests.

- ***Cost efficiency***

  We find that the coefficient of the Cost to Income ratio (CTI) is positive and significant. This implies that cost inefficiency has negative effect on bank risk and a positive effect on bank stability. One possible explanation for this is that Tunisian banks are investing in skilled staff that would potentially improve their stability and decrease their risk exposure through better screening and monitoring of borrowers in the long run. Our finding is in contrast with the result documented by Alber (2017) and Dutta and Saha (2021) whose findings show a positive and significant association between efficiency and stability and with that of Yakubu and Bunyaminu (2021) who does not find any significant association between efficiency and bank stability.

Table 2.10: Estimation using OLS and GLS for Z-score

	(1) Fixed effects Z-score	(2) GLS Z-score
CAP	.546***	.045***
	(.069)	(.001)
GCP	-.023**	-.001***
	(.01)	(0)
CTI	.039	.074***
	(.043)	(0)
SIZE	-.117***	.008***
	(.029)	(0)
AG	.087***	-.009***
	(.031)	(0)
LNPL	-.089***	-.071***
	(.027)	(0)
LLTD	.035*	.019***
	(.02)	(0)
ROAA	1.545***	.676***
	(.317)	(.002)
COMOP	-.02	.05***
	(.027)	(0)
POL	.011	-.009***
	(.007)	(0)
INF	.074	.012***
	(.151)	(0)
GDP	-.064	.057***
	(.077)	(0)
cons	.701***	-.085***
	(.181)	(.001)
Observations	160	160

Standard errors are in parentheses
*** p<.01, ** p<.05, * p<.1

- ***Size***

  For our stability model, we report a positive effect of size on bank stability hence a negative effect on bank risk. This can be justified by the fact that larger banks tend to benefit from

greater investment opportunities, greater negotiating powers and economies of scale and scope which reduces their probability of default. Nguyen (2020) explains that large banks tend to be more profitable and have lower bankruptcy costs which generally foster bank stability and reduces their default risk.
Our finding is consistent with the findings of De Haan and Poghosyan (2012) who also document a positive association between size and bank stability. However, it is in contrast to past literature documenting a negative relationship between size and stability (Altaee et al., 2013; Laeven et al., 2014; Köhler, 2015; Ali and Puah, 2018).

- ***Credit risk***

  In our stability model the coefficient of credit risk is negative and significant. This implies that credit risk increases bank risk and instability. This finding is in line with economic logic since an accumulation of NPLs can deplete a bank's capital and render a bank insolvent. This finding is in line with Ghenimi et al., (2017) who find that credit risk is positively correlated to bank instability because it is associated with higher probabilities of default.

- ***Profitability***

  In the second model, we use ROAA to proxy for bank profitability. We find that the coefficient of profitability is positive and significant. This finding is to be expected because profitability increases bank capital via retained earnings which boosts bank stability and reduces bank insolvency risk . This result contradicts the one obtained by Srairi (2013), and Imbierowicz and Rauch (2014) who found a negative effect of ROA on banking stability.

- ***Liquidity risk***

  Interestingly, the coefficient of our liquidity risk variable is positive and significant. This can be explained by the fact that our ratio also takes accounts of the lending activity of the bank financed by the cheapest form of liability which is depositors' funds. This finding is in contrast with that of Ghenimi et al., (2017) and Ali and Puah, (2019). Ghenimi et al., (2017) find that liquidity risk is positively correlated to bank fragility. Similarly, Vazquez and Federico (2015) find that liquidity risk negatively affected bank stability in period of financial crisis.

- ***Diversification***
  We find that diversification is positively associated with bank stability. This implies that diversification has helped Tunisian banks mitigate their risk of insolvency. Our findings are in line with past literature that documented the positive relationship between diversification and bank stability (Litan, 1985; Wall and Eisenbeis, 1984; De Jonghe, 2010) but in contrast with literature that documented the adverse effect of diversification (Lepetit et al., 2008; Abedifar et al., 2013; Maudus, 2017; Shin, 2019).

- ***Lending policy***
  We use asset growth to control for the growth strategy of Tunisian banks (Abedifar et al.,

2013). We document a negative (positive) relationship between asset growth and stability (risk). This confirms empirical wisdom that associated rapid asset growth to increased in risk. Our findings are in line with the findings of Abedifar et al., (2013) whose findings show that asset growth is associated with higher risks and reduced bank stability.

- ***Political instability***

  The coefficient of the political instability variable is negative and significant This implies that political instability increased bank risk of insolvency since it negatively affects the banks main source of income which is heavily influenced by market conditions.

- ***Real GDP growth***

  The coefficient of real GDP per capita is positive and significant for our second model. This implies that economic growth boosts bank stability. This finding confirms earlier studies of Rupeika-Apoga et al. (2018) and Chand et al. (2021).

- ***Inflation***

  Contrary to our first model, in our second model we document a positive (negative) relationship between inflation and bank stability (risk). This finding is in line with the finding of Yakubu and Bunyaminu (2021) and Chand et al., (2021) who documented a positive relationship between inflation and bank stability.

IV.3 Robustness check

Studies have shown that most economic and financial relationships are dynamic. Dynamic models differ from static models by the presence of lagged dependent variables among the other independent variables.

Bank profitability tends to persist due to the influence of long lasting economic shocks and market conditions (Berger et al., 2000). Based on these grounds, it is reasonable to expect the relationship to be dynamic and adopt a model in which lagged profitability variables are included. We also test whether bank stability can showcase a persistence effect.

We also test if regulatory capital can have a “U-shape” form relationship with stability (risk taking) like that reported in our profitability model.

Least squares estimation technique produce biased and inconsistent coefficients when lagged dependent variables are present and dynamic relationships need to be modeled using dynamic appropriate techniques such as the Generalized Method of Moments (GMM) and Two-Stage Least Squares (2SLS) Regression Analysis. However, Judson and Owen (1999) performed Monte Carlo simulation to test the bias in the coefficient in least squares estimation and found that the bias tends to approach zero when T increases.

