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*Topic :*

# Cash-Based Compensation and Systemic Risk: Evidence from the Tunisian Banking Sector

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# List of Tables



# List of Figures

# List of Appendices

# OVERVIEW

# Introduction

*"Compensation practices at some banking organizations have led to misaligned incentives and excessive risk-taking, contributing to bank losses and financial instability."*

*Chairman Ben S. Bernanke*
*(Board of Governors of the Federal Reserve System, 2009)*

In the aftermath of the global financial crisis of 2008, regulators, bank supervisors, and policymakers have argued that executive compensation leading to excessive risk is among the main factors that contributes to the development of the financial crisis (Board of Governors of the Federal Reserve System, 2010; Basel Committee on Banking Supervision 2010).

Moreover, the financial crisis has revealed that excessive risk-taking resulting in higher systemic risk had adverse consequences on financial stability, social well-being, and economic growth. Generally, the compensation package of top managers is designed to alleviate agency problems and to maximize shareholder value (Pathan, 2009). Nevertheless, compensation incentives tend to promote excessive risk-taking and encourage top managers to be risk-seeking (Bai and Elyasiani 2013; Gande and Kalpathy 2017).

A large stream of research has addressed the effects of managerial compensation on bank performance and risk-taking. Several studies examined how each component of compensation structure and managerial incentives affect the riskiness of financial institutions (Minhat and Abdullah 2016; Gande and Kalpathy 2017; Bharati and Jia 2018). For instance, Guo et al. (2015) examine the link between CEO compensation and risk-taking and find that higher default risk and stock return volatility are positively associated with incentive compensation. Furthermore, DeYoung et al. (2013) and Bai and Elyasiani (2013) argue that the compensation structure is among the key determinants of bank risk-taking and bank policies. Their findings indicate that a higher level of systemic risk and idiosyncratic risk is associated with higher CEO compensation sensitivity to stock return volatility. In addition, they argue that banks involving in non-traditional banking activities contribute more to systemic risk levels. Hence, managerial compensation may generate bank instability and lead to higher levels of both idiosyncratic and systemic risk. However, in contrast to previous studies, Bharati and Jia (2018) argue that systemic risk is negatively related to the sensitivity of CEO pay to stock return. They postulate that the link between pay for performance sensitivity and systemic risk is nonexistent. Overall, it is shown that previous studies report mixed results about whether compensation structure affects risk-taking and systemic risk.

Systemic risk can be defined as a measure of the independencies between the risk profile of an individual financial institution and the aggregate riskiness of the financial system. Based on prior literature addressing the effects of managerial compensation package on bank risk-taking, we presume that the compensation may influence the level of system risk.

According to the agency theory, the compensation is generally designed to maximize the value of shareholders by increasing managerial risk appetite so that managers will undertake risky and value-enhancing investments. Indeed, the agency theory postulates that compensation can reduce the difference between risk preferences of shareholders and those of executives by inducing managers to take more risks (Pathan, 2009). According to Fahlenbrach and Stulz (2011), greater alignment incentives between managers and shareholders can have adverse consequences on financial stability.

Given the moral hazard problem which is basically linked to the too big to fail phenomenon, government support through implicit or explicit government guarantee, the presence of deposits insurance, and even managerial compensation structure may encourage top managers to adopt risky strategies and decisions that can lead to a higher level of systemic risk (Acharya, 2009 ). Furthermore, it is worth saying that managers and executives of systemically financial institutions do pay neither for the adverse consequences that they are responsible for nor for their excessive risk-taking. Hence, the managers' compensation may increase not only the individual risk of the financial institutions but it helps to increase the level of systemic risk and to create negatives externalities in the financial sector.

Accordingly, the main purpose of this study is to provide empirical evidence on the impact of cash-based compensation on systemic risk levels in the Tunisian banking sector. This sector is large in size and the number of financial institutions is up to 42 of which 23 are resident banks and 7 are non-resident banks. The Central Bank is working to further strengthen the soundness of banks in order to ensure the stability of the banking system. Nevertheless, several shortcomings are detected. Thus, the central bank does not exert enough control on governance practices in banks. In fact, evaluating banking corporate governance is complex and the regulators tend to rely on subjective supervisory judgments that make the assessment less subject to precise quantifications. For this reason, the Central Bank tends several times to rise up developments in the governance area to align with international standards.

In fact, in 2018, the Central Bank initiates the circular 2011-06 in order to capitalize on the feedback from its application. At present, the regulator work on a new project that aims to reinforce governance practices, committees' responsibilities, transparency, and reporting. Furthermore, a review of financial banks' reporting reveals some missing information with regard to remuneration policy. Some components such as annual bonuses and perks are hidden; only the aggregate amount of managers' remuneration is disclosed. The variable component of the remuneration is assumed to assess accurately the pay for performance sensitivity and risk-taking behavior. So, we wonder whether the remuneration explains the risk-taking behavior of managers and influences, at large, the systemic risk. More specifically, we attempt to provide answers to the following central question:

- *What relationship can exist between managers' compensation and systemic risk level?*

To answer this question, we focus on the next two research questions:

- *Is managers' compensation a systemic risk driver?*

- *In which way does the remuneration of top managers influence the level of systemic risk?*

This study will consequently extend our understanding of whether the remuneration of top managers triggers systemic risk levels. In doing so, in our empirical analysis, we use data on 10 listed Tunisian banks over the period 2009-2019. Following prior literature such as those of Choi (2014) and Ghrab (2017), we measure CEO compensation as cash-based compensation since we fail to obtain data on the variable component. We follow prior studies (e.g., Iqbal et al. 2015, 2019; Acharya et al. 2017, 2010) and we use a market-based approach to measure systemic risk level. Thus, we use the marginal expected shortfall (MES) and the long-run marginal expected shortfall (LRMES) as proposed by Acharya et al. (2012, 2017) and Brownlees and Engle (2017). MES is defined as the decline of the equity capital of an individual institution when the market drops more than a given threshold; whereas the LRMES captures the expected loss in equity conditional on the market fall by more than 40% over a 6-months horizon. For a robustness check, we use the SRISK measure to gauge the expected capital shortage during a financial crisis (Acharya et al. 2017). Essentially, all these measures aim to identify how exposed is a given bank to the aggregate tail shocks in the banking sector.

While it contributes to the extant literature, to the best of our knowledge, the current paper is the first that questions the relationship between cash-based compensation and systemic risk in the Tunisian banking sector. Furthermore, unlike previous studies such as those of Mselmi et al. (2018), we attempt to address the endogeneity problem by using the system GMM estimator. Moreover, our study highlights another methodological contribution as we carry out some robustness checks. In fact, we use alternative measures of systemic risk that cover the marginal expected shortfall (MES), the long-run marginal expected shortfall (LRMES), and SRISK as provided by Acharya et al. (2012, 2017) and Brownlees and Engle (2017). Furthermore, as failing to obtain data about the variable component of managers' remuneration and under the hypothesis that fixed salary caries rigidly over time, we use the variation of remuneration as a proxy of pay-for-performance.

Our work is also of practical interest since understanding the linkage between remuneration structure and systemic risk enables us to better assess whether the remuneration triggers systemic risk. It is useful to regulators and policymakers who should care about systemic risk determinants and seek potential remedies that can alleviate systemic event occurrence.

The present study proceeds as follows. Chapter I will present an overview of systemic risk. Then, it will review previous literature and empirical evidence related to systemic risk and remuneration structure relationships. Chapter II describes data and variables. It also presents the research design and reports empirical results as well as a battery of robustness checks. The conclusion is presented in the final part.

# CHAPTER 1:

# THEORETICAL FRAMEWORK ON MANAGERS COMPENSATION AND SYSTEMIC RISK

The consequences of the recent financial crisis of 2007-2008 have promoted extensive research on systemic risk, either on its measurement or regulation. Of particular interest is the determination of possible causes that exacerbated the financial crisis. Regulators and policymakers postulate that managers' compensation could play a role since it was shown that banks' CEOs who have taken excessive risks were almost well-paid. Hence, the subject of remuneration structure with its causes-effects on systemic risk has drawn considerable attention in financial research.

This chapter will dig further into the understanding of how managers' compensation may be a trigger of systemic risk. Firstly, the chapter presents an overview of the systemic risk, its definition, and its measures. In the subsequent section, we will highlight in which way macro prudential policies have dealt with it. In section 3, we present its main factors that can trigger this risk. In section 4, we outline the theories explaining this relation between executives' compensation and systemic risk. Then, we review relevant empirical research, and finally, in the light of what is received from the theoretical framework and empirical results, our testable hypotheses will be formulated.

# I Systemic risk overview

*"Financial institutions are systemically important if the failure of the firm to meet its obligations to creditors and customers would have significant adverse consequences for the financial system and the broader economy*[1]*."*

Federal Reserve Governor Daniel Tarullo

The instability of financial institutions may pose a threat to the economic growth and welfare. Indeed, the latest financial crisis illustrates how the collapse of several financial institutions have brought down the entire financial system and made a disruption of the economy leading to a global recession. This has shaken the entire economy and has emerged consequently the value relevance of the systemic risk. Thus, the objective of this section is to provide an overview of the systemic risk. Thus, based on academic research perspective, we will be defining the systemic risk, presenting its multitude measures and defining how macro prudential policies deal with it.

## I.1 Systemic risk definition

According to the International Monetary Fund (IMF) and the Financial Stability Board (FSB), *"The systemic risk is the disruption of the flow of financial services that is caused by an impairment of all or parts of the financial system and has the potential to have a serious negative consequence for the real*

[1]Regulatory restructuring, Testimony before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate, Washington, D.C., on July 23, 2009

*economy"*. The systemic risk is a baseline for a better understanding of the financial crisis and a tool for monetary and prudential policies to preserve the stability of the financial and economic systems.

We attempt hereafter to give a comprehensive analysis of the systemic risk.

Economic growth and welfare may suffer materially due to the widespread of systemic risk. The latter can be defined as the collapse of the company, industry, financial institution, or the entire economy. According to the CFA Institute, it is a failure that results when capital providers i.e. investors, depositors, capital markets lose trust and confidence toward capital users i.e. investors, banks. Taken together, a systemic risk occurs when unhealthy institutions are contaminated through risk spread.

From other research perspectives, according to Lepetit (2010), systemic risk is not clearly identified in the financial regulations. In addition, De Hann et al. (2006) argue that central banks do not propose a specific definition of the systemic risk but generally are likely to tie it with the concept of financial stability.

Based on the G10 report, systemic risk can be defined as follows: *"Systemic risk is the risk that an event will trigger a loss of economic value or confidence in, and attendant increases in uncertainty about, a substantial portion of the financial system that is serious enough to quite probably have significant adverse effects on the real economy"*. By defining it in this way, G10 only emphasizes the consequences of this risk through the number of contaminated institutions and risk spread (Gerlach, 2009).

However, Bandt et al. (2000) agree that systemic risk covers more facets. In fact, there are those who concentrate on the contagion effect (Kaufman, 1994; Schwarcz, 2008) and define it as a series of losses or a series of failures that jeopardize the functioning of financial markets. Others alike Mishkin (1995) assert that the systemic risk corresponds to a sudden and generally unpredictable and unexpected event.

For a better understanding, a report of the Bank for International Settlements (2010) distinguishes two major dimensions of systemic risk classified into cross-sectional and time dimensions. These dimensions are summarized in table I.1.

Another difference is required to be mentioned and relative to systemic risk and systematic risk. In fact, the systematic risk has been widely the subject of very extensive literature (Hansen, 2014). It is a speculative risk that manifests itself through the change in the prices of financial instruments. It cannot be reduced by diversification (Hansen, 2014). Systemic risk is the risk of a problem at the level of an institution transmitted by a chain reaction to the whole system causing a general breakdown of its functioning (Hansen, 2014; Smaga, 2014). It is a highly opaque definition insofar as it involves complex contagion and interconnection mechanisms. In addition, another characteristic of systemic risk relates to the fact that it cannot be managed at the level of a single institution. Indeed, a bank can take action to avoid its own bankruptcy without being able to control other institutions. This concern arises, instead, from the role of the authorities, to mitigate the consequences of certain macroeconomic shocks.

Table I.1: Systemic risk dimensions

| | Cross-sectional dimension | Time dimension |
|---|---|---|
| **Type** | structural | cyclical, time-varying, time series |
| **Approach** | At a given moment | Period over time |
| **Sources** | Instability of particular institutions | Don't directly result from activities of a single institution, but from the collective behavior |
| | structure and concentration level of the financial system | |
| | Degree of interconnectedness | |
| **Macro prudential Objectives** | Enhance the resilience to shocks | Control for imbalances accumulation and their impact |
| **Aim of the analyse** | Shock transmission | Build-up of imbalances |

*Own construction*

As presented above, the systemic risk can be described as the risk of the presence of a tough systemic event that can adversely affect financial institutions. The trigger of such an event could emerge from exogenous shock, from outside the financial system, either idiosyncratic or systematic, or from an endogenous shock that emerges within the financial system or within the economy. The strength of systemic events could threaten the good functioning of the system and may disturb its business cycle. Its adverse effects would be seen in consumption, investment, growth, and economic welfare at large.

## I.2 Root cause of systemic risk

### I.2.1 Contagion and propagation mechanisms

The financial theory characterizes idiosyncratic or systemic shocks. While idiosyncratic shocks affect the stability of a single financial institution or only the price of a single asset, systemic shocks affect the health of all financial institutions and, thus, the whole economy. Internal fraud leading to the failure of a single financial institution or a prompt devaluation of the currency leading to unsustainable budget deficit could be regarded as examples of idiosyncratic shock. Business cycle fluctuations, an increase in the inflation rate, stock market crash leading to liquidity shortage could be regarded as systemic shocks that threaten financial health (Bandt and Hartmann, 2000).

Kaufmann (1994) argues that bank failure contagion is more likely to occur faster and to spread broadly within the banking industry. It may result in more failures, greater losses to depositors, and can spread further beyond the banking system, generating substantial damage to the economy as a whole.

Bandt and Hartmann (2000) argue that the definition of systemic risk goes beyond the traditional view of bank vulnerability to depositor runs. Hence, it is based on the contagion concept; when a failure is transmitted from one system to another.

Furthermore, Smaga (2014) postulates that the banking system is vulnerable to contagion effects. This contagion vulnerability may be generated due to several factors: high leverage, confidence loss, interconnectedness, an increase in shadow banking, and the adoption of aggressive liquidity strategy (For example, high reliance on interbank market funding). Consequently, this will increase the risk of contagion and bankruptcy. Diamond and Dybvig (1983) argue that the case is exacerbated due to behavioral factors that can induce coordination failure, especially in an asymmetric information environment.

Furthermore, the contagion effect is understood as the propagation of systemic risk through several channels, in other words, how shocks are transmitted from one institution or market to another. Bandt and Hartmann (2000) consider that this is the core of the systemic risk concept. In fact, although the propagation of shocks may be equally important with regards to non-financial firms, those within the financial sector resulting from losses of confidence are regarded as "special" and needed to be clarified in many details. Moreover, the literature review reveals two main types of transmission. First, it is relative to the real or fundamental dimension, which takes the form of direct exchanges between institutions and direct exposures to the payment system. Second, it is relative to the information dimension. This is either the asymmetry between the investor and the financial institution it works with or the asymmetry among investors who do not have access to the same information. Far from being mutually exclusive, these two channels are largely dependent (Dijkman, 2010). Indeed, real links can induce irrational and speculative responses from investors. In the same way, the information channel can amplify the effects of the real channel.

The contagion transmission is much wider. A great attention is paid to the transmission of this risk to the real economy. The latter is generally illustrated via three main channels:

- A first channel related to disruptions in the payment system which causes the bankruptcy of certain solvent banks, which suffer from liquidity shortage.

- A second channel is related to investments in the non-financial sector. In fact, the disturbances in the credit systems generate an increase in the uncertainty and a lack of available assets to promote projects financing.

- The third channel relates to the contraction of the money supply. It results in a slowdown in economic activity and deterioration in social well-fare.

### I.2.2 Macroeconomic shocks and unwinding of imbalances

Above this range of systemic risk's characteristics, this risk seems to be complex when defining it through how it would be managed. Following the study of Bandt and Hartmann (2000), the systemic risk could be concluded through its forms: contagion risk, macro shocks risk, and the unraveling of imbalances risk. These forms can occur even independently or simultaneously in conjuncture with each other.

Contagion risk, simple to define, is when an idiosyncratic risk becomes widespread and is transmitted to other institutions. In other words, an unhealthy bank can threaten other healthy banks and cause their failure. Macro shocks risk is when an exogenous shock could impact negatively the health of markets or intermediaries in a simultaneous fashion. This is a case of an economic downturn that mitigates the vulnerability of banks. The third form concerns the widespread unraveling imbalances in the financial system over time. This will adversely affect market participants over time.

The European Central Bank proposes three main reasons for how widespread imbalances can make financial systems vulnerable. Firstly, it is according to herding behavior in financial markets, leading almost all agents to take similar risks. This is the case of managers who tend to mimic other investment managers when their evaluation or bonuses depend on their performance. Secondly, low-interest rates may encourage risk-taking and contribute to the buildup of crisis. For example, the more interest rates are low, the less the banks screen their borrowers. Thirdly, deposit insurance is associated with greater risk-taking and with lower incentives to monitor bank risk.

All these forms play role in the pro-cyclicality of the financial system. Behind this form of systemic risk, other important elements should be mentioned such as market imperfection, information asymmetry, public behavior, externalities, etc... All these actions contribute to exacerbating the fragility of the financial system due to information intensity, the existence of a panoply of financial contracts, different bank structure, and interconnection between market activities. The combination of all systemic risk features lets us think for more powerful policies and mechanisms. It is high time that supervisors and regulators paved the way to capture market imperfections, analyze its features, and examine whether they may lead to a strong systemic event.

Accordingly, the authority must play a role in order to avoid system risk, its contagion, or even to mitigate its post effects. In fact, the central bank is known for being the lender of last resort. Friedman and Schwartz (1963) find that the FED's expansionary monetary policy could have prevented panics and reduced contraction severity. The central bank may support banks with liquidity assistance. In fact, when a bank suffers from a liquidity shortage, a potential solution is to provide it with liquidity to meet its obligations. Unless such emergency lending takes place, the risk of causing contagion to the whole market will be high.

Apart from defining the concept of systemic risk, the following section will provide the range of systemic risk measures. Thus, if they are accurate, they should be used in regulatory interventions, maximizing general welfare, and setting optimal taxation[2].

## I.3 The main systemic risk measures and comparison

Academics and regulators are focusing on the determinants of systemically implicated financial institutions. Although it was highly associated with institutions' size, known as the "too big to fail" problem, recent financial crises prove that it is more complex and suggest that systemic importance is also linked to the interconnection of financial institutions identified, especially, with an interbank market link. That's why; a multitude of measures has been presented in order to provide a complete and realistic measure of the systemic importance (Bisias et al. 2012).

### I.3.1 Main systemic risk measures

The study of Acharya et al. (2012; 2017) is the main reference that analyses systemic risk measures. In fact, the authors provide a systemic risk model that can help to measure the contribution to systemic risk. Hereafter, different measures are presented and compared to each other.

#### I.3.1.1 Component expected shortfall (CES)

The first alternative to identify systemically implicated institutions refers to the component approach in which restrictive policies are applied. However, this method includes the weight of institutions within the system and offers the possibility to decompose the aggregate financial system risk for better risk management (Banulescu et al., 2014). Indeed, this statistical measure is presented by Banulescu et al. (2013) and is drown from Jorion's work (2007)[3] .

According to Banulescu et al. (2013), this measure is advantageous as it enables to identify the riskiest financial institutions on the market and to rank them according to their risk. Obviously, the riskiest institutions contribute more to systemic risk. Thus, the component expected shortfall seems to be a good candidate for regulators to identify the riskiest institutions, to penalize them if needed, and to discourage their risky practices.

To enhance its accuracy, the measure needs high-frequency available data to cover all useful information and to be used in forecasting systemic risk. Indeed, high-frequency data ensure better prediction and provide notices about banks' interconnection and the presence of potential spillover. Still, according to the authors, the CES measure relies on two banks' features. The first is relative to the bank's

[2]For more details, see V. V. Acharya, L. H. Pedersen T. Philippon and M. Richardson, "Measuring systemic risk", The Review of Financial Studies, Volume 30, Issue 1, January 2017, Pages 2–47,

[3]Jorion, P. (2007). Value-at-Risk: The New Benchmark for Managing Financial Risk. McGraw-Hill, 3rd Edition

size, measured as market capitalization; while the second is relative to the expected loss in the period of distress or crisis. However, its calculation is computed once the marginal expected shortfall is measured.

From a recent study, Banulescu and Dumitrescu (2014) try to identify systemically financial institutions within the United States from June 2007 to June 2010, covering the global financial crisis, through using the component expected shortfall (CES). They found that AIG, Lehman Brothers and Merrill Lynch are among systemically important financial institutions.

#### I.3.1.2 Conditional Value at Risk (CoVar)

The value at risk (VaR) has been the commonly used measure to assess the risk of individual institution.[4] However, it is obvious that the VaR cannot reflect systemic risk, the risk that threatens the stability of the financial system. According to Brunnermeier et al. (2012), systemic risk measures should be able to assess the risk of the system while considering the individual bank's risk.

Thus, Adrian et al. (2011) suggest the CoVaR as a candidate to measure systemic risk. It is defined as the VaR of the financial system conditional on the firm being in distress. The marginal contribution of each institution is captured by the difference between CoVaR and the unconditional VaR (conditional on the normal state) of the financial sector. Thus, as the first advantage of this measure, the CoVaR compasses traditional risk measures to focus more on contribution to the overall risk. The authors argue that relying only on individual risk may mislead regulators in systemic risk assessment.

More explicitly, considering two firms (A) and (B), having the same VaR, but differ in $\Delta$ CoVaR. (A) Reports the difference as null and (B) reports large difference. Based only on VaR measure, both institutions present the same risk, however, when taking the CoVaR difference into consideration, (B) is more likely to contribute more to systemic risk. Since risk carries a high-risk premium, (B) will generate higher returns and the institution (A) will herd under competitive pressure. As consequences, regulators should be stricter toward institution (B) rather than (A) to break the tendency of generating risks (Gauthier et al., 2012). Alike CES, the CoVaR measure can identify possible spillovers from one institution to another across the financial sector (Gauthier et al., 2012).

