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Behavioral Finance and Financial Contagion: The Evidence of DCC-MGARCH Model From 63 Equity Markets

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ABSTRACT

The paper aims to test the existence of financial contagion between foreign stock markets of several emerging and developed countries during the U.S subprime crisis. It empirically attests for contagion through a DCC-MGARCH (1.1) and an adjusted correlation test over 63 emerging and developing stock markets during the period from 02/01/2003 to 31/12/2013. As a result of the model of DCC-MGARCH analysis, we find the evidence of contagion during U.S subprime crisis for most of the developed and emerging countries. Another finding is the emerging markets seem to be the most influenced by the contagion effects during U.S. subprime crisis. Since financial contagion is important for monetary policy, risk measurement, asset pricing and portfolio allocation, the findings of paper may be the interest of policy makers, investors, and portfolio managers.

Keywords: Dynamic Conditional Correlation, Financial Crisis, Financial Contagion, Interdependence
JEL Classifications: E44, G01

1. INTRODUCTION

During the last decades, and since the collapse of the Bretton Woods system 1971, the crises which had shaken international markets include both emerging and developing markets. These key historic downturns explicitly track down particularly the growing financial vulnerability of those countries which are developing and open to international financial markets following policies of financial liberalization conducted at the beginning of the 1980s. Indeed, in a context of financial globalization enforced by financial liberalization, the growing volume of debts financing speculative investments is seen as the trigger of financial crises which scope, on the one hand, revived debates on the theoretical foundations of financial crises, and, on the other hand, re-launched discussions on the mechanisms likely to intensify propagation of these violent "ravages." Currently, the international financial system has been hit by a serious crisis since the summer of 2007 which manifestation initially surfaced on the real estate market soon affected the entire financial system.

Against these upheavals which made of the current crisis an international ordeal, it is quite important to question whether contagion has been the source of this bottleneck situation. Indeed, this paper tries to bring about some answers, thanks to the theories focusing on explaining contagion phenomena and to econometric modeling approaches used to decipher the phenomenon at the heart of this crisis. Our aim is then to empirically explain contagion in this crisis as a transmission mechanism across the US market and the other examined markets, using the DCC-MGARCH (1.1) technique and the test of correlation coefficients.

Financial or economic crises can have serious consequences for investors and as a result, the topic issue has attracted a considerable amount of interests among academic researchers. For example, the crash of 1987 (Forbes and Rigobon, 2002), the Russian, Brasilian and Asian crises of 1997-1998 (Forbes and Rigobon, 2002; Kenourgios et al., 2011), the terrorist attacks of 9.11 (Hon et al., 2004) and the "tech bubble" (Kenourgios et al., 2011) have been widely examined. More recently, scholars have addressed the impact of 2008-2009 financial crisis on foreign exchange markets (Baba and Packer, 2009; Melvin and Taylor, 2009; Fratzscher, 2009), on fixed income markets (Dwyer and Tkac, 2009; Acharya et al., 2009; Hartmann, 2010) and on stock markets (Bartman and Bodnar, 2009; Dooley and Hutchison, 2009; Billio and Caporin, 2010; Chudik and Fratzscher, 2011; Schwert, 2011; Syllignakis and Kouretas, 2011). All these studies demonstrate that financial markets' volatilities increase substantially during the crisis, which further implies that both financial markets' volatilities and correlations move together over time. 1 this co-movement diminishes the diversification benefits and it is commonly known to be apparent especially in the equity markets.

In this study, we investigate the effects of one major banking event, i.e., the financial crisis on the time-varying correlations of international stock markets.

Our objective is to examine the impact of this event on a total of 63 international stock markets from 6 different regions using an augmented dynamic conditional correlation (hereafter DCC) model. In particular, the model allows us to examine the effect of the financial crisis of 2008-2009 on the conditional correlations across all investigated stock markets while simultaneously controlling for changes in the conditional variances. Our study contributes to the earlier studies on the financial crisis by examining time varying covariance structure between global stock indexes during the financial crisis. Like Syllignakis and Kouretas (2011) we also analyze dynamic correlations, but unlike them, we do not focus on the contagion issue. Instead, we examine the dynamic correlations from the portfolio manager's point of view across global stock markets. Specifically, in addition to modeling the conditional covariance matrix we evaluate the performance of the estimated conditional correlations in the asset allocation framework, evaluating in-sample portfolio optimization and hedging performance.

We also extend the work of Syllignakis and Kouretas (2011) by reporting the results for all major economic areas, namely Developed Europe, G7, Asia Pacific, Middle East, Africa, Latin America, and Emerging Europe. Our study also adds to the earlier literature on DCC models by modeling simultaneously 63 stock index return series (i.e., the 62 stock markets' correlations against the U.S. market). The characteristics of the DCC models make it possible to take into account the effect of heteroscedasticity on the variance of the sixty-five return series over the estimation periods. By allowing correlation to change over time, we are able to demonstrate in a portfolio framework that the conditional model estimates outperform simple models. Our empirical findings show that the impact of the Lehman Brothers' collapse resulted in significant increases in correlations, whereas the acquisition of Bear Stearns had negligible effects on correlations.

We find that the effect of the Lehman Brothers' collapse on global stock markets is prominent for all the regions, which is evident from both the unconditional and conditional correlation estimates. Furthermore, when evaluating the performance of the conditional correlations in the asset allocation framework, in which portfolio optimization and hedging performance are considered in-sample, we find that the augmented DCC model outperforms all the other models. The augmented DCC model constitutes the lowest portfolio variances within all crisis periods implying that the augmented DCC model is efficient in capturing the dynamics of the stock market variances during high volatility periods.

This paper is structured as follows. The first section reviews the theoretical and empirical literature. The second presents the methodology and data. The third section presents and interprets the results. A Forth section concludes the paper.

2. REVIEW OF LITERATURE

Although contagion has recently attracted much attention especially of economists, several are the theoretical and empirical studies which treated this crises transmission mechanism. The abundance in contagion research in the financial literature made assigning a single definition to the concept even a harder task to carry out. Indeed, the multitude of studies on the topic is at the origin of the diversity in defining contagion.

Generally speaking, contagion describes the transmission of a country's financial markets disturbances to other countries' financial markets Marais (2004).

Dornbusch et al. (2000) define financial contagion as the transmission of markets shocks or imbalances. This process of transmission is possible when volatility stretches from the financial market of the country in crisis to the financial markets of other countries. Pericoli and Sbracia (2001).

Other authors stipulate that contagion occurs when there is a mutual influence and that channels of contagion relate to interdependence, whether real (Eichengreen et al., 1996), or financial. This latter is referred to as mechanical contagion (Calvo and Reinhart, 1996). Mechanical contagion describes noncontingent theories of crises. Other authors associate the presence of contagion with the significant increase of economic interdependence. In the financial literature, this describes contingent theories of crises. These theories put to the fore the investor's behavior. Masson (1998) and Forbes and Rigobon (2000) respectively qualified these theories as "pure contagion" and "shift contagion."

2.1. Contagion Theories

Financial literature distinguishes between two types of contagion: Mechanical contagion resulting from real and financial interdependencies between countries Calvo and Reinhart (1996); Kaminsky and Reinhart (1998), and psychological contagion focusing on the investor's behavior.

In fact, Forbes and Rigobon (2000) oppose two categories of contagion theories: Noncontingent theories and contingent theories. The first category assumes that transmission mechanisms following a shock are not significantly different from those prior to the crisis, whereas, the second category stipulates the mechanisms during or just after the shock are significantly different from those before the shock.

- Contingent theories: This current endorses the idea that financial crises follow channels of transmission basically different from those which prevailed before the shock, or which were even inexistent during the financial instability period (Forbes and Rigobon, 2000).
- Pritsker (2000) this category is primarily based on multiple equilibriums, endogenous liquidity, and political contagion.

- Noncontingent theories: This approach assumes that transmission mechanisms following a shock are not significantly different from those prior to the crisis. In other words, co-movements existing between markets represent only a continuation of pre-crisis interdependences. Moreover, Forbes and Rigobon (2000) reveal that these theories can be categorized into four fundamental channels; trade, coordination of economic policy, learning and random shocks.

2.2. Investors' Behavior

The distinction between contingent and noncontingent theories to crises reveals the crucial role of investors' behavior in the transmission process and especially with regard to financial contagion. These points to the heavy role of increased financial integration, as treated by Pritsker (2000) and Dornbush et al. (2000). In this regard, the authors insist that investors can make decisions which are ex-ante individually rational, leading to excessive co-movements.

Conceptually, Dornbush et al. (2000) distinguish three forms of investors' behavior as follows;

- Liquidity and incentive problems: It is a form of individual rational behavior associated with liquidity and other constraints on investors Dornbush et al. (2000).
- Information asymmetries and coordination problems: It is about another consideration which is able to generate contagion. This presumes mainly that investors are imperfectly informed. Indeed, in the absence of information investors assume that a financial crisis in one country may cause the emergence of a similar one in other countries Dornbush et al. (2000), Calvo (1999).
- Changes in the rules of the game: Contagion can also occur when there is a change in investors' assessment of the rules governing international financial transactions Calvo (1999).

2.3. A Preview of Contagion Models

Studying contagion, the theory has identified many possible contagion channels (Eichengreen et al., 1996), Kaminsky and Reinhart (2000), Forbes and Rigobon (2001), Dornbusch et al. (2000). Following these studies, we identified the main models representing and explaining contagion. Indeed, the six channels proposed by Dehove (2003) that Dornbusch et al. (2000) are classified into three categories as follows:

- Fundamentals-based contagion which distinguishes between business channel, finance, and change.
- Investors' behaviour - based contagion which distinguishes portfolios arbitration channels, liquidity and information asymmetries.
- Institutional change-based contagion induced by a crisis within a country.

3. METHODOLOGY AND EMPIRICAL EVIDENCE

In order to empirically analyze contagion in this paper, we use Forbes and Rigobon's definition (2001) which assumes that contagion is a significant increase in the links between markets following a shock in a country or a group of countries.

Thus, in view of conducting this empirical investigation, we align ourselves with the work of Chiang et al. (2007). These authors tried to study the Asian crisis using a DCC-GARCH(1.1) model and a test of adjusted correlation coefficients.

3.1. Dynamic Conditional Correlations' Asymmetric Model (DCC-GARCH(1.1)) Engle (2002)

We apply DCC-MGARCH model of Engle (2002) to test the existence of contagion during global financial crisis. A major advantage of using this model is the detection of possible changes in conditional correlations over time, which allows us to detect dynamic investor behavior in response to news and innovations. Moreover, the dynamic conditional correlations measure is appropriate to investigate possible contagion effects due to herding behavior in emerging financial markets during crises periods Corsetti et al. (2005), Chiang et al. (2007) and Syllignakis and Kouretas (2011). Another advantage of DCC-MGARCH model is that DCC-GARCH model estimates correlation coefficients of the standardized residuals and so accounts for heteroscedasticity directly (Chiang et al., 2007). Since the volatility is adjusted by the procedure, the time-varying correlation (DCC) does not have any bias from volatility. Unlike the volatility-adjusted cross-market correlations employed in Forbes and Rigobon (2002), DCC-GARCH continuously adjusts the correlation for the time-varying volatility. Hence, DCC provides a superior measure for correlation (Cho and Parhizgari, 2008). The estimation of Engle's DCC-GARCH model comprises two steps: The first is the estimation of the multivariate GARCH model; the second is an estimation of the conditional correlations that vary through time. The multivariate DCC-GARCH model is defined as follows;

$$X_t = \mu_t + H_t^{1/2} \varepsilon_t$$

$$\begin{cases} H_t = D_t R_t D_t \\ R_t = (\mathrm{diag}(Q_t))^{-1/2} Q_t (\mathrm{diag}(Q_t))^{-1/2} \\ D_t = \mathit{diag}(\sqrt{h_{11,t}}, \sqrt{h_{22,t}}, \ldots, \sqrt{h_{NN,t}}) \end{cases}$$

Where $X_t = (X_{1t}, X_{2t}, \ldots X_{Nt})$ is the vector of the past observations, H_t is the multivariate conditional variance, $\mu_t = (\mu_{1t}, \mu_{2t}, \ldots \mu_{Nt})$ is the vector of conditional returns, $\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t}, \ldots \varepsilon_{Nt})$ is the vector of the standardized residuals, R_t is a N×N symmetric dynamic correlations matrix and D_t is a diagonal matrix of conditional standard deviations for return series, obtained from estimating a multivariate GARCH model with $\sqrt{h_{ii,t}}$ on the i^{th} diagonal, i=1, 2,…N.

