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On the Contribution of Banks and Other Financial Services to Systemic Risk in an Era of Revolution: Fresh Insights from Tunisia

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Abstract

In this paper, we approach the systemic risk of the Tunisian financial system in the broad sense, that means the impact of a financial market downturn on financial firms' recapitalization. We adopt the SRISK methodology to measure the capital shortfall a firm could experience conditional on a financial market distress and to identify the most exposed institutions with it. We retain all Tunisian listed financial institutions in banking, leasing, insurance and financial investment sectors. The study period covers 45 months over the period 2007–2015, when Tunisian market generated monthly negative returns. Results suggest that rankings remain stable before and after the revolution, marked by the predominance of public banks (STB and BH, BNA becomes systemic after the revolution) and then few private ones (AB and BT) and the investment company TUNINVEST. Tunisian Insurance companies are not exposed to systemic risk, both before and after the revolution. The leasing sector had extremely low exposure to systemic risk during the 2007 year and then recovered following recapitalization of the two companies ATL and CIL.

Keywords: Systemic risk, Index construction, Emerging countries, Banking system, Tunisian Revolution, African context

JEL classification: G01, G21, G23

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1. Introduction

For the past fifteen years, the International Monetary Fund (IMF) report pointed out some weaknesses in the Tunisian financial system. In 2006, it highlighted the higher degree of credit risk incurred by banks and the low capitalization of the financial market. Besides, stress tests revealed that Tunisian banks need recapitalization. The 2009 IMF report underlined a rise of non-performing loans (NPL) and wide divergences between the banks. In fact, some banks raised up their rate of provisioning to 70%, whereas others still need recapitalization. Therefore, the report underlined undertaking stress tests and complying Basel II requirements to tackle the 2008 worldwide financial crisis. Moreover, according to the 2012 IMF report, the country's financial situation has dramatically deteriorated after the 2011 political revolution. The important injection of liquidity in order to support Tunisian banks

in 2011, led to low foreign exchange reserves and strong inflation. In addition, long-term loans continue to be funded by short-term deposits, which has resulted in long-term financial instability.

Within the context of the 2011 political revolution, it seems important to study the Tunisian systemic risk evolution over the years 2007–2015. The systemic risk is approached by the degree of the whole financial system undercapitalization. As far as we know, this paper is the first to measure the systemic risk index (SRISK) in the Tunisian financial context. First, it allows us to measure the systemic risk of each financial institution and thus to establish a ranking of risky financial firms. Second, it takes into account all financial services (banking, leasing, insurance and financial investment companies) contrary to previous Tunisian studies on systemic risk that focused only on the banking sector. Third, it lets us analyze the evolution of systemic risk in Tunisia in an era of political revolution and formulate recommendations. Finally, this paper provides the extent of literature on African countries that could be good candidates for analyzing systemic risk. These economies are dominated by bank financing within a rapidly changing environment, facing technological, financial and regulatory challenges. The remainder of the paper is organized as follows. Section 2 reviews some relevant literature on systemic risk measurement. Section 3 presents the methodology and data employed. Section 4 outlines and discusses empirical results while section 5 concludes.

2. Related Literature Review: Systemic Risk Measurement and Empirical Studies in the Tunisian Context

In this section, we first conduct a literature review of existing measures of systemic risk and second, we refer to earlier studies on the Tunisian financial context.

2.1 Systemic Risk Measures

Systemic risk is frequently considered as “hard-to-define-but-you-know-it-when-you-see-it” (Benoit et al., 2017). The European Central Bank (ECB, 2009) defines systemic risk as “so widespread that it impairs the functioning of a financial system to the point where economic growth and welfare suffer materially”. Both exogenous and endogenous shocks (market and financial institutions’ failures, global macroeconomic imbalance) could be considered to cause this trigger point. According to the Group of Ten (G10) (2001), “Systemic financial risk is the risk that an event will trigger a loss of economic value or confidence in [...] a substantial portion of the financial system that [...] have significant adverse effects on the real economy.” As there is no universal definition of systemic risk, different measures were developed in the literature. Benoit et al. (2017) classify systemic risk measures into two groups: those resulting from specific sources of systemic risk and those resulting from the global financial system. The previous systemic risk’s literature emphasis on specific sources of systemic crises or systemic risk-taking mechanisms. Some measures are based both on balance sheet and public market data of financial institutions in order to identify tensions and potential problems in a given financial sector (Lin et al., 2018).

The first approach in the narrow sense is to explore the impact of one financial institution on the market and its contribution to the systemic risk of the global financial system. Acharya et al. (2010) established the Systemic Expected Shortfall measure (SES) to estimate the contribution of individual financial institutions to the global systemic risk. SES is the expected capital shortage of an individual financial institution conditional on a substantial reduction of the system capitalization. They concluded that the failures of a systemically important institution can impose an externality on the rest of the economy when the financial system is undercapitalized. Nevertheless, using a static SES structural approach allows us to measure each institution’s contribution to systemic risk in times of crisis. Acharya et al. (2017) provided theoretical justification for the relation between SES, the financial firm’s marginal expected shortfall (MES) and its leverage effect. They reported that MES is easy to estimate how a firm is exposed to aggregate tail shocks and, interestingly, it has a significant explanatory power of systemic risk firm contribution, when it is combined with leverage

effect. Adrian and Brunnermerier (2011) extended the Value at Risk (VaR) measure that permits the calculation of the worst expected loss over a specific time interval at a given confidence level. The VaR measure limit is that it focuses only on individual firm systemic risk and it is unable to capture contagion effects between firms and thus to approach the overall systemic nature of risk. Afterwards, the authors defined the cover measure as the fear of the financial system when a single market or sector encounters some specific events. Indeed, CoVaR is the contribution of an individual institution to systemic risk. It is the difference between sectors or markets' covers during the turmoil and stable periods. The authors found that there is a strong relationship between a firm's war and its CoVaR in the time series dimension but a weak nexus in the cross-sectional dimension.

Girardi and Ergün (2013) used a slightly modified cover in which distress events occur when an institution experiences loss worse than war level. According to Brownlees and Engle (2017), the potential problem of SES approach is that financial institution's contribution to systemic risk during financial crises can only be analyzed ex-post. They further developed a more flexible SRISK measure, which is defined as the capital that a firm is expected to need in times of financial crisis. The SRISK index includes the financial firms estimated long run marginal expected shortfall (LRMES), its size and leverage level. The sum of the individual institution's contribution to systemic risk, also called aggregate SRISK, provides a systemic-wide estimate of overall potential capital shortfalls in the event of a systemic crisis (Manap T.A., 2019). Brownlees and Engle (2017) found that aggregate SRISK serves as an early warning signal of distress in the U.S. Engle et al. (2015) reached the same conclusion for European countries. Many recent studies used SRISK to measure systemic risk (Buch et al., 2019; Bostandzic and Weiß, 2018; Colletaz et al., 2018; Brownlees et al., 2020; Bats and Houben, 2020). SRISK is preferred to CoVaR for the following reasons. First, SRISK combines both market and book information, and does not purely rely on market prices. Second, while CoVaR determines the financial system risk due to the distress of one particular firm, SRISK focuses on the capital shortfall that financial institutions face in case of overall systemic turmoil.

