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Présentation des articles de la revue de l'IFID

Par Professeur Olfa BEN OUDA
Professeur de l'Enseignement Supérieur
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Fidèle à ses traditions, l'IFID vous propose à travers le nouveau numéro de sa revue des articles d'excellente qualité portant sur des analyses économiques empiriques d'actualité.

Cette revue, ouverte à tous les domaines d'analyse économique et financière, a pour objectif d'enrichir la réflexion et les débats autour de plusieurs questions d'actualité. Elle s'adresse non seulement au public des scientifiques mais également aux praticiens et aux autorités financières et se veut porteuse d'enseignements théoriques et pratiques à tous les intervenants dans le secteur.

Le présent numéro vous propose six articles qui portent sur diverses thématiques et s'appuient sur des méthodes empiriques rigoureuses et innovantes. Les trois premiers articles étudient l'impact de certaines décisions internes ou contraintes règlementaires sur la stabilité des banques, leurs performances et leurs niveaux de risque.

- L'article « The effects of Foreign Direct Investment and Corruption on Tunisian Economic Growth : Vine Copula approach » s'intéresse à l'impact de l'investissement direct étranger et la corruption sur la croissance économique. S'appuyant sur l'approche par les copules, l'étude a été menée sur des données tunisiennes sur la période 1996-2019, et propose une analyse de dépendance bivariée entre la corruption / financement direct étranger et la croissance économique.

  La corruption affecte négativement les finances publiques, perturbe la stabilité politique et décourage fortement les investisseurs étrangers à investir en Tunisie. Par contre, le soutien de l'investissement direct étranger favorise un transfert technologique important pour le développement des entreprises locales et l'impulsion d'une croissance économique durable.

- L'article « Enjeux des cryptomonnaies en tant qu'actif d'investissement pour les banques centrales : cas de la banque de Tunisie » propose une analyse de l'opportunité d'intégrer le Bitcoin et l'Ethereum en tant qu'actif dans le portefeuille d'investissement de la banque. Les résultats soutiennent que la diversification du portefeuille de réserve de change par les cryptoactifs favorise l'amélioration du rendement du portefeuille avec un faible impact sur le niveau du risque. Les résultats montrent également que pendant la crise COVID le marché des cryptoactifs a été insensible aux facteurs liés aux marchés obligataires et aux chocs externes, ce qui permettrait de les qualifier comme étant un outil de diversification de grande efficacité et une valeur refuge.

- L'article « Stabilité financière et surveillance macro-prudentielle : test de résilience en matière du risque de liquidité avec application au système bancaire tunisien » s'intéresse aux déterminants clés du risque de liquidité mesuré par le ratio de liquidité LCR et le ratio de transformation LTD. L'étude s'est basée sur des données de Panel de dix banques tunisiennes de la place. Les résultats soutiennent que la capitalisation bancaire, la taille et le taux directeur impactent négativement le risque de liquidité tandis que les prêts non performants, la spécialisation et le refinancement sur le marché monétaire l'impactent positivement.

  Par ailleurs, la résilience des banques face à un choc touchant la qualité des actifs a été testée via des stress tests. Les résultats montrent la fragilité de certaines banques de la place à de tels chocs.

  Les conclusions confirment les résultats des recherches empiriques menées sur d'autres pays. L'implémentation de règles de bonne gouvernance et la mise en place d'une politique efficace de lutte contre la corruption sont indispensables pour stimuler la croissance économique et assurer une stabilité macroéconomique.
- Le quatrième article prévu au niveau de ce numéro est intitulé « Can central Bank FX interventions help achieving the inflation-targeting framework goal ? ». Il s'intéresse au rôle des banques centrales via leurs interventions sur le marché de change pour assurer la stabilité des prix et maitriser l'inflation. L'étude a été menée sur le marché tunisien et soutient que la politique de change est fortement liée au gap d'inflation. Les interventions de la banque centrale ont essentiellement pour objectif de réduire la déviation du niveau du taux de change effectif réel de son niveau objectif.

  S'appuyant sur un modèle VAR, l'étude montre également que les interventions de la banque centrale sur le marché de change ont un effet simultané sur l'inflation et le taux du marché monétaire.
- Le cinquième article intitulé « The impact of regulatory capital pressure on profitability and risk : Evidence from tunisian banks » porte sur l'impact du renforcement des exigences de fonds propres par la règlementation Bâloise sur la performance et le niveau de risque des banques. Cette problématique a suscité de grands débats au niveau de la littérature théorique et empirique puisque cette exigence en fonds propres pourrait certes favoriser une stabilité financière des banques et une bonne résilience du système financier mais risque également de réduire le niveau des prêts bancaires octroyés et ralentir par conséquent la croissance économique.

  A l'instar de l'article précédent, cet article s'appuie sur l'étude de dix banques tunisiennes cotées en bourse sur la période 2005-2020. En s'intéressant au comportement des banques en réponse aux contraintes en capital, l'auteur note que l'existence des ratios réglementaires de fonds

propres impacte positivement la rentabilité et la maitrise du risque au niveau des banques avec une persistance de la rentabilité dans le temps.

- Le dernier article intitulé « Non-interest Income activities, bank performance and risk during crises : Evidence from Tunisian banks » propose une étude sur des données de panel de 10 banques tunisiennes cotées en bourse sur la période 2005-2020. Ce papier a noté le changement des modèles d'affaires des banques durant les deux dernières décennies. En effet, plusieurs banques ont fortement opté pour une stratégie de diversification de leurs activités. On note d'ailleurs une augmentation des revenus hors intérêts générés par des activités bancaires non traditionnelles telles que les activités de marché, les activités d'assurance et d'autres prestations. Les résultats soutiennent que ces activités impactent positivement la performance des banques et diminuent leurs niveaux de risque et ce particulièrement en périodes de crise.

Parcourir ces articles de grand intérêt et d'une grande diversité fût un grand plaisir pour moi. La richesse des sujets traités pour la plupart centrés sur la stabilité économique et la performance et le risque bancaire et les techniques empiriques avancées retenues confirment la rigueur scientifique retenue pour la sélection des articles pour cette revue.

Je tiens à remercier toute l'équipe scientifique et administrative qui a travaillé sur ce projet fort important pour le secteur. Je voudrais également féliciter les auteurs des articles sélectionnés pour ce numéro pour tous les efforts consentis pour améliorer leurs premières versions. Je voudrais lancer un appel aux autres étudiants et IFIDARs pour soumettre des articles et partager les résultats de leurs travaux avec tous les intervenants dans le secteur.

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The effects of Foreign Direct Investment and Corruption on Tunisian Economic Growth: Vine Copula approach

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Abstract

This study examines the effects of Foreign Direct Investment and corruption on Tunisia's economic growth. Basing on the bivariate Copula theory, empirical findings suggest that FDI contributes to promote economic advancement. Concurrently, there is a negative relationship between corruption and economic growth. By looking into the transmission channels through which these effects may occur, the multivariate Copulas (C-vine and D-vine) show that FDI brings positive effect by generating resources of technology transfer, bringing positive impact to domestic firms and improving financial development. On the other hand, corruption causes negatively public finances, discouraging foreign investors and shaking political stability. These results provide policy implications to government and regulatory authorities.

Keywords : Economic Growth ; Foreign Direct Investment; corruption; transmission channels; bivariate Copula; C-vine and D-vine Copula.

Introduction

Tunisia experienced sustained economic growth during the 1990s, following the adoption of various structural reforms. The most prominent reform was the structural adjustment program (SAP) of the late 1980s. In addition, Tunisia has ratified and signed several international conventions related to economic activities. These ratifications have provided a significant boost to the local economy.

Despite the performance of the Tunisian economy, several problems persist and some have worsened. These economic problems were compounded by the negative effect of the Tunisian revolution which has shaken political and macroeconomic stability. Social agitation, strikes, and protests have hampered production and discouraged foreign investors. Many economic researchers have argued that Foreign Direct Investment (FDI) is an important factor affecting economic success mainly for countries suffering from high level of unemployment and lack of technological advancement such as Tunisia (Bouchouche and Ali, 2019). At the same time, corruption has continued to be a contagion, infecting all levels of Tunisian economy and putting further progress at risk. Consequently, Tunisia has gone through a period of profound transformation that has given rise to double challenges, attracting FDI and combating corruption.

The considerable role that has played FDI on economic growth has prompted policymakers and researchers to understand the empirical link between inward FDI in host economy and gross domestic product (GDP) and examine the channels through which FDI promotes economic development. Borensztein et al. (1998) and Carkovic and Levine (2005) suggested that it is through the investments of multinational firms that host developing economies have access to the elements of productivity, modern technologies and management skills that are essential for growth but are otherwise unavailable in the developing countries. Wang and Blomstrom (1992) identified three main channels of technological spillovers from foreign to local companies which are: imitation, competition and skills (transfer of knowledge). FDI contributes also to enrich human resources through the integration of new technologies in the training of workers, which will help countries to develop in the long term (Hoi Van et al., 2020). Moreover, FDI provides a means of financial development. An increase in FDI would have a significant positive impact on most economic activities in the recipient country, leading to an increase in the funds available in the economy. Consequently, financial intermediation via the available banking system would improve (Henry, 2000).

Unfortunately, corruption appears as an important factor that has a distortive effect on investment through rent-seeking activity which would certainly increase cost of doing business. Corruption is a grave concern since it affects not only investments but also the achievement of growth. Therefore, understanding this phenomenon in term of its implications on growth is of a particular interest to Tunisia that was engaged in a strategy of development in the post 2011 revolutionary period, aiming to become an emerging country by the year 2035. In this regard, it is crucial to know how corruption affects economic growth. Empirically, although many researchers have shown that corruption adversely impacts economic growth, others contest this finding and find that the effect of corruption on growth becomes non significant once some of the determinants of economic growth are controlled. These mixed results seem to favor the idea that if corruption is likely to affect economic growth, its effects will be divided into direct and indirect effects. These formers acted as transmission channels. (Dridi ,2013). Indeed, various types of obstacles that corruption may create for the economic progress such as affecting public finance through reducing public revenues and increasing public debt (Cooray and Schneider,2013; Sonmez and Tülümce, 2018), and creating political and social instability (Mo, 2001; Dridi, 2013). On the other hand, somewhat surprisingly, some studies, have recorded that corruption acts as a motor of economic progress by overcoming the obstacles that an inefficient bureaucracy creates (Leff, 1964; Swaleheen and Stansel ,2007).

The fact that corruption can often been seen as an impediment to economic growth and at the same time this former can be boosted by foreign investments, it is crucial to specify the channels via which FDI and corruption should affect economic growth. We are thus trying to provide an answer to this research question: How corruption and FDI affect economic growth in Tunisia? We attempt to resolve that problematic by answering the following sub-questions: How do FDI and Corruption co-move with economic growth? What are the channels through which FDI and corruption may affect growth? To this end, we use the copula theory, more precisely the bivariate copula and the vine copula, which model the dependence on average and tail dependence with more flexibility compared to the standard models. Therefore, to the best of our knowledge, this study is the first uses these approaches to model such links.

By leading this study, we contribute to the existing literature in different ways. Firstly, we shed the light on the bivariate dependence structure between corruption/ FDI and economic growth by applying different parametric copula functions which enable us to detect tail dependence. Second, we attempt to compare the effect of both of them during the pre-revolution and post- revolution period. Third, we study the multivariate dependence through the C-vine and D-vine copulas to reveal the channels through which FDI and corruption may affect growth. Finally, given that the situation of public finances remains at the top of the Tunisia's priorities due to an expansion of public spending ,we include public finance variables as transmission channels to investigate whether corruption was an issue that contributes to an increase of the level of public debt and budget deficit. We mention that no empirical contribution in the Tunisian context has paid attention to these channels.

The rest of the paper is as follows. The next section sheds light on the relevant literature. Section 3 explains the methodology. Section 4 introduces the data and variables, and Section 5 analyzes the results. Lastly, Section 6 provides conclusions and policy implications.

1. Review of relevant literature

1.1. Empirical studies on economic growth and FDI

The nexus between FDI and economic growth has received considerable attention from researchers and governments of developing countries around the world. Unfortunately, no consensus on the empirical finding has been achieved among researchers. Lee (2013) argues that FDI plays an important role in boosting economic growth for the G20 through introducing new technologies and

developing renewable energy resources. On the other hand, Moura and Forte (2009) show that modern technology can negatively affect the growth of the host country depending on the technologies generated by foreign firms. Ngouhouo (2008) argues that there is a more beneficial long term effect on domestic investments that sake advantages from FDI spillovers. Nevertheless, the establishment of foreign firms can have a negative impact on local firms by leveraging power in terms of technological advantage, branded products and crowding out domestic investment (kumar and Pradhan ,2002). Results of Fauzel (2016) based on the PVAR model suggest that FDI presence contributes to economic growth in the small island developing states (SIDS) by strengthening financial development. However, J.Osei and Kim (2020) show that there exists a potential maximum financial development threshold, beyond which , the effect of FDI on economic growth becomes negligible. Busse and Groizard, (2008) show that FDI is viewed as an important source of capital inflow and the improvement of human capital development in the host country. According to OECD (2002), given that multinational firms use advanced technology, the number of workers compared to those used by local companies is reduced consequently there is an increase in the unemployment rate, which threatens economic growth. For Jyun-Yi and Chih-Chiang (2008), FDI plays an ambiguous role in accelerating economic growth. They didn't find a positive relationship between FDI and economic growth for 62 countries covering the period 1975–2000. Results of Curwin and Mahutga (2014) suggest that if FDI penetration happens too quickly, it may affect negatively economic growth in transition countries in the short and long term, thus less FDI penetration is better than more.

1.2. Empirical studies on economic growth and corruption

In recent years, the link between corruption and economic growth is widely discussed. While many scholars support the “sand the wheels” hypothesis that predicts corruption decreases economic growth, some support the “grease the wheels” hypothesis that predicts corruption increases growth. Ugur and Dasgupta (2011) look over 115 studies in a meta-analysis of earlier studies on the effect of corruption on economic growth in developing nations. It was stated that corruption has a negative impact on growth through direct and indirect means. They confirm that investment, public expenditures and human capital are transmission channels through which the indirect effects of corruption occur. Zouaoui et al (2018) suggest that there is a gap between the real and the predicted GDP per capita in Tunisia, which represents the cost of corruption. The analysis of Gründler and Potrafke (2019) suggest that FDI is the most important variable through which corruption is likely to influence negatively economic growth. For Akrout (2020), corruption adversely affects Tunisia’s economic growth through channels mainly the private capital stock, total public expenditure, and human capital. There are very few studies that look into the effect of corruption on public finances. For instance, Thuy Van et al. (2020) show that public debt and budget deficit have negative effect on sustainable economic development. However, controlling corruption may limit this effect and pushing economic growth. In other words, countries with low level of corruption, an increase of public debt or budget deficit will lead to higher economic growth than countries with high level of corruption.

On the other hand certain studies, have recorded a positive relationship between economic growth and corruption. Theoretical work of Leff (1964) identifies an intriguing link between corruption and economic growth: corruption acts as a motor of economic progress when the government's bureaucratic delays and rigid restrictions allow private agents to purchase their way out of politically imposed inefficiencies. Thus, corruption improves an economy's efficiency and affects positively growth. For Delgado et al (2014), corruption has a positive effect on growth rates in about 30% of the countries in the sample, a negative effect in 11% and no effect in the other 59 %. Trabelsi and Trabelsi (2020) argue that corruption can be beneficial to economic growth under a certain optimal threshold.

2. Methodology

This study applies the Copula theory. The popularity and usefulness of copulas in modeling dependence is due to numerous advantages relative to traditional empirical methods. (1) Copula function is a robust technique as it is able to separate the dependence structure from the univariate marginal. (2) Give the flexibility to capture nonlinear distribution. (3) There was no requirement that the marginals should be normally distributed. (4) Another important advantage of copula over the other models resides in its ability to analyze upper, lower, symmetric and asymmetric tail dependencies which is not feasible with dependency methods applied in the literature.

2.1. Estimation procedure

We are going to examine the effects of FDI and corruption on growth by using the copula theory. Firstly, we shed light on the bivariate dependence by applying different bivariate copulas which enable us to analyze the dependence on average obtained from rank measures and the dependence on extreme market obtained from tail dependence. In the second part, we turn to evaluate how these effects occur. Doing so, we include variables as transmission channels and we base on the Vine copula to analyse the multivariate dependence.

2.2. Bivariate Copula

Theorem Let F be a joint distribution function with margins F1 and F2. Then there exists a copula C such that for all (x,y) in $\mathbb{R}^2$; F(x,y) = C(F1(x),F2(y)) and if F1 and F2 are continuous then C is unique.

An appealing feature of a copula is that it provides information on average dependence and on tail dependence. On one hand, the dependence on average is given by dependence measures such as Kendall's tau which measure the dependence as the difference between probability of concordance and probability of discordance which is defined as follows:

$$r_k(X,Y) = \Pr(concordance) - Pr(discordance)$$
$$= \Pr[(X_1 - X_2)(Y_1 - Y_2) > 0] - \Pr[(X_1 - X_2)(Y_1 - Y_2)$$

Furthermore, the Kendall's tau can be written as a function of the copula as follow:

$r_k(X,Y) = 4\int_0^1\int_0^1 C(u,v)\,d(u,v) = 4E[C(U,V)] - 1$ Where U, V ~ U (0, 1) with joint distribution function ***C.***

On the other hand, the dependence structure during periods of extreme market conditions is given by upper (right) and lower (left) tail dependence measures.

Definition 1 (Upper Tail Dependence)**:**Let X and Y be random variables with distribution functions, respectively F_X and F_Y, the coefficient of upper tail dependence is defined as:
$\lambda_U = \lim_{u\to 1} \Pr[Y > F_Y^{-1}(u) \mid X > F_X^{-1}(u)]$ .Furthermore, the upper-tail coefficient may be written in terms of copulas as follow: $\lambda_U = \lim_{u\to 1} \frac{1-2u+\boldsymbol{C}(u,u)}{1-u}$

Definition 2 (Lower Tail Dependence)**:** Analogously, the coefficient of lower - tail dependence is defined as: $\lambda_L = \lim_{u\to 0} \Pr[Y \le F_Y^{-1}(u) \mid X \le F_X^{-1}(u)$. Furthermore, analogously the lower-tail coefficient may be written in terms of copulas as follow: $\lambda_L = \lim_{u\to 0} \frac{\boldsymbol{C}(u,u)}{u}$

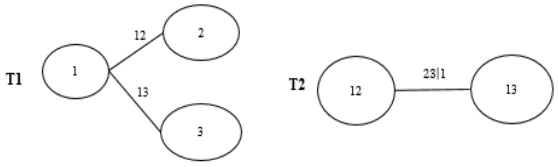
Our study uses different range of copulas . More precisely Elliptical copulas (Gaussian and Student-t) and Archimedean copulas (Gumbel, Clayton and Frank). The Gaussian Copula is symmetric without tail dependence hence it exhibits a poor representation of extreme events. Similar to the normal copula, t-copula is symmetric but it presents a tail dependence. For Archimedean copulas, they detect asymmetric tail dependency.

3.3 Multivariate Copula: Vine Copula

A vine is a graphical representation based on Pair Copula Construction (PCC), introduced by Bedford and Cooke (2001, 2002). The idea is to construct multivariate distributions using conditional and unconditional bivariate copulas as building blocks. They called the structure as Regular vine (R-vine) since it is based on graphical trees. Aas et al. (2009) focused on the canonical vine (C-vine) and drawable vine (D-vine) copulas which are two special cases of the R- vine. In our study, we consider the C-vine and the D-vine copulas with different hierarchical tree structures.

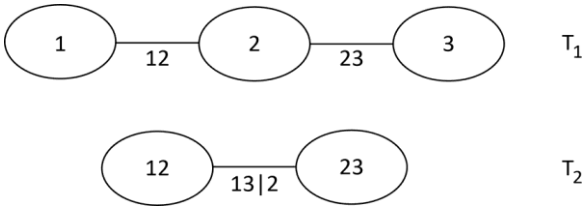
A. C-Vine Copula

A C-vine copula is an R-vine copula for which each tree has a unique node which connects with all the other nodes. Figure below represents 3-dimensional C-vine structure with 2 trees and 3 edges



B. D-vine Copula

A D-vine copula is an R-vine copula for which each tree has a path structure means node are connects in a symmetric way. Figure below represents 3-dimensional D-vine structure with 2 trees and 3 edges.



3. Data description

Our database is recorded annually1 for all variables on the period that spans from 1996 to 2019. The data is collected from several sources. The first source, which is used to obtain the growth rate as measured by the growth rate of real per capita GDP is (https://www.theglobaleeconomy.com/). Then, the data about corruption which is measured by Corruption Perception Index (CPI) is derived from International Transparency (IT) database. Concerning FDI, the data is provided from the World Bank's website. Then, we explore the channels through which economic growth is affected. To this end, we include domestic investment measured by the gross fixed capital formation (% of GDP) obtained from

[1] To give better results, Copula theory is more appropriate for a larger database. Therefore, we transform our annual data to quarterly data basing on the formula explored by many researchers such as Mansouri (2003), Mansouri, Brahim and El Baz, Ayad (2018). For each variable y, we associate a quantity "k" such as , $k = \sqrt{4y_t(0.5y_{t-1} + 3y_t + 0.5y_{t+1})}$. The values of the variable "y" at the first (y1), second (y2), third (y3) and the fourth (y4) quarters may be formulated as follows.
$y_1 = 4\left(\frac{y_t}{K}\right)(y_{t-1} + 0.625y_t - 0.625y_{t-1})$. $y_2 = 4\left(\frac{y_t}{K}\right)(y_{t-1} + 0.875y_t - 0.875y_{t-1})$.
$y_3 = 4\left(\frac{y_t}{K}\right)(y_t + 0.125y_{t+1} - 0.125y_t)$. $y_4 = 4\left(\frac{y_t}{K}\right)(y_t + 0.375y_t - 0.375y_{t-1})$.

IFS. We use also public debt (% of GDP), budget deficit (% of GDP), political instability, tertiary gross enrolment rate as a proxy for human capital, domestic credit to private sector by banks divided by GDP as a measure of financial development. Our dataset contain also High-tech imports (% total goods imports) used to represent the variable technology transfer. These variables are collected from the World Bank's website.

4. Empirical results

4.1. Statistical analysis

At the beginning, in order to summarize and describe the main characteristics of the sample, we present the descriptive statistics of the databases[2] cited above.

Table 1: Descriptive statistics

	FDI	CPI	GDP	HC	DI	ICT	FD	PI	DEBT	DEFICIT
Mean	0.0291	4.5050	3.702e+03	0.2914	0.2343	0.04876	0.5481	1.1963	0.5690	0.0372
Standard deviation	0,09457	0,012005	0,019357	0,02969	0,01773	0,032636	0,0169	0,02791	0,01841	0,067091
Maximum	0.0958	5.3000	4.471e+03	0.3589	0.3084	0,066579	0.7112	2.1413	0.8408	0.0696
Minimum	0.0095	3.7593	2.627e+03	0.1356	0.1835	0,032056	0.4577	0.6755	0.3904	0.0101
Kurtosis	8.6283	1.6827	1.7549	2.5683	4.3661	-0,993283	1.8605	1.6781	2.1388	2.3708
Skewness	2.2300	0.1147	-0.4274	1.0146	-0.4399	-0,066572	0.5817	0.6436	0.3196	0.3888

As it is shown in table 1, the standard deviation is small for all the variables where FDI is the most volatile. The kurtosis coefficient is above [3] for FDI and DI, hence these series are leptokurtic suggesting that the probability to obtain extreme values are higher than the normal distribution. For the rest of the series, the distribution produces thinner tails compared to the normal distribution. The Skewness coefficient is positive for all the series except for the GDP, DI and ICT. These positive values imply that the extreme values are located on the right side of the mean. In contrast, for the others, the left tail is longer and the mass of the distribution is concentrated on the right of the mean. Thus, the results of the skewness and the kurtosis coefficients reinforce the rejection of normality.

The study of the dependence structure between variables requires as a preliminary step to build marginal distributions3. To this end, some statistical tools will be used such as tests of stationarity[4], normality, autocorrelation and ARCH effect. Table below summarizes p-values of tests used. According to JB test, distributions are beyond being normal. By referring to KS test, the Student's t-distribution is more appropriate to describe our time series. We turn then to examine the existence of the autocorrelation. The results of LB test show that FDI, CPI, GDP, HC and DEFICIT are autocorrelated with the absence of autocorrelation for the other residual of returns. Likewise, the ARCH effect test indicates the presence of ARCH effects in all series except for CPI and PI. In addition, all the variables are described by EGARCH process except for HC and FD which are described by GJR-GARCH model (see appendix 1).

[2] Human capital (HC), domestic investment (DI), technology transfer (ICT), financial development (FD), political instability (PI), public debt (DEBT), budget deficit (DEFICIT).

[3] This step is fundamental, because using a misspecified model for the margins, leads to a misspecified copula.

[4] By applying ADF test, all the series are stationary at the first difference

Table2: Primary tests

	FDI	CPI	GDP	HC	DI	ICT	FD	PI	DEBT	DEFICIT
JB test	0.0035	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}
KS test[5]	0.1080	0.6866	0.5816	0.2700	0.2068	0.2929	0.3504	0.1579	0.2543	0.1895
LB test	7.7716e-15	0.0072	0.0093	0.0196	0.9071	0.2079	0.1950	0.7555	0.6263	0
ARCH test	0.0138	0.3976	2.187e-05	1.054e-06	5.280e-06	4.556e-06	1.179e-07	0.695	0.003	4.3347-04

4.2. Bivariate Copula results

4.2.1. Dependence on average

- **Rank correlation**

Table 3: Rank correlation matrix

	Overall period		Pre-revolution		Post-revolution	
	Kendall	Spearman	Kendall	Spearman	Kendall	Spearman
GDP-FDI	0.1516	0.1959	0.0290	0.0270	0.4452	0.5665
GDP-CPI	0.0641	0.0741	0.0495	0.0581	0.0686	0.0748
CPI-FDI	0.0257	0.0285	-0.0129	-0.0293	-0.0108	-0.0064

According to Kendall and Spearman coefficients, there is a positive correlation between GDP and FDI for all the periods suggesting that FDI plays a considerable role in boosting economic growth. On the other hand, we find that CPI6 is positively associated with GDP which implies that an increase of the level of corruption leads to a decrease of the GDP per capita. Furthermore, we find a positive relationship between CPI and FDI during the full sample. In other words, an increase of the level of corruption in Tunisia may discourage foreign investments. Unfortunately, these results are insufficient until we identify the appropriate fitting copulas to our data.

- **Fitting Copula**

We turn to estimate copula functions for each pair and for all the periods using a Canonical Maximum Likelihood (CML) method. Indeed, as it is shown previously, our return data are exposed to autocorrelations and ARCH effects. For that, we consider the vector of standardized residuals from EGARCH and GJR-GARCH models (instead of the returns) and transform it into the vector of uniform variates using the ECDF. Given that the studied copulas provide different interpretations (see appendix 2), a question of high importance arises: Which copula to choose? The decision rule is to choose the copula which maximises the log likelihood and minimises the AIC and BIC criterion.

[5] The null hypothesis is that the distribution of the return series comes from the specific distribution object of test and under the alternative hypothesis, the distribution of returns is different from the distribution object of test. In our case we test whether our series are Student's t-distributed.

[6] We note that the CPI ranges from 0 to 10, where 0 indicates high level of corruption and 10 indicates less level of corruption into the country. Indeed, a positive dependence between CPI and GDP means that economic growth increases as the level of corruption decreases, thus corruption hurts economic growth.

➢ **Copula selection**

According to appendix 3 and 4, the most appropriate copula for all pairs is the Student-t copula except for the pair GDP-FDI during the second sub period where the Gumbel copula is the most adequate to model the dependence structure.

4.2.2. Dependence in extreme movements

Now, we analyze the dependence in times of extreme market movements . We identify and focus on periods of crises and high incertitude which is the Tunisian revolution (TR) that dates from 2011 to 2014.We reproduce the same procedure explored previously. According to table below, there is no co-movement between GDP-CPI and CPI-FDI during the post-revolution period if any shock happens. However, there is a meaningful impact of FDI on GDP. Indeed, a negative or positive shock leads the FDI to cause the economic growth of Tunisia. This finding is thus consistent with the view that high (low) level of FDI into a country leads to increase (reduce) the extreme dependence level of its economic growth.

Table 4: Tail dependence (TR)

	λ_L	λ_U
GDP-FDI	0.6066	0.6066
GDP-CPI	0	0
CPI-FDI	0	0

4.2.3. Nonlinear Granger causality test

In order to further analyze the cause-effect relation, we use the nonlinear Granger causality test seen that the linear Granger causality test assumes linearity7. Obtained values of F-test show that there is a bidirectional relationship between FDI and GDP. On the other hand, we find a unidirectional causality from CPI to economic growth. Similarly, a unidirectional causality was perceived from CPI to FDI.

Table 5: Nonlinear Granger causality test results

	Direction					
	GDP⇨FDI	**FDI⇨GDP**	**GDP⇨CPI**	**CPI⇨GDP**	**CPI⇨FDI**	**FDI⇨CPI**
F-statistic*	9.09808	2.02265	0.530202	11.1893	3.58014	1.61017

4.2.4. Discussions

Empirical findings show evidence that FDI acts as a stimulus for growth. Thus, when FDI rises, GDP per capita should be seen growing. Furthermore, through the granger causality test, we find that economic growth is recognized as a determinant for attracting multinational firms. A growing market can be attractive to foreign investors because it leads to an increase in the aggregate demand and offers the opportunity to benefit from economies of scale (Zhang, 2001). The obtained results reveal also that corruption is directly and negatively associated with economic growth especially after the revolution

[7] BDS test confirms the existence of the phenomenon of nonlinearity in the residuals and therefore using the linear Granger causality test may lead to misspecification.

compared to the pre-revolution period. Somewhat surprisingly, we find a negative relationship between CPI and FDI during the two sub-periods. In this regard, different explications of this unexpected result. First, GDP per capita prove to be positively correlated with FDI in Tunisia. This finding implies that income or wealth is an important factor that instigates FDI in Tunisia as elsewhere and has a greater impact than corruption. Therefore, an increase of the GDP or another determinant of FDI, increases FDI even if corruption rises. Another explication supported by Helmy (2013) is that, given that corruption can be viewed as a means of economic expansion by overcoming restrictive laws, so that the benefits generated by FDI exceeds the costs supported by corruption.

Apart from dependence on average, we have turned to assess the dependence structure in times of extreme market conditions. Our findings reveal that there is a significant impact of FDI on GDP. Indeed, a negative shock leads the FDI to cause the economic growth of Tunisia.

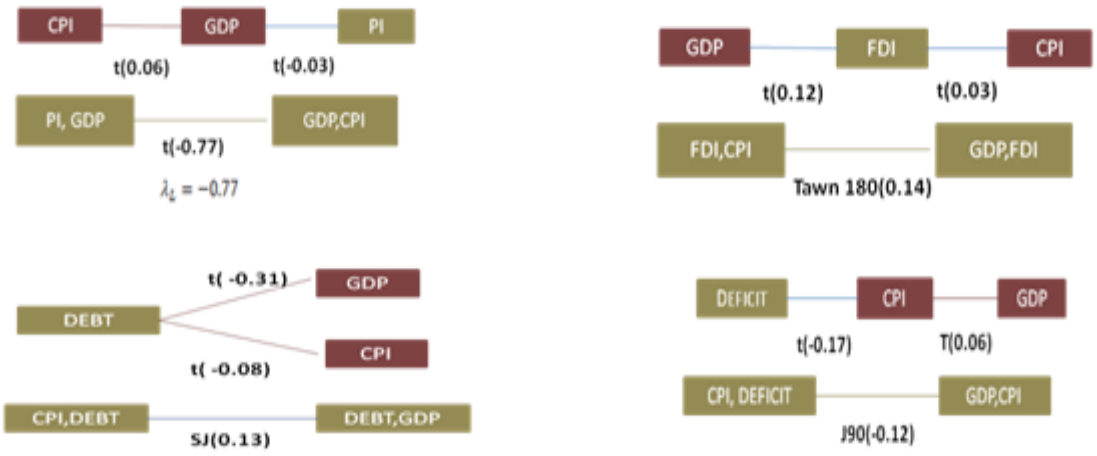
4.3. Multivariate Copula results

4.3.1. Constructing Vine Copulas

First of all, we specify the order of the variables by calculating the empirical Kendall's tau for all the considered pairs and select the variable which has the sum of the absolute value of all Kendall's tau maximized.8 Then, we follow the process of parameter estimation for the vine copula using the maximum likelihood estimation (MLE). Finally, we select the appropriate vine model (C-vine or D-vine) for each channel to analyze whether it serves as a source of indirect effect of corruption/FDI on economic growth. Information criterions9 reveal that the C-vine structure for DEBT and HC is more appropriate than the D-Vine, whereas the latter is more suitable than the former for the rest of the channels. After estimating and selecting the appropriate vine model for each channel, we plot the tree structure of our vine copula models that give us a clear vision about the dependence structure.

4.3.2. Discussions

- **Indirect effects of Corruption**



8 For DEBT: DEBT (order 1), GDP (order 2), CPI (order 3). For PI: CPI (order1), GDP (order2), PI (order3). For DEFICIT: DEFICIT (order1), CPI (order2), GDP (order3). For FDI: GDP (order 1), FDI (order 2), CPI (order 3). For DI: DI (order 1), GDP (order 2), FDI (order 3). For FD and HC: GDP (order 1), transmission channel (order 2), FDI (order 3). For ICT: GDP (order 1), FDI (order 2), ICT (order 3).

9 LL, AIC and BIC criterions

According to trees presented above:

- There is a significant negative dependence on average between CPI and PI conditional on growth (-0.77). Thus, Corruption hurts economic growth through its detrimental impacts on political instability. In addition, during extreme conditions, there is a significant negative effect of corruption on growth through political instability ($\lambda_L = -0.77$). This is obviously due to the revolution period where Tunisia has experienced a policy transition which affects the stability of the country and creates uncertainties. Indeed, in 2011, the CPI has marked a significant decrease in its history to reach 3.8.
- A positive dependence was perceived between GDP and CPI conditional on FDI (0.14). Hence, an increase of level of corruption reduces the impact of FDI on economic growth, suggesting that the presence of strong institution quality and regulatory mechanism have an impact in attracting foreign investors.
- There is a negative dependence on average between GDP and DEFICIT conditional on CPI (-0.12). Furthermore, we find a positive dependence on average between CPI and GDP conditional on DEBT (0.13). Therefore, we can conclude that corruption was an issue that contributes to an increase of the level of public debt and budget deficit in Tunisia. Indeed, corruption is a conductive of the accumulation of larger public debt and budget deficit because it leads to an increase of public expenditures and a decrease of public revenues through tax evasion.

➢ **Indirect effects of FDI**

The 3-dimensional C-vine and D-vine tree graphs reveal:

- A positive dependence on average between FDI and DI conditional on GDP (0.3). So, FDI contributes to boost economic growth by bringing positive impact to domestic investment. Multinational firms stimulate rather than crowd out local firms. More precisely, the presence of foreign investment on the Tunisian market allows feed the local market through the advantageous competition, pushing local firms to higher productivity.
- A positive dependence was perceived between GDP and ICT conditional on FDI (0.08). Therefore, FDI located in Tunisia represents one of the generating resources of technology transfer. This brings an important advantage to the economic growth of Tunisia through the transfer of a new technology for a country that seeks to develop.
- A weak positive dependence between FDI and GDP conditional on FD (0.06). Indeed, FDI exerts positive externalities on banking sector by improving the monetary availability of banks, which allows them to grant more credit. However, in this study, we specify only banking sector to measure financial development and we ignore the stock market which suffers from narrowness.
- A negative dependence on average between HC and FDI conditional on GDP (-0.05). Attracting FDI into the country will not contribute to increase the quality of human resources yet the latter improves perfectly the country's economic growth (dependence on average: 0.38). Indeed, FDI in Tunisia is predominantly in sectors not in need of skilled workers, thus FDI is not expected to have a positive impact on tertiary school enrolment rate.

Conclusion and policy implications

Sustainable economic growth was and still remains one of the main goals of every government. There have been various measures undertaken by government aiming to attract FDI, as it is considered as a source to promote the Tunisian economy. Concurrently, corruption appears as a grave concern that would hurt not only investment by the overall economy. In this paper, we attempt to assess the roles of these two factors by analyzing the channels through which they may affect growth.

Empirical results find a negative dependence between corruption and GDP per capita, as well as a bidirectional causality exists from corruption to growth suggesting that corruption decreases economic growth. Moreover, we find that political instability, public debt, budget deficit are channels through which corruption impacts economic growth. Results reveal also that corruption can hinder economic growth by reducing FDI. On the other hand, we find that an increase of the FDI will generate various positive effects on growth. The C-vine and the D-vine copulas show that foreign investments impacts growth indirectly by generating resources of technology transfer, bringing positive impact to domestic firms and improving financial development. However, no effect on the quality of human resources is shown.

Despite the advantages generated by foreign investors, Tunisia has experienced insufficient levels of development. Current and future Tunisian governments need to focus their efforts on improving FDI attraction policies and absorption capacity in order to establish a more favorable environment for the development. Policies should focus on three important areas; enhancing macroeconomic stability, improving infrastructure and strengthening the good governance and anti-corruption strategy. Furthermore, they need to put forward huge efforts to fight corruption by implementing new rules and laws that aim to reduce corruption and encourage transparency. These efforts may bring positive impact on economic growth by reducing public debt and budget deficit, attaining higher political stability and attracting more FDI.

