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Empirical analysis of global financial stress indicators

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Abstract: This paper has attempted to achieve three main objectives with regard to the global finical stress indicators. First, using Seemingly Unrelated Regression (SUR) in a Vector Autoregressive, the paper examines volatility spillover across the indicators. Second, by employing Granger (non) causality test, it determines whether there is a feedback from each indicator and whether there is a unique direction in the volatility spillover. Third, it identifies the state and length of the stress by using Markov Regime Switching model. The results suggest that volatility spillover of each indictor is predominantly explained by its own past volatility, although there are cross influences with different directions. Granger (non) causality test results indicate the existence of bi-directional causal relationship proceeding from one indicator to another. Furthermore, the duration of volatility collectively show longer state of volatility in the high volatility regime than the low and moderate regimes implying that stock and commodity markets are highly unstable.
Keywords: spillover, globalization, financial stress and causality.

JEL classification: G1, G15, G19

1. Introduction

Whether or not there is a strong and well-functioning eco-financial system in the globe can be detected by the indicators of global financial stress which normally assist in speculating the short and long run directions of the financial markets. Among the global financial stress indicators, examining the performances of emerging countries' stock index (MSCI_EM), advanced countries' stock index (MSCI_A) and the commodity price index measured by Commodity Research Bureau (CRB) will enable researchers to measure the extent of the stress and interdependence of the markets. Therefore, analysing the interactions among the stock markets of developed countries, emerging markets and commodity markets will enlighten how much globalization of the financial as well as goods and services markets play their role in the determination of world markets' integration and policy changes.

More specifically, the study of stock as well as commodity markets' volatility is very crucial in that it provides key information for making portfolio investment decision at individual level and for adjusting macroeconomic and financial policies of the economy in general. The contagion effect of the stock market volatility over the commodity markets and vice versa can signal financial market players the future directions of the returns in the markets. By examining the spillover effect of the markets, therefore, it is possible to examine the predicting power of the markets. In other words, analysing to what extent the commodity price volatility spills over to the stock market volatility enables us to see to what extent volatility in the stock market can be predicted via volatility in the commodity market. On the other hand, predictability of the commodity market volatility can also be determined by the spillover effect of the stock market volatility on the commodity market.

Some studies have shown that there is negative relationship between oil price, a commodity price, and stock market returns (see Jones and Kaul 1996; Sadorsky 1999; Filis 2010; Chen 2009; Miller and Ratti 2009 and Park and Ratti 2008). It should be noted here that the findings of these studies are reliant on whether the economy under investigation (study) is oil importing or oil exporting country. An increase in commodity price such as oil does not necessarily reduce the stock return. The outcome depends on whether or not the economy of the country under examination is based mainly on commodity exports. If the economy depends on commodity exports, it is likely to see an increase in investment flow from overseas when the world commodity price increases, as also evidenced by the rise in the value of the economy's currency with the increase in commodity price. This outcome is mainly due to the speculations of investors with regard to the fluctuations of commodity price. Investors tend to speculate good return from the economy for which the commodity price has increased and thereby raise their demand for the stocks which in turn will push the stock prices up. However, if the economy under examination does not depend on commodity exports, then it is likely to see negative correlation between commodity and stock prices. This might be partly due to the switching of investment towards the economy where there is high commodity price and where investors can earn higher return for their investments. This could be part of the reason for the positive volatility spillover between oil price and stock market in the economies of Kuwait, Oman and UAE in the study by Arouri et al., (2011).

The majority of the studies reviewed so far focus on the spillover effect of oil price volatility on the stock market volatility (see Arouri et al., 2011; Hammoudeh et al., 2004; Hossenidoust et al., 2013; Malik and Ewing 2009; Malik and Hammoudeh 2007; Chiou and Lee 2009 and Filis et al. 2011). Some have included the spillover effect of gold price volatility on the equity market, e.g. Choi and Hammoudeh (2010) and Thuraisamy et al., (2007). In contrast to these studies, our focus is on both sides of the markets and in aggregate terms; that is whether or not there are mutual spillover effects between commodities and stock markets in a comprehensive manner. Basher and Sadorsky (2006) examine the impact of oil price changes on the stock market return of emerging countries by using aggregate stock index of emerging countries. Our study differs from their study, in that we examine the spillover effect of the stock market volatility of not only the emerging economies but also advanced economy as well as the commodity price index as a whole. In the literature reviewed so far, less emphasis is given as to whether the markets' own past volatility play major role than the volatility of other markets in the determination of the volatility of each market. We are, therefore, filling the gap by considering these missing areas of discussions. Furthermore, in contrast to the existing literature, this study extends its examination by addressing Granger (non) causalities among the stock markets and the commodity markets. By employing Markov Regime Switching model, this paper also identifies the state and length of the stress among the markets.