For the sake of caution, however, we perform our robustness test using the Two-Stage Least Squares (2SLS) regression analysis. We chose this estimation technique instead of the GMM estimation since the latter requires “small T, large N” panels, meaning few time periods and many individuals (Arellano and Bond, 1991; Arellano and Bover 1995;

Blundell and Bond 1998).We do the same for our stability model.
The dynamic model specification of our first model is as follows:

$$ROAA_{it} = \alpha + \beta_1 ROAA_{it-1} \beta_2 CAP_{it} + \beta_3 CAP_{it}^2 + \beta_4 CTI_{it} + \beta_5 SIZE_{it} + \beta_6 AG_{it} + \beta_7 LLR_{it} + \beta_8 LTD_{it-1} + \beta_9 RENDC_{it} + \beta_{10} DIVER_{it} + \beta_{11} POL_t + \beta_{12} INF_t + \beta_{13} GDP_t + \epsilon_{it} \tag{2.4}$$

Where $ROAA_{it}$ is Return on Average Assets, $ROAA_{it-1}$ is the lagged dependent variable, CAP_{it} is the regulatory capital, $CAP\hat{2}_{it}$ is the regulatory capital, CTI_{it} is the cost to income ratio, $SIZE_{it}$ is the number of operating branches, AG_{it} is the asset growth rate, LLR_{it-1} is the lagged ratio of loan loss reserves over NPLs, LTD_{it-1} is the lagged value of loan to deposit ratio, $RENDC_{it}$ is the net interest margin ratio, $DIVER_{it}$ is the ratio of non-interest income to operating income, POL_t is the political instability score, INF_t is the inflation ratio and GDP_t is the real growth rate of GDP per capita, whereas ε_{it} is the disturbance term.
The dynamic model specification of our second model is as follows:

$$Z-score_{it} = \alpha + \beta_1 Z-score_{it-1} + \beta_2 CAP_{it} + \beta_3 CAP_{it}^2 + \beta_4 GCP_{it} + \beta_5 CTI_{it} + \beta_6 SIZE_{it} + \beta_7 AG_{it} + \beta_8 NPL_{it-1} + \beta_9 LTD_{it-1} + \beta_{10} ROAA_{it} + \beta_{11} COMOP_{it} + \beta_{12} POL_t + \beta_{13} INF_t + \beta_{14} GDP_t + \epsilon_{it} \tag{2.5}$$

Where $Z\text{-}score_{it}$ is our stability proxy, and $Z\text{-}score_{it-1}$ is the lagged dependent variable, CAP_{it} is the regulatory capital, $CAP\hat{2}_{it}$, GCP_{it} is the growth rate of bank capital, LTD_{it-1} is the lagged value of loan to deposit ratio, NPL_{it-1} is the lagged value of NPLs to total loans, $ROAA_{it}$ is Return on Average Assets, $SIZE_{it}$ is the number of operating branches, CTI_{it} is the cost to income ratio, AG_{it} is the asset growth rate, $COMOP_{it}$ is the ratio of net commissions over operating income, POL_t is the political instability score, INF_t is the inflation ratio and GDP_t is the real growth rate of GDP per capita, whereas ε_{it} is the disturbance term.

To control for endogeneity bias, we perform the Hausman endogeniety test to determine whether our regulatory capital ratio variable is endogenous. We use the second and third lag of regulatory capital (CAP) and NPLs ratio as instruments. The null hypothesis for the test is that CAP is exogenous. Table 2.11 reports our test results.

Table 2.11: Durbin–Wu–Hausman test for endogeneity

	ROAA	Z-score
Durbin (score) chi2(1)	1.7818	2.2896
P-value	0.6189	0.5145
Wu-Hausman F(1,114)	1.58421	2.0079
P-value	0.6630	0.5708

The P-value of both dynamic models is greater than 0.05 hence we fail to reject the null hypothesis meaning that our regulatory capital variable is exogeneous. However we also need to test the validity of our instruments using the test of overidentifying restrictions.

Table 2.12: Test of overidentifying restrictions

	ROAA	Z-score
Sargan (score) chi2(3)	1.7818	2.2896
P-value	0.6189	0.5145
Basmann chi2(3)	1.58421	2.0079
P-value	0.6630	0.5708

Table 2.12 reports our overidentifying restrictions test result. We fail to reject the null hypothesis for both of our models. Hence, we can confirm that our instruments are valid.

Table 2.13 displays regression results of 2SLS estimation in which ROAA is the dependent variable. The coefficient of the one-period lagged value of ROAA is positive and significant. This implies that Tunisian banks profitability showcase a persistence effect meaning that banks that performed well in the past year tend to perform well the following year.

Table 2.13: Instrumental variable (2SLS) regression using ROAA

ROAA	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
LROAA	.205	.066	3.11	.002	.076	.335	***
CAP	.086	.026	3.28	.001	.034	.137	***
CAP2	-.239	.121	-1.98	.048	-.475	-.002	**
CTI	-.026	.006	-4.28	0	-.038	-.014	***
SIZE	.01	.003	3.86	0	.005	.016	***
AG	.029	.007	4.01	0	.015	.043	***
LLLR	.01	.004	2.82	.005	.003	.017	***
LLTD	-.012	.003	-3.42	.001	-.018	-.005	***
RENDC	.19	.06	3.18	.001	.073	.307	***
DIVER	.116	.067	1.72	.085	-.016	.248	*
POL	-.004	.001	-2.67	.008	-.007	-.001	***
INF	.041	.039	1.04	.298	-.036	.117	
GDP	.03	.015	2.07	.038	.002	.059	**
Constant	-.054	.016	-3.43	.001	-.084	-.023	***
Mean dependent var		0.011		SD dependent var		0.011	
R-squared		0.800		Number of obs		150	
Chi-square		599.776		Prob > chi2		0.000	

*** p<.01, ** p<.05, * p<.1

Even though the magnitude of coefficients generated by the 2SLS regression varies from the GLS to some extent, the impact of our independent variables is basically consistent. All of our independent variables have economically reasonable signs. The coefficient of the regulatory capital ratio is positive and significant and the coefficient of the same ratio squared is negative. This further confirms the non-linearity of the capital-profitability hypothesis and in line with the "U-shape" nature of the relationship documented in the GLS regression.

Table 2.14 displays regression results of the 2SLS estimation in which Z-score is the dependent variable. The coefficient of the one-period lagged value of Z-score is not significant. This implies that bank stability or risk taking does not tend to persist.

We find that the coefficient of regulatory capital ratio is positively correlated with bank stability (negatively correlated with bank risk) which confirms the results find in our static model.

