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Developing vulnerability index for MENA Region.

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Abstract

Financial crises like the subprime crisis in particular have brought attention to the possible threats to the stability of the financial system and the necessity of tighter oversight. However, there is still much to learn about financial stability, and its precise definition is elusive. This work's goal is to identify the financial systems' vulnerabilities in a number of MENA nations, including Morocco, Egypt, Palestine, Kuwait, Bahrain, Turkey, Lebanon, and the United Arab Emirates.

The detection of financial system fragility was achieved by developing three vulnerability indices : the BSFI vulnerability index proposed by Kibritcioglu (2003), the banking system vulnerability index used by the Swiss National Bank, and the third indicator proposed in this work by the Romanian National Bank (Albulescu, 2010), which differs from the previous two indices by incorporating several variables indicating changes in both the real and financial spheres.

The results from the calculations and analyses of the three indices proposed in our study led us to the following conclusions : Bahrain and Kuwait experienced financial turbulence during the 2008 crisis. Palestine and Lebanon experienced fragility during the period of 2011 and 2012, likely due to the political conflicts faced by both countries, though they were not spared from the extent of the 2008 financial crisis. Regarding the financial system in Turkey, the three indices detected financial turbulence during the monetary crisis that hit the Turkish economy in 2000-2001. The Egyptian financial system experienced a period of high financial stress during the international financial crisis of 2008. As for Morocco, the Moroccan banking and financial system encountered three periods of vulnerability detected by the vulnerability indices : the financial turbulences of 2000 and those of 2008 were detected by both the BFSI and ISF indices, as well as that of 2013, detected by the three indices ISF, BSFI, and IASF.

Keywords : *Vulnerability Index ; Banking Fragility ; Financial Crises ; The MENA Region*

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Introduction

Financial stability seems difficult to define and assess. This is due to the interdependencies and complex interactions characterizing the financial system itself and its linkages with the real economy. The European Central Bank (ECB, 2007) defines financial stability as the capacity of the financial system to absorb shocks and to mitigate their consequences on the process of financial intermediation. This definition has led analysts to focus their attention on the risks and vulnerabilities that are threatening a financial system. In this regard, several techniques have been developed to study financial stability. Among these different techniques, there are three that are used in the literature and by Central Banks as well, namely macro-stress tests, early warning systems and financial stability indices which are the main object of this article, although these techniques are usually complementary.

Financial stability indices are based on the aggregation of several economic and financial indicators in order to grasp financial stability in its broadest possible definition, and to capture different facets of financial vulnerabilities. Furthermore, indicators such as those of financial soundness developed by the IMF (Financial Soundness Indicators - FSI), are generally used in the literature to monitor the health of a financial system. Also, Central Banks have constructed aggregate indices to analyze the stability of their country's financial systems and provide input into their financial stability reports.

In the present article, we have chosen three types of indices, which will be studied in depth in this section. The first index (BFSI) and that of Kibricioglu (2003) for a panel of countries, aims to identify high tension situations in the banking system through the monthly examination of three banking variables which constitute proxies for three types of risk namely liquidity risk, currency risk and credit risk.

The second indicator is the banking system vulnerability index (ISF), suggested by the National Bank of Switzerland, which is based on variables that track the evolution of two major components of the financial system, namely : the banking sector and financial markets. The upward or downward trend of this indicator is interpreted as a situation of financial stress.

The last indicator proposed in this article is the one of the Bank of Romania (Albulescu 2010). It differs from the two previous ones since it incorporates several variables indicating the evolutions of the real and financial spheres. This index is obtained from four sub-indices related to several dimensions of financial stability : the financial development sub-index, the financial vulnerability sub-index, the financial soundness sub-index and the business climate. Several

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reasons allowed us to choose the MENA countries as an example the scarcity of studies elaborated in this sense, and also these countries are characterized by political instability, armed conflicts, revolutions, regime changes and international tensions.

The objective of this article is to analyze the sources of vulnerability in the financial systems of some countries in the MENA region through the development of vulnerability indices proposed by the theorists mentioned above. Thus, the rest of this article is organized as follows : the first section is devoted to the review of theoretical and empirical literature ; the second section is dedicated to the presentation of the methodology and indicators used in the construction of the indices. The empirical results are presented in the third section and the final section is reserved for the conclusion.

1. Review of theoretical and empirical literature

1.1. The notion of vulnerability and financial instability

When triggering events interact with vulnerabilities and put stress on the financial system, it can result in extreme cases of financial instability, such as the current financial crisis. A "trigger event" is a negative shock that can create systemic stress if the financial system is sufficiently vulnerable. Vulnerability is defined as a pre-existing condition that can magnify shocks and spread them across the financial system. Financial stability risks can be evaluated in terms of the loss to the financial system that could come from their materialization after a number of vulnerabilities and triggers are recognized, depending on the likelihood of the risk occurring and the estimated impact on the system.

The first appearance of the word vulnerability in the literature dates from the end of the 17th century. For an organisation (civilian or military), vulnerability is a weakness, susceptibility, defect, or gap in a defence system that can endanger the integrity of a system and what it protects, under the action of internal or external constraints. Another definition of financial system vulnerabilities is conditions that increase the likelihood of a resurgence of stress. The level of vulnerability of a financial system depends, among other things, on the particular risks to which it is exposed. Imbalances create vulnerabilities because they expose the financial system to the risk of an abrupt correction and impair its ability to absorb further shocks. Financial vulnerability can be equated with the probability of a systemic failure of the financial system, while at a less severe level it can be equated with the sensitivity of the financial system to relatively small disruptions.

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According to (Illing and Liu, 2006, Grimaldi, 2010), vulnerability or financial stress is a deterioration of financial conditions to endogenous or exogenous shocks. It is associated with increased uncertainty, liquidity and credit risks, information asymmetry, profitability losses, adverse shocks to collateral and deterioration of the balance sheet of one or a set of financial institutions.

Mishkin, (1998), Hakkio and Keeton, (2009), in the aftermath of the 2008 financial crisis, the multiple characteristics of financial vulnerability have led international institutions (IMF, Central Banks, Financial Regulatory Authorities) and researchers to place particular emphasis on assessing the dynamics of financial system imbalances at the micro and macro prudential level, in addition on developing related surveillance tools.

Hanschel and Monnin (2005), proposed to describe vulnerability as: "a continuum of states, wich describe the banking sector's condition at a given point in time". Illing and Liu (2006) consider financial vulnerability to be a continuous variable with a range of possible values and whose extreme points reflect crisis situations. They further argue that vulnerability is the product of structural weakness and the emergence of exogenous shocks. In other words, structural fragility is the ground on which shocks develop into major events that can affect the entire financial system. Other authors prefer to define the vulnerability test rather than vulnerability itself. Thus, Frøyland and Larsen (2002), consider that the role of vulnerability tests is to assess the degree of sensitivity of financial institutions to changes in economic circumstances. As for the definition of vulnerability testing proposed by Sorge and Virolainen (2006), it refers to the estimation of the level of risk generated by the simulation of an exceptional but realistic event.

On the issue of financial instability, it is defined by Andrew Crockett (2000) as "a situation where economic performance may be affected by fluctuations in asset prices or by the failure of a financial institution to meet its contractual obligations". He emphasises four aspects of this definition : the existence of actual economic costs, the importance of the potential disaster and not the importance of actual losses, the consideration of institutions other than banks and, at the same time, the consideration of banks as a very special category of financial institutions. At the same time, Crockett separates between two categories of financial instability : institutional and market instability.

Financial instability is defined by Ferguson (2002), as a market dysfunction or imperfection that negatively affects the real economy. Also, according to the same author, financial

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instability is a situation characterised by a divergence of the prices of a set of financial assets from the availability of credit, which leads to a deviation of the global expenditure from the production capacity of the economy. This notion requires thinking in terms of the impact on the real economy to understand the factors of instability.

Allen and Wood (2006), consider financial instability as a situation where a large number of economic agents (households, firms, governments) simultaneously experience a financial crisis that is not necessarily justified by their past behaviour but that has negative repercussions on the economy. These authors consider that a view of stability that focuses exclusively on banks or financial institutions is too narrow, as the collapse of non-financial firms can also cause damage to the economy. Similarly, the characteristics of episodes of financial instability should not include the efficient allocation of savings to investment, as it is very difficult to judge whether resources have been allocated efficiently in an economy.

According to Fisher's (1933) "debt deflation" theory, excessive economic agent debt and dramatic price swings are to blame for the phenomenon of financial instability. Through this approach, Fisher explains that the indebtedness of agents during the expansion phases of the economic cycle is at the origin of the deflationary process during the recession phases. In periods of strong expansion, investors increase their level of borrowing to finance their projects (financial leverage). This process of borrowing leads to higher prices and lower real value of debt and further encourages an over-indebtedness situation. The change in the perception of risk on the part of investors leads them to sell their assets massively in order to repay the debts incurred. These sales lead to a fall in asset prices and cause an appreciation in the real value of the debt, which requires further asset sales. Thus, through the mechanism of debt deflation, the fall in prices becomes even more exacerbated, leading to a crisis marked by a contraction in economic activity.