For future research, it will be more interesting to investigate the impact of FDI on growth in Tunisia during the COVID- 19 period to make a comparison with that of the Revolution. Furthermore, it is useful to include other developing countries to show how corruption affects growth in countries with different institutional settings or at different stages of economic development.

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Appendix

Appendix 1: information criteria for GARCH models

	GARCH		EGARCH		GJR-GARCH	
	BIC	AIC	BIC	AIC	BIC	AIC
GDP	-376.9487	-381.8805	**-416.7140**	**-426.5776**	-374.3140	-381.7118
FDI	-28.5783	-35.9760	**-30.3032**	**-40.1668**	-25.7495	-35.6132
HC	-394.1368	-399.0686	-415.3712	-425.2348	**-419.0808**	**-428.9444**
DI	-329.5259	-334.4577	**-327.0238**	**-336.8874**	-328.0947	-335.4924
ICT	-350.2099	-357.6076	**-372.8405**	**-382.7042**	-363.8975	-373.7611
FD	-378.3399	-384.0860	-362.8436	-372.7073	**-379.1541**	**-388.2035**
DEBT	-300.9665	-308.3643	**-342.8834**	**-352.7470**	-301.8473	-311.7109
DEFICIT	-135.9096	-143.3074	**-137.4013**	**-147.2649**	-135.0914	-144.9550

Appendix 2: CML estimation of copulas parameters

Overall period						
	Gaussian	Student-t		Frank	Clayton	Gumbel
	ρ	ρ	ϑ	θ	θ	θ
GDP-FDI	0.3348	0.2807	197.1489	1.7118	0.5553	1.2777
GDP-CPI	0.1457	0.1055	197.1535	0.5693	0.2053	1.1027
CPI-FDI	0.0176	0.0778	197.1535	0.3112	0.0227	1.0113
Pre-revolution						
	Gaussian	Student-t		Frank	Clayton	Gumbel
	ρ	ρ	ϑ	θ	θ	θ
GDP-FDI	0.0201	0.1195	197.1527	0.1966	0.0259	1.0130
GDP-CPI	0.1826	0.0484	197.1529	0.6979	0.0992	1.0496
CPI-FDI	0.0377	0.0395	197.1527	0.3327	0.0492	1.0246
Post-revolution						
	Gaussian	Student-t		Frank	Clayton	Gumbel
	ρ	ρ	ϑ	θ	θ	θ
GDP-FDI	0.7761	0.7367	2.4480	6.7533	2.6040	2.3020
GDP-CPI	-0.0742	0.0673	197.153	0.1109	0.2648	1.1324
CPI-FDI	-0.2847	0.0549	197.153	0.4852	0.4503	1.2252

Appendix 3: Results of the LL, AIC and BIC criterions (full sample)

	Elliptical copulas					
	Gaussian			**Student-t**		
	LL	**AIC**	**BIC**	**LL**	**AIC**	**BIC**
GDP-FDI	-7.6805	-13.3610	-10.8951	+∞	−∞	−∞
GDP-CPI	-0.1488	1.7024	4.1683	+∞	−∞	−∞
CPI-FDI	- 1.3548	-0.7096	1.7563	+∞	−∞	−∞

	Archimedean copulas								
	Gumbel			**Clayton**			**Frank**		
	LL	**AIC**	**BIC**	**LL**	**AIC**	**BIC**	**LL**	**AIC**	**BIC**
GDP-FDI	- 1.1671	-0.3342	2.1317	-3.0729	-4.1457	-1.6798	-3.1810	-4.3619	-1.8960
GDP-CPI	- 7.6153	-13.2306	-10.7647	-0.1258	1.7483	4.2142	-0.1112	1.7775	4.2434
CPI-FDI	- 2.5261	-3.0522	-0.5863	-1.4116	-0.8231	1.6428	-0.5083	0.9834	3.4493

Appendix 4: Results of LL, AIC and BIC criterions for the first and second sub-periods

	First sub-period					
	Gaussian			**Student-t**		
	LL	**AIC**	**BIC**	**LL**	**AIC**	**BIC**
GDP-FDI	1.5108	-1.0216	1.4443	+∞	−∞	−∞
GDP-CPI	0.8474	0.3053	2.7712	+∞	−∞	−∞
CPI-FDI	0.3406	1.3187	3.7846	+∞	−∞	−∞

	Gumbel			**Clayton**			**Frank**		
	LL	**AIC**	**BIC**	**LL**	**AIC**	**BIC**	**LL**	**AIC**	**BIC**
GDP-FDI	0.0013	1.9973	4.4633	0.3879	1.2242	3.6901	0.0244	1.9511	4.4170
GDP-CPI	20.7626	-39.5252	-37.0593	0.0793	1.8414	4.3073	5.5155e-04	1.9989	4.4648
CPI-FDI	4.9312	-7.8624	-5.3965	0.3167	1.3667	3.8326	0.1557	1.6886	4.1545

	Second Sub-period					
	Gaussian			**Student-t**		
	LL	**AIC**	**BIC**	**LL**	**AIC**	**BIC**
GDP-FDI	37.8798	-73.7597	-71.2937	44.4193	-86.8386	-84.3727
GDP-CPI	0.0070	1.9859	4.4518	+∞	−∞	−∞
CPI-FDI	2.22 e-04	1.9996	4.4655	+∞	−∞	−∞

	Gumbel			**Clayton**			**Frank**		
	LL	**AIC**	**BIC**	**LL**	**AIC**	**BIC**	**LL**	**AIC**	**BIC**
GDP-FDI	**46.9168**	**-91.8336**	**-89.3677**	5.2761	-8.5521	-6.0862	11.5843	-21.1686	-18.7027
GDP-CPI	10.0386	-18.0773	-15.6114	0.3770	1.2460	3.7119	0.2511	1.4979	3.9638
CPI-FDI	18.7600	-35.5201	-33.0542	0.9760	0.0479	2.5138	0.0215	1.9569	4.4229

Enjeux des cryptomonnaies en tant qu'actif d'investissement pour les banques centrales : Cas de la Banque Centrale de Tunisie

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Résumé

Dans ce travail, nous étudions l'intérêt d'intégrer les cryptomonnaies comme étant un actif dans le portefeuille d'investissement de la Banque Centrale de Tunisie. Nous avons utilisé le Bitcoin et l'Ethereum. Ce travail utilise principalement le cadre de la Moyenne-Variance de Markowitz, afin d'étudier les performances des portefeuilles diversifiés avec et sans inclusion des cryptoactifs. Nos résultats fournissent des preuves empiriques quant au gain de diversification fourni par les cryptoactifs au portefeuille de réserve de change de la Banque Centrale de Tunisie. Cela se traduit par l'amélioration du rendement du portefeuille à variance minimale, sans qu'il n'y ait une importante minimisation du risque, et ce malgré leur modeste pondération. Les résultats de notre étude soutiennent aussi l'idée selon laquelle la crise du Covid-19 consolide l'attrait pour les cryptoactifs en tant qu'actif refuge.

Mots-clés : cryptoactifs ; banques centrales ; réserves de change ; optimisation de portefeuille ; Moyenne-Variance de Markowitz.

Introduction

Ces dernières décennies ont été marquées par une croissance considérable des technologies innovantes qui exigent une restructuration de l'économie mondiale traditionnelle. Les cryptomonnaies et les blockchains en sont un exemple. En effet, les avantages offerts par ces dernières et leur marché qui a explosé en taille pour devenir une industrie mesurée en milliards, plutôt qu'en millions de dollars remettent en question et modifient le système financier traditionnel.

Étant donné le nom « cryptomonnaies », nous pourrions nous attendre à ce que les cryptomonnaies puissent être considérées comme des monnaies. Cependant, ce lien primitif est considéré par plusieurs chercheurs comme étant trompeur étant donné qu'elles n'aient pas le pouvoir de respecter les critères d'une monnaie traditionnelle (être une unité de compte, un moyen de paiement et une réserve de valeur). En effet, les cryptomonnaies ne remplissent que partiellement les conditions. C'est seulement l'attribut de moyen d'échange qui est rempli et respecté par les cryptomonnaies à forte capitalisation. En revanche, il semble que, d'un point de vue économique, les cryptomonnaies aient le pouvoir de respecter les trois exigences initialement introduites par Sharpe en 1992 (l'exclusivité mutuelle entre les autres classes, l'exhaustivité au sein de la classe elle-même, et la différence significative dans les rendements par rapport aux autres actifs), ce qui a conduit les chercheurs et la majorité des banques centrales à les considérer comme des actifs et nous parlons donc des cryptoactifs.

Le potentiel de ces derniers n'échappe pas non plus aux banques centrales. A l'origine, ces institutions ont regardé les cryptoactifs comme une initiative farfelue qui allait s'étouffer dans sa propre volatilité. Pourtant, aujourd'hui les banques centrales sont de plus en plus attirées par cette innovation qui semble servir à ces institutions à des fins diverses. En effet, la littérature a jusqu'à présent solidement établi les avantages potentiels de la détention des cryptoactifs dans des portefeuilles d'investissement. Elle montre que ces derniers sont utiles à la fois pour la gestion des risques comme pour l'optimisation de portefeuille (Burniske et White, 2017 ; Ankenbrand et Bieri, 2018 ; Elendner et al, 2018 ; Kim et al, 2018 ; Krueckeberg et Scholz, 2019 ; Yechi et al, 2020). Par conséquent, même les banques centrales pourraient être amenées à revoir les instruments dans lesquels elles placent la majeure partie de leurs réserves de change et à incorporer les cryptoactifs dans leurs portefeuilles. Des banques centrales ont

même commencé à examiner les enjeux des cryptoactifs privés existants, à l'instar du Bitcoin, en tant qu'actif d'investissement.

Notre travail vise principalement à répondre à la question de savoir s'il est intéressant que ces cryptoactifs soient intégrés au portefeuille de réserve de change de la banque centrale de Tunisie en tant qu'actif d'investissement grâce à une meilleure optimisation du couple risque-rendement. Nous examinons aussi le comportement des cryptoactifs lors de la dernière crise sanitaire afin de vérifier s'ils ont joué durant cette période le rôle de valeur refuge.

Ce travail est doté de nombreuses contributions. Premièrement, il contribue à la littérature existante dans le sens où les travaux quant à l'inclusion des cryptomonnaies dans les réserves de change des banques centrales sont peu nombreux jusqu'à aujourd'hui. A notre connaissance, notre étude est l'une des premières à examiner l'effet des cryptomonnaies dans les réserves de change des banques centrales. Deuxièmement, les résultats empiriques de notre travail permettront de clarifier et d'accroître les connaissances quant au comportement des cryptomonnaies durant les crises et leur potentiel en matière d'optimisation et de diversification des portefeuilles, étant donné qu'à ce jour, les résultats demeurent mitigés. Finalement, les résultats de notre recherche, seront d'une importance capitale pour la Banque Centrale de Tunisie et pourraient l'inciter à réfléchir à l'ajout des cryptomonnaies dans ses réserves de change et à être parmi les premières banques centrales à rompre avec les mécanismes d'investissement traditionnels et à diversifier ses réserves. Cependant, avant de procéder à ces changements, notre travail pourrait monter la pression en faveur des lois favorables aux cryptoactifs en Tunisie qui s'alignent avec les règlementations internationales de plus en plus nombreuses.

1. Revue de la Littérature

Les opinions sur les mérites de l'ajout de cryptoactifs à un portefeuille varient. D'abord, Glaser et al (2014), Elbeck et Baek (2015) et Ward et Rochemont (2019) stipulent qu'ils s'agissent d'actifs spéculatifs qui permettent aux investisseurs de réaliser des profits importants. En effet, il semble que les cryptoactifs ne sont pas corrélés aux actifs traditionnels, tels que les actions et les obligations, et qu'ils étaient principalement utilisés comme des investissements spéculatifs (Baur et al, 2018). D'ailleurs, la hausse spectaculaire du cours des principaux cryptoactifs au début de leurs mises en circulation, notamment du Bitcoin, est due sans aucun doute en grande partie à une demande spéculative. Autrement dit, le Bitcoin à titre d'exemple n'était pas acheté au début que dans l'attente que son prix augmentera pour le revendre plus cher (Rotelli, 2018).

Cependant, il faut noter que malgré la nature spéculative de ces actifs et la présence des investisseurs, qui par appétit pour le risque, vont utiliser les liquidités injectées dans l'économie pour faire des investissements dans les cryptoactifs dans l'espoir d'avoir des retours significatifs, l'utilisation de cette innovation à des fins spéculatives commence à diminuer avec le temps (Yatié, 2021). En effet, l'année 2020 a été une année exceptionnelle pour les cryptoactifs, avec un changement dans leur perception par les acteurs institutionnels. Ces derniers, qui étaient autrefois très sceptiques quant à la détention de ces actifs, ont commencé à revoir leurs positions. Par exemple, la banque JP Morgan qui auparavant avait qualifié les cryptoactifs de produits purement spéculatifs, change d'avis en accueillant en juin 2020 les plateformes d'échange Coinbase et Gemini tout en conseillant ses clients d'investir 1 % de leurs portefeuilles en cryptoactifs. De plus, la banque centrale du Kenya a annoncé envisager acheter des Bitcoins pour se protéger de la dépréciation de sa monnaie face au dollar (Yatié, 2021).

En bref, il semble que les cryptoactifs ne s'agissent plus de simples outils de spéculation, mais qu'ils deviennent de plus en plus de véritables valeurs refuges pour les investisseurs. D'ailleurs certains stipulent qu'ils ont joué par le passé le rôle de valeur refuge, et comptent continuer de le faire. Selon eux, ces derniers offrent un véritable refuge aux investisseurs et ce en raison de leurs corrélations négatives avec les actifs financiers traditionnels (Brière et al, 2015 ; Dyhrberg, 2016 ; Corbet et al, 2019). Ainsi, il semble que ces cryptoactifs ont été utilisés pour se protéger contre l'incertitude : la sur-réaction des marchés financiers, les politiques monétaires accommodantes, la perte de valeur de la monnaie de certaines économies, notamment émergentes (Yatié, 2021). Par exemple, certains particuliers ont, lors de la crise grecque, investi massivement en Bitcoin car cet actif inspirait bien plus confiance que la monnaie réelle et régulée, en proie à une crise monétaire exceptionnelle et subissant une inflation record. Des tendances similaires ont été observées pendant les résultats de l'élections

présidentielle des États-Unis où les prix de Bitcoin bougeaient par rapport aux chances de Donald Trump gagnant l'élection présidentielle et pendant le référendum sur le Brexit en 2017 où son prix a montré une corrélation presque parfaite avec la probabilité projetée du vote de « sortir », ce qui était considéré comme l'option ayant les impacts les plus négatifs sur les marchés mondiaux (Smith et Rosevear, 2017). Plus récemment, selon Yatié (2021), certains pensent que la crise du Covid-19 a renouvelé l'attrait pour les cryptoactifs en tant qu'actifs refuges, notamment auprès d'investisseurs institutionnels. Cela s'est manifesté via les prix des cryptoactifs qui ont progressé durant cette période, en réaction notamment aux politiques monétaires des différents pays (baisse des taux d'intérêt, rachat d'actifs). Cependant, selon la même source, d'autres stipulent que la crise liée à l'épidémie de coronavirus que nous connaissons actuellement, n'a fait que mettre encore en question le potentiel des cryptoactifs en tant que valeurs refuges (Wątorek et al., 2021). Cela se manifeste surtout par la corrélation négative qui tend à s'estomper et à devenir positive pendant certaines périodes (au début de la crise de Covid-19 par exemple) (Yatié, 2021). Nous pouvons donc constater qu'aucun consensus n'existe jusqu'au nos jours quant au comportement des cryptoactifs durant la dernière crise sanitaire et financière mondiale. De là découle la nécessité de réaliser des recherches empiriques supplémentaires concernant ce sujet.

Enfin, d'autres soutiennent qu'en raison de leur profil risque-rendement particulier et de l'absence de corrélation avec d'autres classes d'actifs, les cryptoactifs entraînent une surperformance ajustée au risque. Nous rappelons que l'amélioration de ce dernier signifie soit la réduction du risque lié au portefeuille sans sacrifier son rendement, soit la maximisation du rendement de portefeuille sans augmenter son risque (Yechi et al, 2020). En d'autres termes, nous voulons tirer un avantage de diversification de son inclusion (Holovatiuk, 2020). La majorité des travaux existants considèrent que le potentiel de diversification des cryptoactifs ressort dans l'amélioration du rendement plutôt que dans la minimisation du risque. Nous citons les travaux de Platanakis et al (2018), Petukhina et al (2018), Holovatiuk (2020), Yechi et al (2020) et les analyses menées par Fidelity et Natixis en 2020. Quant au potentiel des cryptoactifs de réduire le risque, les études sont beaucoup moins nombreuses. Nous citons, la recherche de Brauneis et al (2018) qui est la première à avoir mis en évidence un potentiel de réduction du risque considérable par l'ajout de plusieurs cryptoactifs dans un portefeuille contenant des classes d'actifs traditionnelles. De plus, Guesmi et al (2018) ont révélé que les stratégies de couverture impliquant des cryptoactifs (représentées par le Bitcoin) réduisent considérablement le risque d'un portefeuille par rapport à un portefeuille qui ne compte pas le Bitcoin parmi ses composantes. La même conclusion a été tirée par Symitsi et Chalvatzis, (2019).

Alors que la littérature devient de plus en plus riche pour ce qui est des travaux ayant abordé le sujet de l'optimisation de portefeuille des investisseurs en général via l'inclusion des cryptoactifs, la réflexion sur les banques centrales reste relativement inexplorée et les travaux quant à l'inclusion des cryptoactifs dans leurs réserves de change sont peu nombreux. La question sur rôle potentiel des cryptomonnaies en tant qu'actifs de réserve de change a été abordée par Clark et Mihailov (2019). Les auteurs se sont intéressés au cas de la Banque d'Angleterre (BoE). Une analyse contrefactuelle a été élaborée pour avoir un aperçu visuel de ce qui aurait pu se passer si la BoE avait investi une fraction de ses réserves de change dans le Bitcoin et l'Ethereum. Ils ont constaté que le portefeuille incluant les cryptoactifs a obtenu de meilleurs rendements que le portefeuille traditionnel de réserves de change. Mais, cette surperformance est accompagnée par un niveau extrême de prise de risque, chose qui est à l'encontre des banques centrales. Ce résultat met en doute le bénéfice de la diversification procurée par les cryptoactifs.

Un tel constat est conforme aux conclusions tirées par de nombreux autres auteurs. En effet, Perugini et Maioli (2014) affirment que le Bitcoin, à titre d'exemple, est susceptible de connaître davantage de périodes de forte volatilité, rendant sa viabilité en tant que partie d'un portefeuille diversifié dépendante de sa capacité à compenser la volatilité "extrême" par des rendements significativement élevés et une faible corrélation continue. En outre, ils révèlent qu'à long terme, l'ajout de Bitcoins à un portefeuille n'a aucun effet. Cette suggestion s'aligne sur l'observation de Kajtazi et Moro (2017) selon laquelle l'effet de l'ajout de Bitcoin à un portefeuille optimal est incohérent au fil des ans (après 2013, il s'est avéré qu'il n'avait aucun effet alors qu'avant 2013, il présentait des avantages significatifs). L'étude n'a pas non plus réussi à produire un portefeuille plus efficient lorsque le Bitcoin est ajouté, ce qui s'explique en partie par le fait qu'il n'y avait pas d'effet sur le portefeuille. De plus, les mêmes auteurs

ont évalué l'impact du Bitcoin sur l'optimisation et la diversification des portefeuilles dans le contexte d'investisseurs américains, européens et chinois en ajoutant le Bitcoin à quatre scénarios de portefeuille différents. Ils ont indiqué que le Bitcoin améliorait le rendement mais augmentait le risque des portefeuilles. Ajoutons finalement que Holovatiuk (2020) a utilisé à la théorie post moderne de portefeuille PMPT et stipulent qu'en raison de l'extrême volatilité des cryptoactifs, en particulier le risque de baisse, les mesures de performance se sont détériorées, ce qui signifie que les cryptoactifs ne peuvent pas offrir un avantage de diversification pour l'investisseur.

L'absence de consensus peut être attribuée à de nombreux facteurs, notamment à des méthodologies et à des périodes d'échantillonnage différentes. Afin de clarifier, voire de dégager un consensus, sur le rôle approprié que les cryptoactifs devraient ou pourraient jouer dans la gestion de portefeuille, des recherches empiriques supplémentaires sont nécessaires. Cette nécessité est beaucoup plus persistante pour le cas des banques centrales dont les travaux quant à l'inclusion des cryptoactifs dans leurs réserves de change sont peu nombreux.

Notre travail contribuera donc aux deux objectifs mentionnés ci-dessus, et ce en se référant au cas de la Banque Centrale de Tunisie (BCT).

2. Démarche Méthodologique

2.1. Variables et données

Le choix des actifs de base à inclure dans ce travail est justifié par notre volonté de s'adapter au mieux au profil d'investissement particulier de la BCT et de se conformer donc au cadre de gestion des réserves de change de ladite banque. Nous rappelons que la BCT a mis en place une politique rigoureuse de sélection des marchés, des actifs et des contreparties. Le champ d'investissement a été limité aux marchés des obligations gouvernementales et supranationales avec des marchés secondaires profonds et liquides, qui garantissent le plus haut niveau de sécurité et ce dans l'objectif de limiter l'exposition aux risques du marché obligataire et de gérer le risque de liquidité et le risque de crédit. En outre, les obligations à retenir doivent être émises en USD. Ce choix trouve sa justification dans le fait que l'USD représente la devise la plus détenue par la majorité des banques centrales et dans notre recherche de se concentrer strictement sur cette dernière étant donné que les cryptoactifs choisis s'échangent directement en dollars américains et que leur marché américain est le plus mature.

Cependant, dans la pratique et au moment de choix des obligations à retenir, nous nous sommes heurtés à la limite quant à leurs notations. En effet, d'une part il fallait retenir des obligations gouvernementales et supranationales émises par des pays différents et en USD et, d'autre part, il fallait que ces dernières soient bien notées, c'est-à-dire ayant une notation AAA. Nous avons retenu, dans un premier lieu, l'obligation supranationale de la banque islamique de développement (AAA). Cependant, pour le reste des obligations, nous n'avons pas trouvé des obligations qui répondent à nos besoins (à savoir la notation et émises en USD) qui sont encore en cours de vie (non totalement amorties). Ainsi, il fallait supposer que la BCT est prête à investir dans l'obligation gouvernementale américaine (AA+) et l'obligation gouvernementale internationale japonaise (A+).

Il a été décidé d'inclure comme obligations : l'obligation supranationale de la banque islamique de développement (ISDB), l'obligation gouvernementale américaine (US) et l'obligation gouvernementale internationale japonaise (JBIC). Ces obligations sont émises en USD.

Pour les cryptoactifs, nous nous alignons dans notre choix aux recherches précédentes. Nous trouvons que le classement des cryptomonnaies par capitalisation boursière est l'approche la plus courante et a été utilisée dans plusieurs études sur le marché des cryptoactifs et qu'un potentiel de réduction du risque considérable existe par l'ajout de plusieurs cryptomonnaies, plutôt que d'une seule dans un portefeuille contenant des classes d'actifs traditionnelles. Ainsi, il a été décidé d'inclure le Bitcoin (BTC) et l'Ethereum (ETH). La sélection de ces variables a été réalisée à partir des données de capitalisation boursière observées sur « coinmarketcap.com ».

Des données relatives aux prix de clôture quotidiens en jours ouvrables de ces variables nous ont été communiquées par la BCT. Ces données vont nous servir pour le calcul de leurs taux de rendement respectifs. La période d'échantillonnage des variables s'étend du 26 février 2019 au 1er octobre 2021.

Le nombre total d'observations pour chaque variable est de 654 observations. De plus, des données concernant les taux des rendements actuariels couvrant la même période nous ont été communiquées aussi. Ces données nous seront utiles pour la définition de nos différentes périodes d'études.

2.2. Définition des périodes d'études

La période d'échantillonnage des variables a été marquée par une crise sanitaire inédite (Covid-19) qui a affecté tous les marchés boursiers du monde. Comme l'impact de cette épidémie est très important, il ne peut pas être négligé dans notre analyse. Nous procédons dans notre travail à examiner l'évolution des rendements actuariels des obligations retenues afin de définir deux sous-périodes avant et après la pandémie du Covid-19.

2.3. Construction des portefeuilles

Pour chaque sous-période étudiée, nous construisons les deux portefeuilles suivants.

- **Portefeuille de base**

C'est un portefeuille simulé et construit en se basant sur les obligations précédemment mentionnées.

- **Nouveau portefeuille**

Après la construction du portefeuille de base, le Bitcoin (BTC) et l'Ethereum (ETH) seront ajoutés à ce dernier pour voir s'ils offrent des avantages en termes de risque et de rendement et quel pourcentage doit être investi dans ces deux cryptoactifs.

Nous optimisons les portefeuilles construits suivant le cadre traditionnel de sélection et d'optimisation de portefeuille moyenne-variance de Markowitz.

2.4. Optimisation moyenne-variance de Markowitz

Nous utilisons le cadre traditionnel de sélection de portefeuille moyenne-variance (MV) pour examiner les opportunités d'investissement présentées à la BCT par les cryptoactifs. Avant d'identifier formellement les préoccupations concernant l'optimisation pour l'analyse moyenne-variance de Markowitz, nous calculons, les rendements quotidiens de chaque actif au moyen de la formule suivante :

$$R_{i,t} = \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}} \qquad (1)$$

Où $P_{i,t}$ t est le prix du i-ème actif dans les données au temps t. $P_{i,t-1}$ est le prix du même actif au temps t- 1 (c'est-à-dire le jour précédent), $R_{i,t}$ est le rendement de l'actif i, au temps t.

En utilisant ces derniers, nous calculons le rendement attendu $E(R_i)$ et l'écart type σi pour l'actif i en utilisant les formules suivantes.

$$E(R_i) = \frac{\sum_{t=1}^{n} R_{i,t}}{n} \qquad (2)$$

$$\sigma(R_i) = \sqrt{Var(R_i)} = \sigma_i = \sqrt{\frac{1}{n-1}\sum_{t=1}^{n}(R_i - E(R_i))^2} \qquad (3)$$

Où t est le nombre d'observations pour l'actif i.

Les rendements attendus et les écarts types, tels que calculés ci-dessus, fournissent quotidiennement les caractéristiques de rendement et de risque des actifs individuels et ils feront l'objet des statistiques descriptives qui vont nous permettre d'avoir un premier aperçu sur l'ensemble des variables de notre travail. En outre, ils seront utilisés dans le cadre de notre problème d'optimisation et par conséquent pour le calcul du rendement de chaque portefeuille, de sa variance et de son coefficient de variation. De plus, moyennant ces derniers, nous obtiendrons la matrice de corrélation. Il sera

immédiatement visible si les cryptoactifs offrent des avantages ou non, en examinant les valeurs de leurs corrélations avec les obligations. Enfin, à l'aide des coefficients de corrélation, nous pourrons également répondre à la question de savoir s'ils représentent ou non un refuge pour la BCT pendant la période de crise.

Nous calculons, le rendement et la variance de chaque portefeuille construit, composé de m actifs, comme indiqués ci-dessous :

$$E(R_p) = \sum_{i=1}^{m} w_i E(R_i) \qquad (4)$$

Où R_p est le rendement du portefeuille, Ri est le rendement de l'actif i, w_i est la pondération d'un actif individuel et i représente le nombre d'actifs dans le portefeuille.

$$Variance = W^T \sum W \qquad (5)$$

Où $W = (w_1, w_2, \dots, w_n)$ est le vecteur des poids, et Σ désigne la matrice de variance-covariance des actifs du portefeuille.

Comme la BCT est considérée comme un investisseur conservateur et prudent qui cherche à minimiser le risque de son portefeuille, nous formulons et nous résolvons la version suivante de l'analyse moyenne-variance de Markowitz.

$$Min\ Variance = W^T \sum W$$
$$s.c.\ w^T E(R_p) = \alpha \qquad (6)$$
$$\sum_{i=1}^{m} w_i = 1$$

$w_i \geq 0$ pour tous les i

Où α est le niveau de rendement.

Il s'agit ici de chercher à chaque fois les pondérations optimales requises qui offrent à la BCT le niveau de risque le plus faible possible, et ce en ne considérant que les obligations dans un premier temps et de travailler ensuite avec les obligations et les cryptoactifs. La première contrainte définit un taux de rendement minimum, bien qu'elle puisse être omise, comme nous allons faire puisque l'objectif de la BCT est la minimisation absolue du niveau de risque. La deuxième contrainte oblige à investir tout l'argent, de sorte que la somme de tous les poids soit égale à 1, tandis que la dernière condition impose des positions longues dans tous les actifs.

Une fois les caractéristiques du portefeuille optimisé en termes de rendement et de risque, nous calculons leurs valeurs périodiques et nous calculons par la suite le coefficient de variation appelé aussi l'écart-type relatif. Mathématiquement, la formule standard de ce dernier est exprimée de la manière suivante :

$$CV = \frac{\sigma_p}{E(R_p)} \qquad (7)$$

Suivre cette démarche à chaque fois va nous permettre d'avoir des positions d'investissement où la BCT obtient le risque le plus faible pour un niveau de rendement donné. Ce processus d'optimisation va nous permettre d'évaluer l'impact de l'inclusion des cryptoactifs dans le portefeuille de référence.

Par la suite, à travers la résolution du problème d'optimisation mentionné ci-dessus pour différents niveaux de rendements (cette fois la première contrainte sera utilisée), nous fournissons les profils risque-rendement, avec et sans l'ajout de cryptoactifs dans le portefeuille de base et nous identifions la frontière efficiente de ces portefeuilles afin d'établir une comparaison entre les deux. Nous pourrons ainsi conclure si les cryptoactifs offrent des avantages ou non et ce pour chaque sous-périodes étudiée.

2.5. Approche naïve :

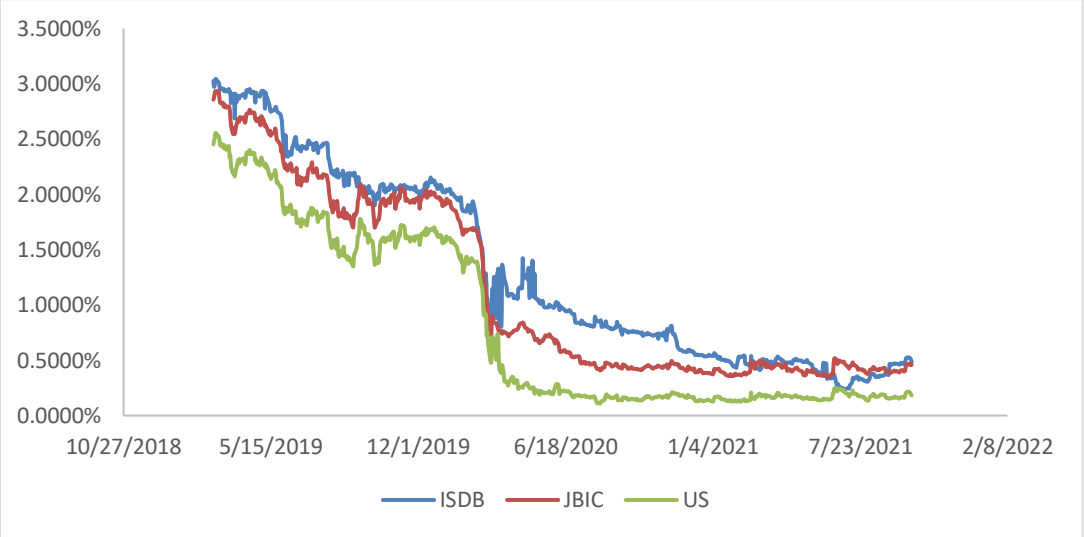
Cette approche nous permettra d'examiner en quoi l'impact de l'ajout des cryptoactifs d'une manière naïve sur le couple « rendement risque » diffère de l'ajout des cryptoactifs suivant cadre moyenne-variance de Markowitz. Pour chaque sous-période nous reprenons le portefeuille de base à variance minimale et nous forçons l'allocation des cryptoactifs. Des scénarios dans lesquels 0,1%, 1%, 3% et 5 % des réserves sont investies en cryptoactifs sont également considérés. Nous supposons que ces poids seront déduits de manière égale des différents poids alloués aux diverses obligations qui constituent le portefeuille à variance minimale de base.

3. Résultats empiriques

3.1. Définition des périodes d'études

La figure suivante montre l'évolution des rendements actuariels des obligations retenues dans le cadre de notre travail empirique durant toute la période d'étude.

Figure 1: Évolution des rendements actuariels des actifs de base (26 février 2019 – 01 octobre 2021)



Nous pouvons remarquer que les taux de rendement actuariels de toutes les obligations retenues dans le cadre de notre étude ont été orientés à la baisse. Cette baisse est à l'ordre de 43,2% pour l'obligation américaine, 41,2% pour l'obligation japonaise et à l'ordre de 44,1% pour l'obligation émise par la banque islamique de développement. Ces évolutions peuvent être expliquées par le recours des différentes banques centrales en question à l'assouplissement quantitatif comme mesure de la politique monétaire. L'idée de cette dernière mesure est de faire baisser les rendements des actifs les plus sûrs (obligations souveraines et supranationales) grâce à des achats massifs qui ont pour objectif de faire monter les prix de ces actifs et ainsi de pousser les investisseurs à se reporter vers des classes d'actifs plus attrayantes en termes de rendement.

Cependant, nous remarquons que l'épidémie de Covid-19 a conduit à une chute brutale des rendements de ces obligations en février-mars 2020 (voir figure 1). En effet, la pandémie de Covid-19 a provoqué une récession économique mondiale qui a poussé les banques centrales à adopter une réaction rapide afin de limiter les effets négatifs des chocs de l'offre et de la demande) tout en adoptant de vastes programmes de rachats de dette. Ces constats se traduisent par une baisse des rendements à l'ordre de 86,6% pour l'obligation américaine, 71,9% pour l'obligation japonaise et 71,5% pour l'obligation émise par la banque islamique de développement et ce entre la période qui s'étend du 20 février 2020 au 01 octobre 2021.

Ainsi, durant le reste du travail nous considérons deux sous-périodes d'observation. La première s'étend du 26 février 2019 au 19 février 2020 et la deuxième couvre la période allant du 20 février au 1er octobre 2021, et ce dans l'objectif de prendre en considération l'impact de l'épidémie dans nos

analyses. Les statistiques descriptives et l'analyse de corrélation seront établies pour les deux sous-périodes.

3.2. Statistiques descriptives

Les tableaux 1 et 2 ci-dessous présentent les statistiques descriptives des cryptoactifs et des actifs de base durant les deux sous-périodes considérées.

Tableau 1 : Statistiques descriptives des rendements quotidiens des actifs (Période 1)

	ISDB	*JBIC*	*US*	*BTC*	*ETH*
Moyenne	0,0159%	0,0142%	0,0234%	0,4873%	0,4035%
Écart-type	0,1789%	0,1634%	0,1662%	4,6204%	4,9106%
Kurstosis (Coefficient d'aplatissement)	5,3652	0,5419	1,2617	5,0125	2,4725
L'excès de Kurstosis	2,3652	-2,4581	-1,7383	2,0125	-0,5275
Coefficient d'asymétrie	0,2691	0,0522	0,1550	0,8192	-0,0019
Minimum	-0,8085%	-0,5339%	-0,6072%	-16,0799%	-19,2978%
Maximum	0,8331%	0,4897%	0,5886%	25,0035%	17,2491%
Nombre d'observations	246	246	246	246	246

Tableau 2 : Statistiques descriptives des rendements quotidiens des actifs (Période 2)

	ISDB	*JBIC*	*US*	*BTC*	*ETH*
Moyenne	-0,0009%	0,0000%	-0,0019%	0,5062%	0,8268%
Écart-type	0,1838%	0,0931%	0,0658%	4,6783%	6,3869%
Kurstosis (Coefficient d'aplatissement)	30,4676	14,1836	50,0039	4,4648	5,2885
L'excès de Kurstosis	27,4676	11,1836	47,0039	1,4648	2,2885
Coefficient d'asymétrie	-0,7867	0,2764	2,3816	-0,3121	0,0134
Minimum	-1,5780%	-0,6615%	-0,5814%	-27,1874%	-33,2849%
Maximum	1,3799%	0,5441%	0,6447%	18,0484%	36,2887%
Nombre d'observations	408	408	408	408	408

Nous pouvons constater que, durant la première sous-période tous les actifs ont une performance positive. Puis avec la survenance de la crise de Covid-19, un rendement négatif marque la majorité des obligations alors que le rendement des cryptoactifs a augmenté. D'ailleurs, pour les deux sous-périodes considérées, les deux cryptoactifs ont les performances les plus élevées en termes de rendement quotidien moyen. Cependant, et sans surprise, nous pouvons dire aussi que l'écart-type des cryptoactifs est largement supérieur à l'écart-type des obligations considérées. En effet, les cryptoactifs sont des actifs à haut risque avec la possibilité de pertes et de profits extrêmes. Certains jours, durant la première sous-période par exemple, la BCT pu obtenir un rendement supérieur à 25%, ou subir une perte de plus de 16% avec le Bitcoin et un rendement supérieur à 17 %, ou une perte de plus de 19% avec l'Ethereum. Alors qu'avec les obligations et pour la même sous-période, le rendement maximal que la BCT pourrait obtenir est de 0,83% moyennant l'obligation ISDB et la perte maximale est de -0,81% moyennant la même obligation.

