International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies

http://TuEngr.com

PAPER ID: 11A05F

CONTAGION AND INTERDEPENDENCE AMONG GOLD, OIL, FOREX, AND ASIAN EMERGING EQUITY MARKETS

Nazakat Hussain [1], Imran Riaz Malik [1*]

[1] *Department of Business Administration, Iqra University, Islamabad, PAKISTAN.*

ARTICLEINFO

Article history:
Received 04 July 2019
Received in revised form 14 November 2019
Accepted 16 December 2019
Available online 23 December 2019

Keywords:
AEEMs; Commodity; DCC GARCH Model; Global Financial Crisis; Market turmoil; Forex market; Subprime crisis; Equity risk.

ABSTRACT

The terms contagion and interdependence strike the mainstream literature, specifically in times of crisis in financial markets. This study put an effort to examine the contagion and interdependence among Asian Emerging Equity Markets (AEEMs) (e.g., China, Taiwan, Pakistan, Malaysia, Thailand, South Korea, Philippines, India, and Indonesia), and the developed market of the US, Gold, WTI, and UDI during the Global Financial Crisis (GFC). This study adds to the literature on portfolio diversification by testing the dynamic correlation among AEEMs, gold prices, oil prices, and forex markets during tranquil and turmoil situations. The multivariate GARCH-DCC model is applied to data series. To measure interdependence and contagion, the data is divided into tranquil and turmoil time period. Hence, in this study for GFC, the data is divided into tranquil (03-01-2005 to 16-07-2007) and turmoil (17-07-2007 to 31-08-2009) time period. The results show that except for China, Philippines, Taiwan, gold and forex markets, most of the AEEMs and oil markets were influenced by the contagion effect during the U.S. subprime crisis. The study indicates that in order to reduce the risk of equity portfolio at the time of crises, investors can add gold and forex in their portfolios.

Disciplinary: Financial Sciences.

1 INTRODUCTION

Financial markets all over the globe are increasingly becoming integrated due to globalization, financial capital flows, development of information and communication technology and trade openness. The correlation among the security returns across the countries has increased leading to a reduction in the benefit of international diversification. Few earlier studies have revealed that due to stock market contagion and rise in cross-market links the benefits of diversification across the globe, both at national and international levels, are declining, especially in situations of crises. These linkages are found to lead towards a positive correlation among the different assets (Bekaert et al., 2005; Markwat et al., 2009).

*Corresponding author (I.R. Malik) Email: Imran.malik@iqraisb.edu.pk

At the time of abnormal market condition cross-market linkages increases. This increase in correlation among the markets is known as contagion. A number of authors have come up with different definitions for the term 'contagion'. Extracting from the previous studies, we, in this paper, will be using the definition given by (Forbes and Rigobon, 2002), according to whom, Contagion refers to "*a significant and temporary increase in cross countries linkages after a shock*".

The financial crises that occur in one country may spread to another country through different channels. These channels are divided into two classes, one is fundamentals-based contagion and the other is pure contagion. Fundamentals-based contagion, presented by Calvo and Reinhart (1996), emphasis the country-to-country diffusion of shock. This diffusion of shocks between the countries is the outcome of real and financial linkages in the crisis period as well as in a normal period. Whereas, Eichengreen et al. (1996) define pure contagion as diffusion of shocks from one market to another market beyond any idiosyncratic turbulence and fundamental linkages.

The consequence of the contagion effect is the increase in correlation among equity markets. Increase in the correlation among equity markets increases the fear of market sentiment about potential disastrous financial events, thus alerting investors about situations where they should become more conscious and should instinctively look for stock alternative (e.g. commodities) which would hold better value even in disastrous time (Hood & Malik, 2013). It is also necessary for the investors to have knowledge of association among the commodity markets and equity markets in order to get the maximum benefit from investment opportunities. Commodity markets are very liquid and investors use commodity markets for the purpose of investment (Vivian & Wohar, 2012). By incorporating commodities in the portfolio, investors may reduce risk and enhance portfolio performance. Hence, it is important to carefully inspect the connection between commodity and equity markets for making a wise decision and sustaining the wealth of investors in the scenario of a highly volatile market.