Even while the episodes of economic instability do not have the same dynamic range and ex-post impacts, according to Kindleberger (1978), they are characterized by a comparable sequence of stages. In fact, there are three steps that precede financial crises. Indeed, banking crises are caused by three phases. The first stage consists of the exit from a period of recession to a phase of growth fuelled by a credit boom and a massive purchase of financial assets in connection with optimistic expectations of economic agents. This leads to a rise in asset prices away from their fundamental and intrinsic values. The second phase begins as soon as agents' balance sheets show high levels of indebtedness and is characterized by a reversal of economic

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agents' confidence and a change in perception and aversion to risk. Thus, declines in asset prices begin to be recorded, leading to a decrease in the collateral held by financial companies. The logical response of agents is to accelerate more liquidity by rushing sales operations while accepting large losses. In the final stage, this situation leads to deflation, which increases the level of agents' real debts and ultimately leads to a financial crisis.

Minsky's (1982) 'financial instability hypothesis' links the financial fragility of capitalist economies to the downturn in the business loop. During the early stages of the economic cycle, firms increasingly resort to debt to support their investment projects. The acceleration of the debt process creates a shift in the financial structure of economic agents from a robust structure to one weakened by over-indebtedness and speculation. In this respect, Minsky identifies three categories of companies : hedge finance companies that do not take financial risks, speculative finance companies and companies that continually refinance themselves to repay their debt (Ponzi Finance). Thus, during a credit boom, rising interest rates put over-indebted companies (speculative and ponzi) in a difficult situation, prompting them to liquidate their assets, which are no longer sufficient to pay the interest and principal on their debts. This situation leads to a collapse in financial asset prices, which in turn heralds the economy's entry into a phase of financial instability.

Mishkin (1991) explains financial instability as imperfections in financial markets. These imperfections can manifest themselves in the form of asymmetric information between lenders and borrowers. In the same sense, financial instability arises when shocks affect the financial system by significantly aggravating the problems of information asymmetry and prevent the financial system from fulfilling its role of channelling savings to investment. In this framework, Mishkin (1991) describes two forms of information asymmetry : adverse selection and moral hazard. Adverse selection is defined as a situation where one party in a market is unable to assess the quality of the other party to the transaction. For example, those who actively seek financing are those who have risky projects and will accept credit even at high rates. As a result, lenders may wrongly favour their cases. The moral hazard problem arises after the contract, describing the risk to the creditor when the borrower decides to increase his risk-taking to a level that is inconsistent with his commitments to the lender. For example, a distressed borrower has an incentive to invest in risky projects in which the lender will have to bear most of the losses if the project fails.

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1.2. Approaches to quantifying financial vulnerability (Early warning systems EWS)

The financial crises that have hit most of the world have highlighted the need to consider the fragility of the financial system. Thus, financial instability has become the Achilles heel of contemporary capitalism. In this sense, it is wise to get to know the warning indicators. The latter concept has been defined by B.G. Hermosillo (1999) as signals that can anticipate disturbances and the occurrence of crises. Such a definition may lack depth. In this case, it is of paramount importance to illuminate the various facets of the definition. A.R. Ghosh, J.D. Ostry and N. Tamirisa consider warning indicators as a set of tools to signal triggers and emerging vulnerabilities in a system. Following this line of thought, the various triggers for such vulnerabilities often refer to the build-up of a credit or asset price bubble, a balance sheet mismatch (too much borrowing in foreign currencies, with too short maturities, or with insufficient capitalisation), but the trigger can also take the form of any exogenous event such as political unrest, terms of trade shock, contagion, or, more recently, a financial market collapse.

Early warning systems allow for the early identification of difficulties in the economy, using indicators that emit signals, facilitating the rapid adoption of crisis prevention measures. They can be described as "a set of processes, procedures, models, indicators, etc., that synthesize the information and data needed to identify financial institutions at risk and the risks affecting them, their customers, other financial institutions and the financial system as a whole, and that make it possible to anticipate the occurrence of a future crisis" (Lutton, 2006).

Early warning systems (EWS), for example, are based on key indicators that are selected according to their predictive power to forecast the likelihood of a financial crisis occurring. They were initially used to forecast foreign exchange crises (Calvo et al 1993), and their application has expanded to all components of the monetary system. In order to detect financial fragility, researchers at the Bank for International Settlements (BIS) suggest, for example, monitoring a few simple indicators such as the ratio of credit to gross domestic product (GDP), as well as its evolution from one period to another or a deviation from a historical norm. While EWS are a crucial tool for analyzing financial stability, they do not allow for an accurate diagnosis of the vulnerabilities of the financial system.

In addition, these early indicators are generally used for their ability to predict the occurrence of a crisis, but they may also have another purpose. In order to identify the most vulnerable

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banks, regulators also use these techniques. In this case, there are internal processes for assessing the banking model that take place on-site, as well as external (off-site) processes for synthesizing information and data. Such an approach combines features of discriminant analysis (identifying weak banks according to certain criteria) with elements of stress testing (assessing internal models and the impact of shocks).

There is an extensive literature on early warning systems and financial crisis forecasting (Kaminsky et al 1998; Gaytan and Johnson, 2002; Davis and Karim, 2008). In a multinomial logit model, Angora and Tarazi (2011) examined the four phases of banking crises in the WAEMU: pre-crisis, crisis, crisis duration and post-crisis. In 2014, Doucouré and Sene developed a banking stress index that ignores the asset quality and financial sensitivity of banks to external shocks. These authors do not specify at what level the index or these additional explanatory factors may exhibit behaviors that may lead to financial stress in the banking sector. Frankel and Saravelos (2012) and Rose and Spiegel (2011), respectively, considered 50 and 60 potential variables in an early warning model. However, the majority of the variables were found to be insignificant. In contrast, Balecky et al (2012) demonstrated using a PVAR that the domestic credit/GDP ratio is the most effective early warning indicator of banking crises in 40 developed economies between 1970 and 2010. Deviation of this ratio by at least 2% from its long-term trend can therefore be interpreted by policymakers as a warning signal. In addition, Balecky et al (2012) point to other important risk factors, such as rising FDI and market interest rates and global economic booms (rising global GDP and inflation), as worth monitoring.

Because of this predictive capacity of early warning indicators, many investment banks use these methods (Abiad, 2003). In other words, these methods can also be used by individual institutions. The time horizon used by the private sector is shorter and the assumptions are somewhat different, yet it is useful to take these results into consideration when analysing the vulnerability of the financial system (Berg et al. 2005).

As we have seen, the majority of studies use early warning indicators to assess systemic vulnerabilities and determine the likelihood of a crisis occurring. This methodology includes two broad categories of EWS: the sign method (signal-based approach) and likelihood or probit models (limited dependent variable). The majority of studies examine both approaches to compare their results. The possibility of using the results of the first method to improve the accuracy of the results of the second method is another reason why the two procedures are studied together.

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1.3. Vulnerability indices :

Financial vulnerability indices are based on the aggregation of several economic and financial indicators in order to capture financial stability in its broadest possible definition, and to capture the different facets of fragilities in financial systems. Thus, indicators such as the Financial Soundness Indicators (FSI) developed by the IMF are generally used in the literature to monitor the health of a financial system. 1In addition, central banks have constructed aggregate indices to analyse the stability of their countries' financial systems and to feed into their financial stability reports. Examples include the Regional Fed's FSI [2], the ECB's CISS [3,] the Bank of England's FSI [4]and the FSI in Romania. In Morocco, Bank Al-Maghrib has also developed, since 2018, a financial stability index (FSI) to monitor financial vulnerabilities, guide its macro-prudential action and feed into the work of the Systemic Risk Coordination and Supervision Committee (CCSRS). The index is described in Box 9 of Bank Al-Maghrib's "Financial Stability Report - Fiscal Year 2018".

Kaminsky (1999) has developed three composite indices of financial fragility. The first index is a simple aggregation of all indicators that signal a crisis. The second is calculated on the basis of the magnitude of the signals by setting a second threshold for the extreme values of each individual indicator. In contrast, the third composite index aims to represent the progression of deteriorating fundamentals by adding signals from the recent past. Finally, these indices are calculated as the average of each explanatory variable, and they are used to calculate crisis probability measures. El-Shazly (2002) used this strategy for Egypt, while Christensen and Liu (2014) used it for 13 OECD economies. In contrast to these authors, Borio and Love (2002) use only composite indicators of variables including asset prices, exchange rates and credit.