Finalement, nous pouvons remarquer que la plus grande différence entre les deux sous-périodes réside au niveau du coefficient d'aplatissement. En effet, l'excès d'aplatissement des obligations durant la deuxième sous-période est élevé et voire très élevé par rapport aux cryptoactifs et par rapport à la première sous-période. Cela signale que les rendements quotidiens des obligations sont sujet à des résultats extrêmes. Autrement dit, il est probable que les rendements futurs des obligations seront soit extrêmement importants, soit extrêmement faibles. En contrepartie, il parait que les coefficients d'aplatissement des cryptoactifs ont subi une légère variation durant la deuxième sous-période par rapport à la première sous-périodes et en comparaison avec les obligations. En effet, le Kurtosis du Bitcoin a passé de 5,0125 à 4,4648, et celui de l'Ethereum est passé de 2,4725 à 5,2885. Nous pouvons donc conclure que les cryptoactifs ont été presque à l'abri durant la période de la crise dans le sens ou la probabilité d'obtenir un rendement extrême moyennant ces deux actifs est beaucoup moins élevée qu'en faisant recours aux obligations.

3.3. Analyse de corrélation

Nous comparons ici la corrélation entre les rendements du Bitcoin, de l'Ethereum et ceux des actifs traditionnels représentés par diverses obligations.

Tableau 3 : Corrélation entre les rendements journaliers des cryptoactifs et les actifs traditionnels (Période 1)

	ISDB	*JBIC*	*US*	*BTC*	*ETH*
ISDB	1	0,9675	0,9594	0,1088	0,0327
JBIC	0,9675	1	0,9961	0,0888	0,0379
US	0,9594	0,9961	1	0,0895	0,0451
BTC	0,1088	0,0888	0,0895	1	0,7985
ETH	0,0327	0,0379	0,0451	0,7985	1

Tableau 4 : Corrélation entre les rendements journaliers des cryptoactifs et les actifs traditionnels (Période 2)

	ISDB	*JBIC*	*US*	*BTC*	*ETH*
ISDB	1	0,8015	0,5977	0,0096	-0,0199
JBIC	0,8015	1	0,9002	-0,0654	-0,0864
US	0,5977	0,9002	1	-0,0781	-0,0974
BTC	0,0096	-0,0654	-0,0781	1	0,7688
ETH	-0,0199	-0,0864	-0,0974	0,7688	1

Nous constatons que, pour les deux sous-périodes étudiées, les rendements quotidiens des obligations sont fortement corrélés et évoluent dans la même direction. En outre, le Bitcoin et l'Ethereum sont positivement et fortement corrélées entre eux, ainsi, une forte association existe entre les deux cryptoactifs. Cependant, nos résultats suggèrent que ces derniers se distinguent clairement des obligations. En effet, des relations faibles entre les rendements des cryptoactifs et les obligations existent. Ainsi, nous pouvons dire que les cryptoactifs dans leur ensemble évoluent de manière relativement indépendante de toutes les obligations. Nous pourrions ainsi nous attendre à ce que les deux cryptoactifs soient capables d'offrir des possibilités de diversification en raison des faibles corrélations avec les obligations et ce durant les deux sous-périodes considérées.

Cependant, durant la deuxième sous-période, qui a été marquée par l'épidémie de coronavirus, nous constatons une relation négative entre les rendements des cryptoactifs et la majorité des obligations. Ces associations négatives, inexistantes au cours de la première période, laissent penser que les cryptoactifs en question ont des propriétés de refuge en temps de crise et nous nous attendons également à ce qu'ils puissent être qualifiés comme étant un outil de diversification de plus grande efficacité par rapport à la première sous-période.

3.4. Résultats d'optimisation selon l'approche de Markowitz

Les poids des portefeuilles optimisés ainsi que les rendements périodiques moyens, le risque périodique moyen et le coefficient de variation sont présentés dans les tableaux 5 et 6 suivants :

Tableau 5 : Résultats d'optimisation selon l'approche de Markowitz : Période 1

	Rendement périodique	*Écart-Type périodique*	*Coefficient de variation*	*Allocation d'actifs (Poids)*				
				ISDB	*JBIC*	*US*	*BTC*	*ETH*
Portefeuille de base (sans cryptoactifs)								
PVM de base	*4,4420%*	*1,5179%*	*0,3417*	*31,2976%*	*32,2221%*	*36,4804%*	*-*	*-*
Nouveau Portefeuille (avec cryptoactifs)								
Nouveau PVM	*4,5068%*	*1,5172%*	*0,3366*	*31,0903%*	*32,3412%*	*36,5057%*	*0,0241%*	*0,0386%*

Tableau 6 : Résultats d'optimisation selon l'approche de Markowitz : Période 1

	Rendement périodique	*Écart-Type périodique*	*Coefficient de variation*	*Allocation d'actifs (Poids)*				
				ISDB	*JBIC*	*US*	*BTC*	*ETH*
Portefeuille de base (sans cryptoactifs)								
PVM de base	*-0,5168%*	*1,0621%*	*-2,0552*	*8,0667%*	*29,4118%*	*62,5214%*	*-*	*-*
Nouveau Portefeuille (avec cryptoactifs)								
Nouveau PVM	*-0,3901%*	*1,0610%*	*-2,7197*	*8,2744%*	*29,3164%*	*62,3683%*	*0,0092%*	*0,0318%*

Le potentiel de diversification des cryptoactifs ressort bien dans l'amélioration du rendement du portefeuille à variance minimale sans trop minimiser le risque, et ce malgré leur modeste pondération de 0,06 % pour la première période et de 0,04% pour la deuxième. Le même constat est remarqué en examinant les frontières efficientes présentées dans les figures 2 et 3 ci-dessous[1].

Figure 2 : Profils risque-rendement de plus près - Portefeuille de base avec et sans allocations de cryptoactifs (Période 1)

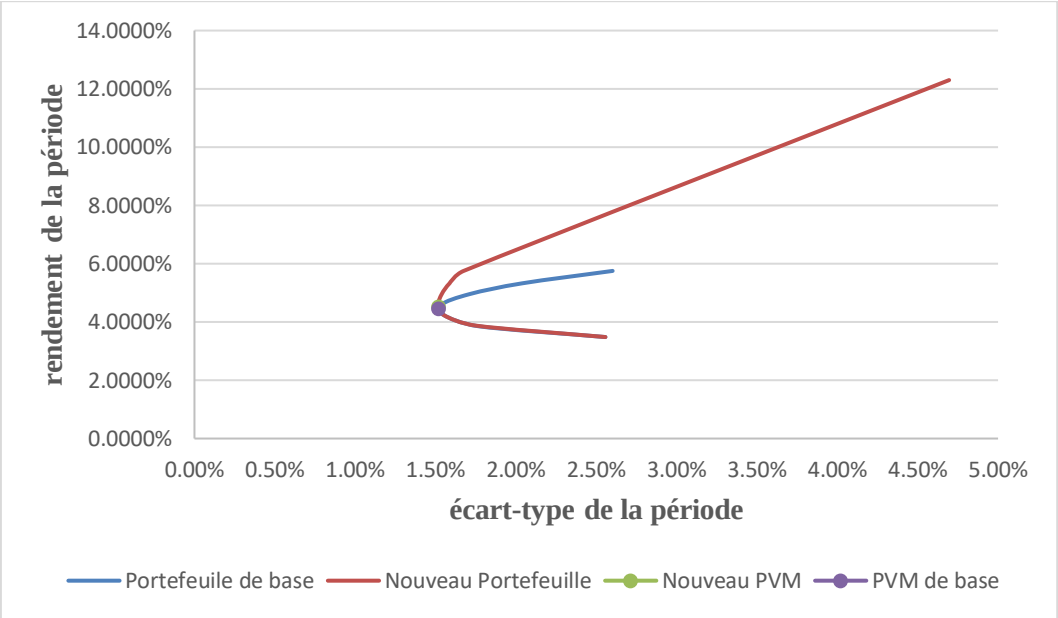
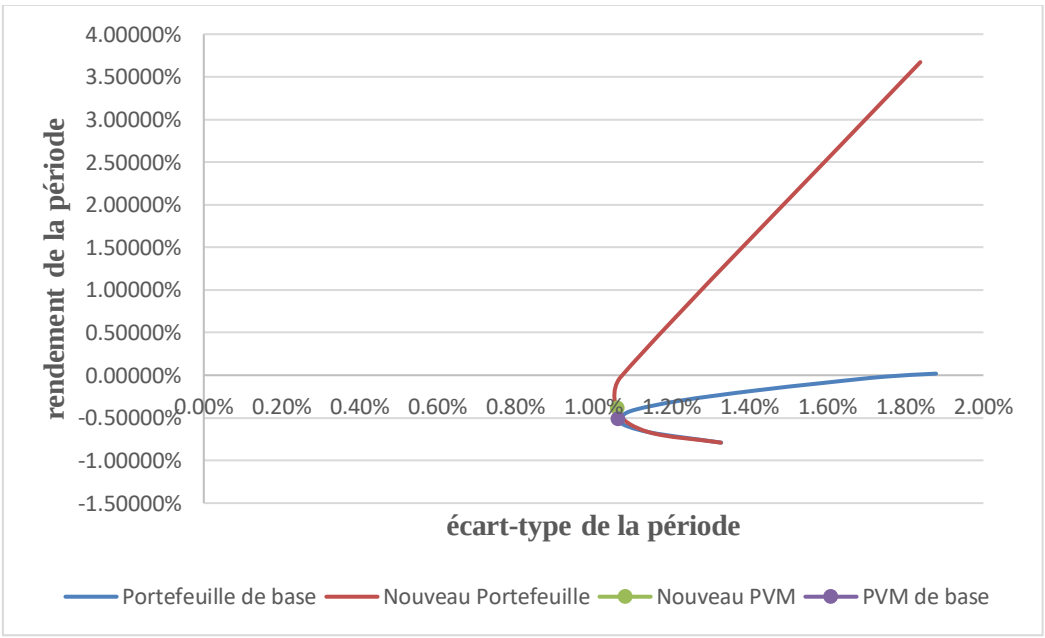


Figure 3 : Profils risque-rendement de plus près - Portefeuille de base avec et sans allocations de cryptoactifs (Période2)



En effet, nous constatons que l'inclusion des cryptoactifs déplace les frontières efficientes vers de meilleures positions (vers le haut). En d'autres mots, cela signifie que pour un niveau de risque donné, les nouveaux portefeuilles surpassent les portefeuilles de base en matière de rendement.

Il convient cependant de noter que l'ampleur de cette diversification n'est pas la même durant les deux périodes. En effet, l'impact de l'ajout des cryptoactifs durant la première sous-période peut être

[11] Nous notons que les frontières efficientes des nouveaux portefeuilles vont plus loin que ce qui est visible sur les figures, mais en regardant de plus près le point où les frontières efficientes de base sont visibles, la différence devient plus claire.

qualifié de faible en matière d'amélioration du couple rendement-risque. L'inclusion des cryptoactifs ne révèle aucun effet significatif en termes de performance. Cette dernière, mesurée par le rendement, a légèrement augmenté de 1,46%, passant de 4,44% à 4,51%. De plus, en raison des niveaux élevés de volatilité des cryptoactifs, nous n'avons pas trouvé de réduction significative du risque. Ce dernier s'est réduit approximativement de 0,04%. Finalement, concernant le coefficient de variation, le portefeuille à variance minimale améliore ce dernier de 1,5 %, lorsqu'il comprend des cryptoactifs par rapport au portefeuille de base à variance minimale (passant de 0,342 à 0,337). En bref, le nouveau portefeuille à variance minimale qui tient en compte les cryptoactifs superforme légèrement celui de base. D'ailleurs en regardant la figure 2, nous remarquons qu'ils sont quasiment confondus.

En revanche, il semble qu'au cours de la deuxième sous-période étudiée, une amélioration significative des caractéristiques du portefeuille à variance minimale a eu lieu : le rendement a augmenté de 24,51% et le risque a diminué de 0,1%. D'ailleurs, nous pouvons même remarquer que le nouveau portefeuille qui minimise la variance se situe au-dessus de celui du portefeuille de base, contrairement à la première période où les deux étaient quasiment confondus. Nous pouvons conclure donc que durant cette période, le Bitcoin et l'Ethereum peuvent être qualifiés comme étant un outil de diversification de grande efficacité tout en maximisant le rendement du portefeuille, sans augmenter le risque de ce dernier. Ce constat est conforme à la majorité des travaux existants qui considèrent que le potentiel de diversification des cryptoactifs ressort dans l'amélioration du rendement plutôt que dans la minimisation du risque. Nous citons à titre d'exemple les travaux de Platanakis et al (2018), Petukhina et al (2018), Holovatiuk (2020) et Yechi et al (2020).

Economiquement parlant, il semble que durant la période de crise, le marché des cryptoactifs était insensible aux facteurs liés aux marchés obligataires et aux chocs externes, ce qui permet de les qualifier comme étant un outil de diversification de grande efficacité et une valeur refuge. Nous soutenons ainsi l'idée selon laquelle la crise du Covid-19 a renouvelé l'attrait pour les cryptoactifs en tant qu'actifs refuges et ce même auprès des banques centrales.

3.5. Résultats de l'allocation naïve

Tableau 7 : Résultats de l'allocation naïve : Période 1

	Rendement périodique	*Écart-Type périodique*	*Coefficient de variation*	*Allocation d'actifs (Poids)*				
				ISDB	*JBIC*	*US*	*BTC*	*ETH*
Portefeuille de base (sans cryptoactifs)								
PVM de base	*4,4420%*	*1,5179%*	*0,3417*	*31,2976%*	*32,2221%*	*36,4804%*	*-*	*-*
Allocations naïves des cryptoactifs								
0,1%	*4,5472%*	*1,5175%*	*0,3337*	*31,2642%*	*32,1887%*	*36,4470%*	*0,05%*	*0,05%*
1%	*5,4939%*	*1,6561%*	*0,3014*	*30,9643%*	*31,8888%*	*36,1471%*	*0,5%*	*0,5%*
3%	*7,5979%*	*2,5737%*	*0,3387*	*30,2976%*	*31,2221%*	*35,4804%*	*1,5%*	*1,5%*
5%	*9,7018%*	*3,8092%*	*0,3926*	*29,6309%*	*30,5554%*	*34,8137%*	*2,5%*	*2,5%*

Tableau 8 : Résultats de l'allocation naïve : Période 2

	Rendement périodique	Écart-Type périodique	Coefficient de variation	Allocation d'actifs (Poids)				
				ISDB	JBIC	US	BTC	ETH
Portefeuille de base (sans cryptoactifs)								
PVM de base	*-0,5168%*	*1,0621%*	*-2,0552*	*8,0667%*	*29,4118%*	*62,5214%*	*-*	*-*
Allocations naïves des cryptoactifs								
0,1%	*-0,2445%*	*1,0626%*	*-4,3461*	*8,0334%*	*29,3785%*	*62,4881%*	*0,05%*	*0,05%*
1%	*2,2063%*	*1,4619%*	*0,6626*	*7,7334%*	*29,0785%*	*62,1881%*	*0,5%*	*0,5%*
3%	*7,6524%*	*3,2887%*	*0,4298*	*7,0667%*	*28,4118%*	*61,5214%*	*1,5%*	*1,5%*
5%	*13,0985%*	*5,3267%*	*0,4067*	*6,4001%*	*27,7452%*	*60,8548%*	*2,5%*	*2,5%*

Comme le montrent les deux tableaux ci-dessus, durant les deux sous-périodes, les portefeuilles contenant des cryptoactifs ont tendance à être plus performants que ceux qui n'en contiennent pas et ce en générant des rendements sensiblement plus élevés que le portefeuille de base. Naturellement, l'impact des cryptoactifs sur le portefeuille a été proportionnel à la taille de l'allocation. Par exemple, pour la première sous-période, une allocation de 0,1% aux cryptoactifs aurait fait grimper le rendement annuel du portefeuille seulement à 2,4%. Cependant, une allocation de 3 % dans les cryptoactifs aurait fait grimper ce dernier de 71% (passant de 4,44% à 7,60%) soit plus du double du rendement du portefeuille de base. Il s'agit d'un impact remarquable compte tenu de la taille relativement faible de l'allocation. Cependant, à mesure que le poids des cryptoactifs augmente, les risques des portefeuilles ont tendance à augmenter et cette augmentation semble être de plus en plus prononcée. Bien que nous puissions penser que l'augmentation des rendements vaut le risque supplémentaire, la logique pour un investisseur institutionnel comme la BCT n'est pas pareille. En effet, une banque centrale n'est pas en mesure d'assumer un risque supplémentaire élevé même s'il y'a amélioration plus importante des rendements.

En outre, nous pouvons remarquer que durant la première sous-période, l'augmentation du rendement n'arrive plus à compenser le risque accru du portefeuille, d'où la détérioration du coefficient de variation. Nous soutenons ainsi le constat de Yechi et al (2020) selon lequel la méthode d'allocation en risque via l'optimisation de la moyenne-variance de Markowitz est plus optimale que l'option de diversification naïve. En effet, il est vrai qu'avec le cadre de moyenne-variance, nous n'avons pas été en mesure de diminuer le risque de manière significative. Cependant, quelle que soit la période sur laquelle nous travaillons, et quelles que soient les grandes fluctuations que les cryptoactifs et les obligations ont connues, cette approche nous permet d'atténuer toujours le risque du portefeuille, alors que l'allocation naïve est une approche arbitraire et pourrait faire subir à la BCT d'énormes pertes. En conclusion, l'allocation naïve de cryptoactifs dans un portefeuille diversifié ne semble pas être l'approche la plus appropriée pour un investisseur averse au risque comme la BCT.

4. Discussions

Dans l'ensemble, il parait que les cryptoactifs sont plus intéressants pour les stratégies qui exigent des rendements plus élevés, sans pour autant contribuer à la minimisation de la variance. De plus, nous avons constaté qu'ils n'offrent cet avantage de diversification que dans une certaine mesure, soit grâce à l'ajout d'une fraction minimale. Nous pensons ainsi que la BCT devrait faire attention à ne pas surinvestir dans les cryptoactifs. Nous recommandons aussi à la BCT d'opter pour une approche d'allocation par les risques, en suivant l'approche de Markowitz que d'opter pour une allocation naïve. En effet, nous avons trouvé qu'en suivant l'approche de Markowitz, même si l'augmentation du rendement devient non significative en raison de la forte volatilité des cryptoactifs durant certaines

périodes, le risque tel que mesuré par l'écart type est atténué et donc il n'y aura pas de pertes en capital à subir.

Cependant, bien que nos résultats soient encourageants, il semble que la BCT pourrait être encore réticente quant à l'investissement en ces derniers et ce bien qu'elle croie en la pérennité de la technologie sous-jacente de la blockchain. En effet, il semble que même si l'investissement dans ces cryptoactifs présente une véritable opportunité, il pose de sérieux problèmes que les banques centrales doivent être en mesure de surmonter afin qu'elles puissent envisager légitimement de les inclure dans leurs réserves en tant qu'actifs d'investissement.

À notre avis, l'évolution des cryptoactifs et le soutien réglementaire sont les deux facteurs qui doivent être améliorés afin que les banques centrales puissent penser à les considérer comme des actifs d'investissement de réserve de change. Nous ne pensons pas que cette condition est impossible. D'ailleurs de nombreux régulateurs à travers le monde cherchent un cadre réglementaire qui permettrait d'encadrer les cryptoactifs, car selon eux ces derniers ont atteint des niveaux de capitalisation suffisamment importants pour ne plus être considérés comme négligeables. En effet, les cryptoactifs deviennent de plus en plus incontournables, et en prenant conscience de ce constat, les Etats commencent à rompre avec la tendance de mettre en place des restrictions et commencent de plus en plus à mettre en place des mesures de reconnaissance et d'encadrement, afin de protéger les investisseurs. A cet égard, la Présidente de la Banque Centrale Européenne, Christine Lagarde a appelé à un encadrement du Bitcoin. En effet elle a déclaré lors d'une conférence organisée par l'agence Reuters « Il doit y avoir une réglementation. Il faut l'appliquer et s'accorder sur ce point au niveau mondial car, s'il y a une échappatoire, celle-ci sera utilisée ». Ainsi, la réglementation internationale pourrait faciliter la création d'infrastructures d'information et de conseillers financiers certifiés formés aux actifs numériques et pourrait réduire les risques de cybercriminalité et de fraude en ligne.

Finalement, nous pensons que l'inclusion des cryptoactifs dans les réserves de change de la BCT se heurte en grande partie à l'instabilité des prix de ces derniers, et ce bien que cette instabilité puisse être compensée par les rendements élevés qu'ils procurent. Nous pouvons comprendre en partie la logique derrière cette réflexion, cependant, nous ne croyons pas que le refus total de l'idée soit la solution la plus judicieuse. En effet, nous croyons que « Mieux vaut prendre le changement par la main avant qu'il ne nous prenne par la gorge » comme dit le dicton.

Conclusion

L'émergence des cryptoactifs a marqué cette décennie et a attiré l'attention de nombreux acteurs du secteur, particuliers et experts. Leur potentiel en tant qu'investissement de portefeuille viable pour la gestion des risques n'échappe pas non plus aux banques centrales. Ces dernières qui ne croyaient pas auparavant au potentiel des cryptoactifs ont décidé d'infléchir leur position. Nous parlons ici de la réflexion quant à l'ajout de ces derniers dans les réserves de change des banques centrales. Nous avons décidé donc d'examiner ce que l'ajout de ces actifs dans le portefeuille d'investissement de la banque centrale de Tunisie pourrait avoir comme conséquences en termes de diversification et d'optimisation du portefeuille en question. Dans l'objectif de mener à ce travail, nous avons simulé un portefeuille de base constitué de trois obligations : souveraine, internationale et supranationale, avec des marchés secondaires profonds et liquides, qui garantissent le plus haut niveau de sécurité. Concernant les cryptoactifs, il a été décidé d'inclure le Bitcoin et l'Ethereum étant donné qu'ils ont les capitalisations boursières les plus fortes. Le cadre traditionnel de moyenne-variance de Markowitz était appliqué afin d'étudier les performances des portefeuilles diversifiés avec et sans inclusion des cryptoactifs. Nous avons pris en considération l'épidémie de Covid-19 dans nos analyses via la définition de deux périodes d'analyse, avant et après l'épidémie. Les résultats sont fournis sous la forme de tableaux où les statistiques de rendement moyen, de risque moyen et de coefficient de variation sont présentés et sous forme des frontières efficientes de ces portefeuilles.

Nos résultats fournissent des preuves empiriques quant au potentiel de diversification des cryptoactifs. Ce dernier ressort bien dans l'amélioration du rendement du portefeuille à variance minimale sans que la minimisation du risque soit importante, et ce malgré leur modeste pondération durant les deux sous-périodes considérées. Ce constat est conforme à la majorité des travaux existants qui considèrent que le potentiel de diversification des cryptoactifs ressort dans l'amélioration du

rendement plutôt que dans la minimisation du risque. En outre, l'inclusion des cryptoactifs déplace la frontière efficiente vers une meilleure position et améliore le portefeuille à variance minimale. Cependant, nous avons constaté que l'amélioration de ce dernier est plus significative durant la deuxième période post Covid-19. Il semble que durant cette période de crise, le marché des cryptoactifs était insensible aux facteurs liés aux marchés obligataires et aux chocs externes, ce qui permet de les qualifier comme étant un outil de diversification de grande efficacité et une valeur refuge. D'ailleurs, durant cette période nous avons constaté une relation négative et faible entre les rendements des cryptoactifs et la majorité des obligations, alors que ces relations n'existaient pas dans la première période. Nous soutenons ainsi l'idée selon laquelle la crise du Covid-19 a donné de l'intérêt pour les cryptoactifs en tant qu'actifs refuges.

En outre, nous avons eu recours à l'allocation naïve en cryptoactifs, où quatre scénarios d'allocation ont été utilisés, allant d'une allocation infinitésimale de 0,1% jusqu'au une allocation de 5%. Nous avons constaté que les cryptoactifs n'apportent des avantages en termes de diversification et d'amélioration de la performance du portefeuille de la BCT qu'à travers de faibles allocations en cryptoactifs et que ces avantages sont essentiellement la résultante de l'amélioration du rendement. Cependant, en ayant recours à des pondérations plus forte des cryptoactifs, les résultats indiquent qu'à mesure que le poids des cryptoactifs augmente le rendement et le risque devient plus élevé et à un certain niveau durant la première période, l'augmentation du rendement n'arrive plus à compenser le risque accru du portefeuille d'où la détérioration du coefficient de variation. Ainsi, nous soutenons le constat selon lequel la méthode d'allocation via l'optimisation de la moyenne variance de Markowitz est plus optimal que l'option de diversification naïve.

Bien que nos résultats sur l'investissement prudent en cryptoactifs soient encourageants, il existe certaines limites qui nécessitent des recherches futures afin de confirmer la véracité des résultats de notre étude. Tout d'abord, nous avons essayé de simuler ce portefeuille en nous limitant aux obligations gouvernementales et supranationales dont le marché secondaire est profond et liquide. Cependant, notre choix reste relativement arbitraire. Par conséquent, l'impact de l'ajout de cryptoactifs pourrait être totalement différent si nous travaillons avec les actifs réels inclus dans le portefeuille d'investissement de la BCT. En outre, nous n'avons pas pris en considération les effets des coûts de transaction et de rééquilibrage optimal sur la performance du portefeuille et sa diversification. Ces deux limites peuvent déboucher sur de nouvelles voies futures de recherche.

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Stabilité financière et surveillance macro-prudentielle : test de résilience en matière du risque de liquidité avec application au système bancaire tunisien

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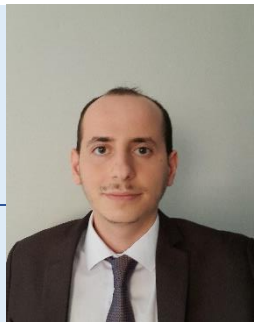


Résumé

La crise financière mondiale de 2008 a démontré à quel point il importe de veiller à ce que le système financier dispose d'un niveau de liquidité suffisant pour faire face à des conditions défavorables. De ce fait le Comité de Bâle a été amené à multiplier ses efforts afin de renforcer les principes et les normes concernant la mesure et la gestion du risque de liquidité.

Ces mesures ont été préconisées dans les Accords de Bâle III, par la mise en place des instruments qualifiés de macro-prudentiels qui sont principalement le ratio de liquidité à court terme (LCR) et le ratio structurel de liquidité à long terme (NSFR).

C'est dans ce contexte que s'inscrit notre travail de recherche qui vise à identifier les déterminants clés du risque de liquidité des banques tunisiennes mesurés par le ratio de liquidité LCR et le ratio de transformation LTD. Nous adoptons la méthode des moindres carrés généralisés (GLS) des données de panel pour analyser la relation entre ces déterminants, aussi bien spécifiques aux banques que macroéconomiques, et le risque de liquidité en retenant un échantillon de 10 banques représentatives du secteur bancaire tunisien.

Nous procédons par la suite à un stress test pour déceler l'impact de quelques mesures prises par la Banque Centrale de Tunisie pendant la pandémie Covid-19 sur la résilience des banques tunisiennes. Les résultats de cette étude ont des implications pertinentes pour les banques tunisiennes et l'autorité de surveillance afin de préserver la stabilité du système bancaire.

Mots-clés : Banques Tunisiennes, ratio de liquidité, ratio de transformation, déterminants du risque de liquidité, Panel GLS, stress test, résilience.

Introduction

Le secteur bancaire occupe de plus en plus une place prépondérante en matière de financement et de développement de l'économie. Ceci se manifeste principalement par la fonction d'intermédiation qu'assurent les établissements bancaires. Suite à ce rôle, les banques se trouvent, en permanence, exposées à une panoplie de risques,qui s'ils sont mal gérés, peuvent exposer non seulement les institutions financières individuelles mais également l'ensemble du système bancaire et le système financier de manière générale à des tensions susceptibles de menacer la stabilité et la résilience financière. La meilleure illustration est la dernière crise financière mondiale qui a débuté en juillet 2007. Cette crise a mis en évidence les faiblesses de la gestion du risque de liquidité par les banques, qui ont souffert d'une pénurie de liquidité.

L'identification des principaux déterminants de ce risque financier a fait l'objet de plusieurs études, qui n'ont pas abouti aux mêmes facteurs explicatifs. Certaines études attribuent le risque de liquidité aux caractéristiques internes de la banque elle-même, comme le niveau de capital, la taille de la banque, etc. (Ahmed, et Naqvi (2011) Giannotti, Gibilaro, et Mattarocci (2010), Vadovà (2011) et Stiroh et al. (2006)). D'autres études montrent que le risque de liquidité dépend de la structure du secteur bancaire dans son ensemble, comme la concentration bancaire et la structure de propriété des banques (Zouari et Sonia (2012), Nakan et Weinturb (2005), Dinc (2005) et Sapienza (2004)). En outre, certaines autres études incluent la crise financière qui a provoqué l'effondrement de plusieurs institutions financières (Vodovà (2013)).

Ainsi, face à l'importance de la liquidité dans le fonctionnement et la survie des banques et l'absence de consensus concernant les déterminants du risque de liquidité, l'objectif principal de ce

papier est d'identifier dans un premier lieu, les déterminants clés du risque de liquidité des banques tunisiennes afin qu'elles puissent gérer correctement ce risque pour éviter l'assèchement de la liquidité et la faillite et de tester dans un deuxième lieu la résilience du système bancaire tunisien en terme de liquidité face aux chocs en retenant un échantillon représentatif composé des principales banques de la place.

A ce titre, cet article est structuré comme suit : une première section sera consacrée à une brève revue de littérature traitant le concept de la politique macro-prudentielle ainsi que la notion de stabilité financière. La deuxième section s'intéresse à la notion du risque de liquidité des banques ainsi que ses principaux déterminants. La dernière section sera consacrée à l'étude empirique : La méthodologie de recherche, les différents résultats des déterminants du risque de liquidité qui en découlent ainsi que les résultats du stress testing.

1. La politique macro-prudentielle et stabilité financière

1.1 La politique macro-prudentielle

Une surveillance micro-prudentielle des banques et des établissements financiers est basée sur une analyse et une évaluation continue des profils des risques des dits établissements sur une base individuelle et ce, par référence au cadre légal et prudentiel régissant l'activité bancaire. Cette approche suppose donc que la santé du système dans sa globalité sera garantie quand chaque établissement présente une bonne santé financière. Néanmoins, la crise de 2007 a montré que cette manière d'analyser le système financier présente des limites, ainsi les normes formulées dans les accords de Bâle I et Bâle II qui s'inscrivent essentiellement dans une approche micro-prudentielle des risques n'étaient pas suffisantes pour la maitrise du risque systémique d'où la nécessité d'évoluer vers des interventions prudentielles axées sur le système.

Le terme " macro-prudentiel " a commencé à être utilisé plus largement à la suite de la crise asiatique de 1997, avec le développement d'indicateurs macro-prudentiels pour mieux évaluer les vulnérabilités du système financier.

La signification du terme macro-prudentiel est devenue plus claire en 2000, lorsque deux caractéristiques distinctives de l'approche macro-prudentielle de la supervision ont été soulignées :

- Premièrement, l'accent mis sur le système financier dans son ensemble
- Deuxièmement, la reconnaissance du fait que le risque global dépend du comportement collectif des institutions financières (Crockett 2000).

À la Banque des règlements internationaux (BRI), la politique macro-prudentielle désigne l'utilisation d'outils prudentiels dans le but explicite de promouvoir la stabilité du système financier dans son ensemble, et pas nécessairement des institutions individuelles qui le composent (Clement 2010).

La politique macro-prudentielle peut être définie également selon trois critères à savoir son objectif, sa portée et ses instruments (FSB-IMF-BIS 2011) :

Son objectif est de limiter le risque systémique, c'est-à-dire le risque de perturbations généralisées de la fourniture de services financiers ayant des conséquences négatives graves pour l'économie dans son ensemble.

Son champ d'application est le système financier dans son ensemble (y compris les interactions entre les secteurs financier et réel), par opposition aux composantes individuelles (qui considèrent le reste du système comme acquis).

Ses instruments : Elle utilise principalement des instruments prudentiels calibrés pour cibler les sources de risque systémique.

Les différences de perspectives entre les approches micro-prudentielles et macro-prudentielles sont largement comprises. La politique macro-prudentielle se concentre sur le risque global résultant des interactions entre les institutions financières, les marchés, l'infrastructure et l'économie au sens large, ainsi que sur l'approche macro-prudentielle de la surveillance. La politique micro-prudentielle se concentre sur les risques des entités individuelles, qui tendent à considérer le système financier et l'économie comme donnée.

Tableau 1 : Comparaison des perspectives macro-prudentielle et micro-prudentielle

	Perspective macro prudentielle	Perspective micro prudentielle
Objectif immédiat	Limiter la crise financière systémique	Limiter les difficultés individuelles des institutions
Objectif final	Eviter les coûts en terme de PIB	Protéger le consommateur
Caractérisation du risque	Endogène	Exogène
Calibrage des contrôles prudentiels	En terme de risque systémique : Top-down	En terme de risques propres à chaque institution : Bottom- up

Source : Borio (2003)

L'objectif principal de la politique macro-prudentielle est d'assurer la stabilité du système financier dans son ensemble, de prévenir l'apparition d'un risque systémique et de réduire ainsi la probabilité d'occurrence d'une crise financière, ou d'en diminuer l'impact s'il est impossible d'en empêcher la matérialisation et ce tout en renforçant la résilience face aux chocs, ce qui permet au système financier de contribuer durablement à la croissance économique.

Toutefois et pour atteindre l'objectif final de la politique macro-prudentielle, l'identification d'objectifs intermédiaires comme spécifications opérationnelles de cet objectif constitue une étape primordiale qui rendra la politique macro-prudentielle plus opérationnelle, plus transparente et plus responsable.

Dans ce contexte, le Comité Européen du Risque Systémique (CERS) a défini quatre objectifs intermédiaires de la politique macro prudentielle dans le secteur bancaire :

- Atténuer et prévenir une expansion excessive du crédit et de l'endettement ;
- Atténuer et prévenir une transformation excessive de maturité et liquidité ;
- Limiter la concentration des expositions directes et indirectes ;
- Limiter l'impact systémique d'incitations décalées afin de réduire l'aléa moral.

En outre, leur identification est importante car elle permet à l'autorité de lier ces objectifs à des instruments spécifiques. En d'autres termes, lorsque l'autorité identifie une évolution qui menace un des objectifs intermédiaires, elle peut sélectionner l'outil adéquat pour l'atteindre

Selon Crockett (2000) et Borio (2003) une approche macro-prudentielle de la réglementation a deux dimensions, une dimension temporelle, également connue sous le nom de procyclicité du système financier, qui se concentre sur les risques résultant de la fluctuation du cycle économique, et une dimension transversale, où l'accent est mis sur les interconnexions entre les institutions financières avec un accent particulier sur les institutions financières d'importance systémique. Le tableau ci-dessous présente les différents instruments macro-prudentiels en fonction de ces deux dimensions :

Tableau 2 : Analyse récapitulative des instruments macro-prudentiels dans les dimensions temporelle et transversale

	Dimension temporelle	Dimension transversale
Fonds propres	• Provisionnement des pertes sur prêts variable dans le temps/dynamique • Exigence de capital anticyclique général(e) • Exigences de fonds propres sectorielles • Pondérations de risque sectorielles	• Ratio de levier • Coussin de risque systémique
Crédits	• Ratio prêt/valeur • Ratio dette/revenu • Plafonds du ratio prêt/valeur	• Limites des expositions interbancaires • Limites de concentration • Prélèvement/taxe sur les institutions financières
Liquidité	• Limites des prêts en devises étrangères • Limites des prêts en monnaie nationale • Exigences en matière de devises et/ou de réserves contracycliques	• Ratios de réserves obligatoires • Ratio de couverture de liquidité (LCR) • Ratio de financement stable net (NSFR)

Source : Bennani et al (2014), Carreras et al (2018).

De ce qui précède, nous distinguons deux objectifs essentiels de la politique macro prudentielle, le premier est d'atténuer le cycle financier ou la procyclicité au fil du temps, et le second est de rendre le système financier plus résilient en modérant le risque systémique causé par les liens entre les expositions communes de toutes les institutions financières.

Cependant, la politique macro-prudentielle seule ne peut pas œuvrer pour réaliser effectivement cet objectif. Il faudrait qu'il y ait de l'harmonie avec la politique monétaire, la politique budgétaire qui à leurs tours ont un rôle très important à jouer dans la stabilisation du système financier.

1.2 La stabilité financière

Après la récente crise financière internationale, les autorités de régulation ont pris conscience de la nécessité de disposer d'un cadre réglementaire et analytique à même de contribuer au maintien de la stabilité financière. Néanmoins, en l'absence d'objectif explicite, les mesures adoptées par les autorités peuvent se révéler inefficaces. Par conséquent, la recherche d'une définition claire de la stabilité financière est indispensable afin de mieux fixer les objectifs et orienter les politiques en la matière.

La stabilité Financière, selon Crockett (1997), correspond à un état de l'économie où les institutions financières importantes sont en mesure de remplir leurs activités habituelles en dehors de toute assistance des autorités régulatrices et les principaux marchés financiers fonctionnent normalement dans le sens où les intervenants sont confiants et les prix des actifs reflètent leurs valeurs fondamentales.

Certains auteurs ont jugé plus approprié de considérer, plutôt, la notion d'instabilité financière. En d'autres termes, définir la stabilité financière comme étant la propriété d'un système qui n'est pas exposé aux épisodes d'instabilité financière. À cet effet, la stabilité financière pourrait être considérée comme une absence d'instabilité financière.