It is observed that many studies have been conducted to investigate the effects of contagion and interdependence at time of crises, but their focus has mainly been on equity markets (Hamao, Masulis, and Ng, 1990; Edward and Susmel, 2001; Morana and Belratti, 2008; Narayan et al., 2014; Burzala, 2016). Unlike previous studies, our paper is aimed at finding out the contagion and interdependence effects among Asian emerging equity markets, commodity (Gold & oil) markets and the Forex market during Global Financial Crises. This study will add value to the existing body of knowledge by investigating the dynamic correlation between forex, commodity and equity markets remain static or fluctuate during both tranquil and turbulent situations and try to find out which commodity can be a safe haven during turmoil situation. Moreover, with the perspective of investors, this study shall provide distinct strategies for portfolio diversification during both tranquil and turmoil period. As this study examines dynamic correlation of different classes of assets both during crises as well as normal time, it shall assist investors (e,g. mutual funds, insurance companies, pension funds, and brokerage firms) in choosing the combination of assets which shall be more durable and hold value in the scenario of contagion.

2 LITERATURE REVIEW

During the last two decades, the recurring nature of crises, its speedy transferring across borders without justifying for fundamentals has caught the attention of many researchers. Such as

global financial crises, Eurozone crises, these crises disseminate like a contagious disease, which affected the neighboring as well as distant markets. These scenarios became the main subject of many theoretical and empirical types of research. After the crash of the stock market in 1987 the interest in studying contagion increased. King and Wadhwani, (1990) examined the correlation round the crash by considering the major stock markets. It was observed that crisis leads to a rise in dynamic correlation. Hamao et al. (1990) investigated the correlation between markets during the US stock market 1987crisis. Moreover, the evidence of contagion was also presented by Lee and Kim (1993).

The investigation of cross-market correlations is important with regards to portfolio selection across countries. Some researchers explored the presence of contagion in the currency market at the time of crises by considering the correlation coefficients across countries. Eichengreen (1996) explored the currency crises contagion effect in France, Germany and Holland nations by applying a bivariate probit model. They found that if an abnormal situation occurred in a country, the possibility of opportunistic attacks on other countries would rise. Nagayasu (2001) analyzed the presence of contagion effect in the currency crises of Thailand by applying Vector Auto-Regression (VAR). Results denoted the existence of the contagion effect.

Additionally, the contagion effect in financial markets has been explored by a number of studies. To study the dynamics in stock markets during crisis time, Balla and Torous, (2002) applied the stochastic correlation technique on the stock indices of different markets. They found that over the period of time the structure of correlation is dynamic. The proof of higher correlation among the stock return of the US and OECD member countries are also presented by Longin and Slonik (1995). Edward and Susmel (2001) also explored that at the time of crises many markets of Latin America were correlated significantly which verifies that contagion exists in the crisis time period.

Further proof of contagion in Asian markets is presented by Narayan et al. (2014) by using EGARCH (DCC) for 2001-2012. The study found that there exists a correlation between Asian and US equity markets. The study further inferred that the reasons for stock market integration are price differentials, exchange rate risk, global financial crisis, bilateral trade relations, and domestic market characteristics. Wang, (2014) established a study to find out whether financial crises strengthen the relationships among US and East Asian stock markets. The consequences of the study suggested that before the financial crisis, East Asian markets tended to respond to global shocks. However, the financial crisis seemed to strengthen linkages among Asian equity markets while the US market impact was weak during the crisis period.

It can be inferred from the cited literature that contagion exists at the time of crises. The higher correlation of the equity markets with developed markets indicates that the contagion effect transfers from one country to another country which affects its equity market during the crisis time period. But no study covered the contagion between AEMs and gold, oil and forex markets at the time of GFC. This study will find out the presence of contagion among the gold, oil, forex and Asian Emerging Equity Markets (AEMs) during the Global Financial Crisis.

3 METHOD

3.1 DATA DESCRIPTION

This paper attempts to examine the contagion and interdependence among Gold, Oil, Forex

*Corresponding author (I.R. Malik) Email: Imran.malik@iqraisb.edu.pk Volume 11 No.5 ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8 Paper ID:11A05E http://TUENGR.COM/V11/11A05E.pdf DOI: 10.14456/ITJEMAST.2020.86

Markets and AEEMs during the GFC. To find out the contagion and interdependence among Gold, Oil, Forex Markets and AEEMs, daily data from 03-01-2005 to 31-08-2009 of stock indices, Forex, oil, and Gold is utilized which covers the incidence of Global Financial Crises. The sample includes the stock-index returns of the nine AEEMs markets and one developed market of US and of Gold, WTI and UDI (US Dollar Index). The selection of sample countries is based on the classification of MSCI (2018).

