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International Transmission of Financial Crises: How Much Contagion is Responsible? - Evidence from MENA Countries -

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Summary: This study shall discuss the phenomenon of international transmission of financial shocks, with a special focus on distinguishing between contagion and other similar mechanisms causing the simultaneous occurrence of crises. After an attempt to review the related analytical and empirical literature, we try to test for the presence of contagion from the US financial market towards a selected sample of Middle East and North African markets during the 2008 mortgage crisis, using correlation analysis methodology proposed by (Forbes and Rigobon-2002). The main findings of the study reveal the existence of contagion towards only one market in the sample that is Qatar SE when adjusting for heterskedasticity. Although study results confirm the existence of a spillover effect between the US market and all other markets in the sample, Qatar SE was the most affected, and this can be explained by a high-level of financial integration.

Keywords: Contagion, Interdependence, Correlation Analysis, Mortgage Crisis, MENA.

JEL Classification Codes : G01, G15.

ملخص: تهدف هذه الدراسة إلى مناقشة ظاهرة الانتقال الدولي للصدمات المالية مع التركيز بشكل خاص على التمييز ما بين العدوى وغيرها من الآليات المشابهة والمتسببة في الحدوث المتزامن للأزمات. بعد محاولة عرض الدراسات النظرية والتجريبية المتصلة بالموضوع، سنحاول اختبار وجود العدوى من السوق المالي الأمريكي باتجاه عينة منتقاة من الأسواق المالية في دول الشرق الأوسط وشمال إفريقيا خلال أزمة الرهن العقاري في 2008 وذلك باستخدام منهجية تحليل الارتباط المقترحة من طرف فوربز & ريغوبون (2002). أظهرت الدراسة وجود عدوى باتجاه سوق مالي واحد في العينة وهو سوق قطر وذلك بعد تصحيح مشكل عدم تجانس التباين. وعلى الرغم من أن الدراسة تؤكد وجود ارتباط مشترك بين سوق المال الأمريكي وجميع الأسواق في العينة، إلا أن سوق قطر المالي كان الأكثر تأثرا وهذا ما يمكن إرجاعه إلى المستوى العالي من الاندماج المالي لهذا السوق مع الاقتصاد العالمي.

الكلمات المفتاحية: عدوى، ارتباط مشترك، تحليل الارتباط، أزمة الرهن العقاري، دول الشرق الأوسط وشمال إفريقيا.

تصنيف JEL: G01 ; G15.

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I- Introduction :

Contagion is a long-standing concern for academic community, investors and policymakers. It is commonly viewed as an indispensable result of globalization, and without globalization, contagion cannot exist according to some studies.

This paper shall investigate the presence of contagion effect during the 2008 crisis from the US market toward a selected sample of MENA countries using the Forbes & Rigobon (2002) correlation analysis methodology. Although, there has been a decade since this crisis, the question of whether financial contagion was responsible is still unsolved. The distinction between different mechanisms of crises transmission is needed more than before to decide appropriate measures to take depending each scenario.

The remainder of this paper is organized as follows. Section one, discusses the main problem and objectives of the study. Section two provides a theoretical debate on different mechanisms responsible for crisis occurrence, and distinguishes between contagion and other similar phenomena. Section three is devoted to the empirical study that is the test of contagion of the 2008 crisis to a sample of MENA countries. It starts with reviewing the main testing methods with a special focus on correlation analysis methodology.

I.1. Research Problem and Objectives:

There is a voluminous analytical and empirical literature on the international propagation of shocks. These studies aim mainly to understand and to explain the widespread of the 1990s crises, due to their virulence and their far-reaching effects. In fact, research on crises transmission has several ramifications : first, it affects portfolio diversification. According to Markowitz (1952), investors should select a combination of financial instruments that are not perfectly, positively correlated. However, according to Longin & Solnik (1995), correlation between assets or markets indices is not constant. Financial markets tend to be highly volatile and correlated during turmoil periods, which undermine the benefits of diversification. Second, this strand of research is related to globalization and markets integration. Financial integration and openness is an inevitable feature of today's economic structure. Countries are facing different challenges mainly how to integrate into international financial system, and taking advantage of all positive outcomes of this process, while minimizing its risks mainly reducing their vulnerability to external shocks (Seddiki, 2015). Finally, research on contagion may contribute on a political level by helping international institutions and policymakers to focus their efforts and intervention plans where they are needed most. For instance, if a country has a solid economic system and it is temporarily affected by a crisis elsewhere, financial assistance and short-term bailout may be more effective compared to a country with a fragile economic system where a new equilibrium is inevitable. Any intervention and bailout strategy will only delay this adjustment of economic fundamentals (Claessens & Forbes, 2001).

