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Volatility Spillovers and Contagion between Stock Markets

Emna Abdennadher[1,*], Slaheddine Helara[2]

[1]Higher Institute Of Management Of Sousse, University Of Sousse, Tunisia
[2]Higher Institute Of Management Of Tunis, University Of Tunisia, Tunisia
*Corresponding author: abdennadheremna@hotmail.com

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Abstract One of the most debated issues of financial markets is the importance of volatility and contagion, especially during the periods of global financial crises. To address this literature gap, this paper tries to examine the possible factors behind contagion. To achieve that, we examine a wide array of proxies' variables controlling fundamental and pure contagion for MENA and US stock markets during the period from April 2005 to March 2015 using a regression model. Overall, our results provide considerable evidence about the coexistence of "pure" and "fundamental-based contagion" during the global financial crises and its effect on the stock market volatility spillovers.

Keywords: *volatility spillover, fundamental based contagion, pure contagion, Global Financial Crisis, MENA stock markets*

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1. Introduction

The phenomenon of financial contagion has generated a lot of debates aiming at reducing its risks. This makes it possible to emphasize on links that may be transmission channels of shocks. In fact, a variation of shocks transmission ways is noted during the periods of crises and these variations appear to be important [1,2].

The succession of crises during the recent years to the Global Financial Crisis (GFC) showed that financial shocks in one country can quickly affect other countries and have bad effects on several other financial markets [3,4]. Consequently, this has fueled the debate on the contagious character of these financial crises and highlighted its seriousness [3,4]. In fact, there is a considerable ambiguity surrounding the precise definition of contagion. Generally, contagion signifies the extension of turmoil in the financial markets from one country to the financial markets of the other countries. Specifically, we traditionally oppose the fundamental contagion induced by real and financial interdependencies between countries [5] to the pure contagion which take into consideration investor behavior [6].

This study extends the literature by studying MENA stock markets, given that the researches made on these markets are minimal unlike the great number of researches made on developed financial markets. Truly, the importance of the emerging markets is that, in recent years, they have become more and more attractive to investors from developed countries [7]. From 1995, there was at least one African stock market listed at the top ten lists of the best performing markets in the world [8].

Moreover, diverse possible transmission mechanisms may be in place across different stock markets, particularly during the periods of financial crises. To address this literature gap, we use a combination of variables in order to examine the possible factors behind contagion. This has been little dealt with, literally, especially in the context of MENA countries.

To achieve that, we started by estimating volatilities of MENA stock markets. Then, using these estimated volatilities, we investigate the volatility spillover between MENA and USA stock markets in a GFC context. Finally, using a regression model, we examine a wide array of variables proxies controlling for fundamental contagion such as inflation, interest rates, trade balance and other proxies controlling for pure contagion like liquidity, asymmetry of information as well as Global Index of Economic Policy Uncertainty (GEPUIndex).

Actually, we can note that MENA stock markets exhibit the presence of significant volatility spillover in general. Thus, the results show that the MENA stock markets respond heterogeneously to the GFC. For that, an overview on the results allows us to especially identify the intensification and the appearance of new significant volatility spillover among countries, which may be explained by both variables proxying pure contagion and fundamental contagion in determining contagion outcomes. As a result, these findings confirm our hypothesis about the coexistence of "pure contagion" and "fundamentals-based contagion" during the GFC. In fact, this is consistent with Gómez-Puig and Sosvilla-Rivero [2] and Leung et al [1],

where their empirical evidence confirms the presence of either one or both types of contagion during the crises period.

The rest of the paper is organized as follows: Section 2 introduces literature review and hypothesis development. Section 3 presents our econometric methodology and data used, while Section 4 discusses the results. Finally, Section 5 concludes.

2. Literature Review and Hypothesis Development

Studying financial contagion is important in generating a better understanding of how it can be transmitted through markets and then embedded in asset prices. Moreover, it also informs us about volatility spillover between markets. In crashes and crises times, especially, it is critical to examine this phenomenon to better understand market booms and crashes. In the following paragraphs, we review relevant theories and empirical literature on volatility spillover as well as contagion to develop our research hypotheses.

Several authors such as Assaf [9] and Chau *et al* [10] demonstrate that the GFC has an impact on all the countries; the MENA's relatively low integration into global financial markets has minimized some of the downturn on MENA's economies while Hammoudeh and Li [11] concluded that most of Gulf stock markets were more influenced by major international events than local and regional factors. Hence, we set our first hypothesis as follows.