The data of all the markets is taken in Dollar form, as Rigobon (2002) reported that the use of local indices or dollar indices does not alter the results. For gold, the study used the nearby contract prices of the gold futures contract. For oil spot daily crude oil prices of the WTI in dollars per barrel is used, for forex US Dollar Index is used. All the market data is obtained from Bloomberg. To measure interdependence and contagion it is required that the sample must be split into pre crises and crises period. Hence, in this study data is divided into tranquil 03-01-2005 to 16-07-2007 and turmoil 17-07-2007 to 31-08-2009 period for the crisis under investigation. The time period of tranquil and turmoil chosen for this study is the same as Brière et al. (2012).

3.2 ECONOMETRIC TECHNIQUE

To study the correlation among the return of different assets over time, it is required to estimate the time-varying correlation. In literature number of methods is suggested to study the time-varying correlation especially in the multivariate GARCH family. These methods are burdensome in estimation and difficult to interpret. Engle, (2002) suggested a pragmatic model for studying the time-varying correlation among the different assets return over time known as the Dynamic conditional correlation (DCC) model. The Multivariate (DCC) specification model proposed by Engle (2002) is stated as follows:

$$H_t = D_t C_t D_t \qquad (1),$$

where $D_t = diag\left(h_{11t}^{\frac{1}{2}} \dots \dots h_{NNt}^{\frac{1}{2}}\right)$. The estimates of time-varying standard deviation are taken from univariate GARCH (1, 1) models with $\sqrt{h_{ii,t}}$ on the *i*th diagonal. The C_i is a time-varying conditional correlation matrix having size $N \times N$. The elements of D_t are simply created by the univariate GARCH (1, 1) process

$$H_{i,t} = \boldsymbol{\omega_i} + \alpha_i \mu_{i,t-1}^2 + \beta_t h_{i,t-1} \qquad (2),$$

where $\boldsymbol{\omega_i}$ is the constant term, $\alpha_i$captures the Auto-Regressive Conditional Heteroscedasticity (ARCH) effect and $\beta_t$measures the persistence of the volatility. The evolution of correlation in the DCC model is given as

$$Q_t = (1 - \alpha - \beta)\overline{Q}^{\cdot} + \alpha U_{t-1} U_{t-1}' + \beta Q_{t-1} \qquad (3),$$

where $Q_t = \left(q_{ij,t}\right)$ is the $N \times N$ time-varying covariance matrix of residuals, $\overline{Q} = E\lfloor \mu_t \, \mu_t \rfloor$ is the $N \times N$ time-invariant variance matrix of u_t. The nonnegative scalar parameters α and β satisfy $\alpha + \beta < 1$. Because Q_t does not have unit elements on the diagonal, the correlation matrix *Ct* is obtained by scaling it as

$$C_t = (diag(Q_t))^{-\frac{1}{2}} \cdot (diag(Q_t))^{-\frac{1}{2}} \quad (4)$$

Each C_t element has a normal form

$$P_{ij,t} = q_{ij,t}/\sqrt{q_{ii,t}}q_{jj.t'} \quad \text{(i,j =1,2.....n, and } i \neq j) \quad (5)$$

Thus, the correlation coefficient $P_{ij,t}$ at time t is defined as

$$P_{ij,t} = \frac{(1-\alpha-\beta)\overline{q}_{ij}+\alpha\,\mu_{it-1}\,\mu_{jt-1}+\beta q_{ijt-1}}{\sqrt{(1-\alpha-\beta)\overline{q}_{ii}+\alpha\mu_{it-1}^2}+\beta q_{it-1}\sqrt{(1-\alpha-\beta)\overline{q}_{jj}+\alpha\mu_{jt-1}^2+\beta q_{jt-1}}} \ldots \quad (6)$$

In this study, correlation coefficients are of significant importance because these coefficients produce key evidence on the pattern of correlation among gold, oil, forex and equity markets series over time. Since the volatility is accustomed by the process, the DCC does not have any bias from volatility. Unlike the volatility-adjusted cross-market correlations used in Forbes and Rigobon (2002), DCC-GARCH constantly adjusts the correlation for the time-varying volatility. Hence, DCC offers a superior measure for dynamic correlation. This notion is also supported by a number of studies.