Cette instabilité survient lorsque des chocs affectant le système financier aggravent sensiblement les problèmes d'asymétrie informationnelle, empêchant le système financier de réaliser sa fonction principale de canalisation de l'épargne vers les opportunités d'investissement productif.

Sur le plan national, la Banque Centrale de Tunisie, contribue au maintien de la stabilité financière de manière à soutenir la réalisation des objectifs de la politique économique de l'Etat. En vertu de l'article 8 de la loi N°2016-35, Portant fixation du statut de la Banque Centrale de Tunisie : *« La banque centrale est chargée de la détection et du suivi des différents facteurs et évolutions susceptibles d'affecter la stabilité du système financier, notamment celles constituant une atteinte à sa solidité ou une accumulation de risques systémiques ».*

Pour ce faire, la BCT est dotée d'une direction Générale de la Stabilité Financière et de la Prévention des Risques « DGSFPR » dont la mission principale consiste à contribuer à la préservation de la stabilité et de la sécurité du système financier et ce conformément aux dispositions de la loi n° 58-90 relative à la création et à l'organisation de la BCT.

Dans ce cadre et de par sa mission qui lui est confiée par la loi, elle est appelée à :

- Elaborer une cartographie des risques permettant d'évaluer et de hiérarchiser les risques du secteur financier.
- Suivre le risque du crédit sur les entreprises en tant que source principale de vulnérabilité pour le secteur bancaire.
- Proposer les mesures permettant l'anticipation, la prévention et la résolution des crises financières.

Dans un même contexte, un comité de surveillance macro-prudentielle et de gestion des crises financières, a été créé au sein de la BCT en vertu de la loi 2016-35, dont la mission consiste à « *émettre des recommandations portant sur les mesures devant être prises par les autorités de régulation du secteur financier et leur application en vue de la contribution à la stabilité du système financier dans son ensemble, consistant notamment en le renforcement de la solidité du système financier, la prévention de la survenance de risques systémiques et la limitation des effets d'éventuelles perturbations sur l'économie* ».

En 2020, la propagation rapide de la pandémie de la Covid-19 et les mesures de confinement sévères qui ont suivi ont durement secoué les marchés et affecté les comportements des agents économiques, annonçant l'entrée de plusieurs pays dans le monde, y compris la Tunisie, dans une forte récession.

Certes, ce confinement a sauvé des vies, mais ses retombées ont été lourdes pour toutes les économies. Elles ont été particulièrement désastreuses en Europe, où le confinement a été strict et long. Il s'agit d'une récession d'une ampleur inédite, bien pire que la crise financière mondiale en 2008-2009.

En effet, face à cette crise inédite plusieurs secteurs sont touchés de plein fouet notamment celui du tourisme et des activités qui lui sont liées comme le transport, les services, les hôtels et l'artisanat. Au niveau macro-économique, le déficit budgétaire ne cesse de s'élargir vu les dépenses multiples de l'Etat, alors que les recettes se font rares.

Au même titre que les autres composantes de l'économie, le secteur bancaire n'était pas à l'abri des effets néfastes de cette crise. Selon Aldasoro et al. (2020), les pandémies telles que COVID-19 ont des conséquences complexes et diverses pour les banques et menacent la stabilité du système bancaire.

En effet, les banques traitent traditionnellement un large éventail de risques et la pandémie va accroître leur gravité en provoquant un resserrement de la liquidité, un resserrement du crédit, une augmentation des actifs non performants et des taux de défaillance, réduisant ainsi les rendements des prêts bancaires et des investissements et même le déclenchement d'un bank-run contagieux.

De tels dommages pourraient menacer la survie et la pérennité des institutions financières, la stabilité et la sécurité du système financier, ainsi que la discipline réglementaire dans tous les pays qu'ils soient développés ou en voie de développement.

Selon Wilson (2020), cette situation risque d'être pire dans les pays en développement, où les banques servent des millions d'individus et d'entreprises dont la capacité financière et économique est relativement faible, dans un environnement politique plus faible et une concurrence agressive sur le marché.

En Tunisie, les établissements de crédit en tant qu'instrument clé du maintien du système économique et vu leur rôle dans la responsabilité sociétale, se retrouvent confrontées à de nouveaux

défis liés à la crise mais également en première ligne pour soutenir les entreprises faisant face à des difficultés de trésorerie.

Dans le même sillage, et pour faire face aux retombées de la crise sanitaire COVID-19 sur l'activité économique et la sphère financière, la Banque Centrale de Tunisie a décidé d'agir de manière proactive afin de limiter les répercussions de l'épidémie sur l'activité économique et soutenir les entreprises ainsi que les catégories sociales les plus affectées.

2. Le risque de liquidité et ses déterminants

2.1 Le risque de liquidité

Etant donné l'avancée remarquable qu'a connue l'activité bancaire ces dernières années et l'évolution de l'environnement concurrentiel dans lequel elles opèrent, les banques sont devenues de plus en plus exposées aux multiples risques financiers qui peuvent mettre en péril leur pérennité et même conditionner leur existence à savoir le risque de liquidité.

Le risque de liquidité est inhérent à l'activité bancaire. En effet, les banques ont un rôle intermédiaire particulier de transformation de passifs liquides (dépôts) en actifs illiquides (prêts), cette activité d'intermédiation qui se traduit par une transformation d'échéances peut engendrer un risque de liquidité pour la banque qui est susceptible d'entraîner une défaillance en chaîne de l'ensemble du système bancaire.

Selon Calvet (2002) le risque d'illiquidité correspond pour une banque à son incapacité de faire face au remboursement de ses engagements à court terme et plus précisément ses dettes à vue et les emprunts interbancaires en raison de l'impossibilité de vendre ses actifs sur un marché considéré comme étant liquide.

Selon (Diamond & Rajan, 2005), le risque de liquidité provient de l'absence de liquidités nécessaires pour couvrir les obligations à court terme d'une banque et les sorties de fonds inattendues.

Pour John Hull (2012) le risque de liquidité correspond à « l'incapacité d'une institution financière à faire face à ses engagements de court terme à temps. Soulignons à nouveau que la liquidité est différente de la solvabilité. Une banque solvable peut faire faillite pour des problèmes de liquidité ».

Au travers de ces définitions, nous pouvons retenir que le risque de liquidité, ou plutôt d'illiquidité, représente pour une banque, l'impossibilité de pouvoir faire face, à un instant donné, à ses engagements ou à ses échéances, par la mobilisation de ses actifs.

En revanche, cette définition est assez large car elle ne prend pas en considération les trois notions de liquidité.

- **Risque de liquidité de la Banque Centrale**

La liquidité de la banque centrale correspond à la capacité de l'autorité d'émission de répondre au besoin de liquidité du secteur bancaire. De ce fait, le risque de la liquidité centrale est le risque inhérent à la capacité de l'autorité monétaire d'un pays à faire face aux demandes de liquidité d'un système bancaire via les opérations de refinancement. En général, ce risque est presque inexistant parce que la banque centrale peut toujours fournir de la monnaie banque centrale dont elle a le monopole d'émission.

- **Risque de liquidité de marché**

Le risque de liquidité de marché est un risque fortement associé à la liquidité des actifs financiers négociables sur le marché secondaire. Il représente la composante systématique et non diversifiable du risque de liquidité. Nous pouvons donc définir le risque de liquidité de marché comme étant le risque qu'une banque ne puisse pas facilement se débarrasser d'une position au prix du marché « juste valeur » en raison d'une profondeur de marché, « la capacité du marché à absorber un volume important d'opérations financières à des coûts de transaction faibles et sans qu'il y'ait un effet important sur les prix des actifs », insuffisante ou d'une perturbation du marché.

- **Risque de liquidité de financement**

Le risque de liquidité de financement est le risque que la banque ne soit pas en mesure de répondre efficacement aux besoins actuels et futurs, attendus et inattendus, en matière de flux de trésorerie et de garanties, sans affecter les opérations quotidiennes ou la situation financière.

Autrement dit, c'est le risque qui réside dans l'incapacité d'une institution financière à faire face à ses engagements suites aux demandes inattendues de retrait de fonds en raison d'une trésorerie insuffisante à un instant donné

Selon Drehmann. M et Nikolaou. K (2009), le risque de liquidité de financement est la conséquence de l'insuffisance, l'indisponibilité des fonds ou l'incapacité de la banque à trouver des sources de financement de nature à la mettre dans l'impossibilité d'honorer ses obligations au moment convenu. Donc ce risque correspond à la possibilité que sur un horizon donné, la banque puisse devenir incapable de régler ses obligations d'une manière immédiate.

2.2 La règlementation macro-prudentielle lié au risque de liquidité

2.2.1 Le ratio de liquidité de court terme

Le ratio de liquidité à court terme ou « Liquidity Coverage Ratio (LCR) », a pour but de s'assurer que, à tout moment, la banque dispose d'un niveau adéquat d'actifs liquides de haute qualité « High Quality Liquid Assets – HQLA », non grevés, pouvant être convertis en liquidités pour résister à une sortie de trésorerie ou « Net Cash Outflows » pour une période de 30 jours, sur la base d'un scénario défini par les responsables prudentiels.

Ce ratio prudentiel, considéré comme un instrument macro-prudentiel de risque de liquidité, servira en cas de tensions à renforcer la capacité du secteur bancaire à absorber les chocs générés par des tensions financières et économiques et à protéger ainsi la résilience du secteur bancaire à court terme.

Du fait que dans la présente étude, nous ciblons le secteur bancaire tunisien, ce ratio sera ainsi calculé conformément à la circulaire de la BCT aux banques n°2014-14 relative au ratio de liquidité.

2.2.2 Ratio Crédits/Dépôts « Loan-To-Deposit Ratio »

Le ratio LTD « crédits/dépôts » peut être utilisé par l'autorité macro-prudentielle pour traiter les risques de liquidité au niveau du secteur bancaire qu'ils soient structurels (à long terme) ou cycliques (à court terme).

Ce ratio a été mis en place pour s'assurer qu'il y a suffisamment de liquidités pour couvrir les prêts en cas de ralentissement économique, plus précisément lorsque des retraits importants de fonds à court terme se produisent.

Autrement dit, dans le cas où les crédits accordés dépassent largement la base des dépôts, les banques sont confrontées à un déficit de financement élevé ce qui se traduit par conséquent par un recours massif au financement de marché, plus cher que le financement auprès de ressources stables (les dépôts) traduisant ainsi une exposition accrue au risque de liquidité.

A ce titre, le ratio LTD vient de compléter les ratios de liquidité du cadre de Bâle III pour renforcer à la fois la surveillance prudentielle en matière de risque de liquidité ainsi que la solidité et la résilience du système financier.

Cet instrument marco-prudentiel a été instauré en vertu de la circulaire aux banques n°2018-10 du 1er novembre 2018. La dite circulaire implique qu'une banque ne peut pas garder ce ratio à un niveau supérieur à 120%.

2.3 Les déterminants du risque de liquidité

L'identification des principaux déterminants du risque de liquidité bancaire a fait l'objet de plusieurs études, menées aussi bien au niveau d'un pays déterminé, qu'au niveau international.Ces déterminants peuvent être répartis en deux catégories, déterminants internes et externes.

2.3.1 Déterminants spécifiques aux banques

La taille de la banque

Le courant de la littérature ayant traité la relation entre la taille de la banque, mesurée généralement par le total des actifs, et le risque de liquidité a fait ressortir que celle-ci est jugée comme un facteur déterminant du risque de liquidité pour les banques. Généralement, les grandes banques disposent en permanence des ressources stables de long terme, principalement les dépôts, pour financer l'octroi des crédits et un stock important d'actifs liquides et des trésoreries excédentaires pour faire face aux chocs éventuels de liquidité

Dans ce sens, l'étude de Zaghdoudi et Hakimi (2017) a montré que la taille des banques tunisiennes a un impact négatif et significatif sur le risque de liquidité. En Tunisie, la petite taille des banques est un déterminant du risque de liquidité, car elles restent des banques spécialisées donnant de l'importance à l'activité de prêt, malgré les réformes et les lois qui encouragent les banques à intervenir sur les différents marchés de capitaux. Ce qui affirme par conséquent que la petite taille exposait les banques tunisiennes à un risque de liquidité élevé.

H1 : Les grandes banques sont moins exposées au risque de liquidité

La capitalisation bancaire

La capitalisation bancaire mesurée par le rapport entre les capitaux propres et le total des actifs est considérée comme un facteur déterminant du risque de liquidité. En effet, se disposer d'un niveau élevé de capital est un signal très positif envoyé au marché sur la solvabilité et la solidité financière de la banque. Une banque fortement capitalisée, comparée à une banque faiblement capitalisée, n'a pas besoin d'emprunter pour financer un niveau donné d'actifs.

En d'autres termes, une banque fortement capitalisée a une capacité plus élevée à absorber les risques et plus particulièrement le risque de liquidité. Ceci a été affirmé par les études effectuées par Ben Moussa (2015) et Zaghdoudi et Hakimi (2017) qui ont trouvé que plus la banque dispose d'un niveau élevé de capitalisation moins élevé sera le risque de liquidité.

H2 : Les banques les plus capitalisées sont moins exposées au risque de liquidité.

La qualité des actifs

La qualité des actifs désigne principalement la qualité des prêts bancaires. Elle est mesurée par les prêts non performants qui représentent la part des créances classées par rapport au total des engagements de la banque et elle est considérée comme le premier facteur interne susceptible d'influencer la liquidité des banques.

En effet, la transformation d'un plus grand nombre de prêts en prêts non performants réduirait les opérations de prêt des banques et, par conséquent, affecterait la liquidité globale. En d'autres termes, si la probabilité de défaut des emprunteurs augmente, le risque de liquidité sera plus important. Ces constatations ont été prédites par EL chaarani (2019), El Khoury (2015), Umar et Sun (2016).

H3 : La dégradation de la qualité des actifs d'une banque entraine une forte exposition au risque de liquidité.

Les opérations de refinancement sur le marché monétaire

Selon De Haan et al. (2019), les opérations de refinancement à court terme constituent une source de l'exposition des banques au risque de transformation des échéances lorsqu'elles constituent des ressources destinées à l'octroi de crédits à long terme. Nous attendons alors à une relation positive entre refinancement et le risque de liquidité.

H4 : les opérations de refinancement constituent une source de risque de liquidité.

La spécialisation bancaire

La spécialisation bancaire désigne le degré d'implication d'une banque dans l'octroi du crédit, cet indicateur est généralement exprimé par le rapport entre les crédits nets et le total actif. En analysant la littérature traitant la relation entre la spécialisation bancaire et le risque de liquidité, nous constatons que les résultats des différentes études effectuées sur ce sujet convergent. En effet, les chercheurs ont affirmé qu'il existe une relation positive entre cet indicateur et le risque de liquidité.

Ainsi si le ratio « prêts nets sur le total des actifs » est élevé, cela signifie que la banque a accordé plus de crédits, que sa position de liquidité est faible et qu'elle est plus exposée au risque de liquidité. Ceci est approuvé également par Cucillini (2013) et Zaghdoudi & Hakimi (2017) qui concluent également que les banques spécialisées dans l'octroi des crédits sont les plus exposées au risque de liquidité.

H5 : Les banques spécialisées dans l'activité de prêt sont plus exposées au risque de liquidité.

La solvabilité de la banque

La solvabilité d'une institution financière fait référence à sa capacité à honorer ses dettes à tous les horizons (court, moyen et long terme). Cette solvabilité est mesurée par le rapport entre les fonds propres net et l'ensembles des actifs pondérés par les risques.

La littérature bancaire met en évidence la relation entre ce ratio et le risque de liquidité, en effet, les recherches antérieures menées par Akhtar et al. (2011), Bonfim et Kim (2011), Ghenimi et Omri (2015) et Rahman et Banna (2015), stipulent l'existence d'une relation négative. En revanche, un ratio de solvabilité élevé signifie que les banques disposent d'un capital important qui peut être utilisé afin de couvrir leurs échéances, ce qui permet d'assurer la stabilité et la croissance de ces dernières et constitue en même temps un signal très positif envoyé au marché concernant la solvabilité des banques.

H6 : Le ratio de solvabilité (RS) aura un impact négatif sur le risque de liquidité : Les banques ayant un ratio de solvabilité élevé sont moins exposées au risque de liquidité.

2.3.2 Déterminants macroéconomiques

Le taux d'intérêt

Dans le cadre du système financier conventionnel, les banques peuvent se refinancer sur le marché monétaire en cas de besoin de liquidité. La demande et l'offre de liquidité sur ce marché évoluent en fonction aussi bien du niveau de liquidité injecté par la banque centrale que du taux directeur de cette dernière. En effet, ce taux est utilisé comme instrument de monitoring de la politique monétaire de la banque centrale qui veille à préserver la bonne santé de l'économie (Gertler & Karadi, 2013 ; Lucchetta, 2007). D'où toute fluctuation de ce taux que ce soit à la hausse ou à la baisse impacte directement la liquidité bancaire.

H7 : Une relation négative est prédite entre le taux d'intérêt et le risque de liquidité.

Le taux d'inflation

Le taux d'inflation désigne la hausse générale du niveau des prix. En se référant à la littérature économique et financière traitant la relation entre cet indicateur et le risque de liquidité on trouve que la majorité des recherches effectuées par Trenca et al. (2015), Ghenimi et Omri (2015), Moussa (2015) confirment qu'une augmentation du taux d'inflation réduira le pouvoir d'achat des individus, qui auront alors besoin de plus d'argent pour acheter les mêmes produits. Par conséquent, les demandes de crédits seront multipliées et par conséquent, la liquidité bancaire sera réduite traduisant en ce sens un risque de liquidité.

H8 : Le taux d'inflation impacte positivement le risque de liquidité

3. La méthodologie économétrique

3.1 Présentation de l'échantillon d'étude

Notre étude porte sur un échantillon composé de 10 banques commerciales tunisiennes cotées sur la BVMT. Ce choix est justifié par le fait que ces banques constituent le noyau dur du système financier national en assurant un rôle vital dans le financement de l'économie et sont considérées comme les plus représentatives du secteur bancaire tunisien. En effet, ces banques accaparent en 2020 près de 90 % des dépôts collectés et près de 80 % des prêts octroyés par rapport au total secteur.

Le tableau ci-dessous présente la liste des banques sur lesquelles se base notre échantillon.

Banques	Acronyme
Amen Bank	AB
Arab Tunisian Bank	ATB
Attijari Bank	ATTIJARI
BH Bank	BH
Banque Internationale Arabe de Tunisie	BIAT
Banque Nationale Agricole	BNA
Banque de Tunisie	BT
Société Tunisienne de Banque	STB
Union Bancaire pour le Commerce et l'Industrie	UBCI
Union Internationale de Banques	UIB

Ainsi notre analyse portera sur des données trimestrielles tirées principalement à partir de la base de données interne de la BCT. D'autres variables, comme les variables macroéconomiques, sont collectées à partir du site web de la Banque Centrale de la Tunisie (BCT) ainsi que du site web de l'Institut national de la statistique (INS).

3.2 Méthodologie économétrique

Dans ce qui suit, nous cherchons à trouver les principaux facteurs déterminants du risque de liquidité des banques tunisiennes. En effet, nombreux sont les travaux empiriques qui ont traité ce sujet dont nous citons ceux de Khemais et Zaghdoudi (2017), Ghenimi, A., & Omri (2018) et Faruque Ahamed (2021).

La dimension temporelle et individuelle de notre échantillon nous amène à utiliser l'approche des données de panel. Contrairement aux observations en séries temporelles, les données de panel combinent deux dimensions à la fois, à savoir la dimension individuelle et la dimension chronologique. La particularité de ces modèles réside dans le fait qu'ils nous permettent d'étudier des relations de comportement économique dans le temps en tenant compte de l'hétérogénéité des banques. Les données de panel sont généralement définies selon le modèle de régression suivant :

$$y_{it} = \alpha + \beta X_{it} + u_{it}$$

*Avec : **i** : indique la banque ; **t** : indique le temps ; **α** : la constante ; **y** : la variable à expliquer ; **X** : la matrice des observations des variables explicatives ;* $\boldsymbol{u_{it}}$ *: le terme d'erreur*

Dans notre étude, nous nous référons particulièrement aux travaux de recherche effectués par Khemais et Zaghdoudi (2017) et Faruque Ahamed (2021). A cet effet, pour chaque banque i et compte tenu de nos variables explicatives, les deux modèles Panel pour le ratio de liquidité de CT et le ratio du risque de liquidité correspondant à la banque i peuvent être représentés de la manière suivante :

$$\boldsymbol{LIQR_{it} = \beta_0 + \beta_1\, CAR_{it} + \beta_2\, SIZE_{it} + \beta_3\, NPL_{it} + \beta_4\, SPEC_{it} + \beta_5\, RF_{it} + \beta_6\, RS_{it} + \beta_7\, TD_{it} + \beta_8\, INF_{it} + u_{it}}$$

Avec :

- **i** : Les banques i = [1…10] ;
- **t** : trimestre t = [1…26] pour le premier modèle et t = [1…12] pour le deuxième modèle ;
- $\boldsymbol{LIQR_{it}}$: - Ratio de liquidité LCR de la banque i au trimestre t (modèle 1)
  - Ratio du risque de liquidité LTD de la banque i au trimestre t (modèle 2) ;

- $\boldsymbol{CAR_{it}}$ **:** La capitalisation de la banque i au trimestre t ; $\boldsymbol{SIZE_{it}}$: Taille de la banque i au trimestre t ; $\boldsymbol{NPL_{it}}$: Ratio des Prêts Non Performants de la banque i au trimestre t ; $\boldsymbol{SPEC_{it}}$: Ratio de spécialisation de la banque i au trimestre t ; $\boldsymbol{RF_{it}}$ **:** Refinancement trimestriel de la banque i au trimestre t ; $\boldsymbol{RS_{it}}$: Ratio de solvabilité de la banque i au trimestre t ; $\boldsymbol{TD_{it}}$: Taux directeur du trimestre t ; $\boldsymbol{INF_{it}}$ **:** Taux d'inflation du trimestre t. - **β :** Les coefficients associés aux variables explicatives - $\boldsymbol{u_{it}}$: Le terme d'erreur

3.3 Résultats empiriques et interprétations des résultats

En utilisant des données trimestrielles, les estimations des deux modèles sur Eviews-12 sont résumées dans le tableau ci-dessous :

Tableau 3 : Résultats de l'estimation pour les deux ratios LCR et LTD

Variables Dépendantes	$\boldsymbol{LCR_{it}}$			$\boldsymbol{LTD_{it}}$		
	Coefficient	*t-statistic*	*P-value*	*Coefficient*	*t-statistic*	*P-value*
Déterminants spécifiques à la banque						
CAR	17.5726	3.7083	0.0003**	-2.0604	-2.6504	0.0093**
NPL	-5.5246	-2.7811	0.0058**	2.3041	6.3439	0.0000**
SIZE	0.9515	2.6477	0.0086**	-0.1882	-2.1299	0.0342*
SPEC	-6.4605	-3.6809	0.0003**	1.0049	4.0421	0.0001**
RF	-0.6807	-7.6709	0.0000**	0.0585	5.4077	0.0000**
RS	-3.5896	-1.2107	0.2271	0.0033	0.0062	0.9951

Déterminants macroéconomiques						
TD	15.4837	2.0898	0.0377*	-0.8910	-1.1496	0.2530
INF	-20.4986	-3.2672	0.0012**	2.3695	2.6194	0.0102*

*** et * indiquent une signification au seuil de 1 % et 5 %, respectivement.*

L'analyse de l'impact des variables inclus dans notre modèle montre des relations significatives communes de sens inverse sur le ratio LCR et le ratio LTD. Ceci s'avère cohérent avec les résultats de plusieurs auteurs qui ont prédit que les facteurs déterminants de la liquidité bancaire sont les facteurs du risque de liquidité, mais de sens inverse.

Dans ce qui suit nous allons détailler l'impact de chaque déterminant sur les deux ratios macro-prudentiels.

3.3.1 Les variables spécifiques aux banques

❖ **La taille de la Banque**

Il est à rappeler que la taille de banque (SIZE) est mesurée par le logarithme népérien du total des actifs des 10 grandes banques. D'après les deux modèles, l'impact de la taille de la banque est positif sur le ratio LCR et négatif sur le ratio LTD, de sorte que la liquidité bancaire croit avec l'augmentation de la taille de la banque diminuant ainsi l'exposition de la banque à un éventuel risque de liquidité et de transformation.

Ce résultat supporte la vision de plusieurs chercheurs à savoir Abdullah et Khan (2012) Sulaiman et al. (2013) ; Giannoti, Gibilaro et Mattarocci (2010) ; Zaghdoudi et Hakimi (2017) qui ont affirmé empiriquement la relation négative qui subsiste entre la taille de la banque et le risque de liquidité. En effet, les grandes banques disposent en permanence des ressources stables de long terme, principalement les dépôts, pour financer l'octroi des crédits (↘ LTD) et un stock important d'actifs liquides et des trésoreries excédentaires pour faire face aux chocs éventuels de liquidité (↗ LCR).

De même, l'accès facile des banques de taille importante au marché interbancaire et au financement de la banque centrale ainsi que la surveillance prudentielle très rapprochée assurée par les autorités de supervisions sur ces banques compte tenu de leur importance systémique au niveau du secteur, expliquent leur aptitude à respecter les ratio macro prudentiels imposés par les autorités monétaires.

Toutefois, les banque de petite taille qui détiennent généralement des faibles parts d'actifs liquides restent des banques spécialisées donnant de l'importance à l'activité de prêt, malgré les réformes et les lois qui encouragent les banques à intervenir sur les différents marchés de capitaux. Ce qui affirme par conséquent que la petite taille exposait les banques tunisiennes à un risque de liquidité élevé.

En comparant les résultats avec les statistiques descriptives (présentées en annexes), BQ4 la plus grande banque compte tenu de sa taille, est une banque ayant un niveau de liquidité robuste qui se matérialise par le respect des contraintes réglementaires des ratios LCR et LTD.

Pareil pour les autres banques, caractérisées par un arbitrage harmonieux entre la taille et les niveaux de deux ratios. Le problème se pose essentiellement par rapport aux banques BQ1 et BQ10, malgré leur taille systémique dans le secteur, elles présentent les niveaux des deux ratios les plus critiques

❖ La qualité des actifs

Le Ratio NPL est considéré comme une mesure du risque de crédit des banques. En effet, les prêts non performants sont les crédits dont les débiteurs sont en défaut ou en retard de paiement (du principal et intérêts) pour une période supérieure à 90 jours. Il est défini comme « le rapport du montant total de prêts douteux détenus par la banque par le montant total des prêts ». (Fernández et González, 2014).

D'après les estimations, une relation négative existe entre NPL et le ratio de liquidité LCR et positive avec le ratio LTD, donc les prêts non performants impactent négativement la liquidité des banques tunisiennes.

Ce lien positif entre le ratio NPL et le risque de liquidité a également été corroboré empiriquement dans les études de El Khoury (2015) ; Zaghdoudi et Hakimi (2017) et EL chaarani (2019).

A ce titre, le risque de crédit accentue le risque de liquidité et réduit le volume de liquidité détenue par la banque. Ceci est expliqué par le fait que la banque, par sa fonction de prêteur, est exposée au défaut de ses contreparties, ainsi l'insolvabilité d'un emprunteur entraîne une perte totale ou partielle de la créance, ainsi que les revenus qui s'y attachent ; d'où une absence de la liquidité initialement prévue.

Ces constatations peuvent également être expliquées par le fait que la transformation d'un plus grand nombre de prêts en prêts non performants réduirait les opérations de prêt des banques et, par conséquent, affecterait la liquidité globale. Ce qui montre par conséquent l'importance d'une bonne politique de sélection de la clientèle.

En comparant les résultats avec les statistiques descriptives (présentées en annexes), les 3 banques BQ1, BQ7 et BQ10 ayant une situation critique des deux ratios LCR et LTD sont les mêmes qui présentent NPL les plus élevés et inversement pour les banques BQ3, BQ6 et BQ8.

❖ La capitalisation bancaire

Le ratio d'adéquation des fonds propres (CAR) est mesuré par le rapport entre les capitaux propres et le total des actifs de la banque. Le ratio démontre l'étendue du financement des actifs à risque par les fonds propres de la banque.

Sur la base des estimations obtenus par nos modèles, nous constatons qu'il existe une relation positive entre ce rapport et le ratio de liquidité LCR et négative avec le ratio LTD. De ce fait nous pouvons conclure que la capitalisation bancaire impacte positivement la liquidité des banques tunisiennes.

Cette association négative entre la capitalisation des banques et le risque de liquidité, a été démontrée par Vodovà (2011) ; Bonfim et Kim (2011) ; Ben Moussa (2015) et Zaghdoudi et Hakimi (2017).

La logique qui sous-tend de cette relation est simple. Un niveau de capital élevé améliore la capacité de la banque à absorber les risques et plus particulièrement le risque de liquidité. En d'autres termes, plus la banque dispose d'un niveau élevé de capitalisation moins élevé sera le risque de liquidité. Nous pouvons également justifier ceci par le fait qu'une banque fortement capitalisée, comparée à une banque faiblement capitalisée, n'a pas besoin d'emprunter pour financer un niveau donné d'actifs, elle dispose d'un soutien suffisant pour faire face aux pertes potentielles liées aux investissements à risque.

En se référant aux statistiques descriptives (présentées en annexes), la banque BQ8 qui dispose du plus haut niveau de capitalisation présente des niveaux adéquats de ratios LCR et LTD, inversement pour la banque BQ10 qui présente le niveau le plus faible du ratio CAR.

❖ La spécialisation bancaire

La spécialisation bancaire désigne le degré d'implication d'une banque dans l'octroi du crédit, cet indicateur est généralement exprimé par le rapport entre les crédits nets et le total actif.

D'après les estimations, une relation positive et significative entre la variable SPEC et le risque de liquidité mesuré par le ratio LTD, tandis qu'une association négative régit la relation entre cette variable et le LCR. Donc, la spécialisation est un élément générateur du risque de liquidité. Ce résultat a été approuvé par Bonfim et Kim (2011), Cucillini (2013) et El Khoury (2015).

Vu l'importance des crédits comme une source de revenu, les banques tendent à consacrer une grande partie de leurs actifs aux prêts qui sont des actifs non liquides. Ainsi, toute augmentation des demandes de crédit va se traduire par une baisse de liquidité.

Nous pouvons justifier ceci par le fait que malgré les réformes qui ont amené les banques à développer de nouveaux métiers et à intervenir sur les différents marchés de capitaux, l'activité principale des banques tunisiennes reste l'octroi de crédits. Les actifs bancaires sont restés dominés par les crédits, qui ont évolué plus rapidement que les dépôts collectés. Ce résultat valide par conséquent l'hypothèse qui soutient l'idée que les banques spécialisées dans l'activité de crédit sont les plus exposées au risque de liquidité.

En se référant aux statistiques descriptives (présentées en annexes), nous constatons que malgré leur niveau de spécialisation assez élevé par rapport aux autres banques de l'échantillon, les banques BQ2, BQ6 et BQ8 assurent un arbitrage harmonieux entre leur activité d'intermédiation et les niveaux de deux ratios prudentiels, inversement pour les banques BQ1, BQ9 et BQ10.

Toutefois, pour les autres banques qui présentent des niveaux plus faibles de spécialisation, nous constatons que leur degré de respect des normes prudentielles est assez satisfaisant à l'exception de la banque BQ5 qui présente un ratio LCR moyen assez faible.

❖ Le refinancement sur le marché monétaire

En analysant les résultats fournis par nos modèles, nous constatons que la relation entre le refinancement (REF) et le ratio LCR est négative tandis qu'elle est positive avec le ratio LTD. Ce qui signifie qu'un recours excessif des banques aux refinancement se traduit par un risque de liquidité élevé. Cette relation a été également approuvée par De Hann (2019).

Pour accéder aux opérations de refinancement, la BCT mène une politique de collatéral prudente sur la base d'une sûreté appropriée. Elle exige en contrepartie des opérations de refinancement des garanties, de qualité, matérialisées par des titres négociables publics (BTA) pour un minimum de 50% du montant de refinancement, et titres privés (créances bancaires saines) pour le reste. La présentation des Bons de Trésor se traduit par une baisse des actifs liquides des banques ce qui génère une baisse du ratio LCR.

Les opérations de refinancement à court terme constituent une source de l'exposition des banques au risque de transformation des échéances lorsqu'elles constituent des ressources destinées à l'octroi de crédits à long terme d'où l'instauration du ratio LTD, comme une contrainte réglementaire par la BCT, que les banques tunisiennes sont tenues de respecter une limite de 120% pour alléger le recours aux refinancements.

Une analyse entre les niveaux des ratios LCR et LTD des banques BQ1, BQ7 et BQ10 et ses niveaux de refinancements trimestriels révèle que ces 3 banques sont les plus dépendantes de la BCT. Par ailleurs, BQ2, BQ3, BQ4 et BQ6 même si elles font recours au marché monétaire, elles ont poursuivi

leurs efforts pour trouver un compromis crédible entre les niveaux de refinancement et les ratios de liquidité.

❖ **La solvabilité de la banque**

Les résultats de notre régression montrent une relation non significative entre la solvabilité des banques tunisiennes et les ratios prudentiels LCR et LTD.

3.3.2 Les variables macro-économiques

❖ **Le taux d'intérêt directeur**

Une association négative entre le taux directeur et le risque de liquidité marquée par un effet positif sur le ratio de liquidité LCR est constatée.

En effet, tout en disposant d'une panoplie d'instruments qui l'habilitent à mettre en œuvre sa politique dans un contexte d'excédents ou de déficits de liquidité, la BCT intervient sur le marché monétaire pour réguler la liquidité bancaire et agir sur le coût de financement de l'activité économique, en manipulant principalement le taux directeur (coût du refinancement).

Sur le plan opérationnel, la hausse du taux directeur se traduit par une baisse du volume de refinancement des banques (suite à l'augmentation des coûts de refinancement) entrainant ainsi une hausse des taux pratiqués par le système bancaire (taux débiteurs LT) ce qui conduit par conséquent à freiner la demande des crédits. Ceci a donc pour impact de réduire les pressions sur la liquidité disponible au niveau de la banque et par extension réduit le risque de liquidité.

Toutefois, nous constatons une relation non significative entre cette variable et le ratio LTD.

❖ **Le taux d'inflation**

En se référant aux résultats fournis par notre modélisation économétrique, nous constatons que la relation analysée entre le niveau d'inflation et les deux ratio macro-prudentiels LCR et LTD confirme nos hypothèses.

En effet, la relation entre le taux d'inflation et le ratio de liquidité à court terme LCR est négative tantdis qu'elle est positive avec le ratio LTD ce qui montre que l'inflation impacte négativement la liquidité bancaire et provoque par conséquence un risque de liquidité.

Ainsi, une augmentation du taux d'inflation réduira le pouvoir d'achat des individus, qui auront alors besoin de plus d'argent pour acheter les mêmes produits. Par conséquent, les demandes de crédits seront multipliées et par conséquent, la liquidité bancaire sera réduite traduisant en ce sens un risque de liquidité.

Un résultat similaire a également été trouvé par Malik et Rafique, (2013) dans les banques pakistanaises, El Khoury (2015) dans les banques libanaises et Trenca et al. (2015), dans les banques européennes.

3.4 Application du stress test

Dans la présente section, nous nous proposons d'examiner la résilience des banques en terme de liquidité face à un choc défavorable touchant le niveau des prêts non performants (NPLs) en utilisant comme technique d'estimation l'outil de stress testing. Notre analyse du test de sensibilité consiste en la comparaison entre le niveau des ratios LCR et LTD pour une période de référence et leur niveau en cas de choc provoqué dans la période suivante afin d'apprécier le changement constaté.

- **Choix des scénarios**

A l'instar de plusieurs pays dans le monde, la pandémie COVID-19 s'est transformée en Tunisie, en une crise économique et sociale inédite. Cette crise est intervenue dans un contexte économique déjà fragilisé caractérisé par une instabilité politique chronique, une économie héritée depuis des années avec un encours de la dette publique qui dépasse les 81% du PIB. Les conséquences économiques de la pandémie du covid-19 viennent encore aggraver cette situation critique.

Le PIB réel a diminué de 8,8 % en 2020 (le recul le plus important d'Afrique du Nord hors Libye), après avoir augmenté de 1 % l'année précédente, en raison de la baisse générale de l'activité économique et du durcissement des conditions financières mises en place pour lutter contre l'inflation. La production a chuté dans tous les secteurs à l'exception du secteur agricole et celui de la pêche. Le secteur des services, notamment le tourisme, considéré comme un moteur de croissance, a subi les conséquences de la pandémie.

A cet effet, et pour contrer les répercussions négatives de la crise et limiter ses effets secondaires sur plusieurs secteurs tels que le tourisme, le transport, l'artisanat et l'industrie manufacturière, la BCT a entrepris des mesures d'urgence visant à protéger le tissu économique national affecté par la crise, afin de lui permettre de conserver les emplois et de garantir un minimum de revenus aux petites et moyennes entreprises concernées et ce tout en gardant à l'esprit la nécessité de préparer l'après-Covid 19.

Parmi ces mesures, nous notons celle relative aux reports des échéances tel que prévus par la circulaire de la BCT n°2020-06 permettant aux professionnels et particuliers le report, sous certaines conditions, des échéances de crédits accordés et ce jusqu'à fin septembre 2020.

Toutefois, au vu des dommages persistants au niveau, aussi bien des entreprises que des professionnels dans de nombreux secteurs suite aux répercussions de la pandémie du Covid-19 et dans un souci de garantir la stabilité financière et ce en s'engageant dans une logique privilégiant le sauvetage des entités productives et les emplois, le Conseil d'administration de la Banque centrale de Tunisie (BCT) a décidé, lors de sa réunion périodique du 30 décembre 2020, de prolonger d'un an la période de report des échéances de crédits accordés aux entreprises et aux professionnels jusqu'à fin septembre 2021.