2.2 Tunisia Systemic Risk: Previous empirical researches

The concept of systemic risk has captured a growing importance in Tunisia since the 2011 revolution which generated a political and social crisis concomitant with a security and economic situation deteriorates. The latter has largely affected the banking sector, which represents the country's major financial engine (about 80% of all financial assets in 2011) (Khiari and Nachnouchi, 2018). This made it possible to highlight the inter-relationship between systemic risk and banking sector vulnerability (Barth, Caprio and Levine, 2006; Brunnermeir and Pedersen, 2009), especially in view of national and international unfavorable economic conditions that made the banking sector unable to absorb financial turmoil. As aforementioned, there is a lack of universal definition and measure of systemic risk. Consequently, some researchers proposed a Tunisian banks' systemic risk mapping in order to display the key contributors to it. Hmissi, Bejaoui and Snoussi (2017) adopted the CES measure to identify Tunisian domestic systemically important banks during the period 2008–2015. This hybrid measure permits to assess each bank's contribution to the country's overall systemic risk, by combining "Too big to fail" and "too interconnected to fail" criteria. The authors found first that public banks are the riskiest ones and second that the top five ranking of these is the same both before and after political revolution Khiari and Nachnouchi (2018) proposed a two-level approach to measure and evaluate Tunisian banks systemic risk. First, the authors started with a unified approach that combines the cues and multidimensional scaling techniques (MDS). They found that public banks are the riskiest ones, followed by the two most important private banks BIAT and UBCI. Second, they used a composite index of systemic risk implication and showed that Tunisian bank systemic risk depends on the bank size, its technical efficiency and its direct exposure to the inter-bank lending markets. These results were corroborated by the findings of Khiari and Ben Sassi (2019) who used ΔCoVaR measure to identify the banks that impact the most the systemic risk and those

which are the most exposed to it. Results pointed out that public banks ranked in the top five places followed by the two largest private ones. Moreover, these banks contribute the most to other banks' distress and are the least exposed to their financial difficulties. In this sense, Mselmi and Regaieg (2018) displayed that internal governance mechanisms are positively associated with Tunisian banks' systemic risk and that the risk management committee's presence has no effect on the level of systemic risk incurred by these banks. In fact, compliance with governance standards within banks leads to the minimization of their individual contribution to overall systemic risk. According to Ati (2015), the crisis emerges because of the excessive bank risk-taking despite good rating agencies' assessments. Financial liberalization, international competition and lack of banking supervision exacerbate bank fragility.

Overall, there are few empirical studies on Tunisian systemic risk. To our knowledge, studies on the Tunisian context have not yet adopted the SRISK measure which takes into account the financial institution's size, its leverage degree and its expected equity loss conditional to a market downturn. Our paper proposes to measure first the SRISK of Tunisian financial institutions and by extension SRISK of the overall financial system, second to classify the banks according to their contributions to it and ultimately to compare our findings with those of other studies.

3. Methodology of Tunisian SRISK measurement

We begin by the SRISK measurement methodology and then focus on the Tunisian financial system. Finally, we present the studied financial institutions and the study period.

3.1 Empirical Methodology

The IMF's financial stability reports on Tunisia over the period 2006–2012 underlined the need to recapitalize Tunisian banks. A capital shortfall not only endangers the financial health of the institution and its bondholders, but also produces huge negative externalities to the whole economy. From an empirical standpoint, we adopt SRISK as a measure of systemic risk in Tunisia, based on the paper of Brownlees and Engle (2017). This index is defined as the expected capital shortfall of a financial institution when there is a prolonged market downturn. This measure gives advantage to combine both market and balance sheet data. Noteworthy, SRISK is a function of the institution's size, its leverage degree, and its expected equity loss conditional on the market decline also named LRMES. We calculate SRISK of each listed financial institution, which measures the firm's contribution to the financial system and the economy's undercapitalization. Individual SRISK measures allow us to establish rankings of systemically risky institutions. The overall systemic risk is obtained by summing up all individual SRISKS and can be understood as the capital to inject into the financial system in case of a sudden crisis.

More formally, the SRISK formula in accordance with its definition is as follows:

$$SRISK_{it} = E_t(CS_{it+h}/R_{mt+1:t+h} < C) \quad (1)$$

Where $SRISK_{it}$ denotes the SRISK of an institution i on date t , and $E_t(CS_{it+h}/R_{mt+1:t+h} < C)$ the expected capital shortfall of the institution i when the market is in decline (below a threshold C) during a temporal horizon h . The market is approached by TUNINDEX, the main Tunisian stock index, for which we calculate monthly returns over the period 2007–2015. We set the horizon h equal to 1 a month in our empirical work and we retain only months when TUNINDEX returns are negative (Acharya et al, 2010). The worst market monthly return over the study period is about -4.880% . So, we retain a global market threshold C off -5% . The capital shortfall of firm i on date t is defined as:

$$CS_{it} = kA_{it} - W_{it} = k(D_{it} + W_{it}) - W_{it} \quad (2)$$

Where k is the prudential capital fraction, A_{it} is the value of quasi-assets, W_{it} is the market value of equity and D_{it} the book value of debt. A positive capital shortfall reveals financial hardship, unlike a negative one that unveils a capital surplus. So, (2) becomes:

$$SRISK_{it} = kE_t(D_{it+h} | R_{mt+1:t+h} < C) - (1-k)E_t(W_{it+h} | R_{mt+1:t+h} < C) \quad (3)$$

As a debt cannot be renegotiated in times of systemic crisis, $E_t(D_{it+h} | R_{mt+1:t+h} < C) = D_{it}$
It follows that:

$$SRISK_{it} = kD_{it} - (1-k)W_{it}(1 + LRMES_{it} = W_{it}[kLVG_{it} - (1-k)LRMES_{it} - 1] \quad (4)$$

Where LVG_{it} is the leverage ratio $(D_{it} + W_{it})/W_{it}$ and $LRMES_{it}$ is the expected multi-period firm equity return in case of systemic crisis. It can be approximated by:

$$LRMES_{it} = \sqrt{h}\beta_i ES_{t+1/t}$$

Previous research showed that the LRMES estimation approach based on the standard GARCH DCC time series model provides the most accurate forecasts (Brownlees and Engle, 2017). Our approach combines a DCC model to estimate the dynamic of the beta parameters and univariate GARCH models to estimate the dynamic of the volatility error term. The closing prices of financial institutions and Tunisian stock index are converted into the logarithmic form. $ES_{t+1/t}$ is the expected market shortfall. It is defined as the product of the market standard deviation and the ratio of $\phi(\cdot)$ and $\Phi(\cdot)$ that are respectively the standard normal density and distribution:

$$ES_{t+1/t} = E(r_{mt} + 1 | r_{mt+1} < C) = -\sigma_m \frac{\phi\left(\frac{C}{\sigma_m}\right)}{\Phi\left(\frac{C}{\sigma_m}\right)}$$

SRISK is computed at the end of each month for all firms in the panel from January 2007 to December 2015. We first retain only firms with positive SRISKS that are the contributors to market turmoil and then provide their rankings. The total amount of the whole financial sector systemic risk is obtained by the aggregation of individual positive SRISKS of firms.

$$SRISK_t = \sum_{i=1}^N (SRISK_{it}) +$$

Finally, we report the percentage SRISK index that is a systemic risk share, as follows:

$$SRISK \% = \frac{S_{1}ISK_{it}}{S_{RISK}} \text{ if } SRISK_{it} > 0$$

These SRISK shares allow us to identify and classify the top systemically risky Tunisian financial institutions over the period surrounding the 2011 revolution, going from 2007 to 2015.