This study employs the one-tail t-test to observe the presence of the contagion effect. This test finds the mean of DCC correlation in crises and normal time period, moreover, this test clarifies that either mean of DCC correlations is higher at the turmoil time as compared to tranquil time. The study defines the null and alternative hypothesis as

$$H0=\mu_p^{crises} \leq \mu_p^{pre-crises} \quad (7)$$

$$H1= \mu_p^{crises} > \mu_p^{pre-crises}$$

μ_p^{crises} denotes the means of dynamic conditional correlation at the time of crises and $\mu_p^{pre-crises}$ denotes the means of dynamic conditional correlation in pre-crises time. The value of t statistics is compared with critical value. If the value of t statistics is higher than the critical value, H_0 is rejected and H_1 is accepted which supports the proof for the existence of contagion.

4 RESULT AND DISCUSSION

4.1 DESCRIPTIVE STATISTICS

Table 1 represents the descriptive statistics of stock-index returns of the nine Asian emerging markets China, Taiwan, Pakistan, Malaysia, Philippine, Thailand, India, South Korea, Indonesia, one developed market US and of Gold, oil and forex markets. Table 1 only contains the summary of the whole sample whereas Tables 2 and 3 contain the summary statistics of US pre crises time and crises time.

Table 1 depicts the average positive daily return of all the markets except UDI. The highest average daily return is of

*Corresponding author (I.R. Malik) Email: Imran.malik@iqraisb.edu.pk Volume 11 No.5 ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8 Paper ID:11A05E http://TUENGR.COM/V11/11A05E.pdf DOI: 10.14456/ITJEMAST.2020.86

Table 1: Descriptive Statistics (Full Sample)

Variables	BSE	SP500	GOLD	JCI	KOSPI	KSCI	PSEI	PSX	SET50	SSE	TWSE	UDI	WTI
Mean	0.000	8.97E	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.08E	-3.91E	0.000
Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.146	0.105	0.068	0.076	0.112	0.045	0.161	0.085	0.105	0.093	0.065	0.017	0.164
Minimum	-0.124	-0.082	-0.095	-0.109	-0.128	-0.099	-0.130	-0.077	-0.160	-0.092	-0.069	-0.022	-0.170
SD.	0.012	0.009	0.009	0.011	0.013	0.006	0.010	0.011	0.011	0.012	0.011	0.002	0.020
Skewness	-0.721	-0.061	-0.321	-0.787	-0.667	-1.120	0.423	-0.282	-0.828	-0.152	-0.215	-0.006	-0.284
Kurtosis	15.326	16.135	12.105	14.009	13.255	20.119	27.226	9.389	18.257	11.052	8.276	10.518	11.313
Jarque-Bera	358	401	193	287	248	693	136	957	548	151	652	131	161
Probability	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Table 1 describes the summary statistics of the whole sample. Summary statistics include means of all the markets, results depict the average daily positive return of all the markets except UDI. Higher values of Kurtosis and Jarque-Bera test show that data is not normally distributed. Conditional heteroscedasticity is represented by ARCH values, which show the presence of heteroscedasticity in the data. * denotes the rejection of null hypothesis at 5% significant level**.**

Table 2: Descriptive Statistics (US Pre-crisis Data)