Furthermore, Acharya et al. and Huang et al. (2009) use the CoVaR measure and find that it has several drawbacks. According to them, CoVaR does not match with larger systemic events, is only bivariate and cannot be aggregated. The CoVar is appropriate to assess the risk generating from individual distress to the whole system, rather than the opposite direction. Thus, the CoVar could not be interpreted as a causal effect.

[4] Kupiec (2002) and Jorion (2006) for more comprehensive analyses

In response to CoVar measure, Boucher et al. (2014) suggest a corrected model-risk. In fact, since CoVar relies on quantile estimates, it is sensitive to extreme ones which could affect the accuracy of the measure. To compass this error, the authors build a model-risk in order to cover these types of errors. From recent research, Reboredo and Ugolini (2015) use a sample of European sovereign debt markets and try to measure the systemic risk after the Greek debt crisis. They find that systemic risks are present similarly in all countries before the crisis and they reduced after its outbreak. More recently, Karimalis and Nomikos (2017) adopt the CoVar and the Copula model to measure the contribution of European large banks to the systemic risk.

More recently, Khiari et al. (2019) attempt to measure the systemic risk of Tunisian listed banks and try to rank them according to their risk involvement. Unsurprisingly, public banks and the two largest private banks occupy the top places and contribute the most to the systemic risk. These banks are less sensitive to other banks but are more likely to contribute to others' distress.

#### I.3.1.3 Marginal expected shortfall (MES)

Acharya et al. (2010) suggest a risk-model that can price and measure the systemic risk contribution of each financial institution. Indeed, a systemic expected shortfall (SES) measure is used as a proxy for the extent of negative externality within the system. This measure captures the likelihood of financial institutions to be undercapitalized when a financial shock hits the financial sector.

However, according to the authors, externalities are not easily specified and, thus, this measure can be estimated and aggregated. The SES of financial institutions increases according to equity volatility, equity connection with market index, tail dependence and leverage. The first three components are aggregated in marginal expected shortfall (MES). The latter is defined as an expected equity loss when the market drops from a specified threshold during a given horizon. So, the authors argue that both leverage and MES are useful in detecting systemic instability, as for the case of the 2007-2009 crisis.

Brownlees and Engle (2012) have worked on Acharya et al. (2010) model and provide an improved version of MES. In fact, compared to the traditional version which is based on equity returns with regard to a market index, Brownlees and Engle tend to estimate the time-varying of conditional volatilities, correlations with market index and joint tail indices while using sophisticated tools. In doing so, with no need for high-frequency data, it is easy to assess the propensity of financial institutions to be undercapitalized.

#### I.3.1.4 Long run marginal expected shortfall (LRMES)

According to Acharya et al. (2012), the long-run marginal expected shortfall is an improved version of the marginal expected shortfall. It has a pessimistic view and it takes into consideration the worst scenario of the market return. In fact, whether the market index drops by a certain threshold, generally

40% over a certain horizon, such a situation is seen as a crisis and equity losses of individual firms are called long-run marginal expected shortfall (LRMES). Hence, LRMES is the returns' average in this scenario.

#### I.3.1.5 Systemic risk index measure (SRISK)

Acharya et al. (2017) suggest another systemic risk measure which is an extension of marginal expected shortfall. This improved measure takes into consideration the liability and the size of financial firms. Simply, it corresponds to the MES conditional upon the extent of the crisis affecting the financial sector. In other words, it reflects the capital needed to employ if another financial crisis occurs. In the same vein, Brownlees and Engle (2017) use the SRISK with the purpose to rank financial firms in different crisis stages.

The SRISK has considerable limitations. Pankoke (2014) draws attention to the fact that this measure does not take into account the probability of the occurrence of a crisis, a limit which it shares with MES. Furthermore, Tavolaro and Visnovsky (2014) raise the irrelevance of this measure on the prudential level. They criticize this measure for being based only on publicly available data and therefore for neglecting the confidential data that supervisors don't have access to.

#### I.3.1.6 Comparison of systemic risk measures

Systemic risk measures have been widely addressed from different perspectives (Bandt et al., 2013; Acharya et al, 2010 and International Monetary Fund, 2011). Essentially, two types of measures are proposed. Firstly, those based on balance sheet data or macroeconomic indicators showing low frequency and secondly those obtained from market data showing high frequency. So far, market-based methods could be subject to biases. These measures are accurate if several conditions are respected; (i) the extent of well-informed market participants, (ii) the extent of good assessing financial risk, and (iii) an absence of herding or behavioral biases. Furthermore, some measures ignore capital structure that can play an important role in assessing risk.

Unlike low-frequency measures that should capture the build-up of imbalances in the financial sector or in the economy at large, high-frequency measures should warn of an abrupt emergence of systemic risk. Both could be used at an aggregate level or at the individual level (individual institution). Although low-frequency measures follow overall market evolution and follow global perspectives to detect possible tensions in the economy, policymakers could not be informed of impending financial distress (Peña et al., 2013).

For instance, even in the extent of systemic stress, several macroeconomic and balance sheet indicators don't present a negative profile (Peña et al., 2013). Low-frequency approaches are suggested by Borio et al. (2010), in which unwinding imbalances are measured by price misalignments while using

inflation-adjusted equity prices or sector leverage. Furthermore, Schwaab et al. (2011) build forward-looking measures based on macroeconomic and credit risk factors and they find that they may be value relevant for macro-prudential policymakers.

As mentioned before, high-frequency measures are based on market data and rates and are classified into two groups as macro and micro measures. Whereas macro measures provide information about the extent of systemic risk in the whole system, micro measures use individual institution information in order to gauge joint tensions at the portfolio level. Peña et al. (2013) examine and compare high-frequency based measures on European and US Financial markets in the period from 2004 to 2009. They find that measures linked to CDSs are better than measures based on the stock market or inter-bank market.

Hence, the authors argue that the CDSs outperform other indicators in assessing systemic risk simply because they contain much information on the individual institution and on the joint probability of default. Furthermore, the authors argue that the success of market-based measures is conditional upon the markets' ability to provide relevant, available, and complete information, especially, the information that is known widely. Recently, Lin et al. (2016) use different risk measures such as SRISK, MES, CoVar, and other measures.

Taken together, it is argued that systemic risk is among the elusive phenomenon in finance. At present, none of the above measures has outperformed and remained efficient. In fact, a good systemic risk measure should be able to capture as much as possible from banks' environments and able to distinguish a given financial institution from its peers in the financial system (Benoit, 2014). For instance, according to Financial Stability Board, systemic risk should cover banks' size, liquidity, capital, interconnection, leverage and complexity.

From another perspective, Danielson et al. (2011) state that CoVar is a very convincing systemic risk measure. Furthermore, Hansen (2013) underlines that it is among the most used risk measure. Indeed, the CoVar takes into account the effects of contagion and the strong dependence between institutions. Moreover, Banilescu and Dumitrescu (2014) compare empirically the MES to the SRISK. The results support the superiority of MES, which seems to be easily implemented. However, the SRISK is privileged to the MES since it takes into consideration certain characteristics of the company such as size and leverage; which are not integrated into the MES. Taken together, we attempt to highlight the advantages and the disadvantages of the measures presented above, by presenting the table I.2.

Table I.2: Summary comparison of systemic risk measures

| Measures | Authors | Advantages | Disadvantages |
|---|---|---|---|
| MES | Acharya et al, (2010, 2017) | It captures risks | Underperforms balance sheet data in crisis prediction (Idier et al., 2014)[5]. Strongly correlated with beta which leads to confusion between the systemic and systematic risk (Benoit et al., 2013) |
| SRISK | Brownless and Engle (2012) | It takes into consideration certain characteristics such as size and leverage | Does not take into account the probability of the occurrence of a crisis |
| CoVar | Adrian and Brunnermeier (2011) | A measure followed by the FED; CoVaR measure allows to identify possible spillovers from one institution to another across the financial sector | CoVaR does not match with larger systemic events, is only bivariate and cannot be aggregated. The CoVar is appropriate to assess the risk generating from individual distress to the whole system, but not the causal effect. |

*Own construction*

For a better presentation, we attempt hereafter to present the table I.3 that summarizes the empirical studies with regard to systemic risk measures.

[5]Idier, J., Lamé, G., and Mésonnier, J.-S. (2012). How Useful is the Marginal Expected Shortfall for the Measurement of Systemic Exposure? A Practical Assessment. Working Paper, Banque de France

Table I.3: Empirical studies on different systemic risk measures

| **Authors** | **Sample** | **Systemic risk Measures** | **Findings** |
|---|---|---|---|
| Chan-Lau (2009) | Financial institutions in Europe, Japan and United States | CoVar | Distress periods show greater risk codependence. |
| Gauthier et al. (2010) | Canadian Financial institutions | Merton model | Financial stability can be enhanced by means of good bank regulation system. |
| Reboredo and Ugolini (2015) | European sovereign debt markets | Covar | Before the crisis, the systemic risk is present similarly in all countries and it is reduced globally after the Greek debt crisis takes place. |
| Grieb (2015) | Asia and Russia | Logistic regression model | An increased system risk of hedge fund is found |
| Kupiec and Güntay (2016) | Many countries | MES and Covar | The non reliability of MES and Covar as measures of systemic risk. |
| Lin et al.(2016) | Taiwan context | SRISK, MES, Covar | Although these measures are different, they all succeed in identifying systemically financial institutions. |
| Karimalis and Nomikos (2017) | Large banks in the Europe | Copula and CoVar | Changes in macroeconomic indicators can amplify systemic risk. |
| Brownlees and Engle (2017) | International Financial Firms | SRISK | By means of SRISK, the authors build a ranking of financial institutions in different periods. |
| Hmissi et al . (2017) | Tunisian Listed banks | CES | STB, BNA and BH are the top systemically financial banks. |
| Di Clemente (2018) | European banks | Extreme Value Theory | The author examines the interconnection between individual financial institution and the whole financial system. |

| | | | |
|---|---|---|---|
| Khiari and Nachnouchi (2018) | Tunisian context | CoES and MES | Public banks and two largest private banks are in the top systemically financial institutions. |
| Duan (2019) | Chinese context | Covar | Largest risk spillover value is attributed to China Pacific Insurance Company. Whether the least value is attributed to Ping'an Insurance |
| Khiari et al. (2019) | Eleven Tunisian listed banks | CoVaR | Public banks and two large private banks are the main systemic players within the banking system. |

*Own construction*

# II Macro prudential policy and systemic risk

The financial system is a vital actor in the real economy and in its healthy growth. Leading up to the last financial crisis, the financial system has experienced an unsustainable situation that intensified macroeconomic and financial imbalances. Against these tensions, it seemed that setting financial supervision and imbalances predictions tools were essential. Thus, macroprudential policies took place in order to prevent systemic risk and to ensure the well functioning of the financial system. Hereafter, an overview of macroprudential policies is presented.

This section attempts to present separately the macro-prudential policies internationally and according to the Tunisian context, respectively.

## II.1 International overview

A series of measures have been taken to limit or at least to mitigate systemic risk contagion effect. One of the measures is relative to the adoption of the third Basel Agreement (Basel III ), which could, appropriately, answer to imbalances of deficiencies triggered by the financial crisis. The third Basel Agreement is advanced in order to cover the lack of a wide system approach of banking sector risk. It is based on a macroprudential perspective that attempts to mitigate systemic risk and ensure financial stability.

Basel III introduces two safety buffers: countercyclical buffer and capital conservation buffer which are useful to protect banks from their loan portfolio deterioration in case of a change in the economic cycle. The capital conservation buffer is intended to provide banks with usable capital to overcome the incurred losses. It is equal to 2.5% of total risk-weighted assets. Whenever the buffer drops below the required rate, automatic constraints will be imposed, especially when dealing with a capital distribution such as dividends payments[6].

Basel III requires also respecting the countercyclical buffer that aims to protect banks from credit growth periods and from the build-up of systemic risk. This buffer varies between 0% and 2.5% of risk-weighted assets and must be divulgated like other prudential ratios.

[6]For more details, see https://www.bis.org/

In the existing literature, mixed points of view are reported. From the first side, there are those who agreed about the implementation of Basel III with regard to its major benefits (Ayadi et al., 2012). On the other side, there are those who are concerned about the higher cost of Basel III implementation with its possible effects on lending and therefore on growth (Ojo, 2010).

From recent studies, Berger et al. (2018) examine the effect of the US Troubled Assets Relief Program (TARP) on systemic risk. Jointly, Mutu and Ongena (2018) examine the impact of recapitalizations, liquidity injections and public warranties on systemic risk. A broad conclusion from both studies suggests that systemic risk decreased by a pure recapitalization. This provides novel support for bank capital regulation requirements outlined by Greenwood et al. (2017) which opts more for capital regulation rather than capital ratios.

## II.2 Tunisian regulation toward systemic risk

With regard to prudential regulation, it is difficult to place Tunisia at a specific Basel level. It would be fairer to say that it accounts for several prudential rules. Tunisia was strongly inspired by Basel II in terms of internal control and has just introduced some regulations from the third Basel agreement. In fact, the central bank is adapting to new difficulties and is trying to build appropriate solutions to strengthen the sector's resilience. At present, systemic risk is becoming a major concern, especially with the ongoing changes in the risk profile of financial institutions.

A framework of strategies has been adopted since 2011. The first step was the shift from compliance supervision based on an individual bank assessment to risk-based supervision which devotes a macro-prudential perspective. This new strategic and focal conception is oriented towards monitoring the systemic crisis.

The guideline of all reforms aims to lead the Tunisian banking legislation towards the best international standards. The first step towards achieving this objective is the consolidation of the financial base of banks. To do so, the prudential solvency ratio was gradually increased to reach 9% at the end of 2013 and set the threshold of 10% at the end of 2014. Furthermore, in 2014, the short-term liquidity ratio (LCR) was adapted according to the provisions of circular 2014-14. At the same time, the central bank is looking into the development of the structure of long term liquidity ratio, called Net Stable Funding Ratio (NSFR), which is also part of the Basel III prudential framework related to bank liquidity.

Moreover, one of the priority axes of the new law 2016-48 is the establishment of a complete banking resolution scheme inspired by international standards as well as the creation of a guarantee fund of deposits as a safety net contributing to financial stability. These new provisions mark the clear directions of this law towards the management of systemic risk. Although considered as a real step forward, the

Tunisian Professional Association of Banks and Financial Institutions (2016) underlines that the law has not defined a mechanism to be adopted when the fund goes bankrupt and calls on the supervisory organs in order to provide a remedy to this shortcoming.

To ensure the accuracy of systemic risk measures, it is needed to investigate the drivers of the occurrence of systemic events, which will be presented in the next section.

# III What factors drive systemic risk?

In June 2016, the Wharton Partners conducts research about systemic risk factors and lets us think about what really triggers a systemic risk crisis. The famous housing market meltdown in the US has generated adverse consequences that still being felt today. Such an example will underscore the need to draw attention not only to what goes within the national borders but also to systemic risk factors which can bring down the economy as a whole.

The Basel Committee has published in 2011 several guidelines on the criteria to identify systemically important institutions. The selected indicators are supposed to reflect the most the different factors that generate negative externalities and make a bank critical for the soundness of the financial system. There is no perfect measurement approach to determine systemic important banks; that's why supervisors should implement a quantitative indicator-based approach for better identification.

Indeed, we feel the need to study the explanatory factors of systemic risk which are classified into two groups: microeconomic and macroeconomic factors.

## III.1 Macroeconomic factors

Dealing with macroeconomic factors, we will be presenting the financial liberalization and macro-prudential regulation.

### III.1.1 Financial liberalization

A retrospective study (between 1970 and 1990) of 76 monetary crises and 26 banking crises allowed Kaminsky and Reinhart (1996) to argue that banking crises are generally preceded by policies of financial liberalization. In the same vein, Detragiache et al. (1998) show empirically that the probability of the occurrence of systemic banking crises is greater in liberalized financial systems. More recently, Dehove et al. (2004) conclude that periods of financial liberalization may generate an increase in the frequency of crises.

The contemporary theory asserts that financial liberalization is a catalyst for a systemic crisis. Hence, Caprio and Summers (1996) establish the link between financial liberalization and excessive risk-taking. This link is seen to be exacerbated by banks' competition, but also, according to Aglietta

(1998), between banks, non-banks and other financial institutions. Anglietta (1998) argues that liberalization, qualified as brutal, has not given banks time to learn how they control the new risks associated with new opportunities.

### III.1.2 Regulation

Although microprudential rules tend to ensure the safety of individual financial institutions by requiring minimum capital level, how to deal with systemic risk is likely to be not mentioned as Franklin Allen said: *"The problem with [focusing on microprudential rules] is it ignores systemic risk."* (30 June 2016).

Caprio and Summers (1993) advance the laxity of the regulation which advocates the "laissez-faire" approach. Banks take excessive risks by being almost certain to benefit from public protection.

From a recent study, Gregor et al. (2014) examine the determinants of bank contribution to systemic risk and don't find empirical evidence supporting that bank size, non-interest income, the quality of credit portfolio and leverage are among the persistent factors of systemic risk. However, they argue that the systemic risk is driven by the regulation.

## III.2 Microeconomic factors

The Bank for International Settlements, the Council for Financial Stability, and the International Monetary Fund draw up a list of indicators to identify systematically important institutions which include size, interconnection, and lack of substitutability.

### III.2.1 Size of financial institution

Lepetit (2010) considers that large-scale institutions have the technical means and the necessary skills to ensure good coverage against the risk, notably through diversification. However, the lessons learned from the 2007-2009 crises classify these institutions as systemically important in the financial system. Pais and Stork (2011) joint this argument and argue that large banks present a significantly high level of systemic risk. Although these latter recommend that systemic risk can be reduced by limiting the size of financial institutions, others like Lepetit (2010) considers that only managing size is not the solution to overcome systemic risk.

The factor of bank size is tied to the moral hazard of too big to fail. The authorities believe that the costs of the bankruptcy of these establishments are greater than the costs of their rescues. These banks

benefit from the rescue plans set by the regulatory authorities. Hence, such banks will consider this advantage by taking excessive risks that optimize their positions; but which endanger the stability of all systems.

Calluzzo and Dong (2015) and Acharya et al. (2017) are among the authors who examine firm-specific features and risk. They argue that bank size and equity capital are among the important factors that explain the variation in systemic risk. These studies show that larger financial firms reporting lower capital ratios and which are more involved in nontraditional banking activities are the most linked to higher systemic risk.

### III.2.2 Banking sector interconnectedness

According to Tarashev et al. (2010), the more banks are interconnected, the higher systemic risk is. In fact, banks are qualified to be systemically important if they are showing a high level of interbank activities.

Danielsson (2012) shows, theoretically, that complex banking interactions play a major role in the transformation of simple endogenous shocks into major financial crises. This is all the more worrying insofar, as modern financial systems exhibit a high degree of interdependence and exponential interconnection. This new market structure is therefore an ideal platform that amplifies the contagion effect and reinforces the transmission of financial difficulties from one bank to the whole system (Sankaran et al., 2011).

It is also possible to talk about "too interconnected to fail" (Hansen, 2013). In fact, this type of institution enjoys implicit state guarantees. The latter considers that helping these institutions is less expensive than managing the consequences generating by their bankruptcy.

### III.2.3 Absence of substitutability

According to Lepetit (2010), it is important to examine whether the system is resilient in case of a collapse of a financial institution. The absence of substitutability can be identified in particular through concentration indicators such as the Hirschman-Herfindahl index, which measures the distribution of market shares in the financial sector.

In the light of recent international work (cf. criteria for identifying systemically important institutions of the IMF), we can consider that the lack of substitutability of certain actors who occupy dominant positions can be qualified as a systemic vulnerability factor that should call for increased vigilance of supervisors.

### III.2.4 Speculation and new technologies

Miotti and Plihon (2011) explain that the phenomenon of speculation, encouraged by financial liberalization, arises during periods of economic growth. Indeed, they explain that banks attracted by the lure of profit are more likely to take risks on financial operations. This myopia of disaster widens the gap between bank debts and revenues generated by productive investments. This imbalance accentuates the fragility of the system when, in the event of a crisis, the banks can no longer meet their commitments (Miotti and Plihon, 2001).

Moreover, a flow of ideas expands the horizon of the banking industry and is highly based on innovation. However, these actions generate risks. In fact, the integration of a complex system may generate unknown and unexpected consequences. Economies are facing new challenges and maybe they are not well prepared for this. Although the complexity is good by providing greater connections and flows and by making the global economy more dynamic, it poses a severe problem toward risk management.

Qualified as complex and involving several players, the new products are sources of systemic risk. Aglietta (2003) suggests that this increases the dependence between institutions and, thus poses an additional risk to the system. Schwarcz (2008) focuses on the opacity of the banking activity in view of these increasingly complex financial practices and arrangements. This lack of transparency amplifies the information asymmetry, which accentuates the fragility of the banking system by generating panics (Mishkin, 1995). It is therefore imperative to develop a culture of clear and reliable financial communication between banks and their customers.

### III.2.5 Corporate governance mechanisms

With reference to the Basel Committee report, effective corporate governance plays a critical role in ensuring the proper functioning of the banking sector and the whole economy. Indeed, banks act as intermediaries between depositors and borrowers and, hence, help drive the growth of the economy. However, it is argued that financial stability is conditional on the bank's soundness and especially to the manner they conduct their businesses. Banks' governance fragility or weaknesses could be a channel of problem transmission and therefore could threaten the health of the financial system and the economy. So, strengthen governance quality will mitigate the adverse effect of crises and problems (Karkowska et al., 2020).

With reference to the report published by the Organization for Economic Co-operation and Development (OECD), the dramatic failure of corporate governance is among the key determinants of the financial crisis (Kirkpatrick, 2008). Further, according to the National Commission on the Causes of the Financial and Economic Crisis in the United States, the failure and the weakness of corporate

governance shown in many systemically financial institutions are the main trigger of this crisis (The Financial Crisis Inquiry Report, 2011).