In addition, Ali ARI and Rustem Dagtekin (2000), examined the Turkish financial crisis of 2000-2001 using the two approaches listed below: First, they use an approach based on leading indicators. Then, they developed a new generation crisis indicator that combines the macroeconomic and microeconomic elements of the crisis. Indeed, third generation currency crises usually combine weak economic fundamentals with fragility of the financial system, especially the banking sector. Following the example of Eichengreen et al (1995), Sachs et al (1996), Kaminsky et al (1997), Cartapanis et al (1998, 2002), Dagtekin (2002) and Abiad (1999,

[1] International Monetary Fund, "Financial Soundness Indicators : Compilation Guide 2019".

[2] Bisias et al, 2012, "A Survey of Systemic Risk Analytics", OFR wp 0001

[3] Hollo, Kremer, ET Lo Duca, 2012, "CISS - A Composite Indicator of Systemic Stress in the Financial System", ECB WP No 1426.

4 Chatterjee et al, 2017, "A Financial Stress Index for the United Kingdom", Bank of England wp no

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2003), the first part of their crisis indicator consists of changes in the real exchange rate, the stock of foreign reserves (minus the country's gold reserves) and the real interest rate. The third risk indicator for the banking system that can be found in an aggregated form by Kibritcioglu is mentioned in the second part of the crisis indicator (2002). They conclude that the crisis indicator is increasingly high as the amount of credit extended to the private sector by the banking system increases, liabilities to the private sector increase, and deposits in the banking system fall considerably.

Economies in early 1997, including Thailand, the Maldives and Korea. The same type of finding was made for Mexico and Argentina before the 1994 financial crisis.

In his 2003 paper, Kibricioglu proposed an indicator of financial vulnerability based on three key criteria, which reflect three different types of risk, including liquidity risk and bank panic, foreign exchange risk and credit market bubble risk. Illing et al (2005) create a stress index for the Canadian monetary system. This is based on data from various components of the financial system, including the foreign exchange market, the bond market, the equity market and financial data from the banking sector. Hanschel et al (2004), present a financial system stress indicator composed of several families of variables. They therefore chose to focus on the compilation of financial system accounting data as well as market data, non-public information on the state of selected banking institutions and information on the architecture of the financial system.

In addition, the International Monetary Fund (IMF) has calculated a composite indicator of macroeconomic vulnerability based on three variables : the real rate of change, domestic credit growth and the ratio of M2 to international reserves. The calculations are based on the relative volatilities of the three fundamentals, each of which is included in the indicator on the basis of differences from its three-year trend. Calculations for six Asian and four Latin American countries were made between November 1993 and November 1997. The indicator showed increasing vulnerability in the vast majority of Asian.

2. Adopted methodology :

The description of the chosen approach, to develop vulnerability indices of the financial system of the MENA zone, will be based on the three techniques that we have identified in the previous paragraph. Before providing a detailed description of the different methods, we can summarize these three approaches in the following table :

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Tabl N°1 : CHARACTERISTICS OF INDICES

Indices	Variables	Characteristics
Sub index of Illing and Liu	Sensitivity of the banking index to movements of the market index	- Requires the presence of a bank index - Assumes an informational efficiency of the financial market - Reduces risk to a single unit of risk
Index of Illing and Liu and of Hanshel and Monnin	An aggregate index that depends on a combination of balance sheet, economic and financial variables	- Any positive development indicates a fragility of the system
Indice de Kibritcioglu	Composer de trois variables, les dépôts, les crédits et les capitaux étrangers	

Source : Developed by the author.

Once the different indices are calculated, the choice will be made either by elimination, or by using a combination of indices. First, we will define the different indices succinctly. Secondly, we will be able to apply these different indices to the MENA banking sector.

We have chosen three types of indices, already mentioned in Table 1, which will be studied in depth in this section, knowing that developing economies cannot use the models that are adopted within developed countries. Due to lack of divergence in terms of activity[5]. We start with the Kibritcioglu index, followed by that of Illing and Liu index of first generation (sub-index), and last but not least the Hanshel and Monnin and Illing and Liu index.

The BSFI indicator proposed by Kibricioglu (2003) for a panel of countries. Its objective is to identify situations of high stress in the banking system through the monthly examination of three banking variables which constitute proxies for three types of risk :

[5] In developed countries, market activities are very important and banking results are correlated with them. This is not the case in developing countries where intermediation activities are more dominant. These different indices have been elaborated in favor of developing countries (such as Brazil, Chile, Tunisia, Mexico, Kenya …. etc.)

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- The risk of liquidity and bank panic
- Credit risk and speculative bubbles
- Currency risk.

Three variables are used in the construction of the BSFI to describe the evolution of the banking risks in question ; customers' deposits "DP" (liquidity and bank run risk), loans to the private sector "CSP" (lending boom) and currency liabilities "PD" (exchange rate risk). The banking and financial crises are mainly due to the materialisation of these risks. Thus, this indicator will ensure effective monitoring of the banking system and describe the changes affecting its degree of fragility.

The BSFI index takes the following form[6] :

$$BSFI_t = \frac{\left(\frac{CCSP_t - m_{ccsp}}{\sigma_{ccsp}}\right) + \left(\frac{CDP_t - m_{cdp}}{\sigma_{cdp}}\right) + \left(\frac{CPD_t - mc_{pd}}{\sigma_{cpd}}\right)}{3}$$

où

$$CCSP_t = \left(\frac{CSP_t - CSP_{t-4}}{CSP_{t-4}}\right)$$

$$CDP_t = \left(\frac{DP_t - DP_{t-4}}{DP_{t-4}}\right)$$

$$CPD_t = \left(\frac{PD_t - PD_{t-4}}{PD_{t-4}}\right)$$

With:

$CCSP_t$: Year-on-year growth rate of loans to the private sector,

CDP_t : Year-on-year growth rate of bank deposits,

CPD_t : Year-on-year growth rate of foreign currency liabilities,

[6] The author proposes another indicator (BSFI*) that does not include the risk of banking panic.

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The variables that are included in the construction of the index have been standardized. Thus, any upward deviation can be interpreted as excessive risk-taking on the part of the banking system and which can lead, in case of shock, to a banking crisis which translates into a rapid fall in the BSFI. However, it should be noted that a drop in this index does not necessarily mean that the banking system is in a recession period or financial crisis, it is very likely that the latter will only register medium fragility.

Two phases of fragility can therefore be identified through the analysis of this index :

- If -0.5 $\prec$ BSFI $\prec$ 0: presence of medium fragility;
- If BSFI $\leq$ -0.5: the banking system is very fragile.
    - Phase 1: is characterized by excessive risk-taking that can lead to a systemic crisis. This situation is mainly due to the optimistic interpretation of the growth prospects which are often associated with massive over-indebtedness of economic agents.
    - Phase 2: during this phase, banks behave less risky and attentive to economic developments. The decline in the indicator shows that the fragility of the banking system tends to increase and the probability of a bank run occurrence is quite high.
    - Phase 3: this situation reflects an average fragility of the banking system since the indicator is negative, which means that the system is on the verge of a systemic crisis.
    - Phase 4: below -0.5 the indicator informs on strong financial fragility and the high probability of a financial crisis.
    - Phase 5: the banking system comes out of a stress period of and risk aversion decreases.

The vulnerability index of the banking system used by the National Bank of Switzerland is based on variables that track the evolution of two major components of the financial system, namely : the banking sector and the financial markets. The upward or downward trend in this indicator is interpreted as a situation of financial stress.

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Based on a history of financial crises, Hanschel et al. (2002) chose several variables capable of predicting and describing situations of financial stress. In this article, the following variables were involved in the construction of the composite index : the stock market index, the spreads of yields of bonds issued by banks, provisions on bad debts, interbank deposits, return on assets (ROA), bad debts and two variables related to the evolution of the banking system structure[7]. The proposed index takes the following form :

$$ISF_t = \sum_{i=1}^{n} \frac{X_{it} - \overline{X_i}}{\sigma_i}$$

With : X_{it} : variables comprising the index

The last indicator proposed in this article is the one by the Bank of Romania (Albulescu 2010). It is different from the two previous indices since it includes several variables indicating the evolutions of the two real and financial spheres. This index is obtained from four sub-indices related to several dimensions of financial stability :

- Financial development
- Financial vulnerability
- Financial soudness
- Global business climate

The financial development traces the evolution of the financial system and the risk of being exposed to speculative bubbles due to excessive optimism among economic agents. Financial vulnerability refers to changes in macroeconomic aggregates and to the various indicators proposed by the IMF. The third sub-index relates to the level of the financial system soundness and in particular its banking component, it incorporates the variables commonly used by financial institutions in the assessment of the robustness of the financial system. The last sub-index includes changes in the global economic outlook and therefore incorporates the exogenous vulnerabilities facing the domestic economy.

[7] Rouabah (2007), using a similar approach, added other variables such as customer deposits and others.