3.2 Overview of Tunisian Financial System

The Tunisian financial system depends on several factors such as the financial market's size, activities and performance, the degree of individuals' recourse to financial services, the institutional environment quality and finally the system's opening to foreign investors. In 2011, the Tunisian financial sector was small and dominated by banks, with assets representing around 115 percent of GDP. Indeed, the Tunisian financial system included the Central Bank of Tunisia, 23 residents and 7 offshore banks, and 13 financial institutions containing 2 investment banks, 8 leasing establishments

and 2 factoring companies. Moreover, the Tunisian financial landscape covers the National Poste Office, the Financial Market Council, the Tunis Stock Exchange, Tunisie Clearing, investment companies and the UCITS (Undertakings for Collective Investment in Transferable Securities). In terms of financial depth (the ratio of the money supply to GDP), Tunisia has observed an uptrend, going from 57% in 2001 to 70% in 2014, with moderate falls in 2003, 2004 and 2015. The most pronounced drop was observed in 2015 with an average of 85%, despite efforts of BCT not only to offer necessary liquidity to the banking system in order to finance the economy, but also to promote conditions for a resumption of healthy and sustainable growth. In our paper, our data covers listed financial institutions in banking, insurance, leasing and financial investment sectors.

On the one hand, the banking industry has been gaining attention; the banks being considered as more accessible and less expensive than other sources of financing. An important network of representations and bank agencies has been set up, currently comprising more than 1,905 agencies (approximately one agency for 5,775 habitants). The outstanding loans granted to the private sector by the Tunisian banking system recorded an upward trend during the last period 2005–2015, the loan to GDP ratio reached nearly 80% in 2011. Tunisian banks have therefore fulfilled their mission of financing the economy during this transitional period. More than half of total bank credit was oriented towards industry, trade and tourism, considered among the pillars of the Tunisian economy. The table 1 below presents Tunisian listed banking sector statistics (in thousands of TND) over the period 2007–2015. We note the banking activity expansion in Tunisia over this period, where the indicators of size, outstanding to the economy and capitalization have doubled and net profits in 2015 reached 7 times their value of 2007.

Table 1. Descriptive Statistics Of Tunisian Banking Sector (2007 – 2015) (In Million Tnd)

Year	Total Assets	Total Deposits	Total credits	Total Equities	Net Banking income	Net Profit
2007	32 475 999	24 228 085	22 700 325	2 795 853	1 396 989	82 463
2008	37 109 763	28 003 953	26 216 180	3 206 012	1 587 724	365 014
2009	41 571 224	31 460 873	28 666 140	3 684 367	1 746 939	434 772
2010	47 018 968	34 691 224	34 086 627	4 048 085	1 938 651	416 771
2011	50 255 828	36 396 077	38 165 538	4 260 882	1 944 137	345 090
2012	54 997 926	39 679 898	40 784 222	4 467 310	2 008 781	562 502
2013	56 824 449	42 845 733	42 015 022	3 728 074	2 268 713	359 001
2014	60 461 019	45 776 251	45 246 069	4 304 676	2 604 212	604 593
2015	64 548 283	46 987 879	47 404 016	5 610 953	2 753 261	677 783
Mean	49 473 718	36 674 441	36 142 682	4 011 801	2 027 712	427 554
Standard						
Deviation	10 859 271	7 886 766	8 726 167	808 505	447 544	175 654
Median	50 255 828	36 396 077	38 165 538	4 048 085	1 944 137	416 771
Variation						
(2007 -2015)	98.76%	93.94%	108.83%	100.69%	97.09%	721.92%

On the other hand, the non-bank financial sector is relatively small (about 20 percent of all financial system assets in 2011). The insurance sector is limited to 19 companies, that main vocation (almost 85% of premiums) does not relate to life insurance. In respect of financial investment companies, fixed and variable income–markets remain modest. Their capitalization around 24% of GDP, which is lower than those of other countries in the region (112% in Jordan and 76% in Morocco). The leasing industry includes 8 companies, 7 of which are listed. The sector regressed over the four years following the revolution because of the increase of the average costs of funds and

of the unpaid debts. However, it rebounded after and reached a penetration rate to the economy of 10.6% in 2016. In terms of returns, table 2 displays descriptive statistics of the sample's firms as well as the Tunisian stock index.

Table 2. Descriptive Statistics Of Tunisian Listed Financial Institutions

Financial Institution	Observation	Mean (%)	Std. Dev (%)	Skewness	Kurtosis	J - Bera
Bank						
BT	2236	0,0126	0,5217	0,7003	14,0456	213,3138
AB	2236	0,0107	0,5572	0,3371	3,7494	42,5001
BIAT	2236	0,0135	0,0053	0,3543	4,9923	416,6261
STB	2236	-0,0103	0,7415	0,6305	6,1535	1074,709
ATTIJARI BANK	2236	0,0230	0,5753	0,8975	12,7051	323,794
ATB	2236	-9,036E-08	0,5697	-0,3659	11,4049	6631,458
BH	2236	-9,288E-07	0,7372	-5,0179	120,9943	1306511
BNA	2236	5,1306E-07	0,9116	-0,0090	243,3615	5382582
UIB	2236	2,7855E-07	0,5114	0,2099	7,2041	1663,156
UBCI	2236	4,075E-07	0,7858	-6,5975	159,1388	2287564
BTE	2236	-0,0103	0,4552	-2,9577	72,9785	459497,2
Insurance						
ASTREE	2236	-4,177E-08	0,8444	-0,6636	320,1740	9372673
STAR	2236	0,0514	0,7858	0,3275	13,4224 1	0160,36
Investment						
SPDIT	2236	-0,0261	1,9867	-40,2322	1805,1306	3,03E+08
TUNINVEST	2236	3,4993E-07	0,7978	-2,7017	42,7360	3114,999
Leasing						
WIFACK	2236	2,6429E-07	0,9757	-25,7482	994,3899	91816307
ATL	2236	6,4578E-07	0,7198	-3,0605	64,4527	4434,78
ATTIJARI LEASING	2236	0,0001	0,9766	3,1840	56,0126	4480,732
CIL	2236	0,0137	0,6558	-0,7345	34,6007	93238,11
TL	2236	3,8925E-09	0,6311	0,0076	2,2000	0,181703
TUNINDEX	2236	0,0149	0,2591	-0,5916	11,7293	7229,864

The average bank returns over the study period vary between -9,036E-06 and 0.023%, insurance and investment companies display positive and negative returns, and the average leasing returns are positive. All daily returns standard deviation values display higher volatility and Jarque Bera tests reject the normal distribution hypothesis of returns, except for SPDIT and TL. As for TUNINDEX, the mean return is positive, returns display high volatility and abnormal distribution.