Cette décision devrait certainement contribuer à alléger les tensions de trésorerie et de liquidité des entreprises et des professionnels, mais elle produira sans doute des conséquences défavorables sur les banques qui n'ont pas été épargnées par la tempête. Selon l'agence de notation Fitch Ratings, une telle décision pourra essentiellement provoquer une détérioration de la qualité des actifs des banques tunisiennes.

C'est pour cette raison, qu'il est primordial de connaitre le degré de résilience des banques tunisiennes en cas de dégradation de la qualité de ses actifs, et ce en analysant leur capacité à respecter les normes macro-prudentielles édictées en matière de risque de liquidité, à savoirs les ratios LCR et LTD, face à une situation de choc défavorable. Pour ce faire nous allons appliquer des tests de résistance sur la variable **des Prêts Non Performants (NPL).**

Nous allons mettre en place deux tests de sensibilité afin de stresser la variable NPL. L'amplitude des chocs à appliquer, en s'inspirant de la littérature économique et financière en la matière, vont être de 3 fois (scénario 1) et de 6 fois (scenario 2) l'écart type de la variable en question[11].

[11] Modelling the distribution of credit losses with observable and latent factors, Gabriel Jiménez, Javier Mencía, Journal of Empirical Finance 16 (2009) 235–253.

La relation qui régit la qualité des actifs (NPL) avec le ratio LCR est négative, ce qui signifie qu'une augmentation des prêts non performants d'une banque traduit une baisse du ratio LCR. Donc la variation que nous allons effectuer qui traduit le scénario défavorable sera dans le sens de la hausse des prêts non performants de chaque banque.

Il est à noter que cette hausse va survenir au niveau du quatrième trimestre de 2021, puisque la reprise de remboursement est prévue pour octobre 2021 (La dégradation de la qualité des actifs sera comptabilisée en décembre 2021).

Le tableau ci-dessous reprend les données nécessaires pour l'application des deux tests sur les NPL, à savoir, l'écart-type, les valeurs initiales des NPL et la valeur après choc pour les 10 banques.

Tableau 4 : Scénarios appliqués sur NPL

	BQ1	BQ2	BQ3	BQ4	BQ5	BQ6	BQ7	BQ8	BQ9	BQ10
Ecart type de NPL en %	2,95	1,09	0,86	0,93	1,93	0,23	5,75	0,97	0,86	2,27
Scénario 01 : ↗ NPL de 3*σ (%)	8,84	3,27	2,59	2,79	5,8	0,69	17,26	2,9	2,57	6,82
Scénario 02 : ↗ NPL de 6*σ (%)	17,67	6,53	5,18	5,57	11,61	1,39	34,52	5,8	5,14	13,65
NPL en % (T3-2021) Scénario de base	16,49	7,15	5,72	5,28	12,97	6,57	12,14	9,79	14,37	12,01
NPL en % (T4-2021) Selon le Scénario 01	25,33	10,42	8,32	8,07	18,78	7,26	29,41	12,69	16,94	18,84
NPL en % (T4-2021) Selon le Scénario 02	34,16	13,69	10,91	10,85	24,58	7,95	46,67	15,59	19,52	25,66

Source : Auteur

Une fois les valeurs des prêts non performants des 10 banques sont déterminées, pour le quatrième trimestre de 2021, il convient de chercher les valeurs des variables exogènes pour la même période. Ceci sera effectué grâce à nos modèles estimés, à partir desquels nous avons pu déduire les équations traduisant la relation entre les déterminants clés du risque de liquidité des banques tunisiennes et les normes macro prudentiels LCR et LTD. Enfin, ces prévisions seront comparées à celle retrouvées en situation normale (Scénario de base). Le tableau suivant reprend les valeurs des ratios LCR calculés pour l'ensemble des scénarios :

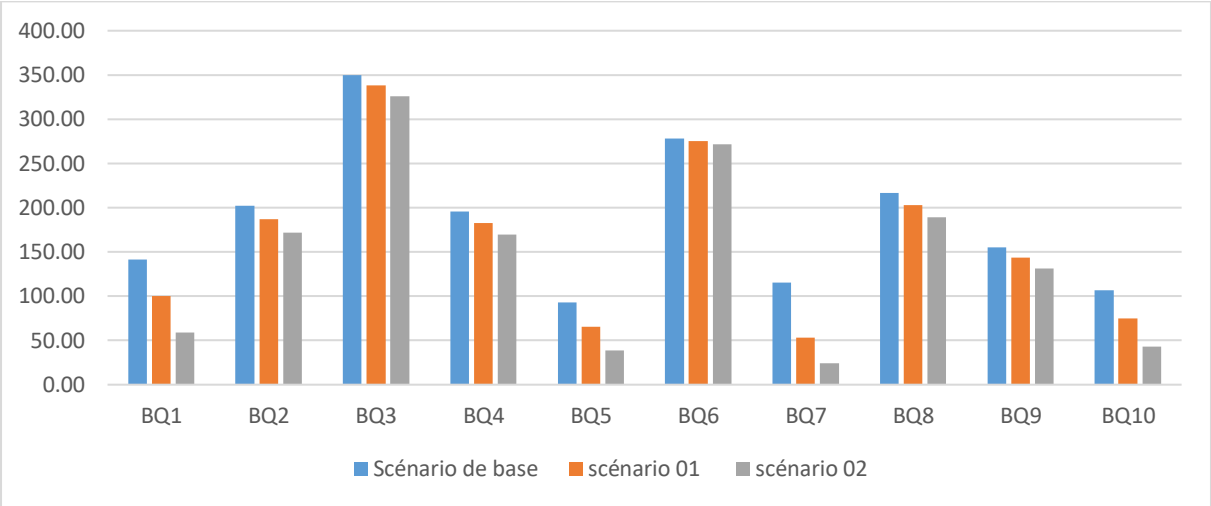
Tableau 5 : Valeurs des LCR avant et après les tests appliqués sur NPL

	BQ1	BQ2	BQ3	BQ4	BQ5	BQ6	BQ7	BQ8	BQ9	BQ10
Scénario de base	141,25	202,48	350,09	195,95	92,59	278,17	115,31	216,41	155,47	106,83
Scénario 01	100,02	187,23	337,96	182,94	65,49	274,95	53,14	202,89	143,48	74,97
Variation 1	-41,23	-15,25	-12,13	-13,01	-27,10	-3,22	-62,17	-13,52	-11,99	-31,86
Scénario 02	58,83	171,98	325,88	169,97	38,44	271,73	24,50	189,36	131,45	43,16
Variation 2	-82,42	-30,50	-24,21	-25,98	-54,15	-6,44	-90,81	-27,05	-24,02	-63,67

Source : Auteur

Pour plus de visibilité, nous avons représenté les résultats obtenus des ratios LCR dans la figure suivante:

Figure 2 : Valeurs des LCR avant et après les tests appliqués sur NPL



Source : Auteur

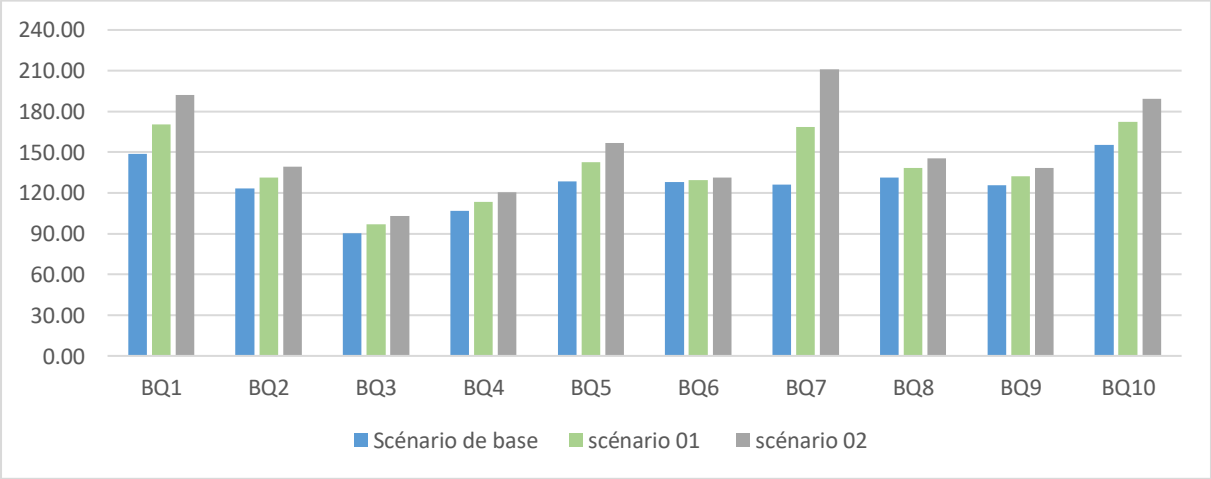
Le même travail est refait pour le ratio de transformation LTD. Le tableau suivant reprend les valeurs des ratios LTD calculés pour l'ensemble des scénarios :

Tableau 6 : Valeurs des LTD avant et après les tests appliqués sur NPL

	BQ1	BQ2	BQ3	BQ4	BQ5	BQ6	BQ7	BQ8	BQ9	BQ10
Scénario de base	148,66	123,39	90,46	106,57	128,49	127,86	126,03	131,34	125,78	155,57
Scénario 01	170,36	131,41	96,85	113,42	142,75	129,55	168,43	138,46	132,08	172,33
Variation 1	21,70	8,02	6,39	6,85	14,26	1,69	42,40	7,12	6,30	16,76
Scénario 02	192,04	139,44	103,21	120,25	156,99	131,25	210,80	145,58	138,42	189,08
Variation 2	43,38	16,05	12,75	13,68	28,50	3,39	84,77	14,24	12,64	33,51

Source : Auteur

Figure 3 : Valeurs des LTD avant et après les tests appliqués sur NPL



Source : Auteur

➢ Analyse des résultats et recommandations

Suite à l'application d'un choc défavorable sur les NPLs visant à apprécier l'impact de la dégradation de la qualité des actifs sur la résilience des banques tunisiennes et leur capacité à respecter les normes macro-prudentielles en terme de liquidité à savoir les ratios LCR et LTD, nous pouvons conclure que les dix banques de notre échantillon ont affiché une relative résistance au choc appliqué.

En effet, nous constatons que les banques BQ2, BQ3, BQ4, BQ6, BQ8 et BQ9 ont fait preuve de résilience que ce soit au niveau du premier scénario de choc considéré comme modéré qu'au niveau du deuxième qualifié de grande ampleur. Cette résilience est plus prononcée pour la banque BQ3 qui malgré la situation économique morose à laquelle est venue s'ajouter la pandémie du Covid-19, elle a réussi à respecter les exigences règlementaires imposés par les autorités de régulation en affichant un ratio LCR de 337.96% et de 325.88% et un ratio LTD de 96.85% et de 103.21% pour le premier et le deuxième scénario respectivement.

Toutefois cette surperformance ne permet pas cacher les disparités qui existent entre les banques de notre échantillon. En effet, les résultats de notre simulation montrent également que malgré les efforts considérables déployés aussi bien par l'autorité de supervision afin d'assurer la solidité et la résilience des établissements financiers, en s'assurant de leur conformité avec les lois et la réglementation en vigueur notamment en matière de liquidité, que par les banques elles-mêmes dont les efforts visent essentiellement à l'assainissement du portefeuille des crédits et au maintien d'un niveau faible des créances classées par rapport à la moyenne du secteur, les banques BQ1, BQ5, BQ7 et BQ10 demeurent vulnérables face au choc appliqué touchant la qualité de leurs actifs.

Cette dégradation est plus nuisible pour les banques BQ1, BQ7 et BQ10 dont les deux ratios prudentiels atteignent des niveaux critiques (un ratio LCR de 24.5% et un ratio LTD de 210.8% pour la banque BQ7), qui dépassent largement les exigences réglementaires fixées aussi bien pour le ratio LCR (inférieur à 100%) que le ratio LTD (supérieur à 120%).

En effet, ces trois banques peuvent s'exposer à un éventuel risque de liquidité inhérent à la qualité des actifs et dont les conséquences peuvent être néfastes, non seulement pour les banques en question mais également pour l'ensemble du système bancaire étant donné qu'il s'agit des banques systémiques.

Toutefois, il reste à s'interroger sur les sources de défaillances de ces trois banques, à ce titre, les statistiques descriptives (présentées en annexes) peuvent nous délivrer une partie de la réponse. En effet, ces banques présentent le taux de prêts non performants le plus élevé qui dépasse les 23% par rapport à une moyenne du secteur qui ne dépasse pas les 12%. De même, l'analyse du niveau moyen de refinancement trimestriel des banques nous renseigne sur la forte dépendance de ces banques au refinancement de la BCT. Ce recours massif au refinancement est généralement considéré comme une source de risque de liquidité essentiellement lorsque les fonds empruntés à court terme sont destinés à l'octroi de crédits à long terme.

Nous pouvons également lier les défaillances constatées, d'une part, à l'incapacité de ces banques à reconduire un financement stable (dépôts↘), ou également à l'utilisation de leur encours d'actifs liquides de haute qualité pour accéder au marché monétaire , et d'autre part, à des raisons liées aux conditions générales de crédits, puisque malgré les retards de paiements et des impayés enregistrés, les banques continuent en permanence au financement de l'économie dans le cadre de son activité d'intermédiation (essentiellement en période de crises), traduisant ainsi une augmentation du risque de transformation (LTD↗).

A l'issue de ce qui précède, les banques, même celles qui disposent d'une situation jugée satisfaisante en terme de liquidité, doivent :

- Consolider les pratiques en matière de recouvrement et de résolution de l'ancien stock des créances classées, accumulé depuis plusieurs années ce qui permet d'aboutir à l'assainissement du portefeuille des crédits et au maintien d'un niveau faible des créances classées.

- Effectuer périodiquement des simulations de crise portant sur divers scénarios de tensions brèves ou prolongées afin de s'assurer que ses expositions courantes au risque de liquidité restent conformes au niveau de tolérance qu'elle s'est fixée.

Toutefois, dans une situation de tensions suffisamment fortes à l'échelle du système, il faudrait tenir compte des effets sur le système financier tout entier. C'est ici que se manifeste le rôle de la BCT dans la détection et le suivi des différents facteurs et évolutions susceptibles d'affecter la stabilité et la résilience du système financier, notamment celles constituant une atteinte à sa solidité ou une accumulation de risques systémiques.

Conclusion

Garce à leur rôle d'intermédiation financière et les divers services qu'elle fournissent, les banques tunisiennes se présentent aujourd'hui comme le pôle le plus important du système financier tunisien en assurant en permanence le financement de l'économie et la promotion de la croissance tout en se retrouvant en première ligne pour soutenir l'ensembles des acteurs et opérateurs économiques pendant les périodes marquées par un ralentissement économique, des tensions accrues et des crises inattendues.

Dans cette veine, l'environnement actuel dans lequel opèrent les banques tunisiennes, dont l'inconnu et l'incertain sont désormais les maîtres-mots qui le dominent, est considéré comme un catalyseur de risques par excellence.

C'est dans cette optique que s'inscrit notre travail de recherche dans lequel nous avons essayé d'identifier les déterminants clés du risque de liquidité des banques tunisiennes tout en testant par la suite la résilience de ces banques, mesurée par le degré de leur conformité aux normes macro-prudentiels de liquidité, face à un choc touchant la qualité de leurs actifs.

Dans ce sillage, les résultats trouvés à la suite de notre estimation économétrique montrent que la capitalisation bancaire, la taille et le taux directeur impacte négativement le risque de liquidité, tandis que les prêts non performants, la spécialisation, le refinancement sur le marché monétaire ont un impact significatif et positif sur le risque de liquidité. Ces résultats convergent avec la majorité des études antérieures. Toutefois, nous avons trouvé une relation non significative entre la solvabilité et le risque de liquidité.

Les résultats du stress test effectué, montrent que la majorité des banques ont fait preuve de résilience face aux scénarios de chocs proposés, toutefois, cela ne doit pas cacher la disparité dans notre échantillon. En effet, quelques banques tunisiennes demeurent vulnérables aux scénarios de chocs appliqués touchant la qualité de leurs actifs, les exposant par conséquent à un éventuel risque de liquidité dont les conséquences peuvent être néfastes, non seulement pour elles-mêmes mais également pour l'ensemble du système bancaire étant donné que la plupart de ces banques sont des banques systémiques.

Toutefois, malgré cette situation économique alarmante et financière préoccupante, il existe un scenario optimiste pour la période 2022-2023 qui n'est pas du tout évident, mais qu'il faudra chercher. À cette fin, les banques doivent gérer l'incertitude avec détermination et réinventer leur stratégie pour assurer leur résilience et ce tout en restant vigilantes car les risques persistent toujours.

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Annexe 1 : Statistiques descriptives du ratio LCR et LTD par banque

Banques	BQ1	BQ2	BQ3	BQ4	BQ5	BQ6	BQ7	BQ8	BQ9	BQ10	Echantillon
Ratio de liquidité CT _ LCR (en %)											
Obs	26	26	26	26	26	26	26	26	26	26	260
Mean	81.40	171.37	261.6	127.12	87.32	222.18	135.34	182.27	99.31	88.22	145.61
S.Dev	48.37	76.49	144.89	62.48	16.27	166.48	64.23	152.35	28.16	19.88	110.16
Max	195	310.62	529.39	253.29	111.76	724.19	313	596	184	121.43	724.19
Min	7	49	92	34	47	79	55	75	60	47	7
Ratio du risque de liquidité _ LTD (en %)											
Obs	12	12	12	12	12	12	12	12	12	12	120
Mean	153.16	126.08	98.81	112.96	124.31	130.54	130.23	129.83	129.20	157.82	129.29
S.Dev	4.69	6.90	5.27	11.36	9.69	10.55	4.93	6.09	6.48	7.11	17.83
Max	159.29	135.91	106.91	128.81	145.76	142.90	138.60	140.57	143.23	165.74	165.74
Min	146.24	116.87	91.88	95.98	109.43	113.74	124.73	120.23	120.24	145.91	91.88

Annexe 2 : Statistiques descriptives des variables spécifiques aux banques

Banques	BQ1	BQ2	BQ3	BQ4	BQ5	BQ6	BQ7	BQ8	BQ9	BQ10	Echantillon
Capital Adequacy Ratio _ CAR (en %)											
Obs	26	26	26	26	26	26	26	26	26	26	260
Mean	8.89	8.90	6.99	8.63	9.29	8.72	12.03	13.39	11.44	5.83	9.41
S.Dev	1.60	0.63	0.78	1.18	0.62	1.16	2.15	0.61	0.94	0.99	2.46
Max	11.17	10.45	8.82	10.86	10.26	10.92	15.39	14.44	12.91	7.31	15.39
Min	6.29	8.00	5.85	7.04	8.40	7.32	7.37	12.3	9.89	3.81	3.81
Non-Performing Loans _ NPL (en %)											
Mean	19.42	8.84	6.81	6.59	10.13	6.33	23.21	8.59	15.26	14.13	11.93
S.Dev	2.95	1.09	0.86	0.93	1.93	0.23	5.75	0.97	0.86	2.27	6.03
Max	25.4	10.9	8.6	8.6	12.76	6.9	30.4	10.3	16.9	18.7	30.4
Min	16.3	7.6	5.6	5.2	7.0	6.0	12.85	6.80	13.30	11.40	5.2
Total Assets _ Size (en mDT)											
Mean	14 268 730	6 129 930	8 540 419	14 889 720	6 832 793	3 984 901	12 620 801	6 107 517	9 709 434	12 554 930	9 563 918
S.Dev	2 766 491	1 122 290	1 495 882	3 140 294	1 045 088	306 444	1 396 299	897 859	492 646	2 845 343	4 059 907
Max	18 857 120	7 807 720	10 554 950	19 472 280	8 809 986	4 483 858	14 898 490	7 373 032	10 439 150	17 146 380	19 472 280
Min	10 432 230	4 414 381	5 866 280	9 889 042	5 394 942	3 340 881	10 387 660	4 718 071	8 917 899	8 071 474	3 340 881
Specialization _ SPEC (en %)											
Mean	70.59	81.51	61.57	61.52	65.11	68.59	62.68	71.17	67.30	68.46	67.85
S.Dev	2.99	3.05	2.29	3.21	2.41	2.89	3.91	2.52	3.79	1.82	6.37
Max	76.15	86.13	65.02	66.07	69.27	73.05	71.53	74.73	73.97	72.99	86.13
Min	66.91	75.70	57.90	55.92	60.59	63.81	58.3	66.37	61.28	65.8	55.92
Refinancing _ RF (en mDT)											
Mean	1 429 288	92 306	559 153	978 929	666 138	143 145	1 147 453	425 392	943 507	1 340 425	772 573
S.Dev	498 305	72 738	247 893	661 711	193 129	86 506	449 348	150 229	190 921	550 957	576 628
Max	2 535 100	237 300	996 000	2 603 000	915 000	322 000	1 819 000	690 000	1 297 000	2 316 140	2 603 000
Min	628 900	0	65 000	56 500	58 000	0	335 700	127 000	611 000	510 000	0
Solvability Ratio _ RS (en %)											
Mean	13.98	11.52	11.98	11.36	14.12	11.11	11.35	16.07	14.12	10.55	12.61
S.Dev	3.87	0.65	1.37	1.13	1.31	0.81	3.52	2.36	1.31	1.29	2.66
Max	20.44	12.6	14.2	13.5	16.4	12.7	13.5	22.3	16.4	12.05	22.3
Min	9	9.8	9.7	9.9	12.1	10.1	5.1	13.8	12.1	1.29	1.29

Can central bank FX interventions help achieving the Inflation-Targeting framework goal?

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Abstract

In this investigation, we provide insights into the crucial role of central banks' monetary s trategy for achieving price stability. Particularly, we assess the impact of central bank foreign interventions in controlling inflation rates. To this end, we choose to employ a methodology based on the Structural VAR as it permits us to consider the interaction between monetary and exchange rate policies' components. We defined two different specifications where we modelled the contemporaneous effects between our variables in the presence and absence of the mixed policy. We contribute to the literature by inspecting the effectiveness of central bank interventions in order to attain the inflation objective in Tunisia, as our country is moving toward Inflation Targeting. We find that the money market rate responds to an inflation shock instantly. Furthermore, interventions are claimed to be effective in countering exchange rate deviations. However, there is little to gain in terms of inflation objective.

Keywords: Inflation targeting, FX interventions, Structural VAR, Monetary policy, Exchange rate policy, Price stability.

JEL Classifications: C32, E58, F31, F41

Introduction:

In order to look for economic and financial stability, central banks try to develop a variety of strategies based on a set of instruments. As time went on, monetary authorities have made several changes in the conduct of the monetary policy and in accordance with predetermined objectives. Consequently, many changes have been observed in the monetary framework basis over time. Nowadays, different central banks introduce Inflation Targeting (IT) as their monetary regime. Despite of being requiring, IT has proved its efficiency in many emerging and developing economies. In the early 1980s, the economic situation in New Zealand was somehow difficult. Inflation rates were in rise, which pushed decision makers to operate some reforms with the objective to control inflation rates. Since this pioneer experience, many central banks learned from the New Zealander case and moved toward this regime. Indeed, it has captured the attention of researchers, as many countries were moving toward this framework. This fact should not be surprising. In fact, a variety of papers have praised this regime. For instance, Palomino (2012) demonstrated that an IT adoption contributed to improve public understanding of monetary policy and increased the credibility of central banks' actions. Consistent with this work, Bernanke et al. (1999) claimed that IT should reduce inflation rates and their variability and enhance the transparency of how the monetary policy is conducted. In fact, many advantages may result from setting an IT regime. Adding to the credibility of central banks, a successfully implemented IT framework is a proof of having a sound banking sector and a well-developed financial market, which should result in reducing the risk (for instance, we cite country risk, sovereign risk and exchange risk, among others).

The Tunisian monetary authorities are not far from the international economic context. After the failure of the Monetary Targeting Strategy (MTS) that has been introduced as the main monetary framework in order to achieve price stability, a debate emerged inside the CBT about maintaining the MTS with some modifications or adopting IT. As it is perceived to be a wanting regime, Tunisia is trying to move toward IT as it displays a set of benefits in terms of economic stability and credibility.

However, the main problem for Tunisia is that it does not satisfy the requirements of an IT framework. Consequently, a flexible version of this regime is proposed, where monetary authorities use the available instruments to achieve it. To maintain price stability, central bankers use the interest rate as the main instrument for conducting monetary policy. Nevertheless, a stand of the literature showed the importance of the mixed policy. In other terms, exchange rate and monetary policies may yield to better results in terms of attaining the price stability objective. As the exchange rate policy constitutes one of the pillars that affects the monetary policy, monetary authorities should take into account the impact of exchange rate movements on monetary policy components. One of the ways that central bankers use to control exchange rate developments is the Foreign Exchange (FX) interventions. A number of studies have shown evidence of this fact (we cite, Abenoja, 2003; Nordstorm et al., 2009; and Vizinuic, 2020; among others). In this respect, we think that central bank interventions might present a prominent additional tool for monetary policy and particularly to a flexible IT framework. To the best of our knowledge, we are the first to provide answers to this issue.

Our methodology is based on studying the interaction between monetary and exchange rate policies. For this reason, we choose to employ a Structural Vector Autoregressive (SVAR) where we propose two different specifications. In the first specification, we suggest that deviations in inflation and NEER are supposed to be faced mainly by the money market rate and FX interventions. In the second, we assume that interventions react to shocks on inflation and money market rate.

The remainder of this article is outlined as follows: section 2 reviews the existing literature on the interplay between monetary and exchange rate policies and the role of FX interventions in emerging markets particularly in economies announcing IT as their main regime. In section 3, we introduce our methodology as well as the data employed in this study. The empirical analysis is carried out in the fourth section. Finally, we conclude and present the implications of our work.

1. Related Literature

Monetary authorities manage the exchange rate policy by intervening in the foreign exchange market. The central bank purchases or sells currencies to influence or contain the excessive movements in the exchange rates. Unsurprisingly, policy making of the FX interventions in advanced economies differs from developing countries. A stand of researches focused on the effectiveness of FX interventions in emerging markets. Most of academics presume that undertaking FX interventions in developing countries would make a difference compared to developed countries, which operate with a floating exchange rate regime. Disyatat and Galati (2005) claimed that when foreign exchange market is not large and dominated by few financial operators, monetary authorities should provide guidance as the exchange rate is likely to be volatile. Indeed, exchange rate policies have to be managed in a way that permits policy makers to achieve their goals such as for East Asia when authorities were leaned toward ensuring export competiveness between 1980 and 1990. In addition, Tapia and Tokman (2004) argued that public announcements of the coming interventions by the central bank of Chile are found effective in impacting both the level and the trend of the exchange rate. In line with this idea, Berganza and Broto (2011) used a sample of 37 emerging countries and a panel model to prove that in emerging IT countries, FX interventions have been more effective to lower exchange rate volatility, than in non-IT countries. In addition, Vizinuic (2020) created a small open economy model through a DSGE technique to investigate the implications of FX interventions on agents' welfare. He showed that FX interventions might be beneficial in case of financial shocks particularly when the level of currency discrepancy in the economy is high.

Thus, as documented by academics, FX interventions seem to play a key role in emerging countries. In this logic, what are the gains of emerging countries if they undertake FX interventions in an IT context?

Gersl and Holub (2006) shed light on the role of FX interventions in an IT regime in Czech Republic. Since 1998, the Czech National Bank (CNB) announced that IT had become the main monetary policy framework. However, the CNB was applying a mixed policy combining inflation and exchange rate objectives. Using different statistical tools, they showed evidence of the impact of FX interventions on the exchange rate and its volatility. Authors concluded that in small economies, it is better not to use excessively FX interventions. Nevertheless, interventions are claimed to present the best additional instrument that helps an IT framework. Indeed, to ensure the effectiveness of these interventions, authors insisted on the fact that they should be communicated with the same credibility that does the conduct of the IT policy. Catalan-Herrera (2016) studied the influence of FX interventions on daily exchange rate returns of the Quetzal over the American dollar. He used a GARCH model because interventions are instrumented with a conditional expectation to interventions. Although it was not found a great evidence of this fact, the author showed that monetary authorities' interventions on the foreign market had a dampening effect on the volatility of daily returns under an IT regime.

In line with this idea, Adler et al. (2019) developed a small open economy model where the central bank opts for a flexible inflation targeting to analyse at what extent the FX interventions contribute to the IT goals in terms of credibility. They found that when the central bank is credible, FX interventions might stabilise potential output and inflation rates in response to foreign shocks. Consistent with this finding, Canzoneri and Cumby (2013) employed a DSGE model to investigate whether the performance of IT is improved when running FX interventions by monetary authorities. They concluded that FX interventions affect strongly inflation and output in an IT regime. Gosh et al. (2016) demonstrated that in emerging countries a mix of monetary and exchange rate policies should exacerbate positive effects mainly when targeting exchange rate through FX interventions in an IT context. Briefly, FX interventions should help the IT framework goals. Nevertheless, as Tunisia intended to opt for a flexible IT framework since 2003, we think intuitively, that FX interventions may provide more effectiveness in achieving the IT regime objectives. Consequently, we contribute to the literature by inspecting in what way, FX interventions would help the CBT efforts in order to attain the inflation goal.

2. Data and Methodology

2.1. Data

To produce this work, we employ data collected from the central bank database. To construct the SVAR, we use, mainly, quarterly data related to Industrial production Index (IPI), Consumer Price Index (CPI), Nominal Effective Exchange Rate (NEER) and, Money Market Rate (TMM) as a proxy for the central bank policy rate and FX interventions (FX). Our sample spans from the first quarter of 2010 to the fourth quarter of 20191.

As we intend to estimate the Taylor rule and intervention equations, we employ other variables such as, inflation rates, output growth, deviations and changes of the REER and changes in FX reserves computed using the elementary variables presented previously.

2.2. SVAR framework

The SVAR model can be expressed as follows:

$$A_0 X_t = D(L) X_t + B u_t$$

Where: X_t is a $(n \times 1)$ vector containing economic variables, and u_t is a same dimension vector of mean zero structural innovations. A_0 is a matrix of structural coefficients is a non-singular matrix and is normalised to have ones on the diagonal. This matrix summarises the contemporaneous relationships

[1] Due to FX interventions data unavailability, we only consider the period spanning from 2010 to 2019, which results in using 40 observations.

between the variables of the model and is most commonly where identification restrictions are imposed. L is a lag-operator and $D(L) = \sum_{i=1}^{n} L_i$ contains structural polynomials, **B is supposed to be an identity matrix.**

To the structural model, we associate the reduced form VAR representation expressed as follows:

$$X_t = C(L)X_t + \varepsilon_t$$

Where: ε_t is also a vector containing the variables' structural disturbances expressed as:

$$\varepsilon_t = A_0^{-1} u_t$$

Its covariance matrix is:

$\Omega = E(\varepsilon_t \varepsilon_t') = A_0^{-1} \sum \varepsilon A_0'^{-1}$ and characterized by $E(\varepsilon_t) = 0, E(\varepsilon_t / X_{t-1}) = 0, E(\varepsilon_t \varepsilon_s') = 0$

The identification of the SVAR model is done through the addition of other information to estimate A_0. To make it simple, we only use short-run restrictions.

2.3. Instruments of the central bank

To ensure economic resilience, the central bank of Tunisia should conduct monetary and exchange rate policies in an optimal manner. In other words, it should take into consideration all the factors deemed to influence its reaction function in order to counter their movements by well managing its instruments. To this end, we start by examining the Taylor rule and the interventions' equations2 to identify the possible interplays with the considered variables.

To assess the determinants of **central bank interventions** in Tunisia, we inspire from Neely (2005) where interventions are described as follows:

$$\boldsymbol{I_t = c + \omega_1 I_{t-1} + \omega_2 \Delta S_{t-1} + \omega_3 (S_t - \overline{S}_t) + u_t^I}$$

Where:

I_{t-1} stands for the lagged intervention, ΔS_{t-1} is the lagged change in REER and $(S_t - \overline{S}_t)$ represents the deviation of the REER from its targeted value. The targeted REER, $\overline{S}_t$, is calculated using an HP filter.

Indeed, we suggest a **Taylor rule specification** that can be expressed as follows:

$$\boldsymbol{i_t = \beta_0 + \beta_1 i_{t-1} + \beta_2 (\pi_t - \pi_{t+4}^e) + \beta_3 (REER_t - REER_{t-1})) + \beta_4 (y_t - y_{t-1}) + u_t^i}$$

Where i_{t-1} is the lagged interest rate, π_{t+4}^e is the model-consistent projection of inflation four quarters ahead which assumed to be at the level of 4% drawing on Makni (2019), REER is the real effective exchange rate, and $(y_t - y_{t-1})$ is the change in output.

3. Evaluation of the two instrument monetary policy

3.1. Descriptive Statistics

We present the descriptive statistics of the main variables of this investigation. Our variables are the money market rate (TMM), the Nominal Effective Exchange Rate (NEER), the Industrial Production Index (IPI) as a proxy of the Tunisian output, the Consumer Price Index (IPC) and FX interventions (FX).

As provided by Table 1 (see appendix), the money market rate varies between 3.2% and 7.8%. During the study period, the rise of this rate was due to the policy pursued by the monetary authorities

[2] Estimations are done using OLS technique. All the variables employed in this section are stationary.

based on controlling inflation rates and their variability as the money market rate moved along with the central bank policy rate. The NEER shows more fluctuating figures compared to the TMM. However, the output presents more variability with a 48-point difference between the highest observation and the lowest one. The social movements might explain this fact. The economic context has been impacted by the Arab spring pushing the production indices to drop. Indeed, the fragile political situation had led to claim uncertainty by Tunisia's partners, which deeply affected the level of production and productivity. The consumer price index has been in an increasing trend since the revolution. Inflation surged its highest score level during the last quarter of 2019, after which the central bank reacted to by rising its policy rate.

It stands out from Table 1 that the Kurtosis is higher than three only for TMM and FX. In other words, while most of the variables are platykurtic, TMM and intervention distributions are characterized by thick tail because they are leptokurtic. The Skewness coefficient is statistically different from zero for all the considered variables. It bears a negative sign for the IPI, NEER and FX and positive sign for the remaining variables. In this way, we can conclude that all the distributions are found asymmetric. Although, IPI, NEER and FX series are left skewed, others are right skewed. As we can remark, the Kurtosis and Skewness coefficients are different from those characterizing the normal distribution. Intuitively, we may claim that the considered distributions are not normal. We run the Jaque-Bera test to make sure of the non-normality of the distributions.

As we can see in Table 2 (see appendix), the p-values are less than 5% for the TMM and FX, which justifies their non-normality at 5% and 10% levels. For the IPI, IPC and NEER, p-values are high which means the failure of the rejection of null hypothesis at all levels of significance. Thus, we may conclude that they present normal distributions.

3.2. Determinants of central bank instruments

3.2.1. Interest rate rule

We estimate the interest rate rule where the policy interest rate is supposed to depend on the deviations of inflation from its target, change in output growth and REER, respectively. The estimation results are depicted in the Table 3 (See below).

Table 3: Taylor rule estimation

Variable	Coefficient	Std. Error	P-value
Constant	0.002097	0.030917	0.9462
Lagged TMM	0.536336	0.112434	0.0000
Deviation of inflation from its target	0.115885	0.066678	0.0879
Change in output growth	0.007505	0.006774	0.2728
Change in REER	-0.022231	0.015788	0.1648

Source: My own calculations based on Eviews software.

To estimate the Taylor rule, we include variables in the first difference to guarantee the accuracy of our results. Our results suggest that the money market rate is strongly dependent on its lagged observation as well as inflation movements. This observation is consistent with the economic theory. According to Bernanke et al. (1999), the main instrument of an IT central bank is the interest rate, which is employed to limit inflation developments. The deviations of the inflation rate from its target pushes the money market rate to respond, as the coefficient is significant under 10% level. Put simply, this finding clearly demonstrated that the primary goal of the central bank is maintaining price stability. Surprisingly, the change in output growth is not a significant variable for the Taylor rule estimation. This result indicates that, during a context of deep recession, the central bank of Tunisia is well aware of the difficulty of containing the inflation and promoting the output simultaneously, it has privileged the first goal over the second one. In addition, the estimation of the Taylor rule may give us a glimpse

of how the exchange rate policy contributes to the monetary policy. The change in REER is not significant under all levels suggesting that the latter variable is not supposed to influence the TMM. However, a more detailed analysis is necessary to a have a clear picture about the assessment of the monetary policy. For this purpose, we conduct a structural VAR investigation.

3.2.2. Foreign Exchange intervention

Turning to foreign exchange market interventions, the literature tells a lot about this variable. According to Neely (2005), Gosh et al. (2016) and Kim and Sheen (2018), interventions should depend mostly on past interventions, change in REER, in reserves and deviation of the REER from its target. The considered variables are integrated same order to guarantee the accuracy of our estimations.