H1: There is a significant volatility spillover between stock markets in the context of the GFC.

Contagion maybe triggered by possible macroeconomic factors such as: Trade balance, interest rate and inflation.

According to Dornbusch *et al* [12], trade links can play an important role in the inter-connection between different economies. Several studies [13,14] find that there is a link between the financial markets and macroeconomic variables such as interest rate, trade finance, exchange rate and consequently real sector economic activity.

In the context of interest rate, several authors [13,15] reveal that interest rate may have an impact on stock return.

As a matter of fact, stock market volatility changes through time which may be related to the volatility of inflation [16,17].

Therefore, we can develop our second hypothesis:

H2: Volatility spillover between stock markets is explained by fundamental contagion in financial crises.

Considering pure contagion and due to it reflects a part of the non-visible factors, it can be expressed via variables proxies capturing market sentiment in each different country. As a result, three variables have been used to gauge irrational investors' behavior which is the information asymmetry in each country, liquidity problems, and finally the global market sentiment.

Considering information asymmetry, the relationship investigation between volume and returns is essential to the extent that it permits to have a clear idea about how market information is firstly transmitted and then implanted in asset prices [18,19].

Moreover, a second channel, which is the cross-market illiquidity transmission, can be noted [20]. Amihud and Mendelson [21] find that liquidity is correlated with trading frequency in equilibrium.

As we are talking about pure contagion, which may be triggered by a shift in idiosyncratic market sentiments. From a literary point of view [2], we use the Global Index of Economic Policy Uncertainty (GEPU Index).

This allows us to develop our third hypothesis:

H3: Volatility spillover between stock markets is explained by pure contagion in financial crises.

Suggesting a mixture of "fundamentals-based contagion" as well as "pure contagion" and based on the contagion theory of the previous work, we set our fourth hypothesis as follows.

H4: Volatility spillover between stock markets is explained by a mixture of fundamental and pure contagion in financial crises.

3. Econometric Methodology

3.1. Estimating Volatility

In order to estimate the volatility series, we make use of GARCH (1, 1) model:

$$\sigma_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 \quad (1)$$

Furthermore, in order to take into account the GFC effect, we include in the regression model a dummy variable which took a value of one for the pre-crisis period and zero otherwise.

Indeed, the choice of the break point was motivated by Bai and Perron [22,23] results where we have perceived that for the period under study, the year that has the highest number of structural breaks is 2008. This is not surprising because September 2008 is associated with the break of the American investment bank Lehman Brothers. Consequently, we have chosen the GFC, whose effects have spread to most countries [24], including the emerging ones[1], as a break point. Thus, the "pre-crisis period" runs from April 2005 to August 2008 and the "post crisis period" runs from September 2009 to March 2015.

3.2. General Volatility Spillover Effects

We perform a regression analysis to examine the volatility transmission in MENA and USA markets. The model can be expressed as below with $\sigma_{SM,i}^2$ representing the volatility of a stock market and $\sigma_{SM,k}^2$ indicating the volatility of the remaining stock markets. The volatilities of the rest of stock markets $\sigma_{SM,k}^2$ stand for the independent variable of spillover effects study between stock markets.

$$\sigma_{SM,i}^2 = \alpha_{i,0} + \sum_{k=0}^{n} \alpha_{i,k} \sigma_{SM,k}^2 + d_{mi} D_{mi} + \varepsilon_{i,k} \quad (2)$$

[1] To save space, the Bai and Peroon [22,23] results are available upon request.

where D_{mi} is a dummy variable which takes the value 0 before the breakpoint (GFC) and 1 after the breakpoint until the end of the period. The spillover coefficient $\alpha_{i,0}$ verifies if the volatility of the rest of stock markets has an impact on the volatility of the equity markets.