Broadly speaking, poor-governed banks are more likely to take excessive-risk actions, leading them to larger losses if crises occur (Beltratti et al., 2012). Hereafter, we will be presenting several factors that emerge from the governance mechanisms.

#### III.2.5.1 Board of directors

Among several corporate governance mechanisms, the Basel Committee on Banking Supervision (2006) in its consultative reports "Enhancing Corporate Governance of Banking Industry" advances the board of directors as among important regulatory reforms. Further, the Basel Committee underlines the role of the board of directors in the implementation of pillar II and the entire risk management architecture (Basel Committee on Banking Supervision, 2005, pp. 163–164). Because the board plays a crucial role in monitoring managers' behaviors and instructs managers about strategies and its implementations, the board should have the required knowledge and skills in order to ensure the efficiency of those roles.

Strong and independent boards perform better than others in controlling systemic risk exposures. Hence, strong boards are perceived as less risky and are more likely to perform better during the crisis (Battaglia et al., 2017).

According to Jensen (1993) and independently of other governance attributes, board size seems to affect governance quality and the more boards become larger, the less effective directors are because of the coordination and communication problem. Thus, the smallest board size may have better monitoring abilities. However, from another perspective, larger boards are more able to supervise and monitor managers. They can control excessively the CEOs' actions (Yermack, 1996). Therefore, a trade-off between the advantages (monitoring, supervision) and the drawbacks (coordination and communication problem) should be taken into account.

As concerning the effect of independent directors, no conclusive evidence is offered. Independent directors are considered good monitors for managers (Fama and Jensen, 1983) but the findings of several studies are mixed. For instance, Hermalin and Weisbach (2003) postulate that board independence does not matter on day to day basis but maters, especially, for certain actions that occur infrequently or in a period of crisis. Besides, outside directors would find difficulties in gathering information compared to insiders on how to have direct access to valuable information (Coles et al., 2006). From a recent study, Gallo et al. (2017) examine the link between corporate governance and bank risk-taking and use a sample of European banks during the crisis. They find that banks with large boards are the most that suffer from losses and contribute more to the banking system losses.

#### III.2.5.2 Ownership structure

A stream of research has examined the bank risk-taking with regard to the ownership structure. Pre and post-crisis studies show mixed results without providing a conclusive view (Berger et al., 2013). Laeven and Levine (2009) argue, in line with the agency theory, that powerful owners with substantial cash flow are more likely to induce managers to take more risk. In other words, large banks with powerful owners can give greater bargaining power with the government and regulators in a crisis period.

Hence, banks with concentrated ownership are more associated with systemic risk rather than other banks. Besides, in this case, shareholders can impose good monitoring on managers and obtain insight about opaque and complex actions that lead to bear the risk. Empirically, Beltratti et al. (2012) examine the link between bank governance and risk-taking and they find that lower distance to default is more attributed to banks with shareholder-friendly boards, even these latter are less leveraged and don't have greater idiosyncratic risk than other banks. These results are quite similar to Laeven and Levine (2009) who find that banks with higher controlling ownership are more likely to be riskier, have higher idiosyncratic risk, and a lower distance to default.

From a recent study, Saghia et al. (2018) find that the more ownership is concentrated, the more the bank contributes to the systemic risk. Indeed, the presence of controlling shareholders promotes risk-taking which makes the banks more vulnerable.

#### III.2.5.3 Remuneration system

Executives are rewarded by means of bonus compensation; the latter seems to be more aligned not with the interest of common shareholders but with the interests of preferred shareholders, bondholders and the government, the guarantor of depositors. Such a structure induces managers to serve the interest of preferred shareholders even by taking excessive risks (Bebchuk, 2009).

Hence, it was argued that pay arrangements have substantial consequences on bank risk behavior and on the economy at large (Bebchuk, 2009). According to the US Committee of Financial Services (2009), it is required to take into consideration the bank's pay structure in order to assess well the risk posed by the bank. In fact, when the pay structure encourages risk-taking, regulators should monitor closely the bank and impose its capital requirements. Doing so, it can help ensure that the banking industry and the economy would not suffer from excessive risk-taking consequences.

When managers take risks, shareholders can benefit from the full upside but a part of the downside might be supported by the government as it is the guarantor of the deposits. Because bankruptcy imposes costs that are internalized by the government instead of shareholders, the interest of shareholders will be firstly served by excessive risk-taking (Bebchuk, 2009). Indeed, shareholders should provide

incentives to induce managers to act on their behalf and take more risks. As a result, executives with such pay incentives will be committed to using their informational advantages to increase risk.

In practice, many observers argue that bank executives don't act in the shareholders' interests and therefore they take risks. In response to this argument, well-governed banks will set control mechanisms to avoid risky actions that don't support shareholders' benefits. However, with reference to Merton (1977), risk-taking may be in the interests of shareholders, especially in the extent of deposit insurance. Furthermore, poor governance can encourage executives to take less risky actions in order to protect themselves from control (John et al., 2010).

Researchers and academics have sought, in-depth, for financial crisis causes and roots; one possible argument postulates that banks' CEOs have taken excessive risk and they were almost well-paid. For this reason, a stream of research has focused on CEO compensation and risk-taking behavior link. Houston and James (1995) are the first authors who address the relationship and attempt to examine whether compensation in the banking industry is structured and induces risk-taking. With a sample composed of 134 bank holding companies in the period from 1980 to 1990 in the United States, the authors did not support the hypothesis that CEO pay encourages risk-taking. Using the same sample but covering a recent period (1992-2000), Brewer et al. (2003) find a positive link between equity based-compensation and bank risk. This result is also confirmed later by and Chen et al. (2006).

Thus, our study tends to fill the missing literature gap and will shed light on whether executives' pay arrangements induce risk-taking, especially in a context in which a lack of tough supervision and regulations in terms of executives' pay is felt.

Hereafter, the following section will highlight in-depth the link between executives' compensation and systemic risk.

# IV Bank's executives compensation and systemic risk

Basel committees introduce several principles with regard to best practices of corporate governance. As our study will attempt to examine CEO compensation of the banking sector, we will be focusing on the principle n°11 with reference to executive remuneration package. This principle is as follows:

*"Remuneration systems form a key component of the governance and incentive structure through which the board and senior management promote good performance, convey acceptable risk taking behavior and reinforce the bank's operating and risk culture. The board is responsible for the overall oversight of management's implementation of the remuneration system for the entire bank. In addition, the board or its committee should regularly monitor and review outcomes to assess whether the bank-wide remuneration system is creating the desired incentives for managing risk, capital and liquidity. The board or subcommittee should review the remuneration plans, processes and outcomes at least annually."*[7]

Taken together, it is worth examining top executives' compensation, as a mechanism of corporate governance, its link with risk-taking behavior and systemic risk.

## IV.1 Let's know more about executives compensation components

This section allows us to get more familiar with the compensation package by presenting its components, to have an idea about its historical perspectives broadly and according to the Tunisian context and to present how Basel committees address the issue of executives' pay.

[7] Basel Committee on banking supervision guidelines: Corporate governance principles for banks

### IV.1.1 Executive compensation components

Executive compensation typologies are various and, generally, a compensation package can include some or all of them. Hereafter, these typologies are presented:

- Cash compensation: is the salary and bonuses received by the executive. Generally, companies are unable to attract the best leaders when only offering a simple salary.

- Option grants: consist of the award issuance, for instance, stock options given to key executives and allowing them to buy the shares of a given stock at an exercise price fixed a priori in the future (Murphy et al., 2004). Option grants are advantageous since they are seen as an incentive tool in aligning management and shareholders' interests. Thus, the manager will be more engaged to meet better corporate performance because, if the stock price drops because of bad performance, the manager will lose his lucrative option. However, it was argued that executives, whose compensation is highly composed of stock options, are more likely to take risks. Stock options include performance-vested options either based on accounting performance or market performance.

- Deferred compensation: It is the sum of the contingent compensation types and includes restricted shares of common stock (Murphy et al., 2004). The idea behind deferred compensation is that it offers tax benefits. In fact, it allows the manager to reduce income in the year he opts for this plan, and then, allowing the sum to grow without a tax imposed on invested earnings.

- Contractual agreements: represents other cash or stock payment provided in an employment agreement, as for retirement packages which are given to executives either after they retire or in case the company is taken over by another one (Golden parachute). Hence, the manager will make a greater effort until his retirement.

- Perks: Includes other executives' advantages such as travel reimbursements, the use of function cars and other rewards.

- Benefits: Includes life insurance, health insurance, reimbursement of taxes owed on taxable benefits and supplemental retirement plan.

### IV.1.2 Historical international perspective of executive compensation

High remunerations are supposed to induce managers to boost firm value, but it may cause interest conflicts between managers and debt holders since the latter doesn't participate in profits but are more responsible for losses in case of insolvency (John et al., 2010). Hence, managers may expropriate debt holders in favor of shareholders.

Furthermore, banks are heavily regulated, and so its governance features are special to promote the application of effective control mechanisms. This makes banks' governance unique which requires different behavior toward the setting of executive compensation (John et al., 2010).

In the US, it was shown that executive compensation structures are composed at most of the performance-based compensation to promote investing in positive net present value projects. Further, during the period of recession, US banks commit remuneration abuse to its executives, because it is noticed that banking is simply a "gravy train" for executives. Indeed, there are several remuneration cases of abuse applied by U.S banks and financial institutions (Rajagopalan and Zheng, 2010):

To begin with, Bear Stearns, who pays $ 11.3 billion for employees while only $ 1.4 billion given to stockholders. In addition, Citigroup pays in 2007 $ 34.4 billion to its executives, whereas it is only valued at $ 18.1 billion. Still, the most outrageous case belongs to AIG the insurance and financial services giant. They lose $ 61.7 billion in 2008 and they pay over $ 165 million as bonuses to executives, provided the reception of $ 170 billion in federal bailouts. These failures, caused specifically by inadequate CEO compensation, were pursued and led, consequently, to the collapse of many financial institutions.

Central banks around the world have been entered uncharted territory, in particular, by regulating the compensation of banks CEO. These actions are taken as a response to the issue that compensation packages are risk-taking triggers that preceded the financial crisis (International Monetary Fund, 2014).

With regard to different banking jurisdictions, a regulatory trend has been applied to determine the design of pay structures with the purpose to meet the Financial Stability Board standards (FSB Principles for Sound Compensation Practice). These principles are formulated with regard to each country features to ensure its flexible implementation.

In Europe, the FSB standards are applied through the enacted rules of the primary legislation. The most important is relative to the 4th Capital Requirements Directive (CRD IV of 2013), which postulates that the variable part of the compensation package can't exceed 100% of fixed compensation, with a possible 40% of it can be deferred for a minimum of 3 years.

Subsequently, the European Banking Authority (EBA) publishes additional rules that clarify the Capital Requirements Directive. In fact, variable pay should rely on risk-adjusted performance and thus performance can be gauged by means of a set of criteria ranging from absolute to relative (vis-à-vis peers) performance measures.

In contrast to Europe, the US follows the regulatory approach to check for the FSB standards consistency with regard to compensation policies. Thus, no specific limits on variable pay or deferred pay have been set.

### IV.1.3 Managers' compensation in the Tunisian banking context

High CEO compensation has sparked heated debate. It has faced criticism, saying that the remuneration is excessive, and as a response, the executives are trying to ensure that it based on their contribution to bank performance.

Generally and even in the Tunisian context, lifetime employment for civil servants has long been justified as consideration for lower wages than in the private sector. The wage differential in favor of the private sector has thus existed, but it is particularly more pronounced in the banking sector, especially when dealing with CEO compensation.

Faced with the large pay gap between CEOs of private banks and those of public banks, the Ministry of Finance announced in 2015 its decision to increase the salaries of the CEOs of the three public banks, named STB, BH and BNA. A decision that is part of a general reform introduced by the ministry for the public sector, aimed at improving governance within these banks.

In fact, the new remuneration of the managing directors of the three public banks was fixed by government decree n°2015-968 of August 6, 2015. It presumes the fixed and variable parts of the remuneration with a set of benefits in kind.

Fixed remuneration is a fixed component which consists of a monthly salary set in line with the bank's medium and long-term performance and risk. With regard to the variable component, it is fixed by the nomination and remuneration committee of each bank and calculated on the basis of the quantitative and qualitative indicators adopted by the compensation committees. The decree announces that the variable part of the remuneration should not exceed 50% of fixed compensation[8] .

[8]Governmental decree n ° 2015-968 dated 6 August 2015, fixing the remuneration regime for the managing directors of public banks and the chairmen of their boards of directors.

### IV.1.4 Managers' pay according to Basel Committee

According to the Basel Committee report, Boards' members should be able to design a compensation system with a frequent review, at least annually, in order to ensure whether remuneration is the adequate incentive in managing liquidity, capital and risk. Furthermore, it is stated that systemically important banks should dispose of a compensation committee as an integral part of their organization to oversee remuneration design and its operation. With reference to principle 10 pp.15 *"The compensation committee should oversee the compensation system's design and operation and ensure that compensation is appropriate and consistent with the bank's culture, long-term business and risk appetite, performance and control environment"*. Moreover, the compensation committee should be composed of competent and independent members to ensure better policies and practices' judgments. Then, it works, closely, with risk committees in order to evaluate compensation incentives.

For a comprehensive basis, the remuneration structure should not only support effective corporate governance but also risk management. It belongs to an incentive structure which has the purpose to boost good performance, to convey appropriate risk-taking behavior and to reinforce the risk culture of the bank. With reference to the FSB principles, compensation committees are intended to cover systemically financial institutions. National jurisdictions may also adopt these principles in a manner to cover also smaller institutions.

Board members, working with the compensation committee, should, firstly, make several approvals including the compensation of the top executives e.g. CEO, CRO, managing directors, and secondly, should oversee the development of compensation policies, practices, and control process. Thus, the compensation structure should be aligned with a bank's strategies, objectives, and long-term interests and more likely to mitigate conflicts of interest. Hence, sound risk culture is enhanced through which executives act properly in the interest of the institution rather than privileging their businesses and private interests. Particularly, remuneration structure, embedding incentives, should lead to appropriate risk-taking behavior and not to encourage executives to take excessive risk. Furthermore, remuneration which is based on future revenue, whose timing and likelihood are uncertain, should be evaluated by means of appropriate qualitative and quantitative indicators.

# IV.2 Executive compensation and systemic risk: Explaining theories

Executive compensation contracts are considered as effective mechanisms that can resolve or mitigate the interest problem between managers and shareholders. Hereafter, we attempt to highlight the different theories and discuss what they support in relation to CEO package plans and systemic risk. Thus, we will be examining, at first, the moral hazard theory, as it provides a comprehensive basis for incentive alignments and risk-taking. Secondly, other general related theories will be presented as they provide additional arguments toward risk-taking behavior.

## IV.2.1 The moral-hazard hypothesis

Generally, bank manager compensation is linked to performance indicators and managers' efforts. These latter are unobservable for depositors and shareholders because institutions are more likely to be opaque as argued in several studies such as those of Jens Forssbaeck and Lars Oxelheim (2015).

Unlike non-financial firms and apart from the common responsibility in increasing shareholders' wealth, banks are constrained by regulations. Its prominent and important activity is known for transforming deposits into loans which will generate default risk. So, to prevent banks from being run, deposits are insured and the government provides guarantees. Such insurance will incentivize the CEO to pursue an inherent risk that may result in an increase or a decrease in asset value. According to Bebchuk and Spamann (2010), a decrease in asset value has adverse effects not only on shareholders but also on stakeholders, including debt holders and regulators.

Thus, regulators and shareholders need to monitor executive compensation in the banking industry in order to alleviate the moral hazard problem (Mehran et al., 2011).

To build a comprehensive view, Charles and Mathew (2016) advance the role of deposit insurance in their paper entitled "Deposit insurance: Theories and Facts". They highlight that deposit insurance is designed to protect the interest of the public by limiting the likelihood of systemic risk events. Furthermore, they argue that deposit insurance serves the interests of banks, its borrowers and depositors, even at the expense of public interest.

From a previous study, O'Driscoll (1988) advances the need and the objective of deposit insurance in the US banking system. He examines the risk of an individual bank default which makes it unable in paying off its depositors. In addition, the default of banks considered as "too big to fail", may lead to contagion risk that adversely affects other banks.

Hence, it was through the Banking Act of 1933 in the US, created by the Federal Deposit Insurance Corporation (FDIC), banking safety is promoted with the purpose to avoid bank runs and protect the public interest. Obviously, larger banks will pay larger premiums, however, riskier banks seem to pay no more than less risky ones. In doing so, managers tend to manage and hold the riskier portfolios in order to get greater expected returns (O'Driscoll, 1988), leading therefore to moral hazard problems. Moreover, Merton (1977) argues that banks take risky decisions to receive implicit transfers from the insurer. Such decisions capture the upside through profits while losses are assumed by the government. The use of deposit insurance may limit the control of depositors and debt holders and therefore banks will take a greater risk. Thus, our moral hazard hypothesis postulates that banks use compensation incentives to induce managers to take more risk at the expense of deposit insurance.

### IV.2.2 The agency theory

The agency problem arises due to the separation of the ownership from control, different risk preferences and information asymmetry. In particular, it refers to a conflict of interest between an agent (who acts on behalf of the owner) and a principle. Jensen and Meckling (1976) define this agency relationship as *"a contract under which one or more persons (the principal) engage another person (the agent) to perform some service on their behalf which involves delegating some decision making authority to the agent"*.

To the best of our knowledge, Adam Smith (1776) is the first author who studied the agency problem and since then, the subject has motivated researchers to go beyond the agency theory. Smith (1976) argues in The Wealth of Nation that if *"organization is not managed by the owner; so there is a chance that the agent won't work for the owner's benefits."* Arrow (1971) argues that the agency problem arises from different risk preferences among the corporation. Whereas the owners invest their capital and take a risk to acquire benefits, the agents are risk-averse and focusing on their private benefits.

From another view, Jensen and Meckling (1976) define firms as 'legal frictions' in which several contractual relationships are involved. Agency conflict emerges when contracts are incomplete. Both the principal and the agent will maximize their wealth and in order to mitigate this opportunistic behavior; the principal monitors the agents, which constitutes a cost for the firm.

Furthermore, additional approaches explain the conflict between managers and shareholders namely cognitive and behavioral conflicts. In fact, withholding the same information, managers and shareholders may do not have the same opinion. They can oppose decisions or strategies simply because they have different cognitive models.

Moreover, several behavioral biases are attributed to managers and are considered as sources of inefficiency such as overconfidence, aversion to regret and optimism. These behavioral biases serve as

additional agency costs, and therefore, they tend to affect financial decisions (Charreaux and Albouy, 2005).

Dealing with the agency problem in the banking sector is different from analyzing it in other sectors. Generally, stakeholders including depositors are focusing on risk minimization, whereas shareholders are more likely to accept the risk to maximize their wealth. Managers seem to be more aligned with shareholders' preferences and are induced to take a greater risk (Pathan, 2009).

With the purpose to minimize the divergence of interest, the agency theory proposes a range of incentive alignment and it recommends the design of executives' compensation packages. Indeed, the agency theory postulates that compensation can reduce the difference between risk preferences of shareholders and those of executives by inducing managers to take more risks (Pathan, 2009).

The agency problem is present in all leveraged companies, however, it may be more severe in the banking sector for a couple of reasons. Firstly, the opacity and the long maturity of the assets help easily covering the misallocation of resources, at least in the short term. Secondly, the wide dispersion of bank debt among small and uninformed investors may prevent effective discipline on banks. Hence, since banks can behave less prudently without being detected, they have incentives to take risks than other firms in other industries.

For a comprehensive analysis, it is crucial to examine managers' incentives with regard to risk-taking. Generally, in contrast to shareholders who opt for excessive risk, managers may prefer less risk for several reasons. Unlike investors, the wealth of managers is mostly based on the firm they manage and, hence, managers are supposed to protect it internally by selecting safe assets or by diversification (Smith and Stulz, 1985). Shareholders are more likely to diversify their portfolio risk in the financial market, whereas managers are dedicated to do so at the firm level (May 1995, p.1292). Furthermore, the expected value of tax and even the cost of bankruptcy may induce bank managers to select safe assets rather than risky projects (Weisbach et al., 2005). Moreover, bank managers can act differently with regard to risk-taking incentives. In fact, if managers receive fixed wages, they are more likely to take risks because they will have a little gain if the bank does well but they may lose their job if the bank goes bankrupt (Saunders and Cornett 2006, p.532). Thus, bank shareholders may induce managers to invest in all projects reporting net present value irrespective of their risk, but risk-averse managers don't accept risky but value-increasing projects (May, 1995).

Hence, compensation serves as an incentive alignment between the interests of managers and shareholders, and so it influences bank risk. Thus, optimal compensation tends to lead managers to share the same purposes of shareholders. However, because shareholders are more willing to take risks than managers, hence, compensation will induce them to take a higher risk ( Felício et al., 2018).

### IV.2.3 The optimal contracting approach

For the first theoretical framework, it was shown that shareholder and management interests are aligned by means of an ideal model of governance (Jensen and Meckling, 1976). Under the optimal contracting view, boards should make the appropriate compensation schemes in a way to reward, efficiently, managers, and therefore, to promote interest alignment. Moreover, the author argued that shareholders can intervene in CEO compensation contract determination in order to maximize performance indicators and to induce managers to act on their interests. Under the contracting approach, a fixed salary tends to satisfy the regular wage but bonuses serve as alignment incentives.

Alike other approaches, the optimal contracting view presents several limitations, which are formulated by Bebchuk and Fried (2004). The first limit is linked to managers' ability to unwind their incentives. If compensation contracts are optimal and include management incentives, undoubtedly, executives are not likely to unwind their incentives. Furthermore, Bebchuk and Fried (2004) advance the extent of compensation camouflage with the purpose to extract greater rents from shareholders. Such an argument seems to be more aligned with the managerial power approach since, based on the contracting view, firms have no reason behind hiding executives' compensations. The camouflage may be generated to surpass the outrage constraints and could take many forms. For instance, retirement plans can easily be camouflaged simply because they are reported neither in media nor in the report press. In addition, managers are able to defer their compensations until retirement and may even receive some perks which also are not publicly disclosed.