The remainder of the paper is organized as follows: the next section discusses the methodology used in the study; Section 3 explains the data type and sources of the data; Section 4 reports the results and Section 5 gives the conclusion.

2. Methodology

To examining the spillover effects and the causalities, volatility of the global financial stress indicators are captured by Generalized Autoregressive Conditional Heteroskedasticity

(GARCH (1, 1)). In the procedure, whether there is an Autoregressive Conditional Heteroskedasticity (ARCH) effect in each series is determined prior to the estimation of GARCH (1, 1). The GARCH model is specified as follows:

$$\varepsilon_{i,t} = \alpha_i + u_{i,t} \quad (1)$$

$$\sigma_{i,t}^2 = \mu_i + \alpha_i u_{i,t-1}^2 + \beta_i \sigma_{i,t-1}^2 \quad (2)$$

Where $\varepsilon_{i,t}$ stands for the return on global financial stress indicator *i* at time *t*. $u_{i,t}$ is the random error term for the global financial stress indicator *i* at time *t* and is normally distributed, *N (0,* σ_t^2 *).* $\sigma_{i,t}^2$ is the conditional variance term for the global financial stress indicator *i* at time *t-1*. α_i and β_i are ARCH and GARCH parameters for the global financial stress indicator *i* respectively.

The spillover effect of volatility can be captured using different methods (see Dungey et al., 2005; Eichengreen et. al., 1996; Favero and Giavazzi, 2000; Bae et. al., 2003; and Hartman et. al., 2004). This paper uses Seemingly Unrelated Regression (SUR) in a Vector Autoregressive form to capture the volatility spillover from among the stock markets of developed, emerging and the commodity market. The advantage of SUR is that it provides efficient estimates even though the error terms are correlated across the equations. To carry out SUR, first the volatility series for each market (V_i) is collected from the model specified above. The series then was regressed on its own lagged volatility ($V_{i,\,t-1}$) together with the lagged volatilities of the other series ($V_{j,\,t-1}$). The model can be specified as:

$$V_i = \mu_i + \alpha_i V_{i,t-1} + \sum_{j \neq i} \alpha_j V_{j,t-1} + u_{i,t} \quad (3)$$

To determine the state and length of the global finical stress indicators' volatility, Markov Regime Switching ARCH (SWARCH) model is employed. Markov Regime Switching model was first introduced by Goldfeld and Quandt (1973) and later Hamilton (1989) emphasized on autoregressive model with Markov Regime Switching form. In this study, the Markov Regime Switching model by Hamilton and Susmel (1994) is used as follows: let Z_t denotes the return on the commodity market, the stock markets of developed and emerging countries each at a time. Z_t follows SWARCH (*k, q*) model, where *q* is the number of ARCH terms and *k* is the number of regime states. The main equation can be specified as follows:

$$Z_t = \beta_0 + \beta_1 Z_{t-1} + \varepsilon_t \quad (4)$$

The conditional disturbances can be specified as follows

$$\varepsilon_t = \sqrt{g_{st}} u_t\,,\ u_t = \sqrt{h_t}\, v_t,\ \ v_t \sim N(0,1) \quad (5)$$

$$\mathrm{h_t} = \mu_0 + \textstyle\sum_{\mathrm{i=1}}^{\mathrm{q}} \alpha_{\mathrm{i}}\, \varepsilon_{\mathrm{t\text{-}i}}^2 \quad (6)$$

st is an unobserved random variable that shows the volatility state following the first-order Markov chain and it takes values 1, 2, …K. s_t can have an impact on conditional disturbances of Z_t. u_t is multiplied by the constant $\sqrt{g_1}$ when it is in state 1, by $\sqrt{g_2}$ when it is in state 2, by $\sqrt{g_3}$ when it is in state 3. g_{st} under different state would produce different ε_t. Therefore, g_{st} is a scale parameter that captures the size of volatility in different regimes. In this study, it has been assumed that the volatility of the stock markets of emerging and developed countries as