Even though some economists argue that there has been less contagion during other crises after the 1990's like (Argentina 2001-2002, Turkey 2001) (Bordo & Murshid, 2001), which may lead to think that a learning effect may have enabled the financial system to mitigate the spread of shocks. The spillover of US subprime turmoil and the spread of economic shock resulted from the outbreak of Covid-19 Coronavirus pandemic in the end of 2019, show that financial contagion still exists. Thus, this study aims to answer the following question: what are the mechanisms responsible for international crises transmission, and to what extent, should we blame contagion?

I.2. Simultaneous Occurrence of Financial Crises: Contagion Versus Other Mechanisms:

Contagion is generally viewed as the main cause of crises transmission. Investors and policy makers consider crisis occurrence in a country resulted from a shock or crisis elsewhere as an evidence of contagion. In fact, everyone can notice the presence of financial contagion through its related negative effects, such as high markets volatility and movement, in addition to general economic turbulence associated with a fall in economic indicators (Claessens & Forbes, 2004). However, economists refuse to blame only contagion for the transmission of negative shocks, and they focus on distinguishing it from other similar mechanisms in addition to investigating the real contribution of this phenomenon in the spread of past crises (Moser, 2003).

Despite the increasing interest in financial contagion, a generally accepted definition still does not exist. Some researchers have tried to define contagion in itself along with possible testing methodologies; others have focused on distinguishing between transmission channels, and trying to determine which channel has the biggest contribution in transmission. Many studies have

provided a survey of empirical literature on this subject (Dornbusch et al., 2000)(K. Forbes, 2012) (Claessens & Forbes, 2004) (Claessens & Forbes, 2001), and they all agree that the term **'Contagion'** did not appear in financial lexicon until the late of 1990s, after a series of sharp and intense crises episodes that hit mainly emergent markets. Edwards (2000) indicates that this term was rarely used before 1995, and it appeared gradually in the second half of the 1990s. In his survey of the use of this term between 1969 and 2000, he reveals only 17 appearance of this term in studies before 1990 (Edwards, 2000). Both researchers and policymakers began to use this term on a large scale in the aftermath of the Asian crisis 1997, and then it became a part of economic lexicon. Studies aiming at discussing the transmission of the 1990s crises have used **'Contagion'** interchangeably with other similar terms such as spillover, interdependence, spread, propagation, and transmission without giving a solid and agreed-upon criterion to distinguish between all these terms, which adds more ambiguity to this phenomenon.

In its medical use, contagion already entails the meaning of transmission, Peckham (2014) compared between economic and medical contagion to conclude that both phenomena share similar characteristics like fast spreading, element of surprise, complexity of international network and intervention measures to take…etc; and this may justify the adequacy of choosing this term (Peckham, 2014)(Haldane, 2013). Nevertheless, in a purely financial context, not all transmission mechanisms are considered as contagion. After the Asian crisis, studies start to focus more on giving an accurate definition and classification for all transmission mechanisms, in addition to giving empirical evidence that measures the real contribution of each mechanism in the 1990s crises. Masson (1998) provides a clear classification of factors behind the simultaneous occurrence of crises. These factors include common cause, also called 'Monsoonal effect' (P Masson & M Mussa -, 1995)(Masson, 1998)that is "major economic shifts in industrial countries that trigger crises in emerging markets". The second factor is normal transmission also called 'spillover' that is "transmission resulted from the interdependence among developing countries themselves". The last factor is 'pure contagion' that "involves changes in expectations that are not related to changes in country's macroeconomic fundamentals". Masson (1998) describes contagion as a jump between multiple equilibria resulted from a change in investors' expectation. Goldstein (1998) explains this change by considering that investors perceive crisis elsewhere as a 'wake up call' that makes them change their portfolio strategies abruptly (Goldstein, 1998). Similar definition is given by Ahluwalia (2000), who defines contagion as "*temporal clustering of currency crises caused by a change in investors' expectations*". Ahluwalia (1999) suggests another classification of contagion based on similarities in fundamentals. She calls 'discriminating contagion' when crisis in a specific country hits other countries that share the same economic weaknesses along with the same geographical location, otherwise, it would be non-discriminating (Ahluwalia, 1999). Consequently, Masson's 'pure contagion' may be discriminating if having the criteria cited in Ahluwalia's study.

K. J. Forbes & Rigobon (2002) employ the expression 'shift contagion' instead of Masson's (1998) 'pure contagion' and Kaminsky & Reinhart (2000) 'true contagion' to distinguish between contagion and other similar mechanisms. The word 'shift' is suitable and adequate to describe exactly what happens and triggers this phenomenon that is, a shift (a significant and sudden change) in markets' linkages. They define contagion as "*significant increase in cross-market linkages after a shock to one country (or a group of countries)*". K. J. Forbes & Rigobon (2002) have used this restrictive definition to test for contagion using correlation analysis during three crises episodes (debt crisis 1987, Asian crisis 1997, and Mexican crises 1994) versus the larger definition that is 'Transmission of an extreme negative shock in one country to another country (or group of countries)' (K. Forbes, 2012). According to the restrictive definition, it is possible to test for contagion only by comparing correlation coefficients between markets in stable period with the same coefficients in turmoil period. Contagion occurs if there is a significant increase in correlation; otherwise, it is only interdependence. After adjusting for bias in correlation coefficients, the study of K. J. Forbes & Rigobon (2002) made on 28 financial markets, reveals that contagion is not the culprit and was not responsible for the propagation of the 1990s crises. Unbiased correlation coefficients did not increase significantly after the three crises almost in all markets in the sample, which indicates only the presence of a high comovement between markets or as they called it 'interdependence'. The main advantage of this testing methodology is that it allows testing for contagion without having to identify or explain its related