However we find, just like in our profitability model, that the coefficient of CAP2 is negative and significant which further showcases the non-linearity of the capital-risk hypothesis and in line with the "U-shape" nature of the relationship documented in the GLS regression.

Some of the variables in our models are no longer significant. This may be due to the use of a dynamic model in which we see no effect of persistence. Hence, we believe that the static model is more appropriate and we retain the same conclusions mentioned above for all the control variables.

Table 2.14: Instrumental variable (2SLS) regression using Z-score

Z-score	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
LZscore	-.029	.044	-0.66	.508	-.116	.057	
CAP	1.409	.083	16.92	.000	1.246	1.572	***
CAP2	-4.824	.368	-13.11	.000	-5.545	-4.103	***
GCP	-.029	.007	-3.94	.000	-.044	-.015	***
CTI	-.027	.021	-1.28	.200	-.068	.014	
SIZE	.002	.009	0.24	.807	-.016	.021	
AG	.04	.021	1.94	.052	0	.08	*
LNPL	-.042	.015	-2.76	.006	-.072	-.012	***
LLTD	.005	.01	0.50	.616	-.014	.023	
ROAA	.317	.193	1.64	.101	-.061	.696	
COMOP	-.022	.012	-1.86	.063	-.045	.001	*
POL	-.002	.004	-0.51	.609	-.01	.006	
INF	-.041	.097	-0.42	.671	-.232	.15	
GDP	.097	.043	2.27	.023	.013	.181	**
Constant	-.047	.073	-0.64	.523	-.191	.097	
Mean dependent var		0.034		SD dependent var		0.035	
R-squared		0.831		Number of obs		150	
Chi-square		736.145		Prob > chi2		0.000	

*** p<.01, ** p<.05, * p<.1

CHAPTER CONCLUSION

In this chapter, we sought to investigate the impact of regulatory capital requirements on bank profitability and risk raking (stability). We used a sample of 10 listed Tunisian covering the period 2005 to 2020 and found that regulatory capital has a positive impact on bank profitability and stability. This finding refutes bank managers' claims, at least in the Tunisian context, that stringent capital requirements reduced bank profits. However, we do find that the relationship is not linear but "U-shaped". This means that regulatory pressure has a positive effect on bank profitability and stability up until a certain threshold. After that, more stringent capital requirements will negatively affect bank profitability and increase risk taking. We also find that size is positively (negatively) associated with bank profitability and stability (risk). Interestingly, we find that credit risk positively affect profitability whereas liquidity risk has a negative effect on bank profits. Conversely, we find that credit risk positively (negatively) affect bank solvency (stability) risk whereas liquidity risk has a negative (positive) effect.

We also find the cost inefficiency reduces bank profits but also reduces (improves) bank insolvency risk (stability). This is because we believe that Tunisian banks invest more and more on skilled labor to improve their long term efficiency. Bank rapid growth rate improves bank profitability since banks usually invest in illiquid assets which offer higher return but increases (reduces) bank insolvency risk (stability) since more lending is associated with lower asset quality. Political instability is found to reduce bank profits and increase their risk. This is because political instability affects bank asset quality which reduces bank profits and increase default on loans.

Moreover, we find that Tunisian banks branching out into new sources of income through diversification improved their profitability and helped mitigate their risk of insolvency. We find that inflation has no significant impact on bank profitability but reduces bank risk. This can be explained by the hypothesis that inflation reduces the real value of borrowers' debt burden and hence reduces their probability of default. We also find that bank profitability and stability is procyclical that is in periods of booms bank solvency and profitability improves, and vice versa.

CONCLUSION

Bank capital is considered to be the center of micro- and macro prudential regulation in banking all over the world. The Basel Accords view capital as the most important target to ensure the resilience and the stability of the financial system.

Before the 2008 financial crisis, however, banks were permitted to engage in excessive risk taking activities without holding enough capital to withstand losses in case things go south. The financial crisis exposed longstanding weakness of the traditional banking business model and highlighted to crucial role of capital to absorb unexpected losses. Many experts ascribe the failing banking system in the period of the global crisis to the failure of regulation and the lack of enforcement of said regulation by supervisory authorities to detect early warning signs before the crisis took place (Calomiris 2017).

Therefore, regulatory authorities have implemented regulation that aim to compel banks to hold adequate capital.

In theory, regulatory capital requirements should be effective because they seek to align the incentives of bank shareholders and managers with that of depositors. Empirically, however, the impact of regulatory requirements on bank behavior remains debatable. Several researchers posit that regulators should focus on capital requirements in order to curb bank incentives to take on excessive risks since the primary cause for excessive risk taking is ascribed to bank business model that overly dependent on leverage (Bhagat et al., 2015). Conversely, several empirical studies document that banks increase their risky assets portfolio in response to more stringent capital requirements (Devereux et al., 2015; Dautovic, 2019).

On the other hand, bank managers oppose capital requirements on the grounds that regulatory capital ratios shrink bank profits and impose substantial costs on banks. In practice, however, banks usually keep capital ratio well above the required minimum.

Thereby, regulatory authorities are torn about the costs and benefits of bank capital. On the one hand, stringent capital requirements protect depositors' interest, provide banks with a cushion to absorb unexpected losses and inspire confidence in the banking sector. On the other hand, capital requirements' social costs in terms of availability and cost of lending which, if not taken seriously, can jeopardize real economic activity.

Key findings and contributions

Our contribution to the empirical literature investigating the impact of regulatory pressure on bank behavior is threefold. First, very few empirical studies have investigated the simultaneous effect of regulatory capital ratios on bank profitability and risk. We seek to fill the literature gap by analyzing bank behavior in response to capital constraints. Second, the majority of studies that tackled our research question have focused on testing its impact on developing countries and mainly the U.S. and some European countries leaving a gap to fill in developing countries. Also, international capital standard did not distinguish between market-based and bank-based market systems or any particularity of each country. For instance, Naceur and Kandil (2013) found that regulatory pressure in bank-based MENA countries (Egypt, Jordan, Lebanon, Morocco, and Tunisia) has caused an increase in loan growth rates rather than a credit crunch that was reported in most developed countries.

Last, to our knowledge very few papers have investigated the potential non-linear effect of capital requirements on bank behavior. Disregarding this relationship can infer very misleading conclusions about the relationship and increase the social costs of capital requirements.