Table 4: FX interventions' equation

Variable	Coefficient	Standard Error	P-value
Lagged interventions	0.357945	0.148849	0.0220
Change in REER	261.3029	153.4376	0.0980
Deviation of the REER from its target	294.9353	156.1786	0.0678
Lagged deviation of the REER from its target	292.2234	155.5278	0.0690
Change in reserves	0.064279	0.033364	0.0627
Constant	514.3747	146.3311	0.0013

Source: My own calculations based on Eviews software

Table 4 reports the estimation results of the central bank FX interventions regressed on exchange rate policy variables. Although interventions are revealed to fluctuate in response to changes in the exchange rate policy determinants, the considered factors do not reflect huge relevance. Actually, past interventions seem to be the most important determinant in this equation because it appears statistically significant under 5% and 10% levels. However, the remaining variables are only significant at the level of 10%. A positive change in REER affects the positively interventions. In other words, the central bank intervenes in the foreign exchange market to counter highly changes in REER, particularly when the misalignment is getting larger. Change in reserves are supposed to lessen interventions, which is consistent with the economic theory. Simply put, the central bank tends to reduce its interventions when the amount of international reserves is tightening.

3.3. Effectiveness of the Foreign exchange interventions in Tunisia

A large body of the literature praised the use of FX interventions within an IT framework (Gosh at al., 2016; Adler et al., 2019). Consequently, it is relevant to assess their effectiveness in terms of inflation control. To this purpose, we consider a Structural VAR composed of the following variables: Industrial Production Index (IPI) as a proxy for the Tunisian output, Consumer Price Index (IPC) as a proxy for inflation, the Money Market Rate (TMM) because it is strongly dependent on the central bank policy rate, and the Nominal Effective Exchange Rate (NEER). All the variables are considered in their **first difference** to guarantee their stationarity and consequently yielding to better SVAR model results[3].

To answer our main question, we consider **two different specifications**. In the first specification, we assume that the monetary and exchange rate policies do not have contemporaneous effects on each other. That is, shocks on exchange rate components are not supposed to impact immediately the monetary policy components. We simulate a mix of policy in the second specification where we suppose the interaction between FX interventions, TMM and IPC to examine to what extent interventions may help achieving the price stability goal.

[3] ADF and PP tests are provided in the appendix.

The conduct of the SVAR will be done using **one lag**[4]. Consequently, the **SVAR(1)** model is defined as follows:

$$\begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} & a_{15} \\ a_{21} & 1 & a_{23} & a_{24} & a_{25} \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} \\ a_{41} & a_{42} & a_{43} & 1 & a_{45} \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} \begin{bmatrix} Dipi_t \\ Dipc_t \\ Dtmm_t \\ Dneer_t \\ Dfx_t \end{bmatrix} = \begin{bmatrix} a_{10} \\ a_{20} \\ a_{30} \\ a_{40} \\ a_{50} \end{bmatrix} + \begin{bmatrix} 1 & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & 1 & b_{23} & b_{24} & b_{25} \\ b_{31} & b_{32} & 1 & b_{34} & b_{35} \\ b_{41} & b_{42} & b_{43} & 1 & b_{45} \\ b_{51} & b_{52} & b_{53} & b_{54} & 1 \end{bmatrix} \begin{bmatrix} Dipi_{t-1} \\ Dipc_{t-1} \\ Dtmm_{t-1} \\ Dneer_{t-1} \\ Dfx_{t-1} \end{bmatrix} + \begin{bmatrix} u_t^{Dipi} \\ u_t^{Dipc} \\ u_t^{Dtmm} \\ u_t^{Dneer} \\ u_t^{Dfx} \end{bmatrix}$$

Where: Y_t presents the vector of endogenous variables$(Dipi_t\ Dipc_t\ Dtmm_t\ Dneer_t\ Dfx_t)$.

The vector U_t presents structural shocks. A_0 is the matrix of structural coefficients.

3.3.1. Two instruments, two targets

As said before, we suppose that the main instrument of the monetary policy is the interest rate. That is, exchange rate policy components do not have simultaneous effect on inflation and money market rate. In addition, if we run a shock on inflation, NEER and FX interventions may not respond immediately to this shock. The contemporaneous effect matrix A_0[5] should be designed to reflect these interactions. We suggest the matrix to be presented such as:

$$A_{01} = \begin{bmatrix} 1 & a_{12} & a_{13} & 0 & 0 \\ a_{21} & 1 & a_{23} & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & a_{45} \\ 0 & 0 & 0 & a_{54} & 1 \end{bmatrix} \begin{bmatrix} Dipi_t \\ Dipc_t \\ Dtmm_t \\ Dneer_t \\ Dfx_t \end{bmatrix}$$

Estimation results for the A_0 matrix are revealed below.

Table 7: Estimation of the structural coefficient matrix$\boldsymbol{A_{01}}$

Element	Coefficient	Standard error	P-value
a_{21}	-0.013276	0.049869	0.7901
a_{31}	0.009063	0.050856	0.8586
a_{12}	-1.734577	0.399612	0.0000
a_{32}	2.220300	0.296014	0.0000
a_{13}	-2.085002	0.708321	0.0032
a_{23}	-3.909340	0.497864	0.0000
a_{54}	21.29853	0.082372	0.0000
a_{45}	0.000779	0.000579	0.1783

Source: My own calculations based on Eviews software.

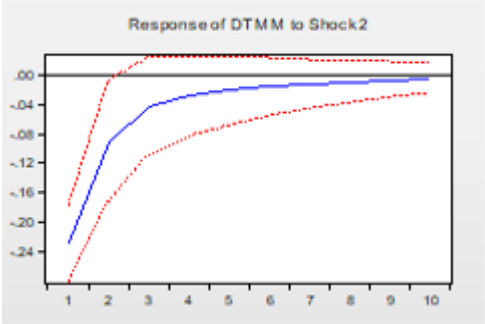
Table 7 depicts the estimations of structural coefficients. As we can remark, inflation and money market rate have simultaneous effect on each other, which is consistent with the economic theory where the central bank controls inflation through this rate. In addition, structural coefficient related to the FX interventions reaction to fluctuations in NEER seems highly significant, which supports the idea that the central bank tries to limit the misalignment through its actions on the exchange rate using FX interventions.

[4] After running preliminary tests (Lag length criteria and Heteroskedasticity tests), we find that one lag would be the optimal choice.

[5] In this study, we estimate an over-identified SVAR model drawing on several researches such as Sims (1986), Gordon and Leeper (1994), Kim and Roubini (1999) and Brischetto and Voss (1999).

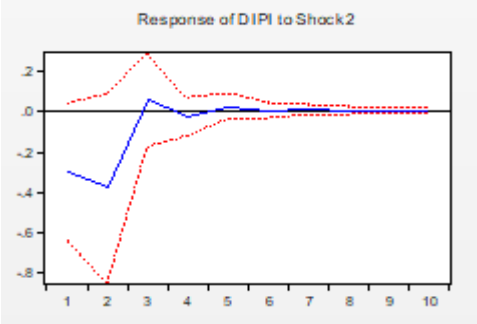
We present the **impulse reaction function**[6] due to shocks on inflation and NEER to reveal the behaviour of the considered economic variables.

Figure 1: Response of TMM to an inflation shock



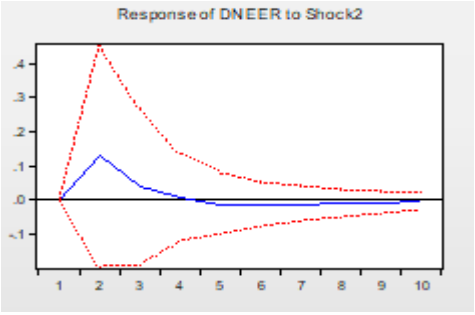
As expected, fluctuations in inflation should lead the money market rate to respond immediately, within a quarter. The central bank of Tunisia has announced itself as in independent institution to conduct the monetary policy. This is one of the requirements for Tunisia to be an IT country in addition to focussing on inflation control as its primary objective. Thus, for a country such as Tunisia, the following results seem to reflect economic reality because the main issue for the CBT is to achieve price stability. Thus, an increase in inflation should lead the central bank policy rate to deviate from its normal level driving the money market rate to move either.

Figure 2: Response of IPI to an inflation shock



Indeed, the output responds immediately to an inflation shock as the rise of the money market rate creates a less attractive environment for investors, which ultimately depletes the industrial production index. We shift our interest to interpret movements in exchange rate policy components.

Figure 3: Response of NEER to an inflation shock

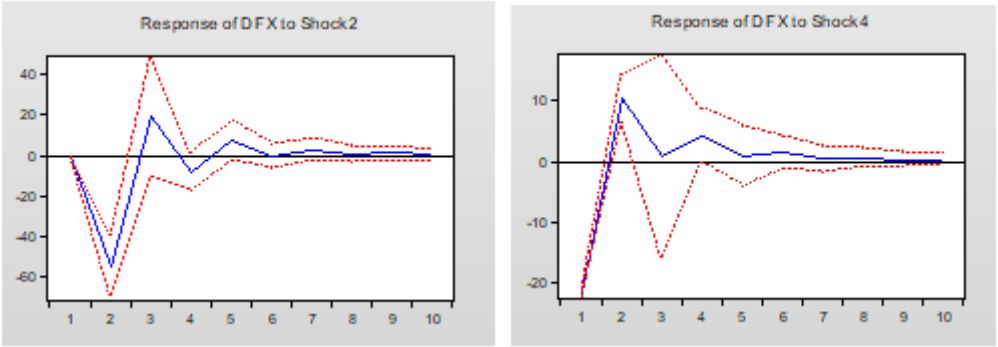


[6] Shocks 1, 2, 3, 4 and 5 correspond to shocks on output, inflation, money market rate, NEER and FX interventions, respectively.

As we may see, the NEER does not respond instantly to the inflation deviation. It takes at least one quarter to observe the NEER response. As a country aspiring to adopt IT, the NEER does not figure among the key monetary policy instruments. However, it may be affected by changes in the central bank policy rate since the exchange rate equation is defined with regards to the Uncovered Interest Parity (UIP).

Moreover, we provide the results of **FX interventions** response, respectively, to inflation and NEER shocks.

Figure 4: Responses of FX interventions to shocks on inflation and NEER



FX interventions promptly react only to a shock on NEER. This result is rather expected. When the REER deviates from its targeted value, the central bank intervenes in the foreign exchange market to contain the misalignment. It acts mainly on the NEER that transmits movement to the REER in order to get back to its equilibrium. Despite being effective for NEER developments, FX interventions seem to respond after one quarter to an inflation shock. Unfortunately, this finding can hardly be explained because of simultaneous effect and interplay between interventions and inflation. The only explanation that we may put forward is that interventions respond to gradual deviations in NEER.

3.3.2. Benefits of the mixed policy

In this subsection, we propose a modification of the previous specification by suggesting an interaction between the key instruments in monetary and exchange rate policies. In other words, we suppose that FX interventions present an interesting tool to the monetary policy to control inflation movements. In this way, interventions are supposed to react immediately to an inflation shock. For this purpose, we undertake several changes in the contemporaneous effect matrix, A_0, in a manner that reflect this possible interaction between inflation, money market rate and interventions[7]. Structural coefficient matrix will be described as follows:

$$A_{02} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & a_{23} & 0 & 0 \\ 0 & a_{32} & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} \begin{bmatrix} Dipi_t \\ Dipc_t \\ Dtmm_t \\ Dneer_t \\ Dfx_t \end{bmatrix}$$

[7] Coefficients a_{52}, a_{53} and a_{54} are supposed to reflect the reaction of FX interventions due to shocks on inflation, money market rate and NEER, respectively.

In the table below, we provide estimation results of the structural factorization.

Table 8: Estimation of the structural coefficient matrix A_{02}

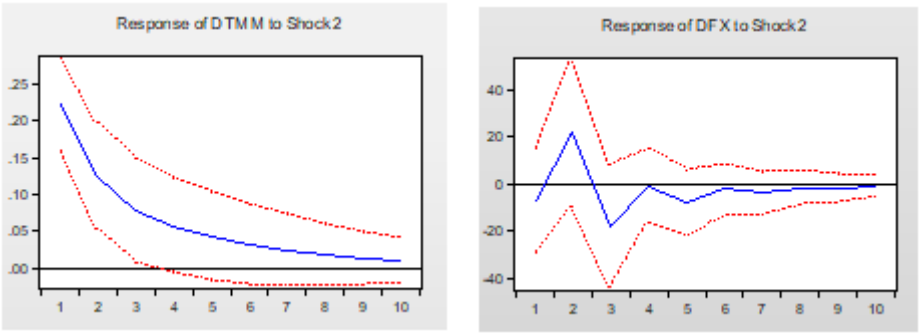
Element	Coefficient	Std. Error	P-value
a_{32}	2.229701	0.302387	0.0000
a_{52}	90.91332	0.384487	0.0000
a_{23}	3.955374	0.622938	0.0000
a_{53}	310.1792	0.753937	0.0000
a_{54}	39.82034	0.092340	0.0000

Source: My own calculations based on Eviews software.

With reference to the estimation results, we mainly notice that the structural coefficients a_{52} *and* a_{53} are highly significant, which suggests that central bank interventions are supposed to effectively respond to inflation and money market rate movements. More importantly, FX interventions react also to a shock in NEER, as the coefficient a_{54} is also statistically significant. This finding is of huge importance insofar as it presents interventions as the best instrument to control changes in the exchange rate. Furthermore, interventions seem to be a prominent tool for better monetary policy management. Unsurprisingly, we found that inflation and money market rate responses are significant, which confirms that Tunisia is moving toward an IT framework as it considers the central bank policy rate as the main component to counter inflation deviations.

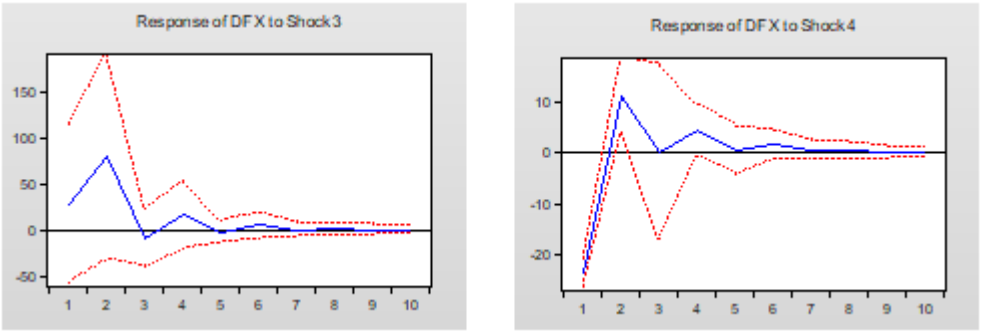
To corroborate these estimation results, we shift to explore fluctuations in FX interventions and money market rate subsequent to an inflation shock.

Figure 5: Responses of TMM and FX interventions to an inflation shock



As we predicted, the response of money market rate to an inflation shock is highly significant. The central bank tends to immediately react to inflation movements since monetary authorities announce that their main objective is to ensure price stability. Despite the use of the money market rate as the main instrument for the conduct of the monetary policy, the central bank still lacks another relevant supplementary tool to support its efforts. Although FX interventions instantly react to inflation deviations, their response remains almost insignificant. It takes one quarter for interventions to be involved in controlling inflation. More precisely, interventions' response is not explained only by the inflation shock. They are supposed to respond to the exchange rate deviations brought about by the rise in the money market rate.

Figure 6: Responses of FX interventions to shocks on TMM and NEER



We reveal in the graphics above, the responses of FX interventions to money market rate and NEER shocks, respectively. The central bank interventions react to both instruments. Although, interventions promptly react to money market rate movements, they nevertheless remain statistically insignificant. In contrast, their responses to NEER shock are relevant, which confirms that the central bank of Tunisia has recourse to interventions, mainly to limit the exchange rate fluctuations from the targeted rates.

Conclusion

Since Inflation-Targeting (IT) moved into spotlight, many academics claimed that implementing this strategy in a successful way implies a high degree of exchange rate flexibility while defining a policy dedicated to ensure the sustainability of the economic growth. However, the former condition was considered as a hard challenge for a country that assumes its commitment to a credible IT regime. It was often recognized that emerging markets are reinforced to consider large exchange rate movements from their medium run equilibrium because neglecting these fluctuations is costly. Thus, central banks of emerging IT economies should operate with two policy targets: inflation and exchange rate. In this respect, a possible tension may be unavoidable between monetary and exchange rate policies. Despite of the conflict that might happen between both strategies, surveying recent literature may lead to draw different conclusions. Emerging market experiences showed that foreign exchange interventions may display a prominent tool that helps achieving price stability (Gersl and Holub, 2006; Canzoneri and Cumby, 2013; Gosh et al., 2016; Adler et al., 2019). We contributed to the related literature through investigating one of the unexplored issues. Since the central bank of Tunisia is gradually moving toward IT, we shed light on the effectiveness of FX interventions as a noteworthy tool to support inflation control. To the best of our knowledge, we are the first to provide answers to this issue.

To better understand the drivers of monetary and exchange rate policies, we first inspected, the determinants of central bank interventions as well as the factors suggested to influence the dynamic Taylor rule in Tunisia. Although changes in the Real Effective Exchange Rate (REER) matter, the interest rate rule seems to be impacted mainly by the inflation gap. Moving to FX interventions, the central bank of Tunisia seems to only react to deviations in the REER from its targeted rate.

Secondly, in order to answer our main question, a Structural VAR model was adopted. We defined two different specifications. In the first specification, we suppose that no interaction exists between both policies. That is, exchange rate policy uses the FX intervention as its key instrument to only limit deviations in the exchange rate. Besides, the interest rate is considered as the main instrument to ensure inflation control. Then, we introduced a different specification where central bank interventions take part in achieving price stability. In other words, FX interventions were assumed to have a simultaneous effect on inflation and money market rate.

By and large, the central bank policy rate appeared to be the most effective instrument to control inflation as stipulates the IT regime. In addition, FX interventions seemed to be the main instrument to counter exchange rate deviations consistent with our intuition. However, there was little to gain in terms of inflation objective. Despite of reacting promptly to an inflation and money market shocks, FX interventions remained insignificant. To this end, the central bank of Tunisia needs to put forward a huge effort to ensure the efficiency of its interventions. However, we recognize the contribution of central bank interventions in stabilising the exchange rate. This fact should result in mitigating the imported inflation. Actually, inflation rates have been stable since the CBT increased its actions on its policy rate. Nevertheless, it is noteworthy to say that forex interventions played an important role to control this type of inflation.

In this study, we did not present FX interventions as the best tool to support the monetary strategy. However, we praised its role in helping achieve price stability. The central bank of Tunisia should define a meticulous approach to ensure the efficiency of the mixed policy. This fact is related enormously to the requirements of the IT regime. As the central bank keeps enhancing its credibility, it will be able to anticipate the expectations of financial agents. In this way, the central bank may guarantee the effectiveness of all its different instruments in order to achieve economic stability. Thus, FX interventions may matter. Although, there is no consensus about the effectiveness of central bank interventions in emerging markets, it was found that interventions are effective only if they tend to be consistent with the monetary policy strategy (Mohanty, 2013; Mihaljek, 2005). Actually, inconsistency between the exchange rate and the monetary policies may damage the transmission mechanisms for monetary policy and prevent the success of the interventions. For this reason, several central banks emphasized on the role of a good and transparent communication to guarantee that market perception is in line with the monetary policy stance.

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Appendix

Table1: Descriptive statistics of the main variables

	IPI	IPC	TMM	NEER	FX
Mean	94.71987	99.25284	4.987223	82.81050	516.4250
Median	94.41284	98.18415	4.711934	86.41243	572.0000
Maximum	101.5906	127.9158	7.849778	101.8369	1230.000
Minimum	85.31683	79.51656	3.236853	57.15311	-462.0000
Std. Deviation	3.652119	14.18037	1.248015	13.43987	323.9594
Skewness	-0.281841	0.402900	1.226228	-0.494092	-0.872513
Kurtosis	2.778590	2.093774	3.468380	1.982113	4.366335
Observations	40	40	40	40	40

Source: My own calculations based on Eviews software.

Table2: Jaque-Bera Test

	IPI	IPC	TMM	NEER	FX
Jarque-Bera	0.611267	2.450930	10.38987	3.354340	8.186640
Probability	0.736657	0.293621	0.005545	0.186902	0.016684

Source: My own calculations based on Eviews software.

- **Unit root test**

First, we start by testing the stationarity of the considered variables in level[8]. As shown in Table 4, all the variables have a unit root under all levels of significance except for the NEER and FX, that appear stationary under 5% and 10% levels.

Table 5: ADF test

	IPI	IPC	TMM	NEER	FX
ADF	0.6804	0.9763	0.8400	0.0001**	0.0285**

Notes: *, **, *** denote significance level at 1%, 5% and 10% respectively. We show estimation results where the model does not include a trend or an intercept. They are found to be insignificant for all the variables.

The second step consists in testing the unit root for all the variables considering the first difference. The results of the different tests are displayed in the table below.

As we can remark, all the variables are stationary in the first difference. Consistent with the ADF test, PP test leads to draw the same conclusions. Thus, the considered variables are integrated first order except for the NEER and FX.

Table 6: PP and ADF Tests

	D(IPI)	D(IPC)	D(TMM)	D(NEER)	D(FX)
ADF	0***	0***	0***	0***	0***
PP	0***	0***	0***	0***	0***

Notes: *, **, *** denote significance level at 1%, 5% and 10% respectively. We show estimation results where the model does not include a trend or an intercept. They are found to be insignificant for all the variables.

[8] We report the P-values for the stationarity test.

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

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Abstract

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

Keywords : Banking, Regulatory capital, Basel Accord, Profitability, Risk, 2SLS

Jel classification: G21, C23, G29

Introduction

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

Regulatory authorities are torn between the costs and benefits of bank capital. On the one hand, stringent capital requirements protect depositors' interest, provide banks with a cushion to absorb unexpected losses and inspire confidence in the banking sector. On the other hand, capital requirements' social costs in terms of availability and cost of lending which, if not taken seriously, can jeopardize real economic activity. Indeed, Bank managers are not incentivized to choose to raise capital over debt due to mainly three reasons eloquently summarized by Aiyar et al. (2015): First, if managers act against the interest of shareholders and are able to extract personal gains from keeping a high default risk, they are more likely to opt for leverage since the probability of default rises when the bank is more and more leveraged up. Second, the social costs of a banking crisis (e.g. tightening of the credit supply, disruption of the payment system) are not internalized by the bank's stakeholders. Hence, bank managers receive no incentives to keep a prudent management of risk. Third, the presence of safety nets that protect creditors' interests creates incentives for bank managers and shareholders whose interests are now aligned with the managers to "game these safety nets" by keeping a high default risk. This situation is more dangerous when depositors are not able to monitor the risk portfolio of banks due to asymmetry of information and high costs of monitoring. This is the reason why some countries have given explicit deposit insurance schemes to protect the interest of depositors since bank depositors are not protected by the standard covenants of debt contracts.

One way of going about this nexus is to assess the response of the regulated entities to risk-weighted capitals. The expected response from banks when faced with more stringent regulation is to either adjust their balance sheet risk or to increase their capital. However, the strategically response of banks is not as simple as one might think. Banks that chose to raise new equity to comply with regulatory capital may see their profits deplete due to the costly nature of equity financing compared to leverage (Myers, 1977; Myers and Majluf, 1984). Banks can offset high equity costs by passing on this cost to

borrowers through charging higher interest rates (King, 2010). However, higher interest rates affect borrowers' ability to pay back the amounts borrowed and in turn increase borrowers default and ultimately bank instability (Martynova, 2015). Hence, the effect of capital requirements on bank risk and profitability remains ambiguous. In addition, Empirical studies investigating the effect of regulatory capital often focus on developed nations. Scant attention has been paid to developing nations in Africa and Asia. Our paper seeks to close down the gap in research about the impact of regulatory capital on bank profitability and risk by investigating the effect of regulatory pressure in a developing nation. Given these disparities between developing and developed nations, we are uncertain if the impact of regulatory requirements on bank behavior has been the same for both. We chose the Tunisian banking sector because it has been understudied and because banks are still at the heart of the financial system. Thus, regulators are interested in knowing the impact of more regulatory pressure through bank capital on bank behavior mainly in terms of profitability and risk. In addition, the Tunisian stock exchange is much smaller and less active than markets in developed nations which can provide more insight on bank-based systems. The contribution of our paper to the relevant literature is fourfold: First, very few empirical studies have investigated the simultaneous effect of regulatory capital ratios on bank profitability and risk. We seek to fill the literature gap by analyzing bank behavior in response to capital constraints. Second, the majority of studies that tackled our research question have focused on testing its impact on developing countries and mainly the U.S. and some European countries leaving a gap to fill in developing countries. Also international capital standard did not distinguish between market-based and bank-based market systems or any particularity of each country. Third, to our knowledge very few papers have investigated the potential non-linear effect of capital requirements on bank profitability and risk. Disregarding this relationship can infer very misleading conclusions about the real effect of capital requirements and increase the social costs inflicted by them. Last, we also investigate the impact of bank specific characteristics and macro-economic and political conditions on bank profitability and risks using both static and dynamic methodology to make sure that our results are not biased by endogeneity.

1. Theoretical review

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

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

Kahane (1977), Koehn and Santomero (1980), and Kim and Santomero (1988) have used the mean-variance framework to model bank portfolio selection in order to understand the dynamics between the introduction of more stringent capital requirements and bank risk taking incentives. They show that when banks are faced with more stringent capital requirements they expect a reduction in their profits. This is commonly referred to as the "***expected income effect***". Under this theory, banks engage in excessive risk taking in order to remain profitable. Thereby, capital requirements encourage bank risk taking. Hence, this theory challenges the ability of capital requirements to curb bank excessive risk taking (Koehn and Santomero, 1980; Kim and Santomero, 1988; Rochet, 1992). Indeed, when banks are pressured to raise capital they do that by substituting leverage with risky assets. This means that banks would have incentives to raise their portfolio risk exposure when confronted with involuntary regulatory induced increases in capital (Merton, 1972; Kahane, 1977; Koehn and Santomero, 1980; Kim and Santomero, 1988).

The option pricing theory posits that banks can maximize shareholder equity value by maximizing the option value of the deposit insurance through higher risky assets and leverage. The

problem that arises from this particular bank behavior is that banks can increase shareholder value at the expense of their depositors through exploiting the deposit insurance subsidy induced by the flat-rate deposit insurance pricing. Thus, banks can use deposits to take in more risks while at the same time not having to pay a default risk premium induced by the higher risk exposure. This situation is referred to as the "moral hazard" hypothesis. Capital requirements can restrict this bank behavior by forcing shareholders to increase their "skin in the game" thus diminishing the value of the deposit insurance put option. Notwithstanding the contribution of theory of options valuation applied by Merton (1977) to the conventional wisdom, this framework was criticized for overlooking the presence of market frictions. In particular, information asymmetry was not taken into account in the option pricing theory (Dewatripont and Tirole, 1994).

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

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

The theory of the disciplinary role of debt offers another view to the nexus. The theory postulates that equity-capital does not confer the same control rights as that of creditors. Debt holders are informed about the real outcomes of bank investment otherwise only known by bank managers (Diamond, 1984; Ramakrishnan and Thakor, 1984; Calomiris and Kahn, 1991). These control rights make it harder for bank managers to serve their own interests in keeping a high default rate by taking excessive risk and create incentives for them to improve their job performance. Under this theory, capital requirements weaken the disciplinary role of debt since it decreases the level of leverage.

A large body of theoretical literature also sought to shed light on the relationship between capital regulation and bank profitability. This is explained by the important effect of profitability on the willingness of bank owners and managers to comply with regulation.

The theory of irrelevancy of Modigliani and Miller (1958) was the starting point for research relative to firm capital structure and profitability. Under this theory, capital has a neutral effect on firrm cash flows and in turn profits. This theory was later challenged by many others for the simplicity of its assumptions about the world which includes no tax advantages and no bankruptcy costs. Even though this theory has been criticized for its unrealistic representation of real world, it is still considered the starting point of several other theories. The trade-off theory, for instance, used the irrelevancy theory as a starting point.

Myers and Majluf (1984) introduced **the signaling theory** to describe the reaction of the market after a firm announces equity offerings. They document that when banks or any other firm resort to external equity, outside investors will not be able to accurately value the bank's future earnings prospects

due to information asymmetry. This information asymmetry causes adverse selection. This phenomenon can be witnessed in the stock market after a firm announces equity offerings which are generally followed by a drop in its share prices forcing them to raise capital at prices well below fair value. Capital requirements impose adverse selection costs not just when banks are below the minimum requirements but also include adjustment costs to a new minimum.

The moral hazard theory postulates that due to limited liability, shareholders' losses are limited to the amount paid in capital. Hence, this provides an incentive to take excessive risks at the expense of other stakeholders in the bank. Debt holders anticipate this behavior and require a premium in return, thus debt holders' market discipline forces banks to maintain a positive amount of capital (Calomiris and Kahn 1991). More capital, induced by capital requirements, may hinder the willingness of shareholders to take excessive risks. In contrast, debt holders require a lower premium in the case of better-capitalized banks.

2. Empirical review

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

The relationship between capital and risk has been largely discussed. No consensus has been yet reached on the impact of capital on risk. Hovakimian and Kane (2000) analyzed the effect of an increase in capital requirements on the risk behavior of U.S. commercial banks. They find that regulatory capital ratios do not curb bank risk-taking incentives. On the contrary, they find that capital requirements increase the risk-taking incentives of poor-capitalized banks more than well-capitalized banks. Similarly, Bhattacharya (2013) attempted to compare the change in the risk 40 taking behavior of U.S. before and after the implementation of capital requirements in 1980. The author argues that, contrary to what regulatory and supervisory authorities would expect, capital requirements increased bank risk-taking. He explains that since binding capital requirements reduced the lending activity of banks by more than a half, banks had no other way than to increase their risky asset portfolio to generate income in order to keep shareholders happy.

Other studies documented the success of capital requirement in limiting bank excessive risk taking. Rime (2001), using a sample of Swiss banks during the period 1989 to 1995, found that regulatory pressure had a positive impact on bank capital due to harsh consequences if banks fail to comply with the Swiss capital requirement which may lead to bank closure and takeover. Hendrickson and Nichols (2001) argue that we cannot lump financial regulation in one basket. They claim that certain types of regulations (e.g. deposit insurance schemes) increased bank risk taking whereas other types of regulation (e.g. capital requirements, lending and deposit rate regulations) decreased bank risk taking incentives and improved bank stability. Barth et al. (2004) use the capital regulatory index (CRI) which compiles quantitative and qualitative characteristics of capital stringency. They find that regulation and its impact differs across countries, regions and income groups. They also find that regulatory capital stringency helped reduce non-performing loans which confirms that regulatory capital were effective in mitigating bank credit risk. However, they find that regulatory stringency did not reduce bank risk when it is defined as the likelihood of bank crises. This confirms our view that different definitions of concepts can yield to different results.

Other studies have shown that capital stringency is less effective when certain aspects of markets are present. Agoraki et al. (2011) and Lee and Lu (2015), argue that regulatory capital only reduces bank risk for banks with relatively small market powers. For banks with strong market power, the effectiveness of such regulation can be minimal or, in extreme cases, reversed (Agoraki et al., 2011). On a similar note, Behr et al. (2010) defend the view that the effectiveness of capital regulation depends on market concentration. They argue that to be able to achieve the desired effect of regulatory capital,

markets concentration has to be low. Similarly, Laeven and Levine (2009) reveal that the effectiveness of capital requirements depends on bank ownership concentration. They explain that the more concentrated ownership is, the higher are banks incentives to take on higher risks to offset utility losses imposed by capital requirements. Camara et al. (2013) argue that the different responses to higher capital requirements are ascribed to the differences in capital levels among banks. Well-capitalized banks, with capital ratios above the minimum required) adjust their risk and capital in the same direction whereas poorly capitalized banks (below the minimum required) reduce their risky assets portfolio to comply with regulatory capital ratios.

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

Coccorese and Girardone (2017) revealed a positive association between capital and profitability using a global sample comprising of 4 414 banks operating in 77 countries for the period 2000 to 2013. They argue that by issuing new capital banks signal positive private information about the bank soundness and prospects. In the U.S., Berger and Bouwman (2013) analyzed the implications of higher capital on bank performance using a sample of U.S. based banks during the financial crises. They document a positive relationship between capital and bank profitability. They find that the effect remains positive even after controlling for bank size. In Europe, Goddard et al. (2004) investigated the determinants of European banks' profitability using cross sectional data during 1990s. The results showed that capital requirements improved bank profitability. On the same line, Kundid and Pavic (2021) investigated the relationship of our key variables using a sample of 24 commercial banks from the Croatian banking sector between 2011 and 2016. They document a positive and strong association between regulatory capital and profitability consistent with the capital buffer theory when using Return on Assets and net interest margin as bank profitability indicators. However, the relationship does not hold with Return on Equity as a profitability indicator. In Asia, Swamy (2018), using a sample of Indian commercial banks between 2002 and 2011, examined the effect of new capital regulations under Basel III proposals on Indian banks profitability. They find that an increase in the ratio of capital to risk weighted assets had a positive impact on banks profitability. Le and Nguyen (2020) examine the relationship between capital and bank profitability using a quantile regression approach on a sample of 30 Vietnamese banks between 2007–2019. They find a positive association between capital and profitability. Notably, they find an inverted U-shaped relationship with the bank capital ratio. The relationship is more significant for highly-profitable banks than for less-profitable ones.

In Africa, Madugu et al. (2019) argue that capital requirements reduced bank profitability in Ghana. Ajayi et al. (2019) assessed the impact of capital requirements on the profitability of eight Deposit Money Banks (DMB's) of Nigeria for the year 2017. They find a strong and positive association between capital and the profitability of Deposit Money Banks (DMB's) of Nigeria. They recommend that policymakers should focus on capital adequacy but also on monitoring and evaluating its implications on the banking industry in Nigeria. So far now we have discussed empirical evidence that suggest that capital regulation can either improve or diminish bank profitability. Another strand of literature reported that regulatory requirement had no significant impact on bank profitability. Ngo (2006) investigated the relationship between regulatory capital and profitability. The results showed no significant relationship between capital and profitability. Similarly, De Bandt et al. (2018) used a sample of 25 French banks for the period 2007-2014 to investigate the effect of higher capital requirements on bank profitability. They report that French banks were unfazed by higher capital restrictions.

3. Empirical Investigation

Bank stability and profitability does not just depend on the regulatory capital but also several other variables. These other variables can either be specific to each bank or capture macro-economic conditions.

3.1. Sample selection and data sources

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

3.2. Dependent variable

- **Return on Average Assets (ROAA)**

Following Chen et al. (2018), we use the return on average assets (ROAA) to proxy for bank profitability. Hence, we compute ROAA as the ratio of net income to average total assets. This ratio indicates the asset intensity of each bank. A high ROAA signifies that the bank has a higher asset intensity and vice versa.

$$ROAA = \frac{Net\ income}{Average\ Total\ Assets}$$

- **Z-score**

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

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

3.3. Independent variables

We use the Basel minimum capital adequacy ratio as a proxy for regulatory requirements. The ratio is calculated by summing Tier 1 and Tier 2 capital and dividing by the risk weighted assets (RWA). Several empirical studies have also used the ratio of capital to the risk-weighted to account for regulatory imposed capital (Adjeitsey, 2015; Afriyie and Akotey, 2013). We follow the methodology of Le and Nguyen (2020)) whereby they use the square value of bank regulatory capital to test if the relationship is non-linear and increases profits up to a threshold before dropping after. This is commonly referred to as a "U-shape" form. If regulatory capital is indeed nonlinear and follows a "U-shape" form, this reveals serious implications of regulation decisions on bank behavior. Bank managers claim that capital regulation reduces bank profitability due to social costs. Hence, by using the square value of the regulatory capital ratio we seek to see if the coefficient can change value if capital requirements increase up to a threshold.

3.4. Control variables

Bank specific characteristics

- **Size:** we use the number of operating branches to account for bank size. The rationale for using this proxy for bank size is that by using the natural logarithm of total assets we fall into multicollinearity problems when two or more explanatory variables are highly correlated and render our estimation spurious. Large banks, at least in the Tunisian context, tend to open more branches.
- **Net interest margin:** We use the ratio of net interest margin to total loans to measure Tunisian banks' interestbased activity. This ratio only appears in the profitability model since we have already included a proxy for bank profitability that is the Return On Average Assets (ROAA) in our risk (stability) model.
- **Liquidity Risk: t**o proxy for bank liquidity risk, we follow Carsemar et al. (2021) and use the ratio of Loan to Deposits (LTD). This ratio measures how much loans are being financed by depositors' funds and can predict the potential liquidity risk a bank can face in a situation of a bank-run.
- **Credit risk:** we use the ratio of Loan Loss Reserves (LLR) in our profitability model since loan loss reserves are deducted from bank profits and directly impact bank profitability. On the other hand, we use the ratio of NPLs to total loans (NPL) to account for asset quality in our stability model because we believe that NPLs have a stronger impact on the overall risk and stability of a bank.
- **Cost efficiency:** We use the ratio of operating costs which consist mainly of labor costs to total operating income to account for bank inefficiency.
- **Lending policy:** Lending policy refers to the bank strategic choices when it comes to their growth and development. In our models, we use asset growth to proxy for bank lending policy.
- **Diversification:** For our profitability model, we use the ratio of non-interest income to total operating income (DIVER). This ratio provides information about the bank's income structure but also showcases the weight of non-traditional income. For our risk model, we use the ratio of net commissions to payroll and benefits expenditure (COMOP) to account for diversification. This is because banks are more likely to sustain their normal activity if they are able to meet their short term financial obligations including payroll and benefits.