Variables	BSE	S&P500	GOLD	JCI	KOSPI	KSCI	PSEI	PSX	SET50	SSE	TWSE	UDI	WTI
Mean	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	-0.000	0.000
Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.062	0.020	0.040	0.053	0.034	0.026	0.047	0.058	0.105	0.079	0.029	0.008	0.084
Minimum	-0.071	-0.033	-0.062	-0.065	-0.035	-0.047	-0.082	-0.060	-0.160	-0.092	-0.043	-0.009	-0.123
SD	0.011	0.005	0.009	0.009	0.008	0.005	0.010	0.013	0.010	0.013	0.007	0.002	0.016
Skewness	-0.876	-0.311	-0.599	-0.801	-0.324	-1.050	-0.645	-0.504	-3.186	-0.702	-0.639	0.078	-0.199
Kurtosis	10.230	6.625	8.880	10.290	5.296	14.837	9.622	6.064	83.865	10.923	7.696	5.273	8.030
Jarque-Bera	2130	520	1386	2145	219	5565	1752	400	2533	2493	912	199	980
Probability	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Table .2 describes the summary statistics in US pre-crisis time. Summary statistics include means of all the markets, results depict the average daily positive return of all the markets except UDI. Values of Kurtosis and Jarque-Bera test show that data is not normally distributed.

Table 3: Descriptive Statistics (US crisis Data).

Variables	BSE	S&P500	GOLD	JCI	KOSPI	KSCI	PSEI	PSX	SET50	SSE	TWSE	UDI	WTI
Mean	0.000	-0.000	0.000	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000	-0.000
Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.146	0.105	0.068	0.076	0.112	0.042	0.093	0.082	0.075	0.090	0.065	0.016	0.164
Minimum	-0.111	-0.082	-0.079	-0.109	-0.111	-0.099	-0.130	-0.051	-0.110	-0.080	-0.067	-0.023	-0.128
Std. Dev.	0.020	0.016	0.013	0.017	0.017	0.009	0.015	0.014	0.015	0.020	0.016	0.003	0.029
Skewness	-0.057	0.141	-0.099	-0.575	-0.544	-1.381	-0.844	-0.142	-0.840	-0.166	-0.229	-0.427	0.137
Kurtosis	9.598	10.755	7.955	10.095	10.804	18.413	14.451	6.902	11.965	6.118	5.709	9.409	8.252
Jarque-Bera	1399	1934	790	1659	1994	7877	4304	491	2673	315	242	1342	888
Probability	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

S&P500 (8.97E-05) is followed by the Taiwan stock exchange weighted index (1.08E-05). Table 2 shows the descriptive statistics before US crises and Table 3 for the US crisis time. In pre-crisis time the average return of all the markets is positive except UDI but in crisis times Table 3 shows that the average return of all the markets is negative except India, Indonesia, Gold, and UDI. Same as the pre-crisis period, all the markets show the high value of Kurtosis in crisis time which leads towards the rejection of the null hypothesis that series are normally distributed. Tables 2 and 3 represent that the values of standard deviation for all the markets are higher in crisis time as compared to pre crises time which provides the evidence of higher risk at the time of crisis.

Hypothesis test results are presented in Table 4. The results show that the dynamic correlations are higher in crisis time as compared to the pre-crisis time for the markets of Thailand, India, South

Korea, Pakistan, Malaysia, Indonesia, and WTI, which leads towards rejection of the null hypothesis and signifies the presence of contagion effect in these markets.

Table 4: Dynamic conditional correlation coefficient and contagion effect test

Condition	Mean	Variance	t-statistics $H_0=\mu_p^{crises} \leq \mu_p^{pre-crises}$
Pre-crises DCC US_ China	0.019	0.003	3.617
Crises DCC US_ China	-0.014	0.003	
Pre-crises DCC US_Philipine	0.039	0	-16.284
Crises DCC US _Philippine	-0.012	0.001	
Pre-crises DCC US_Taiwan	0.062	0	-12.908
Crises DCC US_Taiwan	0.025	0.006	
Pre-crises DCC US_Thailand	0	0.002	28.99*
Crises DCC US_ Thailand	0.083	0.012	
Pre-crises DCC US_ India	0.023	0.002	17.198*
Crises DCC US_ India	0.088	0.002	
Pre-crises DCC US_SouthKorea	0.058	0.001	11.410*
Crises DCC US_ South Korea	0.094	0.005	
Pre-crises DCC US_Pakistan	0.021	0.001	10.499*
Crises DCC US_ Pakistan	0.067	0.003	
Pre-crises DCC US_Malaysia	-0.014	0.003	44.520*
Crises DCC US_ Malaysia	0.31	0.012	
Pre-crises DCC US_Indonesia	0.006	0.002	27.579*
Crises DCC US_ Indonesia	0.095	0.004	
Pre-crises DCC US_GOLD	0.081	0.002	-3.204
Crises DCC US_ GOLD	-0.027	0.01	
Pre-crises DCC US_WTI	-0.024	0.001	9.519*
Crises DCC US_ WTI	0.013	0.039	
Pre-crises DCC US_UDI	0.049	0.003	-7.776
Crises DCC US_ UDI	0	0.052	