well as the commodity market might be high, moderate or low. For this reason, *k*, which stands for the number of states, is chosen to be 3. The scale parameter for the first state g_1 is normalized at unity with $g_{st} \geq 1$ for s_t =2, 3. It has also been assumed that $g_2 < g_3$. The state 1 (s_t =1), therefore, can denote the low volatility regime, the state 2 represents the moderate volatility regime and the state 3 signifies the high volatility regime. The three states regime switching is assumed to follow a Markov process. If *st* is assumed to follow the first-order Markov chain, then given that s_t is in state *i* at point *t-1*, the probability of making a transition to state *j* at point *t* can be represented as follows:

$$\begin{aligned} &P(s_t=j/s_{t-1}=i, s_{t-2}=k,\ldots,Z_{t-1}, Z_{t-2}, \ldots.) \\ &\quad =P(s_t=j/s_{t-1}=i) \\ &\quad =Pij, \text{ where } i,j=1,2,\ldots,k \end{aligned} \tag{7}$$

The switching probabilities between three states follow the transition probabilities Matrix *Pij* which can be represented by

$$P = \begin{bmatrix} p_{11} & p_{12} & p_{13} \\ p_{21} & p_{22} & p_{23} \\ p_{31} & p_{32} & p_{33} \end{bmatrix} \tag{8}$$

$Pij \leq 1$ *for all i and j.* The sum of *Pij* is 1 for all *i* and the sum of *Pij* is also 1 for all *j*. *Pij* represents the probability of switching from state *i* at time *t* to j at time *t+1*. P_{12}, for instance, stands for the probability of going from state 1 at time *t* to state 2 at time *t+1*.

3. Data

To examine the spillover effects, causality as well as the state and length of the stress among the indicators, data on emerging countries' stock index (MSCI_EM), advanced countries' stock index (MSCI_A), the commodity price index measured by Commodity Research Bureau (CRB) and the implied volatility of the S&P500 index (VIX) are collected from DataStream. Daily data starting from the first month of 1994 to the seventh month of 2013 is used. The data was collected in the seventh month of 2013 and availability of data is the main reason for restricting to this range.

Table 1. Descriptive analysis of the returns

	RCRB	RMSA	RMSE
Mean	0.000128	0.000171	0.000106
Median	0.000004	0.000614	0.000762
Maximum	0.023337	0.089030	0.100729
Minimum	-0.035645	-0.073713	-0.099944
Std. Dev.	0.004458	0.009767	0.012165
Skewness	-0.498057	-0.382728	-0.544496
Kurtosis	8.349818	11.03647	10.56113
Jarque-Bera	6328.501	13927.52	12471.28
Observations	5129	5129	5129

Note: RCRB is the return on commodity price index measured by Commodity Research Bureau. RMSA represent the return on advanced countries' stock index. RMSE stands for the return on emerging countries' stock index.

The data descriptions in Table 1 indicate that the mean returns on the stocks of advanced countries is greater than that of emerging countries. The mean return on CRB is also higher than the returns on the stocks of emerging countries. Based on the data range selected for the

study, the maximum return on the stocks of emerging countries is higher than that of advanced counties and the return on CRB. There is higher standard deviation in the emerging countries' return relative to the standard deviation of the returns on the stocks of advanced countries and CRB. This result implies that there are higher stock market movements in the emerging countries than that of advanced countries. The returns are not normally distributed as shown by high values of Jarque-Bera results. There is negative skewness in the returns but positive Kurtosis which alerts that the distributions are leptokurtic. The distributions of the series are vital in the determination of volatility of the returns using GARCH (1, 1) model.

4. Empirical Results

ARCH effect test is carried out to verify the validity of using GARCH which captures the volatility of the series. The results are reported in Table 2 in which the second column indicates the evidence of ARCH effect before the estimation of GARCH (1, 1). After detecting the ARCH effect in the series, the lag length of the GARCH is determined based on the ARCH-LM test. To carry out this procedure, first GARCH (1, 1) is estimated for each series and then whether there is a remaining ARCH effect in the series is examined. As can be seen from the third column which reports high p-values and low F-statistic values, the ARCH effect disappears after the estimation of GARCH (1, 1) which indicates that there is no need of adding extra lags. The volatility of the indices then is measured using GARCH (1, 1).