3.3 Study Period and Data

Our study period spans from 2007 to 2015. This period was marked by the 2011 revolution. We retain months that display negative TUNINDEX returns. For each one, we calculate the corresponding expected shortfall. So, our study period is based on 45 months, 17 before the revolution and 28 months after.

Table.3. Descriptive Statistics Of Tunisian Listed Financial Institutions

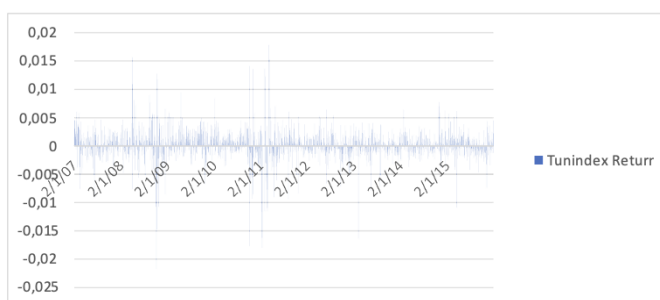
Month	ES	Month	ES
March 2007	-0,0007	May 2012	9,93E-05
May 2007	-1,47E-06	June 2012	-0,0004
June 2007	0,00207	August 2012	0,0011
July 2007	-0,0004	September 2012	-0,0019
September 2007	8,78E-05	October 2012	-8,87E-07
May 2008	-0,0016	November 2012	2,68E-05
July 2008	-0,0003	December 2012	-0,0002
August 2008	0,0049	February 2013	0,0028
November 2008	-0,0024	April 2013	-0,0002
December 2008	0,0012	May 2013	0,0015
July 2009	-0,0007	July 2013	-0,0013
November 2009	-0,0008	September 2013	0,0006
February 2010	-0,0006	November 2013	0,0009
June 2010	0,0010	December 2013	-0,0013
October 2010	0,0064	March 2014	-0,0006
November 2010	-0,0008	April 2014	0,0008
December 2010	-0,0017	September 2014	0,0006
February 2011	0,0098	March 2015	0,0020
March 2011	-0,0006	July 2015	0,0012
April 2011	-0,0015	August 2015	-0,0008
November 2011	0,0019	September 2015	-0,0009
January 2012	0,0002	October 2015	0,0006
		November 2015	-0,0003

Our dataset includes daily data of stock returns and market capitalizations; book value of the assets and equities are given yearly. Data is manually collected from the Tunis stock exchange website. It consists of the TUNINDEX index and listed financial firms' returns. Our sample is composed of 11 banks (AB (Amen Bank), ATB (Arab Tunisian BANK), ATTIJARI BANK, BIAT (Arab International Bank of Tunisia), BH (Bank of Housing), BNA (National Agricultural Bank), BT (Bank of Tunisia), BTE (Tunisia and Emirates Bank), STB (Tunisian Banking Company), UBCI (Banking Union for Banking and Trade) and UIB (International Banking Union)), 02 insurance companies (ASTREE and STAR), 05 Leasing companies (ATL (Arab Tunisian Lease), ATTIJARI LEASING, CIL (International Leasing Company), TL (Tunisia Leasing), WIFAK LEASING), and 02 financial investment companies (SPDIT and TUNINVEST). At the end of 2015, the largest market capitalizations in the bank sector were BT (1,350 billion TND), BIAT (1,299 billion TND) and ATTIJARI BANK (942 million TND). The biggest insurance company was STAR (362,308 million TND), the largest Leasing companies were WIFAK LEASING (221,7 million TND) and TUNISIE LEASING (167,4 million TND) and the greatest financial investment company was SPDIT (346,08 million TND).

Figure 1 provides TUNINDEX return evolution during the study period (January 2007- December 2015). It appears that the TUNINDEX time series plots show cyclical movements over the sample period. All return series tend to fluctuate over time.

Figure 2 (in appendix) illustrates the dynamic conditional correlation between listed financial institutions and TUNINDEX during retained months. First, Figure 2.1 displays high volatility of conditional correlations between TUNINDEX and listed bank returns, especially during the post

Figure 1. Tunindex Return 2007-2015



Source: Authors' estimates

revolution period (November 2011 – November 2015). Second, Figure 2.2 shows a controversial correlation between insurance companies and the TUNINDEX returns. Finally, Figures 2.3 and 2.4 highlights a stable volatility for both leasing and financial investment companies.

4. Empirical results

The first set of our study presents SRISK listed institutions. Rankings seem to be stable before and after the revolution, marked by the predominance of public banks and then by few private ones as well as the investment company TUNINVEST. This result is very interesting because previous Tunisian researches on systemic risk have traditionally been based on the banking sector only. Therefore, the introduction of all financial industries has made it possible to highlight the financial investment sector, in particular the TUNINVEST company, as a contributor to the systemic risk before and after the revolution. Before the revolution, the two public banks BNA and STB were at the global forefront (nearly 55% of global SRISK), followed by the two private ones AB and BT (approximately 40%) and the financial investment company TUNINVEST (5%). Moreover, the latter ranked first positions from October, 2010 to December, 2010, reaching 70% of global SRISK (in November 2010) followed by STB. It should also be noted that ATL leasing company contributed discreetly to the overall systemic risk (2%) over the beginning of 2007. Then, it disappeared from the listing of riskiest institutions due to its recapitalization. After the revolution, and from February, 2011 to March, 2015, the three and only public banks (STB, BNA and BH) occupied the highest systemic risk slots pursued by TUNINVEST (13%) and AMEN BANK (12%). Since July, 2015, TUNINVEST has occupied the second rank with a contribution of nearly 30%. Lastly, we note a lack of insurance and leasing companies' contribution to the overall systemic risk, both before and after the revolution (see table 4 in appendix).