channels compared to other existing testing methodologies that specify the main transmission channel, which is more complex due to the lack of data about all countries in the sample.

Other parameter in crises transmission discussed in studies like King & Wadhwani (1990) is 'global shocks' or as it was called in Masson (1998) 'monsoonal effect'. Although researchers do not agree upon one definition of contagion, they all agree on considering crises propagation resulted from global shocks, as not contagion (Kaminsky & Reinhart, 2000)(K. Forbes, 2012). A new debate on this idea appears with the mortgage crisis 2008, and the economic shock of Covid-19 pandemic (2019-2020) : Do we have to consider the transmission of these crises in all over the world as contagion, or they are simply global shocks as they originated from the biggest and most dominant economies in the world (US/ China)? A survey of studies on the subprime crisis transmission shows a tendency to avoid going through this debate. Researches tend to use the term 'spillover' to describe the phenomenon in general, and they focus more on exploring testing models rather than theoretical debate. Additionally, the outbreak of Covid-19 Coronavirus may lead to rethinking the whole mechanisms of international crises transmission and globalization.

In addition to global shocks, independent shocks may also make crises to be contemporaneous in time. This phenomenon describes the scenario where multiple shocks coincidently hit different countries at the same time with no cause-effect relationship, and without any transmission. Masson (1998) describes this mechanism by saying '*simultaneous crises are not a sufficient condition for contagion*'. Thus, crises occurrence due to independent shocks and global shocks is not contagion.

The distinction between normal transmission (spillover/interdependence) and contagion can be approached through identifying transmission channels. Almost all studies classify crises channels into fundamental channels and investor's behavior. Fundamental channels include trade (real) links including direct bilateral trade and competitive devaluation ; and financial links through capital flows control and 'common creditor' effect. Fundamental channels are generally considered as a normal vector of transmission, i.e. they are responsible for spillover or interdependence with inconclusive evidence on which channel contributes more in crises spread: trade (Eichengreen et al., 1995)(Glick & Rose, 1999) or Financial links, that play an uprising role especially with financial globalisation (Kaminsky & Reinhart, 2000)(Dornbusch et al., 2000)). The second category is the change in investors' behavior (Claessens & Forbes, 2004) or herding behavior (Kaminsky & Reinhart, 2000) that refers to all markets' imperfections that lead to the appearance of new transmission channels which do not exist in tranquil periods, and cannot be explained based on fundamentals. These channels are mainly psychological and are attributed to fear and panics. (K. Forbes & Rigobon, 2001) employ non-crisis contingent theories to explain this abrupt change in transmission linkages as opposed to crisis-contingent theories that explain normal transmission. They suggest different explanations like liquidity problems, multiple equilibria…etc. Moser (2003) divides investors' behavior into two mains classes: information effects, in which information asymmetry is the main cause of sudden change in behavior, as well as domino effect, which describes the accumulation of different events that contribute in crisis propagation. Based on the two principle categories of crisis channels, studies consider any crisis transmission through normal linkages (trade and/or finance) as a normal transmission (spillover). However, any transmission that cannot be explained by these linkages is considered as contagion.

To conclude, contagion effect **'may be'** responsible for crises transmission from one country to other countries. However, it is more accurate to say that crises may happen simultaneously in more than one country even in the absence of any kind of transmission. This is why it is preferable to use the expression 'simultaneous occurrence of crises' rather than crises transmission. Figure (01) shows the main mechanisms responsible for simultaneous occurrence of crises, in which we can clearly see the role of both contagion and interdependence (spillover).

The spread and severity of past crisis (especially during the 1990's) led to a belief that having strong and sound economic fundamentals can no longer ensure a nation's immunity from crises. Bordo & Murshid (2001) find evidence that recent financial crises (1990's) are not more contagious compared with crises in the past. Other studies (K. Forbes, 2012) also find evidence that starting from mid-2000's, contagion risks had permanently declined. Accominotti et al.(2020) go further to assert that contagion was absent during the period of 'extreme' globalization (1972-2014) and could become a significant problem if stock markets return to a moderate level of globalization seemingly to the period of (1880-1914).