Note: This table presents the dynamic correlation in the turmoil and tranquil time of the US crisis. The time period for pre-crisis is from 03-01-2005 to 16-07-2007 and for crisis time is from 17-07-2007 to 31-08-2009. Rejection of null hypothesis against the one-sided alternative that at the time of crisis the dynamic correlation increases is tested at a 5% significant level denoted by *.

However, results revealed that the dynamic correlations are lower in crisis time as compared to the pre-crisis time for the markets of China, the Philippine, Taiwan, Gold, and UDI, which signifies that we cannot reject the null hypothesis for these markets. The results of this study support the presence of contagion effect in AEEMs. As t-test confirms the higher correlation at the time of crises. The results are in line with the definition of contagion which was given by Forbes and Rigobon, (2002). Consistent with the above-cited studies and with the studies of (Bae et al., 2003: Kallberg et al., (2005), this study confirms the presence of contagion effect in Emerging Asian equity markets except for China, Taiwan and Philippine. The results of this study provide no evidence of contagion for the markets of China, the Philippine and Taiwan. These results for the equity market of China are consistent with Wen, Wei and Huang et al., (2012) who found the low level of DCC between China and the US at the time of crises. However, these results are not consistent with the study of Wang, (2014) and Narayan et al., (2014) with respect to the China equity market.

Moreover, with respect to Taiwan, the study reports different results as compared to the study of Celik, (2012) who reports the presence of contagion effect in the market of Taiwan. The reason for the difference in results is that Celike, (2012) provides evidence of contagion effect for foreign exchange markets of Taiwan whereas this study focused on the equity market. This study also reports no contagion effect on the market of the Philippine. This result is not in line with the study of (Chiang, Jeon & Li, 2007), who found the presence of a contagion effect in the equity market of

*Corresponding author (I.R. Malik) Email: Imran.malik@iqraisb.edu.pk Volume 11 No.5 ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8 Paper ID:11A05E http://TUENGR.COM/V11/11A05E.pdf DOI: 10.14456/ITJEMAST.2020.86

the Philippine. The difference in result is due to the difference of crises under this study and source of contagion country.

Finally, this study is different from the above-mentioned studies because this study investigated the contagion effect not only in equity markets but also in commodity and forex markets. Results provide evidence for the presence of contagion effect in the oil market but no contagion effect for the market of Gold and UDI.

5 CONCLUSION

This study attempts to find out that either there exists contagion or independence across emerging Asian equity markets and markets of gold, oil, and forex. According to the definition of forbs and Rigobon, (2002) contagion is the significant increase in the correlation of the markets at the time of crises. This study used the one-tail t-test to check either the means of correlation are higher in crisis time as compared to pre-crisis time. Results revealed that the contagion effect exists at the time of US crises for most Asian emerging markets except China, Taiwan, and the Philippine. It shows that most of the Asian emerging markets seem to be influenced by the contagion effect during the U.S subprime crisis. Moreover, results inferred that the contagion effect exists for the market of WTI. One of the major findings is that the Gold and USD market is not affected by the contagion effect of the GFC.

It is observed from the analysis that at the time of crises the dynamic conditional correlation of equity markets got significance increase. This significant increase in correlation is not a good sign for portfolio investors. Because a higher correlation between the securities reduces the benefits of diversification. To reduce the risk of investment at the time of crises there must be a low or negative correlation among the securities. The study suggests that investors should incorporate Gold and USD in their portfolio in order to reduce the risk of higher correlation among the equity markets at the time of crises.

6 AVAILABILITY OF DATA AND MATERIAL

Data can be made available by contacting the corresponding author.

7 REFERENCES

Andersen, T. G., & Teräsvirta, T. (2009). Realized volatility. In *Handbook of financial time series* (pp. 555-575). Springer, Berlin, Heidelberg.