Globally, systemic Tunisian financial institutions seem to be the same before and after the revolution, even their ranks differ from month to the next. These are primarily public banks (STB, BNA and BH) followed by private banks (BT and AB) and the financial investment company TUNINVEST. Except for the latter, our results are consistent with those of previous Tunisian studies that have focused only on the banking sector and showed the primary position of banks on Tunisian financial architecture (Hmissi, Bejaoui and Snoussi, 2017; Khiari and Nachnouchi, 2018 and Khiari and Ben Sassi, 2019). The systemic risk induced by public banks is mainly explained by excessive risks taken and the weakness of supervision of their activities that included both deterioration of solvability and liquidity ratios and the increase of doubtful assets. Besides, following the political regime overthrow, local banks published their commitments with Ben Ali family members. It then turned out that State-owned banks were the most affected in terms of commitments and especially in terms of classification and provisioning classified receivables. BNA was undermined because of

non-performing loans and deficiency of provisioning. For its part, the fragility of STB intensified following the merger undergone in 2003, and worsened between 2013 and 2015, following the terrorist attacks. These wiped out the Tunisian tourism sector that STB finances up to 36.7%. Moreover, BH became a SRISK systemic bank after the 2011 revolution. In fact, it monopolized nearly 20% of real estate sector loans. Despite the double revision of the key interest rate of Tunisian Central Bank from 3.5% to 4.5% in 2011 and the household debt capacity following wage increases, housing loans fell from 78% in 2010 to 43% in 2012. Consequently, BH activity was altered, which increased its risk in the market. Otherwise, considering private banks, BT lost its systemic contributor position following its post-revolution recapitalization. Its operating activity was also well oriented, with a net banking income up to 9.6% to 115 MD in December 2015 and a 9.8% increase of interest margins at 61 MD. AB returned to its systemic position at the end of the study period, i.e. the year 2015, that is characterized by decreasing resources of 5.7%, mainly due to the decline of customers' deposits, treasury bills and commercial papers. Equities increased slightly (+5.7%) between 2014 and 2015 despite the drop of 32.3% in net income. The most interesting findings of the research are considering the financial investment company TUNIVEST as SRISK systemic, both before and after the revolution. In fact, it suffered from a debt increase as well in 2010 (34.3%) and 2015 (100%), combined with a capital shortfall because of a nominal share value reduction of up to 50%.

By and large, tables 5.a and 5.b display the overall systemic risk (SRISK), respectively before and after the 2011 revolution.

Table 5.A. Pre-Revolution Srisk System

Month	SRISK SYSTEM (million dinars)	var %
March 2007	323,739	
May 2007	587,387	81,44
June 2007	583,631	-0, 64
July 2007	606,359	3,89
September 2007	603,199	-0, 52
May 2008	743,226	23,21
July 2008	785,297	5,66
October 2008	714,544	-9, 01
November 2008	743,634	4,07
December 2008	726,462	-2, 31
July 2009	586,546	-19, 26
November 2009	428,69	-26, 91
February 2010	504,294	17,64
June 2010	315,027	-37, 53
October 2010	127,057	-59, 67
November 2010	122,205	-3, 82
December 2010	104,274	-14,67

The most striking element from these tables is obviously the increased SRISK of Tunisian financial system over the two periods. Before the revolution, the overall SRISK reached its highest levels during the year 2008 (785.297 million TND) but then it saw a sharp decline to 104.274 million TND between October and December, 2010. Following the revolution, the SRISK has dramatically increased to 747.439 million TND in February, 2011; that is a variation of 616.8% over two months. The SRISK followed an increasing trend, reaching its peak at 1399.316 million TND during March, 2015, marked by the terrorist attack on the National Museum of Bardo.

Table 5.B. Post-Revolution Srisk System

Month	SRISK SYSTEM (million dinars)	var %
February 2011	747,439	616,80
March 2011	740,578	-0,92
April 2011	807,688	9,06
November 2011	743,157	-7,99
January 2012	975,815	31,31
May 2012	818,539	-16,12
June 2012	846,259	3,39
August 2012	860,062	1,63
September 2012	775,593	-9,82
October 2012	979,097	26,24
November 2012	1031,292	5,33
December 2012	691,67	-32,93
February 2013	994,496	43,78
April 2013	1047,688	5,35
May 2013	1046,53	-0,11
July 2013	1056,814	0,98
September 2013	1079,248	2,12
November 2013	1047,191	-2,97
December 2013	1096,302	4,69
March 2014	1265,283	15,41
April 2014	1284,369	1,51
September 2014	1349,938	5,11
March 2015	1399,316	3,66
July 2015	724,064	-48,26
August 2015	765,763	5,76
September 2015	823,683	7,56
October 2015	839,137	1,88
November 2015	901,505	7,43

Based on the obtained empirical results, our paper raises several policy implications, including:

- **More regulation of state-owned banks:** Public banks are more risky than private and foreign banks, as they are supported by the state. They are more involved in the implementation of credit policy decisions and their loans are less sensitive to macroeconomic shocks. Hence, they tend to take excessive risks and their failure could have major effects on financial and economic spheres. Therefore, policymakers should tighten control of public-bank activities and ensure their capital regulation as well as good governance mechanisms. This could enhance bank stability and may lead banks to shift their portfolio composition towards less risky assets.
- **Greater emphasis toward investment companies:** Conversely to anterior studies that focused only on bank systemic risk in Tunisia, this study considers all financial services and highlights the investment company TUNINVEST as systemically financial institution, both before and after revolution. Hence, policy-makers should develop private equity fundraising; which could be a solution for companies that face banks' reluctance, while they ensure better returns on investments.
- **Management of Market sentiment:** Systemic risk and market sentiment are two joint concepts,

crucial to be considered by policy-makers and regulatory bodies. Periods of low risk are associated with feelings of optimism and increased leverage. Conversely, a systemic risk increase, especially after a political or financial crisis, could weaken investors' level of confidence and inhibit their investment decisions. That's why the SRISK measures allow policy-makers to better manage the determinants of risks and to foster a conducive business environment.

From a management perspective, our paper has three-fold implications. First, SRISK is a relevant measure that takes into account both the intrinsic characteristics of the firm and its spillover effects on the market. It gives a useful early warning signal of institution's distress. Therefore, this measure is crucial to ensure financial stability. Second, the SRISK measure is important for both policy-makers and investors. These are usually concerned about their investments' risks. Third, overall, SRISK is a relevant measure to assess a country's economic growth and to better understand its business environment.

5. Conclusion

In this paper, we approach Tunisian systemic risk in the broad sense, meaning the impact of a financial market downturn on financial firms' recapitalization. We adopt the SRISK methodology to measure the capital shortfall a firm could experience conditional on a financial market distress, and hence to identify the largest firms' contributors to it. We retain all Tunisian listed financial institutions in banking, leasing, insurance and financial investment sectors. The study period covers 45 months over the period 2007–2015, when Tunisian market generated monthly negative returns. Results suggest that bank rankings remain stable before and after the revolution, marked by the predominance of public banks (STB and BH, BNA appears systemic after the revolution), followed by few private ones (AB and BT) and finally the investment company TUNINVEST. Tunisian Insurance companies are not concerned with systemic risk, both before and after the revolution. The leasing sector, which had extremely low exposure to systemic risk during the year 2007 recovered following recapitalization of the two companies ATL and CIL. The most interesting result is finding TUNINVEST as a systemic Tunisian institution; unlike previous research that focused only on the banking sector. It has emerged as a SRISK institution because of its debts' increase combined with capital reduction. Overall, the SRISK financial system increased after the 2011 revolution, enhanced by the country's political instability and terrorist attacks. Besides, the rise in non-performing loans, the loss loan provisions combined with the poor banking governance, especially for public banks weakened banking stability, and prompted banks to be recapitalized. This considers Basel III recommendations and strengthens micro- and macro-prudential supervision. Our paper provides some policy implications and useful insights for forecasting systemic risk of emerging markets in African context, marked by political shocks. Also, it may help investors and policy makers to take into account banks and financial investment companies to capture some early signs of financial turmoil. Finally, it offers a deep understanding of systemic risk that may guide investors in designing risk management strategy and adopting efficient macroeconomic policies.