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The same approach was adopted for the MENA context. The variables used in the construction of the index are presented in the following table :

Tabl N°2 : Variables used in the index

Index	Variables
Financial development index (IDF)	Capitalisation / GDP
	Total credit / GDP
	Interest rate spread
Vulnerability index (IV)	Budget deficit / GDP
	Inflation rate
	Real effective exchange rate
	Private credit / total credit
	Credit / deposits
	Deposit on M2
	Reserves / deposits
Financial soundness indicators (ISF)	Non-preforming loans rate
	Equity / total assets
Global economy (EM)	GDP growth of partner countries
	Inflation of partner countries

Source : Developed by the author.

The composite indicator takes the following form :

$$IASF_t = \frac{(IDF_t + IV_t + ISF_t + EM_t)}{4}$$

Each variable included in the construction of a sub-index has undergone a transformation to achieve a standardization of measurement scales. Thus, we opted for the following method :

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$$I_{it} = \frac{X_{it} - Min(X_{it})}{Max(X_{it}) - Min(X_{it})}$$

With :

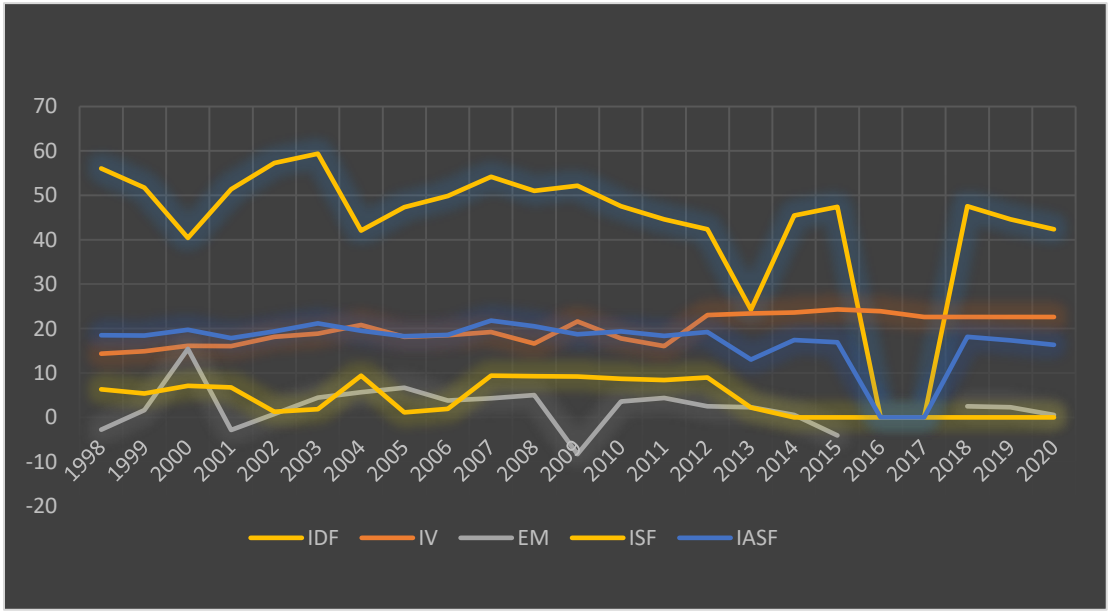
X ^{t} : Variable under study

In addition, for the computation of the sub-indices, the arithmetic mean method was adopted to ensure that the variables involved in the construction of the sub-indices were given an equal weight. However, in the development of the financial stability index (IASF) we opted for two aggregation methods namely : the arithmetic mean and the principal component method.

3. Results Analysis :

(a) Bahrain case

Figure N°1 : graphical representation of the iasf index and the sub-indices for bahrain



Source : Developed by the author.

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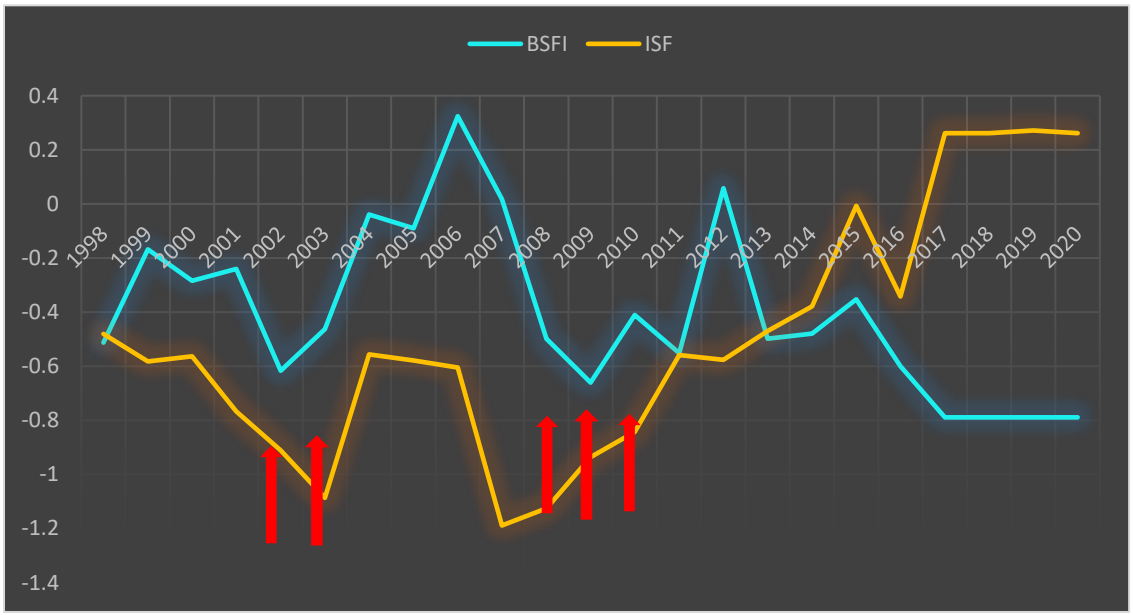
Figure N°2 : Graphical representation of the bsfi and isf index for bahrain



Source : Developed by the author.

The 2002-2003 period (figure 2), was characterized by financial tensions illustrated by a remarkable drop in the BFSI indicator, which is below -0.5, this shows that the Bahrain banking system has experienced a strong fragility, explained by the increase in credit risk and lending boom. Thus, the vulnerability index of the ISF banking system also recorded a significant drop during the same period, which explains why the country's banking system underwent a period of significant financial stress.

Regarding the period from 2008 to 2010, we notice a considerable drop in the BSFI indicator, which is below -0.5 which means that the Bahrain banking system has been so fragile, this period has been characterized by the increase in exchange rate risk, liquidity risk and bank run which coincides with the financial instability experienced by the global economy due to the 2008 subprime crisis. The banking system fragility index ISF also showed a downward trend which means the existence of a financial stress situation.

Figure 1 shows the evolution of the IASF indicator for Bahrain which recorded two periods of financial stress in 2013 and 2016 which are different from the other indices in figure 2. This stress is explained by a significant increase in the sub-index of the financial development.