Several reasons can explain the decreasing tendency of crises transmission, including for instance structural economic changes in emergent markets that enable these countries to reduce

their vulnerability to external shocks. Other factor is related to 'learning effect', that is investors' increasing maturity and ability to analyze country's risks and assessing the financial and economic situation of emergent markets separately and not treating them as one similar block, thus, avoiding what is called by Moser (2003) the 'Lump together hypothesis'. Moreover, international investors have significantly reduced the percentage of emergent markets in their portfolios to minimize their exposure to future risks. The last factor is the development of risk assessment tools and early-warning systems that allow both investors and financial institutions to predict crises, thus eliminating the 'element of surprise' responsible for investors' panics and irrational behavior (Claessens & Forbes, 2004).

Despite all these factors, and all mitigating policies taken by governments and international institutions, recent financial crisis that began in the US housing market in 2007, and spread to all over the world especially after the bankruptcy of Lehman brothers in 2008, has shown that previous studies and forecasts were too optimistic. The turbulence that started in housing market spread rapidly into financial markets and then to international economic sphere. The result was the most severe financial crisis since the great depression in 1929. This crisis hit almost all countries in the world and MENA markets were no exception.

I.3. Testing Financial Contagion : Application on the 2008 Crisis :

I.3.1– Contagion Tests :

Empirical studies have used different techniques to test for the existence of contagion effect versus other possible transmission mechanisms. Related literature distinguishes between two testing approaches: the first is testing for contagion itself versus normal transmission (interdependence/ spillover). The second approach is testing for specific transmission channel (trade/ finance/ investors' behavior). This later generally avoids going through the debate on the existence of contagion. A third approach can be added, even though there is not a plenty of researches that can be classified in it, that is combining the first two approaches, i.e. testing first for the presence of contagion, then identifying the main transmission mechanisms of crisis. Obviously, combining the two approaches can be a challenging task due to unavailability of data of economic fundamentals and financial markets of all countries inside the sample.

The present study belongs to the first category that is testing for the presence of contagion itself and whether or not, it was responsible for the spread of a specific crisis. Generally, several strategies have been widely utilized to measure how shocks propagated, among them we cite: probability analysis (Probit models) suitable with contagion definition adopted in some studies as '*an increase in the probability of a speculative attack on the domestic currency which stems not from domestic "fundamentals*' (Eichengreen et al., 1996)(Glick & Rose, 1999). Cointegration technique (Longin & Solnik, 1995), ARCH and GARCH models to test for volatility spillover between financial markets (Hamao et al., 1990), extreme value or jump approach that considers contagion as 'the transmission on extreme negative return'(K. Forbes, 2012). and cross-market correlation analysis (Baig & Goldfajn, 1999)(King & Wadhwani, 1990) that is described by K. J. Forbes & Rigobon, (2002)to be '*the most straightforward approach to test for contagion*'.

I.3.2– Cross-Correlation Analysis Using 'Forbes and Rigobon (2002)' Methodology:

The most used technique to test for the presence of contagion is correlation analysis. This method consists of a simple comparative analysis of Pearson's correlation coefficient between markets in calm and in crisis periods (El Ghini & Saidi, 2015). Cross-correlation analysis was proposed by K. J. Forbes & Rigobon (2002) in accordance with their restrictive definition of contagion. According to them, this definition (although it is not universally accepted) has two main advantages: 'first, it provides a straightforward framework for testing if contagion occurs, and second, it provides a straightforward method of distinguishing between alternative explanations of how crises are transmitted across markets'. Unlike testing shocks transmission using ARCH and GARCH models that test only for volatility spillover between markets, Forbes & Rigobon (2002) methodology captures this phenomenon by linking between theoretical background and testing models. Moreover, studies that have used ARCH/GARCH models tend to find more evidence compared to studies that have used VAR specification or correlation analysis.

Forbes & Rigobon (2002) propose alternative models of inter-market dependencies that allow for constructing measures of correlation between turbulent and calm stock markets during crisis periods. Based on their restrictive definition and other related empirical studies (Corsetti et al., 2005)(Baur, 2012), Forbes & Rigobon (2002) consider a model (between two markets for

simplicity), where stock returns in the crisis market, x are exogeneous and influence returns in the calm (stable) market, y. These returns are related according to the following equation:

$$y_t = \alpha + \beta x_t + \epsilon_t$$

Where:

$$E[\epsilon_t] = 0$$

$$E[\epsilon_t^2] = c < \infty$$

$$E[x_t \epsilon_t] = 0$$

α is a constant and describes market's own shock

β is a parameter that describes the linkages between the two markets, and it is assumed to be constant in all time periods (turmoil versus stable period)

The study distinguishes between two scenarios: a relative market stability with low variance(l), and market turmoil with high variance(h), directly after a shock or a crisis. Forbes & Rigobon (2002) show that under the assumptions of no omitted variables and the absence of any feedback effects from the non-crisis market to the turmoil country, conditional correlation can be written as:

$$\rho^h = \rho^l \sqrt{\frac{1+\delta}{1+\delta(\rho^l)^2}}$$

Where ρ^h is the conditional correlation coefficient, ρ^l is the unconditional correlation coefficient, and δ is the relative increase in the variance of market y after a shock in x. Where $\delta$is given as:

$$\delta = \frac{\sigma_{xx}^h}{\sigma_{xx}^l} - 1$$

$\sigma_{xx}$is the variance of the crisis market x in the high and low-period volatility.