3.3. Volatility Spillover Effects in the Context of GFC (Contagion)

Our aim is to establish the relevant determinants of volatility spillover under the theoretical framework of "fundamental contagion" and "pure contagion" during the period under study. For that, we expand the regression model of Eq (2) which can be expressed as below, $\sigma^2_{SM,i}$ representing the volatility of a stock market and $\sigma^2_{SM,k}$ indicating the volatility of the rest of stock markets. The volatilities of the rest of stock markets $\sigma^2_{SM,k}$ correspond to the independent variable for the analysis of spillover effects between stock markets.

$$\begin{aligned}\sigma^2_{SM,i} &= \alpha_{i,0} + \sum_{k=0}^{n}\alpha_{i,k}\sigma^2_{SM,k} + a_i Inflation \\ &+ b_i Interest\ rate + c_i Trade\_balance + d_i Volume \\ &+ e_i Turnover\ ratio + f_i Global\ EPU\ index \\ &+ d_{mi}D_{mi} + \varepsilon_{i,k}\end{aligned} \quad (3)$$

where D_{mi} is the dummy variable.

The spillover coefficient $\alpha_{i,0}$ verifies if the volatility of the remaining stock markets has an impact on the volatility of the equity markets. The regression coefficients a_i, b_i, c_i, d_i, e_i, and f_i measure respectively the regression controls for fundamental contagion (Inflation, interest rates and Trade balance) and pure contagion (Volume, Turnover ratio and Global EPU index).

4. Data Presentation and Preliminary Study

Our empirical study will be conducted in eight countries: the USA market (Dow Jones Index, DJI) and seven from Middle East and African region: Bahrain (Bahrain All Share, BHSEASI); Dubai (Dubai Financial Market, DFM), Jordan (Amman Se Financial Market, ASE), Morocco (Morocco All Share, MASI), Saudi (Saudi Tadawul All Share, Tasi), Turkey (Borsa Istanbul, Bist National 100) and Tunisia (Tunisia Stock Exchange, Tunindex). The monthly data (closing prices) were obtained from Datastream. The period under study starts from April 2004 to March 2015.

In order to investigate the factors behind the volatility spillover between the different stock markets, we will focus on the literature presenting the two operational definitions of contagion.

To achieve that, we examine on the one hand a large range of proxies variables controlling for fundamental contagion such as inflation, interest rates, trade balance, and on the other hand, other proxies controlling for pure contagion like liquidity, asymmetry of information, and also the Global index of economic policy uncertainty [2].

A summary with the definition, proxies and frequency of all variables used in our study is presented in Table 1.

Table 1. Definition, proxies and frequency of the variables in the regression model

Data	Proxies	Frequency
Data of stock markets	Stock Volatility	Monthly
Proxies controlling for fundamental contagion		
Trade-Balance	Trade balance is measured by the balance of imports and exports amongst all other trading partners [12].	Monthly
Inflation	Proxy Consumer Price Index(CPI) [16]	Monthly
Interest rate	Interest on deposit [25]	Monthly
Proxies controlling for pure contagion		
Liquidity	Turnover Ratio (Datar et al., 1998)	Monthly
Information Asymmetry	Trading volume (Chordia & Swaminathan, 2000)	Monthly
Global Index of economic policy uncertainty	(Baker et al., 2016)	Monthly

Throughout the study, the returns are calculated by: $r_t = 100 \times ln\,(P_t/P_{t-1})$ where P_t is the monthly closing price and r_t is the monthly log-returns.

Table 2. Summary statistics for monthly returns

	Bahrain	Dubai	Jordan	Morocco	Saudi	Tunisia	Turkey	USA
Mean	-0,006	-0,005	-0,009	0,249	-0,030	0,000	0,051	0,011
Median	-0,002	-0,046	-0,014	0,154	0,177	0,000	0,210	0,046
Maximum	0,169	6,227	0,663	9,790	3,003	0,006	3,697	1,847
Minimum	-0,227	-7,095	-0,611	-5,958	-4,757	-0,011	-5,020	-1,606
Std. Dev.	0,063	1,889	0,187	2,133	1,435	0,003	1,340	0,419
Skewness	-0,588	-0,139	-0,027	0,475	-0,825	-0,849	-0,393	0,109
Kurtosis	4,783	5,161	5,693	6,090	4,081	5,390	3,958	7,323
Jarque-Bera	22,616***	23,543***	35,960***	51,810***	19,286***	42,617***	7,604***	92,918***
ADF	-7,323***	-9,414***	-9,194***	-9,800***	-9,354***	-10,06***	-9,825***	-9,124***
LB (12)	35,266***	20,239**	26,312***	19,355*	16,419	7,691	11,109	31,091***
LB²(12)	28,107***	22,672**	20,920**	14,590	32,720***	5,954	28,992***	36,695***
Arch-Lm	10,761***	5,802***	3,531***	1,784	1,223	0,346	0,475	3,645**
Observations	121	121	121	121	121	121	121	121
Note: *, **, *** indicate significance at 1 %, 5% and 10% respectively								

Table 2 presents our summary statistics, where we may note via the Q statistics results, the presence of serial correlation in both levels and squared levels, and also suggesting volatility time varying. We can also notice the strong evidence of Arch effects in the residual series for most of the markets. Thus, GARCH model will be used to capture the fat tails and volatility time-variant found in the stock series.