The DCC specification is defined as follows;

$$R_t = Q{*}_t^{-1} Q_t Q{*}_t^{-1}$$

$$Q_t = (1 - \alpha - {}^2)\bar{Q} + \pm \mu_{t-1} \varepsilon'_{t-1} + {}^2 Q_{t-1}$$

Where Q_t is a positive matrix, it defines the structure and dynamic $Q{*}_t^{-1}$ resizes the items in Q_t to ensure that $|q_{ij}| \leq 1 Q{*}_t^{-1}$ is the inverse matrix of the matrix Q_t. Q_t is the conditional variance of standard errors.

And α and β are two scalar:

$\lambda_2 = \alpha$ and $\lambda_2 = \beta$ are parameters that govern the dynamics of conditional quasicorrelations.

λ_2 and λ_2 are nonnegative and satisfy $0 \le \lambda_1 + \lambda_2 < 1$.

Therefore, for a pair of markets i and j their conditional correlation at time t can be defined as:

Where q_{ij} is the element on the i^{th} line and j^{th} column of the matrix Q_t. The parameters are estimated using quasi-maximum likelihood method introduced by Bollerslev et al. (1992).

3.2. Contagion Effect Test with Dynamic Conditional Correlation Coefficient

We use t-statistics to test the consistency of dynamic correlation coefficients between foreign Stock markets returns in the pre-crisis and crisis periods to judge the contagion effect.

Hypothesis test:
We define null and alternative hypotheses as:

$$H_0 = \mu_\rho^{crisis} = \mu_\rho^{pre\text{-}crisis},\ H_1 = \mu_\rho^{crisis} \neq \mu_\rho^{pre\text{-}crisis}$$

Where μ_ρ^{crisis} and $\mu_\rho^{pre\text{-}crisis}$ are the conditional correlation coefficient means of population in the pre-crisis and crisis periods.

If the sample sizes are n^{crisis} and $n^{pre\text{-}crisis}$ the population variances σ^2 crisis and $\sigma^2_{pre\text{-}crisis}$ are different. If the means of dynamic correlation coefficients estimated by DCC are $\overline{\rho}_{ij}^{crisis}$ and $\overline{\rho}_{ij}^{pre\text{-}crisis}$ and the variances are $S^{2^{crisis}}$ and $S^{2^{pre\text{-}crisis}}$, the t-statistic is calculated as:

$$t = \frac{(\overline{\rho}_{ij}^{crisis} - \overline{\rho}_{ij}^{pre\text{-}crisis}) - (\mu_{\acute{A}}^{crisis} - \mu_{\acute{A}}^{pre\text{-}crisis})}{\sqrt{\frac{S^{2^{crisis}}}{n^{crisis}} + \frac{S^{2^{pre\text{-}crisis}}}{n^{pre\text{-}crisis}}}}$$

If t-statistics is significantly greater than the critical value, H0 is rejected supporting the existence of contagion effect.

3.3. Correlation Test: Measurement of Pure Contagion

The correlation coefficient is considered probability and statistics-wise as an indicator of the link between two variables. It is admitted then that two variables are correlated if these latter progress in a common fashion (Mignon, 2008).

We give two stochastic variables respectively ri and rj denoting stocks returns in two different markets. In order to test the relationship binding these returns, we will use the following simple linear model:

$$Y_{it} = \alpha + \beta X_{it} + \varepsilon_{it}$$

$$E(\varepsilon_{it}) = 0,\ E(\varepsilon_{it}^2) < \infty,\ E(X_{j,t}, \varepsilon_{it}) = 0$$

In this context, Forbes and Rigobon (2001) propose an adjusted correlation coefficient defined as follows:

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

And $\delta = \frac{V^c(X_t)}{V^t(X_t)} = 1$; where "c" and "t" respectively denote the crisis and the stability periods. Indeed, (δ) denotes the relative increase within V (X_t) between the stable and the crisis periods. Hence, in order to statistically test the increase of an adjusted correlation coefficient, we use the following two hypotheses:

$$\begin{cases} H_0 = \rho_1 = \rho_2 \\ H_1 = \rho_1 \neq \rho_2 \end{cases}$$

With

ρ_1: The crisis period correlation coefficient

ρ_2: The stable period correlation coefficient.

Still, to test the two hypotheses, we will use a Student test where the test statistics is defined as follows:

$$t = (\rho_1 - \rho_2)\sqrt{\frac{n_1 + n_2 - 4}{1 - (\rho_1 - \rho_2)^2}}$$

Where follows a Student (t) with (n_1+n_2-4) degrees of freedom. Then, accepting H_1 is about highlighting contagion between two markets, whereas the null hypothesis H_0 implies that the increase in the correlation coefficient reflects solely interdependence between the two markets.

4. EMPIRICAL EVIDENCE

The aim of this paper is then to empirically test for contagion of the US subprime financial crisis towards a set of emerging and developed stock markets. The paper first examines the effect of the subprime crisis on the 63 examined markets using a MGARCH-DCC (1.1), and second it attempts to identify the presence of pure contagion by testing the statistical importance of the increase in heteroscedasticity's adjusted correlation coefficients and this between the quiet and the crisis period (Forbes and Rigobon, 2001).

4.1. Data

The study examines the international transmission of the subprime financial crisis making us retain stock markets index as a variable. At this level, we notice that the data used in this study are daily stock markets data in terms of stock markets index for some tests and these indexes' daily returns of the 63 markets examined (P_t, t) which are computed as follows:

$$R_{it} = \frac{P_t - P_{t-1}}{P_{-1}}$$

With, P_t: Stock market's index I at day t

P_{-1}: Stock market's index i at day t−1

R_{it}: Index's return of stock market i at day t.

The retained data are stock indices, considered as the reference index for the sample's different markets. These latter are taken from internet 7 and priced in US dollar to eliminate any problems related to change rate variations.

The considered sample includes 63 stock markets, classified in terms of geographical location. The groups are as follows:

- Africa: Tunindex, Moroccan All Shares, FTSE/JSE 40 for Tunisia, Morroco and South Africa.
- Latin America: Marvel, Bovespa, IPSA select, Col General, IPC, IGVBL Bursatil, Venezuela SE Financial for Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela.
- Pacific/Asia: S&P/ASX 200, Shanghai, Hang Seng, Senex, Jakarta SE composite, FTSE Malaysia KLCI, DJTM NEW ZEALAND, Karachi 100, PSEI composite, SINGAPORE-DS Market, KOSPI, CSE All-share, Taiwan weighted, Thailand SET for Australia, China, Hong Kong, India, Indonesia, Malaysia New Zealand, Pakistan, Philippines, Singapore, South Korea, Sri Lanka, Taiwan et Thailand.
- North America.
- Europe: (1) Developed country: ATX, BEL 20, OMXC20, OMX Helsinki 25, Athens General, ICEX Main, ISEQ Overall, LUXEMBOURG SE LUXX, MALTA SE MSE, AEX, Oslo OBX, PSI 20, IBEX 35, OMX S30, SMI for Austria, Belgium, Denmark, Finland, Greece, Iceland, Ireland, Luxembourg, Netherland, Malta, Norway, Portugal, Spain, Suisse, Sweden, (2) Emerging country: Talinn SE General, PX, BSE sofix, Budapest SE, WIG20, RTSI, SAX, SBI, BIST 100 for Bulgaria, Czech republic, Estonia, Hungary, Poland, Russia, Slovakia, Slovenia and Turkey.
- G7: S&P/TSX, CAC 40, Euro stoxx 50, FTSE MIB, NIKKEI 225, FTSE100 for USA les, Canada, Japan, France, Germany, Italy and finally UK.
- Middle East: Bahrain all share, EGX30, Amman SE Genaral, Kuwait S.E, MSM30, QE General, Tadawul All share, ADX General for Bahrain, Egypt, Jordan, Kuwait, Oman, Qatar, Saudi Arabia and Unis Emirates Arabs.

The study period ranges between 02/01/2003 and 31/12/2013 using daily data with a total of 2870 observations for each market.

This period is divided into two sub-periods:

- Pre-crisis period between 02/01/2003 and 31/07/2007
- Post-crisis period between 01/08/2007 and 31/12/2013.

The first period totals 1195 observations while the second period totals 1675 observations. We notice that in this study we use the US S&P500 as a reference.

4.2. Results and Interpretations

4.2.1. Descriptive statistics of the variables: Appendix (Tables 1 and 2)

First, we interpret the descriptive statistics of the returns of stock indexes before and after the financial crisis, they summarize the means and standard deviations of the time series for 63 countries in our sample that spans the period from 02/01/2003 to 31/12/2013, These statistics lead several comments.

We note that for all series that the statistics of skewness and kurtosis are respectively different from 0 and 3. In addition to these results, the Jarque-Bera statistic shows a probability (0.0000) less than the 5% level, so we reject the assumption of a normal distribution of the series. That is to say that the normality of the distributions is not remarkable that the characteristics of the series appear to be different from a Gaussian distribution. It is found that the coefficient of kutosis far exceeds three; this ratio is significantly higher than 3 indicate the character series leptokurtic variables in question and to all countries.

Second, the skewness coefficient is different from zero; the presence of this asymmetry can be an indicator of non-linearity as the linear Gaussian models are necessarily symmetrical. Examining standard deviations during the crisis period, we notice a significant increase; also, the Volatility analysis shows that the standard deviation increased between the pre-crisis and the crisis periods. Indeed, the risk for all this countries is seen in relatively high standard deviations, which illustrate higher volatility in prices and instability of returns.

Statistics-wise, most of the series have either leftward or rightward flat skewness. Then, we note that most emerging and developed countries' returns have skewness coefficients either inferior or superior to zero, i.e., leftward and rightward distributions.

On the other hand, most examined variables have significant kurtosis coefficients, where for all variables they are superior to 3, in which some countries.

Therefore, the preliminary study of the statistical properties of the various series used is important as some statistics specific series should be checked to apply numerous econometric tests. Considering all these results, we can conclude that all series of the variables involved do not follow a normal distribution; this will motivate our choice later to use a model of ARCH. In this respect, will be analyzed the stationarity of the distribution of sets of all variables.

From the test stationarity ADF and PP over the various daily series tests, we see that all the series used are stationary. Let's start with the ADF test (with constant, with constant and trend; constant Ni or trend), all series have values of ADF below critical values not displayed directly Eviews, with levels 1%, 5% and 10%. The same is for the PP test, as can be noticed that all variables have a t-test lower values recorded by various critics Eviews PP. As the three thresholds for different types of PP are the same as that of ADF since the asymptotic distribution of the test statistic is the same to that observed in the case of ADF hence the rejection of the null hypothesis H_0 "he is a unit root, the process is not so stationary" PP test. It may be noted also that the probability of accepting H_0 for all series in both stationarity tests: ADF and PP equal to zero, we can conclude that all series are stationary in levels.