During periods of high volatility in market x, estimated correlation (the conditional correlation) between markets, y and x will be greater than the unconditional correlation; thus, conditional correlation coefficient tends to increase after a crisis, even if the unconditional correlation coefficient (the underlying cross-market relationship) is the same as during more stable periods. this problem of heteroskedasticity in market returns, can cause estimates of cross-market correlation coefficients to be biased upward after a crisis. Forbes & Rigobon (2002) propose to adjust the bias (correcting for heteroskedasticity), and they suggest calculating unconditional correlation coefficient using the following equation:

$$\rho = \frac{\rho^*}{\sqrt{1+\delta[1-(\rho^*)^2]}}$$

Where ρ is the adjusted or unconditional correlation coefficient, and ρ^* is the unadjusted or conditional correlation coefficient.

II– Data and Methodology:

Similar to Forbes & Rigobon (2002) methodology, this study applies correlation analysis to test for the presence and contribution of contagion in the spread of the 2008 crisis to a selected sample of MENA countries. Although, there have been more than a decade since this crisis, studies continue to analyze its causes and implications since it is considered by researchers and economists to be one of the most severe crisis in economic history.

For this purpose, six financial markets main indices within MENA countries were chosen. The term 'Middle East and North Africa- MENA' covers an extensive region stretching from Morocco in the west to Pakistan in the east. This classification is not based on religious or social criteria; it is only a geographic definition. The list of countries within MENA varies from one

organization to another. Although, there are some countries that change in the list, other countries figure in almost all existing lists.

In order to investigate the transmission of 2008 crisis from the (Unites States of America) US stock exchange toward MENA countries, we have selected only six (06) countries namely: Morocco, Tunisia, Egypt, Jordan, Lebanon and Qatar. Table (01) shows the list of countries in the sample along with their main stock exchange indices.

Following Forbes & Rigobon (2002) methodology, we employ a VAR specification to take into account the different working hours of stock markets in the sample, in addition to remedy for serial correlation between stock returns. Moreover, VAR model captures any feedback effects between markets in the sample, and any effect of other exogenous variables, this why we include other variables into the model, mainly US short-term interest rates (taken from Federal Reserve Bank of St. Louis website). Another additional index is CBOE Volatility Index (VIX) which is an index calculated by Thomson Reuters to reflect the general state of global economic system. All the data is from Thomson Reuters Datastream.

The model specification is given as follows:

$$X_t = \phi(L)X_t + \Phi(\mathrm{L})I_t + \eta_t$$

$$X_t \equiv \{x_t^c, x_t^j\}$$

$$I_t = \{i_t^{US}\}$$

Where x_t^c is the stock market returns in the crisis country;

x_t^j is the stock market returns in the target market;

X_t is a transposed vector of returns in the same two stock markets;

$\phi(L)$ and $\Phi(\mathrm{L})$ are vectors of lags;

i_t^{US} is short-term interest rate for the crisis country;

Stock markets returns are calculated as rolling average , two-day return to control for different opening hours in markets inside the simple, and similar to the same methodology, we choose five lags for $\phi(L)$ aid $\Phi(\mathrm{L})$.

As cited earlier, correlation analysis methodology is based on estimating correlation between the crisis country (ground-zero country) –where crisis originated- and the target country – affected country-. Thus, the US stock exchange main index is chosen; mainly S&P(500), this index covers the value of 500 companies listed on the US stock exchange compared to the Dow Jones Industrial index that covers only 30 listed companies. Graph (01) shows the variation of S&P500 daily returns during the period of 2005 until 2014. The sharp drop in this index is clearly seen in the middle of 2008, which can reflect the starting point of the 2008 financial crisis.

S&P 500 movement is used to determine both stable and turmoil period. According to Forbes & Rigobon (2002), it is important to determine the exact crisis period, that is the 'full period'. This period will then be divided into two sub periods: stable (tranquil) period and turmoil (turbulence) period. Stable period describes the period just before crisis happens, and turmoil period that describes the period just after the crisis. The full period should not stretch for too long in order to avoid other effects and the possible appearance of new linkages between markets. Studies have used different techniques to determine these periods, and still the choice of full period and sub periods vary from one research to another. Determining the exact starting point of the crisis is crucial for this methodology. Forbes & Rigobon (2002) methodology focuses on tracking daily news to indicate the exact period of crisis, other studies have adopted other classifications based on structural breakpoints in the return series (El Ghini & Saidi, 2015), or based on other definitions of shocks (Serwa, 2005).