Macroeconomic conditions

- **Political instability:** We use the score of political stability provided by the world Bank multiplied by (-1) to assess the impact of political instability on bank profitability and stability.
- **Business Cycle:** We use real GDP per capita growth rate to account for the business cycle. Real GDP growth is generally used to measure economic growth and to assess the business cycle
- **Inflation:** We use the yearly inflation rate to account for inflation

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

3.5. Model specification

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

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

Where ROAAit is Return on Average Assets, CAPit is the regulatory capital, CTIit is the cost to income ratio, SIZEit is the number of operating branches, AGit is the asset growth rate, LLRit-1 is the lagged ratio of loan loss reserves over NPLs, LTD it-1 is the lagged value of loan to deposit ratio, RENDCit is the net interest margin ratio, DIVERit is the ratio of non-interest income to operating income, POLt is the political instability score, INFt is the inflation ratio and GDPt is the real growth rate of GDP per capita, whereas ϵit is the disturbance term.

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

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

Our second model will be written as follows:

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

Where and Z-scoreit is our stability proxy, CAPit is the regulatory capital, GCPit is the growth rate of bank capital, LTDit-1 is the lagged value of loan to deposit ratio, NPL it-1 is the lagged value of NPLs to total loans, ROAAit is Return on Average Assets, SIZEit is the number of operating branches, CTIit is the cost to income ratio, AGit is the asset growth rate, COMOPit is the ratio of net commissions over operating income, POLt is the political instability score, INFt is the inflation ratio and GDPt is the real growth rate.

4. Results and discussion

4.1. Empirical evidence on the impact of regulatory capital on bank profitability

Table 3 displays our results for Model (1) in which ROAA are the dependent variable. The Fixed effect regressions are presented as a baseline specification from which we depart by examining the Generalized Least Squares (GLS) estimates which controls for heteroskedasticity and autocorrelation.

For our first model, we evidence a positive impact of regulatory capital on bank profitability. This means that regulatory pressure did not curb bank profits. Interestingly, regulatory capital improves Tunisian banks' profitability. Our result confirm the findings of Baker and Wurgler (2013) who interpret these higher realized returns as proxying for higher expected returns ex ante and concluded that shareholders in well-capitalized banks require higher returns. This can also be ascribed to the fact that since banks are constrained to increase capital commensurately with their risk weighted assets, they increase the monitoring and screening of their borrowers in order to select the most solvent borrowers who are able to pay back the principle borrowed with interest (Altunbas et al., 2007). Our result is in contrast with the expected income theory in which capital requirements are thought to reduce bank profitability.

Furthermore, the coefficient of regulatory capital squared (CAP2) in regression (4) is negative and significant. This finding confirms the view that stringent capital requirements help improve bank profitability up to a certain threshold. After that, an increase in capital is more likely to reduce bank profitability. This is commonly referred to as a "U-shape" form relationship. Le and Nguyen (2020) have also documented a U-shaped relationship between bank capital requirements and bank profitability.

Moreover, the coefficient of our cost inefficiency is negative and significant. This finding is consistent with the view that efficient management provides banks with the opportunity to improve their profitability. Hence, as the conventional wisdom posits, efficient use of labor can only positively affect bank profits (Bourke, 1989; Khediri and Ben-Khedhiri, 2011). We also find that size is positively correlated with profitability. Our findings are in line with the size-profitability hypothesis whereby larger banks benefit from economies of scale and scope which in turn lead to higher profits (Le and Nguyen, 2020; Zhang et al., 2008). The positive association between size and bank profitability in the Tunisian context can also be explained by the "stewardship theory" which suggests that managers' interest align with that of the bank owners. Based on this argument, bank profitability will benefit managers as well as bank owners (Donaldson and Davis 1991; Davis et al., 1997). We use asset growth to proxy for bank growth strategy and lending policy. We document a positive relationship between asset growth and bank profits and stability. This can be explained by the fact that growth in assets translates to higher interest income which in turn leads to better profitability.

We find that the coefficient of the net interest margin ratio (RENDC) is positive and significant. This result is expected since Tunisian banks' profitability generally stems from their traditional interest based activities. In addition, the coefficient for our diversification variable is positive and statistically significant. This means that higher diversification entails higher return. This finding is in line with the findings of Ahamed (2017), Kohler (2015) and Li (2021) who documented a positive association between diversification and bank profitability.

Interestingly, credit risk has a positive and significant coefficient. This can be explained by the risk-return hypothesis under which bank shareholders expect to be compensated with higher return for the increases in risk. The coefficient of our liquidity risk variable is negative and significant. This implies that liquidity risk negatively affects bank profitability. This can be explained by the fact that illiquid banks face higher funding costs which in turn reduces their profitability. Our findings are in line with the findings of Bassey and Moses (2015) who also document a negative impact of liquidity risk on bank profitability.

For macroeconomic conditions, we find that the coefficient of political instability is negative and significant. Political instability negatively affects economic growth and foreign direct investment which in turn would lead to less lending and lower profits. Moreover, we observe that the coefficient of real GDP per capita is positive and significant for our first model. This implies that economic growth stimulates bank profitability. We also document a non-significant relationship between inflation and bank profitability. Our findings are in line with that of Jokipii and Monnin (2013) who also found no clear evidence of inflation on profitability.

4.2. Empirical evidence on the impact of regulatory capital on bank risk (stability)

Table 4 displays our result for Model (2) in which Z-score is the dependent variable. The Fixed effect regressions are presented as a baseline specification from which we depart by examining the Generalized Least Squares (GLS) estimates which controls for heteroskedasticity and autocorrelation.

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

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

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

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

We find that credit risk is negatively associated with bank stability. This finding is in line with economic logic since an accumulation of NPLs can deplete a bank's capital and make a bank insolvent. This finding is in line with Ghenimi et al., (2017) who find that credit risk is positively correlated to bank instability because it is associated with higher probabilities of default. Interestingly, the coefficient of our liquidity risk variable is positive and significant. This can be explained by the fact that our ratio also takes accounts of the lending activity of the bank financed by the cheapest form of liability which is depositors' funds. This finding is in contrast with that of Ghenimi et al. (2017) and Ali and Puah (2019).

We use ROAA to proxy for bank profitability. We find that the coefficient of profitability is positive and significant. This finding is to be expected because profitability increases bank capital via retained earnings which boosts bank stability and reduces bank insolvency risk. This result contradicts the one obtained by Srairi (2013) and Imbierowicz and Rauch (2014) who found a negative effect of ROA on banking stability. In addition, we find that diversification is positively associated with bank stability. This implies that diversification has helped Tunisian banks mitigate their risk of insolvency. Our findings are in line with past literature that documented the positive relationship between diversification and bank stability (Litan, 1985; Wall and Eisenbeis, 1984; De Jonghe, 2010) but in contrast with literature that documented the adverse effect of diversification (Lepetit et al., 2008; Abedifar et al., 2013).

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

For macroeconomic conditions we find that the coefficient of the political instability variable is negative and significant. This implies that political instability increased bank risk of insolvency since it negatively affects the banks main source of income which is heavily influenced by market conditions. The coefficient of real GDP per capita is positive and significant for our second model. This implies that economic growth boosts bank stability. Contrary to our first model, in our second model we document a positive (negative) relationship between inflation and bank stability (risk). This finding is in line with the finding of Yakubu and Bunyaminu (2021) who also document a positive relationship between inflation and bank stability.

5. Robustness check

Studies have shown that most economic and financial relationships are dynamic. Dynamic models differ from static models by the presence of lagged dependent variables among the other independent variables. Bank profitability tends to persist due to the influence of long lasting economic shocks and market conditions (Berger et al., 2000). Based on these grounds, it is reasonable to expect the relationship to be dynamic and adopt a model in which lagged profitability variables are included. We also test whether bank stability can showcase a persistence effect. We also test if regulatory capital can have a "U-shape" form relationship with stability (risk taking) like that reported in our profitability model. Least squares estimation technique produces biased and inconsistent coefficients when lagged dependent variables are present and dynamic relationships need to be modeled using dynamic appropriate techniques such as the Generalized Method of Moments (GMM) and Two-Stage Least Squares (2SLS) Regression Analysis. However, Judson and Owen (1999) performed Monte Carlo simulation to test the bias in the coefficient in least squares estimation and found that the bias tends to approach zero when T increases. For the sake of caution, however, we perform our robustness test using the Two-Stage Least Squares (2SLS) regression analysis. We chose this estimation technique instead of the GMM estimation since the latter requires "small T, large N" panels, meaning few time periods and many individuals (Arellano and Bond, 1991; Arellano and Bover 1995; Blundell and Bond 1998).We do the same for our stability model.

The dynamic model specification of our first model is as follows:

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

Where ROAAit is Return on Average Assets, ROAAit-1 is the lagged dependent variable, CAPit is the regulatory capital, CAP2it is the regulatory capital, CTIit is the cost to income ratio, SIZEit is the number of operating branches, AGit is the asset growth rate, LLRit-1 is the lagged ratio of loan loss reserves over NPLs, LTDit-1 is the lagged value of loan to deposit ratio, RENDCit is the net interest margin ratio, DIVERit is the ratio of non-interest income to operating income, POLt is the political instability score, INFt is the inflation ratio and GDPt is the real growth rate of GDP per capita, whereas it is the disturbance term.

The dynamic model specification of our second model is as follows:

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

Where Z-scoreit is our stability proxy, and Z-scoreit-1 is the lagged dependent variable, CAPit is the regulatory capital, CAPit, GCPit is the growth rate of bank capital, LTDit-1 is the lagged value of loan to deposit ratio, NPLit-1 is the lagged value of NPLs to total loans, ROAAit is Return on Average Assets, SIZEit is the number of operating branches, CTIit is the cost to income ratio, AGit is the asset growth rate, COMOPit is the ratio of net commissions over operating income, POLt is the political instability score, INFt is the inflation ratio and GDPt is the real growth rate of GDP per capita, whereas it is the disturbance term.

To control for endogeneity bias, we perform the Hausman endogeniety test to determine whether our regulatory capital ratio variable is endogenous. We use the second and third lag of regulatory capital (CAP) and NPLs ratio as instruments. The null hypothesis for the test is that CAP is exogenous. Table 5 reports our test results. The P-value of both dynamic models is greater than 0.05 hence we fail to reject the null hypothesis meaning that our regulatory capital variable is exogeneous. However, we also need to test the validity of our instruments using the test of overidentifying restrictions.

Table 6 reports our overidentifying restrictions test result. We fail to reject the null hypothesis for both of our models. Hence, we can confirm that our instruments are valid.

Table 7 displays regression results of 2SLS estimation in which ROAA is the dependent variable. The coefficient of the one-period lagged value of ROAA is positive and significant. This implies that Tunisian banks profitability showcase a persistence effect meaning that banks that performed well in the past year tend to perform well the following year.

Even though the magnitude of coefficients generated by the 2SLS regression varies from the GLS to some extent, the impact of our independent variables is basically consistent. All of our independent variables have economically reasonable signs. The coefficient of the regulatory capital ratio is positive and significant and the coefficient of the same ratio squared is negative. This further confirms the non-linearity of the capital-profitability hypothesis and in line with the "U-shape" nature of the relationship documented in the GLS regression. Table 8 displays regression results of the 2SLS estimation in which Z-score is the dependent variable. The coefficient of the one-period lagged value of Z-score is not significant. This implies that bank stability or risk taking does not tend to persist. We find that the coefficient of regulatory capital ratio is positively correlated with bank stability (negatively correlated with bank risk) which confirms the results found in our static model. However we find, just like in our profitability model, that the coefficient of CAP2 is negative and significant which further showcases the non-linearity of the capital-risk hypothesis and in line with the "U-shape" nature of the relationship documented in the GLS regression.

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

Conclusion

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

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

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

Our empirical investigation reveals very interesting findings. First, we find that regulatory capital ratios improve bank profitability and reduce bank risk at first. However, when regulatory pressure reaches a certain threshold, the positive effect of regulatory capital is diminished and regulatory capital

may reduce bank profitability and increase risk-taking incentives. This means that the profitability and risk taking behavior of Tunisian banks is not linear and follows a "U-shape" form in which capital improve bank stability and profitability up to a certain threshold. This implies that bank managers hold some truth in their claims about the social costs of regulatory capitals. In addition, we also find that Tunisian banks' performance tend to persist over time. This may insinuate that banks increase their capital by means of retained earnings. However, we do not find evidence of the persistence of bank risk. In addition, we find that diversification has helped mitigate bank risk and the political instability reduced bank profits and increased bank fragility.

Hence, we believe that capital regulation can be considered as the effective medicine to prevent future illness in the financial system. Yet, it is legitimate to ask if the medicine can kill the patient? We find that regulatory pressure can increase or decrease bank risk taking depending on a given threshold. We will call that the optimal social capital in which bank profitability is not compromised and regulators are ensure of the soundness and solvency of banks. However, the optimal social capital is very difficult to determine due to the complexity of the banking activity and the divergence of interests between regulators and banks.

For regulatory authorities, we propose that they include the leverage ratio —Equity to total assets ratio —proposed by Basel III and set at 3% as a complement to the regulatory risk-weighted requirements to improve the resilience of the Tunisian banking sector. Riskweighted assets have been the center of criticism due to the complexity and ambiguity of their methods of calculation. Taking into consideration that the Central Bank of Tunisia has dropped the use of internal based approaches in favor of the standards approach gives more freedom to bank managers to engage in a regulatory arbitrage. Indeed, since riskweighted capital ratios are prone to errors and since regulators cannot have full information about the risk portfolio of banks due to asymmetry of information, banks may find incentives to engage in risky activities considered more risky than what was presumed by the Basel framework. Hence, banks can meet capital requirements without having to raise equity capital considered to have the best loss-absorbing capacity. This behavior has been documented by Jackson (1999) whose findings show that banks, in response to capital requirements, increase their average risk-weighted asset ratio whereas the leverage ratio keep declining. Thereby, the leverage ratio can discourage this behavior by ensuring those banks are maintaining an adequate level of capital. The U.S for instance have kept the minimum leverage ratio— which existed prior to the implementation of the Basel framework — set at 3% for "strong" banks and 4% for other banks. Regulators in the U.S claim that the leverage ratio is the more binding constraint on bank activities.

We also propose the introduction of contingent capital otherwise known as "CoCos". Contingent capital is a form of hybrid debt which converts automatically into equity capital when a trigger event is met.

The advantage brought by CoCos is that bank capital increases automatically in situations of distress providing banks with additional loss-absorbing capacities. Contingent capital provides banks with additional capital in times of need while also preserving the disciplinary role of debt since subscribers to CoCos will closely monitor bank compliance. Another advantage of contingent capital is that the Central Bank of Tunisia can set the trigger conditions of contingent capital for example when the leverage ratio reaches a prespecified limit or when Tier 1 capital requirements are no longer me

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Appendix

Table 1: Hausman (1978) specification test

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

Table 2: Poi and Wigging (2001) Test for panel-level heteroskedasticity

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

Table 3: Estimation using OLS and GLS for ROAA

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

Table 4: Estimation using OLS and GLS for Z-score

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

Standard errors are inparentheses

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

Table 5: Durbin–Wu–Hausman test for endogeneity

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

Table 6: Test of overidentifying restrictions

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

Table 7: Instrumental variable (2SLS) regression using ROAA

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

Mean dependent var	0.011	SD dependent var	0.011
R-squared	0.800	Number of obs	150
Chi-square	599.776	Prob > chi2	0.000

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

Table 8: Instrumental variable (2SLS) regression using Z-score

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

Mean dependent var	0.034	SD dependent var	0.035
R-squared	0.831	Number of obs	150
Chi-square	736.145	Prob > chi2	0.000

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

Non-Interest Income Activities, Bank Performance and Risk During Crises: Evidence from Tunisian Banks

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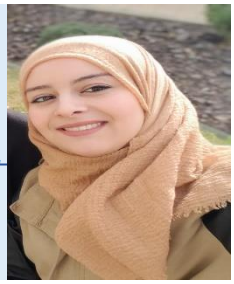


Abstract
Using a sample of 10 Tunisian listed banks from a period going from 2005 to 2020 and a panel data analysis method, we investigate the effect of diversification into non-interest income-generating activities on both bank performance and risk during crises (i.e., financial and sovereign debt crisis, political crisis, and health crisis) compared to non-crisis period. Three main results emerge. First, bank risk (performance) significantly decreases (increases) if banks increase their share of non-interest income and this relationship is strengthened during the crisis period. Second, further analyses show that short-term trading income has a positive effect on bank performance and a negative one on its risk whereas long-term trading increases non-performing loans significantly. Hence, it's better for banks to diversify into profitable non-interest income sources to enhance their performance and their financial stability mainly when crises occur.

Keywords: Non-interest income; Bank Performance; Bank Risk; Financial and Debt Crisis (FDC); Political Crisis (PC); Health Crisis (HC).

Introduction

World-wide financial sectors, as well as economies as a whole, are driven by the banking sectors. In fact, banking sectors lead economies to the creation of wealth, mainly by providing funds for investments. Policymakers and bank supervisors in many countries have deregulated the scope of bank diversification, lowered barriers among commercial and investment banks and security and insurance companies to increase competitiveness in the banking industry, and have made repeated recommendations to banks to diversify their activities (Clark and Siems, 2002). Thus, the combination of regulatory reform, product-market innovation, increased competition, and technological change, has dramatically altered Tunisian commercial banks. In response to the environmental change, financial intermediaries have been steadily shifting away from the core-banking sources of income as loan-making and towards the multiple-revenue structure of both net interest income and non-interest income. In other words, the transition from traditional to modern banking with the implementation of the so-called "universal banking model" (in Tunisia, the law n° 2001–65 of July 10, 2001 on the application of the principle of universal banking) allowed banks to expand, over the past two decades, their traditional and specialized business strategies to a wider range of products and services. According to the central bank of Tunisia's supervision report, in 2020 approximately 45% of Tunisian banks' net operating revenue came from a variety of non-interest sources, namely, X forex operations, insurance, service charges, short-term trading revenue, investment activities, as well as bank fees and commissions, were particularly important in driving industry revenue growth. Thus, non-traditional banking activities have evolved from a supporting role to a major contributor of bank revenue sources.

Theoretically and empirically, the impact of income diversification on bank performance and risk is debatable. According to portfolio theory (Markowitz, 1952), diversified banks benefit from economies of scale which improve performance and reduce risk (Elsas et al. 2010). Incomes from different sources which are uncorrelated or imperfectly correlated with each other result in stable and steady streams of overall bank profits (Chiorazzo et al. 2008). However, when the costs exceed non-interest income-generating activities benefits, this leads to a diversification discount instead of a diversification premium which hurts performance and increases bank risk (Boyd et al., 1993, Laeven and Levine, 2007; Lepetit et al., 2008). Indeed, income diversification into non-interest income activities may benefit banks if these activities are inherently less risky and possess high returns, while it may hurt banks if diversified activities are riskier and have low returns (Nisar et al., 2018). In

addition, the growth of these non-interest business areas has been accompanied by a significant change in their components. In the Tunisian banking sector, the composition of non-interest income has also changed markedly during the last ten years. Trading (commercial and investment portfolio) income has become the dominant source of non-interest income received by Tunisian banks, reaching 53% of total non-interest income as documented in the annual supervision report of the central bank of Tunisia (2020), replacing the traditional mainstays of service charges and income from the lending activity. Thus, we will go further and analyse the relationship between the components of non-interest income and the risk and performance of banks by isolating fee income from trading income. In this study, we seek to resolve the conflicts in the literature by examining the impact of non-interest income activities on Tunisian banks' risk and performance.

Furthermore, only a handful of existing studies rigorously consider the effect of the crises on the relationship between bank income diversification and bank risk and performance (i.e, Elsas et al., 2010; Cheng et al., 2019; Kim et al., 2020). There is an ongoing debate on whether banks suffer or benefit from their income diversification strategy in an unstable context (crisis period) compared to a stable one. More specifically, we try to know if it is better for banks to increase the share of non-interest income activities during the crisis period than concentrate on the core banking activity?

More importantly, we assume that crises do not have the same source or type (financial, economic, health, etc.). Therefore, they also have the same consequences and impacts. Thus, it's interesting to examine whether the types of crises matter on the non-interest income and bank risk/performance nexus. Using a sample of 10 Tunisian listed banks from a period going from 2005 to 2020, we investigate the effect of diversification into non-interest income-generating activities on both bank performance and risk during the crisis period (i.e., financial and sovereign debt crisis, political crisis, and health crisis) compared to a non-crisis period. Two main results emerge. First, bank risk (performance) significantly decreases (increases) if banks increase their share of non-interest income and this relationship is strengthened during the crisis period (any type of crisis). Second, further analyses show that all non-interest income components have a positive effect on bank performance and a negative one on its risk except for long-term trading that seems to significantly increase credit risk measured by non-performing loans (NPL).

Our results have implications for both policymakers and practitioners. First, our results could be important to regulators as they could serve as an advance warning signal that sends them a clear message about the importance of diversifying into non-traditional activities by changing their business models to adapt to Tunisia's financial environment, and they should start seeking adequate staff in terms of skills. Most importantly, during a crisis period (any type of crisis), it is beneficial to diversify more into non-interest income activities, given that these latter have a greater significant positive (negative) effect on the bank performance (risk). Furthermore, because different types of non-interest income have different impacts on bank risk in Tunisia in terms of coefficient and significance, banks should formulate different development strategies based on their characteristics. It should be noted that Tunisian banks should be cautious about long-term investments that may increase non-performant loans, thus lowering asset quality. Finally, policymakers should also create different regulatory policies for different types of non-interest activities.

This study makes three main contributions regarding the existing literature. First, to the best of our knowledge, it's the first study that investigates the relationship between non-interest income activities and bank risk and performance by considering crises impact, specifically, by introducing various types of crises and comparing the questioned relationship during the crisis period to the non-crisis period. Second, no empirical studies have considered the effect of the COVID-19 pandemic on the relationship between non-interest income activities and bank risk and performance, except for the Chinese context. Third, for the robustness of our results, we used various tests to non-interest income on bank risk and profitability in Tunisia.

The rest of this paper is structured as follows. Section 1 reviews the related literature and hypothesis development. Section 2 presents our sample, variables and models. Section 3 discusses the empirical results.

1. Literature review and hypothesis development

1.1. Non-interest income, bank performance and risk

A great deal of literature has emerged on the relationship between non-interest income and bank performance and risk. One category of these studies implies that non-interest income is desirable, as it may improve bank return and reduce total risk, (i.e, Demirgüç-Kunt and Huizinga 2010; Elsas et al., 2010; among others). Related to Markowitz's portfolio theory (1952), investors should seek to diversify their portfolios with assets that are not highly correlated with one another. Through an international sample of 1334 banks in 101 countries, Demirgüç-Kunt and Huizinga (2010) argue that non-interest income-generating activities can improve bank performance and help diffuse risk. Consistent with the managerial efficiency theory, income, where reductions in costs and efficiencies established by banks will increase profitability. Klein and Saidenberg (1997) support this idea and argue that providing a wide range of financial services should increase a bank's efficiency and decrease the total risk thanks to economies of scale. Moreover, as research on non-interest income has progressed, the above opinion of the beneficial effect of non-interest income has been increasingly questioned (Mazur and Zhang, 2015).

Besides, the second strand of empirical studies has stressed the dark side of non-traditional bank activities and has suggested a distinct conclusion. Many arguments have been given in this sense such as the fact that non-interest income is more likely to fluctuate compared with interest income because banks face relatively highly competitive rivalry and relatively low switching and information costs (i,e., Demsetz and Strahan, 1997; Stiroh, 2004). In addition, the growth of non-interest income could fail in leading to higher profits if a relatively large part of the 'additional' non-interest income is absorbed by increased costs which can be associated with higher income volatility, thus, implying higher risk (i,e., Stiroh, 2004; Wolfe et al, 2007; Chiorazzo et al., 2008; Calmès and Liu, 2009). Besides, diversified income may lead to systemic or other channels of risk like credit risk, market risk, liquidity risk, or operational risk. In this sense, Hou et al. (2017) concluded that an increase in the degree of bank income diversification between traditional bank activities and non-traditional bank activities reduces bank liquidity creation. The third strand of income diversification literature leads rather to the insignificance of the effect that has non-interest income on bank risk and return (i.e, Engle et al., 2014 and Weiss et al., 2014). The results related to the Tunisian banking sector are also inconclusive. From here on out, based on both traditional portfolio theory, we would assume that this business strategy affects positively Tunisian banks performance and their risk negatively for three reasons. Foremost, the trend of Tunisian banks to diversify into non-core banking activities is reinforced by the law n° 2001–65 of 10 July 2001 on the application of the principle of universal banking and the act n° 2016-487 on diversification of financial activities. Second, the beneficial effect of non-interest income activities is improved by the majority of empirical investigations in emerging markets (Lin et al., 2012; Nguyen et al., 2012; Lee et al., 2014; among others). Third, according to Abedifar et al. (2018), small banks can benefit from diversification activity to improve their performance (supported by Lepetit et al., 2008) and reduce their risk exposure. Tunisian banks however are considered as small and medium banks, even compared to banks in African countries. Hence, our first hypothesis is formulated as follows:

H1: Non-interest income activities improve Tunisian bank's performance and reduce their risk exposure.

More specifically, based on findings from developed countries, banks in the US and EU encounter greater levels of risk, with the development of non-interest activities, depending mainly on the type of non-interest income components used (i.e, Shaffer, 1985; Stiroh and Rumble 2006; Laeven and Levine, 2007; Lepetit et al. 2008; and Yang et al. 2020). Using data for 20 Asian-Pacific countries, Lee et al. (2014) found that commissions and other non-interest income components would lead to increased stability and profitability. Besides, using data from U.S. commercial banks, DeYoung and Roland (2001) studied the impact of shocks to fee-based activities on bank earnings volatility and show that these revenue sources increase earnings volatility. In the same vein, Edirisuriya et al. (2015) and Nisar et al. (2018) demonstrated that fees and commissions affect

negatively bank profitability and stability. Bearing this in mind, while examining the impact of non-interest income sources, we will bet on the following hypothesis related to fee-based activities:

H2a: Diversification into fee-based activities negatively (positively) affects the performance (risk) of commercial Tunisian banks.

Through a unique dataset of the Philippines' banks, Meslier et al. (2014) concluded that moving towards non-interest activities increases bank risk-adjusted profits, particularly when banks are more involved in dealing with government securities (other non-interest income). Based on these latter observations, we can expect similar results for the Tunisian banking sector, given that the financial market is poorly developed and that banks' portfolios are mainly composed of government securities.

H2b: Diversification into trading income positively (negatively) affects the performance (risk) of commercial banks in Tunisia.

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

Before the global financial crisis, banks increasingly earned a higher proportion of their revenue from non-interest income activities specifically from non-lending activities, such as engaging in venture capital funding, trading, investment banking, and advising. Then, the subprime crisis resulted in reshaping the banks income structure [20]. It has pushed banks, through regulatory changes, to reinforce their capital ratios to maintain their position as financial intermediaries. Banks can face an unprecedented combination of pressures in terms of balance sheets, liquidity, and funding during these hard times (Acharya et al., 2002). Thus, crisis may impact the business model and, specifically, impact the relationship between non-interest income-generating activities and bank performance and risk. There is continuously an increasing number of findings motivating researchers to take into account the temporal dimension (i.e, Derbali, 2011; Park et al., 2019; Flori et al. 2019; Cheng et al. 2019; Kim et al., 2020; Paltrinieri et al., 2020). Most previous studies assume a linear relationship between bank income diversification and financial stability. However, Kim et al. (2019)' study allows for the existence of a non-linear relationship and considers the possibility that the relationship may vary depending on the market state or economic condition.

A variety of studies reveal positive effects of non-interest income on bank performance and financial stability during crises. Hence, banks turn to non-core business activities, which is an attempt to preserve revenue, when interest rates are low and during crises where there is an aggravation of default and liquidity risks (Curry et al. 2008; Ahmad et al. 2008). Simoens and Vennet (2021) noted that "Diversification should work when it matters most" and provide empirical evidence that non-interest income activities should act as a shock absorber when banks are hit by an unexpected event. In contrast, recent academic research shows opposite results. The disadvantages of non-traditional banking activities may outweigh the advantages in the crisis period. In this regard, few empirical studies endorse income diversification as a method of hedging risk because concentrating on traditional functions (i.e., deposits and loans) can be more effective for banks during a crisis. Accordingly, De Jonghe (2010) displayed that banking institutions which are heavily involved in non-traditional activities are characterized by higher risks, which makes them more vulnerable to several market and macroeconomic shocks. This statement is supported by numerous empirical studies (e.g; Acharya et al., 2002; Song and Thakor, 2007; Baele et al., 2007; Hayden et al., 2007; Hayden et al., 2007; De Jonghe, 2010; Li and Zhang, 2013; and Bostandzic and Weiss, 2018). Curi et al. (2015) investigate whether there is an optimal business model for foreign banks in Luxembourg for the period from 1995 to 2009 and find that a concentrated income strategy is the most efficient business model during the crisis period. Tsai et al. (2015) also argue that in Taiwan, the diversification into non-interest income activities is not beneficial during a recession. They found that non-interest income is more likely to fluctuate compared with interest income because banks face relatively high competitive rivalry during crisis. Supporting this point of view, we expect that it's better for Tunisian banks

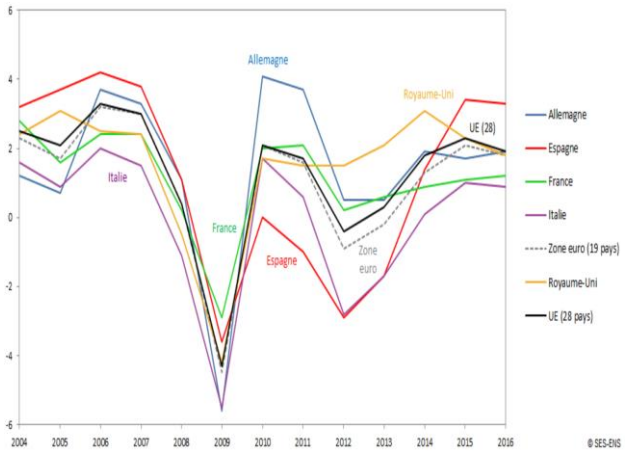
[20] CGFS Papers No 60 "Structural changes in banking after the crisis". Report prepared by a Working Group established by the Committee on the Global Financial System.

to concentrate on their core-business intermediation activities in unstable and competitive environment in order to preserve their financial stability because Tunisian banks do not have enough experience and knowledge to manage non-traditional activities during hard time. These facts support the opinion that banks lacking the experience and knowledge to engage in non-traditional activities might increase their risk in unstable environment (Kohler 2015).

H3: Crises weaken the effect of bank diversification into non-interest income activities on bank performance and risk compared to the non-crisis period.

More interestingly, we assume that crises do not have the same sources or types (financial, economic, health, etc.). Therefore, they do not also have the same consequences and impacts. For that reason, we investigate the major crises (national and international) of the last two decades (see figure.1). Through a data of U.S. commercial banks from 2000 to 2013, Feng et al (2013) found that diversification is significantly associated with an increase in systemic risk during the global financial crisis and the European Debt crisis. On the same note, in his extensive survey article, Maudos (2017) support the idea that only banks that are specialized in traditional activities were able to maintain their solvency level and avoid the negative impact of the crisis on their performance. In line with the results of Stiroh (2004) and Mercieca et al. (2007), Brighi and Venturelli (2015) investigated the Italian market using bank level data on 491 banks over the period 2006-2012 to test the impact of non-interest income-generating activities on bank performance during the global financial crisis and 2010s sovereign debt crisis21. They indicated that in the post-crisis period, smaller banks appear to be riskier, being more exposed to local environmental shocks and strictly linked to traditional interest-bearing activities.

Figure 1: Real GDP growth rates from 2004 to 2016 in the EU, the Eurozone and selected EU countries (%)



Source : Eurostat, Comptes nationaux annuels (série tec00115, last up to date dec 11th 2017)

From an emerging context, Cheng et al. (2019) evaluated the influence of business models on bank risk before, during, and after the financial crisis using Chinese data from 2004 to 2016. They provided empirical evidence that increasing banks' non-interest income share increases insolvency risk and ROA volatility, and this relationship is most visible during and after the financial crisis. In a strongly connected and integrated world, Tunisia was not immune. Hamdi et al. (2017) concluded that the international crisis has increased the risk of Tunisian banks. We expect that financial crisis compounded by the debt crisis (2010) (see Fig.2) reduce the effect of diversification into non-interest income activities on performance and risk during the financial and debt crisis from how it does during the non-financial/debt crisis period.

H3a: Financial and debt crises weaken the relationship between non-interest income activities and bank performance and risk.

[21] "Since the sovereign debt crisis erupted in the autumn of 2009 when the true scale of the Greek fiscal deficit was revealed, the EU, and especially the euro area, has staggered from crisis to crisis" (Iain Begg (2012)).

By analysing MENA countries, Ghosh (2016) concluded that the Arab Spring has lowered profitability and raised the risk of MENA countries' banks. Amidst this context, the banking sector suffers from several shortcomings, notably, a strong need for liquidity and a high level of non-performing loans which put more pressure on credit viability. Tunisian banks have been particularly affected by the revolution's disturbance, at the liquidity mismatch and the level of risk-taking (Ben Salem, 2019). In a related study, Ayadi and Ellouze (2014) found that the performance of Tunisian banks was negatively altered by the revolution of 14 January 2011, and since 2011, macroeconomic vulnerabilities have been still persistent in the Tunisian context, hampering the stability of the financial system. However, banks continued to fulfil their funding mission. Thus, we assume that the net interest margin is still stable and important during the crisis, that is, the negative (positive) effect of the crisis on the bank performance (risk), can present a linear (direct) or non-linear (indirect) effect by reducing the diversification premium. Hence, we will bet on the following hypothesis:

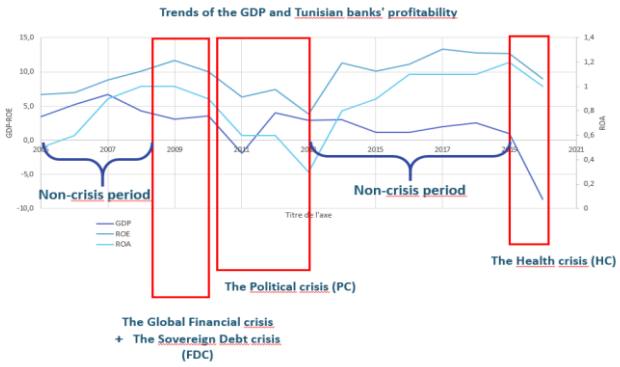
H3b: Political crisis weakens the relationship between non-interest income activities and bank performance and risk.

The World Health Organization (WHO) characterized the spread of the coronavirus as a global pandemic22. The spread of this pandemic caused enormous impacts on economies and financial markets around the world, and it represents an unprecedented global shock that exerts tremendous pressure on corporate liquidity and solvency. The economic effect of the pandemic resulted in tightened credit standards and reduced demand for many types of loans (Li et al., 2021). Given this situation, a relevant question to investigate is whether banks with diversified revenues in both interest and non-interest income activities during the pandemic have better performance and lower risk than banks based on the traditional core intermediation business or not. Using a sample of 56 European banks, Simoensa and Vander Venneta (2021) found that functional diversification (reliance on non-interest income) acts as an economically important shock absorber: banks with high-income diversification exhibit a stock market return of 8.9 to 10.2 percentage points higher than specialized banks during the first months of the pandemic. Furthermore, Çolak and Öztekin (2020) noted that traditional activity of banks declined, especially in countries more affected by the crisis. Consequently, central banks are strongly encouraging banks to focus on their business model to find new sources of revenue and to meet the new needs of their customers to maintain their financial stability. Unfortunately, until now there have been no empirical studies that treat this subject except for Li et al. (2021) which provided evidence that banks with non-interest sources of revenue are positively related to performance but inversely related to risk. Hence, given the fact that a pandemic is a very specific and unpredictable phenomenon (Demirguc-Kunt and al., 2020), and based on the recent study of Li et al. (2021), we expect that the effect of non-interest income on bank risk and performance is stronger during the COVID-19 pandemic compared to non-health crisis period. To assess these relations, we will test the following hypothesis:

H3c: Health crisis reinforces the relationship between non-interest income activities and bank performance and risk.

[22] World Health Organization: WHO Director-General's opening remarks at the media briefing on COVID-19 – 11 March 2020. For more detail see: https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19-11-march-2020 .

Figure 2: Trends of GDP, ROA and ROE over the period between 2005-2020



Data source: The annual report of Professional Association of Tunisian Banks (2005-2020)

2. Data, variables definition and methodology

2.1. .Sample selection and data sources

Our data includes 10 conventional banks. We chose to study listed banks only because of information accessibility. Three banks included in our study are public (i.e., STB Bank, BH Bank and BNA Bank, where the government owns more than 36% of their equity). Furthermore, understudied banks represent 90.58% of the total banking sector balance sheet in Tunisia. Besides, we aim to assess the impact of non-interest income on Tunisian banks from 2005 to 2020. Our sample therefore covers a 16-year time span that includes the tranquil period before the global financial crisis and sovereign debt crisis, the political crisis as well as the health crisis of 2020. This would allow us to compare the effects of diversification on the banks' financial stability and performance during normal and crises periods. Financial data are collected from the professional association of banks website and from the banks' annual reports. As for the macroeconomic indicators, they are collected from the CBT and from the World Development Indicators database, which is an open data source of the World Bank.

2.2. Variables' definitions

According to Garoui et al (2013), internal factors related to bank risk and performance include, mainly, size, capitalization, assets growth, credit quality, efficiency and degree of diversification. Moreover, the macroeconomic determinants that are mostly used in the empirical literature (Kosmidou et al., 2005; Davydenko, 2010) are GDP and inflation rate. Following Lütkepohl and Xu (2010), in order to reduce the skewness and enhance variance stability, most of the variables in the final sample are kept in the fraction form, except for total assets, which is converted to log form as presented in Table (Tab.1).