Table 1: Correlation coefficient test

Source S&P (500)	Pre-crisis coefficient correlation	T-student	Post-crisis coefficient correlation	T-student
Africa				
S&P (500)- FTSE/JSE TOP 40	0.8101318	0.19	0.4097633	9.46*
S&P (500)- Morocco All Shares Index	0.0184645	0.47	0.0098411	0.33
S&P (500)- Tunindex	0.0051111	0.20	−0.0305113	−0.51
Americas				
S&P (500)- Merval	0.4354	1.81	0.5163703	21.6*
S&P (500)- Bovespa	0.524099	22.38*	0.6050045	27.44*
S&P (500)- IPSA	0.339379	11.64*	0.4952221	26.25*
S&P (500)- IGBC	0.2342365	4.47*	0.3387607	11.57*
S&P (500)- BOLSA	0.5460665	22.71*	0.6224775	31.17*
S&P (500)- IGVBL	0.163498	5.13*	0.4404875	6.66*
S&P (500)- Venzuela SE Financial	0.0737337	1.89	−0.070758	−1.84
Asia Pacific				
S&P (500)- S&P ASX 20	0.087324	1.39	0.196621	2.76*
S&P (500)- Shanghai SE Composite	0.1561949	0.73	0.2826168	3.63*
S&P (500)- KOSPI	0.1442923	4.65*	0.244612	4.98*
S&P (500)- Hang seng	0.1333158	4.00*	0.2051532	8.42*
S&P (500)- Senex	0.1800496	5.23*	0.1958805	6.40*
S&P (500)- Jakarta SE composite	0.0567846	1.85	0.3187794	1.11
S&P (500)- KLCI	0.1306324	3.04*	0.1389905	3.04*
S&P (500)- DJTM NEW ZEALAND	0.0737337	1.89	0.1058207	2.53*
S&P (500)- Karachi SE 100	−0.000432	−0.021	−0.000432	−0.021
S&P (500)- PSEI	0.0170534	0.48	0.2133556	1.47
S&P (500)- SINGAPORE-DS Market	0.1889902	4.34*	0.228252	7.5*
S&P (500)- CSE All-share	−0.0534037	−0.97	−0.0134098	−0.43
S&P (500)- Taiwan SE weighted	0.133659	4.25*	0.2674141	3.70*
S&P (500)- Thailand DS market	0.0520232	1.69	0.169822	6.05*
Europe/Developed country				
S&P (500)- BEL 20	0.3809465	14.51*	0.5287069	22.35*
S&P (500)- OMXC20	0.3836659	15.15*	0.4066573	14.62*
S&P (500)- IBEX 20	0.4816906	19.34*	0.5313129	30.19*
S&P (500)- OMX H 25	0.326840	6.97*	0.473910	4.87*
S&P (500)- FTSE ATHEX20	0.1944846	6.04*	0.2093054	7.11*
S&P (500)- ISEQ	0.0938213	2.75*	0.4441315	18.48*
S&P (500)- OMX Iceland All Share	0.0287153	0.39	0.0620536	1.30
S&P (500)- ATX	0.4467215	16.93*	0.4471591	16.92*
S&P (500)- AEX	0.4953317	28.63*	0.6795922	19.33*
S&P (500)- Luxembourg SE LUXX	0.3390009	17.51*	0.4265902	19.29*
S&P (500)- OSLO SE OBX	0.494913	3.28*	0.6605659	17.88*
S&P (500)- PSI 20	0.27085	2.71*	0.565094	19.45*
S&P (500)- OMX 30	0.3892182	14.36*	0.5355962	26.7*
S&P (500)- SUISS SMI	0.424642	20.42*	0.5324005	23.85*
Europe/Emerging country				
S&P (500)-BSE SOFIX	−0.0046915	−0.13	0.079564	2.21*
S&P (500)- OMXT	0.1476794	6.86*	0.1685431	5.91*
S&P (500)- Budapest BUX	0.0674468	2.02*	0.3251012	11.48*
S&P (500)- Malta SE MSE	−0.0297057	−0.92	−0.0234464	−0.95
S&P (500)- WIG 20	0.3589161	13.48*	0.4058437	18.66*
S&P (500)- PX Global Index	0.2407915	10.48*	0.4986464	7.41*
S&P (500)- RTS Index	0.1091885	2.88*	0.4795759	10.16*
S&P (500)- SAX 16	−0.0007954	−0.03	0.0090207	0.40
S&P (500)- SBI	−0.049909	−1.34	0.018739	1.00
S&P (500)- Turkey DS Market	0.2207173	9.35*	0.3093722	9.95*
Group 7				
S&P (500)- DJ EURO STOXX 50	0.5640699	25.07*	0.6188495	34.15*
S&P (500)- S&P TSX composite index	0.6801251	36.14*	0.7319408	20.57*
S&P (500)- CAC40	0.4441832	18.29*	0.6105687	32.08*
S&P (500)- FTSE MIB Index	0.4924284	20.16*	0.4921689	22.13*
S&P (500)- NIKKEI 225	0.1038212	3.50*	0.1637177	5.94*
S&P (500)- FSTE 100	0.3698755	13.77*	0.6917973	5.94*
Middle East				
S&P (500)- Saudi Tadawul All Share	0.002498	0.09	0.0779926	0.10
S&P (500)- Bahrain All Share	0.01078	0.40	0.0228204	0.78

(*Contd...*)

Table 1: (*Continued*)

Source S&P (500)	Pre-crisis coefficient correlation	T-student	Post-crisis coefficient correlation	T-student
S&P (500)- EGX30	0.0624438	0.92	0.0683559	2.64*
S&P (500)- ADX General	−0.0626488	−1.06	0.1123285	2.18*
S&P (500)- Amman SE Financial Market	0.0224388	0.72	−0.0440694	−1.54
S&P (500)- Kuwait S.E.	0.0158508	0.25	0.0388484	0.46
S&P (500)- Oman MSM	0.0247483	0.72	0.0205344	1.10
S&P (500)- Qatar DSM Market	0.0610926	0.25	0.1858069	1.01

Table 2: Results of estimation of the linear and not linear correlation test (Pearson, Spearman and Kendall's Tau)

Region/Country	Pearson		Spearman		Kendall's tau	
	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis
Africa						
S&P (500)- FTSE/JSE TOP 40	0.199	0.381	0.182	0.341	0.123	0.011
	7.015	16.890	6.425	14.878	0.000	0.473
S&P (500)- Morocco All Shares Index	−0.000	0.022	−0.001	0.016	−0.000	0.241
	−0.006	0.904	−0.048	0.690	0.978	0.000
S&P (500)- Tunindex	0.011	−0.008	0.026	−0.021	0.017	−0.014
	0.384	−0.342	0.916	−0.894	0.354	0.369
Americas						
S&P (500)- Merval	0.261	0.533	0.281	0.490	0.195	0.350
	9.358	25.783	10.133	23.043	0.000	0.000
S&P (500)- Bovespa	0.509	0.633	0.498	0.569	0.351	0.412
	20.476	33.500	19.850	28.349	0.000	0.000
S&P (500)- IPSA	0.339	0.493	0.335	0.408	0.229	0.286
	12.485	23.194	12.309	18.297	0.000	0.000
S&P (500)- IGBC	0.122	0.346	0.081	0.329	0.053	0.228
	4.254	15.095	2.824	14.258	0.005	0.000
S&P (500)- BOLSA	0.514	0.690	0.505	0.596	0.352	0.433
	20.740	39.091	20.254	30.416	0.000	0.000
S&P (500)- IGVBL	0.128	0.422	0.158	0.391	0.106	0.275
	4.485	19.082	5.552	17.404	0.000	0.000
S&P (500)- Venzuela SE Financial	0.004	0.014	−0.014	0.006	−0.009	0.003
	0.157	0.599	−0.515	0.248	0.604	0.803
Asia Pacific						
S&P (500)- S&P ASX 20	0.023	0.132	0.037	0.138	0.026	0.096
	0.800	5.448	1.298	5.702	0.169	0.000
S&P (500)- Shanghai SE Composite	0.037	0.072	0.043	0.068	0.028	0.047
	1.281	2.961	1.512	2.813	0.136	0.003
S&P (500)- KOSPI	0.130	0.224	0.135	0.161	0.090	0.112
	4.541	9.437	4.729	6.712	0.000	0.000
S&P (500)- Hang seng	0.085	0.253	0.065	0.193	0.043	0.134
	2.975	10.734	2.263	8.079	0.025	0.000
S&P (500)- Senex	0.047	0.125	0.060	0.122	0.040	0.083
	1.632	5.194	2.084	5.050	0.036	0.000
S&P (500)- Jakarta SE composite	0.130	0.209	0.150	0.185	0.101	0.129
	4.555	8.743	5.250	7.736	0.000	0.000
S&P (500)- KLCI	0.043	0.096	0.038	0.091	0.026	0.063
	1.495	3.948	1.344	3.760	0.173	0.000
S&P (500)- DJTM NEW ZEALAND	−0.029	−0.009	−0.021	0.024	−0.013	0.016
	−1.023	−0.377	−0.755	0.994	0.484	0.301
S&P (500)- Karachi SE 100	0.029	0.006	0.024	0.020	0.016	0.013
	1.032	0.249	0.840	0.839	0.399	0.403
S&P (500)- PSEI	0.015	0.036	0.019	0.048	0.012	0.034
	0.518	1.504	0.672	1.992	0.5059	0.037
S&P (500)- Singapore-DS Market	0.156	0.236	0.157	0.193	0.106	0.134
	5.471	9.954	5.519	8.051	0.000	0.000
S&P (500)- CSE all-share	−0.014	−0.015	−0.030	0.001	−0.020	0.001
	−0.485	−0.645	−1.050	0.077	0.290	0.907

(*Contd...*)

Table 2: (*Continued*)

Region/Country	Pearson		Spearman		Kendall's tau	
	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis
S&P (500)- Taiwan SE weighted	0.139	0.130	0.143	0.138	0.096	0.095
	4.878	5.376	5.004	5.699	0.000	0.000
S&P (500)- Thailand DS Market	0.055	0.224	0.066	0.162	0.044	0.111
	1.919	9.429	2.311	6.743	0.021	0.000
Europe/Developed country						
S&P (500)- BEL 20	0.197	0.454	0.204	0.399	0.137	0.285
	6.946	20.873	7.201	17.836	0.000	0.000
S&P (500)- OMXC20	0.385	0.547	0.308	0.483	0.213	0.347
	14.435	26.761	11.205	22.567	0.000	0.000
S&P (500)- IBEX 20	0.246	0.441	0.229	0.366	0.157	0.256
	8.799	20.152	8.151	16.120	0.000	0.000
S&P (500)- OMX H 25	0.327	0.528	0.271	0.466	0.187	0.333
	11.989	25.496	9.753	21.555	0.000	0.000
S&P (500)- FTSE ATHEX20	0.157	0.252	0.121	0.206	0.082	0.140
	5.522	10.686	4.237	8.634	0.000	0.000
S&P (500)- ISEQ	0.071	0.098	0.064	0.101	0.042	0.068
	2.485	4.040	2.230	4.170	0.028	0.000
S&P (500)- OMX Iceland All Share	0.234	0.447	0.208	0.411	0.142	0.291
	8.317	20.482	7.349	18.472	0.000	0.000
S&P (500)- ATX	0.104	0.392	0.109	0.343	0.074	0.240
	3.626	17.441	3.808	14.945	0.000	0.000
S&P (500)- AEX	0.445	0.567	0.358	0.505	0.249	0.365
	17.191	28.204	13.248	23.962	0.000	0.000
S&P (500)- Luxembourg SE LUXX	0.199	0.480	0.177	0.420	0.120	0.302
	7.030	22.426	6.223	18.963	0.000	0.000
S&P (500)- OSLO SE OBX	0.228	0.415	0.221	0.370	0.150	0.258
	8.089	18.705	7.849	16.291	0.000	0.000
S&P (500)- PSI 20	0.428	0.506	0.354	0.452	0.247	0.320
	16.389	24.000	13.090	20.770	0.000	0.000
S&P (500)- OMX 30	0.334	0.520	0.270	0.446	0.186	0.318
	12.276	24.915	9.688	20.416	0.000	0.000
S&P (500)- SUISS SMI	0.389	0.535	0.314	0.464	0.216	0.332
	14.607	25.938	11.431	21.431	0.000	0.000
Europe/Emerging country						
S&P (500)- BSE SOFIX	−0.044	0.038	−0.0181	0.072	−0.013	0.049
	−1.543	1.584	−0.628	2.960	0.499	0.002
S&P (500)- OMXT	0.137	0.264	0.111	0.293	0.075	0.204
	4.778	11.222	3.881	12.539	0.000	0.000
S&P (500)- Budapest BUX	0.072	0.146	0.057	0.107	0.038	0.073
	2.510	6.075	1.997	4.422	0.043	0.000
S&P (500)- Malta SE MSE	0.070	0.373	0.079	0.322	0.053	0.224
	2.448	16.467	2.745	13.939	0.006	0.000
S&P (500)- WIG 20	−0.042	−0.037	−0.014	−0.013	−0.010	−0.009
	−1.472	−1.519	−0.485	−0.543	0.602	0.578
S&P (500)- PX Global Index	0.180	0.396	0.183	0.347	0.123	0.243
	6.333	17.663	6.432	15.134	0.000	0.000
S&P (500)- RTS Index	0.104	0.310	0.090	0.303	0.060	0.213
	3.633	13.382	3.140	13.017	0.001	0.000
S&P (500)- SAX 16	0.060	0.014	0.048	−0.005	0.033	−0.003
	2.080	0.599	1.688	−0.219	0.086	0.835
S&P (500)- SBI	0.034	0.086	0.027	0.067	0.017	0.042
	1.183	3.532	0.950	2.763	0.360	0.005
S&P (500)- Turkey DS Market	0.099	0.340	0.079	0.285	0.053	0.197
	3.464	14.802	2.740	12.174	0.005	0.000
Group 7						
S&P (500)- DJ EURO STOXX 50	0.520	0.673	0.501	0.645	0.349	0.478
	21.067	37.277	20.044	34.612	0.000	0.000

(*Contd*...)