Therefore, the objective of the thesis is to research theoretical and empirical evidence on the potential impact of regulatory capital on bank behavior. Theoretical wisdom attempted to predict and explain why regulatory capital can curb bank excessive risk or improve profitability or vice versa. Likewise, empirical evidence is torn about the effect of regulatory capital on bank behavior.

How then is bank profitability and risk influenced by regulatory pressure? Ultimately this is an empirical question, and we answer it by investigating the impact of regulatory capital on bank behavior in the bank-based system of Tunisia.

In our empirical investigation, we first began by the identification of the appropriate model. We also test the robustness of our models by ordinary least squares with instrumental variables using lagged regulatory capital and non-performing loans ratio as instruments.

Our empirical investigation reveals very interesting findings. First, we find that regulatory capital ratios improve bank profitability and reduce bank risk at first. However, when regulatory pressure reaches a certain threshold, the positive effect of regulatory capital is diminished and regulatory capital may reduce bank profitability and increase risk-taking incentives. This means that the profitability and risk taking behavior of Tunisian banks is not linear and follows a "U-shape" form in which capital improve bank stability and profitability up to a certain threshold. This implies that bank managers hold some truth in their claims about the social costs of regulatory capitals.

In addition, we also find that Tunisian banks' performance tend to persist over time. This may insinuate that banks increase their capital by means of retained earnings. However, we do not find evidence of the persistence of bank risk. In addition, we find that diversification has helped mitigate bank risk and the political instability reduced bank profits and increase bank fragility.

Implications on regulatory and supervisory interventions

A key question for macro prudential regulators around the world is whether stringent capital requirements can curb bank risk taking, or at least increase bank solvency. Their first instinct is to improve the loss-absorption capacity of banks through recapitalization. However, as we discussed before banks are not willing to increase capital unless required to.

Hence we believe that capital regulation can be considered as the effective medicine to prevent future illness in the financial system. Yet, it is legitimate to ask if the medicine can kill the patient?

We find that regulatory pressure can increase or decrease bank risk taking depending on a given threshold. We will call that the optimal social capital in which bank profitability is not compromised and regulators are ensure of the soundness and solvency of banks. However, the optimal social capital is very difficult to determine due to the complexity of the banking activity and the divergence of interests between regulators and banks. Based on the aforementioned arguments, regulators might need to perform stress tests before any increase in regulatory capitals to gauge the social costs and benefits of said interventions.

We also acknowledge that poorly designed and complex regulations can have an adverse effect on bank risk and jeopardize bank profitability. A survey done by the Bank Regulation and Supervision Survey (BRSS) covering 143 countries revealed that countries with more complex definitions of capital gave room for bank managers to choose how to interpret definitions of regulatory capital.

We also propose that regulatory authorities include the leverage ratio —Equity to total assets ratio —proposed by Basel III and set at 3% as a complement to the regulatory risk-weighted requirements to improve the resilience of the Tunisian banking sector. Risk-weighted assets have been the center of criticism due to the complexity and ambiguity of their methods of calculation. Taking into consideration that the Central Bank of Tunisia has dropped the use of internal based approaches in favor of the standards approach gives more freedom to bank managers to engage in a regulatory arbitrage. Indeed, since risk-weighted capital ratio are prone to errors and since regulators cannot have full information about the risk portfolio of banks due to asymmetry of information, banks may find incentives to engage in risky activities considered more risky than what was presumed by the Basel framework.

Hence, banks can meet capital requirements without having to raise equity capital considered to have the best loss-absorbing capacity. This behavior has been documented by Jackson (1999) whose findings show that banks, in response to capital requirements, increase their average risk-weighted asset ratio whereas the leverage ratio kept declining.

Thereby, the leverage ratio can discourage this behavior by ensuring those banks are maintaining an adequate level of capital. The U.S for instance have kept the minimum leverage ratio— which existed prior to the implementation of the Basel framework — set at 3% for "strong" banks and 4% for other banks. Regulators in the U.S claim that the leverage ratio is the more binding constraint on bank activities.

Another proposal inspired by the Basel standards is to impose a "business tax" on systemically important banks which entails that they have to maintain a higher regulatory capital than that of small institutions. The Geneva Report (Geneva, 2009) propose that the regulatory capital on systemically important banks should be based on a multiplicative factor signaling macro prudential risks as leverage, maturity mismatch and rate of expansion.

Flannery (2005) proposes, and which we advocate for, the introduction of contingent capital otherwise known as "CoCos". Contingent capital is a form of hybrid debt which converts automatically into equity capital when a trigger event is met. The aim of the security is that tax payers do not become providers of contingent capital such as happened after the global financial crisis.
The advantage brought by CoCos is that bank capital increases automatically in situations of distress providing banks with additional loss-absorbing capacities. Contingent capital provides banks with additional capital in times of need while also preserving the disciplinary role of debt since subscribers to CoCos will closely monitor bank compliance.
Another advantage of contingent capital is that the Central Bank of Tunisia can set the trigger conditions of contingent capital for example when the leverage ratio reaches a prespecified limit or when Tier 1 capital requirements are no longer met. The Squam Lake group proposes two necessary conditions before triggering the automatic conversion. One of them involves the Central Bank of Tunisia to declare the existence of a systemic crisis. This condition is intended to protect investors from automatic conversion induced by poor performance and not the occurrence of a systemic crisis. It also attempts to reduce managers' incentives to gamble away the safety net induced by the security. The second condition is that the bank's leverage ratio has hit a minimum which can again be set by the central bank.

Research Limitations and Future Research

A number of limitations of this study can be identified. First, more evidence is needed on the impact of regulatory capital on bank profitability and risk before any generalization of our results can be made. Second, due to data availability, our empirical investigation was conducted only on the ten major listed Tunisian banks over the period 1999-2005 and hence the results of the study cannot be assumed to extend beyond this group of banks or to different study periods.
The use of only quantitative data —accounting data to be exact — in itself can also be

seen as a limitation to some extent, since bank risk and profitability may also depend on other qualitative variables that we did not take into account and may affect the richness of our research data.

Moreover, the study focuses on banking sector and not the overall financial system, which can be considered both as a delimitation and limitation.

Another limitation of our study is that we do not consider insurance deposit schemes when determining the relationship between bank risk and regulatory capital. However, the Tunisian Bank Deposit Guarantee Fund started operating in 2018 which is considered too recent to influence banks' behavior.