Based on this methodology (Forbes & Rigobon (2002)) and similar studies, we took the bankruptcy of Lehman brothers on the 15th September 2008 as the starting point of crisis, thus we determine the whole period and sub periods as follows:

The full period from 28 September 2007 until 31 October 2008 with a total of 286 observations,

Stable period from 28 September 2007 until 15 September 2008 with a total of 252 observations;

Turmoil period from 16 September 2008 until 31 October 2008 with a total of 34 observations;

Table (02) presents descriptive statistics of main indices in the sample during the full period, stable, and turmoil period.

The first five values in the three periods clearly reflect the characteristics of each period: stock returns of S&P500 show their highest variance during the turmoil period. This can be seen clearly from the difference between the MAX and MIN (9.440/-10.213). In addition to the highest value of standard deviation in the same period (3.875) compared to the same value during stable period (0.845) and full period (1.328). The difference between three periods is also seen in all other indices such as VIX (17.657/-14.042). The value increase in standard deviation between stable and turmoil period differs between MENA markets as well: in countries like Jordan and Lebanon, only a small change is observed, respectively (1.067/1.574) and (1.142/1.781). In other markets, we observe a significant change such as in Egypt (1.129/3.568) and in Qatar (1.201/3.555). The Kurtosis of almost all return series is larger than 3 (especially during the full period). Furthermore, the Jarque-Berra normality test reveals a statistically significant deviation of almost all data from normality (some exception during turmoil period due to the limited number of observations as required by testing methodology). The augmented Dickey-Fuller test (ADF) and Phillips-Perron (PP) test statistics for all return series are less than their critical value at the 1%. Since the test is performed on two-days moving average data, the small number of observations during turmoil period affected stationarity test for some series mainly JD all share, BLSI and S&P500. (These series were stationary when taking daily returns instead of two days moving average).

III- Empirical Results and Discussion:

In this section, we test for the presence of contagion effect from the US financial market to the six stock markets during the 2008 financial crisis. Tables 3 and 4 give estimate results of conditional (unadjusted) correlation coefficients between US main index and other indices during the full period and sub-periods, and the unconditional (adjusted) correlation coefficients after adjusting for bias (correcting for heteroskedastiticy). To test if there is significant increase in the unadjusted and adjusted correlations during the crisis period, we use the following hypothesis test:

$$H_0 : \rho^l > \rho^h$$
$$H_1 : \rho^l \leq \rho^h$$

Where H_0 is the null hypothesis of no-contagion (No), H_1 is the alternative hypothesis for the presence of contagion (Yes). ρ^h and ρ^l represent correlations coefficients in high and low volatility periods.

The hypotheses are tested using the Collins & Biekpe (2003) t-test statistic defined as :

$$\text{t-statistic} = \frac{0.5*\ln\left(\frac{1+\rho_h}{1-\rho_h}\right) - 0.5*\ln\left(\frac{1+\rho_l}{1-\rho_l}\right)}{\sqrt{\frac{1}{N_h-3}+\frac{1}{N_l-3}}}$$

Which is distributed as $t_{(\alpha, n_h+n_l-4)}$, n_l (n_h) indicate the number of observations during the low (high) volatility period

Results in table (03) show that all correlation coefficients in stable period were positive except for the negative relationship between JD all share and S&P500. After the crisis, four (04) coefficients in the sample have increased mainly the correlation between the US market and markets in Morocco, Tunisia, Egypt and Qatar. A decrease in coefficients is recorded for the two other countries, where a negative correlation appeared between the US market and Lebanon. Moreover, a decrease of coefficient between the US market and Jordan referring to a continuing negative relationship in both sub periods. Contagion test reveals the presence of contagion effect in three markets among the four markets where correlation coefficients have increased after the crisis, mainly in Tunisia, Egypt, and Qatar. Contagion effect was not present in the three other markets in the sample (Morocco, Jordan, and Lebanon).

After correcting for heteroskedastiticy, results in table (04) show a general decrease in the value of correlation coefficients between the US markets and all other markets in the sample compared with the values of conditional coefficients obtained in table 3. Nevertheless, an increase in the value of unconditional coefficient is seen in the crisis period, compared to stable period in the same markets (where conditional coefficients also increased). The highest increase is seen in the correlation between the US market and Qatar from the value of 0.0129 up to 0.6521. Test of contagion shows the existence of contagion effect only in one market (Qatar) compared to three markets when conditional coefficients are used.