Table 2: (*Continued*)

Region/Country	Pearson		Spearman		Kendall's tau	
	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis
S&P (500)- S&P TSX composite index	0.448	0.567	0.366	0.511	0.254	0.369
	17.308	28.183	13.604	24.370	0.000	0.000
S&P (500)- CAC40	0.483	0.576	0.395	0.509	0.277	0.366
	19.081	28.831	14.879	24.224	0.000	0.000
S&P (500)- FTSE MIB Index	0.448	0.518	0.367	0.465	0.255	0.329
	17.354	24.779	13.651	21.495	0.000	0.000
S&P (500)- NIKKEI 225	0.106	0.094	0.113	0.101	0.076	0.069
	3.702	3.867	3.959	4.186	0.000	0.000
S&P (500)- FSTE 100	0.370	0.542	0.324	0.486	0.224	0.350
	13.775	26.448	11.842	22.794	0.000	0.000
Middle East						
S&P (500)- Saudi Tadawul All Share	0.015	0.001	0.035	0.030	0.023	0.020
	0.528	0.080	1.234	1.236	0.229	0.202
S&P (500)- Bahrain All Share	0.008	0.096	0.027	0.062	0.018	0.042
	0.288	3.986	0.960	2.549	0.342	0.008
S&P (500)- EGX30	0.023	−0.058	0.026	−0.056	0.018	−0.037
	0.815	−2.391	0.914	−2.309	0.345	0.018
S&P (500)- ADX General	0.049	0.036	0.041	0.043	0.028	0.029
	1.728	1.494	1.436	1.791	0.140	0.069
S&P (500)- Amman SE Financial Market	0.003	−0.031	0.020	−0.008	0.013	−0.005
	0.104	−1.284	0.714	−0.340	0.471	0.743
S&P (500)- Kuwait S.E.	−0.024	0.039	−0.039	0.057	−0.025	0.040
	−0.853	1.622	−1.351	2.368	0.182	0.012
S&P (500)- Oman MSM	−0.036	0.183	−0.018	0.142	−0.013	0.097
	−1.246	7.654	−0.650	5.889	0.492	0.000
S&P (500)- Qatar DSM Market	−0.053	0.091	−0.033	0.088	−0.022	0.060
	−1.852	3.756	−1.161	3.613	0.253	0.000

4.2.2. Estimation of the asymmetric DCC-GARCH(1.1) model

4.2.2.1. Estimation of dynamic conditional correlations

Estimating the DCC-GARCH(1.1) model allowed for examining the propagation extent of the crisis between the emerging-developed markets and the US market. These statistics indicate a conditional correlation of the studied markets' returns (emerging-developed markets). Also, these statistics allowed us to see that it is clear that the correlation coefficients vary in time. They are positive and negative variations for all the studied markets.

Against these statistics, we note that conditional correlations between the emerging-developed markets and the US market are higher during the 2008-2009 periods.

This increase is clearly important for the emerging and developed markets, of which the most serious ones are the following markets.

Subsequently, the results of the DCC-GARCH(1.1) model indicate that during the 2008-2009 periods the subprime crisis had a significant visible impact on the conditional correlations between the emerging-developed markets and the US market. Consequently, we can conclude that shocks affecting the US stock market had a significant effect on the stock prices of the emerging and developed markets. This result is coherent with Forbes and Rigobon's analysis (2002) which stipulates that increase in correlations during a crisis period is due to an increase in international stock market's volatility, which was affected by the crisis.

4.2.2.2. The results and interpretation of the correlation coefficient

The results of the correlation test may be summarized in Table 1 which reports the estimations of stocks returns during the crisis and stable periods.

The results of the last picture show that the correlations between returns on market index in the USA and those other markets are large enough, it may be interpreted by the positivity and the high significance of the coefficients, t-statistics of the dynamic correlation Conditional (during times of crisis), the constant term in the mean equation was statistically significant for all markets thus.

The obtained results indicate that the US market as the crisis trigger seems affected by the following markets: The correlation coefficients are of the order of in African countries (0.4097633) for South Africa. In American countries (0.5163703) for Argentina, (0.6050045) for Brazil,(0.4952221) for Chile, (0.3387607) for Colombia, (0.6224775) for Mexico, (0.4404875) for Peru, (0.196621) for Australia (0.2826168) for China, (0.244612) for Korea, (0.2051532) for Hong Kong, (0.1958805) for India, (0.1389905) for Malaysia, (0.228252) to Singapore, (0.2674141) for Taiwan (0.169822) for Thailand.

All these coefficients are significant because the t-statistics following the estimation of the DDC-MAGARCH model between the American index which is the reference index and these different indexes are very important because they are much lower than the critical value which is of the order of (1.96) a threshold 5%, which confirms the effect of financial contagion.

For emerging European countries (0.079564) for Bulgaria (0.4986464) for the Czech Republic, (0.1685431) for Estonia, (0.3251012) for Hungary, (0.4058437) for Poland, (0.4795759) for Russia (0.3093722) for Turkey, in developed countries these coefficients are of the order (0.4471591) for Austria, (0.5287069) for Belgium, (0.4066573) to Denmark, (0.473910) for Finland, (0.2093054) for Greece, (0.4441315) for Ireland,(0.4265902)to Luxembourg, (0.6795922) for Netherland, (0.6605659) to Norway, (0.565094) to Portugal, (0.5313129) to Spain, (0.5355962) for Sweden (0.5324005) for Switzerland. Correlation coefficients group 7 are of the order (0.7319408) for Canada, (0.1637177) to Japan, (0.6105687) for France, (0.6188495) to Germany, (0.4921689) to Italy, (0.6917973) for the United Kingdom. In the countries of the MENA region, (0.1123285) for the United Arab Emirates and (0.0683559) for Egypt.

Then, the t-student of their correlation coefficients during the crisis is significant. This result supports a pure contagion hypothesis after the US market shock.

These conclusions are consistent with Forbes and Rigobon's results (2002) which favour contagion through mechanisms contingent to the crisis.

Nevertheless, for the rest of the sample, while these coefficients are not significant for some countries, their correlation coefficients did not significantly increase where t-student values are respectively inferior to the critical value 1.96: (0.0098411) for Morocco, (0.3187794) for Indonesia, (0.2133556) for Philippines, (0.0620536) for Iceland, (0.0090207) for Slovakia, (0.018739) for Slovenia, (0.0779926) for Saudi Arabia, (0.0228204) for Bahrain, (0.0388484) for Kuwait, (0.0205344) for Oman, (0.1858069) for Qatar, this coefficient Z-statistic is negative for Tunisia, the t-statistic is of the order (−0.0305113), (−0.070758) to Venezuela, (−0.0134098) to Sri Lanka, (−0.0234464) to Malta and finally (−0.0440694) to Jordan, which proves that the correlations are relatively low, and this may be an indication against geographical proximity as a source of contagion.

This leads us to accept for the mentioned markets the null hypothesis according to which the US stock returns had a statistically insignificant effect. Hence, we can say that for these markets it is solely about interdependence and not pure contagion with the US market.

It is necessary to note that the choice of the stability and crisis periods affects contagion, given that it rests on the adjusted correlation coefficients stocks prices returns.

This implies that there is a positive spillover effect on the market of the United States for some markets such as the significant increase in correlation is observed for most countries implying that the markets in these countries are exposed to external shocks with a substantial variation of the regime in the conditional correlation and negative for others. It detects the dynamic behavior of the investor response to news and innovations. DCC after the crisis is higher than before the crisis.

As shown in the figure, the evolution of the conditional dynamic correlation, the correlation between the stock prices of the American market and other markets is increased just after the financial crisis. In particular, it increased incredibly during this financial event. Against by the correlation between the stock price of the American market and some markets is not persistent. Moreover, there is no substantial variation during the event.

Our empirical study concludes that contagion is strong between the United States and developed countries and emerging markets during the subprime crisis. The correlations between markets have increased significantly during the period of the subprime crisis in the United States it can be concluded that the crisis has spread across different markets, which is clear evidence of contagion.

These significant periodic correlations are presented by the substantially larger than the critical value t-statistics (the coefficients are positive and higher than the critical value of 1.96, which is about a 5% threshold), H_0 is rejected supporting the existence of contagion. Based on the increase in average values of DCC some countries seem to be more influenced by the contagion effects of the subprime crisis in the United States. This proves the existence of evidence of a significant increase in transactional conditional correlations of current yields.

We confirm our results after the estimation of the DDC MGARCH Model, after the Analyse of linear and not linear correlation coefficients of Pearson, Kendall's tau and finally Spearman (Table 2).

4.3. Correlation Test of Pearson

The analysis of the coefficients of the conditional correlations of Pearson between the different series of daily stock returns, it's based on the variations of stock market prices, during the period, it gave us the following remarks.

Whatever the considered performance series, there are high and low correlations appear this is the materialization of the persistence phenomenon mentioned above.

The evolution of graphics after the estimation of correlation coefficients calculated for most series studied have significant increasing trends during the subprime crisis. This simultaneous increase has made them achieve their respective levels in 2007-2008 the most increases over the period, followed by a decline from the end of 2008. This is caused by the effect that the crisis has hit the countries whose signs have appeared the beginning of 2007 and has grown immensely in the middle of the same year and the beginning of 2008.

Thus, these factors indicate that series of stock market indexes are highly volatile.

In analyzing the behavior of correlations and those of conditional variances, we note the presence of the phenomenon is asymmetry. This asymmetry results in the given that volatility is higher after a decline after an increase correlation. Nevertheless, for some indexes, the correlations become higher as soon as markets become relatively volatile.

From this study, it appears difficult to validate the hypothesis of non-temporal variation of Pearson correlations. Thus, as we shall see, the approach developed by Nelson (1991) is an extension of its work, which takes so attached to explain the evolution of performance and the volatility.

Although most studies who are interested in the transmission of shocks between different financial markets have performed measuring the dependence between different financial markets, have conducted measuring the dependence of these markets captured by the Pearson correlation coefficient, it is estimated over the entire study period or on particular sub-periods, the correlation coefficient is a linear dependence measure or set of variables whose joint distribution is Gaussian. According to Granger (2002), classical multivariate linear modeling that is based on the Gaussian distribution assumption has clearly shown its shortcomings to explain the stylized facts observed in the time series in economics and finance.

We consider from us two other dependence measures. These two rank correlation coefficients: Kendall's tau and Spearman Rho are two measures of agreement, generalizes the linear correlation, taking into account the joint distributions (not just marginal).

Both ratios were used in this study as references when we returned to see if they are adopted in place of the Pearson correlation coefficient significantly change the results.

4.4. Rank Correlation Coefficients

The rate of Kendall and Spearman Rho correlation measures are two well-known statistics. They provide a measure of the correlation between the rows observations to the linear correlation difference appreciate it the correlation between the observation values. Note that the Kendall rate is simply the difference between the probability of concordance and the discordance. These coefficients reflect how high (low respectively) of a variable are associated with high values (respectively lower) for the other variable. However, the rank correlation to be preserved under strictly increasing transformations.

Analysis of these coefficients asserts the hypothesis of temporal variation as well as the presence of a monotonous connection even non-linear.

In this section, we analyzed the dynamic conditional correlation coefficients between the returns of the US benchmark index (S&P (500)) and those of other international indices. Our main results prove the existence of a strong correlation between the US index and the majority of the indices during the period of financial turbulence, confirming the existence of the phenomenon of pure contagion.

The wide price fluctuations that dominate the news of international financial markets emphasize the importance of further deepening research in order to provide meaningful solutions for damping potential crashes, the consequences can be extremely degrading terms economic stability, financial and social of the country.

4.5. Wald Test

We consider the test H_0: $\beta_j = a$ against H_1: $\beta j \neq a$ which β_j design the j[ieme] Component of the parameter vector $\beta = (\beta_1,\ldots,\beta_k)' \epsilon R^k$ a dichotomous model. The idea of the Wald test is to accept the null hypothesis if the unconstrained estimator $\hat{\beta}_j$ from β_j is near a.