(b) <u>Kuwait case</u>

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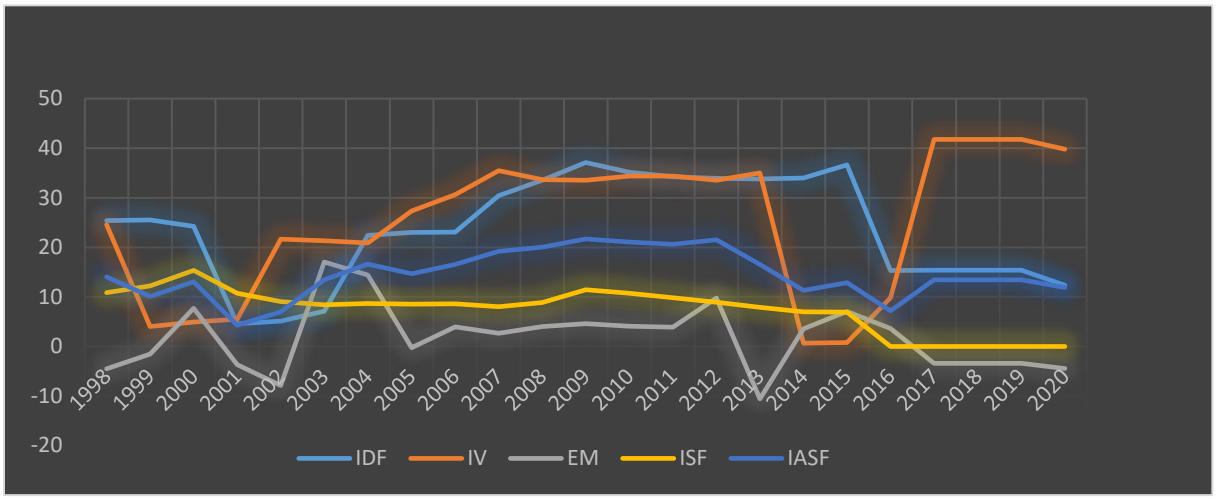
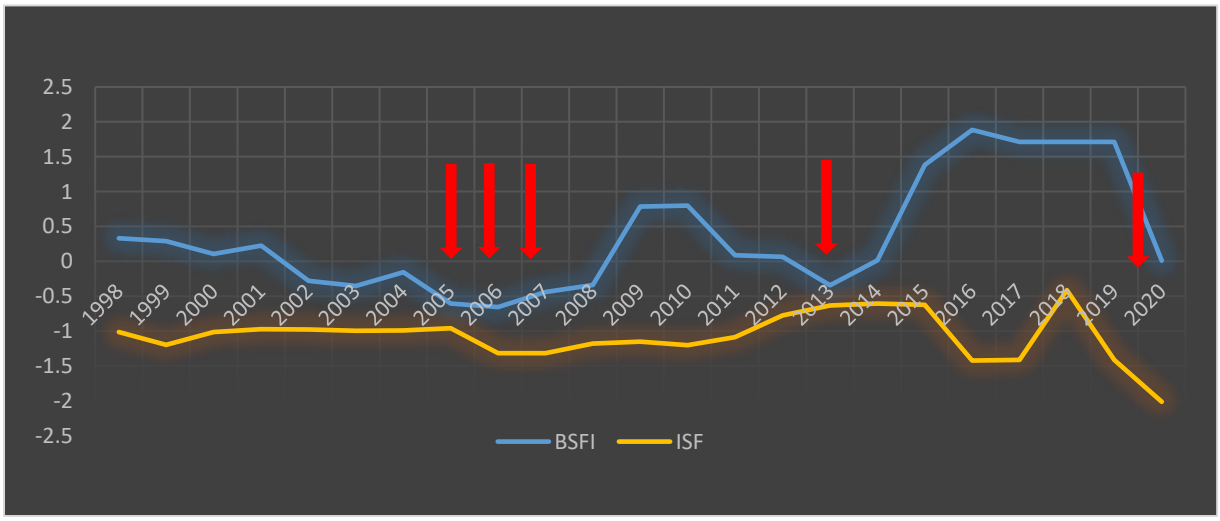
Figure N°3 : Graphical representation of the IASF index for Kuwait



Source : Developed by the author.

Figure N°4 : Graphical representation of the BSFI and ISF index for Kuwait



Source : Developed by the author.

From figure 4, we notice that the BFSI indicator is in a downward trend during the period 2005 - 2008, the latter is below 0, this situation reflects an average fragility of the Kuwait banking system, also the vulnerability index of the banking system ISF recorded a decrease during the same period, this is mainly due to the increase in liquidity risk.

The BFSI and ISF indicators detect a period of financial turmoil in 2013. Regarding the IASF composite indicator, we observe that a period of financial stress appears in 2001 and 2002, this situation coincides with the fall of the sub-indices of financial development (IDF), financial vulnerability index (IV), and the global economy (EM).

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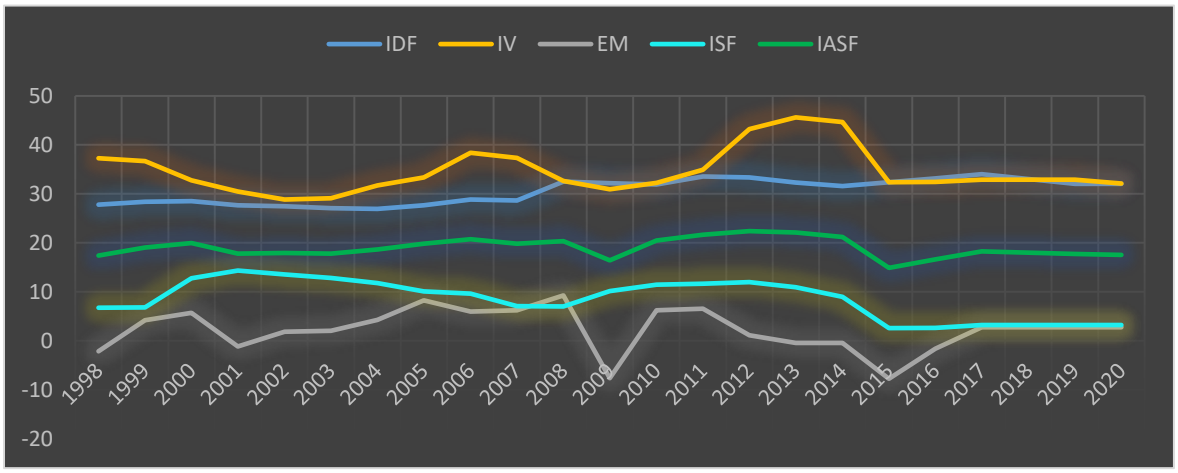
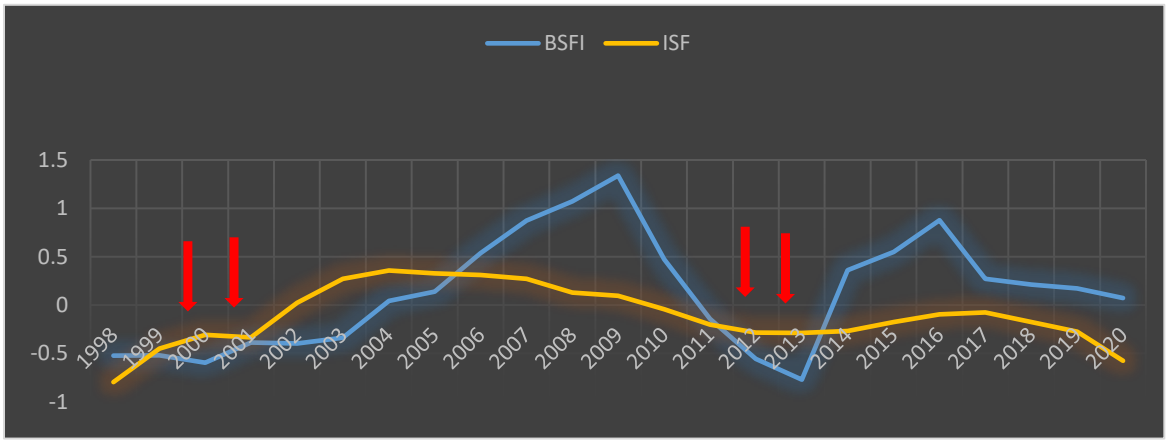
(c) The United Arab Emirates case :

Figure N°5 : Graphic representation of the IASF index and the sub-indices



Source : Developed by the author.

Figure N°6 : Graphical representation of the BSFI and ISF index for the United Arab Emirates



Source : Developed by the author.

The contained evolution of the BSFI and ISF index for the United Arab Emirates confirms that the UAE's banking system has demonstrated resilience during the international financial crisis of 2008. Nevertheless, the index detects a period of moderate financial turmoil between 2000-2001 as well as an episode of tension between 2012-2013. The IASF composite index has detected a vulnerability phase in 2009 due to a significant increase in the EM sub-index which incorporates changes in the global economic outlook facing the domestic economy.