Biographical Notes

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Conflicts of interest

The authors declare no conflict of interest.

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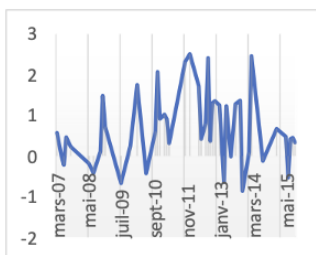
Appendix

Table 4. Risks Rankings of Tunisian Listed Financial Institutions over the Pre-Revolution and Post-Revolution Periods

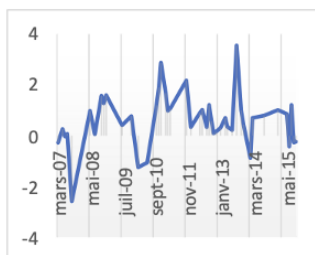
Pre-Revolution								
March 2007	SRISK	%	May 2007	SRISK	%	June 2007	SRISK	%
AB	109,329	33,77	BNA	207,587	35,34	BNA	214,299	36,72
BT	102,319	31,61	STB	119,814	20,40	STB	118,324	20,27
STB	65,959	20,37	AB	115,667	19,69	BT	104,253	17,86
TUNINVEST	28,461	8,79	BT	103,639	17,64	AB	103,728	17,77
ATL	11,538	3,56	TUNINVEST	29,285	4,99	TUNINVEST	31,589	5,41
CIL	6,131	1,89	ATL	11,393	1,94	ATL	11,434	1,96
July 2007	SRISK	%	September 2007	SRISK	%	May 2008	SRISK	%
BNA	225,773	37,23	BNA	216,326	35,86	BNA	255,856	34,43
STB	134,569	22,19	STB	138,400	22,94	STB	202,781	27,28
AB	109,478	18,06	AB	113,060	18,74	BT	124,656	16,77
BT	105,055	17,33	BT	104,324	17,30	AB	118,421	15,93
TUNINVEST	31,482	5,19	TUNINVEST	31,087	5,15	TUNINVEST	41,510	5,59
July 2008	SRISK	%	October 2008	SRISK	%	November 2008	SRISK	%
BNA	270,937	34,50	BNA	252,286	35,31	BNA	259,025	34,83
STB	235,105	29,94	STB	197,814	27,68	STB	213,031	28,65
BT	122,661	15,62	BT	119,566	16,73	BT	120,669	16,23
AB	114,193	14,54	AB	101,914	14,26	AB	109,889	14,78
TUNINVEST	42,399	5,40	TUNINVEST	42,962	6,01	TUNINVEST	41,0189	5,52
December 2008	SRISK	%	July 2009	SRISK	%	November 2009	SRISK	%
BNA	247,737	34,10	STB	183,335	31,26	STB	122,349	28,54
STB	213,212	29,35	BNA	127,840	21,80	BT	100,913	23,54
BT	121,425	16,71	AB	112,940	19,26	BNA	90,273	21,06
AB	103,974	14,31	BT	104,490	17,81	AB	57,728	13,47
TUNINVEST	40,112	5,52	TUNINVEST	57,940	9,88	TUNINVEST	57,424	13,40
February 2010	SRISK	%	June 2010	SRISK	%	October 2010	SRISK	%
STB	142,025	28,16	STB	162,287	51,52	TUNINVEST	84,005	66,12
BT	136,668	27,10	TUNINVEST	82,979	26,34	STB	43,052	33,88
AB	81,287	16,12	BNA	48,819	15,50	AB	10,785	8,49
TUNINVEST	80,006	15,87	AB	20,941	6,65			
BNA	64,306	12,75						
Pre-Revolution						Post-Revolution		
November 2010	SRISK	%	December 2010	SRISK	%	February 2011	SRISK	%
TUNINVEST	84,139	68,85	TUNINVEST	83,942	49,53	STB	290,976	38,93
STB	38,066	31,15	STB	65,196	38,47	BNA	228,446	30,56
			BNA	20,331	12,00	TUNINVEST	102,925	13,77
						AB	89,251	11,94
						BH	35,840	4,80

Post-Revolution								
March 2011	SRISK	%	April 2011	SRISK	%	November 2011	SRISK	%
STB	303,268	40,95	STB	320,762	39,71	STB	290,990	39,16
BNA	204,471	27,61	BNA	218,944	27,11	BNA	170,941	23,00
TUNINVEST	103,087	13,92	TUNINVEST	103,277	12,79	TUNINVEST	101,597	13,67
AB	77,711	10,49	AB	95,899	11,87	BH	90,742	12,21
BH	52,040	7,03	BH	68,803	8,52	AB	88,884	11,96
January 2012	SRISK	%	May 2012	SRISK	%	June 2012	SRISK	%
STB	363,837	37,29	STB	347,465	42,45	STB	367,671	43,45
BNA	225,1205	23,07	BNA	236,518	28,90	BNA	236,093	27,90
AB	145,864	14,95	BH	125,783	15,37	BH	133,558	15,78
STB	392,786	38,09	STB	366,295	52,96	STB	390,973	39,31
BNA	313,405	30,39	BNA	320,056	46,27	BNA	306,287	30,80
BH	216,180	20,96	BH	215,493	31,16	BH	185,615	18,66
TUNINVEST	108,920	10,56	TUNINVEST	109,881	15,89	TUNINVEST	111,620	11,22
April 2013	SRISK	%	May 2013	SRISK	%	July 2013	SRISK	%
STB	421,933	40,27	STB	426,053	40,71	STB	442,213	41,84
BNA	304,029	29,02	BNA	305,169	29,16	BNA	298,951	28,29
BH	210,152	20,06	BH	205,618	19,65	BH	204,610	19,36
TUNINVEST	111,572	10,65	TUNINVEST	109,688	10,48	TUNINVEST	111,038	10,51
September 2013	SRISK	%	November 2013	SRISK	%	December 2013	SRISK	%
STB	447,050	41,42	STB	434,449	41,49	STB	451,160	41,15
BNA	309,984	28,72	BNA	318,501	30,41	BNA	336,326	30,68
BH	210,693	19,52	BH	184,475	17,62	BH	198,900	18,14
TUNINVEST	111,519	10,33	TUNINVEST	109,765	10,48	TUNINVEST	109,914	10,03
March 2014	SRISK	%	April 2014	SRISK	%	September 2014	SRISK	%
STB	470,709	37,20	STB	475,906	37,05	STB	487,127	36,09
BNA	375,983	29,72	BNA	379,239	29,53	BNA	416,087	30,82
BH	303,026	23,95	BH	313,274	24,39	BH	313,775	23,24
TUNINVEST	115,563	9,13	TUNINVEST	115,947	9,03	AB	16,022	1,19
						TUNINVEST	116,925	8,66
March 2015	SRISK	%	July 2015	SRISK	%	August 2015	SRISK	%
STB	461,598	32,99	BH	305,033	42,13	BH	315,136	41,15
BNA	332,385	23,75	TUNINVEST	244,491	33,77	TUNINVEST	244,288	31,90
BH	323,136	23,09	BNA	174,538	24,11	BNA	206,338	26,95
TUNINVEST	244,859	17,50						
AB	37,335	2,67						
September 2015	SRISK	%	October 2015	SRISK	%	November 2015	SRISK	%
BH	347,051	42,13	BH	348,693	41,55	BH	346,505	38,44
TUNINVEST	244,345	29,66	TUNINVEST	244,673	29,16	BNA	269,163	29,86
BNA	232,286	28,20	BNA	243,683	29,04	TUNINVEST	244,762	27,15
			AB	2,088	0,25	AB	36,474	4,05
						ATB	4,599	0,51