The test statistic is a measure of well-chosen near β_j – a zero.

We know that in the general formulation of a type of stress test H_0: $g(\beta)=r$, where r is a vector of dimension (c, 1), we have the following result:

$$[g(\hat{\beta})-r]'[G\hat{V}(\hat{\beta})G']^{-1}[g(\hat{\beta})-r] \xrightarrow[N\to\infty]{} X(C)$$

Where $\hat{\beta}$ denotes the estimator of maximum likelihood unconstrained with $G = \partial g(.)/\partial\beta$, and $\hat{V}(\hat{\beta})$ the estimator of the variance-covariance matrix of the coefficients. In this case we are concerned, we have $g(\beta) = \beta_j$ and $r = a$. The vector G of dimension (K, 1), contains K−1 zeros and 1 to the j[ieme] position.

Thus, the following result:

The Wald test statistic associated with the unidirectional test H_0: $\beta_j = a$ was against H_1: $\beta_j \neq a$ admits the following law under H_0:

$$[\hat{\beta}_j - a]'(v_{ij})^{-1}[\hat{\beta}_j - a] = \frac{(\hat{\beta}_j - a)^2}{\hat{v}_{jj}} \xrightarrow[N\to\infty]{} X^2(1)$$

$\hat{v}_{jj}$ means the estimator of the variance of the estimator of β_j coefficient.

So, if we note X^2 95% (1) the 95% quantile of the law $X^2(1)$, the Wald test at the threshold of 5% of the hypothesis H_0, it accepts H_0 if $(\hat{\beta}_j - a)^2 / \hat{v}_{jj}$ is less than X^2 95% (1) and rejects H_0 if that quantity is higher than X^2 95% (1).

Most software (except SAS) does not offer this Wald statistic, but a defined statistical Z_j as the square root of the preceding one. Given the link between the standard normal distribution and χ^2 law with one degree of freedom, we immediately under H_0:

$$z_j = \frac{\hat{\beta}_j - a}{\sqrt{\hat{v}_{jj}}} \xrightarrow[N\to\infty]{} N(0,1)$$

And especially for a H_0 invalid test: $\beta_j = 0$, we find:

$$\beta_j = \frac{\hat{\beta}_j}{\sqrt{\hat{v}_{jj}}} \xrightarrow[N\to\infty]{} N(0,1)$$

The Wald test computes or test of equality of coefficients is a test statistic based on the unrestricted regression. The Wald statistic measures how close the unrestricted estimates come to satisfying the restrictions under the null hypothesis. If the restrictions are in fact true, then the unrestricted estimates should come close to satisfying the restrictions.

In our case, In order to test the significance and sign of the relationship between returns on major stock indexes, we use a test WALD. This is an econometric test that examines the joint significance of the included variables. In our case, the application allows testing the significance of the increases and decreases in the market return of the US on the market returns in other countries. Therefore, we check two hypotheses are:

$$\begin{cases} H_0: \beta_2^+ = \beta_2^- = 0 \leftrightarrow \text{sinnificant impact} \\ H_1: \beta_2^+ \neq \beta_2^- \neq 0 \leftrightarrow \text{no significant impact} \end{cases}$$

The acceptance of the null hypothesis proves the significance of the relationship between the two variables, and the two variables evolve according to the same direction, and then the impact of the movement of US stock index on other indexes. If not, the fluctuation of the US stock index does not have a significant influence on the return on other indexes (Table 3).

Following the analysis of the equal coefficients test between returns on main stock market indices, the results are in favor of those of the model DCCMGARCH.

For African countries, namely Morocco and Tunisia, the values are very low, are respectively (0.800488), (0.122863), while their probability is very high on both study periods as pre-crisis period and the post-crisis period, which proves that the indices do not evolve in the same direction, except for south Africa, the value is very important, it equal to (3.865334) show that the two indexes move in the same direction, i.e., the evolution of the American benchmark index an impact on the index of south America.

For countries in Latin America, namely, Argentina, Brazil, Chile, Colombia, Mexico and Peru, the significant value of this test (post-crisis period), provides information on the similarity between the stock indexes, such indexes evolve simultaneously except for Venezuela, the value is very low showing that the two indices and the US diverge.

For the countries of the European Union, the majority of indexes have the same evolution as the US index of reference, at the period of financial turbulence or the period of financial crisis, it is given following the result of Wald test include included as an example of the values from which we can judge the degree of adequacy in terms of the evolution between the variables on the post-crisis period: Austria (3.947202), Belgium (7.742677), Denmark (16.21994), Finland(13.02869), Greece (9.035546), Ireland (8.866189), Luxembourg(8.175870), Netherland (7.044804), Norway (3.048448), Portugal (7.935021), Spain (6.139284), Switzerland (8.048753), Sweden (3.632981); by against this test has a low value for Iceland (2.433061). This indicates a weak relationship between it and the American index.

This test shows significant values for emerging countries indicating strong correlation between market indices of these countries and the US index For example the post-crisis values for Bulgaria (12.70323), Czech Republic (9.597492), Estonia (8.903071), Hungary (8.856867), Poland (39.78948), Russia (17.98043), and Turkey (11.74988). This test has no significant values Malta (2.335567), Slovakia (0.341883), Slovenia (1.370317).

For the Group 7 or the most powerful countries in the world, the Wald test shows a significant value, this indicates the strong relationship between the indexes of these countries and the benchmark index of the US; the values are for Canada (11.46111),

Table 3: Result of the Wald test

Country	WALD test			
	Pre- crisis		Post- crisis	
	Chi-square	P	Chi-square	P
Africa				
Maroc	2.089650	0.1483	0.800488	0.3709
South Africa	1.670889	0.1961	3.865334	0.0493
Tunisie	0.330762	0.5652	0.122863	0.7259
Americas				
Argentina	0.171474	0.6788	5.417924	0.0199
Brazil	10.47188	0.0012	4.494073	0.0340
Chile	4.920260	0.0265	6.794607	0.0091
Colombia	6.602767	0.0102	5.401752	0.0201
Mexico	12.43177	0.0004	4.845577	0.0277
Peru	16.24793	0.0001	7.852548	0.0051
Venezuela	0.071622	0.7890	2.974599	0.0846
Asia Pacific				
Australia	1.471655	0.2251	3.771587	0.0521
China	0.106455	0.7442	13.43925	0.0002
Hong Kong	4.262330	0.0390	20.46329	0.0000
India	13.41468	0.0002	4.472291	0.0344
Indonesia	2.591768	0.1074	0.079244	0.7783
Korea	5.908701	0.0151	3.042829	0.0811
Malaysia	4.665616	0.0308	15.51001	0.0001
New Zealand	0.004872	0.9444	9.075304	0.0026
Philippines	1.228598	0.2677	0.141314	0.7070
Pakistan	1.007534	0.3155	0.054174	0.8160
Singapore	6.164547	0.0130	29.75918	0.0000
Sri Lanka	0.261919	0.6088	0.434156	0.5100
Taiwan	2.082396	0.1490	23.58358	0.0000
Thailand	0.941372	0.3319	3.582344	0.0584
Developed country				
Austria	9.407194	0.0022	3.947202	0.0469
Belgium	0.821323	0.3648	7.742677	0.0054
Dane Mark	6.095654	0.0136	16.21994	0.0000
Finland	1.958577	0.1617	13.02869	0.0003
Greece	2.211039	0.1370	9.035546	0.0026
Iceland	1.866098	0.1719	2.433061	0.1188
Ireland	6.082547	0.0137	8.866189	0.0029
Luxembourg	3.047529	0.0809	8.175870	0.0042
Netherland	0.026782	0.8700	7.044804	0.0079
Norway	8.330038	0.0039	3.048448	0.0808
Portugal	0.554134	0.4566	7.935021	0.0048
Spain	0.879667	0.3483	6.139284	0.0132
Switzerland	0.192234	0.6611	8.048753	0.0046
Sweden	1.576239	0.2093	3.632981	0.0566
Emerging country				
Bulgaria	1.519643	0.2177	12.70323	0.0004
Szech Republic	7.710645	0.0055	9.597492	0.0019
Estonia	6.217482	0.0126	8.903071	0.0028
Hungary	3.904245	0.0482	8.856867	0.0029
Malte	2.211251	0.1370	2.335567	0.1264
Poland	5.592863	0.0180	39.78948	0.0000
Russia	12.95927	0.0003	17.98043	0.0000
Slovakia	0.000208	0.9885	0.341883	0.5587
Slovenia	0.436603	0.5088	1.370317	0.2418
Turkey	5.583102	0.0181	11.74988	0.0006
Group 7				
Canada	0.625446	0.4290	11.46111	0.0007
France	0.143717	0.7046	5.351872	0.0207
Germany	0.026063	0.8717	6.864294	0.0088
Italy	0.015867	0.8998	6.693414	0.0097
Japan	13.54849	0.0002	14.78228	0.0000
United Kingdom	0.105088	0.7458	5.735838	0.0166
Middle East				
Bahrain	0.268529	0.6043	0.005364	0.9416

(Contd...)

Table 3: (*Continued*)

Country	WALD test			
	Pre- crisis		Post- crisis	
	Chi-square	P	Chi-square	P
Egypt	0.064914	0.7989	15.70058	0.0001
Jordan	0.627146	0.4284	5.789753	0.0161
Kuwait	2.915713	0.0877	2.202903	0.1378
Oman	0.007703	0.9301	1.690673	0.1935
Qatar	0.774806	0.3787	2.571052	0.1088
Saudi Arabia	1.646157	0.1995	4.510277	0.0337
Emirats Arabes Unis	0.268942	0.6040	8.517093	0.0035

France (5.351872), Germany (6.864294), Italy (6.693414), Japan (14.78228), United Kingdom (5.735838).

For the Middle East countries, the values are very higher in the post-crisis period for example for Egypt, the value is equal to (15.70058), Jordan (5.789753), Saudi Arabia (4.510277), Emirats Arabes Unis (8.517093), these values are significant, it indicates that the major indexes of this countries evolve with the U.S index.

But for the other countries, for example, Bahrain, Kuwait, Oman and Qatar, the values are very low, these are respectively (0.005364), (2.202903), (1.690673) and (2.571052), these values are of no significant, it shows that the indexes of the countries and the US diverge.

5. CONCLUSION

This study explores the relationship between actions yields of 63 developed and emerging economies and those of the US. This article also examines the contagion of stock market based on the irrational investor behavior in the financial market, we used the multi-varied dynamics model to estimate the conditional GARCH dynamic correlations using daily data for current performance period (2003-2013) and to examine the potential channels of contagion, based on dynamic conditional correlations in between seventy-five developed and emerging countries and the USA. Finally, we use a model of DCC-MGARCH that allows simultaneous evaluation conditional correlation coefficients and determinants of conditional correlations over time, which can be used to identify the type of contagion channels. An advantage of the varied multi DCC GARCH model is based on the fact that we can obtain all possible correlation coefficients for the performance of each index in the sample and study their behavior during periods of particular interest, such as periods of financial turmoil. These coefficients were statistically significant, providing evidence for the influential American market on other exchanges. The result of such an important correlation is a group of investor's trade the same direction over a period of time; this showed that a statistically significant increase over time conditional correlations were detected for all rates of returns examined 5% level of significance.

The magnitude of the effect of the 2008 stock market crash on the correlation coefficients is indicated by the size of the coefficients provided, which were significantly higher than those of previous financial crises. This finding provides support for the evidence of herding behavior during the 2008 stock market crash. The analysis of correlation coefficients dynamic has provided substantial evidence for contagion effects due to herding behavior of the developed and emerging markets, especially around financial crash 2007-2009.

The results obtained following the DCC model MGARCH estimate by analyzing the coefficients of the linear and non-linear correlation was confirmed (Pearson Spearman and tKnedall's tau), and by analyzing the of equality of coefficients test (the Wald test).

This validation has tried to study the dynamic conditional correlation between US reference market and a sample of other international markets in terms of volatility.

We discovered that there have different periods of correlations, firstly, periods with low correlations where there are no important events and secondly, periods with strong correlations. The main reunion of this validation confirms with the majority of the literature and it provides that there is excess volatility that cannot be explained by the theory of efficient financial market.

The analysis of correlation coefficients of different tests has provided substantial evidence for contagion effects due to herding behavior in developed and emerging markets, especially around financial crash 2007-2009.