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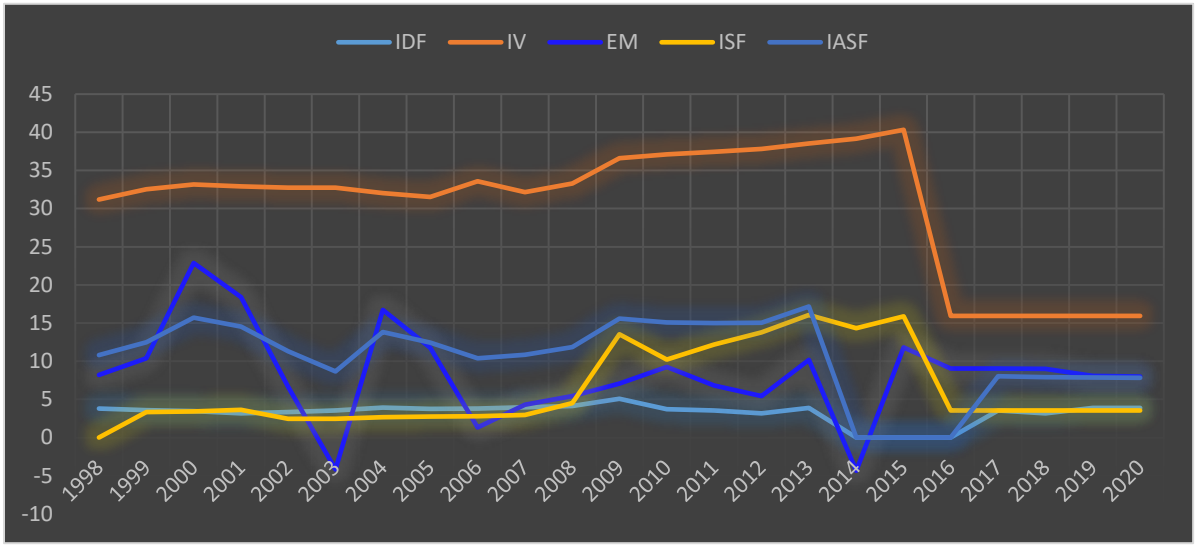
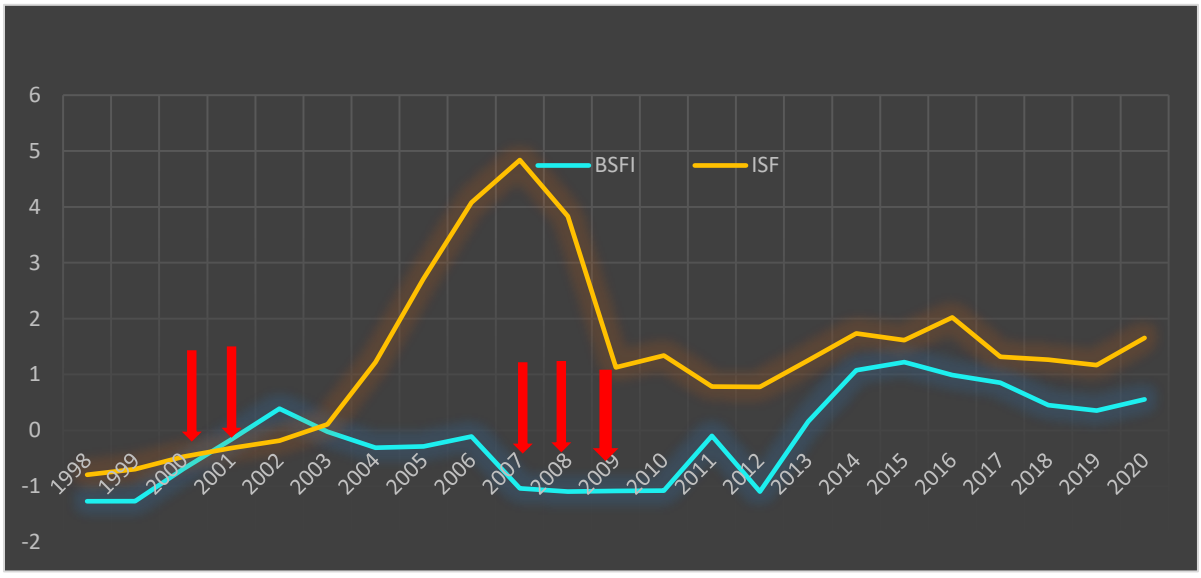
(d) Palestine case :

Figure N°7 : Graphical representation of the aggregate index and the four sub-indices for Palestine



Source : Developed by the author.

Figure N°8 : Graphical representation of the BSFI and ISF index for Palestine



Source : Developed by the author.

The BFSI indicator has detected a strong fragility of the Palestinian banking system 1999-2000. The vulnerability index of the ISF banking system also showed a sign of stress in the same period. The financial stress, contained, between 2007-2010 can be explained by the effects of the international financial crisis that affected the whole world. Similarly, the IASF composite

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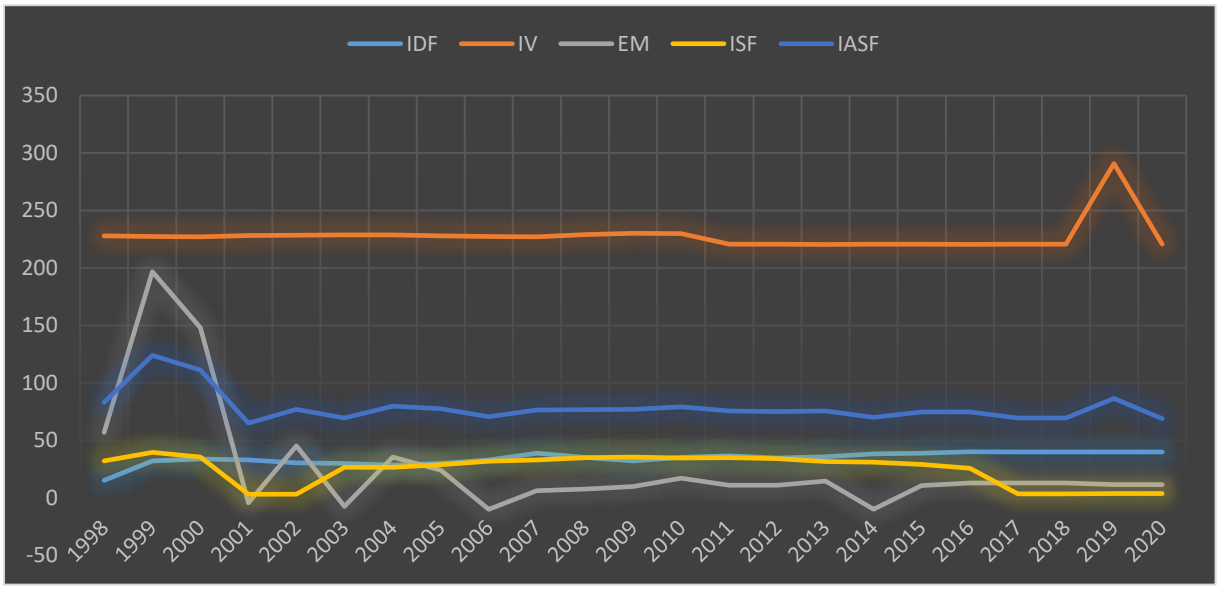
index has detected a period of moderate financial turmoil in the wake of the "subprime" crisis between 2007 and 2009, as well as an episode of tension between 2012-2014.

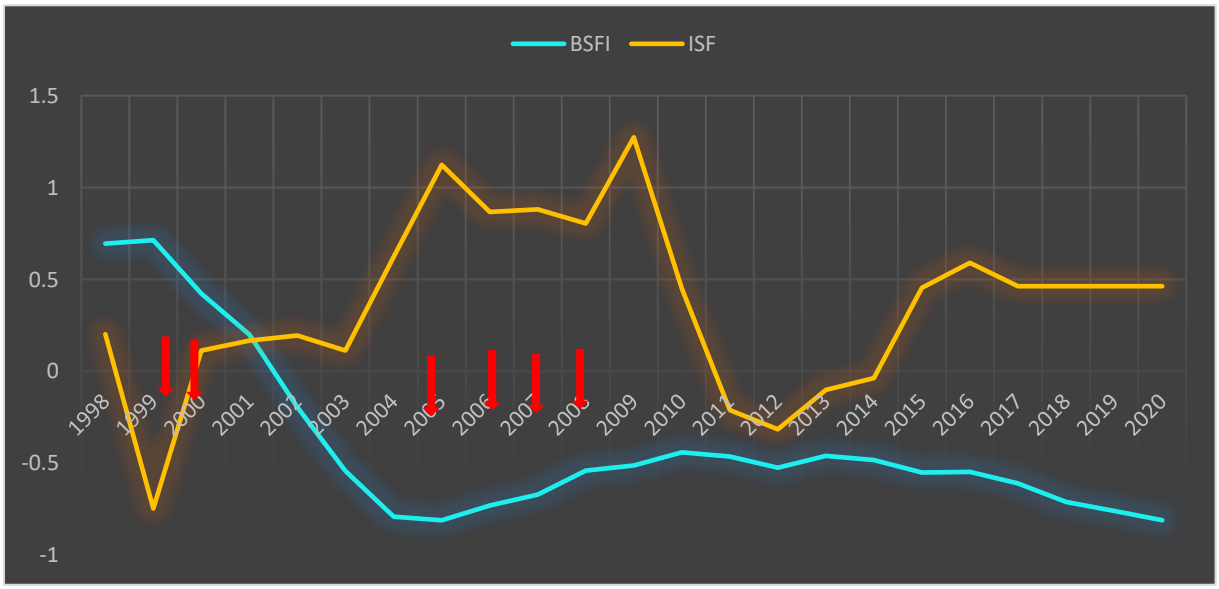
(e) Lebanon case :

Figure N°9 : graphical representation of the IASF index for Lebanon



Source : Developed by the author.

Figure N°10 : Graphical representation of the BSFI and ISF index for Lebanon



Source : Developed by the author.