To provide more insights on stock markets behavior during the period under study, we depict in Figure 1 the monthly volatilities of MENA and US stock Returns over Time. We can note the presence of volatility clustering feature graphically from the presence of sustained periods of high or low volatility.

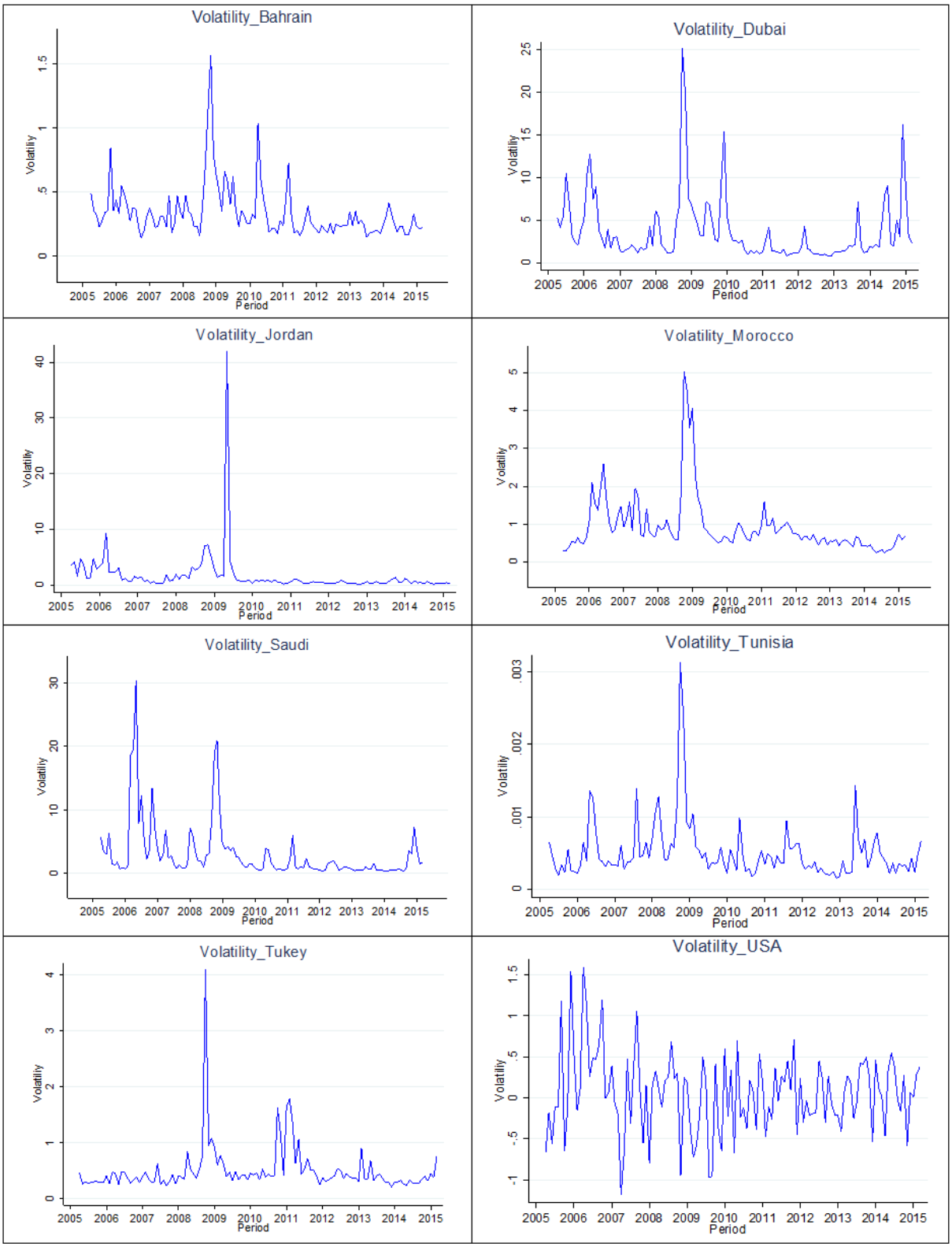

Figure 1. Monthly volatilities of MENA and US stock Returns over Time

5. Results and Interpretations

5.1. Estimated Volatilities of Stock Markets

The results of GARCH (1, 1) model which are shown in Table 3 and which reveal that GARCH parameters are statistically significant at 1% level.