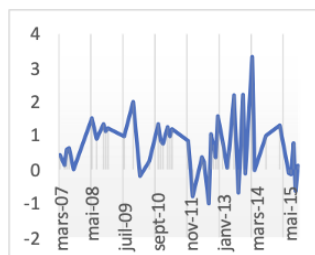
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BNA	332,385	23,75	TUNINVEST	244,491	33,77	TUNINVEST	244,288	31,90
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BNA	232,286	28,20	BNA	243,683	29,04	TUNINVEST	244,762	27,15
			AB	2,088	0,25	AB	36,474	4,05
						ATB	4,599	0,51



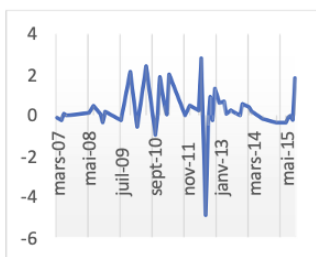
DCC conditional correlation AB - TUNINDEX



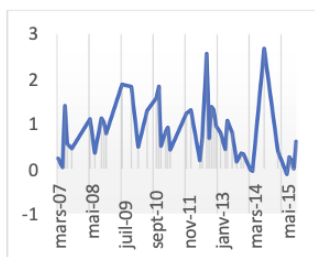
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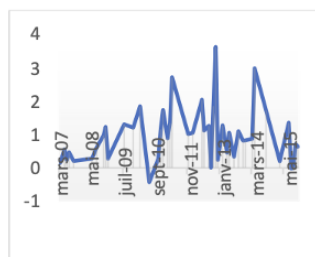
DCC conditional correlation ATTIJARI BANK - TUNINDEX



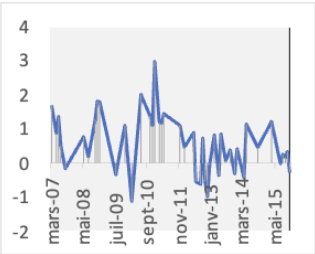
DCC conditional correlation ATTIJARI LEASING - TUNINDEX



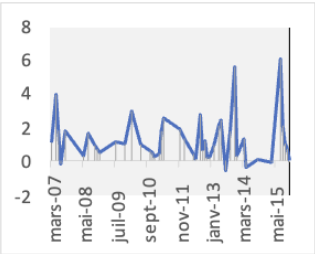
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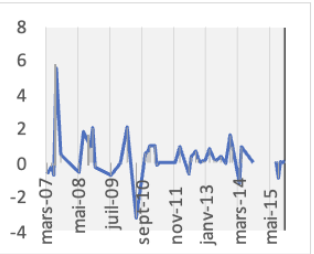
DCC conditional correlation BIAT - TUNINDEX



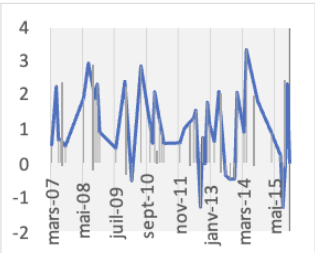
DCC conditional correlation CIL - TUNINDEX



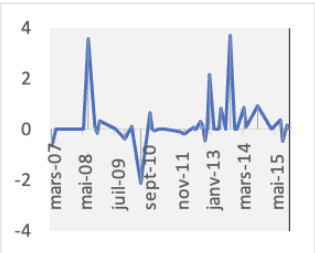
DCC conditional correlation STB - TUNINDEX



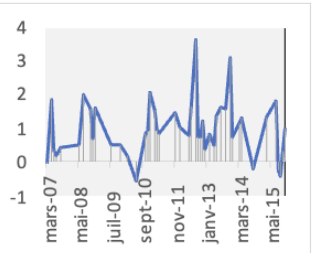
DCC conditional correlation TUNINVEST - TUNINDEX



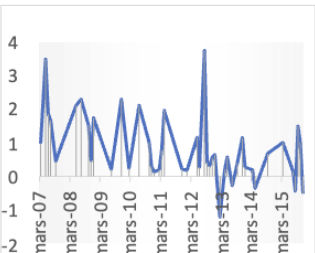
DCC conditional correlation TUNISIE LEASING - TUNINDEX



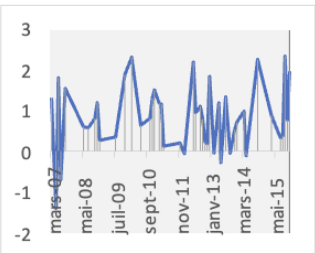
DCC conditional correlation ASTREE - TUNINDEX



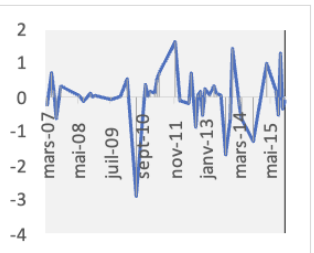
DCC conditional correlation ATB - TUNINDEX



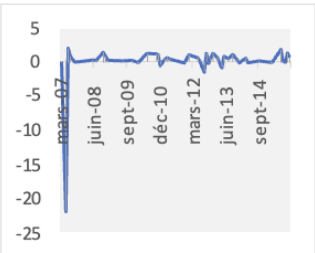
DCC conditional correlation BH - TUNINDEX



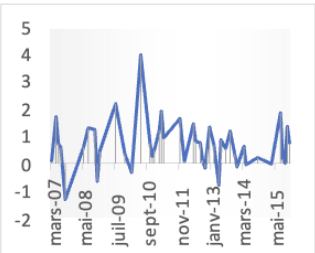
DCC conditional correlation BNA - TUNINDEX