We propose, for future research, investigating the impact of an alternative "regulatory capital" Z-score as an indicator for the likelihood that a bank's regulatory capital drops below a given threshold.

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Appendix

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

R-sq:                                           Obs per group:
     within  = 0.7681                                         min =         15
     between = 0.6118                                         avg =       15.0
     overall = 0.6456                                         max =         15

                                                F(11,129)          =     38.85
corr(u_i, Xb)  = -0.5877                        Prob > F           =    0.0000
```

ROAA	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
CAP	.067398	.0174917	3.85	0.000	.0327903	.1020058
CTI	-.0382444	.0100783	-3.79	0.000	-.0581846	-.0183042
SIZE	.0319833	.0051208	6.25	0.000	.0218517	.0421149
AG	.0187467	.0086297	2.17	0.032	.0016726	.0358207
LLLR	.0023225	.0047305	0.49	0.624	-.007037	.0116819
LLTD	-.0243469	.0068613	-3.55	0.001	-.0379222	-.0107716
RENDC	.2521897	.0766678	3.29	0.001	.1005006	.4038788
DIVER	-.0578564	.1653847	-0.35	0.727	-.3850742	.2693613
POL	-.0010111	.0017481	-0.58	0.564	-.0044698	.0024475
INF	.0284092	.0411356	0.69	0.491	-.0529786	.109797
GDP	.0462785	.0164629	2.81	0.006	.0137063	.0788506
_cons	-.1275981	.0264174	-4.83	0.000	-.1798655	-.0753307
sigma_u	.00607335					
sigma_e	.00524552					
rho	.57274826	(fraction of variance due to u_i)				

```
F test that all u_i=0: F(9, 129) = 2.87                     Prob > F = 0.0040
Click to Open File:  Myfile.doc
```

Figure 2.3: ROAA Fixed effects (1)

```
Cross-sectional time-series FGLS regression

Coefficients:  generalized least squares
Panels:        heteroskedastic
Correlation:   no autocorrelation

Estimated covariances      =        10          Number of obs      =       150
Estimated autocorrelations =         0          Number of groups   =        10
Estimated coefficients     =        12          Time periods       =        15
                                                Wald chi2(11)      =    583.32
Log likelihood             =  604.5542          Prob > chi2        =    0.0000
```

ROAA	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
CAP	.0662742	.0125933	5.26	0.000	.0415918	.0909566
CTI	-.0315843	.0031362	-10.07	0.000	-.0377312	-.0254373
SIZE	.0126672	.0020118	6.30	0.000	.0087242	.0166101
AG	.0090399	.0034448	2.62	0.009	.0022882	.0157917
LLLR	.0126088	.0027533	4.58	0.000	.0072124	.0180051
LLTD	-.0086329	.0023974	-3.60	0.000	-.0133317	-.0039342
RENDC	.078923	.0355071	2.22	0.026	.0093305	.1485155
DIVER	.1675164	.0416385	4.02	0.000	.0859064	.2491265
POL	-.0017888	.0007839	-2.28	0.022	-.0033252	-.0002524
INF	.0285673	.0200138	1.43	0.153	-.010659	.0677936
GDP	.0267943	.0077549	3.46	0.001	.0115948	.0419937
_cons	-.0568611	.0105352	-5.40	0.000	-.0775097	-.0362126

```
Click to Open File:  Myfile.doc
```

Figure 2.4: GLS FOR ROAA (2))

Random-effects GLS regression — Number of obs = 150
Group variable: **BANK** — Number of groups = 10

R-sq: within = **0.7458**, between = **0.9519**, overall = **0.7871**

Obs per group: min = 15, avg = 15.0, max = 15

Wald chi2(**12**) = 506.41

corr(u_i, X) = **0** (assumed) — Prob > chi2 = 0.0000

ROAA	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
CAP	.1127702	.0266238	4.24	0.000	.0605885	.1649519
CAP2	-.3044642	.1281189	-2.38	0.017	-.5555726	-.0533557
CTI	-.0319755	.0061112	-5.23	0.000	-.0439533	-.0199978
SIZE	.0132812	.0027624	4.81	0.000	.0078669	.0186954
AG	.0244687	.0076283	3.21	0.001	.0095174	.03942
LLLR	.0104915	.0037954	2.76	0.006	.0030526	.0179304
LLTD	-.0123555	.0036692	-3.37	0.001	-.0195469	-.0051641
RENDC	.2296955	.0629325	3.65	0.000	.1063501	.353041
DIVER	.1431232	.0721856	1.98	0.047	.001642	.2846044
POL	-.004128	.0015307	-2.70	0.007	-.0071281	-.0011279
INF	.0368712	.0421769	0.87	0.382	-.045794	.1195365
GDP	.0224468	.015638	1.44	0.151	-.0082031	.0530967
_cons	-.0674077	.0161714	-4.17	0.000	-.0991031	-.0357122
sigma_u	0					
sigma_e	.00515243					
rho	0	(fraction of variance due to u_i)				

Figure 2.5: Random effects for ROAA (3)

Cross-sectional time-series FGLS regression

Coefficients: **generalized least squares**
Panels: **heteroskedastic**
Correlation: **no autocorrelation**

Estimated covariances = 10 — Number of obs = 150
Estimated autocorrelations = 0 — Number of groups = 10
Estimated coefficients = 13 — Time periods = 15
Wald chi2(12) = 610.47
Log likelihood = 607.8065 — Prob > chi2 = 0.0000

ROAA	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
CAP	.1190406	.0233109	5.11	0.000	.0733521	.1647292
CAP2	-.3079888	.1113955	-2.76	0.006	-.5263199	-.0896576
CTI	-.0328804	.0033285	-9.88	0.000	-.0394042	-.0263567
SIZE	.0120492	.0019922	6.05	0.000	.0081446	.0159537
AG	.0076879	.003432	2.24	0.025	.0009613	.0144146
LLLR	.0113684	.0027047	4.20	0.000	.0060673	.0166695
LLTD	-.0076272	.0024375	-3.13	0.002	-.0124046	-.0028497
RENDC	.0848095	.0357575	2.37	0.018	.0147261	.1548929
DIVER	.1578639	.0421719	3.74	0.000	.0752086	.2405192
POL	-.0019623	.000769	-2.55	0.011	-.0034696	-.0004551
INF	.0271421	.0198194	1.37	0.171	-.0117033	.0659874
GDP	.0225089	.0077467	2.91	0.004	.0073257	.0376922
_cons	-.0553283	.0105635	-5.24	0.000	-.0760323	-.0346243

Figure 2.6: GLS FOR ROAA (4)

	Coefficients (b) fe	(B) re	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
CAP	.067398	.0610253	.0063728	.0079592
CTI	-.0382444	-.0270857	-.0111587	.0082064
SIZE	.0319833	.0141059	.0178774	.0042964
AG	.0187467	.0288359	-.0100892	.0042203
LLLR	.0023225	.0104793	-.0081568	.0027363
LLTD	-.0243469	-.0126004	-.0117464	.0057596
RENDC	.2521897	.2428973	.0092924	.0426142
DIVER	-.0578564	.1206779	-.1785343	.1485196
POL	-.0010111	-.0041543	.0031431	.0007963
INF	.0284092	.0352474	-.0068382	.
GDP	.0462785	.0228414	.0234371	.0042745

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

Test: Ho: difference in coefficients not systematic

chi2(**11**) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 28.21
Prob>chi2 = 0.0030
(V_b-V_B is not positive definite)

Figure 2.7: Specification test for (1) ROAA

	Coefficients (b) fe	(B) re	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
CAP	.1209419	.1127702	.0081718	.0094365
CAP2	-.3549735	-.3044642	-.0505093	.0753583
CTI	-.0397392	-.0319755	-.0077637	.0078131
SIZE	.0294523	.0132812	.0161712	.004335
AG	.0146035	.0244687	-.0098652	.0040829
LLLR	.0040986	.0104915	-.006393	.0027818
LLTD	-.0239714	-.0123555	-.0116159	.0056554
RENDC	.2847116	.2296955	.055016	.0435445
DIVER	-.1245638	.1431232	-.267687	.148187
POL	-.0014603	-.004128	.0026677	.0008005
INF	.0288459	.0368712	-.0080254	.
GDP	.0429505	.0224468	.0205037	.0043459

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

Test:  Ho:  difference in coefficients not systematic

             chi2(12) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                      =       16.73
            Prob>chi2 =      0.1601
            (V_b-V_B is not positive definite)
```