Table 3. Estimated GARCH (1, 1) coefficients

Country	α_1	β 1
Bahrain	0,770***	-0,120***
Dubai	0,180**	0,509***
Jordan	0,078**	0,888***
Morocco	0,117	0,680**
Saudi	0,561***	0,453***
Tunisia	0,776***	-0,07***
Turkey	0,107	0,755**
USA	2,590***	0,165***
Note: *, **, *** indicate significance at 1 %, 5% and 10% respectively		

5.2. General Volatility Spillover Effects

Table 4 summarizes the volatility spillover results and effects between stock market "X" and the rest of stock markets in the context of the global financial crises, using Eq. (3).

To assess multicollinearity (Pallant, 2007) of the explanatory variables, we use the tolerance and the variance inflation factor (VIF).

Thus, the results show a heterogeneity of MENA stock markets in the context of the influence of the GFC. Where we can note that the dummy variables for the Dubai, Jordan, Morocco and Tunisia markets are insignificant. However, it is negatively significant for the Saudi market and positively significant for the Turkish market. These results were confirmed by Maghyereh *et al* [26] and Chau *et al* [10] who found that MENA equities are weakly associated with the World.

While our results are partially in contrast to those presented in Hammoudeh and Li [11] and Mensi *et al* [27] who found that emerging markets were more influenced by major international events than local and regional factors. This is due to the weakness and immaturity of their financial institutions and regulatory systems.

We can note that for the Bahrain market, there is a significant volatility spillover in general. In other words, most of the coefficients in the volatility equation are significant, except for Saudi and Turkey. However, the coefficient of dummy variables is statistically insignificant suggesting that the recent GFC do not influence the volatility of Bahrain market. Table 4 shows also, that the Bahraini and Saudi volatilities have a positive significant impact on the Dubai, Jordan and Moroccan volatilities. Actually, our results are similar to those of Abbes and Trichilli [28], proving that for MENA stock markets, Islamic indices of Bahrain and Egypt cause the dynamic of other Islamic indices (Kuwait, Oman, Jordan and Morocco).