### IV.2.4 The managerial power approach

With reference to the book of Bebchuk and Fried (2004) entitled "Pay without Performance", CEOs can interfere extremely in determining their own pay under market and outrage constraints. This is contrary to the contracting approach which is based on the optimal contract between managers and shareholders. According to them, managers can sway over their own compensation and more likely to have greater control or authority in setting their remuneration (Weisbach et al., 2005). Consequently, Bebchuk and Fried (2004) tend to reject the arm's length bargaining as the best means to set CEO's pay and advance another approach in which CEO remuneration is the result of interpersonal relationships and negotiations between weak boards and powerful agent.

In fact, it is argued that the board of directors can act either in the interest of shareholders or managers. In fact, board members can act in the interest of the CEOs because they seem to be obliged to rely internally on provided information that interests the top manager (Bebchuk and Fried, 2004). Although there are other factors that induce directors to behave on behalf of shareholders, these factors underperform those that cater to managers' wishes (Bebchuk and Fried, 2004; Weisbach, 2005). In response

to directors' abuse, some actions could be applied in order to induce directors to act in the interest of shareholders. For instance, shareholders could have the right to say on remuneration (Correa and Lel, 2016). Thus, they may vote down compensation and give their proper proposals. Furthermore, market forces and outrage constraints may limit potential deviations made by the directors. However, such measures fail to affect, significantly, the behavior of the executives (Bebchuk and Fried, 2004 and Weisbach, 2005).

With regard to the banking sector, Laeven et al. (2007) find a positive and significant link between the power of shareholders, the incentives towards the shareholders' interest, and the bank risk-taking. Furthermore, Daka et al. (2017) state that the compensation structure is not aligned to shareholders' interest and may converge toward the extraction of rents as postulated by the managerial power approach. Hence, managers benefit from such incentives without the need to take more risk of generating higher returns.

### IV.2.5 Stewardship theory

In response to the agency theory, which is a commonly used tool in management and finance, Davis and Donaldson (1991) introduce their contradicting theory called so the stewardship theory. Under this theory, the interests of shareholders are supposed to be maximized by a mean of the incumbency shared roles between CEO and board chairman. Overall, like the agency theory, the stewardship theory discusses the principal-agent relationship from a behavioral and structural perspective with the purpose of solving the conflict of interest problem. Thus, Madison (2014) postulates that this theory focuses more on firm performance indicators such as growth, profitability, and sales since a steward will act, generally, in the interest of the principal and therefore the organization he works in.

The essence of the theory is based on choosing whether the agent serves the principal's interest by his intrinsic motivation (Madison, 2014) or he uses incentive alignment based on performance contracts.

# V Previous results and hypotheses development

Based on the theoretical framework, we attempt in this section to present the results of previous studies and to formulate our hypotheses.

## V.1 Results of previous studies

A stream of research has investigated the link between corporate governance and risk-taking in financial institutions (Berger, Kick, and Schaeck, 2014; and Minton et al., 2014). In fact, these studies suggest that good mechanisms are positively linked to risk-taking measures whether they are based on the balance sheet or market data. Haan and Vlahu (2015) provide a comprehensive discussion about bank corporate governance and the risk-taking incentives in the financial industry. Their study highlights that shareholder-focused governance structures combined with value maximization objective may increase the risk-taking of financial institutions. Using a sample of US larger banks, Iqbal (2015) and Battaglia and Gallo (2017) find that strong governance mechanisms and shareholder-friendly boards increase the level of systemic risk. In fact, they argue that corporate governance encourages more than constrains risk-taking in the financial industry.

A stream of research has focused on CEO compensation and almost joins the hypothesis that CEO incentives encourage risk-taking in the financial institutions (Gande and Kalpathy 2017). Moreover, Suntheim (2010) explores the link between CEO incentives and almost risk measures and finds significant effects of CEO pay on risk. He postulates that the sensitivity of CEO compensation to the volatility of stock returns' changes accrues not only the total risk and idiosyncratic risk but also the systemic risk; as it decreases the distance to a default of examined banks. Consistent with this result, Vallascas et al. (2013) support the hypothesis that high pay-risk sensitivity promotes risk-taking and CEOs are more likely to invest in risky projects.

Furthermore, exploring CEO compensation components and risk relationships, the literature review has found mixed results. While Levy et al. (2012) illustrate that CEOs' bonuses encourage executives to take risks; Ayadi (2012) finds a negative link. Vallascas et al. (2013) provide additional analysis and argue that risk-taking behavior is more pronounced for highly risky banks, where CEOs are induced to take risks.

Several scholars have blamed the level and the structure of CEO compensation for causing risk-taking behavior; leading to financial crisis onset. With a dataset of 51 banks over the period 2000-2008 in the United States, Bolton et al. (2014) state that CEO pay induces excessive risk-taking, and therefore,

leads to the extent of a financial crisis. This result is consistent with those of Raaballe et al. (2009) and Gande and Kalpathy (2013) but fails to join those of Wang et al. (2011).

Furthermore, Bai and Elyasiani (2013) and Bharati and Jia (2018) investigate whether CEO incentives generate bank's default risk, systemic risk, and idiosyncratic risk. While Bai and Elyasiani (2013) postulate that the higher CEO compensation sensitivity to stock returns volatility, the higher idiosyncratic risk and systemic risk are; Bharati and Jia (2018) find no conclusive evidence between CEO incentives and bank risk-taking.

From a recent study, Iqbal et al. (2018) find that systemic risk is negatively associated with the sensitivity of CEO compensation to stock return volatility. They add that, during the peak of the crisis in 2008, banks showing greater managerial incentives are the most associated with systemic risk.

Recently, Mselmi et al. (2018) examined the link between systemic risk and internal governance mechanisms, managers' entrenchment, and risk management committees' presence, respectively. To do so, they use a sample of listed Tunisian banks on the stock market over the 2006 to 2013 period. Systemic risk is measured by means of LRMS, SRISK in value, and in percentage. Based on this latter, the authors argue that individual contribution to systemic risk is positively associated with good governance practices. Moreover, they find that LRMS is positively linked to internal governance mechanisms, whereas they find no evidence that risk management committees gave an effect on systemic risk. For instance, the authors rely on organizational theory on governance. Indeed, well-structured governance attempts to maximize companies' business indicators and therefore shareholders' wealth.

## V.2 Hypotheses development

After the global financial crisis, policymakers, bank authorities, and even regulators argued that executive compensations at banking institutions can generate risk-taking and are qualified among the contributors of crisis development (Kirkpatrick, 2008; Basel Committee on Banking Supervision, 2010). Moreover, the financial crisis has shown the adverse consequences of both excessive risk-taking incentives and systemic risk on economic growth, financial stability, and societal well fair.

Our study is based on several strands of research. In addition to those examining the link between managerial compensation policies to firm performance and risk-taking behavior, our study will draw on a large view to take systemic risk into consideration instead of only examining the individual firm risk. It is obvious that non-financial institutions are fundamentally different from financial companies with regard to their business models, the degree of opaqueness, their exposure to authority supervision, and their due to respect to the standards. In addition, within the banking industry, the high concern is drawn to the existence of a deposit insurance system, regarded as depositors' protection. Furthermore,

compared to non-financial companies, managerial compensations are regulated and are encompassed in the banking regulatory framework, and hence many kinds of research are warranted on the implication of managerial compensation structure on the stability of financial institutions and on the banking industry, at large.

Given that the top executive's compensation package is supposed to mitigate agency problems and to enhance shareholders' value. However, the compensation packages may generate excessive risk-taking in the banking industry (Gande and Kalpathy, 2017) and thus, the question of whether executive compensation increases the level of systemic risk is raised. Generally, stakeholders including depositors are focusing on risk minimization, whereas shareholders are more likely to accept the risk to maximize their wealth. Hence, managers seem to be more aligned with shareholders' preferences and are induced to take a greater risk (Pathan, 2009).

With the purpose to minimize the divergence of interest, the agency theory proposes a range of incentive alignment and it recommends the design of executives' compensation packages. Indeed, the agency theory postulates that compensation can reduce the difference between risk preferences of shareholders and those of executives by inducing managers to take more risks (Pathan, 2009). A recent study of Iqbal et al. (2018) examines the link between systemic risk and top executives' compensation sensitivity to changes in stock price and return volatility. While using a sample of US financial institutions, they find a negative link between systemic risk and the sensitivity of executive compensation to stock return volatility. However, during the peak of the financial crisis, managerial risk-taking incentives are found to be positively related to systemic risk level.

Furthermore, a stream of research has employed the contracting theory to design the optimal managerial compensation structure. In fact, based on the contracting hypothesis, banks that report greater growth opportunities are more likely to set equity-based incentives in the manager's compensation package. Thus, pay for performance sensitivity [9] is shown to be positively related to capital ratios and negatively related to stock return variance of the bank (Guo et al., 2015).

Moreover, executive compensation may induce executives to engage in riskier activities. This argument gives insight into the extent of agency conflicts, especially between shareholders and deposit insurer. In fact, bank depositors feel safe when a bank gets insolvent simply because their deposits are federally protected. With regard to this federal safety, bank shareholders and even managers will appreciate excessive risk-taking, even if this risk is not deemed to be safe and sound.

This is a kind of moral hazard problem that may increase the likelihood of loss exposure. Indeed, Houston and James (1995) suggest that moral-hazard conflict is severe for troubled and for too big to fail banks. In fact, shareholders are less likely to lose in case of bank failure. In addition, too big to fail

[9] PPS is defined as a unit change in compensation in response to a change in firm value, as measured by annual share price appreciation (Jensen and Murphy, 1990).

institutions may receive subsidies to take a greater risk. Overall, the use of deposit insurance is seen to limit the control of depositors and debt holders and therefore banks will take a greater risk.

Moreover, Francesco et al. (2013) examine the link between CEO compensation and risk-taking behavior and find that banks display a lower distance to default when the CEO receives bonus payments that incentivize them to avoid their institution failure.

It is obvious that the banking sector plays a role in helping companies and industries to invest and produce through alleviating the severe conditions they are facing. Banks are more likely to be fragile to any adverse shocks. Regulators and concerned authorities should improve the efficiency of the banking system through setting reforms and regulations, accompanied by strict supervision to enforce its good application with the purpose to meet the unique purpose of overcoming financial difficulties.

In our case, the Tunisian banking system is plagued with several weaknesses and problems related to under-capitalization, weak reporting and disclosures, deficiencies in the supervisory process and management risk (Jebnoun, 2015). Those vulnerabilities are generated from political and economic changes. It is worth saying that banks are exposed to risks because of their funding to fragile sectors such as tourism and agriculture. These sectors present risk for banks, especially in political instability and security situations.

Based on the argument listed under the agency theory and the moral hazard hypothesis, provided with deposit insurance, banks may take a greater risk; and executives' compensation can promote risk-taking. Thus, our hypothesis is as follows:

***H1: Managers' compensation is tied to banks' contribution to systemic risk.***

Theoretical works posit mixed results when dealing with CEO cash, performance and risk-taking. For the first hand, CEO pay can play an important role as an incentive mechanism to align with the interests of shareholders inducing them to take riskier decisions. On the other hand, CEOs, receiving cash bonuses may protect their institutions from failure and engage in less risky activities. Smith and Stulz (1985) postulate that as long as corporate performance increase linearly with CEO pay, the bonus plan is non-convex. However, when performance is recorded below the earnings threshold at which the cash bonus is payable, the bonus plan will be convex and "offset the concavity of the CEO's risk-averse utility function". By contrast, when performance is above the defined threshold, the bonus plan becomes linear with regard to performance and will not induce risk-averse CEOs to engage in risky activities.

As discussed earlier, the relationship between shareholders and managers is governed by contracts. These contracts may be incomplete and not contingent. In this case, as Shleifer and Vishny (1997) say, managers may have greater expertise than shareholders giving them more latitude to serve their interests. They may take highly inefficient and risky actions that cost shareholders far more than the

personal benefit gained by managers. A better solution is to provide managers with incentive contracts to align their interests with those of investors. However, managers can benefit from powered incentives leading to self-interested behavior, especially when contracts are negotiated with a poorly motivated board of directors (Shleifer and Vishny, 1997).

The literature which examines the link between CEO compensation, pay for performance sensitivity and risk-taking remains inconclusive. A recent study of Rasoava (2019) finds a strongly nonlinear relation between executives' compensations and pay for performance sensitivity supporting the optimal contracting theory. Furthermore, Choi et al. (2020) examine the link between financing decisions and option compensations. They find a nonlinear link between option compensation and risk-taking; in fact, a positive wealth (positive premium) helps increase the firm leverage and hence the risk, while negative risk premium decreases firm leverage and this exists due to the manager's risk aversion.

Overall, this subject is on ongoing debate and is inconclusive. CEO compensation should be set accordingly in exchange for accepting risks. Thus, we hypothesize the non-linearity of the link between CEO compensation and risk.

***H2: There is a non-linear link between managers' compensation and systemic risk.***

# CHAPTER 2:

# DATA, METHODOLOGY AND EMPIRICAL RESULTS

This chapter examines empirically the link between cash CEO compensation and systemic risk. In addition, it attempts to verify our hypotheses which postulate that CEO compensation may be a determinant of systemic risk. Firstly, this chapter presents our sample and data sources. In section 2, we present our research design and we define our variables' measures. In the following section, descriptive statistics are presented and discussed. Finally, in the light of what was tested through empirical regressions, our results are advanced and discussed in section 4.

# I Sample selection and data sources

Describing the banking sector, the number of banks and financial institutions is up to 43 financial institutions. Focusing on the banking sector, eleven banks are listed on the Tunisian Stock Exchange. Three of them as STB, BH, and BNA are public and the government owns in their capital more than 36%. It should be noted that listed banks represent roughly 90.58% of the total banking sector balance sheet in Tunisia.

Hereafter, listed banks with their outstanding deposits and market share are presented in table I.1.

Table I.1: Outstanding deposits and market share of listed banks

| Bank | Outstanding deposits at 12/31/2018 (MTND) | Market share |
|---|---|---|
| BIAT | 10585 | 18,70% |
| BNA | 7633 | 13,50% |
| Attijari Bank | 6002 | 10,60% |
| STB | 5964 | 10,50% |
| BH | 5964 | 10,50% |
| Amen Bank | 5137 | 9,10% |
| ATB | 4689 | 8,30% |
| UIB | 4122 | 7,30% |
| BT | 3450 | 6,10% |
| UBCI | 2449 | 4,30% |

*Financial statements of listed banks*

Our work will follow a market approach i.e. an approach that is based on public data on the Tunisian stock market. We recall that the stock market figures suggest that the banking sector is the main force of the Tunisian stock exchange with 46% of the total market capitalization, the equivalent of 12.2 billion dinars.

Our sample is drawn from 10 listed banks on the Tunisian stock exchange (TSE) between 2009 and 2019. Overall, our sample consists of 110 firm-year observations. Moreover, we decided to use a battery of variables that first describes CEO compensation, bank-specific characteristics, and systemic risk. The period is chosen with reference to data availability. In fact, it is noticed that the remuneration of the managing directors is publicly disclosed from 2009, from which we start to collect data.

Data on CEO compensation of listed banks are collected manually from the financial statements. Control variables are collected either from the Tunisian central bank or from banks' annual reports and financial documents. As for systemic risk measures, we follow the methodology of Acharya et al. (2012; 2017). After specifying the period and the sample selection, the research design will be presented in the following section.

# II Research design

As we mentioned in the previous chapter, we attempt to examine the relationship between systemic risk measures and CEO compensation of listed banks. To do so, we will be presenting our variables, its measures, and its predicted signs. Then, our models' specifications including detailed econometric models will be highlighted.

## II.1 Variables' definitions and measures

### II.1.1 Systemic risk measures

Turning to the measures of systemic risk, several risk metrics approaches have been suggested in the literature. These alternatives could be classified into two groups respectively accounting-based and market-based systemic risk measures. The first alternative is based on balance sheet variables and oriented backward-looking. While the second alternative uses market data and provides a timelier estimate of the risk. In our empirical analyses, the market-based approach, as developed by Acharya et al. (2012, 2017) and Brownlees et al. (2017), will be applied.

The systemic risk measures are various and our study will be limited to some of them qualified as good, highly used in recent studies (Iqbal et al., 2019), and more likely to perform better than others. Unlike Nachnouchi et al. (2018) who use the Covar estimation as a proxy of systemic risk, our study attempts to use the two-market-based measures suggested by Acharya et al. (2017): marginal expected shortfall (MES) and long-run marginal expected shortfall (LRMES). These two measures are built from publicly available stock market data and try to assess the capital shortfall of each bank based on its return volatility and correlation with the market. In our study, we use the average of daily MES and LRMES as our dependent variables.

#### II.1.1.1 Marginal expected shortfall (MES)

The marginal expected shortfall (MES) refers to the marginal contribution of a bank to the aggregate level of systemic risk. Higher MES reflects the greater contribution of the financial institution to the overall systemic risk. In other words, in case of a bank recording a high level of MES, the latter may be bankrupt and almost its capital equity will be depleted during a crisis. Brownlees and Engle (2017) argue that undercapitalized financial institutions are the most that contribute to the systemic risk. Acharya et al. (2012) define MES as the loss of equity capital during a market stress period. The

authors postulate that MES can be defined as the daily percentage decrease in equity value when the stock market declines by a certain threshold(C). Thus, evaluating systemic risk will be as follow:

$$MES_{i,t+h|t}(C) = -E(R_{i,t+h|t}|R_{m,t+h|t} < C) \tag{II.1}$$

Where $R_{i,t}$ is the bank stock return, $R_{m,t}$ denotes the return of TUNBANK[10] between t and t+h, C is the historical Value at risk (Threshold of market decline). We take the daily return on the bank index and the daily return on the bank stock. We set t measured in days and h is equal to one day and C equal to -1.743% at a 99% confidence level. So that, we obtain daily MES over the period 2009-2019 and it is the one-day loss if the market index declines by 1.98%. The literature suggests a range of modeling alternatives to calculate the MES. Thus, we follow previous studies (Brownlees and Engle, 2012) and we use the multivariate DCC-GARCH modeling to capture time-varying dependencies.

#### II.1.1.2 The long-run marginal expected shortfall (LRMES)

The long-run marginal expected shortfall (LRMES) is originally introduced by Brownlees and Engle (2011) and is defined as the long-run MES measured over a period of six months. This risk measure postulates that the banks recording the highest level of LRMES during a given period are the most contributors to the systemic risk and, thus, qualified as systemic risk drivers. To capture the LRMES measure, Brownlees et al. (2011) define two approaches. The first approach corresponds to measure the expected decrease in equity value if the market drops by more than a given threshold (according to Brownlees et al.(2011), the threshold equals to 40%) over a period of 6 months.The second approach is based on determining the probability of an LRMES occurrence over a 6 month period without the market declining by 40%. Hence, Acharya et al. (2012) suggest a proxy using the daily MES as follows:

$$LRMES_{it} = 1 - exp(18 * MES_{it}) \tag{II.2}$$

### II.1.2 Independent variable: Managers' compensation

As we will be focusing on CEO compensation as a governance mechanism in the Tunisian banking context, we consider the logarithm of cash-based compensation as a proxy for executive pay collected from special reports. Previous studies use the structure of CEO pay (Annual salary, bonuses, pensions, stock options) when examining risk-taking. Such variables are not recorded; banks are used to disclose only cash-based compensation and we fail to find its components and its structure. For this reason, we will be limited to annual cash to assess its impact on systemic risk. According to Murphy (1999), compensation components depend on the annual salary and are usually expressed as annual pay percentage. In this case, a change in the magnitude of fixed pay will have an effect on salary-dependent elements of the structure.

[10]The stock market index of the Tunisian banking sector

### II.1.3 Control variables

In our empirical analyses, several control variables are employed to account for the potential effects of the banks' specific features on the level of systemic risk. Previous studies postulate that the riskiness of financial institutions is linked to variables such as size, profitability capital ratio, and income structure (see e.g., Pathan 2009; Iqbal et al. 2015; Iqbal et al. 2019). Hereafter, we will be presenting its measure and its effect.

- Firm size (*Size*): Firm size is among the important control variables, especially when comparing between financial institutions. Different sized institutions have different strategies, corporate governance mechanisms, characteristics, the range of products and services (Palvia et al. 2015). Furthermore, the larger institutions are, the more they have greater systemic importance. Following prior literature, the size is measured by the natural logarithm of total assets (Iqbal et al., 2019). With respect to systemic risk, prior studies find mixed results. While Iqbal et al. (2015) postulate that systemic risk is high for larger institutions, Mayordomo et al. (2014) find no significant link between bank size and systemic risk.

- Capital ratio (*CapR*): Comparing financial institutions requires the measurement of the amount of equity capital. The latter is the interest of both banking regulators and supervisors. In fact, the amount of equity capital is considered as the main factor that can decrease the insolvency risk and the capital ratio is a proxy that can help verify the soundness and the health of financial institutions. The capital ratio is calculated as the ratio of equity capital to weighted total assets. Acharya and Thakor (2016) posit that capital ratio is a predominant factor in explaining the systemic risk. Furthermore, Brownlees and Engle (2017) argue that the level of systemic risk is reflected by the degree of undercapitalization of institutions.

- Profitability (*ROA*): We control for the performance of the financial institution and we include the return on assets, calculated as the ratio of net income to total assets. Profitability can be a proxy of management quality and more profitable financial institutions are more likely to set capital buffers and to reduce the systemic risk. Recent studies, such as those of Iqbal et al. (2015) and Berger et al. (2016), find a negative link between systemic risk and profitability.

- Loans to assets (*LTA*): We follow previous studies like those of Iqbal et al. (2015; 2017) and we include loans to assets ratio to control for the business model and the asset structure of the financial institution.Logically, granting loans results in bank risk increase and thus we hypothesize that the LTA ratio is positively linked to systemic risk.