Table 2. ARCH effect test results of the indices

Index	Before GARCH (1, 1) F-statistic	After GARCH (1, 1) F-statistic
MSCI_EM	233.62***	0.053
	(0.000)	(0.818)
MSCI_A	265.52***	2.116
	(0.000)	(0.146)
CRB	250.91***	1.119
	(0.000)	(0.290)

Note: the results in parentheses are the p-values. *** Significant at 1percent.

To capture the spillover effect, the SUR in a Vector Autoregressive form which is specified in equation 3 of the methodology section is used. The results in Table 3 suggest that volatility of commodity price is highly affected by its own past volatility besides the volatility of the stocks in the advanced and emerging economies. Moreover, there is a spillover effect from implied volatility of the S&P500 index to the volatility of commodity price. It should be noted here that although there is a spillover effect from the remaining of the indices to the volatility of commodity price, the directions of the effects are different. There is a negative and statistically significant spillover from the volatility of advanced economies' stock market to the volatility of commodity price.

The magnitude of the influence is minimal compared to the magnitude of emerging economies' stock market. This shows that the commodity price index is less dependent on advanced economies' stock market which in turn implicitly implies that the economies of advanced

countries might relatively have less impact on the commodity price. It also implies that there is a tradeoff between stock market and commodity price volatility, in that as the demand for stocks in advanced economies rises or falls, there may be slow and opposite reaction in the commodity market. In other words, the result indicates that as more attention and concentration of market players shift towards the stock market of advanced economies, there is less emphasis on the commodity market.

Table 3. Volatility spillover effect across the indices

	Dependent Variable		
	CRB	**MSA**	**MSE**
CRB	0.980***	-0.108***	0.087555
	(0.000)	(0.000)	(0.4484)
MSA	-0.0007***	0.971191***	0.304700***
	(0.000)	(0.000)	(0.000)
MSE	0.0016***	0.010935***	0.756664***
	(0.000)	(0.000)	(0.000)
VIX	1.02E-08***	1.95E-07***	3.33E-07***
	(0.000)	(0.000)	(0.000)
Adj. R^2	0.992792	0.980990	0.894615

Note: CRB is commodity price index measured by Commodity Research Bureau. MSA represent advanced countries' stock index. MSE stands for emerging countries' stock index. VIX is implied volatility of the S&P500 index. The results in parentheses are the p values. *** Significant at 1percent.

On the other hand, there is a positive and statistically significant volatility spillover from the stock market of emerging economies to commodity price. This indirectly suggests that commodity price index is highly determined by the stock market of emerging economies. Moreover, it suggests that there is parallel reaction and interaction between the fluctuations of the stock market of emerging economies and the commodity price. This means that an increase in the volatility of the stock market of emerging economies increases the volatility of the commodity market. Like the results in the second column, the results in the third column confirm that there is high own past volatility spillover in the stock market volatility of advanced economies. There is a negative and statistically significant volatility spillover from the volatility of commodity price to stock market of advanced economies. The magnitude of the stock market volatility spillover of advanced economies to that of commodity price is greater than the magnitude of the volatility spillover of commodity price to that of advanced economies stock market.

The results further indicate that there is a positive and statistically significant volatility spillover from emerging economies' stock market to advanced economies' stock market. Likewise, the results in column three reveal that there is similar effect from stock market volatility of advanced economies to emerging economies. It should be noted, however, that the magnitude of the effect is smaller in the third column than that of the second column, suggesting that the stock market of advanced economies have greater influence. Although the magnitude varies, the results ensure that there is mutual influence between the volatility of the stock markets of advanced and emerging economies.

Across all the dependent variables, implied volatility of the S&P500 index has positive and statistically significant impact even though the magnitude is very small. In summary, two important points stand out from the results of Table 3. First, own past volatility has greater spillover effect across the markets, indicating that the markets can largely be predicted based on their own past volatility. Second, the magnitude of spillover effect from the volatility of advanced economies' stock is greater in all the markets, suggesting that advanced economies'

stock volatility has dominant influence on the rest. It can, therefore, be argued that predictability in the rest can largely be determined by the volatility in the stock market of advanced economies.