According to the BFSI indicator, the Lebanese banking system went through a long period of fragility, especially between 2004-2008. The banking system vulnerability index, also showed

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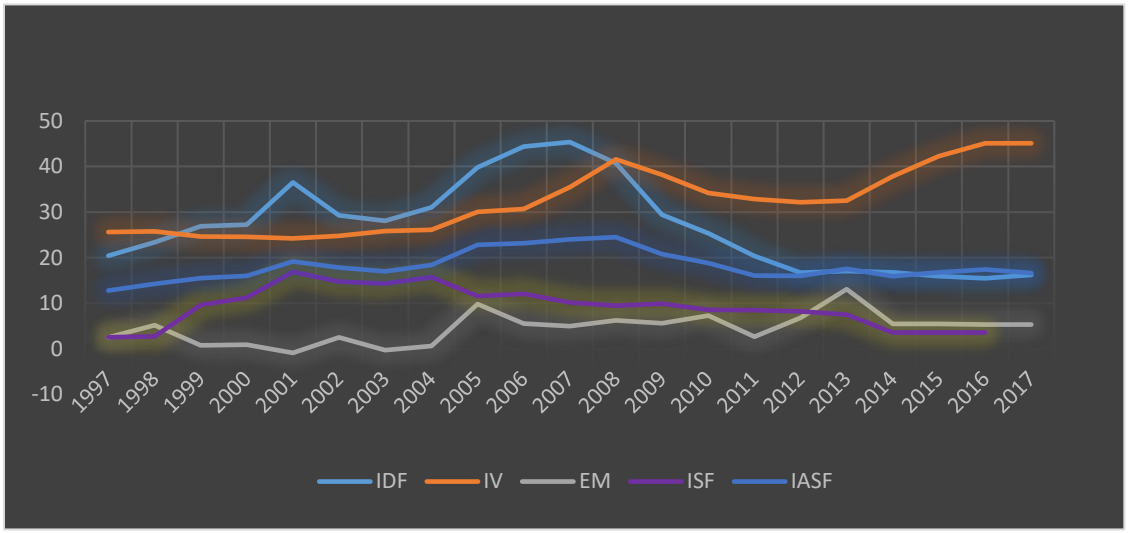
peaks of stress during the same period. Regarding the years 1999-2000, we notice a significant drop in the ISF vulnerability index, this means that the Lebanese banking system was characterized by a period of financial stress, the IASF composite index was also able to detect this fragility with a significant increase in the ISF and EM sub-indices.

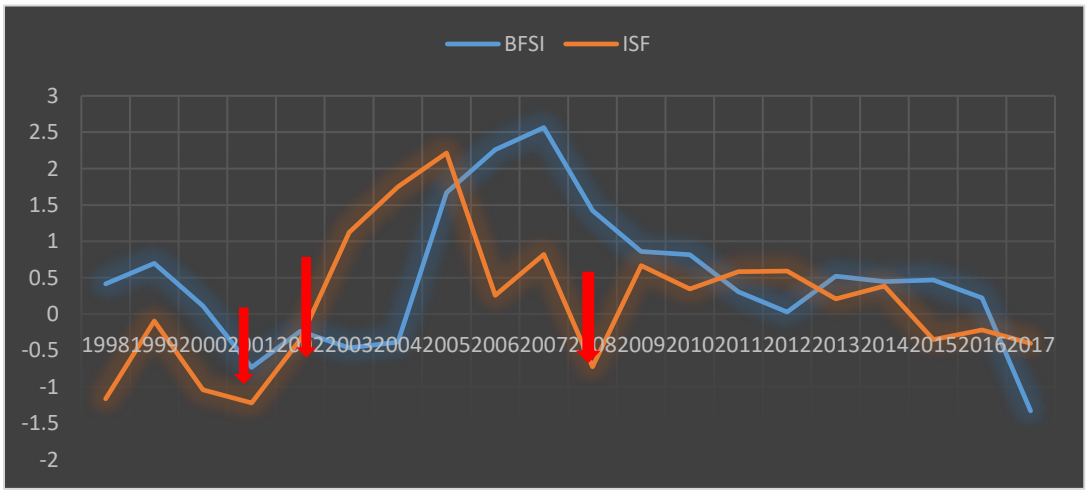
(f) Turkey case

Figure N°11 : graphical representation of the IASF index for Turkey



Source : Developed by the author.

Figure N°12 : Graphical representation of the BSFI and ISF for Turkey



Source : Developed by the author.

Analyzing the results of the BFSI index for the period 2000-2002, it can be observed that the monetary crisis that affected the Turkish economy in 2000-2001 had a significant impact on the health of the banking and financial sector. Indeed, the deterioration of Turkey's macroeconomic

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fundamentals, particularly the increase in the current account deficit and the devaluation of the Turkish lira, affected the country's financial stability.

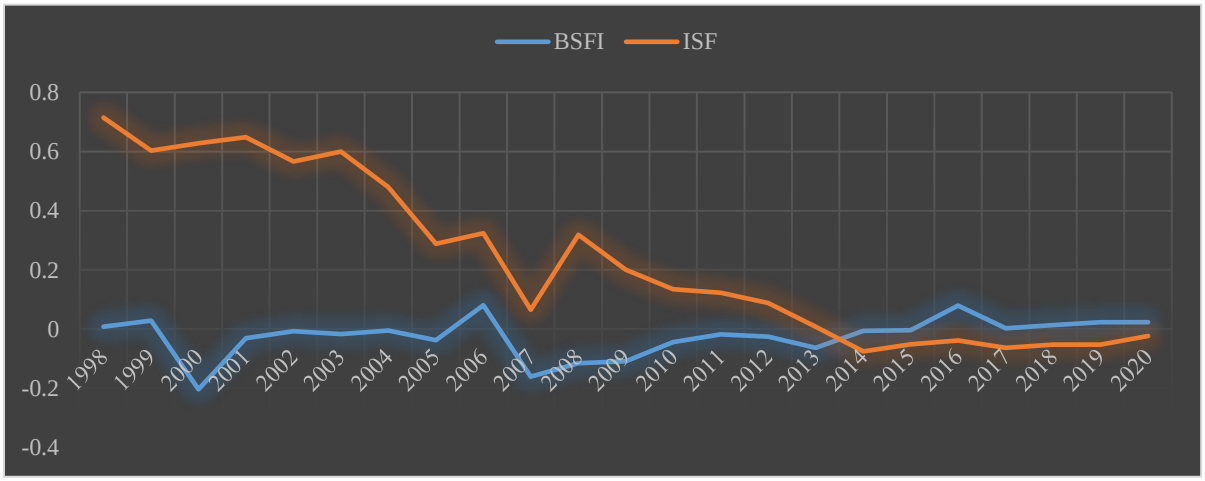
It is important to note that the monetary crisis in Turkey was triggered by rumors of political instability, which affected investor confidence in the Turkish economy. This crisis demonstrates the importance of political stability for the financial stability of a country.

Regarding the composite IASF index, it recorded an increase during the period 2000-2002, with the increase in the IDF (foreign debt index) and ISF (financial stability index) sub-indices. This can be explained by the fact that despite the monetary crisis in Turkey, the global economy as a whole was still relatively stable, which allowed other countries to maintain some financial stability.

However, in 2008, the ISF index recorded a significant decrease due to the effects of the global financial instability. This crisis was caused by a combination of factors, including the subprime crisis in the United States, the liquidity crisis in the financial sector, and the increase in oil prices.

(g) Morocco case

Figure N°13 : Graphical representation of the BSFI and ISF for Morocco



Source : Developed by the author.

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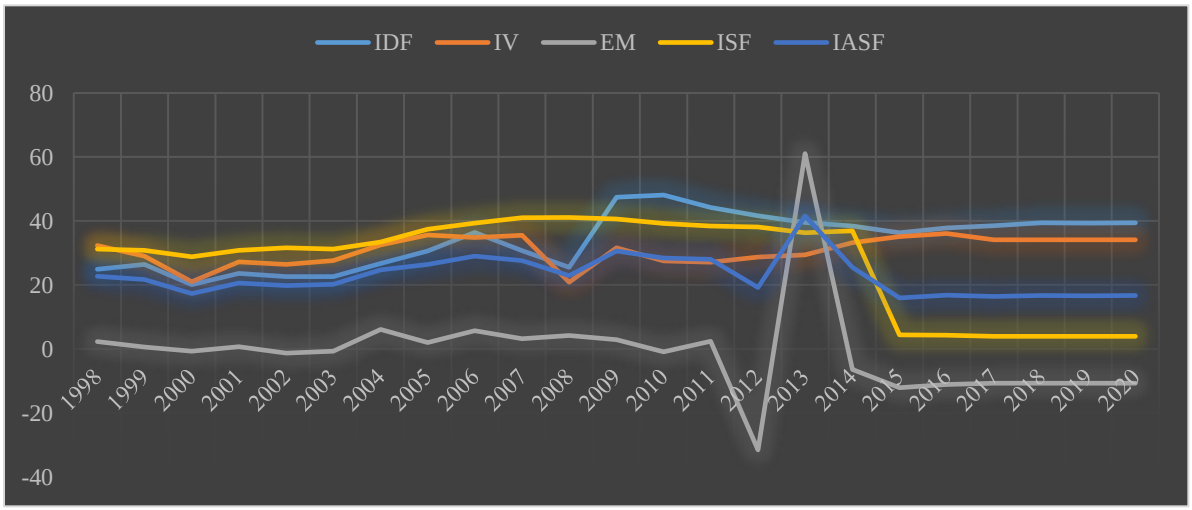
Figure N°14 : Graphical representation of the IASF for Morocco



Source : Developed by the author.