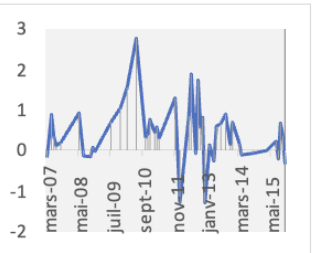
DCC conditional correlation BTE - TUNINDEX



DCC conditional correlation SPDIT - TUNINDEX



DCC conditional correlation STAR - TUNINDEX



DCC conditional correlation UBCI - TUNINDEX

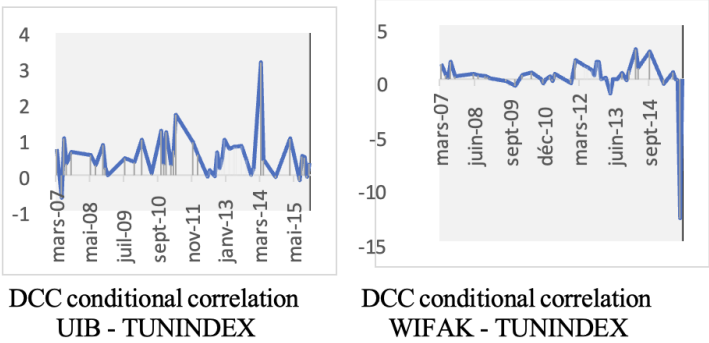


FIGURE 2.1 DCC CONDITIONAL CORRELATION BANKS - TUNINDEX

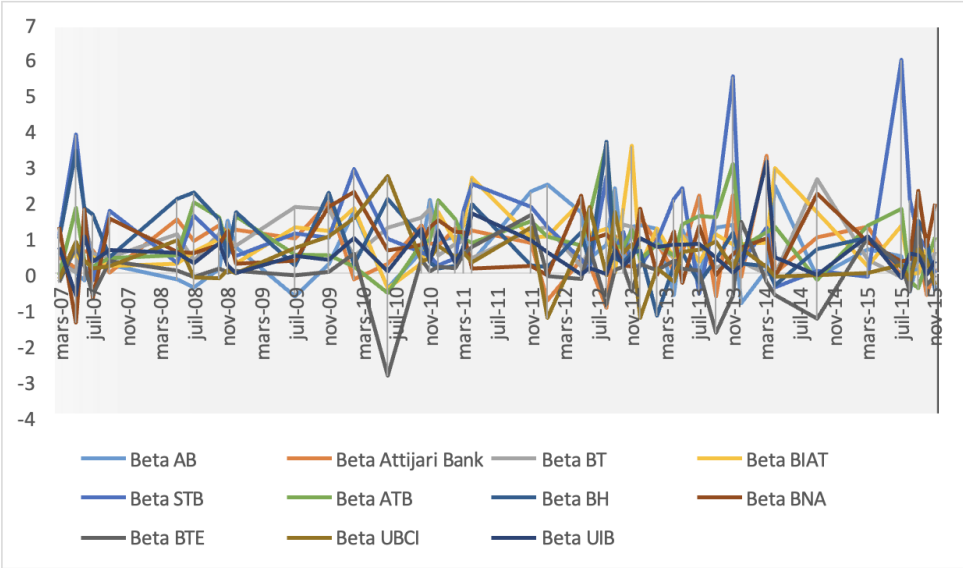


Figure 2.2 DCC CONDITIONAL CORRELATION LEASING COMPANIES - TUNINDEX

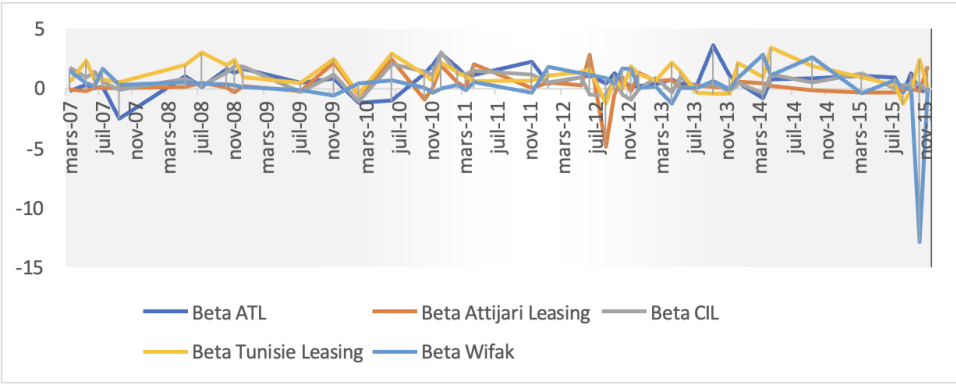


FIGURE 2.3 DCC CONDITIONAL CORRELATION INSURANCE COMPANIES - TUNINDEX

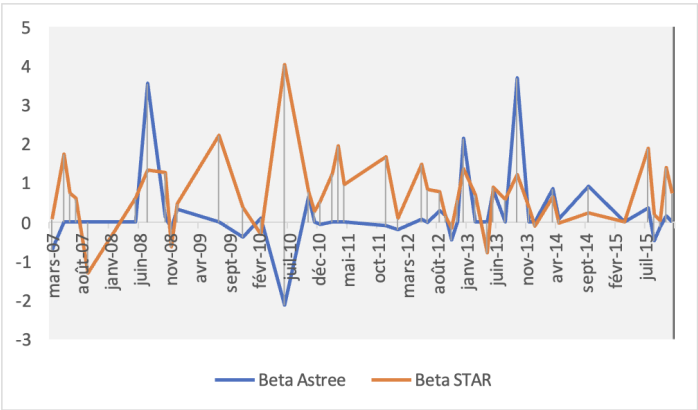
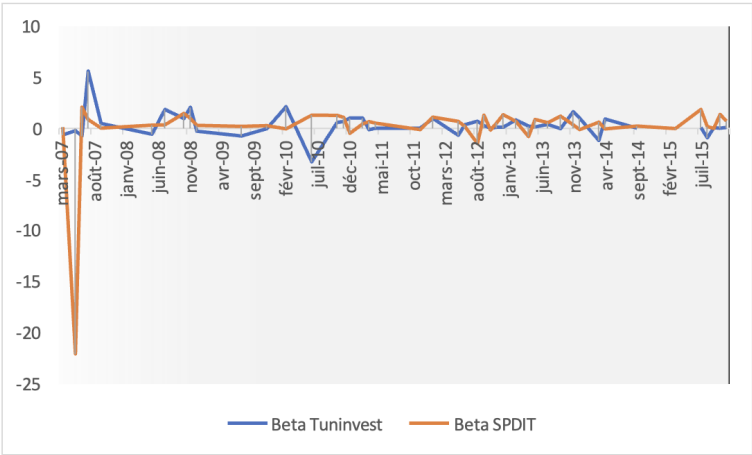


FIG 2.4 DCC CONDITIONAL CORRELATION FINANCIAL INVESTMENT COMPANIES - TUNINDEX



Source: Authors' estimates