To determine whether there is a feedback from each market and whether there is a unique direction in the volatility spillover, Granger (non) causality test is applied. The Chi square results and their equivalent p-values in parentheses are shown in Table 4. The results indicate that causality runs from the stock volatility of advanced and emerging economies to that of commodity price index. Similarly, volatility of commodity price index Granger causes sock volatility of advanced and emerging economies. There is also bi-directional causal relationship proceeding from stock volatility of advanced and emerging economies. This result coincides with Sarkar (2008)'s findings of global contagion in the analysis of volatility causation between the Indian and some of the stock markets of selected advanced economies. Overall, the results in Table 4 commonly pointed out that there is market integration and interdependence which make a bit complex to disentangle the channels of causation and where exactly the volatility started, as most of the markets show bi-directions.

Table 4. Granger (non) causality test

	Dependent Variable		
	CRB	**MSA**	**MSE**
CRB		35.340***	9.166***
		(0.000)	(0.012)
MSA	18.185***		31.886***
	(0.000)		(0.000)
MSE	74.148***	20.446***	
	(0.000)	(0.000)	

Note: CRB is commodity price index measured by Commodity Research Bureau. MSA represent advanced countries' stock index. MSE stands for emerging countries' stock index. The results in parentheses are the p values. *** Significant at 1percent.

To identify the state and length of the global financial stress indicators' volatility, the SWARCH (k, q) model specified from equation 4 to 5 is used. The estimation of SWARCH (k, q) normally requires large data. For this reason, the previous data has been extended to include the data ranging from the first month of 1988 to eighth month of 2013. It should be noted here that the data for MSE covering the specified time period is unavailable. To overcome this, MSE is divided into MSEFLA which stands for the stock index of emerging Latin American economies and MSEFA which represents the stock index of emerging Asian economies. In the procedure, the lag length of AR (q) is determined using Schwarz criterion (SIC).

Table 5. AR(q) based on SIC

			MSE	
Order	CRB	MSA	MSEFLA	MSEFA
AR(1)	-8.148	-6.554	-5.294	-5.838
AR(2)	-8.147	-6.557	-5.293	-5.837
AR(3)	-8.148	-6.555	-5.292	-5.837
AR(4)	-8.154	-6.555	-5.291	-5.837
AR(5)	-8.156	-6.555	-5.289	-5.835

As can be seen from Table 5, each variable is estimated using its own lag as independent variable which ranges from lag length of 1 to 5. The highest negative value of the results is then selected to be the maximum lag of the AR (q) model. The results suggest that AR (5) is

the most appropriate model for CRB, while AR (2) best fits for MSA. For each category of MSE, the results show that AR (1) is the most suitable model that best fits each variable.

Table 6 to 8 collectively report the results of lagged coefficients and the duration of the volatility of each variable in different regimes. In regime 1, CRB is largely and significantly influenced by its immediate lagged variable, although the remaining lagged values have statistically significant impact on the dependent variable. In regime 2 and 3, however, the highest and statistically significant impact comes from lag 4 and 3 respectively. This means that in the periods of low volatility, the immediate lagged variable plays greatest role than the others. However, in the medium and high volatility periods, the farthest lagged variable can have longer effect which indirectly implies that the shocks do not die quickly, that is the turbulence lasts longer. The duration of volatility for CRB lasts approximately 125, 5 and 24 days in regime 3, 2 and 1 respectively. This indicates that the duration of volatility lasts longer in regime 3 followed by regime 1 which implies that the CRB's high volatility period lasts longer relative to periods of low and moderate volatility.

Table 6. SWARCH (k, q) results- Regime 1

				MSE
	SWARCH (3, 5)	SWARCH (3, 2)	SWARCH(3, 1)	SWARCH(3, 1)
Coefficient	CRB	MSA	MSEFLA	MSEFA
B_0	0.0003***	-0.000007**	0.001***	-0.002***
	(0.000007)	(0.000005)	(0.0002)	(0.0008)
B_1	0.047***	0.179***	0.172***	0.129*
	(0.014)	(0.019)	(0.017)	(0.029)
B2	0.034***	-0.043***		
	(0.012)	(0.014)		
B3	0.024***			
	(0.009)			
B4	0.0439***			
	(0.014)			
B5	0.039***			
	(0.017)			
Regime1 duration	23.972	33.060	40.990	19.515

Note: CRB is commodity price index measured by Commodity Research Bureau. MSA represent advanced countries' stock index. MSE stands for emerging countries' stock index. MSEFLA stands for Latin America's emerging countries' stock index. MSEFA represents Asia's emerging countries' stock index. The results in parentheses are the standard errors. *** Significant at 1percent. **Significant at 5 percent. *Significant at 10 percent