In our study, we use three dummy variables to indicate the crises that occurred during our study period (2005-2020) as follows:

FDC: Previous studies (Lins et al., 2013, Wang, 2014; Drakos and Kouretas, 2015; Curi et al. 2015; Adrian et al. 2017; Adelopo et al., 2018; Cheng et al., 2019) agree that the financial crisis occurred mainly between 2007 and 2009. That is, in developed nations, it started in 2007 and ended in 2009. We support the idea that the impact on developing and transition countries was gradually apparent. It was only when the crisis turned into a global economic recession that developing and emerging market economies were affected, mainly through financial and trading channels (Gurtner, 2010). The sovereign crisis is introduced because the financial crisis did not end in 2009 in Europe, as it did in American countries. Tunisia's main partners (i.e, France, Italy and Germany) have experienced the second wave of the financial crisis in 2010 (Annual report of the CBT, 2010). Figure 1 shows how much this crisis impacted the GDP growth of these countries in 2009, which in turn influenced the national economy until 2011 (see Fig. 2). It's clear that the GDP decline from that date was followed by a decrease of bank profitability (ROA and ROE) in 2010 (According to IMF and the annual report of CBT). More interestingly, the sharp fall of these indicators in 2011 is related mainly to the direct effect of the revolution, which worsened the Tunisian national economic and financial situation. Rachdi (2013) found that the Tunisian

banking sector was not impacted by the international financial crisis because of its low integration in international financial markets and the strict control by specific and rigorous rules by the central banking of Tunisia (CBT).

PC= is used to identify the effect of the political crisis on the income diversification strategy and bank risk and return nexus. The choice of the period 2011-2013 instead of just the 2011 year of the revolution as documented in many studies in the Tunisian context (Ayadi and Ellouze, 2014; Saadaoui, 2018 and Ben Salem, 2019), is explained by the fact that the crisis's influence on bank profitability and risk appears with a time lag. As shown by Figure (Fig. 2), despite the recovery in economic growth, performance indicators continue to decline sharply in 2013.

Thus, the year 2013 is the most difficult for the banking sector. It was marked by the establishment of the circular n° 2013-15 concerning the internal control rules for the management of risks related to money laundering and terrorist financing (a consequence of the political crisis and instability)[23].

Table1: Variables' description

Variable	Measured by
Performance (ROA)	net income to total assets.(i.e., Hannan, 1991; Chiorazzo et al., 2008; Ongore and Kusa, 2013; Nisar et al., 2018)
Risk (Zscore)	the sum of the ROA and the equity-to-asset ratio, divided by the standard deviation of the ROA. (i.e., Molyneux and Thornton, 1992 ; Barth et al., 2004 ; Cheng et al., 2016 ; Hung et al., 2017 ; Talavera et al., 2018; Geng et al., 2019 ; Li et al., 2021).
The share of non-interest income SHNII	the ratio of non-interest income to total income (net operating revenue) (i.e., Stiroh & Rumble, 2006 ; Baele et al., 2007 ; Brunnermeier et al., 2012 ; Nisar et al., 2018).
fee and commission income (COM)	the ratio of net commission to total income. (i.e., DeYoung and Rice, 2004; Brunnermeier et al., 2012; Nisar et al., 2018).
short-term trading income (SHORT)	the ratio of commercial portfolio' profits to total income (net operating income). Investment portfolio' profits to total income. (i.e., Brunnermeier et al., 2012; Nisar et al., 2018).
long-term trading income (LONG)	is long-term trading income measured as the ratio of investment portfolio' profits to total income. (i.e., Brunnermeier et al., 2012; Nisar et al., 2018).
Net interest margin (NIM)	the net interest revenues to total earning assets (i.e., Flori et al., 2019 ; Cheng et al.,2019).
SIZE	the natural logarithm of total assets (Zhang et al, 2014)
Assets growth (AG)	Assets growth is proxied as the growth in total assets ratio (Li and Zhang, 2013)
capital adequacy ratio (CAR)	Is the capital adequacy ratio measured by the equity to total assets ratio (i.e., Berger, 1995; Naceur and Goaid, 2001; Stiroh, 2006; Mercieca et al., 2007; Chiorazzo et al., 2008; Sanya et Wolfe, 2011).
Expenses (EXP)	Expenses are a measure of operating costs or bank efficiency. It is calculated as operating costs to total assets (Karakaya and Erik, 2013).
Financial and debt crisis (FDC)	is equal to one for the years 2009 to 2010 and equal to zero otherwise.
Political crisis (PC)	is equal to one for the years 2011 to 2013 and equal to zero otherwise.
Health crisis (HC)	is equal to one for the year 2020 and equal to zero otherwise (i.e., Chen and Yeh, 2021; Fahlenbrach et al., 2020; Demirguc-Kunt et al., 2020).
LGDP	The natural logarithm of the gross domestic product growth rate measure of economic growth (i.e, Meslier et al., 2014 ; Belghuith and Bellouma, 2017 ; Nguyen et al., 2018).
INF	inflation rate (i.e., Dhouibi, 2015; Nisar et al., 2018).

HC: is used to identify the effect of the health crisis on the non-interest income activities and bank risk and return nexus. The choice of the year 2020 (see fig.2) is related just to the available information, despite the fact the pandemic persists until nowadays.

[23] See annual report of CBT, 2013.

2.3. Methodology

Step1: Non-interest income, bank performance, and risk

As a first step, we examine whether non-interest income activities are beneficial for Tunisian banks and to test our first hypothesis H1, we follow the method of Stiroh and Rumble (2006), Calmès and Liu (2009) and Nguyen (2012) by using the following estimation:

$$Y_{i,t} = \alpha 1 + \beta 1\ SHNII_{i,t} + \Sigma\ \delta_k\ Controls_{k,i,t} + \varepsilon_{i,t}\ (A)$$

where i indexes banks; t indexes time. The dependent variable Yi,t is the ROA when we measure bank performance and Zscore when we measure its risk. α $\beta$and δ are estimated parameters. The variable SHNII is constructed as a ratio of non-interest income to net operating income (the sum of net interest income and non-interest income). ControlsKit is a matrix of additional bank controls including NIM, CAR, SIZE, AG, EXP, INF, GDP as presented before in table.1. ε refers to the disturbance term (stands for the regression residual).

Step 2: The non-interest income components, bank performance and risk

According to previous researches, non-interest income is a mixture of heterogeneous components that differ in terms of their relative importance. As presented in equation (B), using this splitting into more detailed categories, we will be able to gain knowledge regarding the impact of non-interest income components on bank performance and/or risk.

$$Y_{i,t} = \alpha 1 + \beta 1\ COM_{i,t} + \beta 2\ SHORT_{i,t} + \beta 3\ LONG_{i,t} + \Sigma\ \delta_k\ Controls_{k,i,t} + \varepsilon_{i,t} \quad (B)$$

Where COM, SHORT and LONG are non-interest income components as defined in the following table.

Step3: Non interest income, bank performance and risk during crisis and non-crisis periods

As a last step, we consider the time dimension effect on the relation between non-interest business and bank performance and risk. Following previous studies (Cheng et al., 2019; Park et al., 2020), we partition the entire sample period into two sub-periods, the tranquil period and the crisis period. This method is used in order to demonstrate the difference in the regression including even the control variables with the aim to compare the impact of non-interest income on bank performance and risk in crisis and non-crisis periods using our basic model (A). Following Onali and Mascia (2021) and Nguyen et al. (2021), we will use dummy variables of each crisis as presented previously, and adopt a methodology similar to Kim et al. (2020) to analyse the compounded effect of the financial and debt crisis (2009-2010), the political crisis (2011-2013) and the health crisis (2020) on the relationship between the banks diversification strategy into non-interest income activities and bank performance and risk. In other words, we try to test if these crises amplify or weaken the effect of non-interest income and bank risk and performance compared to the non-crisis period. Thus, following Kim et al. (2020), we will estimate the following equations:

$$Y_{i,t} = \alpha 1 + \beta 1\ SHNII_{i,t} + \beta 2\ SHNIIFDC_{i,t}\ (SHNIIPC_{i,t}\ or\ SHNIIHC_{i,t}) + \beta 3\ FDC\ (PC\ or\ HC) + \Sigma\ \delta_k\ Controls_{k,i,t} + \varepsilon_{i,t} \quad (C)$$

Where FDC, PC and HC are dummy variables (see Tab.2) used to assess the macroeconomic influence of these various types of crises on bank performance and risk. Following Kim et al. (2020), we include interaction terms (i.e, SHNIIFDC, SHNIIPC and SHNIIHC) between the crises variables and the share of non-interest income (SHNII).

Robustness tests

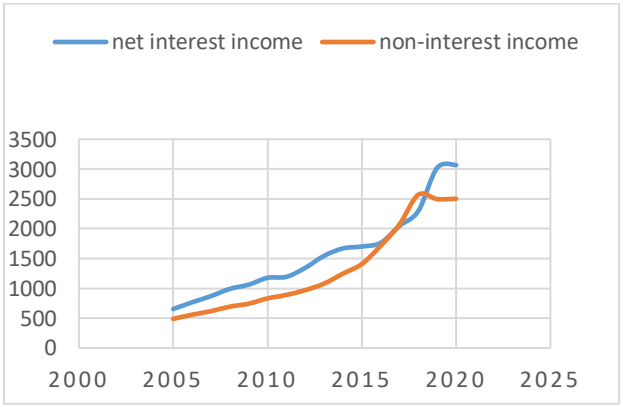
To examine the robustness of our results, we attempt to conduct additional analyses by using two alternative measures, that is return on equity (ROE) following previous literature (Klein and Saidenberg, 1997; Pham et al., 2020; Jayasekara et al., 2020), instead of ROA and performing loans (NPL) following (Acharya et al., 2001; Lin and Zhang, 2009; Tabari et al., 2013; Liang et al., 2013; Chaibi and Ftiti, 2015 instead of Z-score. Geng et al. (2019) noted that the credit risk (NPL) is most related to the bank's core business and represents the main risk that banks should take into account (the reasons for success or failure are attributed to changes in the quality of the loan portfolio).

More interestingly, we also check if our main results related to the effect of non-interest income activities on bank's risk and return during various crises hold when using a Chow test for the structural break. The test examines the stability of the main relationship and is able to confirm the change in the slope between the non-interest income and our dependents variables during the crisis period compared to the non-crisis period.

3. Empirical results

Figure 3 summarizes the evolution of both income components before and after the global financial crisis. We note that Tunisian banking revenues did not stop growing during the whole analyses period despite the global financial crisis and the harmful effects of the revolution on the Tunisian economy. From 2005 to 2016, Tunisian banking income was based on traditional banking activities. However, between 2017 and 2018, non-interest income seems to have increased at the expense of net interest margin, thus, non-interest income bearing activities exceeded interest income activities. From 2018, however , they declined to reach 45% (2500 MTD) of total operating income.

Figure 3: Trends of net operating income components from 2005 to 2020



Data source: The authors from annual reports from the CBT and PATB[24] from 2005 to 2020

Summary statistics

Table 2 reports the descriptive statistics for the variables used in the regression analyses, where panel A presents the descriptive statistics of bank performance and risk measures, ROA and Z-score25. ROA records a minimum of -0,081 and a maximum of 0.029, which gives an overall idea about banks effectiveness in converting its assets into net income (i.e., the higher the ROA, the better the bank manages its assets). This measure indicates the disparities between the Tunisian banks included in our study. Listed banks show relatively low performance with performance averaging 1%. Nevertheless, it is similar to U.S financial institutions, as reported by Iqbal et al. (2019), which average an ROA of 0.119. The Z-score varies from (-0.052) to 0.584 with a mean of 0.226. Hence, the Tunisian banking market contains banks with high level of instability risk, mainly

[24] The Professional Association of Tunisian Banks and Financial Institutions : https://www.apbt.org.tn/

[25] As z-score is highly skewed, following Laeven and Levine (2009), we use to a skilling by divided the z-score by 100, which is normally distributed.

public banks such as STB Bank and BH Bank, versus stable banks such as BT and Amen bank with Z-scores of 0.58 in 2020 (Despite the negative effect of the Covid-19 pandemic). Panel B presents the descriptive statistics of the independent variables. The sample is heterogeneous and contains banks that show different levels of share of non-interest income. Noticeably, there is a large spread for the income diversification strategy between banks as well as across years. The minimum value of the share of non-interest income (SHNII) in the Tunisian banking sector is 22,1%, which belongs to the BH bank in 2008. Still, its maximum reaches 76.6% (an excess of the non-interest income compared to the basic intermediation activity of the bank referred to ATB bank). Furthermore, a mean value of 45.6% shows that non-interest income is significantly high and close to 50% which indicates an even split between net interest income and non-interest income and shows a complete diversification Stiroh (2004). Similarly, the mean of COM is 24% for commercial banks, which is closer to the mean of trading income (i.e.,21.6% SHORT+LONG), but with a large spread between the min and the max for these components of non-interest income.

Let's consider the BH Bank which has zero long term trading from 2005 to 2008. This could be explained by the development of Tunisian financial market after the global financial crisis which led banks to trade more and shift towards non-traditional activities. According to several empirical studies (i.e., Curry et al., 2008; Ahmad et al., 2008; Deos et al., 2013), after the 2008 financial crisis, banks' activities have undergone large transformations (money and securitisation markets, technological innovation, Fintech development). Overall, we conclude that the income structure of Tunisian banks is indeed changing after the global financial crisis and is heterogeneous between banks. These statistics provide evidence that Tunisian banks diversify their income and adopt a new business model.

3.1. Non-interest income, bank performance and risk

Table 2 reports the regression estimates of Models (A) and (B) with the ROA and Z-Score as the dependent variables respectively. We started by computing the baseline regression (Equation (1) for ROA and equation (3) for Zscore) related to our first model, which tests the effect of non-interest areas on bank performance and risk. Supporting the traditional portfolio theory, results for both specifications show that non-interest income has a positive and significant impact (at the 1% level) on both bank performance and stability. In fact, if banks increase their non-interest-generating-business lines, their performance will go up by 6.6% and their risk will decrease by 25.4%. These results confirm our first hypothesis and are consistent with previous researches' results (e.g., Nisar et al., 2018; Lin et al., 2012; Nguyen et al., 2012; Lee et al., 2014; Mostak, 2017; and Hamdi et al., 2017). More particularly, to answer our H2a and H2b, from the equations (2) and (4), we note that all sources of non-interest revenue are positively associated with both bank performance and stability which is in turn inconsistent with Stiroh, 2004 and Williams, 2016. Fees and commissions as sources of income significantly reduce Tunisian banks' risk of failure. However, it doesn't produce high return as it has insignificant coefficient in the ROA equation, which does not support our H2a that predicts that income diversification into fee-based activities negatively affects Tunisian banks performance and stability. This can be argued by the fact that these fees and commissions are highly correlated with the traditional intermediation activity of Tunisian banks. As for the trading income (SHORT and LONG), it is found to be positively and significantly associated with both ROA and Z-score, which is in line with our hypothesis (H2b). This result is discussed in Meslier et al. (2014), who noted that moving towards non-interest activities increases banks risk-adjusted profits particularly when they are more involved in dealing government securities (which is the case of Tunisian banks). In the same line, Kohler (2018) suggests that bank insolvency risk is negatively correlated with the share of income of securities, possibly because it offers the largest diversification potential related to environmental changes. Taken together, our results support previous research concerning the beneficial effects of shifting towards non-interest income generating activities for both performance and stability (e.g., Lin et al., 2012; Nguyen et al., 2012, and Lee et al., 2014).

Moving on to the control variables. The results for net interest income (NIM) show high positive coefficients with high significance levels at 1% for both ROA and Z-score. To put it clearly, since interest rates

remain high even during a recession as the CBT adopts a monetary policy with the aim of controlling the high inflation rates, Tunisian banks still rely heavily on intermediation activity. Mnasri and Abaoub (2010) pointed out that banks that have diversified across both interest and non-interest income generating activities have higher levels of profitability and lower insolvency risk than banks with concentrated portfolios. We found also that there is a positive and significant link between banks performance and size (SIZE), assets growth (AG), capitalization (CAR) and the economic growth (LGDP). In other words, large banks with high capitalization and high levels of growth, experience an increase in their profitability in times of economic prosperity. Sanya and Wolfe (2011) argued that, when entering a new market, larger banks tend to have greater income diversification opportunities and less income volatility than smaller banks. Furthermore, from the same table, the CAR's significant impact is explained by the fact that the most performant banks are those who were able to strengthen their capital (Naceur and Goaid, 2001). With regard to operating costs and inflation, they show a negative and significant impact on banks' performance. This supports the findings of Naceur and Kandil (2009) and Nisar et al. (2018) who argue that a high level of inflation rate caused high expenses, thus, increasing banks risk and consequently affecting performance and stability.

Table 2: Regression results related to the effect of SHNII on ROA/Zscore

	ROA		Zscore	
	(1)	(2)	(3)	(4)
SHNII	0.066***	-	0.254***	
	(0.124)		(0.040)	
COM	-	0.0352		0.306***
		(0.0224)		(0.075)
SHORT	-	0.070***		0.259***
		(0.0176)		(0.434)
LONG	-	0.063***		0.315***
		(0.024)		(0.055)
NIM	1.1.14***	1.179***	3.977***	4.490***
	(0.228)	(0.302)	(0.642)	(0.708)
SIZE	0.118***	0.014***	-0.039***	-0.047***
	(0.005)	(0.005)	(0.016)	(0.024)
AG	0.046***	0.049***	0.007	0.001
	(0.101)	(0.011)	(0.023)	(0.024)
CAR	0.098***	0.081***	1.753***	1.73***
	(0.028)	(0.010)	(0.087)	(0.086)
EXP	-0.284*	-0.245	-0.196	-0.162
	(0.172)	(0.220)	(0.568)	(0.593)
INF	-0.122*	-0.148**	-0.097	-0.133
	(0.067)	(0.074)	(0.175)	(0.180)
LGDP	0.036	0.042**	-0.000	-0.008
	(0.022)	(0.024)	(0.055)	(0.056)
Constant term	-1.126***	-0.141***	0.120	0.147
	(0.035)	(0.035)	(0.113)	(0.178)
Observations	130	130	130	130
Adj R-squared	0.484	0.471	0.863	0.869

Table 2 provides regressions' results using the random/fixed effects estimator. Note that, ROA is used to measure performance and Zscore is a measure of bank risk (instability). All accounting variables 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 1.

To ensure the robustness of our results, we ran our model using ROE and NPL as an alternative measure of performance and risk. After testing individual and multivariate analyses, results of the regression model as presented in Table (Tab. 3) support our main findings. The difference is that for the long-term trading increases bank credit risk by deterring assets quality (There is a positive and significant relationship between the variables LONG and NPL which reach 48% at a 1% level) in line with Nicholas Apergis (2014) results.

Table 3: Regression results related to the effect of SHNII on ROE/NPL: Robustness check

	ROE		NPL	
	(1)	(2)	(3)	(4)
SHNII	0.910***	-	-0.289**	-
	(0.278)		(0.154)	
COM	-	0.243	-	0.082
		(0.442)		(0.278)
SHORT	-	1.104***	-	-0.022
		(0.295)		(0.161)
LONG	-	1.138**	-	0.482***
		(0.538)		(0.219)
NIM	17.67***	19.509***	-7.83***	-4.989**
	(5.221)	(6.435)	(2.57)	(2.700)
SIZE	0.123	0.037	-0.121**	-0.313***
	(0.092)	(0.134)	(0.063)	(0.079)
AG	0.640***	0.744***	-0.134	-0.147
	(0.249)	(0.254)	(0.104)	(0.108)
CAR	-1.021	-1.719**	-0.515	-0.517
	(0.732)	(0.779)	(0.367)	(0.372)
EXP	-6.958**	-7.076**	5.632***	4.794**
	(3.340)	(3.330)	(2.119)	(2.185)
INF	-0.568	-0.429	0.680	0.784
	(1.691)	(1.78)	(0.687)	(0.760)
LGDP	0.138	-0.016	-0.047	-0.086
	(0.685)	(0.046)	(0.224)	(0.018)
Constant term	-1.358*	-0.656	1.201***	2.252***
	(0.685)	(0.774)	(0.385)	(0.445)
Observations	130	130	130	130
Adj R-squared	0.166	0.199	0.317	0.398

Table 3 provides the regressions' results using the random/fixed effects estimator. Note that, ROE is used to measure performance and NPL is a measure of bank credit risk. All accounting variables 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 1.

3.2. Non-interest income, bank performance, and risk during the crisis period

- **Crisis versus the non-crisis period analysis**

As shown in Table 4, for all models, the estimation coefficient of the SHNII is significant (at the 1% level) in both crisis and non-crisis periods. Meanwhile, the ratio of non-interest income of total net operating income participates by 6.4% in banks performance during 'normal' time but it falls to 4.88% during crisis period. This can be due to higher costs of investments and diversification of products during crises (the negative effect of EXP on bank performance and risk was made worse and became significant during the crisis). Supporting the agency theory, Kim et al. (2020) provided evidence that concentrating on traditional functions (i.e., deposits and loans) can be more effective for banks during hard times. However, for the Tunisian context, our results show that the effect of NIM on ROA has dramatically decreased from 125% to 93%. Furthermore, when considering the Z-score, the effect of SHNII on bank stability is only 20% in tranquil periods but reaches 24% during crises. This finding is inconsistent with those reported by Stiroh and Rumble (2006). In sum, a 2% decrease in bank profit compared to a 4% increase in bank stability during crises leads to the reject our H3 hypothesis, giving that there is no negative effect neither on ROA nor on Z-score, which is inconsistent with Hayden et al. (2007); De Jonghe (2010); Li and Zhang (2013); Moore and Zhou (2014) and Williams (2016) who found that non-interest income activities provide higher risk, especially during the global financial crisis. It's important to note that, as for the capital ratio (CAR), there is a positive significant impact, as predicted, in both crisis and non-crisis periods. However, the ratio is higher during crises. By analysing the Tunisian banking sector, Abreu and Mendes (2002) showed that capital enhances bank profitability and has a stabilizing effect on bank revenues during the crisis period. Thus, Tunisian banks use capital as a cushion against potential risks. As for the diversification strategy, the net interest margin revenue (NIM) has declined during crises. This contraction of the core business revenue urges bankers to develop their income diversification strategy and

engage in new services and products. From the robustness test (Tab. 4), the main results mostly remain unchanged. As expected, during the crisis period the effect of non-interest income on both ROE and NPL has increased by 1% and 10% respectively. In contrast with Yang et al. (2019), who report that bank diversification into non-traditional activities differently affects bank performance and financial stability during the GFC crisis from how it does during the non-financial crisis period. Our results are in contrast with our expectations, because the positive effect of non-interest income activities on bank performance and stability is reinforced during the crisis period compared to the normal period.

Table 4: Regression results related to crisis and non-crisis periods' effect on the relationship between SHNII and ROA/Zscore

	ROA		Zscore	
	(1) Non-crisis Period	(2) Crisis Period	(6) Non-crisis Period	(7) Crisis period
SHNII	0.064***	0.0488***	0.200***	0.244***
	(0.020)	(0.013)	(0.057)	(0.083)
NIM	1.25***	0.930***	3.442***	2.905**
	(0.362)	(0.244)	(0.956)	(1.235)
SIZE	0.010	0.003	-0.034**	-0.039
	(0.006)	(0.005)	(0.017)	(0.028)
AG	0.016***	0.032***	0.000	-0.012
	(0.016)	(0.010)	(0.034)	(0.049)
CAR	0.086*	0.104***	1.662***	1.74***
	(0.049)	(0.026)	(0.120)	(0.219)
EXP	-0.268	-0.390***	-0.000	-1.753*
	(0.243)	(0.152)	(1.316)	(1.316)
INF	-0.141	-0.108	-0.027	-0.060
	(0.102)	(0.074)	(0.205)	(0.301)
LGDP	0.032	0.035*	0.235	1.133*
	(0.084)	(0.024)	(0.210)	(0.640)
Constant term	-0.122**	-0.060	0.138	0.108
	(0.053)	(0.041)	(0.113)	(0.186)
Observations	90	60	90	60
Adj R-squared	0.431	0.703	0.854	0.891

Table 4 the regressions' results using the random/fixed effects estimator. Note that, ROA is used to measure bank performance and Zscore is a measure of bank insolvency risk (financial stability). All accounting variables are measured at the end of the prior year. The crisis period is a dummy variable that takes one for the years 2009, 2010, 2011, 2012, 2013 and 2020 and zero otherwise. 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 1.

- **Financial/debt crisis (FDC), political crisis (PC) and health crisis (HC)**

First, results from the table (Tab.5) show that there is no significant direct effect of the crises included in our study on bank performance. This contradicts with the results of Ihaddaden (2020). Meanwhile, risk increased during the political crisis (negative significant direct effect at 1% level). However, the positive effect of the SHNII on bank stability increased (SHNIIPC+SHNII=0.253+0.253=0,477). In other words, the political crisis reinforced the positive effect of investments in non-interest generating activities on bank stability. Hence, non-interest-bearing activities are important to lower the probability of distress during the political crisis which reject our H3b hypothesis. Related to the health crisis, the same table (Tab.6) indicate that the COVID-19 crisis has no significant linear or non-linear effect of ROA, in contrast, it has a negative and significant effect on bank financial stability. The crisis has reinforced the positive effect of the non-interest income activities on bank stability (SHNIIHC+SHNII=0.280 + 0.277 = 0.557). This can be explained by Çolak and Öztekin's (2020) findings, who stated that the COVID-19 crisis decreased the traditional activity of banks especially in countries wich were more affected by this health crisis. It's also important to note that the health crisis pushed banks to look for new sources of income in order to maintain their stability and reduce their global risk. However, in contrast to our expectation, the crisis did not impact the non-interest income and bank performance nexus. This can be interpreted by a compensation between a positive and a negative effect in the given year. In fact, there were worries about the negative effect of the COVID-19 crisis on bank profitability, specifically during

lookdown, when cash withdrawals at ATMs became free, as well as the issuance of debit and credit cards, and all charges made for electronic payments on small amounts suspended. This had a negative effect on banks' profitability in the short term. However, on the other side, the number of credit cards as well as e-banking transactions increased. At the third quarter of the year and with the decontamination, the number of transactions sharply increased with the cancellation of free services.

Table 5: Regression results related to Crisis and non-crisis effect on the relationship between SHNII and ROE/NPL: Robustness check

	ROE		NPL	
	(1) Non-crisis Period	(2) Crisis Period	(3) Non-crisis Period	(4) Crisis period
SHNII	1.002**	1.019***	-0.266**	-0.362***
	(0.449)	(.387)	(0.112)	(0.166)
NIM	15.908**	25.652***	-2.41	-4.188***
	(7.77)	(7.358)	(1.838)	(1.588)
SIZE	0.294*	-0.092	0.133**	0.28
	(.152)	(.151)	(.043)	(0.088)
AG	1.222***	-.143	-0.020	-0.072
	(.333)	(.327)	(0.06)	(0.054)
CAR	1.267	-3.548***	0.774	0.782***
	(1.062)	(.778)	(0.232)	(0.221)
EXP	1.464	-18.101***	4.526	2.69
	(5.345)	(4.334)	(5.18)	(3.69)
INF	-2.729	-0.699	0.040	2.674*
	(2.101)	(2.424)	(0.422)	(0.714)
LGDP	0.2	0.276	1.403**	0.767
	(1.76)	(0.67)	(0.36)	(0.207)
Constant term	-2.849**	0.403	-0.882***	-1.672***
	(1.149)	(1.16)	(0.272)	(0.58)
Observations	90	60	90	60
Adj R-squared	0.431	0.403	0.373	0.6730

Table 5 provides the regressions' results using the random/fixed effects estimator. Note that, ROE is used to measure bank performance and NPL is a measure of bank credit risk. All accounting variables are measured at the end of the prior year. Crisis period is a dummy variable that takes one for the years 2009, 2010, 2011, 2012, 2013 and 2020 and zero otherwise (see regression results in the appendix). 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 1.

The question that arises is: how can crises significantly impact banks stability without influencing their performance. Jayasekara et al., 2020 argued that ROA is an accounting ratio that measures the short-term financial performance of banks whereas the Z-score measures the long-term performance of banks. In fact, some authors used Z-score as an additional bank performance measure. Another explanation for these results is that the CBT continued to set up strict regulatory capital adequacy standards like the introduction of capital requirements to cover credit, liquidity, operational risk (2016) and market risk (2018).

Table 6: Regression results related to FDC, PC, and HC crises' effect on the relationship between SHNII and ROA/Zscore

	ROA			Zscore		
	(5)	(6)	(7)	(8)	(9)	(10)
SHNII	0.064***	0.062***	0.063***	0.245***	0.224***	0.280***
	(0.012)	(0.011)	(5.02)	(0.041)	(0.041)	(0.041)
SHNIIFDC	0.010	-	-	0.094	-	-
	(0.035)			(0.085)		
SHNIIPC	-	0.012	-	-	0.253***	-
		(0.005)			(0.253)	
SHNIIHC	-	-	-0.219	-	-	0.277***
			(0.24)			(0.070)
NIM	1.162***	1.11***	1.189***	3.822***	3.454***	4.494***
	(0.229)	(5.15)	(0.23)		(0.658)	(0.669)
SIZE	0.011***	0.010***	0.011***	-0.040***	-0.041***	-0.045***
	(0.003)	(0.003)	(0.003)	(0.017)	(0.016)	(0.014)
AG	0.046***	0.047***	0.046***	0.011	-0.002	0.003
	(0.010)	(0.010)	(0.010)	(0.024)	(0.024)	(0.024)
CAR	0.097***	0.102***	0.097***	1.752***	1.731***	1.748***
	(0.029)	(0.026)	(0.029)	(0.087)	(0.085)	(0.088)
EXP	-0.278**	-0.265**	-0.298**	0.237	0.116	-0.300
	(0.153)	(0.134)	(0.153)	(0.574)	(0.556)	(0.580)
INF	-0.097	-0.109	-0.119*	-0.106	-0.018	-0.102
	(0.069)	(0.068)	(0.068)	(0.175)	(0.169)	(0.160)
LGDP	0.040*	0.033	-	-0.014	-0.025	-
	(0.023)	(0.024)		(0.057)	(0.054)	
FDC	-0.004	-	-	-0.052	-	-
	(0.002)			(0.045)		
PC	-	-0.004	-	-	-0.141***	-
					(0.057)	
HC	-	-	0.107	-	-	-0.125***
			(0.123)			(0.278)
Constant term	-0.130***	-0.117***	-0.125***	0.134	0.165	0.146
	(0.031)	(0.024)	(0.026)	(0.116)	(0.116)	(0.090)
Observation	150	150	150	150	150	150
Adj R-squared	0.486	0.488	0.492	0.578	0.580	0.597

Table 6 provides the regressions' results using the random/fixed effects estimator. Note that, ROA is used to measure bank performance and Zscore is a measure of bank insolvency risk (financial stability). All accounting variables 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 1.

The robustness test (from Tab. 7) confirms the insignificant effect of studied crises on both performance (ROE) and the effect of non-interest income generating activities on bank performance (SHNII*CRISIS). The positive and significant effect of the SHNII on ROE is persistent during crises as well as during non-crisis periods. Besides, estimations result of model (9) confirm our previous results using the Zscore measure for risk. Even if the PC does not show a significant linear impact on NPL, the crisis strengthens the negative effect of the SHNII on bank risk (NPL). This is granted that the coefficient of SHNIIPC is also negative and statistically significant, in the event that the sum of its coefficient with that on SHNII (-0.348+ (-0.094) = 0.442) is larger than that on non-political (-0.348). During the acute phase of the political crisis (2011-2013), shifting towards non-interest revenue-generating activities entails a diversification premium.

Table 7: Regression results related to FDC, PC, and HC' effect on the relationship between SHNII and ROE/Zscore

	ROE				NPL	
	(5)	(6)	(7)	(8)	(9)	(10)
SHNII	1.020***	1.139***	0.925***	-0.346**	-0.348**	-0.220
	(0.307)	(0.309)	(0.272)	(0.157)	(0.154)	(0.156)
SHNIIFDC	0.212	-	-	0.103	-	-
	(0.950)			(0.110)		
SHNIIPC	-	0.365	-	-	-0.094***	-
		(1.235)			(0.029)	
SHNIIHC	-	-	-0.453	-	-	0.031
			(5.990)			(0.285)
NIM	20.209***	22.277***	18.275***	9.786***	-10.477***	-7.91***
	(5.671)	(5.71)	(0.137)	(2.498)	(2.55)	(2.617)
SIZE	0.158	0.191**	0.1377*	-0.176***	-0.137**	-0.168***
	(0.104)	(0.103)	(0.03)	(2.498)	(0.050)	(0.051)
AG	0.647***	0.730***	0.602***	-0.077	-0.172*	-0.103
	(0.251)	(0.250)	(0.249)	(0.916)	(0.089)	(0.284)
CAR	-1.229*	-1.113	-0.978	-0.398	-0.529*	-0.557*
	(0.722)	(0.715)	(0.651)	(0.329)	(0.331)	(0.346)
EXP	-7.860**	-7.695**	-6.920**	5.795***	5.246***	5.824***
	(3.327)	(3.737)	(3.32)	(2.096)	(2.03)	(2.410)
INF	-0.284	-1.567	-0.616	0.0274	1.004	0.908
	(1.828)	(1.737)	(1.662)	(0.660)	(0.621)	(0.622)
LGDP	0.320	0.414	-	-0.347	-0.296	-
	(0.512)	(0568)		(0.109)	(0.394)	
FDC	-0.071	-	-	-0.116**	-	-
	(0.512)			(0.051)		
PC	-	-0.110	-	-	0.071	-
		(0.653)			(0.043)	
HC	-	-	0.164	-	-	0.034
			(3.089)			(1.158)
Constant term	-1.69***	-1.988***	-1.466***	1.676***	1.395***	1.468***
	(0.764)	(0.765)	(0.602)	(0.383)	(0.422)	(0.280)
Observation	150	150	150	150	150	150
Adj R-squared	0.198	0.226	0.198	0.424	0.467	0.348

Table 7 regressions' results using the random/fixed effects estimator. Note that, ROE is used to measure performance and NPL is a measure of bank risk. All accounting variables 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 1.

To confirm our results, we will perform a Chow robustness test to check if the relationship we're testing is stable over the entire period or there is a change in the magnitude on the slope of the SHNII with both Performance and risk. In other words, testing the structural breaks of the non-interest income and our dependent variables association during the political crisis as well as the FDC (Note: the test cannot be applied for the HC due to the lack of observation after the crisis). The Chow tests' results as reported in table (Tab. 8), show that the coefficients of SHNII on ROA differ significantly between the PC period and non-PC period (F = 1.931, p = 0.072). Moreover, there is an instability of the impact of SHNII on ROA between the pre-FDC and post the FDC period, as expected and in consistency with previous studies on the Tunisian context.

Table 8: Chow test' results

	ROA	Zscore
FDC	0.12	0.13
	(0.8888)	(0.8802)
PC	0.18	0.65
	(0.8341)	(0.5235)

Note: In the context of the Chow test, the null hypothesis is that there is no structural change, i.e. the coefficients are equal for both subsamples. Therefore, if we reject the null hypothesis ("p-value" < alpha), there is a structural change in the magnitude of the tested relationship. The P-value of the test is presented in parentheses.

From both dependent variables, the FDC has no direct effect on Tunisian banks performance (see Tab.7) but it has reinforced the effect of income diversification on bank performance (P-value>5%) and on risk (Zscore) (p=0.8802 >5%).

In sum, inconsistency with DeYoung et al. (2001), Stiroh (2006), Nguyen (2012), DeYoung and Torna (2013), and Williams (2016), from our results, it is assumed that the greater the bank diversify its activities, the high is the bank performance and the lower is the global risk specifically during financial/debt crisis, political crisis or health crisis.

Conclusion

The new banking environment, characterized by a combination of regulatory reform, product market innovation, increased competition, and technological change, has dramatically altered Tunisian commercial banks. In fact, these latter have continued to broaden their potential sources of income growth and to improve their capital and liquidity ratios, especially in light of declining margins on traditional retail lending. One possible effect of these attempts to diversify income sources might be an increase in the share of non-interest income, such as investment banking, securities brokerage, ATM fees and wealth management. In other words, the transition from traditional to modern banking with the implementation of the so-called "universal banking model" allowed banks to expand, over the past two decades, their traditional and specialized business strategies to provide a wider range of products and services. In addition, the growth of these non-interest business areas has been accompanied by a significant change in their components. Results of previous literature on this topic are inconclusive. Recently successive crises with various types, raise questions about the benefits of such functional diversification specifically in hard times.

In line with those of Kohler (2018) and Sanya and Wolfe (2011) and supporting the portfolio theory, our first main result reveals that bank performance and bank financial stability will be increased if Tunisian banks increase their non-interest income share, suggesting that developing non-interest activities has positive effects on Tunisian' financial environment, as predicted. Moreover, the second main result suggests that the short-term trading is the best source of income that significantly enhances bank performance and reduces risk. In contrast, long-term trading enhances bank performance but it

seems that this source of revenue is highly correlated with non-performance loans. More interestingly, our results from the analysis of crises effect, postulate that increasing the share of non-interest income-generating activities during crisis period raises bank performance and reduces

risk. Finally, we prove that all types of crises reinforce (exacerbate) the positive (negative) effect of non-interest income-generating activities on bank performance (risk).

Our results have implications for both policymakers and practitioners. First, our results could be important to regulators as they could serve as an advance warning signal that sends them a clear message about the importance of diversifying into non-traditional activities by changing their business models to adapt to Tunisia's financial environment and they should start seeking adequate staff in terms of skills.

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