Figure 2.8: Specification test for (3) ROAA

```
Likelihood-ratio test                                LR chi2(9)   =     64.42
(Assumption: . nested in hetero)                     Prob > chi2 =    0.0000
```

Figure 2.9: Heteroscedasticity ROAA (1)

```
64 . local df = e(N_g) - 1

65 . lrtest hetero . , df(`df')

   Likelihood-ratio test                             LR chi2(9)   =     64.87
   (Assumption: . nested in hetero)                  Prob > chi2 =    0.0000
```

Figure 2.10: Heteroscedasticity ROAA (3)

```
63 . xtserial ROAA CAP CTI SIZE AG LLLR LLTD RENDC DIVER POL INF GDP

   Wooldridge test for autocorrelation in panel data
   H0: no first-order autocorrelation
       F(  1,       9) =      3.924
             Prob > F =      0.0789
```

Figure 2.11: Autocorrelation test ROAA (1)

```
66 . xtserial ROAA CAP CAP2 CTI SIZE AG LLLR LLTD RENDC DIVER POL INF GDP

   Wooldridge test for autocorrelation in panel data
   H0: no first-order autocorrelation
       F(  1,       9) =      4.681
             Prob > F =      0.0587
```

Figure 2.12: Autocorrelation test ROAA (3)

```
67 . ivregress 2sls ROAA LROAA CAP CAP2 CTI SIZE AG LLLR LLTD RENDC DIVER POL INF GDP

Instrumental variables (2SLS) regression          Number of obs   =        150
                                                  Wald chi2(13)   =     599.78
                                                  Prob > chi2     =     0.0000
                                                  R-squared       =     0.7999
                                                  Root MSE        =     .00506
```

ROAA	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LROAA	.2051375	.0660426	3.11	0.002	.0756964	.3345787
CAP	.0857114	.0261564	3.28	0.001	.0344457	.1369771
CAP2	-.2386799	.1205587	-1.98	0.048	-.4749707	-.0023892
CTI	-.0257273	.0060079	-4.28	0.000	-.0375026	-.0139519
SIZE	.0104734	.0027139	3.86	0.000	.0051541	.0157926
AG	.0288774	.0072077	4.01	0.000	.0147506	.0430043
LLLR	.0099409	.0035204	2.82	0.005	.0030411	.0168407
LLTD	-.0116559	.0034064	-3.42	0.001	-.0183323	-.0049795
RENDC	.1899518	.0596856	3.18	0.001	.0729701	.3069334
DIVER	.1162659	.0674264	1.72	0.085	-.0158873	.2484191
POL	-.0037905	.0014221	-2.67	0.008	-.0065778	-.0010032
INF	.0406612	.03909	1.04	0.298	-.0359537	.1172761
GDP	.030463	.0147145	2.07	0.038	.0016232	.0593029
_cons	-.0535496	.0156308	-3.43	0.001	-.0841853	-.0229138

Figure 2.13: Robustness check 2SLS estimation for ROAA

```
Fixed-effects (within) regression               Number of obs      =       160
Group variable: BANK                            Number of groups   =        10

R-sq:                                           Obs per group:
     within  = 0.6148                                         min =         16
     between = 0.2710                                         avg =       16.0
     overall = 0.3484                                         max =         16

                                                F(11,139)          =     20.17
corr(u_i, Xb)  = -0.7428                        Prob > F           =    0.0000
```

Zscore	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
CAP	.5353276	.0698615	7.66	0.000	.3971989	.6734562
CTI	.0480911	.0432642	1.11	0.268	-.0374499	.1336322
SIZE	-.1196697	.0293108	-4.08	0.000	-.1776224	-.0617171
AG	.0855007	.0318584	2.68	0.008	.022511	.1484903
LNPL	-.0909027	.0278906	-3.26	0.001	-.1460473	-.0357581
LLTD	.037972	.0205961	1.84	0.067	-.0027502	.0786941
ROAA	1.651328	.3185892	5.18	0.000	1.021421	2.281236
COMOP	-.0222302	.0272261	-0.82	0.416	-.076061	.0316007
POL	.0111504	.0072838	1.53	0.128	-.003251	.0255517
INF	.0626394	.153376	0.41	0.684	-.2406121	.3658909
GDP	-.0839356	.0772886	-1.09	0.279	-.2367489	.0688778
_cons	.7075438	.1842441	3.84	0.000	.3432604	1.071827
sigma_u	.03030518					
sigma_e	.02123725					
rho	.67064938	(fraction of variance due to u_i)				

```
F test that all u_i=0: F(9, 139) = 5.42                        Prob > F = 0.0000
```