Table 4. Volatility spillovers between stock markets

Country	variable	Vol_Bahrain	Vol_Dubai	Vol_Jordan	Vol_Morocco	Vol_Saudi	Vol_Tunisia	Vol_Turkey	Vol_USA	Dummy	cons	Adj.R^2
Bahrain	**Estimate**	----	0.010*	0.009***	0.096***	0.002	0.956*	-0.002	-0.083*	0.018	0.129***	0.505
	Std.Err.	----	0.005	0.003	0.028	0.004	0.493	0.039	0.027	0.031	0.030	
	T-value	-----	2.050	2.710	3.410	0.460	1.930	-0.060	-1.930	0.018	40270	
	Tolerance	------	1.830	1.090	2.690	2.350	2.260	1.810	1.060			
	VIF	----	0.547	0.919	0.372	0.426	0.443	0.552	0.942			
Dubai	**Estimate**	3,837**	----	0,029	0.073	0.345***	0.847	10,823	-0,336	0,692	-0,117	0.435
	Std.Err.	1,869	----	0,071	0.593	0.081	0,821	10,004	0,562	0,622	0,656	
	T-value	2,050	----	0,400	0.120	4.270	1.030	1,080	-0,600	1,110	-0,180	
	Tolerance	2.09	----	1.16	2.97	2.02	1.79	2.31	1.09			
	VIF	0.479	----	0.863	0.337	0.495	0.557	0.433	0.914			
Jordon	**Estimate**	6,644***	0,051	----	-0,136	0,105	-0,262	-9,506	-0,093	-0,338	-0,019	0.076
	Std.Err.	2,454	0,126	----	0,788	0,115	1,098	13,355	0,749	0,831	0,872	
	T-value	2,710	0,400	----	-0,170	0,910	-0,240	-0,710	-0,120	-0,410	-0,020	
	Tolerance		2,030	----	1,900	2,970	2,340	1,810	2,320			
	VIF		0,492	----	0,527	0,337	0,428	0,552	0,430			
Morocco	**Estimate**	0,989***	0,002	-0,002	----	0,040**	0,500***	4,727***	0,008	-0,096	0,055	0.639
	Std.Err.	0,290	0,015	0,011	----	0,013	0,123	1,547	0,090	0,100	0,105	
	T-value	3,410	0,120	-0,170	----	3,020	4,050	3,060	0,090	-0,960	0,530	
	Tolerance	1,960	1,900	1,160	----	2,170	1,580	2,150	1,100			
	VIF	0,510	0,527	0,862	----	0,460	0,634	0,464	0,912			
Saudi	**Estimate**	0,946	0,409***	0,070	1,874***	----	-1,091	21, 440**	1,049*	-1,96***	-0,028	0,544
	Std.Err.	2,073	0,096	0,077	0,621	----	0,893	10,770	0,605	0,655	0,714	
	T-value	0,460	4,270	0,910	3,020	----	-1,220	1,990	1,730	-3,000	-0,040	
	Tolerance	2,160	1,630	1,150	2,740	----	1,790	2,250	1,070			
	VIF	0,462	0,613	0,868	0,364	----	0,560	0,444	0,936			
Turkey	**Estimate**	-0,013	0,011	-0,002	0,258***	-0,012	----	2,726	0,028	0,206***	-0,020	0,408
	Std.Err.	0,219	0,011	0,008	0,064	0,010	----	1,128	0,065	0,069	0,075	
	T-value	-0,060	1,030	-0,240	4,050	-1,220	----	2,410	0,430	2,980	-0,260	
	Tolerance	2,170	1,880	1,160	2,590	2,320	----	2,220	1,100			
	VIF	0,461	0,532	0,862	0,386	0,431	----	0,451	0,913			
Tunisia	**Estimate**	0,034	0,000	0,000	0,016	0,001	0,019	----	0,000	0,000	0,008	0,572
	Std.Err.	0,076	0,001	0,000	0,005	0,000	0,008	----	0,005	0,000	0,006	
	T-value	1,930	1,080	-0,710	3,060	1,990	2,410	----	0,160	-0,070	1,340	
	Tolerance	2,100	1,880	1,150	2,740	2,270	1,720	----	1,100			
	VIF	0,477	0, 532	0,866	0,365	0,440	0, 581	----	0,912			
Note: (1) *, **, *** indicate significance levels at 1 %, 5% and 10% respectively; **(2)** Vol_Bahrain, Vol_Dubai, Vol_Jordan,Vol_Morocco,Vol_Saudi,Vol_Tunisia,Vol_Turkey and Vol_USA indicate stock markets 'volatility of Bahrain, Dubai, Jordan, Morocco, Saudi, Tunisia, Turkey and USA respectively.												