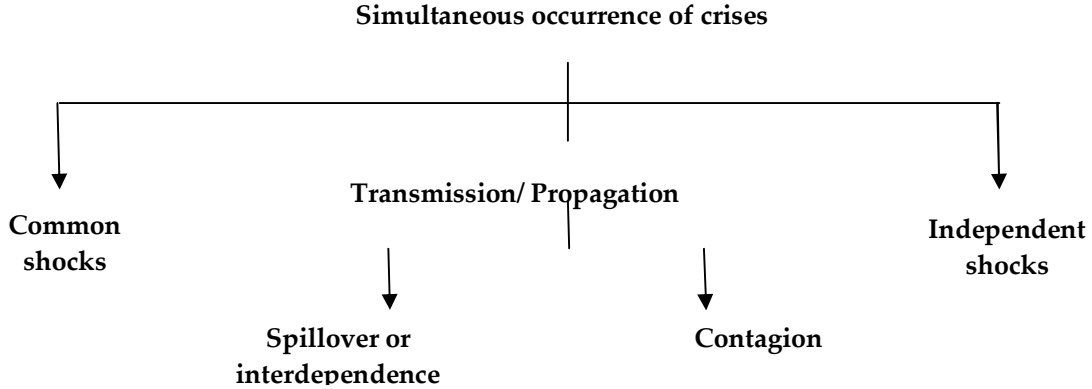
The study results clearly reflect the existing divergences and differences between MENA countries selected in the sample. The increase in almost all correlation coefficients (conditional and unconditional) is an evidence of crisis spillover to these markets and the high level of comovements between the US and MENA markets, which is fully expected in a global financial system and the increasing linkages between financial markets. However, the different changes in standard deviations and correlation coefficients between the US market and each of the countries in the sample can be explained by the degree of economic openness of the country itself and its financial integration with the rest of the world. Qatar stock exchange is the only market where contagion effect was found (after correcting for bias) and this is due to its high level of financial liberalization, where any change in international investors' behavior is susceptible to create panics and negatively affect stock market index. The high-level of financial integration makes this market more vulnerable to all external events such as decisions and announcements from international financial institutions or changes in global economic prospects. All these variables affect also other MENA markets in the sample, even in the absence of contagion, which indicates that an interdependence (spillover effect) exists between the US market and these countries. This finding is an important feature of today's highly integrated financial system, countries have to take into account the risk of any external shocks by building a sound and solid economic system, where the risk of crisis transmission can only be diminished (and not totally cancelled).

IV- Conclusion:

The last financial crisis that started in the USA housing market has revealed the existence of a high interdependence between financial markets, especially in MENA countries. Our empirical results confirm the existence of contagion effect only toward Qatar SE. This finding adds more evidence to the body of literature on contagion, and highlights the importance of taking into account the existing linkages between markets, in addition to the new linkages that may appear directly after a shock to one country, in designing financial portfolio and building diversifying strategies. Providing evidence of contagion and high interdependence between countries may determine financial liberalization process to follow and what strategies to adopt in order to reduce the risk of shocks transmission while opening economic system. The main recommendation is building a solid economic system and working to reduce vulnerabilities. Although this goal is not fully attainable, governments and international institutions can coordinate their efforts to mitigate this risk especially for developing countries.

-Appendices :

Figure (01) : Mechanisms behind simultaneous occurrence of crises



Source: By the authors based on literature review

Table (01) : List of countries in the sample

Country	Main index
Morocco	Morocco all share index –MASI-
Tunisia	Tunisia Tunindex – TUNINDEX6
Egypt	Egypt EGX30 –EGX30-
Jordan	Amman all share index –JD-
Lebanon	Banque du Liban et d'outre-mer stock index –BLSI-
Qatar	Qatar exchange general index –QSI-
US market	Standard and Poor's S&P500

Source: by the authors based on Reuters Datastream

Figure (02): Daily returns of S&P500 variations

Source: Reuters Datastream

Table (02) : Descriptive statistics of return series

[a]Full period (September, 28 2007 to October, 31 2008)									
	S&P500	**MASI**	**TUNINDEX**	**EGX30**	**JD all share**	**BLSI**	**QSI**	**VIX**	**DTB3**
Mean	-0,162	-0,022	0,077	-0,200	0,073	0,037	-0,039	0,443	-0,011
Median	-0,157	-0,001	0,084	0,108	0,175	0	0	0,195	-0,01
Maximum	5,212	3,443	2,890	5,564	3,769	7,690	8,768	17,657	1,975
Minimum	-5,002	-3,805	-3,737	-12,674	-4,512	4,714	-6,939	-14,042	-1,925
Std.dev.	1,328	0,773	0,570	1,669	1,270	1,265	1,663	4,833	0,382
Skewness	-0,165	-0,169	-0,364	-2,524	-0,694	0,745	-0,496	0,208	0,034
Kurtosis	6,791	8,712	12,974	17,115	4,306	9,326	8,628	3,388	15,252
Jarque Berra	172,601	390,176	1191,817	2677,863	43,273	503,250	389,217	3,863	1782,623
ADF	-5,426	-9,042	-5,718	-4,461	-6,371	-6,353	-3,909	-4,663	12,83
PP	-12,185	-7,709	-8,538	-8,132	5,813	-8,680	-6,947	-11,890	-27,815