Graph n°13 represents the evolution of two fragility indices of the Moroccan banking sector between 1998 and 2017. The BSFI index measures credit risk, while the ISF index measures exchange rate risk.

Between 2001 and 2006, the Moroccan banking sector experienced low financial stress, with a slight increase in 2000. This period was characterized by a significant increase in loan volumes and external bank commitments, which increased credit and exchange rate risk.

Between 2007 and 2010, the Moroccan banking sector experienced an increase in financial stress, probably due to the effects of the international crisis that affected the world. This period was marked by an increase in credit and exchange rate risk, as measured by the BSFI and ISF indices.

In 2013, the composite index showed moderate financial stress, characterized by high levels of two sub-indices in particular, ISF and EM. This period coincided with the first agreement under the Precautionary and Liquidity Line (PLL) concluded in August 2012 between Moroccan authorities and the IMF. The increase in ISF may be due to exchange rate instability, while EM measures the risk of banks' exposure to fluctuations in the prices of financial assets.

The causes of financial stress in the Moroccan banking sector vary depending on the period. However, overall, credit and exchange rate risks have been the main factors contributing to financial stress.

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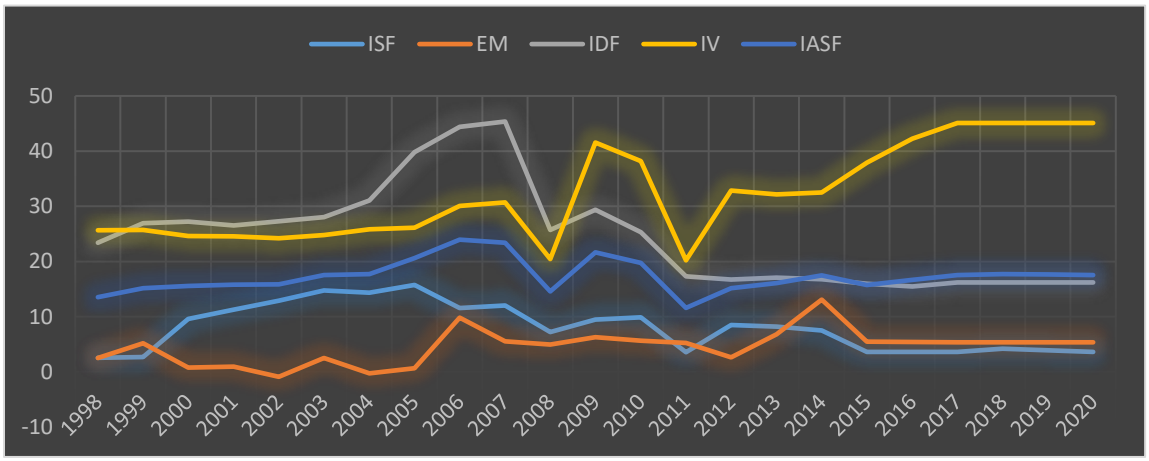
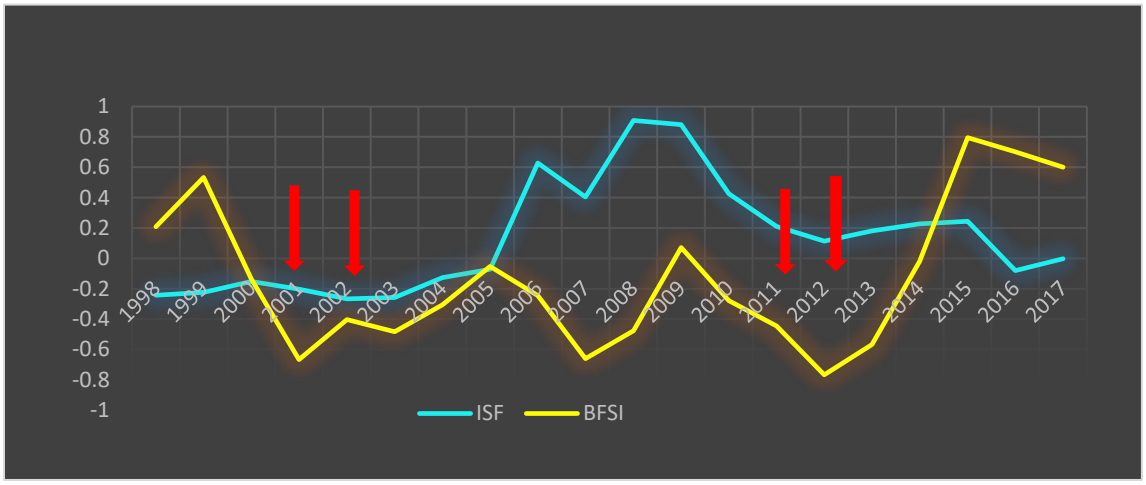
(h) Egypt case

Figure N°15 : Graphical representation of the IASF index for Egypt



Source : Developed by the author.

Figure N°16 : Graphical representation of the BSFI and ISF index for Egypt



Source : Developed by the author.

The graph shows the evolution of two vulnerability indices, the BSFI and ISF, for the Egyptian banking system between 2000 and 2017. The BSFI measures credit risk, while the ISF measures exchange rate risk.

During the period 2000-2002, the Egyptian banking system experienced its highest level of stress, with the vulnerability index of the BSFI reaching its peak. This was mainly caused by the high degree of fragility of the banking system, which was attributed to the increase in credit risk, reflected by the high volume of non-performing loans, and the high level of exposure of banks to the real estate sector. Additionally, the instability of the exchange rate and the volatility of the interest rates contributed to the vulnerability of the banking system during this period.

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In the period 2007-2008, the Egyptian banking system experienced a strong fragility, which was due to the effects of the international subprime crisis. This period was characterized by an increase in liquidity and exchange rate risks, which led to a sharp increase in the vulnerability index of the ISF. The crisis led to a decrease in foreign investment and remittances, which negatively affected the economy and the banking sector.

The period 2011-2013 was characterized by a high level of political conflicts in Egypt, during the revolution of the Arab Spring. This led to a significant decline in foreign exchange reserves, which worsened the activity of all economic sectors. The sudden drop in foreign direct investment (FDI) and the increase in capital outflows recorded after the protests further contributed to the high level of vulnerability of the Egyptian banking system during this period. This was reflected by the high level of the ISF index, which measures the risk of exposure of banks to fluctuations in the exchange rate.

In summary, the causes of the different vulnerabilities of the Egyptian banking system varied according to the different periods. However, in general, credit and exchange rate risks were the main factors contributing to the vulnerabilities of the banking system. Political conflicts, international crises, and fluctuations in interest rates also played a significant role in the fragility of the banking system.

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Conclusion

Financial stress is caused by shocks in the financial system. Therefore, its importance depends on its size, on the conditions initially prevailing in the financial system and also on the composition of the latter. For example, a negative shock is most probable to exacerbate stress when financial conditions are difficult, cash inflows are low, high-leveraged companies, and risk-averse lenders.

Shocks can also spread through loopholes in the organization of the monetary system. The magnitude of a financial crisis stems, on the one hand, from the vulnerabilities accumulated by the economy and the financial sector (endogenous risk), and on the other, from the amplification degree of an initial shock (exogenous risk) during financial stress.

International financial markets experienced periods of exceptional stress during the international subprime financial crisis. The MENA countries have not been spared from this crisis as well. The results of the calculations and the analyzes of the three indices proposed in our study led us to draw the following conclusions : the two vulnerability indices BSFI and ISF all reach their maximum level during all periods of financial stress, in particular the financial subprime crisis period, on the other hand, the IASF composite index was not relevant in such periods, this made us choose the most relevant indices in terms of predictability of historical scenarios.

Bahrain, Kuwait, suffered financial turmoil during the 2008 crisis, illustrated by the two vulnerability indices BFSI and ISF. In contrast, the IASF index did not detect any stress peaks during this period. Palestine and Lebanon have experienced a long period of fragility which is probably due to the political conflicts that the two countries went through, but they were not spared from the magnitude of the 2008 financial crisis. Concerning the financial system in Turkey, the three indices detected the financial turmoil during the currency crisis that hit the Turkish economy in 2000-2001, but it was noticed that during the subprime crisis only the vulnerability index of the financial system (ISF) that showed peaks of stress.

The Egyptian financial system, for its part, experienced a period of strong financial stress during the 2008 international financial crisis, and also during the Arab Spring revolution. Throughout these periods, the BFSI and ISF fragility indices reached their highest levels, while the IASF composite index did not detect any financial stress peaks. For the case of Morocco, the Moroccan banking and financial system has experienced a passage of three periods of vulnerabilities detected by the vulnerability indices, the financial turmoil in 2000 and those in 2008 were detected by the two indices BFSI and ISF, as well as during 2013 detected by the three ISF, BSFI and IASF indices.

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