Bae, K. H., Karolyi, G. A., & Stulz, R. M. (2003). A new approach to measuring financial contagion. *The Review of Financial Studies*, *16*(3), 717-763.

Bala, D. A., & Takimoto, T. (2017). Stock markets volatility spillovers during financial crises: A DCC-MGARCH with skewed-t density approach. *Borsa Istanbul Review*, *17*(1), 25-48.

Ball, C. A., & Torous, W. N. (2000). Stochastic correlation across international stock markets. *Journal of Empirical Finance*, *7*(3-4), 373-388.

Bekaert, G., Harvey, C. R., & Lundblad, C. (2005). Does financial liberalization spur growth? *Journal of Financial Economics*, *77*(1), 3-55.

Bordo, M., Eichengreen, B., Klingebiel, D., & Martinez-Peria, M. S. (2001). Is the crisis problem growing more severe? *Economic policy*, *16*(32), 52-82.

Bouaziz, M. C., Selmi, N., & Boujelbene, Y. (2012). Contagion effect of the subprime financial crisis: Evidence of DCC multivariate GARCH models. *European Journal of Economics, Finance and Administrative Sciences*, *44*, 66-76.

Brière, M., Chapelle, A., & Szafarz, A. (2012). No contagion, only globalization and flight to quality. *Journal of International Money and Finance*, *31*(6), 1729-1744.

Burzala, M. M. (2016). Contagion effects in selected European capital markets during the financial crisis of 2007–2009. *Research in International Business and Finance*, *37*, 556-571.

Calvo, G. A., Leiderman, L., & Reinhart, C. M. (1996). Inflows of Capital to Developing Countries in the 1990s. *Journal of economic perspectives*, *10*(2), 123-139.

Calvo, G. A., Reinhart, C. M., & Vegh, C. A. (1995). Targeting the real exchange rate: theory and evidence. *Journal of development economics*, *47*(1), 97-133.

Celık, S. (2012). The more contagion effect on emerging markets: The evidence of DCC-GARCH model. *Economic Modelling*, *29*(5), 1946-1959.

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 1026–1228.

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

Choi, K., & Hammoudeh, S. (2010). Volatility behavior of oil, industrial commodity and stock markets in a regime-switching environment. *Energy Policy*, *38*(8), 4388-4399.

Collins, D., & Biekpe, N. (2002). *Should Emerging Market Contagion Be a Fear for African Stock Markets?* School of Management Studies, University of Cape Town.

Edwards, S., & Susmel, R. (2001). Volatility dependence and contagion in emerging equity markets. *Journal of Development Economics*, *66*(2), 505-532.

Eichengreen, B., Rose, A. K., & Wyplosz, C. (1996). Is there a safe passage to EMU? Evidence on capital controls and a proposal. In *The Microstructure of Foreign Exchange Markets* (pp. 303-332). University of Chicago Press.

Eichengreen, B., Rose, A. K., & Wyplosz, C. (1996). *Contagious currency crises* (No. w5681). National bureau of economic research.

Engle, R. (2002). Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models. *Journal of Business &Economic Statistics*, *20*(3), 339-350.

Forbes, K., & Rigobon, R. (2000). *Contagion in Latin America: Definitions, measurement, and policy implications* (No. w7885). National Bureau of Economic Research.

Gallegati, M. (2012). A wavelet-based approach to test for financial market contagion. *Computational Statistics & Data Analysis*, *56*(11), 3491-3497.

Hamao, Y., Masulis, R. W., & Ng, V. (1990). Correlations in price changes and volatility across international stock markets. *The review of financial studies*, *3*(2), 281-307.

Hood, M., & Malik, F. (2013). Is gold the best hedge and a safe haven under changing stock market volatility?. *Review of Financial Economics*, *22*(2), 47-52.

Hwang, E., Min, H. G., Kim, B. H., & Kim, H. (2013). Determinants of stock market comovements among US and emerging economies during the US financial crisis. *Economic Modelling*, *35*, 338-348.

*Corresponding author (I.R. Malik) Email: Imran.malik@iqraisb.edu.pk Volume 11 No.5 ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8 Paper ID:11A05E http://TUENGR.COM/V11/11A05E.pdf DOI: 10.14456/ITJEMAST.2020.86

King, M. A., & Wadhwani, S. (1990). Transmission of volatility between stock markets. *The Review of Financial Studies*, *3*(1), 5-33.