REFERENCES

Acharya, V., Phlippon, T., Richardson, M., Roubini, N. (2009), The financial crisis of 2007-2009: Causes and remedies. Financial Markets, Institutions and Instruments, 18, 89-137.

Baba, N., Packer, F. (2009), From Turmoil to Crisis: Dislocations in the FX Swap Market Before and After the Failure of Lehman Brothers. BIS Working Paper No. 285.

Bartman, S., Bodnar, G. (2009), No place to hide: The global crisis in equity markets in 2008/09. Journal of International Money and Finance, 28, 1246-1292.

Billio, M., Caporin, M. (2010), Market linkages, variance spillovers, and correlation stability: Empirical evidence of financial contagion. Computational Statistics and Data Analysis, 54, 2443-2458.

Bollerslev, T., Engle, R.F., Wooldridge, M. (1992), A capital asset pricing model with time series varying covariance. Journal of Political Economy, 96, 116-131.

Calvo, G. (1999), Contagion in Emerging Markets: When Wall Street is a Carrier, University of Maryland.

Calvo, G., Reinhart, C. (1996), Capital Flows to Latin America: Is the Evidence of Contagion Effects? Private Capital Flows to Emerging Markets after the Mexican Crisis. Washington, DC: Institute for International Economics.

Chiang, T.C., Jeon, B.N., Li, H. (2007), Dynamic correlation analysis of financial contagion: Evidence from Asian markets. Journal of International Money and Finance, 26(7), 1206-1228.

Cho, J.H., Parhizgari, A.M. (2008), East Asian financial contagion under DCC-GARCH. International Journal of Banking and Finance, 6(1), 17-30.

Chudik, A., Fratzscher, M. (2011), Identifying the global transmission of the 2007-2009 financial crisis in a GVAR model. European Economic Review, 55, 325-339.

Corsetti, G., Pericoli, M., Sbracia, M. (2005), Some contagion, some interdependence: More pitfalls in tests of financial contagion. Journal of International Money and Finance, 24, 1177-1199.

Dehove, M. (2003), Crises Financières Deux ou Trois Choses que Nous Savons D'elles, Document de Travail. Paris: Conseil d'Analyse Economique.

Dooley, M., Hutchison, M. (2009), Transmission of the U.S. Subprime crisis to emerging markets: Evidence on the decoupling-recoupling hypothesis. Journal of International Money and Finance, 28, 1331-1349.

Dornbusch, R., Park, Y.C., Claessens, S. (2000), Contagion: Understanding how it spreads. World Bank Research Observer, 15, 177-197.

Dwyer, G., Tkac, P. (2009), The financial crisis of 2008 in the fixed income markets. Journal of International Money and Finance, 28, 1293-1316.

Eichengreen, B., Rose, A., Wyplosz, C. (1996), Contagious Currency Crises, NBER Working Paper No. 5681.

Engle, R.E. (2002), Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional Heteroscedasticity models. Journal of Business and Economic Statistics, 20, 339-350.

Forbes, K., Rigobon, R.(2002), No contagion, only interdependence: Measuring stock market co-movements. The Journal of Finance, 57(5), 2223-2261.

Forbes, K.J., Rigobon, R. (2000), Contagion in Latin America: Definitions, measurement, and policy implications, Economia, 1(2), 1-46.

Forbes, K.J., Rigobon, R. (2001), No contagion, only interdependence: Measuring stock market co-movement. Journal of Finance, 57(5), 2223-2261.

Fratzscher, M. (2009), What explains global exchange rate movements during the financial crisis? Journal of International Money and Finance, 28, 1390-1407.

Granger, C.W.J. (2002), Time Series Concept for Conditional Distributions, Manuscript. UCSD.

Hartmann, P. (2010), Interaction of market and credit risk. Journal of Banking and Finance, 34, 697-702.

Hon, M., Strauss, J., Yong, S.J. (2004), Contagion in financial markets after September 11: Myth or reality? Journal of Financial Research, 27, 95-114.

Kaminsky, G., Reinhart, C. (1998), On Crises, Contagion, and Confusion. Washington, DC: University of Maryland Mimeo.

Kaminsky, G., Reinhart, C. (2000), The twin crises: Causes of banking and balance-of-payments crises. American Economic Review, 89(3), 473-500.

Kenourgios, D., Samitas, A., Paltalidis, N. (2011), Financial crisis and stock market contagion in multivariate time-varying asymmetric framework. Journal of International Financial Markets, Institutions and Money, 21, 92-106.

Marais, E. (2003), La Contagion Financière: Une Étude Empirique Sur les Causalités Lors de la Crise Asiatique, Doctoriales Bruxelles, 4 et 5 Décembre.

Marais, E. (2004), An empirical study to identify shift contagion during the Asian crisis. Journal of International Financial Markets, Institutions and Money, 13, 171-186.

Masson, P. (1998), Contagion: Monsoonal Effects, Spillovers, and Jumps between Multiple Equilibria, IMF Working Paper No. 142.

Melvin, M., Taylor, M. (2009), The crisis in the foreign exchange market. Journal of International Money and Finance, 28, 1317-1330.

Mignon, V.(2008), Économétrie, Théorie et Applications. Paris: Edition Economica-Paris.

Nelson, D. (1991), Conditional heteroskedasticity in asset returns: A new approach. Econometrica, 59, 347-370.

Pericoli, M., Sbracia, M. (2001), A Primer on Financial Contagion, Banca d'Italia Temi di Discussione No. 407.

Pritsker, M. (2000), The Channels for Financial Contagion, World Bank, Contagion Conference.

Schwert, W. (2011), Stock Volatility During the Recent Financial Crisis. NBER Working Paper No. 16976.

Syllignakis, M., Kouretas, G. (2011), Dynamic correlation analysis of financial contagion: Evidence from the central and Eastern European markets. International Review of Economics and Finance, 20, 717-732.

APPENDIX

Table 1: Descriptive statistics of developed and emerging markets' daily returns: (Pre-crisis period)

Country	Mean	Median	Maximum	Minimum	SD	Skewness	Kurtosis	Jarque-Bera	P
Africa									
South Africa	0.000	0.001	0.055	−0.068	0.011	−0.168	5.540	326.908	0.000
Maroc	0.001	0.000	0.036	−0.065	0.008	−0.831	10.367	2840.398	0.000
Tunisie	0.000	8.94E-05	0.020	−0.021	0.004	0.188	5.661	359.705	0.000
Americas									
Argentina	0.001	0.000	0.072	−0.086	0.016	−0.292	5.912	439.219	0.000
Brazil	0.001	0.001	0.052	−0.066	0.015	−0.215	3.870	47.036	0.000
Chile	0.001	0.000	0.030	−0.049	0.008	−0.511	5.757	430.706	0.000
Colombia	0.001	0.001	0.158	−0.104	0.015	0.128	17.930	11103.34	0.000
Mexico	0.001	0.001	0.067	−0.058	0.010	−0.116	6.022	457.519	0.000
Peru	0.002	0.001	0.085	−0.075	0.011	−0.018	9.494	2100.475	0.000
Venezuela	0.000	0.000	0.042	−0.033	0.010	0.217	4.376	103.851	0.000
Asia Pacific									
Australia	0.000	0.000	0.035	−0.028	0.006	−0.323	4.950	210.324	0.000
China	0.001	1.05E-05	0.082	−0.088	0.014	−0.170	7.194	881.739	0.000
Hong Kong	0.000	0.000	0.036	−0.040	0.00409	−0.159	4.529	121.508	0.000
India	0.001	0.001	0.082	−0.111	0.013	−0.682	9.806	2399.682	0.000
Indonesia	0.001	0.000	0.054	−0.075	0.012	−0.500	6.821	776.958	0.000
Korea	0.001	0.001	0.049	−0.057	0.012	−0.269	4.723	162.308	0.000
Malaysia	0.000	0.000	0.026	−0.046	0.006	−0.298	7.054	836.429	0.000
New Zealand	0.000	0.000	0.023	−0.023	0.006	−0.180	3.728	32.916	0.000
Philippines	0.001	0.000	0.048	−0.079	0.011	−0.192	6.073	477.575	0.000
Pakistan	0.001	0.001	0.032	−0.032	0.011	−0.259	3.437	22.996	0.000
Singapore	0.000	0.001	0.032	−0.036	0.008	−0.410	5.213	277.523	0.000
Sri Lanka	0.001	0.000	0.036	−0.031	0.009	−0.181	4.367	99.721	0.000
Taiwan	0.000	5.37E-05	0.055	−0.066	0.011	−0.359	6.757	728.652	0.000
Thailand	0.000	0.000	0.124	−0.163	0.013	−0.751	25.055	24334.20	0.000

(*Contd*...)

Table 1: (*Continued*)

Country	Mean	Median	Maximum	Minimum	SD	Skewness	Kurtosis	Jarque-Bera	P
Europe/Developed country									
Austria	0.001	0.001	0.047	−0.074	0.009	−0.860	9.038	1962.960	0.000
Belgium	0.000	0.000	0.097	−0.043	0.009	0.913	16.688	9495.580	0.000
Dane Mark	0.000	0.000	0.037	−0.040	0.009	−0.401	4.856	203.669	0.000
Finland	0.000	0.000	0.040	−0.042	0.009	−0.273	5.142	243.495	0.000
Greece	0.000	0.000	0.053	−0.056	0.011	−0.051	4.985	196.728	0.000
Iceland	0.001	0.001	0.052	−0.054	0.008	−0.612	8.099	1369.666	0.000
Ireland	0.000	0.000	0.042	−0.059	0.008	−0.609	7.936	1287.092	0.000
Luxembourg	0.000	0.000	0.069	−0.043	0.008	0.193	7.891	1198.678	0.000
Netherland	0.000	0.000	0.099	−0.063	0.011	0.398	11.578	3695.444	0.000
Norway	0.001	0.001	0.071	−0.058	0.011	−0.292	6.370	582.621	0.000
Portugal	0.000	0.000	0.039	−0.034	0.006	−0.067	5.814	395.396	0.000
Spain	0.000	0.000	0.041	−0.041	0.009	−0.233	5.450	309.835	0.000
Switzerland	0.000	0.000	0.058	−0.049	0.009	−0.025	7.622	1064.254	0.000
Sweden	0.000	0.000	0.054	−0.047	0.010	−0.138	5.641	351.219	0.000
Europe/Emerging country									
Bulgaria	0.001	0.000	0.063	−0.044	0.010	0.370	7.511	1040.776	0.000
Szech Republic	0.001	0.001	0.068	−0.055	0.009	−0.495	7.928	1258.438	0.000
Estonia	0.001	0.000	0.074	−0.056	0.008	−0.020	13.234	5215.487	0.000
Hungary	0.001	0.000	0.049	−0.054	0.012	−0.146	4.181	73.760	0.000
Malte	0.000	0.000	0.048	−0.044	0.007	0.263	9.922	2399.584	0.000
Poland	0.001	0.000	0.048	−0.055	0.012	−0.085	4.180	70.837	0.000
Russia	0.001	0.001	0.100	−0.100	0.017	−0.661	7.779	1224.849	0.000
Slovakia	0.000	0.000	0.041	−0.049	0.010	−0.155	6.378	573.243	0.000
Slovenia	0.001	0.000	0.046	−0.030	0.006	0.403	8.341	1453.269	0.000
Turkey	0.001	0.000	0.115	−0.125	0.018	−0.141	8.008	1252.896	0.000
Group 7									
Canada	0.000	0.000	0.024	−0.035	0.007	−0.529	4.396	152.903	0.000
France	0.000	0.000	0.072	−0.056	0.010	0.085	7.716	1108.880	0.000
Germany	0.000	0.000	0.067	−0.055	0.010	0.070	7.280	913.368	0.000
Italy	0.000	0.000	0.040	−0.037	0.008	−0.275	5.616	356.029	0.000
Japan	0.000	0.000	0.035	−0.050	0.011	−0.359	4.311	111.385	0.000
United Kingdom	0.000	0.000	0.060	−0.047	0.008	0.058	7.864	1179.103	0.000
United States	0.000	0.000	0.061	−0.042	0.011	0.139	4.602	131.667	0.000
Middle East									
Bahrain	0.000	0.000	0.036	−0.022	0.005	0.829	8.742	1779.220	0.000
Egypt	0.002	0.001	0.201	−0.099	0.017	1.011	18.82	12666.64	0.000
Jordan	0.001	0.000	0.070	−0.084	0.012	−0.08	9.042	1819.586	0.000
Kuwait	0.001	0.000	0.065	−0.077	0.010	−0.257	12.079	4118.269	0.000
Oman	0.001	0.000	0.104	−0.104	0.008	0.285	41.018	71984.99	0.000
Qatar	0.001	0.000	0.059	−0.060	0.013	0.072	5.031	206.543	0.000
Saudi Arabia	0.001	0.002	0.178	−0.110	0.019	−0.108	13.432	5421.926	0.000
Emirats Arabes Unis	0.000	1.41E-05	0.085	−0.082	0.012	0.359	12.155	4199.916	0.000