Figure 2.14: Fixed effect for Z-score (5)

```
Cross-sectional time-series FGLS regression

Coefficients:  generalized least squares
Panels:        heteroskedastic with cross-sectional correlation
Correlation:   no autocorrelation

Estimated covariances      =        55      Number of obs     =       160
Estimated autocorrelations =         0      Number of groups  =        10
Estimated coefficients     =        13      Time periods      =        16
                                            Wald chi2(12)     =   4209643
Log likelihood             =  536.7617      Prob > chi2       =    0.0000
```

Zscore	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
CAP	.0448669	.0007741	57.96	0.000	.0433498	.0463841
GCP	-.0010435	.0000637	-16.38	0.000	-.0011684	-.0009186
CTI	.0743048	.0003514	211.45	0.000	.0736161	.0749936
SIZE	.007578	.0001638	46.27	0.000	.007257	.007899
AG	-.0094888	.0002046	-46.39	0.000	-.0098897	-.0090879
LNPL	-.0707163	.0004393	-160.96	0.000	-.0715774	-.0698552
LLTD	.0192587	.0001264	152.40	0.000	.019011	.0195063
ROAA	.6757358	.0021488	314.47	0.000	.6715243	.6799473
COMOP	.0502831	.0001628	308.81	0.000	.049964	.0506023
POL	-.0093762	.0000628	-149.20	0.000	-.0094994	-.009253
INF	.011649	.0003603	32.33	0.000	.0109428	.0123552
GDP	.0574175	.0002023	283.78	0.000	.057021	.0578141
_cons	-.0847386	.001215	-69.74	0.000	-.0871199	-.0823572

Figure 2.15: GLS for Z-score (6)

```
             ---- Coefficients ----
             (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             fe           re          Difference          S.E.

   CAP    .5458729     .4798355        .0660374        .0157202
   GCP   -.0230022    -.0236027        .0006004               .
   CTI    .0391024     .0240338        .0150687        .0292996
  SIZE   -.1174673     .0016903       -.1191576         .025287
    AG    .0869478     .0720489        .0148989               .
  LNPL   -.0891156    -.0584742       -.0306414        .0171268
  LLTD    .0347673    -.0056425        .0404098        .0145621
  ROAA    1.544831     .8155423        .7292887        .0915899
 COMOP   -.0204896    -.0537443        .0332547        .0195423
   POL    .0113826    -.0071125        .0184951        .0032604
   INF    .0743956    -.0538991        .1282947               .
   GDP   -.0643489     .1032277       -.1675766        .0324594

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

    Test:  Ho:  difference in coefficients not systematic

                 chi2(12) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       19.57
                Prob>chi2 =      0.0757
                (V_b-V_B is not positive definite)
```

Figure 2.16: Specification Test for Z-score

```
Likelihood-ratio test                                 LR chi2(9)  =    117.17
(Assumption: . nested in hetero)                      Prob > chi2 =    0.0000
```

Figure 2.17: Heteroscedasticity test for Z-score

```
. xtserial Zscore CAP GCP CTI SIZE AG LNPL LLTD ROAA COMOP POL INF GDP

Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,       9) =      7.563
           Prob > F =      0.0225
```

Figure 2.18: Autocorrelation test for Z-score

```
. ivregress 2sls Zscore L.Zscore CAP CAP2 GCP CTI SIZE AG LNPL LLTD ROAA COMOP POL INF GDP

Instrumental variables (2SLS) regression          Number of obs   =        150
                                                  Wald chi2(14)   =     736.14
                                                  Prob > chi2     =     0.0000
                                                  R-squared       =     0.8307
                                                  Root MSE        =     .01418

      Zscore       Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]

      Zscore
         L1.   -.0292078   .0440737    -0.66   0.508    -.1155906     .057175

         CAP    1.408804   .0832654    16.92   0.000     1.245607    1.572001
        CAP2   -4.824367   .3678812   -13.11   0.000    -5.545401   -4.103333
         GCP    -.029353   .0074528    -3.94   0.000    -.0439602   -.0147458
         CTI   -.0269058   .0210041    -1.28   0.200    -.0680731    .0142614
        SIZE     .002309   .0094613     0.24   0.807    -.0162348    .0208528
          AG    .0399696   .0205501     1.94   0.052    -.0003079     .080247
        LNPL   -.0420946   .0152473    -2.76   0.006    -.0719787   -.0122104
        LLTD    .0047829   .0095258     0.50   0.616    -.0138873    .0234532
        ROAA    .3172961   .1932137     1.64   0.101    -.0613958     .695988
       COMOP    -.021692    .011675    -1.86   0.063    -.0445745    .0011906
         POL   -.0020552   .0040137    -0.51   0.609     -.009922    .0058116
         INF   -.0413236   .0973954    -0.42   0.671    -.2322151    .1495679
         GDP     .096877   .0426991     2.27   0.023     .0131883    .1805658
       _cons   -.0468225   .0733228    -0.64   0.523    -.1905326    .0968875
```

Figure 2.19: Robustness check 2SLS estimation for Z-score

```
. vif
```

Variable	VIF	1/VIF
POL	2.62	0.381024
RENDC	2.47	0.405112
SIZE	2.38	0.420781
LLLR	2.15	0.465969
INF	1.85	0.539103
CAP	1.85	0.539849
CTI	1.85	0.541191
DIVER	1.75	0.571991
GDP	1.43	0.697615
LLTD	1.32	0.758601
AG	1.25	0.797319
Mean VIF	1.90	

```
.
```

Figure 2.20: VIF (1)

```
. vif
```

Variable	VIF	1/VIF
SIZE	3.36	0.297349
ROAA	3.27	0.305395
CTI	3.18	0.314404
POL	2.65	0.377586
COMOP	2.11	0.473031
CAP	2.03	0.492844
LNPL	1.66	0.603102
GDP	1.53	0.653901
INF	1.45	0.688455
AG	1.32	0.755140
LLTD	1.31	0.762235
GCP	1.05	0.949386
Mean VIF	2.08	