Kuper G, Lestano. (2007). Dynamic Conditional Correlation Analysis of Financial Market Interdependence: An Application to Thailand and Indonesia. *Journal of Asian Economics*. 18: 670-684.

Lahrech, A., & Sylwester, K. (2011). US and Latin American stock market linkages. *Journal of International Money and Finance*, *30*(7), 1341-1357.

Lee, H. Y., Wu, H. C., & Wang, Y. J. (2007). Contagion effect in financial markets after the South-East Asia Tsunami. *Research in International Business and Finance*, *21*(2), 281-296.

Lee, S. B., & Kim, K. J. (1993). Does the October 1987 crash strengthen the co-movements among national stock markets?. *Review of Financial Economics*, *3*(1), 89-102.

Lien, D., & Yang, L. (2009). Intraday return and volatility spill-over across international copper futures markets. *International Journal of Managerial Finance*, *5*(1), 135-149.

Lin, W. L., Engle, R. F., & Ito, T. (1994). Do bulls and bears move across borders? International transmission of stock returns and volatility. *Review of Financial Studies*, *7*(3), 507-538.

Loh, L. (2013). Co-movement of Asia-Pacific with European and US stock market returns: A cross-time-frequency analysis. *Research in International Business and Finance*, *29*, 1-13.

Longin, F., & Solnik, B. (2001). Extreme correlation of international equity markets. *The journal of finance*, *56*(2), 649-676.

Longin, F., & Solnik, B. (1995). Is the correlation in international equity returns constant: 1960–1990?. *Journal of international money and finance*, *14*(1), 3-26.

Morana, C., & Beltratti, A. (2008). Comovements in international stock markets. *Journal of International Financial Markets, Institutions and Money*, *18*(1), 31-45.

Markowitz, H. (1952). Portfolio selection. *The journal of finance*, *7*(1), 77-91.

Markwat, T., Kole, E., & Van Dijk, D. (2009). Contagion as a domino effect in global stock markets. *Journal of Banking & Finance*, *33*(11), 1996-2012.

Nagayasu, J. (2001). Currency crisis and contagion: evidence from exchange rates and sectoral stock indices of the Philippines and Thailand. *Journal of Asian Economics*, *12*(4), 529-546.

Naoui, K., Khemiri, S., & Liouane, N. (2010). Crises and financial contagion: the subprime crisis. *Journal of Business Studies Quarterly*, *2*(1), 15.

Narayan, S., Sriananthakumar, S., & Islam, S. Z. (2014). Stock market integration of emerging Asian economies: Patterns and causes. *Economic Modelling*, *39*, 19-31.

Ramchand, L., & Susmel, R. (1998). Volatility and cross correlation across major stock markets. *Journal of Empirical Finance*, *5*(4), 397-416.

Silvennoinen, A., & Teräsvirta, T. (2009). Multivariate GARCH models. In *Handbook of financial time series* (pp. 201-229). Springer, Berlin, Heidelberg.

Syriopoulos, T., & Roumpis, E. (2009). Dynamic correlations and volatility effects in the Balkan equity markets. *Journal of International Financial Markets, Institutions and Money*, *19*(4), 565-587.

Vivian, A., & Wohar, M. E. (2012). Commodity volatility breaks. *Journal of International Financial Markets, Institutions and Money*, *22*(2), 395-422.

Wang, L. (2014). Who moves East Asian stock markets? The role of the 2007–2009 global financial crisis. *Journal of International Financial Markets, Institutions and Money*, *28*, 182-2

Yiu, M. S., Alex Ho, W. Y., & Choi, D. F. (2010). Dynamic correlation analysis of financial contagion in Asian markets in global financial turmoil. *Applied Financial Economics*, *20*(4).

Nazakat Hussain is a PhD Scholar, Department of Business Administration, Iqra University, Islamabad, Pakistan. He is interested in Financial Crisis and Analysis.

Dr.Imran Riaz Malik is an Associate Professor of Finance/Director of Research, Department of Business Administration, Iqra University, Islamabad Pakistan. He is interested in Financial Econometrics, Financial Risk Management.