SD: Standard deviation

Table 2: Descriptive statistics of developed and emerging markets' daily returns (crisis period)

Country	Mean	Median	Maximum	Minimum	SD	Skewness	Kurtosis	Jarque-Bera	P
Africa									
Maroc	−0.000	0.000	0.045	−0.045	0.007	−0.109	8.218	1904.296	0.000
South Africa	0.000	0.000	0.080	−0.076	0.014	0.073	6.487	850.286	0.000
Tunisie	0.000	5.61E-05	0.040	−0.048	0.006	−0.554	14.743	9711.559	0.000
Americas									
Argentina	0.000	0.000	0.109	−0.121	0.019	−0.397	7.857	1691.017	0.000
Brazil	0.000	0.000	0.172	−0.141	0.020	0.462	13.472	7713.371	0.000
Chile	0.000	0.000	0.125	−0.069	0.011	0.404	15.133	10320.59	0.000
Colombia	0.000	0.000	0.091	−0.086	0.011	−0.358	10.652	4122.752	0.000
Mexico	0.000	0.000	0.110	−0.070	0.014	0.356	10.101	3555.525	0.000
Peru	−7.46E-05	0.000	0.136	−0.125	0.017	−0.288	12.374	6156.420	0.000
Venezuela	0.000	0.000	0.031	−0.039	0.009	−0.066	5.074	301.443	0.000
Asia Pacific									
Australia	−8.03E-07	0.000	0.057	−0.083	0.012	−0.265	6.869	1064.647	0.000
China	−0.000	0.000	0.094	−0.077	0.016	−0.049	6.782	999.354	0.000

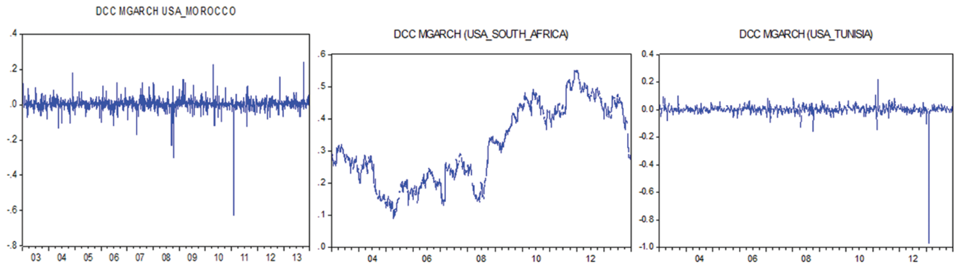
(*Contd...*)

Table 2: (*Continued*)

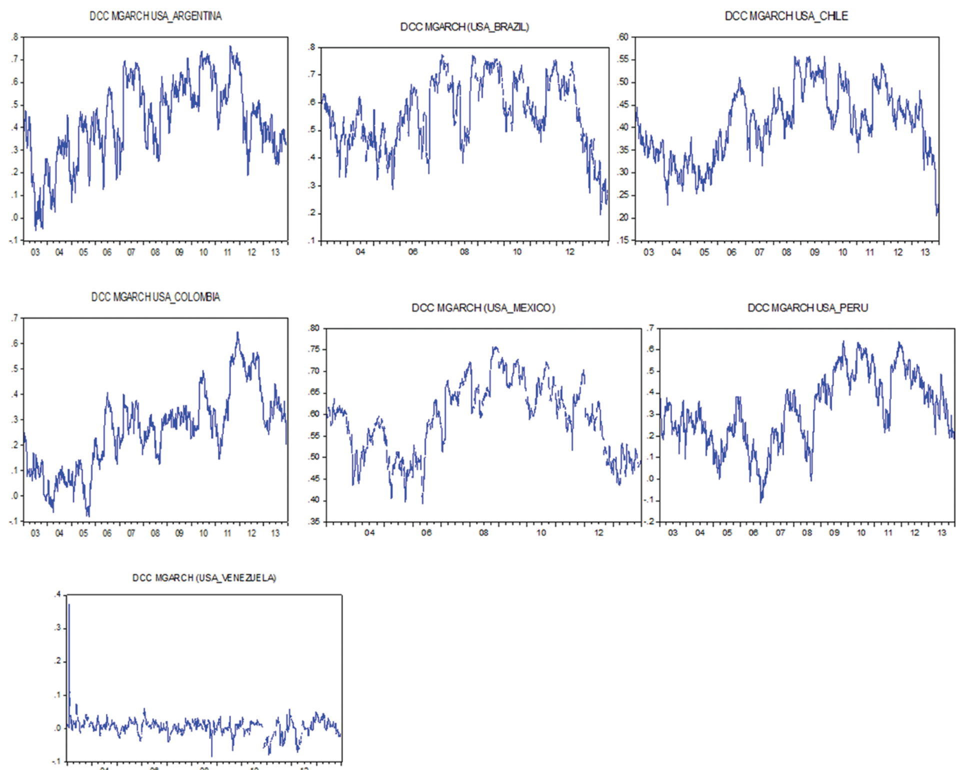
Country	Mean	Median	Maximum	Minimum	SD	Skewness	Kurtosis	Jarque-Bera	P
Hong Kong	0.000	0.000	0.143	−0.127	0.018	0.362	11.094	4607.052	0.000
India	0.000	0.000	0.173	−0.109	0.016	0.524	12.768	6736.536	0.000
Indonesia	0.000	0.000	0.079	−0.103	0.015	−0.432	9.427	2935.153	0.000
Korea	0.000	0.000	0.119	−0.105	0.015	−0.270	10.727	4188.160	0.000
Malaysia	0.000	8.81E-05	0.043	−0.094	0.008	−1.075	17.788	15587.13	0.000
New Zealand	−6.78E-05	0.000	0.056	−0.074	0.008	−0.492	12.059	5795.299	0.000
Philippines	0.000	0.000	0.054	−0.050	0.012	−0.291	6.097	693.155	0.000
Pakistan	0.000	0.000	0.098	−0.122	0.013	−0.507	11.250	4822.765	0.000
Singapore	2.82E-05	0.000	0.079	−0.076	0.011	−0.088	9.157	2648.151	0.000
Sri Lanka	0.000	0.000	0.054	−0.049	0.009	0.231	7.263	1283.254	0.000
Taiwan	4.86E-05	0.000	0.067	−0.065	0.013	−0.212	5.985	634.822	0.000
Thailand	0.000	0.000	0.088	−0.113	0.015	−0.279	8.766	2341.197	0.000
Developed country									
Austria	−0.000	0.000	0.127	−0.097	0.018	0.055	7.908	1682.085	0.000
Belgium	−0.000	0.000	0.096	−0.079	0.014	0.085	8.221	1905.116	0.000
Danemark	0.000	0.000	0.099	−0.110	0.014	−0.033	9.045	2550.970	0.000
Finland	7.55E-05	0.000	0.097	−0.085	0.017	0.186	5.997	636.801	0.000
Greece	−0.000	0.000	0.177	−0.093	0.025	0.395	6.025	682.368	0.000
Iseland	−0.000	0.000	0.051	−0.062	0.010	−0.194	7.301	1302.117	0.000
Ireland	−0.000	0.000	0.102	−0.130	0.017	−0.271	8.245	1940.780	0.000
Luxembourg	−0.000	0.000	0.095	−0.105	0.015	−0.148	8.304	1969.843	0.000
Netherland	0.000	8.74E-05	0.116	−0.106	0.019	−0.315	8.543	2172.786	0.000
Norway	−1.89E-05	0.000	0.105	−0.091	0.015	0.070	10.111	3531.284	0.000
Portugal	−0.000	0.000	0.107	−0.098	0.014	0.128	9.576	3022.673	0.000
Spain	−8.28E-05	0.000	0.144	−0.091	0.017	0.402	8.777	2374.896	0.000
Switzerland	3.43E-05	2.80E-05	0.113	−0.077	0.012	0.241	10.893	4364.860	0.000
Sweden	0.000	0.000	0.103	−0.072	0.016	0.272	7.254	1283.693	0.000
Emerging country		0.000							
Bulgaria	−0.000	0.000	0.075	−0.107	0.014	−0.864	11.895	5731.800	0.000
Szech Republic	−0.000	0.000	0.254	−0.211	0.019	0.989	52.511	171359.5	0.000
Estonia	−1.27E-05	0.000	0.128	−0.068	0.013	0.462	11.848	5524.237	0.000
Hungary	−0.000	0.000	0.140	−0.118	0.018	0.324	10.376	3827.179	0.000
Malte	−0.000	0.000	0.045	−0.046	0.006	0.072	9.896	3320.664	0.000
Poland	−0.000	0.000	0.084	−0.080	0.016	−0.119	6.110	679.202	0.000
Russia	8.72E-05	0.000	0.223	−0.191	0.023	0.151	15.712	11285.20	0.000
Slovakia	−0.000	0.000	0.134	−0.137	0.011	−1.688	38.290	87714.48	0.000
Slovenia	−0.000	0.000	0.079	−0.079	0.009	−0.782	21.619	24366.93	0.000
Turkey	0.000	0.000	0.124	−0.099	0.017	−0.056	7.583	1467.046	0.000
Group 7		0.000							
Canada	8.09E-05	0.000	0.098	−0.093	0.013	−0.428	11.690	5322.072	0.000
France	−3.59E-05	0.000	0.111	−0.090	0.016	0.294	8.779	2355.297	0.000
Germany	−5.90E-05	0.000	0.110	−0.078	0.016	0.251	8.417	2066.179	0.000
Italy	−0.000	0.000	0.114	−0.082	0.018	0.160	7.023	1136.762	0.000
Japan	0.000	0.000	0.141	−0.114	0.017246	−0.318	10.904	4389.310	0.000
United Kingdom	0.000	0.000	0.098	−0.088	0.013972	0.082	9.947	3370.997	0.000
United States	0.000	0.000	0.125	−0.105	0.015535	0.119	10.723	4166.749	0.000
Middle East									
Bahrain	−0.000	0.000	0.026	−0.048	0.005995	−1.006	9.704	3417.734	0.000
Egypt	5.61E-05	0.000	0.075	−0.164	0.017858	−0.954	10.685	4374.535	0.000
Jordan	−0.000	0.000	0.114	−0.079	0.011490	0.056	19.037	17951.51	0.000
Kuwait	−0.000	0.000	0.038	−0.089	0.007781	−1.692	17.641	15761.37	0.000
Oman	0.000	0.000	0.107	−0.151	0.012427	−1.189	32.278	60184.73	0.000
Qatar	0.000	0.000	0.108	−0.089	0.014829	−0.136	14.813	9745.511	0.000
Saudi Arabia	0.000	0.000	0.117	−0.098	0.014621	−0.250	16.211	12199.82	0.000
Emirats Arabes Unis	0.000	0.000	0.079	−0.083	0.011565	−0.233	13.391	7551.337	0.000