[b]Stable period (September, 28 2007 to September, 15 2008)									
	S&P500	**MASI**	**TUNINDEX**	**EGX30**	**JD all share**	**BLSI**	**QSI**	**VIX**	**DTB3**
Mean	-0,089	0,010	0,126	-0,040	0,158	0,131	0,028	0,198	-0,010
Median	-0,141	0,004	0,096	0,157	0,195	0	0,014	0,033	-0,005
Maximum	2,149	1,448	2,890	2,955	2,808	7,690	3,235	13,107	1,975
Minimum	-2,308	-2,195	-1,254	-4,026	-3,252	-3,095	-6,840	-9,457	-1,925
Std.dev.	0,845	0,514	0,465	1,129	1,067	1,142	1,201	4,112	0,399
Skewness	0,112	-0,390	1,589	-0,873	-0,501	1,691	-1,271	0,226	0,014
Kurtosis	2,762	4,959	10,639	4,191	3,356	11,600	9,812	2,985	14,576
Jarque Berra	1,122	46,689	718,771	46,922	11,863	896,724	555,047	2,152	1401,436
ADF	-8,548	-4,103	-4,145	-5,503	-5,204	-6,110	-3,612	-4,701	-12,482
PP	-9,997	-7,507	-6,628	-6,871	-6,947	-8,459	-5,663	-10,859	-31,680

[c]Turmoil period (September, 16 2008 to October, 31 2008)									
	S&P500	**MASI**	**TUNINDEX**	**EGX30**	**JD all share**	**BLSI**	**QSI**	**VIX**	**DTB3**
Mean	0,109	-0,255	-0,284	-1,380	0,166	0,056	-0,534	2,254	-0,016
Median	0,257	-0,482	-0,091	-0,661	-0,060	-0,231	-0,100	5,197	-0,06
Maximum	9,440	3,443	1,976	5,564	3,334	4,806	8,768	17,657	0,53
Minimum	-10,213	-3,805	-3,737	-12,674	-3,186	-3,444	-6,939	-14,042	-0,5
Std.dev.	3,812	1,756	1,002	3,568	1,574	1,781	3,555	8,325	0,226

Skewness	-0,199	0,321	-0,911	-1,105	0,341	0,661	0,310	-0,361	0,445
Kurtosis	3,875	2,679	5,746	4,788	2,879	3,491	2,751	2,065	3,440
Jarque Berra	1,270	0,730	15,386	11,452	0,659	2,734	0,634	1,976	1,355
ADF	-3,768	-3,832	-3,54**	-4,170	-4,331	-6,492	-3,791	-5,521	-7,692
PP	-13,188	-3,401**	-3,553**	3,224**	-4,331196	-6,255	3,142**	-4,330	-4,500

Note: [a](observations: 286) significance level ***1%**5%*10%

[b](observations: 252) significance level ***1%**5%*10%

[c](observations: 286) significance level ***1%**5%*10%

Shaded columns refer to non-stationary series

Source: authors' calculations using Eviews

Table (03) : Conditional (unadjusted) correlation coefficient

	Stable period		Turmoil period		Full period		t-test	Contagion?
Country	**ρ**	**σ**	**ρ**	**σ**	**ρ**	**σ**		
Morocco	0,13131	0,3702	0,4072	2,28890	0,2851	0,4786	1,5758	**No**
Tunisia	0,0806	0,3157	0,6098	0,8532	0,1493	0,4026	3,2964	**Yes**
Egypt	0,0702	0,7799	0,6773	3,1473	0,3255	1,1142	3,9580	**Yes**
Jordan	**-0,0606**	0,6919	-0,1939	0,6133	0,1147	0,7686	-0,7112	**No**
Lebanon	0,0557	0,8421	-0,3103	1,0083	0,1629	0,8854	-1,9773	**No**
Qatar	0,0450	0,8113	0,9490	2,9612	0,2464	1,0638	9,3261	**Yes**

Source: authors' calculations using Eviews

Table (04) : Unconditional (adjusted) correlation coefficient

	Stable period	Turmoil period	Full period	t-test	Contagion?
Country	**ρ**	**ρ**	**ρ**		
Morocco	0,0378	0,1264	0,2851	0,4685	**No**
Tunisia	0,0231	0,2148	0,1493	1,0243	**No**
Egypt	0,0201	0,2545	0,3255	1,2607	**No**
Jordan	-0,0174	-0,0564	0,1147	-0,2053	**No**
Lebanon	0,0159	-0,0929	0,1629	-0,5729	**No**
Qatar	0,0129	0,6521	0,2464	4,0221	**Yes**

Source: authors' calculations using Eviews

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