- Deposits to assets (*DTA*): Alike prior recent studies such as those of Iqbal et al. (2015; 2017), we include deposits to assets ratio to control for the funding structure of the financial

institution. Deposits to assets (DTA) ratio indicates the relative portion of assets funded by deposits. Deposits are qualified as a cheaper source of funding and are deemed to decrease the cost of operation increasing profitability. A higher (lower) ratio leads to a lower (greater) cost of funding.Furthermore, when banks have deposits, they are more likely to grant loans and to invest which increases the bank's risk. Thus, a positive sign between the DTA and systemic risk is expected.

Both proposed variables consider the funding and the lending risks of the financial institutions. The table II.1 hereafter will present the list of variables then we will be exposing in the following section the regression models used to test our hypotheses. We also present our approach within a robustness check framework.

Table II.1: Definitions and measures of variables

| Variable | Definition | Measures | Authors |
|---|---|---|---|
| MES | Marginal expected shortfall | See Acharya et al. (2012;2017) | Acharya et al. (2012;2017) |
| LRMES | Long run marginal expected shortfall | =1-exp(18*MES) | Acharya et al. (2012;2017) |
| CEOPay | CEO compensation | - | Choi (2014) |
| Size | Bank size | Logarithm of total assets | Iqbal et al. (2019) |
| CapR | Capital ratio | Equity capital divided by weighted total assets | Iqbal et al. (2015;2019), Acharya and Thakor (2016) |
| ROA | Return on assets | Net income scaled by total assets | Iqbal et al. (2015;2019), Berger et al. (2016), |
| LTA | Loans to assets | Loans divided by assets | Iqbal et al. (2015;2019) |
| DTA | Deposits to assets | Deposits divided by assets | Iqbal et al. (2015;2019) |

*Own construction*

# II.2 Models' specification

## II.2.1 Endogeneity problem

Throughout the literature review, empirical corporate finance research suffers from serious issues related to endogeneity problems (Karkowska et al., 2020). In fact, finding exogenous factors or natural experiments is not an easy matter and seems to be difficult to put into practice. Before going beyond our methodological approach, we attempt to give a brief definition of endogeneity and its main sources. In fact, the endogeneity problem arises when an explanatory variable is correlated with the error term (Wooldridge, 2012). According to Wooldridge (2002), its sources are classified into three elements: omitted variables, simultaneity and measurement error. To begin with, the omitted variable bias occurs

when additional variables cannot be included in the regression model due to data unavailability or because they are unobservable. Regarding the measurement error bias, it happens when a variable does not have a perfect measure to assess its effect on the dependent variable. Usually, we use proxies to approximate the real value but any difference between the real variable of interest and the variable is chosen to approximate it is found in the error term of the regression. Finally, the simultaneity problem arises when at least one of the explanatory variables and the dependent variable are simultaneously determined.

Until very recently, several studies have examined in depth the endogeneity bias but what was presented as remedies is still inefficient. These remedies tend to mitigate its effects, but they do not guarantee its removal (Navatte, 2016). We recall that we would like to address the relationships between systemic risk and CEO cash compensation. Given the above arguments, we may face a serious endogeneity problem.

Thus, hereafter and in the light of all that we have just presented, we attempt to present our methodological approach to examine the relationship between systemic risk and CEO cash compensation.

### II.2.2 Models' building

Our first hypothesis (H1) predicts that CEO compensation is tied to the level of systemic risk. We hypothesize, in addition, that this relation may be non-linear suggesting that there is a CEO pay threshold from which its impact on systemic risk is more pronounced. Due to endogeneity bias, OLS and fixed effect regressions seem to be inappropriate and inconsistent, since its main assumptions needed to produce unbiased estimates are not respected and verified (Wintoki et al., 2012 and Wooldridge, 2002).In other words, our explanatory variables are endogenous and correlated with the error term which creates an omitted variable problem. Several potential solutions are presented to resolve the endogeneity problem and the instrumental variable technique is one of them (Navatte, 2016). In particular, a set of variables are selected and assumed to be exogenous, and then the coefficients of the estimates are determined by using an n-stage least squares.

However, according to Navatte (2016) and Larcker et al. (2007), such a solution is not an easy matter and is hard to put into practice. In fact, instrumental variable regression can provide unbiased estimates only under two essential assumptions: First, the instrumental variable must be endogenous with the explanatory variable and simultaneously not correlated with the error term. In applied settings, the two conditions are not satisfied: the instrumental variable is found to be weak and partially endogenous (Larcker, 2007). In their seminal papers, Wooldridge (2002) and Wintoki et al. (2012) recommend the GMM system estimator to resolve the endogeneity problem and in order to obtain proper estimates.

Navatte (2016) and Wintoki et al. (2012) suggest that the GMM system estimator can eliminate any endogeneity biases that arise from simultaneity or time-invariant unobservable heterogeneity. In fact, it

uses the history of the explanatory variables as instruments for their current value. The GMM system estimator combines the first difference equations with those at levels (Goaid and Sassi, 2012). In fact, it uses differences estimates to eliminate, firstly, firm-fixed effect and, secondly, in order to be served as instruments in the level equation.

Based on a recent study, Akbar et al. (2017) argue that the endogeneity matters in recent corporate governance research and they recommend the use of a two-step GMM system to control for all types of this endogeneity problem.

Overall, the traditional estimation methods such as the OLS or fixed effects seem to be unable to control for the endogeneity problem; indeed the system-GMM presents more consistent results and can control for the three types of this problem known as the simultaneity, dynamic endogeneity, and unobserved heterogeneity.

Furthermore, we follow Choi (2014) who advances that the impact of compensation on systemic risk in not instant and naturally takes time. Thus, all independent variables are lagged.

Overall, we will be following this approach and we will be using the GMM system estimator to address the endogeneity problem. Doing so, we apply our regression models as follows:

$$MES_{it} = \beta_0 + \beta_1 CEOPay_{it-1} + \beta_2 ROA_{it-1} + \beta_3 CapR_{it-1} + \beta_4 LTA_{it-1} + \beta_5 DTA_{it-1} + \beta_6 Size_{it-1} + \varepsilon_{it} \tag{II.3}$$

$$LRMES_{it} = \beta_0 + \beta_1 CEOPay_{it-1} + \beta_2 ROA_{it-1} + \beta_3 CapR_{it-1} + \beta_4 LTA_{it-1} + \beta_5 DTA_{it-1} + \beta_6 Size_{it-1} + \varepsilon_{it} \tag{II.4}$$

We recall that we would assess the non-linearity relation between CEO cash-based compensation and systemic risk and we will be running these regressions models:

$$\begin{aligned} MES_{it} = {} & \beta_0 + \beta_1 CEOPay_{it-1} + \beta_2 CEOPay^2_{it-1} + \beta_3 ROA_{it-1} + \beta_4 CapR_{it-1} + \beta_5 LTA_{it-1} \\ & + \beta_6 DTA_{it-1} + \beta_7 Size_{it-1} + \varepsilon_{it} \end{aligned} \tag{II.5}$$

$$\begin{aligned} LRMES_{it} = {} & \beta_0 + \beta_1 CEOPay_{it-1} + \beta_2 CEOPay^2_{it-1} + \beta_3 ROA_{it-1} + \beta_4 CapR_{it-1} + \beta_5 LTA_{it-1} \\ & + \beta_6 DTA_{it-1} + \beta_7 Size_{it-1} + \varepsilon_{it} \end{aligned} \tag{II.6}$$

### II.2.3 Robustness check

To examine the robustness of our results, we attempt to conduct additional analyses. We attempt to include an additional variable named SRISK. This latter is a market-based measure and it is proposed by Acharya et al. (2012, 2017). In addition, it extends the MES to take into consideration the size and the liabilities of the financial institutions. The SRISK reflects the expected capital shortfall of the financial institution, conditional on market stress period, or a financial crisis that affects the whole financial system. The authors argue that the higher the SRISK is (equal to greater capital shortfall), the more is the contribution to the overall systemic risk. Hence, the banks which record higher SRISK are assumed to be systemically risky. According to Acharya et al. (2012, 2017), SRISK is estimated as follows:

$$\begin{aligned} SRISK_{i,t} &= E_{i,t}[k(Debt_{i,t} - Equity_{i,t}|Crisis] \\ SRISK_{i,t} &= k(Debt_{i,t}) - (1-k)(1-LRMES_{i,t})Equity_{i,t} \end{aligned} \tag{II.7}$$

Where k refers to the prudential capital ratio which is taken to be 10% (8% before 2013, 9% at the end of 2013 and 10% from the end of 2014), LRMES is the long-run marginal expected shortfall, Equity is the market capitalization, and Debt is bank liabilities. Hence, SRISK is the equity capital amount required by a financial institution within a crisis period in which the value of equity falls with regard to the LRMES while the level of liabilities remains constant. Note that, in the calculation of SRISK, we will ignore banks that record capital surplus (negative value of SRISK) and will take the value of null (Alexey et al., 2017 and Acharya et al., 2012). Thus, we will be running these two models:

$$SRISK_{it} = \beta_0 + \beta_1 CEOPay_{it-1} + \beta_2 ROA_{it-1} + \beta_3 CapR_{it-1} + \beta_4 LTA_{it-1} + \beta_5 DTA_{it-1} + \beta_6 Size_{it-1} + \varepsilon_{it} \tag{II.8}$$

$$\begin{aligned} SRISK_{it} &= \beta_0 + \beta_1 CEOPay_{it-1} + \beta_2 CEOPay^2_{it-1} + \beta_3 ROA_{it-1} + \beta_4 CapR_{it-1} + \beta_5 LTA_{it-1} \\ &+ \beta_6 DTA_{it-1} + \beta_7 Size_{it-1} + \varepsilon_{it} \end{aligned} \tag{II.9}$$

# III Empirical results

This section will discuss the empirical findings of the regression analysis. Firstly, preliminary tests will be conducted to assess the validity of the regression estimator. Then we will highlight the descriptive statistics and the correlation of our selected variables. Finally, the results will be presented and discussed in the final section.

## III.1 Descriptive statistics

Table III.1 summarizes the descriptive statistics of independent, control and dependent variables used in our empirical analysis.

To assess the normality of variables' distribution, we add both skewness and kurtosis values. A normal distribution has a skewness of 0 and a kurtosis of 3. We notice that MES and SRISIK have positive skewness and low kurtosis value; hence they are skewed to the right and have light-tailed distributions. Furthermore, LRMES records a negative skewness and kurtosis of 3 and so it has a symmetric distribution. The interest variable (CEO pay) is not symmetric and light-tailed distribution. With regard to control variables, they show negative skewness and high spread in kurtosis value. In fact, the capital ratio seems to be more symmetric and has normal distribution; whereas the distributions of both LTA and ROA are not symmetric and are heavy-tailed. Overall, the table indicates that the distributions are negatively skewed and leptokurtic.

According to table III.1, the panel A presents the descriptive statistics of systemic risk measures, named MES, LRMES, and SRISK. MES records a minimum of 0.09792% and a maximum of 0.425% over the period 2009-2019. LRMES varies from 1.5% to 18% with a mean of 4.3%. SRISK ranges from 0 to roughly 776 MDT. We recall that the minimum value of SRISK is null and is affected by banks reporting surplus capital. It is evident that the higher the systemic risk measure is, the more is the contribution of the bank to systemic risk. From this output, the sample is heterogeneous and contains banks that show different levels of systemic risk. This joins the findings of Mselmi et al. (2018). The examined sample records an average of 6% of SRISK (%) over the period 2006-2013 and the authors argue that the banking sector is sensitive to political interference that triggers stock price volatility.

Panel B presents the descriptive statistics of the independent variable. The panel shows up the high disparity in CEO pay over the period 2009-2019 between public and private banks with a minimum of 60 mTND and a maximum of 2129 mTND. In 2015, the government has decided to increase the remuneration of public banks CEOs, as a mechanism of good governance. Panel C presents the descriptive

statistics of the control variables. The variable size, measured by total assets, demonstrates that our sample is divergent containing different bank sizes. The amount of total assets ranges from 2 082 971 MDT to 17 990 945 MDT. It is recorded that the biggest bank with reference to total assets is BIAT and the smallest bank in our sample is UBCI.

Turning to the profitability measure, ROA varies substantially from -1.7% to 2.7%. ROA gives an idea about how effective the bank is in converting its assets into net income. The higher the ROA is, the better the bank manages its assets. Almost this performance measure indicates the disparities existing between our sampled banks which are shown through wide spreads. Our Tunisian sampled banks show relatively low performance with an average performance of 1.09%. Iqbal et al. (2019) use a sample of US financial institutions and find an average of 1.19% with a minimum of -18% and a maximum of 22%. Based on the Central Bank supervision report, the profitability indicators of resident banks follow an ongoing improvement proved by the increase of the return on assets by 0.2 points in 2017.

Under Basel accord, the minimum capital adequacy ratio that banks must respect is 10%.In Tunisia, it is equal to 8% before 2013, 9% in 2013, and 10% from 2014. The panel shows up that the capital ratio varies from -6.2% to 22%. This finding indicates the high disparity between banks which display good soundness and stability and which display bad risk management.

To assess the link of the bank loan portfolio to total assets, we include the loans to assets ratio.LTA presents a mean of 0.067, a minimum of -0.0345, and a maximum of 0.139. High LTA refers to two explanations. The first one postulates that a high ratio indicates that the bank runs a higher risk since loans are less liquid assets. The second explanation argues that the greater the loans are, the more likely the bank will get higher net interest income.

Furthermore, to control for the funding structure, we include the DTA (deposits to assets ratio). Descriptive statistics report an average of 62%, a minimum of 44%, and a maximum of 77%. From US financial institutions, Iqbal et al. (2019) find a mean of 61% with a greater spread between a minimum of 1% and a maximum of 90%. We could note that deposits constitute the greater part of the funding sources in the Tunisian banks.

Overall, the descriptive statistics, presented above, suggest that our sample is sufficiently composed of a mixture of large and small banks. Thus, it will minimize the potential problem of sample selection bias (Cuddeback et al., 2004).

Table III.1: Summary Statistics

This table provides summary statistics of all variables used in model specifications.Panel A presents descriptive statistics of our key variables systemic risk measures (MES, LRMES, SRISK). Panel B contains descriptive statistics of the interest variable, CEO pay. Finally, Panel C presents summary statistics of our control variables.

| Variable | Obs | Mean | SdtDev | Min | Max | Skewness | kurtosis |
|---|---|---|---|---|---|---|---|
| Panel A : Dependent variables | | | | | | | |
| MES | 110 | 0.0024 | 0.0009 | 0.00098 | 0.0043 | 0.332 | 1.86 |
| LRMES | 110 | 0.1025 | 0.03802 | 0.0158 | 0.1889 | -0.275 | 3.177 |
| SRISK | 110 | 134.9087 | 196.433 | 0 | 776.030 | 0.139 | 1.195 |
| Panel B: Independent variable | | | | | | | |
| CEOComp (mTND) | 107 | 738.935 | 486.762 | 60.420 | 2129 | -1.010 | 2.901 |
| Panel C: Control variables | | | | | | | |
| ROA(%) | 110 | 1.2390 | 0.6729 | -1.7 | 2.7 | -0.680 | 4.984 |
| Assets(Size) | 110 | 7 471 292 | 3 536 619 | 2 082 971 | 17 990 945 | -0.075 | 2.339 |
| CapR(%) | 110 | 11.4527 | 3.6642 | -6.2 | 22 | 0.9095 | 3.776 |
| LTA | 110 | 0.6768 | 0.0913 | 0.0931 | 0.8447 | -2.408 | 16.854 |
| DTA | 110 | 0.6277 | 0.0784 | 0.4469 | 0.7703 | -0.205 | 2.202 |

## III.2 Correlation analysis

Table III.2 presents information on correlation coefficients for all variables used in our model specification. We document that marginal expected shortfall (MES) and the long-run marginal expected shortfall (LRMES) are strongly correlated to each other at the 5% level (0.7717) suggesting that these two measures capture a similar pattern of systemic risk. This seems obvious and economically confirmed. Furthermore, it is noticed a positive correlation between systemic risk measures and CEO cash compensation suggesting that banks with greater CEO pay contribute more to the systemic risk. This is inconsistent with the findings of Iqbal et al. (2019).

With respect to control variables, it is noted that all systemic risk measures are positively and significantly correlated with the size. Thus, larger banks contribute more to the overall systemic risk. According to Laeven et al. (2014), large banks are riskier than small banks if they engage in market-based activities or they are organizationally complex. Furthermore, it is worth noting that MES and LRMES are negatively and significantly correlated to loans to assets ratio (LTA). Iqbal et al. (2019) report the same finding suggesting that systemically risky banks record low LTA ratios and have less outstanding loans. Consistent with the result of Brunnermeier et al. (2012), the negative correlation suggests that banks which trade in non-traditional activities contribute more to the overall systemic risk. The negative correlation between deposits to assets (DTA) and SRISK joins the previous finding; banks create more risk if they are more involved in non-traditional activities.

The table shows, in addition, that MES and LRMES are negatively associated with capital ratio suggesting that banks with low capital ratios have a higher level of systemic risk. The capital ratio is a proxy of the soundness of the bank, if it is low, then the bank is running the risk and thus has a higher level of systemic risk (Laeven et al., 2014).

Finally, it is worth indicating that control variables are correlated with each other. Most notably, the table indicates that size is positively correlated with capital ratio, while the latter exhibits a significant and positive correlation with ROA.

Moreover, it is worth saying that the correlation matrix reports low values of correlations between variables. This gives insight into the presence of a non-linear link which will be tested in the next section.

Overall, no high correlation coefficients (> 0.8 according to Hair et al, 2001) are found between independent variables making them eligible to be included in our regression models since they reject the potential problem of multicollinearity. The absence of multicollinearity is also confirmed by the Variance Inflation Factor (VIF)[11].

[11] See Appendix A

Table III.2: Correlation Matrix

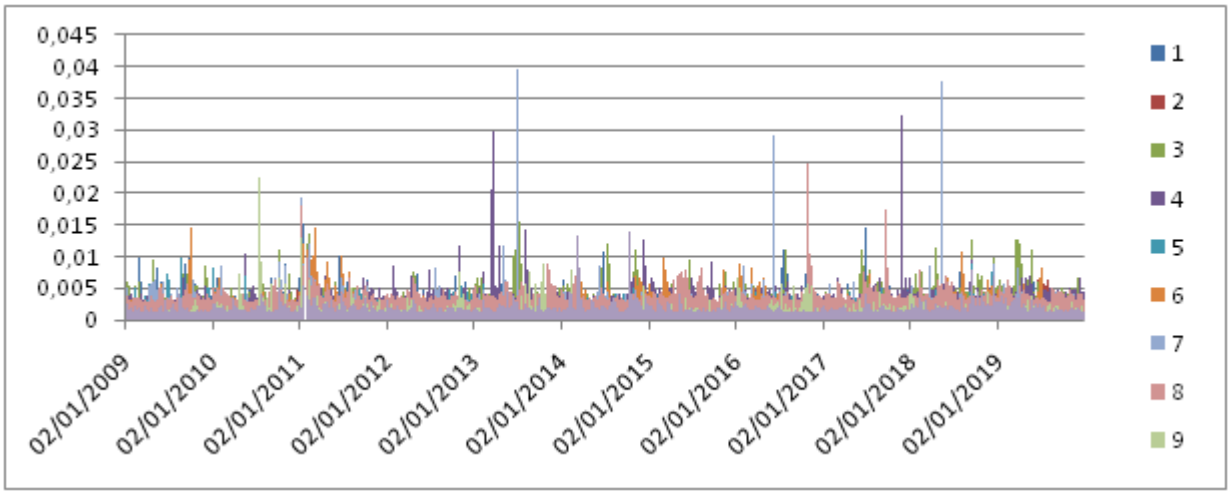
This table reports correlation coefficients for all variables. The correlation matrix provides the Pearson correlation coefficients and their significance at the 5% level. The details of variables' description as well as their measures are reported in Table II.1

| | CEOPay | MES | LRMES | SRISK | ROA | size | CapR | LTA | DTA |
|---|---|---|---|---|---|---|---|---|---|
| CEOPay | 1 | | | | | | | | |
| MES | 0.1073 | 1 | | | | | | | |
| LRMES | 0.2175∗ | 0.7717∗ | 1 | | | | | | |
| SRISK | 0.3110∗ | −0.0868 | 0.0377 | 1 | | | | | |
| ROA | 0.5867∗ | −0.0595 | 0.0076 | 0.1024 | 1 | | | | |
| Size | 0.2165∗ | 0.2888∗ | 0.3253∗ | 0.6344∗ | 0.0815 | 1 | | | |
| CapR | 0.3606∗ | -0.2850 | −0.2363* | 0.2890∗ | 0.4978∗ | 0.2319∗ | 1 | | |
| LTA | 0.0375 | −0.2035* | −0.2367* | 0.0316 | 0.1035 | −0.1873 | −0.0540 | 1 | |
| DTA | −0.0898 | −0.0304 | 0.0579 | −0.5024* | −0.1080 | −0.3672* | −0.0362 | −0.0830 | 1 |

## III.3 The positioning of Tunisian banks based on their systemic risk contribution

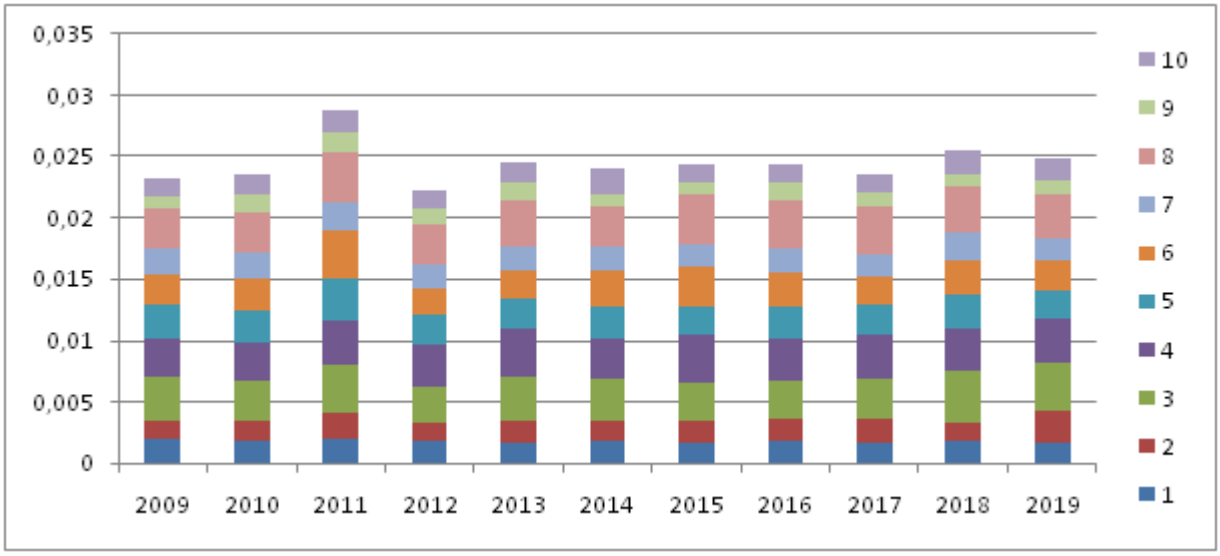
We attempt in this section to provide analyses about the contribution of listed banks to the systemic risk. MES, LRMES, SRISK, as calculated previously, are used to give us a comprehensive view of the relative implication of Tunisian Banks according to systemic risk. Thus, we set several graphs showing the ranking and the contribution of each financial institution.