SD: Standard deviation

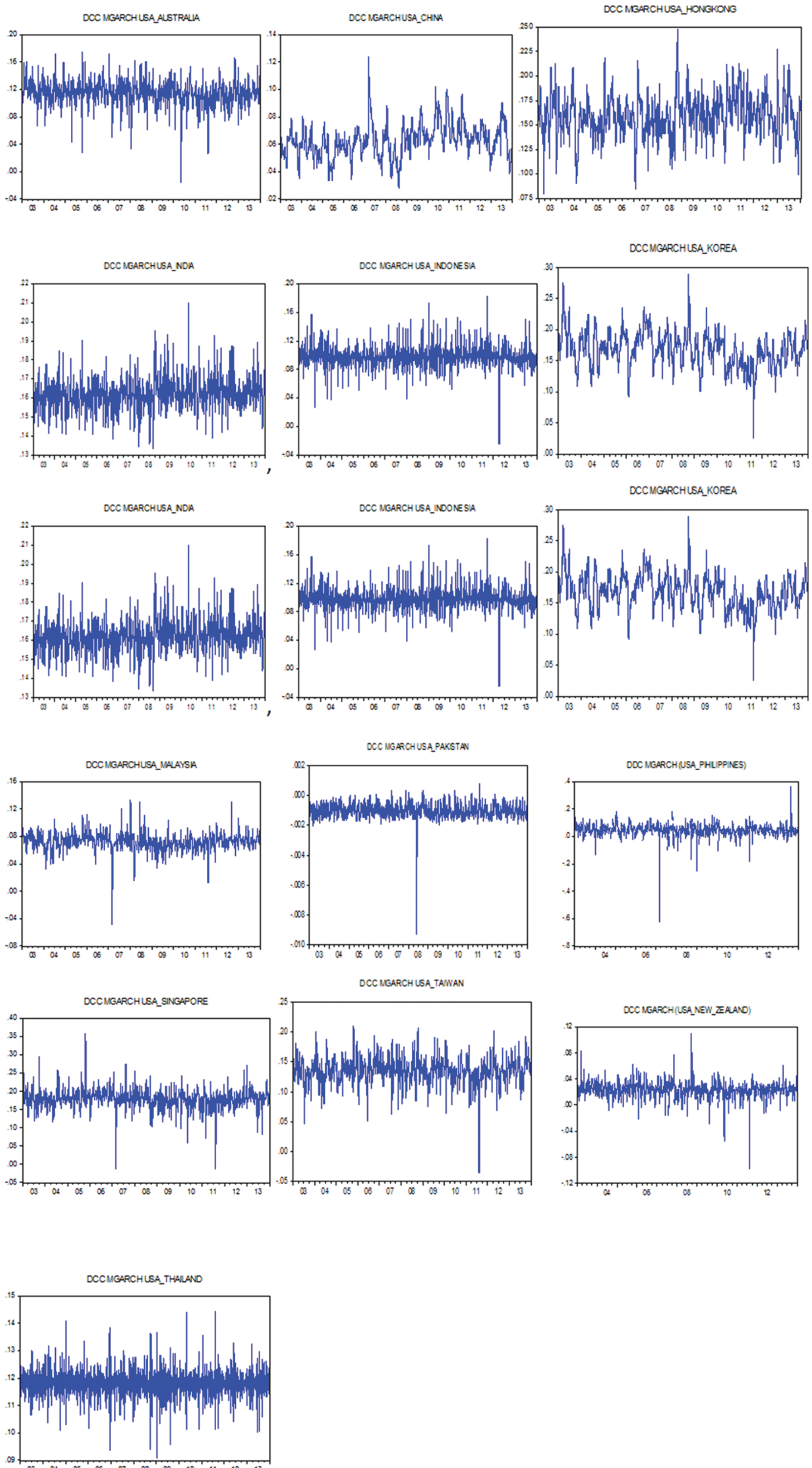
USA_ AFRICA



USA_Latin America

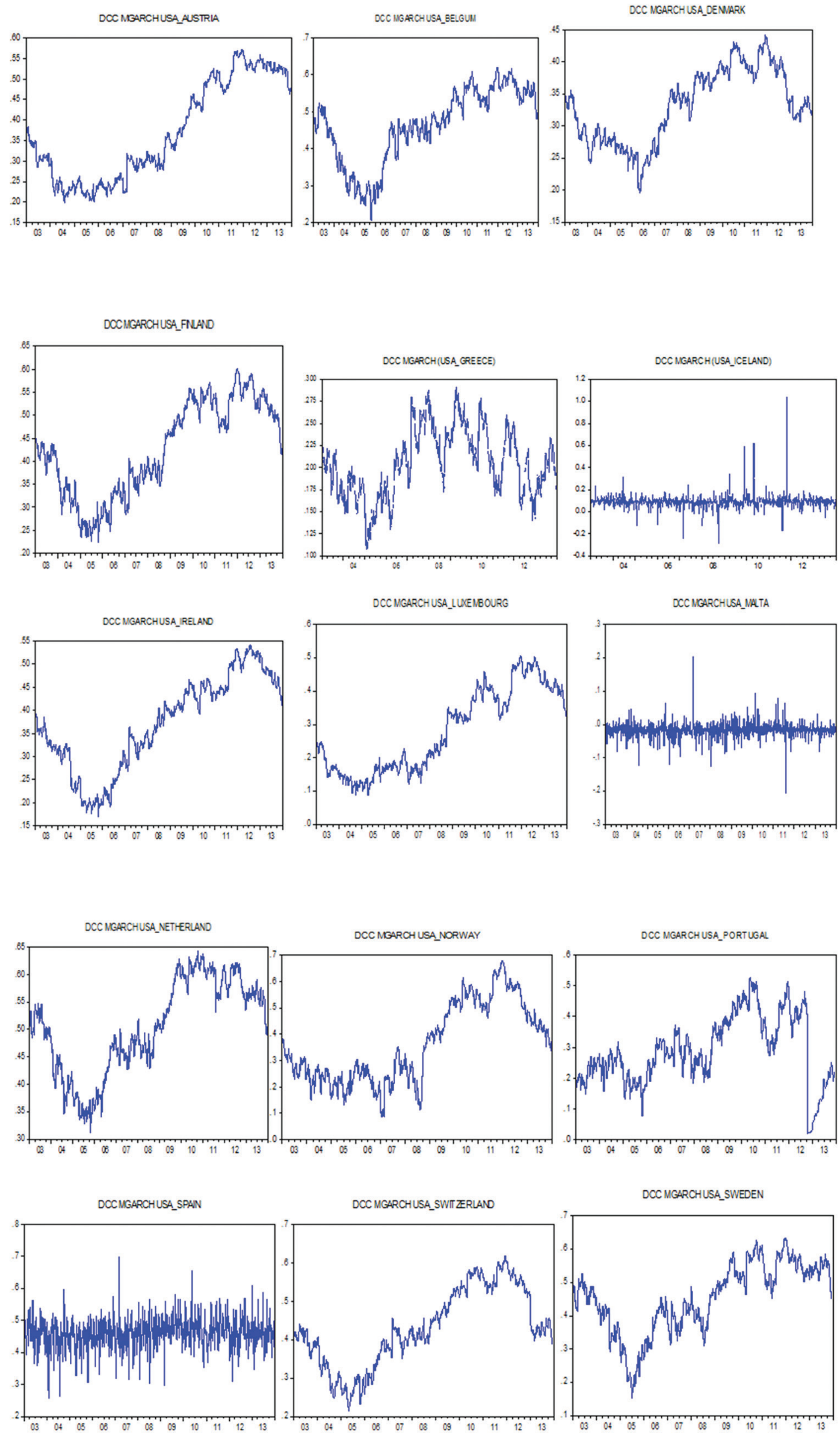


USA_Asia Pacific

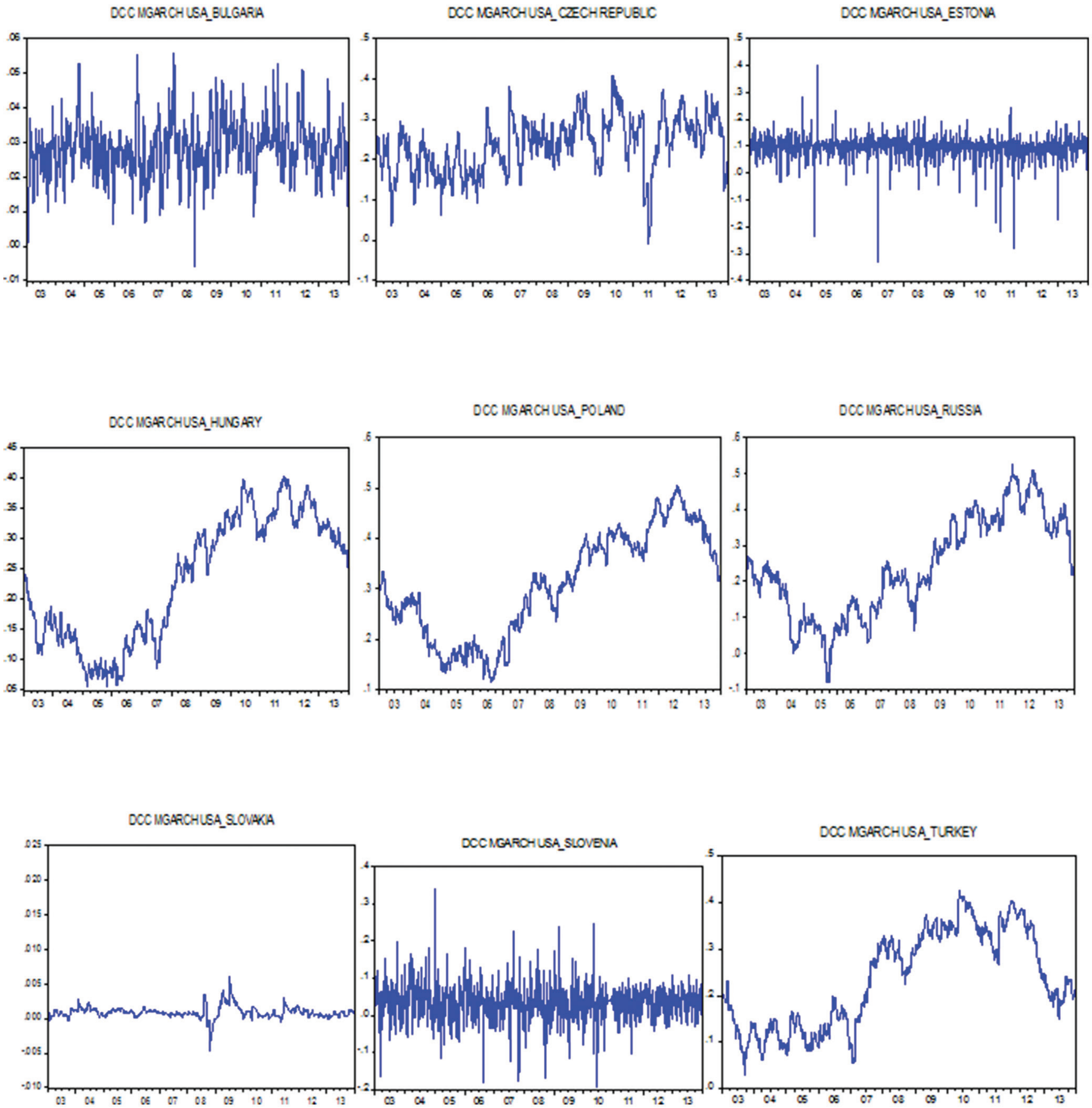


Europe

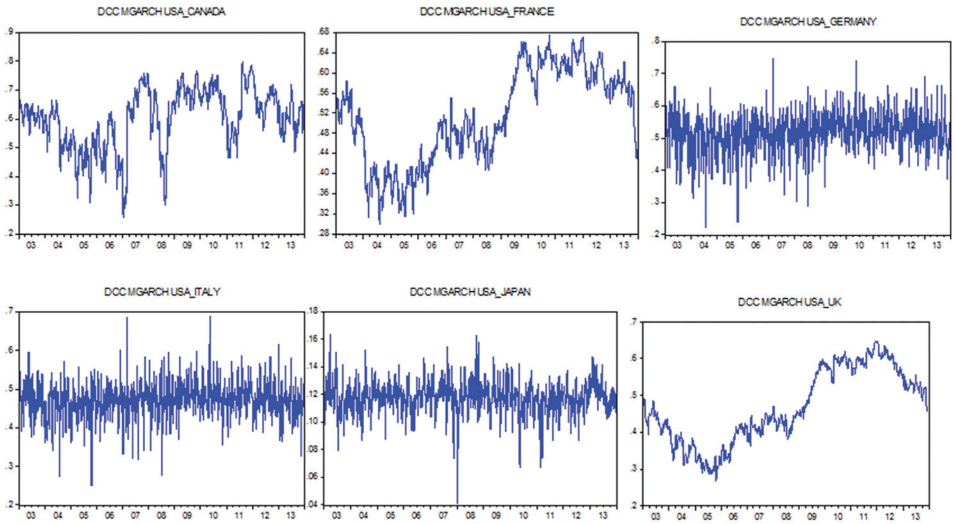
USA_Developped country



USA_Emerging country



USA_GROUP 7



USA-Middle East