Similarly, the volatility of MSA lasts longer in regime 3 followed by regime 1 accounting to approximately 45 and 33 days respectively. Relative to CRB's volatility, however, the duration of MSA's volatility in regime 2 is approximately 25 days which is about five times greater. The remaining independent variables of MSA have statistically significant impact across the regimes with the highest influence coming from lag 2 of regime 3. The results of the lagged coefficients for MSEFLA and MSEFA suggest statistically significant impact across the three regimes although the magnitude is higher in regime 1 for MSEFLA and in regime 3 for MSEFA. Similarly, the volatility duration of MSEFLA lasts longer in regime 1 than in regime 2 and 3 whereas that of MSEFA lasts longer in regime 3. This suggests that low volatility has longer duration for MSEFLA, while high volatility period has longer duration in the case of MSEFA.

Table 7. SWARCH (k, q) results- Regime 2

Coefficient	SWARCH (3, 5) CRB	SWARCH (3, 2) MSA	SWARCH(3, 1) MSEFLA	MSE SWARCH(3, 1) MSEFA
B_0	-0.0007***	-0.002**	-0.009***	0.0005**
	(0.0003)	(0.0008)	(0.003)	(0.0002)
B_1	0.051	0.138***	0.041***	0.126***
	(0.034)	(0.039)	(0.018)	(0.020)
B2	0.029**	-0.118***		
	(0.014)	(0.038)		
B3	0.014			
	(0.009)			
B4	0.157***			
	(0.048)			
B5	0.084			
	(0.068)			
Regime2 duration	4.558	25.764	10.115	28.929

Note: The results in parentheses are the standard errors. CRB is commodity price index measured by Commodity Research Bureau. MSA represent advanced countries' stock index. MSE stands for emerging countries' stock index. MSEFLA stands for Latin America's emerging countries' stock index. MSEFA represents Asia's emerging countries' stock index. The results in parentheses are the standard errors. *** Significant at 1 percent. **Significant at 5 percent.

The results in Table 6-8 collectively show that the period of high volatility lasts longer for all the returns taken in the analysis except for MSEFLA. The durations of moderate volatility across the returns are relatively low. The longer duration, therefore, ranges between regime 1 and 3. The dominance of regime 3 as the longer duration of the volatility across most of the returns signifies that once a critical shock strikes the markets, it does not die out easily. Its effect remains long enough to carry on the volatility for relatively longer period. Moreover, it shows that the stock and commodity markets are highly unstable. In comparison to the remaining returns, CRB has the highest duration of volatility in regime 3 indicating that high volatility regime is dominated by the volatility of the returns on CRB. On the other hand, the returns on MSEFLA have the lowest duration of volatility in regime 3. Furthermore, relative to the other returns, MSEFA has the highest duration of volatility in regime 2, while CRB has the lowest. This suggests that moderate volatility lasts longer for the returns on MSEFA than the remaining returns. In regime 1, the highest duration of volatility comes from MSEFLA and the lowest is from MSEFA.

Table 8. SWARCH (k, q) results- Regime 3

Coefficient	SWARCH (3, 5) CRB	SWARCH (3, 2) MSA	SWARCH(3, 1) MSEFLA	MSE SWARCH(3, 1) MSEFA
B_0	0.0000006**	0.0007***	-0.0005*	0.0007***
	(0.000005)	(0.0000095)	(0.0003)	(0.0001)
B_1	0.004**	0.182***	0.139425***	0.212710***
	(0.002)	(0.019)	(0.022)	(0.023)
B2	-0.031***	-0.033***		
	(0.012)	(0.013)		
B3	0.048***			
	(0.017)			
B4	0.076			
	(0.019)			
B5	0.018			
	(0.008)			
Regime3 duration	124.521	45.337	16.857	56.292

Note: The results in parentheses are the standard errors. CRB is commodity price index measured by Commodity Research Bureau. MSA represent advanced countries' stock index. MSE stands for emerging countries' stock index. MSEFLA stands for Latin America's emerging countries' stock index. MSEFA represents Asia's emerging countries' stock index. The results in parentheses are the standard errors. *** Significant at 1percent. **Significant at 5 percent.