Figure III.1: MES over the period 2009-2010




The above graph III.1 describes the trend of the marginal expected shortfall for ten listed banks. We note that banks are anonymous but we clarified that the figures of 5, 7, and 8 refer to public banks. It is shown that the MES recorded extreme levels several times. 2011 was the year of political interference. Indeed, the graph shows that the peak of MES reached more than 0.02%. At the beginning of 2013, MES reaches its highest level (more than 0.035%). The stock market was nervous following the political turmoil. It is worth saying that the Tunisian stock market is sensitive to political instability. Then, several high MES values are reported in 2017 and in 2018, especially for public banks. According to Fitch's report, Tunisian banks remain fragile, under-capitalized; suffer from poor quality of assets leading them to be at greater risk.

Figure III.2: Average MES over the period 2009-2019




This figure III.2 above attempts to present the contribution of the individual bank (from 1 to 10) to the overall systemic risk from 2009 to 2019. As expected, 2011 records the higher average MES showing that political turmoil has greatly affected bank stability leading them to contribute more to the aggregate systemic risk. Moreover, public banks are assumed to be the most contributors compared to private banks.

Figure III.3: Capital inadequacy of banks over the period 2009-2019

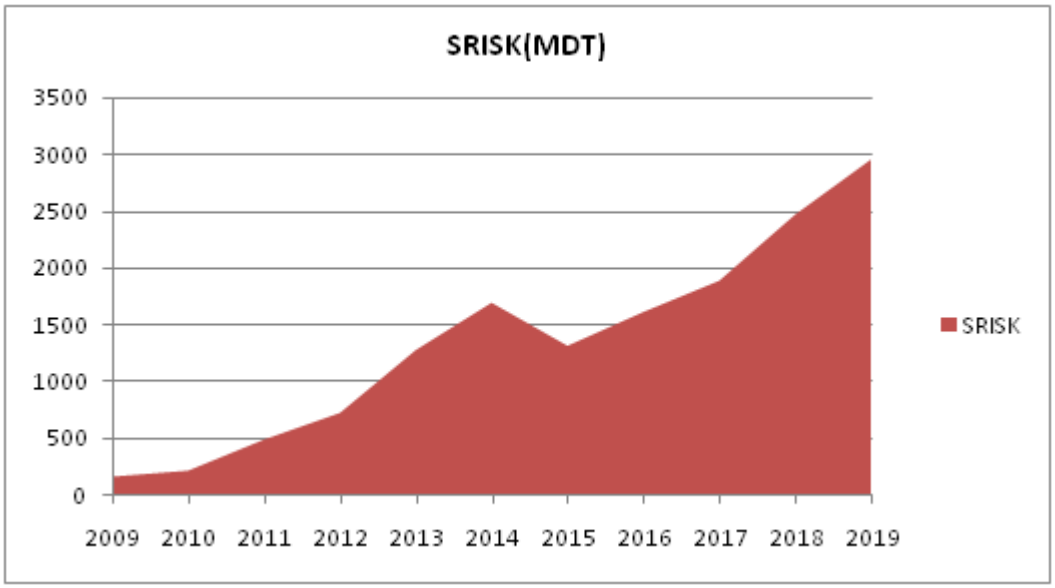
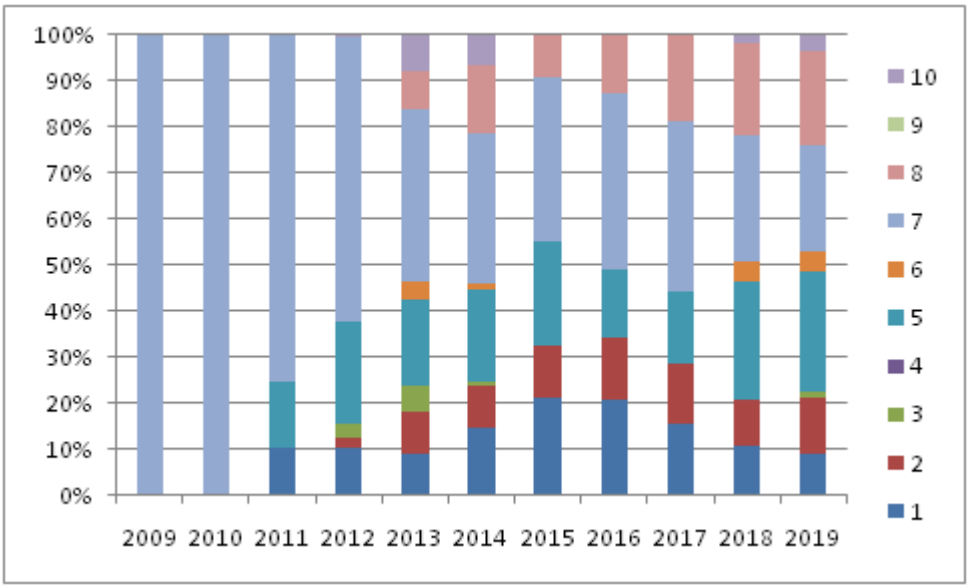


Figure III.3 shows the upward trend of global capital inadequacy from the end of 2010. Mselmi et al., (2018) examine the 2006-2013 period and find that total SRISK dropped from 2006 to the end of 2010 by 1301,357 MDT and began increasing after the political disturbances in 2011. The Tunisian revolution has revealed the fragility of Tunisian banks exacerbated by non-performing loans and weak internal governance mechanisms. The capital shortfall has intensified to reach roughly 3000 MDT at the end of 2019.

For additional analysis, we attempt to measure SRISK in % as the individual proportion of each bank to the aggregate systemic risk (Acharya et al., 2012). The output is presented in figure III.4. We recall that 5, 7, and 8 refer to public banks and the rest denote private banks. In 2009, 2010 and 2011 global SRISK covers public banks as 100% in 2009 and 2010 and more than 80% in 2011 of capital inadequacy. These banks record approximately 890 MDT over the three years. As argued previously, the post-revolution period has revealed the unstable situation of banks and the impairment of the Tunisian banking sector. Private Banks are likely to join the list of systemic risk contributors from 2012. However, its individual contributions are small and insignificant compared to those of public banks. Roughly, they record roughly less than 20% of the total systemic risk in 2019.

Figure III.4: Individual contribution to systemic risk (in%) over the period 2009-2019




After examining the systemic risk measures individually, we will be trying to rank the Tunisian banks according to their contribution to systemic risk. The ranking is presented in table III.3.

Table III.3: Tunisian Banks ranking

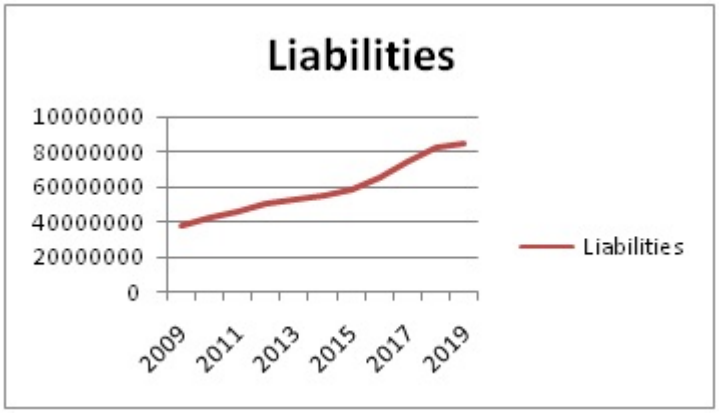
| Bank | SRISK | SRISK(%) | MES |
|---|---|---|---|
| 7 | 5 389,20 | 36% | 0,199% |
| 5 | 3 068,00 | 21% | 0,258% |
| 8 | 2 130,00 | 14% | 0,369% |
| 1 | 1 953,35 | 13% | 0,177% |
| 2 | 1 482,64 | 10% | 0,181% |
| 10 | 357,39 | 2% | 0,165% |
| 6 | 302,78 | 2% | 0,273% |
| 3 | 156,60 | 1% | 0,348% |
| 4 | 0,00 | 0% | 0,350% |
| 9 | 0,00 | 0% | 0,122% |

*Own construction*

As reported in table III.3 above, according to the SRISK measure, public banks (5, 7, and 8) are assumed to be the first contributors to the overall systemic risk over the period 2009-2019. This ranking joins the findings of Mselmi et al. (2018) and Khiari et al. (2019). Indeed, this latter use the CoVar measures as proxies for systemic risk and find that public banks are the systemic players in the banking sector and are the biggest contributors to the distress of other banks. However, we notice that the SRISK ranking is different from the MES ranking. An explanation that could be presented for this difference is that SRISK extends the MES measure to take into consideration the size and the liabilities of financial institutions. The SRISK reflects the expected capital shortfall of the financial institution, conditional on market stress period, or a financial crisis that affects the whole financial system (Acharya et al., 2012 and 2017).

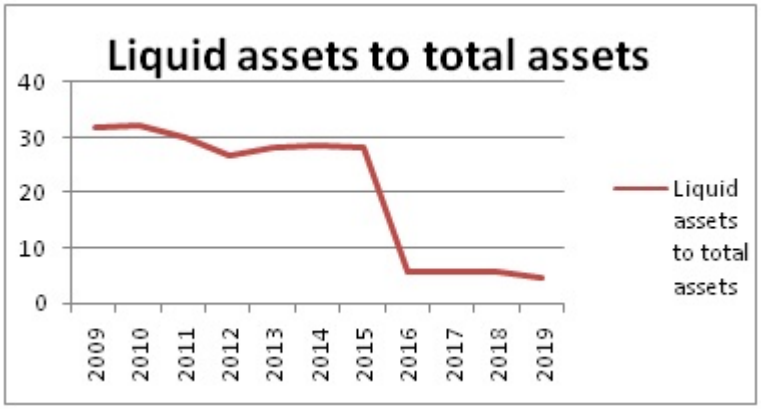
For further analysis, we attempt to present the trend of some indicators that can give an overview of systemic risk drivers. Hereafter, three graphs of liabilities, liquid assets to total assets ratio, and credits to GDP ratio are presented, respectively.

Figure III.5: Liabilities of listed banks over the period 2009-2019



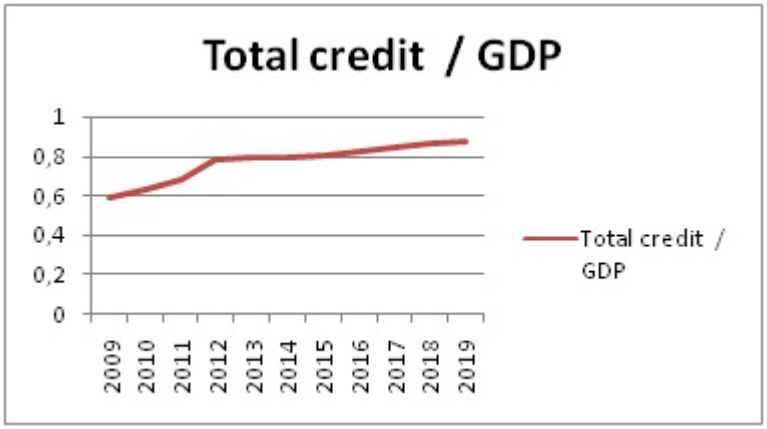

Graph III.5 reports total liabilities. Banks seem to be highly engaged and their liabilities follow an increasing trend. Thus, they should seek funding sources to meet their commitments. Furthermore, total liabilities are a proxy of bank interconnection. Hence, the more the bank is interconnected, the more is its contribution to systemic risk.

Figure III.6: Liquid assets to Total assets




As far as liquid assets holdings which are presented in graph III.6, Tunisian banks record low levels of liquid assets. Indeed, Tunisia is facing a dire liquidity shortage which calls for a constant refinancing by the Central Bank of Tunisia. Hence, it seems that the systemic profile of the Tunisian banking sector is largely influenced by liquidity risk.

Figure III.7: Credits to GDP




From another conjecture, the Basel committee advances the Basel III as a response to strengthen the bank's defense against the build-up of systemic vulnerabilities. Thus, the framework proposes the credit to GDP ratio to act as a guide for policymakers. Borio and Lowe (2002, 2004) are among the first who emphasize the role of credit to GDP ratio as a warning indicator for a banking crisis. It is worth noting that this ratio is not an easy matter and it copes more with developed countries. With regard to the developing and emerging countries, the implementation is difficult but it may give insight into the whole situation. Graph III.7 shows an upward trend of credits to GDP ratio over the period 2009-2019. The IMF advances that 40% is a ratio benchmark for developing and emerging countries that should not be breached in the long term. With reference to the graph, credits to GDP ratios are high and exceed the prudential limit. Thus, crossing such a limit may generate financial system instability. Overall, to control properly for systemic risk, regulators should consider not only banks' capital, bet even should consider holdings liquid assets and liabilities level. Furthermore, it is worth noting that macro-prudential limits, as credits to GDP ratio, should be implemented and be a basis in designing policies and strategies.

## III.4 Multivariate analysis

In this section, we attempt to recall the methodology and the empirical framework. We test our hypotheses regarding the relationships between CEO cash compensation and systemic risk in which we predict that CEO pay may have an impact on bank contribution to the level of systemic risk. This section provides answers to our research questions and presents our empirical results explaining whether cash-based compensation triggers risk-taking and contributes to systemic risk. Our robustness checks are also presented.

### III.4.1 Cash-based compensation and systemic risk relation (H1)

Our first hypothesis predicts that cash-based compensation has an impact on systemic risk. As the instrumental variable method cannot be applied, the dynamic system GMM model will be used in order to address the potential problem of endogeneity. We will be employing firstly the marginal expected shortfall (MES) and then the long-run marginal expected shortfall (LRMES). In order to ascertain whether regression is eligible or not, we need to verify first the absence of the multicollinearity problem. In fact, neither the correlation analysis nor the Variance Inflation Factor (VIF) reported a high correlation between explanatory variables. Then, we ascertain our instruments' eligibility using Hansen tests and we confirm their validity. Moreover, the Arellano-Bond test for AR (2) does not allow rejecting the null hypothesis of the absence of second-order autocorrelation.

Thereafter, we estimate our equations II.3 and II.4 using systemic risk measures in our model using the dynamic panel GMM estimator. Regressions' results are reported in table III.4.

As presented in table III.4, the columns (1) and (2) refer respectively to MES and LRMES regressions. From the first view, the results are quite similar. As highlighted in the table, there is a positive and significant link between CEO compensation and systemic risk level. For instance, if the remuneration increases by 1 unit, LRMES increases by 0.726%. It means the higher the CEO compensation is, the greater will be the level of systemic risk. We recall that we have used cash-based compensation that contains fixed and variable components and we fail to collect data only for variable components in the Tunisian banking sector. Such information is absent and it is disclosed nor in banks' reports neither in auditors' reports. In relation to our first hypothesis, we expected either a positive or negative link between CEO compensation and systemic risk with regard to the moral hazard problem that can result in risk aversion or risk-taking.

In fact, consistent with the moral hazard hypothesis, banks use compensation incentives to induce managers to take greater risk, even worse in case of the existence of deposit insurance. Indeed, deposit insurance is designed to protect the interest of depositors by limiting the likelihood of systemic risk

Table III.4: Regression results from a system-GMM using MES and LRMES

Table III.4 provides the regressions' results using the dynamic panel GMM estimator for all systemic risk measures. Note that, CEO compensation and bank characteristics are measured at the end of the prior year. The numbers in parenthesis are corresponding to Standard errors. *, **, and *** refer to significance at the 10%, 5% and 1% levels, respectively.The definitions of variables are provided in table II.1.

| **Variable** | **MES** | **LRMES** |
|---|---|---|
| lCEOPay | 0.000230** | 0.00726** |
| | (0.000117) | (0.00345) |
| lCapR | 0.000124*** | 0.00312*** |
| | (3.99e-05) | (0.000752) |
| lLTA | -0.00328 | -0.0116 |
| | (0.00298) | (0.0535) |
| lROA | 0.000335* | 0.0185** |
| | (0.000374) | (0.00823) |
| lSize | 0.000141 | -0.0108 |
| | (0.000176) | (0.00849) |
| lDTA | 0.00505*** | 0.121*** |
| | (0.00105) | (0.0367) |
| Constant | -0.00284 | 0.0273 |
| | (0.00351) | (0.108) |
| Obs | 110 | 110 |
| Numbre of years | 11 | 11 |
| Hansen Test | 10.02 | 10.44 |
| Pvalue | 0.614 | 0.577 |
| Arellano-Bond Test for AR(2) | 0.151 | 0.22 |

events. Obviously, larger banks will pay larger premiums, however, riskier banks seem to pay no more than less risky ones. In doing so, managers tend to manage and hold the riskier portfolios in order to get greater expected returns (O'Driscoll, 1988), leading therefore to moral hazard problems. This guarantee will incentivize the CEO to pursue an inherent risk that may result in an increase or a decrease in asset value. Furthermore, the use of deposit insurance may limit the control of deposits and, therefore, banks will take a greater risk. Within the Tunisian banking context, managers may enjoy the deposit insurance known as the Bank Deposit Guarantee Fund and take greater risks simply because there is a rescue in case of default. Moreover, the central bank may intervene in case of systemic events to support banks in trouble as it acts as the lender of last resort.

From another conjecture, consistent with agency theory, compensation serves as an incentive alignment between the interests of managers and shareholders and so it influences bank risk. Thus, optimal compensation tends to lead managers to share the same purposes as shareholders. Hence, because shareholders are more willing to take risks than managers, compensation will induce them to take a higher risk (Felício et al., 2018). Moreover, the agency theory postulates that compensation can reduce

the difference between the risk preferences of shareholders and those of executives by inducing managers to take more risks (Pathan, 2009).

With regard to the Tunisian banking context, there is a lack of transparency, especially when dealing with compensation contracts. Bebchuk and Fried (2004) advance the extent of compensation camouflage with the purpose to extract greater rents from shareholders. Such an argument seems to be more aligned with the managerial power approach since, based on the contracting view, firms have no reason behind hiding executives' compensations. The camouflage may be generated to surpass the outrage constraints and could take many forms. For instance, variable components which can easily be camouflaged simply because they are reported neither in banks' report nor in a public report. In addition, managers may even receive some perks which also are not publicly disclosed, as in the case of the banking Tunisian context.

Working in the same field of research, Bai and Elyasiani (2013) and Bharati and Jia (2018) investigate whether CEO incentives generate a bank's default risk, systemic risk, and idiosyncratic risk. While Bai and Elyasiani (2013) postulate that the higher CEO compensation sensitivity to stock returns volatility is, the higher idiosyncratic risk and systemic risk are; Bharati and Jia (2018) find no conclusive evidence between CEO incentives and bank risk-taking. Our result does not join those of Iqbal et al. (2019) who find that managerial risk-incentives do not contribute to the level of systemic risk but joins those of Choi (2014) who finds weak evidence that cash in compensation structure has a positive link with systemic risk.

Moreover, table III.4 reports that capital ratio has a positive and significant impact on MES (0.0124%) and LRMES (0.312%), respectively. Our result is inconsistent with our prediction, which postulates a negative sign between capital ratio and systemic risk. The capital ratio is assumed to reduce the systemic impact of banks' default, but from what is found, it does not reduce the aggregate systemic risk suggesting that capital ratio is not efficient when dealing with systemic risk.

This central finding is in contrast to the ambition of regulators. In fact, academics and researchers are critical of the Basel process of capital requirement at the time of inception of several regulations. Danielson et al. (2001) raise serious concern about the risks that are not addressed within the Basel II framework and are worried about the correlation between risks, suggesting that Basel II may unintentionally adversely affects the safety and the soundness of the banking sector. Moreover, it is argued that Basel II attracts criticism for not accounting for extreme systemic event and tail risk. Thomas et al. (2017) postulate that the Basel approach is more successful for small banks than large banks in containing systemic risk.

Furthermore, Huang et al. (2007) suggest that it is more effective to set targeted capital requirements than a uniform capital ratio for all banks. In other words, the targeted capital ratio will be more effective in reducing systemic risk and should not depend on the size of the balance sheet but focus enough on

the bank concentration/connection across counterparties. The minimum capital to exposure ratio can be effective in reducing contagion channels between financial institutions by limiting contagious links.

With reference to the Tunisian banking sector, it has known progress in reforms to enhance the stability of the banking system and for better risk management. As Tunisia is a bank-based system, capital adequacy could not by itself guarantee positive stability, but the reforms should include some dimensions related to supervision and anticipation capacity. From a recent study by Kanzari et al. (2017), the capital requirement has a negative and significant effect on the stability of the Tunisian banking sector. Furthermore, Guizani (2014) postulates that Tunisian banking supervision is weak in reducing banks' overall risk and he argues that it is needed to be strengthened.