Table 5. Determinants of volatility spillover changes between stock markets

	Bahrain			Dubai			Jordan		
Variables	**Coef.**	**Std. Err.**	**T-value**	**Coef.**	**Std. Err.**	**T-value**	**Coef.**	**Std. Err.**	**T-value**
Vol_Bahrain	---	---	---	2,547	1,657	1,540	4,208	2,619	1,610
Vol_Dubai	0,003	0,005	0,490	---	---	---	0,022	0,133	0,160
Vol_Jordan	0,008**	0,004	2,140	0,010	0,061	0,170	---	---	---
Vol_Morocco	0,104***	0,033	3,130	0,544	0,526	1,030	-0,953	0,983	-0,970
Vol_Saudi	0,003	0,005	0,640	0,253***	0,073	3,470	0,142	0,117	1,210
Vol_ Tunisia	0,978*	0.520	1,880	11,533	9,158	1,260	-7,552	14,363	-0,530
Vol_Turkey	0,005	0,0411	0,120	1,553**	0,741	2,100	0,045	1,155	0,040
Vol_USA	-0,052*	0,028	-1,860	-0,091	0,492	-0,180	0,101	0,759	0,130
Inflation	0,097	0,070	1,370	-0,2***	0,073	-2,710	0,861	0,578	1,490
Interest rates	0,019	0,026	0,720	-1,071	1,102	-0,970	-0,101	0,074	-1,360
Trade-Balance	-0,016	0,030	-0,540	-0,918	0,947	-0,970	-1,367	3,206	-0,430
Volume	-56,236	37,477	-1,490	0,879***	0,327	2,690	1,305	1,051	1,240
Turnover	0,039	0.005	0,790	0,102**	0,041	2,470	0,000	0,383	0,000
Global EPU index	0,000	0.005	0,724	-0,006	0,01	-0,62	0,004	0,014	0,290
Dummy	0,213**	0,100	2,110	2,740**	1,059	2,590	3,936**	1,884	2,090
cons	464,905	310,570	1,500	8,438	19,839	0,430	-23,208	22,066	-1,050
Adj.R²	0,526			0.5681			0.0990		
	Morocco			**Saudi**			**Tunisia**		
Variables	**Coef.**	**Std. Err.**	**T-value**	**Coef.**	**Std. Err.**	**T-value**	**Coef.**	**Std. Err.**	**T-value**
Vol_Bahrain	0,739**	0,298	2,480	0,775	2,184	0,350	0,036*	0,019	1,930
Vol_Dubai	0,023	0,017	1,360	0,432***	0,100	4,310	0,001	0,000	1,370
Vol_Morocco	---	---	---	0,082	0,081	1,000	0,000	0,000	0,030
Vol_Jordan	-0,013	0,011	-1,130	1,197	0,798	1,500	0,018***	0,006	2,990
Vol_Saudi	0,033**	0,013	2,510	---	---	---	0,001	0,000	1,500
Vol_Tunisia	3,988**	1,626	2,450	23,918**	11,325	2,110	---	---	---
Vol_Turkey	0,302**	0,130	2,330	-0,957	0,961	-1,000	0,016**	0,008	2,000
Vol_USA	0,053	0,086	0,610	0,758	0,627	1,210	0,000	0,005	0,070
Inflation	-0,078***	0,027	-2,840	0,793	0,597	1,330	0,000	0,000	0,110
Interest rates	1,052***	0,385	2,730	0,004	0,061	0,070	0,001	0,009	1,120
Trade-Balance	0,267	0,408	0,650	4,016*	2,303	1,740	-0,047	0,031	-1,470
Volume	0,453**	0,208	2,180	2,147	1,540	1,390	0,019	0,018	1,050
Turnover	1,038	0,938	1,110	-0,122	0,115	-1,060	0,000	0,000	-1,100
Global EPU index	0,002	0,002	1,530	-0,001	0,012	-0,100	0,000	0,000	1,670
Dummy	0,330	0,218	1,520	2,214	2,583	0,860	-0,024	0,017	-1,440
cons	-2,768	3,457	-0,800	-38,453**	22,458	-1,710	-0,239*	0,141	-1,690
Adj.R²	0.6875			0,541			0.5624		

	Turkey						
variables	**Coef.**	**Std. Err.**	**T-value**	**variables**	**Coef.**	**Std. Err.**	**T-value**
Vol_Bahrain	0,025	0,218	0,120	**Volume**	-0,072	0,139	-0,520
Vol_Dubai	0,017	0,011	1,610	**Turnover**	-0,020	0,015	-1,330
Vol_Jordan	-0,001	0,008	-0,130	**Global EPU index**	0,000	0,001	-0,270
Vol_Morocco	0,344***	0,072	4,780	**Dummy**	0,149	0,183	0,810
Vol_Saudi	-0,022**	0,010	-2,220	**cons**	1,538	2,332	0,660
Vol_Turkey	---	---	--	**Adj.R²**	0,475		
Vol_Tunisia	3,356**	1,133	2,960				
Vol_USA	0,010	0,062	0,160				
Inflation	0,000	0,003	-0,100				
Interest rates	-0,034*	0,019	-1,790				
Trade-Balance	-1,039***	0,356	-2,920				

Note: (1) *, **, *** indicate significance levels at
1 %, 5% and 10% respectively; (2) Vol_Bahrain,Vol_Dubai,Vol_Jordan,Vol_Morocco,Vol_S audi,Vol_Tunisia,Vol_Turkey and Vol_USA indicate stock markets ' volatility of Bahrain, Dubai, Jordan, Morocco, Saudi, Tunisia, Turkey, and USA respectively.