The results of transition probabilities in Table 9 suggest that apart from the volatility of the returns on MSEFA's probability of going from state 1 to state 2, from state 2 to state 1 and also staying in state 1, the remaining results are positive and statistically significant. It can be seen from the results of the standard errors that the remaining results are statistically significant at 1 percent with the exception of the probability of switching from state 2 to state 1 for the volatility of the returns on MSA and MSEFLA which are significant at 10 percent. The results on the volatility of the returns on MSA's probability of shifting from regime 3 to regime 2 and the probability of remaining in regime 2 are also significant only at 5 percent. In comparison to the probabilities of switching from one regime to another regime, the probabilities of staying in regime 1 and 2 are highest for the returns on CRB, MSA and MSEFLA. The returns on MSEFA have highest probability of staying in regime 2 which is moderate volatility.

Table 9. The transition probabilities

			MSE	
	SWARCH (3, 5)	SWARCH (3, 2)	SWARCH(3, 1)	SWARCH(3, 1)
Coefficient	CRB	MSA	MSEFLA	MSEFA
P_{11}	0.958*** (0.727)	0.969*** (0.195)	0.918*** (0.183)	0.949 (15.402)
P_{12}	0.039*** (0.803)	0.007*** (0.294)	0.069*** (1.293)	0.051 (15.402)
P_{21}	0.201*** (0.719)	0.039* (7.511)	0.833* (8.891)	0.019 (0.159)
P_{22}	0.781*** (0.679)	0.962** (7.513)	0.122*** (0.294)	0.965*** (0.182)
P_{31}	0.003*** (0.825)	0.022*** (0.201)	0.734*** (0.177)	0.001*** (0.932)
P_{32}	0.005*** (0.644)	0.000** (9.472)	0.244*** (0.362)	0.016*** (0.225)

Note: The results in parentheses are the standard errors. CRB is commodity price index measured by Commodity Research Bureau. MSA represent advanced countries' stock index. MSE stands for emerging countries' stock index. MSEFLA stands for Latin America's emerging countries' stock index. MSEFA represents Asia's emerging countries' stock index. The results in parentheses are the standard errors. *** Significant at 1percent. **Significant at 5 percent. *Significant at 10 percent

5. Conclusion

This paper aims to examine the global finical stress indicators by analyzing the stock and commodity markets' performance in terms of their volatility spillover effect, causality as well as the state and length of their volatility. Both the stock price index of advanced and emerging economies together with commodity price index are considered as global finical stress indicators to capture the overall objectives of this research. By doing so, this empirical study addresses the fundamental controversy on the relationship between commodity price index and the stock markets. Some of the previous studies indicate the existence of positive relationship between stock market and commodity price index, while some others suggest the opposite. In

addressing the controversy, this study finds out that there is no monotonous and generic conclusion with regards to the directions of the interaction between the commodity price index and the stock markets. More specifically, the directions rather depend on whether or not the economy under study depends highly on commodity exports.

According to the author's understanding, the parallel swing of the stock markets with the commodity price movement partly implies greater dependence of the economy on commodity exports. This outcome might be due to the rational reactions of the market players who normally look for ways of maximizing profit from their capital investment and thereby invest on assets with higher returns which can be affected by the rise in the commodity price. The analysis of SUR in VAR suggests that there is a positive and statistically significant volatility spillover from the stock market of emerging economies to commodity price. The magnitude of the influence from the stock market of emerging economies is greater compared to that of advanced economies' stock market. This explicitly shows that commodity price index is highly affected by the emerging countries' stock market. On the other hand, there is a negative and statistically significant spillover from the volatility of advanced economies' stock market to the volatility of commodity price index. The magnitude, however, is minimal. This implies that the economies of advanced countries have less impact on the commodity price. Although the magnitude of each of the return's own past volatility spillover is greater, the global financial stress indicators are also largely influenced by advanced economies' stock price volatility. This indicates greater predictability of the indicators by the volatility of advanced economies' stock price.

Further to the analysis of volatility spillover effect, Granger (non) causality test results show that there are bi-directional feedbacks among the global financial stress indicators. The absence of unique direction of causation suggests the challenge of tracing where the volatility of the indicators has been originated from. With regards to the state and length of the indicators' volatility, the results reveal that CRB has the longest state in regime 3 than the remaining indicators. On average, the indicators' volatility lasts longer in regime 3 which is high volatility regime than regime 1 and 2 which is low and moderate volatility regime respectively. This indirectly implies that there is less stability in the global financial stress indicator.

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