With regard to control variables, it is reported in the table that the return on assets (ROA) has a significant and positive link on LRMES and on MES. Thus, our estimation suggests that banks with weaker financial performance are associated with a low level of systemic risk. Our result contradicts those of Iqbal et al. (2019) who find that MES is negatively linked to return on assets. A possible argument can be highlighted that bank profitability is conditional on how much the bank takes the risk. Higher risk-taking implies higher profitability. When decision-makers take risks, they will enjoy the outcomes and so will be more willing to take additional risks seeking better performance. In return, the CEO will be compensated for doing well and for increasing the bank‘s profit. Laeven and Levine (2009) argue that motivational incentives and moral hazard due to deposit insurance are the main sources of systemic risk. Hence, managers are motivated to generate income which is necessarily the determinant of risk-taking.

Concerning deposits to assets ratio, it is reported that it has a positive and highly significant impact on systemic risk measures MES and LRMES. For instance, if DTA increases by one unit, MES and LRMES increase by 0.5% and 0.121, respectively. From a comprehensive analysis, banks are sensitive to household confidence. The health of the financial system depends highly on the household sentiment and the confidence of customers toward the soundness and the stability of the financial system.

In the same conjecture, empirical evidence highlights that a great level of confidence in banks increases financial inclusion (Allen et al., 2016), enhances financial stability, improves deposit funding (Han and Melecky, 2017), and reduces the overall systemic risk. However, banks could go bankrupt when public confidence is weak. In fact, confidence may be fragile and it is hard to be restored even in the presence of deposit guarantee or bank capital buffers (Iyer and Puri, 2012). An individual bank's failure can undermine the confidence of the customers through the contagion channels. Miao and Wang (2015) argue that losing confidence in banks may lead to a full-blown financial crisis. Consequently, even deposits remain the cheap sources of funding, it is sensitive to the household confidence. Furthermore, the positive sign can be also explained in the sense that banks accept deposits to grant loans and make profits. Indeed, higher deposits result in greater lending activities which may increase the level of systemic risk.

To ensure the robustness of our results, we will be running our model using the SRISK systemic measure (Equation II.8). Table III.5 will summarize our results. We recall that the SRISK index extends the MES measure to capture the capital shortfall of an individual financial institution when a financial crisis occurs depending on bank size, bank leverage, and bank loss conditional capital, defined as the marginal expected shortfall (MES) (Brownlees and Engle, 2017).

Table III.5: Regression results from a system-GMM using SRISK measure

Table III.5 provides the regressions' results using the dynamic panel GMM estimator for SRISK measure. Note that,CEO compensation and bank characteristics are measured at the end of the prior year. The numbers in parenthesis are corresponding to Standard errors. *, **, and *** refer to significance at the 10%, 5% and 1% levels, respectively.The definitions of variables are provided in table III.5.

| **Variable** | **SRISK** |
|---|---|
| lCEOPay | 1.910*** |
| | (0.336) |
| lCapR | -0.251** |
| | (0.0974) |
| lLTA | 7.522 |
| | ((6.359) |
| lROA | 1.563*** |
| | (0.473) |
| lSize | 3.751*** |
| | (0.821) |
| lDTA | -3.643 |
| | (2.653) |
| Constant | -43.60*** |
| | (9.510) |
| Obs | 110 |
| Numbre of years | 11 |
| Hansen Test | 9.84 |
| Pvalue | 0.54 |
| Arellano-Bond Test for AR(2) | 0.27 |

It is noticed that the results are quite similar compared to previous findings. CEO cash-based pay affects positively and significantly the SRISK, suggesting that CEO pay is an incentive to take a risk and increases the level of systemic risk.

Inconsistent with the previous results, the capital ratio is found to affect negatively and significantly the SRISK. This joins the result of Iqbal et al. (2019) suggesting that banks with a high level of capital ratio contribute less to the level of systemic risk. An increase in a capital ratio by 1 unit will imply a decrease in SRISK by 0.251 points. According to Anginer et al. (2018), a high capital ratio will reduce the system fragility; prior literature argues that capital ratio is a buffer that can absorb the liquidity, the information, and the economic shocks.

Alike previous results, ROA is assumed to be robust in explaining systemic risk. Indeed, we have found a significant and positive relation between ROA and SRISK. Banks managers want to enhance the situation to a well-performing level and to increase profits. Systematically, they should take a prudent risk to meet their objectives. Taking a risk could be not rational leading to an increase in the contribution of systemic risk. Thus, managers are facing a trade-off between increasing profits and reducing risks.

Furthermore, the table shows a positive and significant link between bank size and systemic risk. Such a sign is predictable since empirical evidence argues that larger banks contribute more to the overall systemic risk. In fact, large banks are more involved in market-based transactions and are more organizationally complex than small banks. Consequently, they can be more fragile and sensitive to economic shocks. These banks are not individually risky but they contribute more to systemic risk. The bankruptcy of large banks is more disruptive to the financial system than smaller ones since it will generate liquidity stress and its activities cannot be easily replaced by small banks. The situation will be more harmful when banks have low capital ratios and unstable funding. Hence, it is worth saying that targeting bank complexity and activities is needed to be undertaken with the macro-prudential framework (Laeven et al., 2014).

With regard to the Tunisian context, public banks are among the biggest financial institution and hence it is proved that they contribute more to the overall systemic risk; an interpretation that joins the analysis of the positioning of banks regarding its contribution to systemic risk (Section 3 in descriptive statistics).

Overall, we notice that CEO cash-based compensation is robust in explaining systemic risk. All systemic risk measures (MES, LRMES, and SRISK) are positively and highly significant with CEO pay. It is assumed that the greater the CEOs receive cash; the high is the level of systemic risk.

In accordance with the Tunisian banking sector, CEOs of private banks receive higher compensation than public banks. Therefore, in 2015, the Tunisian government has decided to raise managers' pay, as a governance mechanism, for better bank management. Nevertheless, governance mechanisms are assumed to be weak and fragile and the banking sector is characterized by low profitability. We could imagine that CEOs are not taking a prudent risk, as recommended by the Basel Committee, which contributes to the level of systemic risk. Thus, it could be the reason for establishing the Bank Deposit Guarantee Fund (FGDB) to ensure financial safety and to protect bank deposits.

Finally, our findings postulate that high cash compensation increases the level of systemic risk. This is confirmed when using the three market-based systemic risk measures (MES, LRMES, and SRISK). Therefore, our first hypothesis is supported and our predictions are confirmed. With regard to control variables, capital ratio, and deposits to assets ratio remain positive and significant when using MES and LRMES. ROA remains positive and significant for all systemic risk measures. This suggests that banks with high capital ratios and deposits to assets ratio contribute more to the level of systemic risk; and the

amount of capital shortfall is greater in banks showing higher ROA.

We attempt, in the following section, to peruse our empirical analysis and to test our second hypothesis which predicts a non-linear relation between CEO pay and systemic risk level.

### III.4.2 Non-linear relationship between managers' cash-based compensation and systemic risk (H2)

From prior literature, systemic risk is hard to examine due to its complexity and heterogeneity. In fact, systemic risk is known for stochastic links between its effects and its triggers. It is highly complex, stochastic, and assumed to be non-linear in its cause-effects relations. Relationships between cause and effect are not deterministic and this poses a great challenge in risk governance (Schweizer et al., 2019). From another perspective, a common stream of research has argued that governance mechanisms may follow non-linear relations with its effects.

According to the agency theory, for the best interest alignment, shareholders are more willing to provide managers with incentives. Indeed, a remuneration package is a solution to induce executives to work for the benefit of the company. However, managers can benefit from powered incentives leading to self-interested behavior, especially when contracts are negotiated with poorly motivated board members (Shleifer and Vishny, 1997). Thus, excessive remuneration increases the manager's wealth but can generate adverse consequences on the institution.

Moreover, the non-linear relation can raise interest and be proved since we have noticed low values of Pearson's correlation. In fact, generally, Pearson's coefficients work for linear data and are not great in detecting non-linear links. As shown in the previous section, the correlation matrix does not reveal there being much correlation to talk of. Hence, this could reject the presence of linear relations.

Hereafter, we attempt to examine the non-linearity link and we run our non-linear models (EQ II.5), (EQ II.6) and (EQ II.9). Table III.6 will summarize the results.

As shown in table III.6, our findings recognize the presence of a significant non-linear relationship between CEO cash-based compensation and systemic risk measures (MES, LRMES, and SRISK).

Until present, our study is the first that examines the systemic risk non-linearity with its effects. Our results are quite similar to the studies examining the link between CEO pay and risk-taking behavior within the banking context.

It is noticed that CEO compensation and squared CEO compensation report a negative and positive sign respectively with MES, LRMES, and SRISK. This confirms the presence of a U-shaped relationship between CEO pay and the systemic risk level. The convexity suggests that the positive relationship between compensation and systemic risk exists above a certain threshold. Hence, we refer to the incen-

Table III.6: Regression results for non-linearity test

Table III.6 provides the regressions' results using the dynamic panel GMM estimator for all systemic risk measures. Note that, CEO compensation and bank characteristics are measured at the end of the prior year. The numbers inparenthesis are corresponding to Standard errors. *, **, and *** refer to significance at the 10%, 5% and 1% levels, respectively.The definitions of variables are provided in table III.6.

| **Variable** | **MES** | **LRMES** | **SRISK** |
|---|---|---|---|
| lCEOPay | -0.0185** | -0.301** | -2.061*** |
| | (0.00777) | (0.144) | (0.718) |
| $lCEOPay^2$ | 0.00155** | 0.0255** | 0.0825* |
| | (0.000653) | (0.0126) | (0.0498) |
| lCapR | -4.98e-05 | 0.00104 | -0.154** |
| | (8.82e-0.5) | (0.00181) | (0.0624) |
| lLTA | 0.0163 | 0.484 | 8.065 |
| | (0.0124) | (0.333) | (5.670) |
| lROA | 0.000590 | 0.0226* | 0.549 |
| | (0.000381) | (0.0118) | (0.646) |
| lSize | -0.000362 | 0.0179*** | 2.224** |
| | (0.000258) | (0.00574) | (0.906) |
| lDTA | 0.0151** | 0.359*** | 10.13* |
| | (0.00642) | (0.109) | (5.207) |
| Constant | 0.0394** | 0.540** | -24.55 |
| | (0.0131) | (0.229) | (15.64) |
| Obs | 96 | 96 | 93 |
| Numbre of years | 11 | 11 | 11 |
| Hansen Test | 4.76 | 4.76 | 9.07 |
| Pvalue | 0.893 | 0.893 | 0.526 |
| Arellano-Bond Test for AR(2) | 0.218 | 0.218 | 0.879 |

tive that motivates managers and induces them to take more risks. Thus, convexity in the remuneration schema is necessary to induce the remuneration committee to set optimal compensation packages for managers. Moreover, our findings are consistent with Schleifer and Vishny (1997) in the sense that compensation contracts may be incomplete and not contingent. In this case, managers may have greater expertise than shareholders giving them more latitude to serve their interests. They may take highly inefficient and risky actions that cost shareholders far more than the personal benefit gained by managers.

With regard to control variables, only deposits to assets ratio (DTA) is robust and has a positive and significant impact on systemic risk. It is noticed, furthermore, that bank size has a significant and positive impact on both LRMES and SRISK, while ROA has only a positive effect on LRMES suggesting that higher income is associated with high risk-taking. So, our findings suggest that large financial institutions with higher deposits to assets ratio contribute more to the systemic risk.

Overall, our findings support our second hypothesis (H2) which predicts that systemic risk and CEO compensation follow a non-linear relation. The U-shape relation suggests that low compensation is associated with a low level of systemic risk; whereas from a given threshold; the higher the remuneration is, the higher systemic risk will be. In fact, generally, risk-averse managers are more willing to reduce risk, even if this destroys the value of the institution they work for. Therefore, the bank will not bear heavy risks and does not contribute greatly to the aggregate systemic risk. This may be in contrast with shareholders' purpose.

Moreover, managers play a focal role in determining bank strategies that affect the risk profile of the bank they work for. Consequently, shareholders tend to reward managers for their effort and good outcomes. Within the Tunisian banking sector, it is shown that banks record low profitability (does not exceed 2.7% from 2009), even worse, the managing directors are compensated even they record low performance. Furthermore, a recent study advances a weak pay for performance sensitivity (Ghrab, 2017). Thus, it is argued that managers are taking an imprudent risk that increases the level of systemic risk without generating good outcomes.

With reference to control variables, size, and deposits to assets ratio remain robust and affect positively systemic risk. This suggests that larger banks with higher deposits to assets ratio contribute more to the level of systemic risk.

### III.4.3 Robustness check

After analyzing the effect of the remuneration on systemic risk, we attempt to test the robustness of our results for a couple of reasons.

Firstly, we have used the aggregate amount of the compensation as reported in the financial statements. We recall that banks report only the total amount of compensation without decomposing it into fixed and variable components. With reference to the bank's annual financial statements, the managing director receives an annual remuneration that includes a variable net annual bonus that corresponds to 100% of the variable annual component and depends on the achievement rate of objectives defined by the members of the board of directors of the bank. Secondly, from previous findings, it is hard to assess exactly if the variable component is effectively the trigger of the systemic risk. The composite measure gives us the idea that CEO compensation has an impact on systemic risk, but giving the variable parts of the remuneration will give us accurate results.

Under the hypothesis that the fixed component is not remarkable and is more likely to vary rigidly over time, we agreed to test the impact of the difference of CEO compensation on systemic risk variation. Thus, we will be running the model[12] as follows :

$$\begin{aligned}\Delta\text{RiskMeasure}_{it} &= \beta_0 + \beta_1 \Delta\text{CEOPay}_{it-1} + \beta_2 \Delta\text{ROA}_{it-1} + \beta_3 \Delta\text{CapR}_{it-1} + \beta_4 \Delta\text{LTA}_{it-1} \\ &+ \beta_5 \Delta\text{DTA}_{it-1} + \beta_6 \Delta\text{Size}_{it-1} + \varepsilon_{it}\end{aligned} \tag{III.1}$$

Before presenting our results, we attempt in table III.7 to present the descriptive statistics of the variation of managers' remuneration.

Table III.7: Summary statistics of the variation of managers' compensation

| Variable | Obs | Mean | Std.Dev. | Min | Max |
|---|---|---|---|---|---|
| varCEOPay | 98 | 69.293 | 189.142 | -372.912 | 754 |

Based on table III.7, the variation presents a mean of 69.293 mTND and it ranges between -372.912 mTND and 754 mTND.

Hence, we conclude that the remuneration varies greatly which justifies that the change in the compensation comes mostly from the variable component. With regard to the fixed salary, it varies rigidly over time. In fact, the latest increase was in 2015, when the managing directors of public banks have enjoyed the rise in their pay to align with those of the managers of private banks. In 2018 and 2019, the

[12]We include only positive variation of systemic risk to assess whether the variation of CEO compensation has an effect on the upward level of systemic risk.

sector collective agreements for banks and financial institutions update and revise the indicative tables of remuneration. Indeed, it will be more eligible to use this measure as a proxy in our robustness check.

Table III.8: Regression results using $\Delta\, CEOcompensation$

Table III.8 provides the regressions' results using the dynamic panel GMM estimator for all systemic risk measures. Note that, CEO compensation and bank characteristics are measured at the end of the prior year. The numbers in parenthesis are corresponding to Standard errors. *, **, and *** refer to significance at the 10%, 5% and 1% levels, respectively.The definitions of variables are provided in table III.8.

| **Variable** | $\Delta\, MES$ | $\Delta\, LRMES$ | $\Delta\, SRISK$ |
|---|---|---|---|
| $\Delta\, lCEOPay$ | 0.000431** | 0.00587** | 1.174** |
| | (0.000182) | (0.00277) | (0.549) |
| $\Delta\, lCapR$ | 0.000180* | 0.00105* | 0.158* |
| | (0.000105) | (0.00298) | (0.449) |
| $\Delta\, lLTA$ | -0.0461 | 0.736 | -6.750 |
| | (0.0480) | (0.544) | (52.34) |
| $\Delta\, lROA$ | -0.00727* | -0.0286 | -1.658 |
| | (0.00404) | (0.0783) | (9.785) |
| $\Delta\, lSize$ | -0.00134 | 0.0217 | -4.791* |
| | (0.00140) | (0.0253) | (2.820) |
| $\Delta\, lDTA$ | -0.0966 | 0.0300 | 109.6** |
| | (0.0714) | (0.609) | (55.27) |
| Constant | 0.0156* | -0.303 | 61.25* |
| | (0.0176) | (0.326) | (36.04) |
| Obs | 61 | 61 | 61 |
| Numbre of years | 10 | 10 | 10 |
| Hansen Test | 0.42 | 0.08 | 2.74 |
| Pvalue | 1 | 1 | 0.999 |
| Arellano-Bond Test for AR(2) | 0.602 | 0.905 | 0.641 |

Table III.8 reports the results of the GMM estimator. The variation of CEO compensation is the interest variable and we attempt to assess its impact on the variation of systemic risk. Our findings suggest that the variation in CEO pay affects positively and significantly the systemic risk measures (MES, LRMES, and SRISK). Hence, it is worth saying that the variable component is assumed to increase the contribution of the level of systemic risk. Our findings are quite similar to those of Choi et al. (2014). The latter uses a sample of 92 financial institutions over the period of 2000-2012 and finds that higher cash bonuses and stock options result in higher systemic risk levels. Our results are consistent with our hypotheses in which we predict that the remuneration of the managers, especially the variable component, is among the triggers of systemic risk. Indeed, the compensation package may increase the top managers' appetite to take risks. Top managers may be interested in short-term profits leading to more bonus payments without regard to the long-term risks that they imposed on their bank. A lack of attention to these specifications may result in excessive compensation in the banking industry.

With regard to control variables, only the variation in capital ratio remains positive and significant for all systemic risk measures. An increase in the capital ratio will result in an increase in systemic risk levels. The capital ratio is assumed to decrease the implication of banks in risk-taking but cannot control for their contribution to the overall systemic risk. Overall, this robustness test supports our hypotheses and gives insight into the impact of cash compensation in risk-taking behavior resulting in higher systemic risk.

We recall that we attempt to examine the link between managers' compensation and systemic risk. We find strong evidence for a relationship between cash-based compensation and banks' contribution to systemic risk; even more, it is found that when managers receive higher remuneration, the level of the risk increases accordingly.

This result is also confirmed while using the variation of managers' compensation as a proxy for the variable component. Indeed, our results support our hypotheses (H1) and (H2) in which we predict that remuneration can affect the aggregate level of systemic risk.

With reference to our theoretical channel, our outputs are consistent with the agency theory; indeed, a compensation package is an alignment incentive that may induce them to take risks.

With regard to the Tunisian banking sector, the latter is characterized by weak governance mechanisms, weak reporting, and lack of transparency, especially when dealing with managers' compensation package. Several components are hidden and are not disclosed. The Central bank forces banks to set remuneration committees and tends to promote transparency, but until now, such measures are not performing well.

Hiding compensation structure gives an insight into interpersonal relationships between managers and shareholders. Bebchuk and Fried (2004) advance the extent of compensation camouflage with the purpose to extract greater rents from shareholders. Such an argument seems to be more aligned with the managerial power approach since, based on the contracting view, companies have no reason behind hiding executives' compensations. The camouflage may be generated to surpass the outrage constraints and could take many forms. Indeed, shareholders can intervene in setting compensation contract determination in order to maximize performance indicators and to induce managers to act on their interests. Moreover, Bebchuk and Fried (2004) argue that CEO remuneration is the result of interpersonal relationships and negotiations between weak boards and powerful managers.

From another conjecture, under the moral hazard hypothesis, managers are likely to be risk-seeking for a couple of reasons. Firstly, depositors are protected since deposit insurance is designed to protect the interest of the public by limiting the likelihood of systemic risk events. Secondly, the Central Bank of Tunisia plays a crucial role in avoiding system risk, its contagion, or even in mitigating its post effects because it is known for being the lender of last resort. Furthermore, it is worth saying that banks are

highly affected by political and economic instability and are greatly exposed to risks because of their funding to fragile sectors. Hence, we join Jebnoun (2015) who advances that the Tunisian banking system is plagued with several weaknesses and problems related to under-capitalization, weak reporting, and disclosures, and weak supervisory processes. A common thought argues that macro-prudential and micro-prudential policies can protect bank capital; however, bank governance is the crucial guarantor and the mirror of a bank's soundness.

# Conclusion

International financial regulators and bank supervisors have highlighted the focal role of executive compensation in the development of the financial crisis of 2008-2009. Thus, such managerial incentive is correlated with excessive risk-taking that may create negative externalities on the banking sector. Our study takes part in this stream of research and attempts to examine the linkage between cash-based compensation and systemic risk in the Tunisian banking sector.

According to the agency theory, the compensation package is designed to align the interests of managers to those of shareholders. With regard to the banking sector, such interest alignment may induce managers to take a greater risk. Furthermore, the moral hazard problem, government guarantees, and Bank Deposit Guarantee Fund may encourage managers to take excessive risk. From another conjecture, extant studies emphasize that systemic risk is assumed to be non-linear in its cause-effects relations (Schweitzer et al., 2019). It was argued, furthermore, that the corporate governance mechanisms are assumed to be more effective under or above a given threshold (Choi et al., 2020). Thus, we built our hypotheses in which we predict, firstly, that cash-based compensation is tied to the level of systemic risk, and secondly, that the compensation can affect the systemic risk in a non-linear way.

In our empirical analysis, we use data on publicly traded Tunisian banks over the period 2009-2019. Since we fail to collect data on variable components, all cash-compensation is used in our models. Furthermore, to gauge the systemic risk of individual banks, we use the marginal expected shortfall and the long-run marginal expected shortfall proposed by Acharya et al. (2012, 2017) and Brownlees and Engle (2017). To ensure the robustness of our results, the SRISK index measure is used to capture the capital shortfall of each bank. Furthermore, under the hypothesis that fixed remuneration varies rigidly over time, we used the variation of CEO compensation as a proxy of the variable component to assess whether it impacts the systemic risk.