5.3. Volatility Spillover Effects in the Context of GFC (Contagion)

Table 5 represents the estimates of the regression of the volatility of market "X" against the volatilities of the other equity markets (MENA and US stock markets) including a dummy variable in order to assess the impact of the GFC in this context. The regression controls for fundamental contagion (Inflation, Interest rates and Trade-balance) and pure contagion (log volume, Turnover ratio and Global EPU index) described by regression coefficient.

An overview of the results allows us to note that there is a significant volatility spillover among countries; some were intensified, others have emerged and some others decrease.

For instance, we find significant positive volatility spillover increases from the Moroccan market to the Turkish one, new significant negative and positive

volatility spillover from both the Saudi and Tunisian markets respectively to the Turkish market. This increase in volatility spillover is explained by interest rate and trade balance. While, for the Saudi market an increase in volatility spillover from the Dubai and Tunisian markets is noted. This intensification is explained by the trade balance.

For the Dubai market, we can remark the apparition of new volatility spillover from the Turkish to the Dubai market and the slightly decrease from the Saudi to the Dubai market (it decreases from 0.345 to 0.253). The additional controls for fundamental contagion and pure contagion show that inflation, information asymmetry (volume) and liquidity (turnover ratio) influence the volatility spillover changes between the Turkish and Saudi markets to the Dubai market. We can note also, that the dummy variable is significant at 5%, indicating that the GFC has an impact on the volatility spillover of these markets.

Interestingly, The Global EPU index measuring global market sentiment was found to be statistically insignificant for no country (insignificant for all countries). In the case of the global financial crises, the empirical findings do not support the occurrence of either "fundamentals-based" or "pure" contagion in MENA countries, rather it retains the that a mixture both has taken place. And this is found in examining all volatility spillovers. As a result, we find that not only variables which capture pure contagion are statistically significant, but also that macroeconomic variables which gauge inflation, interest rate and trade balance are also relevant.

Dungey and Gajurel [29] evoke that the two types of contagion are not necessary mutually exclusive. While, Arghyrou and Kontonikas [30] showed that a marked shift in market pricing behavior from a pre-crisis 'convergence-trade' model before August 2007 are influenced by both macro fundamentals and international risk afterward. Beirne and Fratzscher [31] document that the prime explanation for the sharp sovereign risk increase during the Europe debt crisis was due to fundamental rather than to pure contagion. By the same taken, Gómez-Puig and Sosvilla-Rivero [2] found that irrational investors' behavior could lead to financial panics in crises and to volatility spillover increases in excess of macroeconomic fundamentals. These results are consistent with Leung *et al* [1] who studied the hourly volatility between developed stock markets and their exchange rates, where the results highlight the important role of both variables proxying market sentiment and macroeconomic fundamentals in determining contagion outcomes.

Whereas, for the Tunisian market, we can notice that the coefficients in the volatility equation are insignificant and very close to zero. Also, the coefficient of dummy variables is statistically insignificant suggesting that the recent global financial crises do not influence the volatility of Tunisian market.

These results were confirmed by Boussaidi [32] and Naoui et al. (2010) who found that this market marks weak dynamic conditional correlations with the US market and seems unaffected by the subprime crisis. The Tunisian market is characterized by a low volume of trading on the market and market microstructure distortions [33,34].

6. Conclusion

We have empirically investigated the dynamic relationship of MENA and USA stock markets and examine whether the volatility transmission was due to pure or fundamentals-based contagion for the period of 2004 till 2015 covering the non-crises period and the global financial crisis. Our empirical investigation lead to a number of interesting results. First, we have found that MENA stock markets exhibit the presence of significant volatility spillover in general. Thus, the results demonstrate a heterogeneity of MENA stock markets in the context of the influence of the GFC were similarly found by Maghyereh and Awartani [26] and Chau *et al* [10] showing that there is little or no significant effect on the interaction and integration of MENA region with the World market.

Finally, an overview on the results confirm our hypothesis about the simultaneous existence of the two notions of contagion during the GFC, which is similar to results found by Gómez-Puig and Sosvilla-Rivero [2] and Leung et al [1], showing that irrational investors' behavior could lead to financial panics in crises, and to the volatility spillover increases in excess of macroeconomic fundamentals.

A future research may investigate fundamental contagion through taking additional variables that measure local and regional macro fundamentals such as Net position in relation to the rest of the world (Current-account-balance-to-GDP); Banks debt. Moreover, the study of pure contagion may be extended through including variables that measure local and regional market sentiment such as rating (credit rating scale).

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