Figure 2.21: VIF (2)

```
76 . ivregress 2sls ROAA CAP2 CTI SIZE AG LLLR LLTD RENDC DIVER POL INF GDP (CAP=L2.CAP L3.CAP L.LNPL
   > L2.LNPL)

   Instrumental variables (2SLS) regression          Number of obs     =        130
                                                     Wald chi2(12)     =     424.93
                                                     Prob > chi2       =     0.0000
                                                     R-squared         =     0.7676
                                                     Root MSE          =     .00487
```

ROAA	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
CAP	.1706187	.12003	1.42	0.155	-.0646357	.4058731
CAP2	-.5229465	.4829886	-1.08	0.279	-1.469587	.4236938
CTI	-.0369907	.0069938	-5.29	0.000	-.0506984	-.0232831
SIZE	.0124089	.003239	3.83	0.000	.0060605	.0187573
AG	.0168511	.0088302	1.91	0.056	-.0004559	.034158
LLLR	.007961	.0043468	1.83	0.067	-.0005585	.0164805
LLTD	-.0149221	.0039246	-3.80	0.000	-.0226141	-.0072301
RENDC	.1692145	.0790331	2.14	0.032	.0143125	.3241165
DIVER	.1801083	.0674194	2.67	0.008	.0479686	.312248
POL	-.0043902	.0015747	-2.79	0.005	-.0074765	-.001304
INF	.0668639	.0506353	1.32	0.187	-.0323794	.1661073
GDP	.0205396	.0161617	1.27	0.204	-.0111367	.052216
_cons	-.0586762	.0177536	-3.31	0.001	-.0934725	-.0238798

```
   Instrumented:  CAP
   Instruments:   CAP2 CTI SIZE AG LLLR LLTD RENDC DIVER POL INF GDP L2.CAP
                  L3.CAP L.LNPL L2.LNPL

77 . estat endog

     Tests of endogeneity
     Ho: variables are exogenous

     Durbin (score) chi2(1)          =  .406584  (p = 0.5237)
     Wu-Hausman F(1,116)             =  .363936  (p = 0.5475)

78 . estat firststage

     First-stage regression summary statistics
```

Variable	R-sq.	Adjusted R-sq.	Partial R-sq.	F(4,114)	Prob > F
CAP	0.8132	0.7887	0.0472	1.41338	0.2340

```
     Minimum eigenvalue statistic = 1.41338

     Critical Values                          # of endogenous regressors:    1
     Ho: Instruments are weak                 # of excluded instruments:     4
```

	5%	10%	20%	30%
2SLS relative bias	16.85	10.27	6.71	5.34
	10%	15%	20%	25%
2SLS Size of nominal 5% Wald test	24.58	13.96	10.26	8.31
LIML Size of nominal 5% Wald test	5.44	3.87	3.30	2.98

```
79 . estat overid

     Tests of overidentifying restrictions:

     Sargan (score) chi2(3) =   1.7818  (p = 0.6189)
     Basmann chi2(3)        =  1.58421  (p = 0.6630)

80 .
```

Figure 2.22: Instrument validity tests for ROAA

Zscore	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
CAP	1.055859	.2120032	4.98	0.000	.6403402	1.471378
Zscore						
L1.	.2031856	.0593639	3.42	0.001	.0868345	.3195367
CAP2	-3.372333	.8207986	-4.11	0.000	-4.981069	-1.763597
GCP	.0062804	.0066065	0.95	0.342	-.0066681	.0192289
CTI	.0296845	.0194885	1.52	0.128	-.0085123	.0678812
SIZE	.0081214	.0069788	1.16	0.245	-.0055567	.0217995
AG	.0320275	.0164101	1.95	0.051	-.0001358	.0641907
LNPL	-.0273843	.012345	-2.22	0.027	-.0515801	-.0031884
LLTD	.0149874	.0077098	1.94	0.052	-.0001235	.0300983
ROAA	.0591405	.2184714	0.27	0.787	-.3690555	.4873365
COMOP	.0013451	.0084937	0.16	0.874	-.0153023	.0179924
POL	-.0038666	.0031275	-1.24	0.216	-.0099964	.0022632
INF	.0110699	.0758266	0.15	0.884	-.1375476	.1596873
GDP	.062809	.0320034	1.96	0.050	.0000834	.1255346
_cons	-.1274714	.0552772	-2.31	0.021	-.2358128	-.0191301

```
Instrumented:  CAP
Instruments:   L.Zscore CAP2 GCP CTI SIZE AG LNPL LLTD ROAA COMOP POL INF
               GDP L2.CAP L3.CAP L.LNPL L2.LNPL
```

```
10 . estat endog

     Tests of endogeneity
     Ho: variables are exogenous

     Durbin (score) chi2(1)          =  1.05622  (p = 0.3041)
     Wu-Hausman F(1,114)             =  .933813  (p = 0.3359)

11 . estat firststage

     First-stage regression summary statistics
     --------------------------------------------------------------------------
                  |            Adjusted      Partial
         Variable |   R-sq.       R-sq.        R-sq.      F(4,112)   Prob > F
     -------------+------------------------------------------------------------
              CAP |  0.8632      0.8425       0.0716       2.15896    0.0782
     --------------------------------------------------------------------------


     Minimum eigenvalue statistic = 2.15896

     Critical Values                      # of endogenous regressors:    1
     Ho: Instruments are weak             # of excluded instruments:     4
     ---------------------------------------------------------------------
                                        |    5%     10%     20%     30%
     2SLS relative bias                 |  16.85   10.27    6.71    5.34
     -----------------------------------+---------------------------------
                                        |   10%     15%     20%     25%
     2SLS Size of nominal 5% Wald test  |  24.58   13.96   10.26    8.31
     LIML Size of nominal 5% Wald test  |   5.44    3.87    3.30    2.98
     ---------------------------------------------------------------------

12 . estat overid

     Tests of overidentifying restrictions:

     Sargan (score) chi2(3) =  2.28958  (p = 0.5145)
     Basmann chi2(3)        =  2.00792  (p = 0.5708)

--
```

Figure 2.23: Instrument validity tests for Z-score