Our empirical findings indicate that cash-based compensation is positively and strongly tied to all systemic risk measures (MES, LRMES, and SRISK) suggesting that higher remuneration results in higher systemic risk. Consistent with the agency theory, compensation serves as an incentive alignment between the interests of managers and shareholders and so it influences bank risk. An optimal compensation tends to lead managers to share the same purposes as shareholders; however, because shareholders are more willing to take risks than managers, compensation will induce them to take higher risks ( Felício et al., 2018). Top managers may be interested in short-term profits leading to more bonus payments without regard to the long-term risks that they impose on their bank.
A lack of attention to these specifications may result in excessive compensation in the banking industry.

Hence, our first hypothesis is confirmed. Indeed, cash compensation drivers systemic risk.

Dealing with the non-linearity hypothesis, we find empirical evidence of the presence of U shape relation between cash-based compensation and systemic risk; which supports our second hypothesis. The convexity suggests that high compensation is associated with a low level of systemic risk; until a given threshold from which the higher the remuneration is, the greater is the level of systemic risk. Hence, we refer to the incentive that motivates managers and induces them to take more risks.

With regard to control variables, the results postulate that ROA and deposits to assets ratio remain robust and explain the level of systemic risk. In fact, deposits to assets ratio affects positively and significantly systemic risk measures (MES, LRMES, and SRISK). This suggests that banks accept holding deposits to grant loans and make profits. Indeed, higher deposits result in higher lending loans to make profits and to take more risks. Furthermore, bank profitability measured by ROA increases the aggregate level of systemic risk. Indeed, increasing ROA requires taking risks by granting loans.

For robustness check, the findings confirm the presence of a high link between CEO compensation and systemic risk. Indeed, an increase in CEO compensation increases the level of systemic risk. Moreover, it is noticed that capital ratio affects positively and significantly systemic risk measures suggesting that a higher capital ratio results in a higher systemic risk level. Thus, capital ratio attempts to reduce the individual risk of a given bank without considering the potential contagious links between this bank and its peers. With reference to the Tunisian banking sector, banks should respect a uniform capital ratio that equals 10%; below which they become penalized.

This practice is useful but it has been strongly criticized for a couple of reasons. In fact, setting a uniform capital ratio won't consider the systemic important financial institutions and the concentration of risk across the counterparties. Large debates on regulatory reform recommend the use of targeted capital requirements and offer the option for a more stringent capital ratio, especially for systemically financial institutions. A first natural idea consists of imposing higher capital requirements on the most systemic institutions in the banking sector; in our case; public banks which are qualified as the first contributors in the aggregate systemic risk. The second idea is to target the weak links that have a higher probability of becoming contagious links and impose a capital to exposure ratio that penalizes unhealthy concentration across counterparties (Danielson et al., 2001). It is worth saying that using targeted immunization strategies is cost-effective than proceeding with an exhaustive immunization schema (Madar et al., 2004). Overall, targeting contagious banks is assumed to be more effective in reducing systemic risk.

Our work presents several contributions that should be recalled. First, to the best of our knowledge, the current work is the first that questions the relation between managers' cash-based compensation and systemic risk in the Tunisian banking context. Second, our work presents a methodological contribution as we carry out some robustness checks and we attempt to correct for the endogeneity problem.

In fact, we use alternative measures that cover the marginal expected shortfall, the long-run marginal expected shortfall, and SRISK as provided by Acharya et al. (2012, 2017) and Brownlees and Engle (2017). Moreover, a system GMM estimator is applied to control for the endogeneity problem.

Furthermore, a thorough analysis reveals that the banking sector shows several shortcomings with regard to governance control. In fact, evaluating banking corporate governance is complex and the regulators tend to rely on subjective supervisory judgments that make the assessment less subject to precise quantifications. Indeed, to ensure compliance with good standards, the Central Bank of Tunisia works on a new project that aims to enhance good governance practices through proper assessment, to promote transparency and reporting, and to reinforce good risk management policies. For instance, with regard to remuneration policy, the latter should align the executives' goals with the long-term interests of the bank they work for. Hence, banks should define, implement, and maintain a compensation structure in alignment with the couple performance-prudent risk.

Our work is also of practical interest. In fact, understanding whether cash-based compensation affects the level of systemic risk enables us to further determine systemic risk drivers. Thus, this study makes several noteworthy managerial implications. Firstly, it gives insight into how bank regulators sensitively should react to mitigate systemic risk or to control for the contagious link between banks. Furthermore, the results could be helpful in designing an optimal compensation structure and in setting policies that could prevent banks from taking "imprudent risk" and reduce any potential negative externalities on the financial system. Overall, our study will enable stakeholders and policymakers better understand the linkage between governance and systemic risk and help designing monitoring policies and effective governance control. Furthermore, they need to care about systemic risk and seek potential remedies that can alleviate systemic event occurrence.

It is worth mentioning that our study contains some limits that can be addressed in future research. Firstly, the sample size is small; it is possible that the results are not highly accurate. We could divide our sample into different groups; we could capture the externalities by comparing banks according to size, or liabilities, or even according to non-traditional banking activities (Choi, 2014). Secondly, we have used market-based measures. Other several popular measures could be used to draw valid results such as CoVar and SES. Our findings could be more accurate with the presence of the variable component of the managers' compensation. Such datum is not available and banks are used to disclose the aggregate amount of the annual remuneration. This weakness is overcome by including the CEO remuneration variation as a proxy of the variable components. Moreover, it is worth noting that we could not report the threshold of the convex relation simply because it does not provide significant interpretation and because our sample is divergent as it includes private and public banks. Further research may use sub-samples for accurate results.

Several research perspectives can be suggested. For instance, additional analyses are needed to assess systemic risk. A common thought argues that macro-prudential and micro-prudential policies can protect bank capital; however, extant studies highlight the importance of governance as it is the mirror of the bank's soundness. So that it is up to further research to determine the main systemic risk triggers and to examine in which way governance mechanisms can enhance the resilience of financial institutions to systemic risk.

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# Appendices

## Appendix A: Test VIF

| Variable | VIF | 1/VIF |
|---|---|---|
| lCapR | 1.39 | 0.721810 |
| lROA | 1.35 | 0.742704 |
| lDTA | 1.23 | 0.812777 |
| lSize | 1.22 | 0.816642 |
| lLTA | 1.11 | 0.902248 |
| Mean VIF | 1.26 | |

## Appendix B: Two-step system GMM using LRMES

---

| | | | |
|---|---|---|---|
| Group variable: Annee | | Number of obs | = 110 |
| Time variable: Banque | | Number of groups | = 11 |
| Number of instruments = 19 | | Obs per group: min | = 7 |
| Wald chi2 (6). | = 433.56 | avg | = 7.73 |
| Prob > chi2 | = 0.000 | max | = 8 |

---

| LRMES | Coef. | Std.Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| lCEOPay | .0072601 | .0034533 | 2.10 | 0.036 | .0004917 | .0140285 |
| lCapR | .0031189 | .0007521 | 4.15 | 0.000 | .0016448 | .004593 |
| lLTA | -.01162 | .0535244 | -0.22 | 0.828 | -.1165258 | .0932858 |
| lROA | .018483 | .0082302 | 2.25 | 0.025 | .0023521 | .0346138 |
| lSize | -.010786 | .0084878 | -1.27 | 0.204 | -.0274217 | .0058497 |
| lDTA | .1210381 | .0367322 | 3.30 | 0.001 | .0490443 | .1930319 |
| _cons | .0273419 | .1081737 | 0.25 | 0.800 | -.1846747 | .2393584 |

---

Arellano-Bond test for AR (2) in first differences: z = 1.29 Pr > z = 0.22

Hansen test of overid. restrictions: chi2(12) = 10.44 Prob > chi2 = 0.577

(Robust, but weakened by many instruments.)

## Appendix C: Two-step system GMM using MES

---

| | | | |
|---|---|---|---|
| Group variable: Annee | | Number of obs | = 110 |
| Time variable: Banque | | Number of groups | = 11 |
| Number of instruments | = 19 | Obs per group: min | = 7 |
| Wald chi2(6) | = 778.69 | avg | = 7.73 |
| Prob > chi2 | = 0.000 | max | = 8 |

---

| MES | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| LCEOPay | .0002302 | .0001169 | 1.97 | 0.049 | 1.04e-06 | .0004594 |
| LCapR | .0001241 | .0000399 | 3.11 | 0.002 | .000046 | .0002023 |
| Llta | -.0032789 | .0029842 | -1.10 | 0.272 | -.0091279 | .0025701 |
| lROA | .0003349 | .0003742 | 1.90 | 0.071 | .0003985 | .0010682 |
| lSize | .0001412 | .0001764 | 0.80 | 0.423 | -.0002045 | .000487 |
| lDTA | .0050545 | .0010459 | 4.83 | 0.000 | .0030047 | .0071044 |
| _cons | -.0028364 | .0035085 | -0.81 | 0.419 | -.009713 | .0040402 |

---

Arellano-Bond test for AR (2) in first differences: z = 1.44 Pr > z = 0.151

Hansen test of overid. restrictions: chi2(12) = 10.02 Prob > chi2 = 0.614

(Robust, but weakened by many instruments.)

# Appendix D: Two-step system GMM using SRISK

| | | | |
|---|---|---|---|
| Group variable: Annee | | Number of obs | = 110 |
| Time variable: Banque | | Number of groups | = 11 |
| Number of instruments = 18 | | Obs per group: min | = 8 |
| Wald chi2(6) | = 37.78 | avg | = 8.73 |
| Prob > chi2 | = 0.000 | max | = 9 |

| SRISK | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| lCEOPay | 1.909611 | .3361579 | 5.68 | 0.000 | 1.250754 | 2.568469 |
| lCapR | -.2507387 | .0973612 | -2.58 | 0.010 | -.4415631 | -.0599143 |
| lLTA | 7.522201 | 6.359286 | 1.18 | 0.237 | -4.94177 | 19.98617 |
| lROA | 1.562804 | .4730517 | 3.30 | 0.001 | .6356395 | 2.489968 |
| lSize | 3.750685 | .8211321 | 4.57 | 0.000 | 2.141296 | 5.360074 |
| lDTA | -3.642826 | 2.65261 | -1.37 | 0.170 | -8.841845 | 1.556193 |
| _cons | -43.60346 | 9.510432 | -4.58 | 0.000 | -62.24357 | -24.96336 |

Arellano-Bond test for AR (2) in first differences: z = 1.10 Pr > z = 0.270

Hansen test of overid. restrictions: chi2(11) = 9.84 Prob > chi2 = 0.544

(Robust, but weakened by many instruments.)

## Appendix E: Two-step system GMM for non linear link using SRISK

---

| | | | |
|---|---|---|---|
| Group variable: Annee | | Number of obs | = 93 |
| Time variable: Banque | | Number of groups | = 11 |
| Number of instruments = 19 | | Obs per group: min | = 7 |
| Wald chi2 (7) | = 81.10 | avg | = 8.45 |
| Prob > chi2 | = 0.000 | max | = 9 |

---

| SRISK | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| lCEOPay | -2.061 | 0.718 | -2.73 | 0.006 | -1.484122 | -.2439057 |
| lCEOpay² | 0.0825 | 0.0498 | 2.63 | 0.008 | .0453996 | .3101648 |
| lCapR | -0.154 | 0.0624 | -1.89 | 0.059 | -.3327259 | .0061573 |
| lLTA | 8.065 | 5.670 | 0.95 | 0.341 | -6.342652 | 18.30547 |
| lDTA | 10.13 | 5.207 | -1.85 | 0.064 | -23.44291 | .6672162 |
| lROA | .549 | 0.646 | 1.33 | 0.184 | -.3778667 | 1.964897 |
| lSize | 2.224 | .906 | 2.47 | 0.014 | .3727377 | 3.262202 |
| _cons | -24.552 | 15.64 | -1.21 | 0.224 | -29.86656 | 7.011267 |

---

Arellano-Bond test for AR (2) in first differences: z = -0.90 Pr > z = 0.879

Hansen test of overid. restrictions: chi2(11) = 9.07 Prob > chi2 = 0.526

(Robust, but weakened by many instruments.)

## Appendix F:Two-step system GMM for non linear link using MES

---

| | | | |
|---|---|---|---|
| Group variable: Annee | | Number of obs | = 96 |
| Time variable: Banque | | Number of groups | = 11 |
| Number of instruments = 18 | | Obs per group: min | = 8 |
| Wald chi2 (7) | = 799.36 | avg | = 8.73 |
| Prob > chi2 | = 0.000 | max | = 9 |

---

| MES | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| lCEOPay | -.0185273 | .0077721 | -2.38 | 0.017 | -.0337603 | -.0032943 |
| lCEOpay² | .0015459 | .0006532 | 2.37 | 0.018 | .0002657 | .0028261 |
| lCapR | -.0000498 | .0000882 | -0.56 | 0.573 | -.0002227 | .0001232 |
| lLTA | .0163022 | .0124287 | 1.31 | 0.190 | -.0080576 | .040662 |
| DTA | .0151084 | .0064231 | 2.35 | 0.019 | .0025194 | .0276974 |
| lROA | .0005898 | .0003814 | 1.55 | 0.122 | -.0001577 | .0013374 |
| lSize | -.0003618 | .0002579 | -1.40 | 0.161 | -.0008672 | .0001437 |
| _cons | .03936 | .013055 | 3.01 | 0.003 | .0137728 | .0649473 |

---

Hansen test of overid. restrictions: chi2(10) = 4.97 Prob > chi2 = 0.893

(Robust, but weakened by many instruments.)

Arellano-Bond test for AR(2) in first differences: z = -1.23 Pr > z = 0.218

## Appendix G: Two-step system GMM for non linear link using LRMES

---

| | | | |
|---|---|---|---|
| Group variable: Annee | | Number of obs | = 96 |
| Time variable: Banque | | Number of groups | = 11 |
| Number of instruments = 18 | | Obs per group: min | = 8 |
| Wald chi2 (7) | = 772.15 | avg | = 8.73 |
| Prob > chi2 | = 0.000 | max | = 9 |

---

| LRMES | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| lCEOPay | -.3013414 | .1441408 | -2.09 | 0.037 | -.5838522 | -.0188306 |
| lCEOpay² | .0254678 | .012587 | 2.02 | 0.043 | .0007978 | .0501378 |
| lCapR | .0010403 | .0018051 | 0.58 | 0.564 | -.0024977 | .0045783 |
| lLTA | .483764 | .3326878 | 1.45 | 0.146 | -.1682921 | 1.13582 |
| lDTA | .3586923 | .1094139 | 3.28 | 0.001 | .1442449 | .5731396 |
| lROA | .022597 | .0117808 | 1.92 | 0.055 | -.0004929 | .0456868 |
| lSize | .0178982 | .0057425 | -3.12 | 0.002 | -.0291534 | -.0066431 |
| _cons | .5400918 | .2294747 | 2.35 | 0.019 | .0903296 | .989854 |

---

Hansen test of overid. restrictions: chi2(10) = 4.76 Prob > chi2 = 0.893

(Robust, but weakened by many instruments.)

Arellano-Bond test for AR (2) in first differences: z = 4.9 Pr > z = 0.218

## Appendix H: Two-step system GMM using var SRISK

| | | | |
|---|---|---|---|
| Group variable: Annee | | Number of obs | = 61 |
| Time variable: Banque | | Number of groups | = 8 |
| Number of instruments = 21 | | Obs per group: min | = 5 |
| Wald chi2 (6) | =15.76 | avg | = 7.63 |
| Prob > chi2 | = 0.015 | max | = 8 |

| lnvarSRISK | Coef. | Std. Err. | z | P>z | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| llnvarCEO | 1.173736 | .5491077 | 2.14 | 0.033 | .0975046 | 2.249967 |
| lvarROA | -1.657803 | 9.784959 | -0.17 | 0.865 | -20.83597 | 17.52036 |
| Lvarsize | -4.791046 | 2.819829 | -1.70 | 0.089 | -10.31781 | .7357163 |
| Lvarcapr | .1581599 | .448726 | 2.35 | 0.0724 | -.7213269 | 2.037647 |
| lvarLTA | -6.750113 | 52.34143 | -0.13 | 0.897 | -109.3374 | 95.8372 |
| lvarDTA | 109.6171 | 55.2732 | 1.98 | 0.047 | 1.283648 | 217.9506 |
| _cons | 61.2529 | 36.04166 | 1.70 | 0.089 | -9.387454 | 131.8932 |

Hansen test of overid. restrictions: chi2(14) = 2.74 Prob > chi2 = 0.999

(Robust, but weakened by many instruments.)

Arellano-Bond test for AR (2) in first differences: z = -0.47 Pr > z = 0.641

## Appendix I:Two-step system GMM using var MES

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| | | | |
|---|---|---|---|
| Group variable: Annee | | Number of obs | = 61 |
| Time variable: Banque | | Number of groups | = 8 |
| Number of instruments = 21 | | Obs per group: min | = 5 |
| Wald chi2 (6) | = 15.76 | avg | = 7.63 |
| Prob > chi2 | = 0.015 | max | = 8 |

---

| VarMES | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| llnvarCEO | .0004314 | .0001822 | 2.37 | 0.018 | .0000742 | .0007886 |
| lvarROA | -.0072706 | .0040414 | -1.80 | 0.072 | -.0151915 | .0006504 |
| lvarsize | -.0013401 | .0014011 | -0.96 | 0.339 | -.0040862 | .001406 |
| lvarcapr | .0001799 | .0001047 | 1.72 | 0.086 | -.0000253 | .0003852 |
| lvarLTA | -.0460832 | .0479599 | -0.96 | 0.337 | -.1400829 | .0479165 |
| lvarDTA | -.096607 | .0713553 | -1.35 | 0.176 | -.2364608 | .0432468 |
| _cons | .0156347 | .0176038 | 0.89 | 0.374 | -.0188681 | .0501376 |

---

Arellano-Bond test for AR (2) in first differences: z = -0.52 Pr > z = 0.602

Hansen test of overid. restrictions: chi2(13) = 0.42 Prob > chi2 = 1.000

(Robust, but weakened by many instruments.)

## Appendix J:Two-step system GMM using var LRMES

---

| | | | |
|---|---|---|---|
| Group variable: Annee | | Number of obs | = 61 |
| Time variable: Banque | | Number of groups | = 8 |
| Number of instruments = 21 | | Obs per group: min | = 5 |
| Wald chi2 (6) | = 15.76 | avg | = 7.63 |
| Prob > chi2 | = 0.015 | max | = 8 |

---

| varLRMES | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| llnvarCEO | .0058665 | .0027675 | 2.12 | 0.034 | .0004423 | .0112908 |
| lvarROA | -.0286044 | .0782715 | -0.37 | 0.715 | -.1820138 | .1248049 |
| lvarsize | .0216592 | .0253438 | 0.85 | 0.393 | -.0280137 | .0713322 |
| lvarcapr | .0010466 | .0029834 | 2.35 | 0.0626 | -.0048008 | .0068939 |
| lvarLTA | .7356814 | .543846 | 1.35 | 0.176 | -.3302373 | 1.8016 |
| lvarDTA | .0300264 | .6092912 | 0.05 | 0.961 | -1.164162 | 1.224215 |
| _cons | -.3033279 | .3262429 | -0.93 | 0.352 | -.9427523 | .3360965 |

---

Arellano-Bond test for AR (2) in first differences: z = 0.12 Pr > z = 0.905

Hansen test of overid. restrictions: chi2(14) = 0.08 Prob > chi2 = 1.000

(Robust, but weakened by many instruments.)

# Contents

**Cash-Based Compensation and Systemic Risk: Evidence from the Tunisian Banking Sector**

Weak and ineffective bank governance mechanisms are identified as the main triggers of a financial crisis. One of the main issues raised by researchers is the role of executive compensation in encouraging risk-taking. We conduct this research to determine whether executive compensation is an incentive for risk-taking and contributes to the overall systemic risk. Based on the agency theory and the moral hazard hypothesis, compensation is assumed to be an incentive for interest alignment. Our results show that managers are more willing to take risks that may increase systemic risk levels. In doing so, we have used the total compensation of banks' managers and three measures of systemic risk (MES, LRMES SRISK) to gauge the contribution of Tunisian banks to systemic risk. Our sample includes ten Tunisian listed banks over the period 2009-2019. Indeed, a non-linear and convex relationship suggesting that the positive relationship between compensation and systemic risk exists above a certain threshold. It is worth saying that efforts are still needed to improve governance practices and to promote banking transparency in order to ensure the soundness of the banking sector.

**Key words:** systemic risk, executive compensation, bank-risk taking,

**JEL Classification :** G01, G20, G21, G30, G32, G34

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**Rémunérations des Dirigeants et Risqué Systémique: Cas des Banques Tunisiennes**

La faiblesse et l'inefficacité des mécanismes de gouvernance des banques sont signalées comme les principaux déclencheurs d'une crise financière. L'une des principales questions soulevées par les chercheurs est le rôle de la rémunération des dirigeants dans l'incitation à la prise de risque. Nous menons cette recherche pour déterminer si la rémunération des dirigeants incite à la prise de risque et contribue au risque systémique global. Sur la base de la théorie de l'agence et de l'hypothèse de l'aléa moral, la rémunération est supposée être une incitation à l'alignement des intérêts. Nos résultats montrent que les dirigeants sont plus disposés à prendre des risques qui peuvent augmenter les niveaux de risque systémique. Nous avons utilisé pour cela la rémunération globale des dirigeants et trois mesures du risque systémique (MES, LRMES SRISK) pour mesurer la contribution des banques tunisiennes au risque systémique. L'échantillon utilisé comporte dix banques tunisiennes cotées sur la période 2009-2019. Plus encore, une relation non linéaire et convexe suggérant que la relation positive entre la rémunération est le risque systémique existe à partir d'un certain seuil. Il convient de dire que des efforts sont encore nécessaires pour améliorer les pratiques de gouvernance et promouvoir la transparence bancaire afin de garantir la solidité du secteur bancaire.

**Mots clés :** risqué systémique, compensation des dirigeants, prise de risqué bancaire,

**JEL Classification :** G01, G20, G21, G30, G32, G34