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An Influence of Global Energy Index and Global Material Index Volatility in Asia Two Stock Markets: Empirical Study of Taiwan and Singapore Markets

WANN-JYI HORNG
Department of Hospital and Health Care Administration, Chia Nan University of Pharmacy & Science, No. 60, Erh-Jen Rd., Sec.1, Jen-Te, Tainan, 71710, Taiwan.
Email: hwj7902@mail.cnu.edu.tw
Tel:+886-6-2664911ext.5220

CHING-HUEI CHEN
Department of Hospital and Health Care Administration, Chia Nan University of Pharmacy & Science, No. 60, Erh-Jen Rd., Sec.1, Jen-Te, Tainan, 71710, Taiwan.
Email: wilsonchen0831@yahoo.com.tw
Tel:+886-6-2664911ext.5208

JUI-CHEN CHANG
Department of Finance & Institute of Financial Management, Nanhua University, Chia-Yi, Taiwan
Email : juichen@mail.nhu.edu.tw
Tel:+886-5-2721001ext.2051

Abstract

The empirical results show that the proposed model is appropriate in evaluating the relationship of the Taiwan's and the Singapore's stock markets. The empirical result also indicates that the Taiwan's and the Singapore's stock markets is a positive relation. The average estimation value of correlation coefficient equals to 0.5597, which implies that the two stock markets is synchronized influence. Besides, the empirical result also shows that the Taiwan's and the Singapore's stock markets have an asymmetrical effect. The volatility of the Taiwan and the Singapore stock markets receives the influence of the positive and negative values of the global energy index and the global material index volatility. For examples, under the good news of global energy index and the global material index markets, the empirical result shows that the variation risk of Taiwan stock market will affect the variation risk of the Singapore stock market. And the variation risk of the Singapore will also affect the variation risk of the Taiwan stock market. Under the good news of the global energy index and the global material index, the variation risk of the Taiwan's stock market is larger than the variation risk of Singapore's stock market.

Key Words: *Stock Market, Asymmetric Effect, IGARCH Model, AIGARCH Model.*

Introduction

We know that Singapore is one of Asian four dragons, also economy growth rate of Singapore in 2013 is 4.4%, and the growth rate of the finance service trade is 7.7% in 2014. Singapore is also one of global financial center, and the Singapore is also the powerful global economic nation in the Asian. We also know that Taiwan is also one of Asian four dragons, Taiwan has a close relationship with the Singapore based on the sightseeing tour. Besides, Taiwan and Singapore have a close relationship based on the trade and the circulation of capital. When the investor has an investment in the international stock market, he/she will usually care about the international capital the motion situation, the international politics and the economical situation change, in particular, in the global energy index and the global material index market changes.

There is a close relationship for Taiwan and Singapore based on the trade and the circulation of capital with the global energy index and the global material index markets, but the global energy index and the global material index markets are also important index in the global economics. Therefore, the relationship between the Taiwan and the Singapore stock markets are worth further discussion with the factors of the global energy index and the global material index markets.

The purpose of the present paper is to examine the relations of the Taiwan's and the Singapore's stock markets. This paper also further discusses the affect of the global energy index and the global material index markets' volatility for the Taiwan and the Singapore stock markets.

And the positive and negative values of global energy index and the global material index markets' volatility are used as the threshold. The organization of this paper is as follows: Section 2 descibes the data characteristics; Section 3 presents the proposed model; Section 4 presents the empirical results, and finally Section summarizes the conclusions of this study.

Data Characteristics

Data Sources

The data of this research included the Taiwan, the Singapore, the global energy index and the global material index prices are collected between January, 2006 and December, 2014. The source of the stock data was the Taiwan economic Journal (TEJ), a database in Taiwan.

The Taiwan's stock price refers to the Taiwan weighted stock index, the Singapore's stock price refers to the Singapore Strait Times stock index, the global energy index price refers to MSCI global energy index (USD), and the global material index price refers to the MSCI global material index (USD). During the process of data analysis, in case that there was no stock market price available on the side of the Taiwan and the Singapore stock market or on the side of the global energy index and the global material index markets due to holidays, the identical time stock price data from one side was deleted. After this, the four variables samples are 2,129.

Return Calculation and Basic Statistics

To compute the return rate of the Taiwan stock market adopts the natural logarithm difference, rides 100 again. The return rate of the Singapore stock market also adopts the natural logarithm difference, rides 100 again.

The return rates of the global energy index and the global material index price markets also adopts the natural logarithm difference, rides 100 again. In Figure 1, the Taiwan, the Singapore, the global energy index and the global material index markets shows the clustering phenomenon, so that we may know the four markets have certain relevance.

Table 1 presents the four sequences kurtosis coefficients are all bigger than 3, which this result implies that the normal distribution test of Jarque-Bera is not normal distribution. Therefore, the heavy tails distribution is used in this paper. And the four markets do have the high correlation in Table 2.

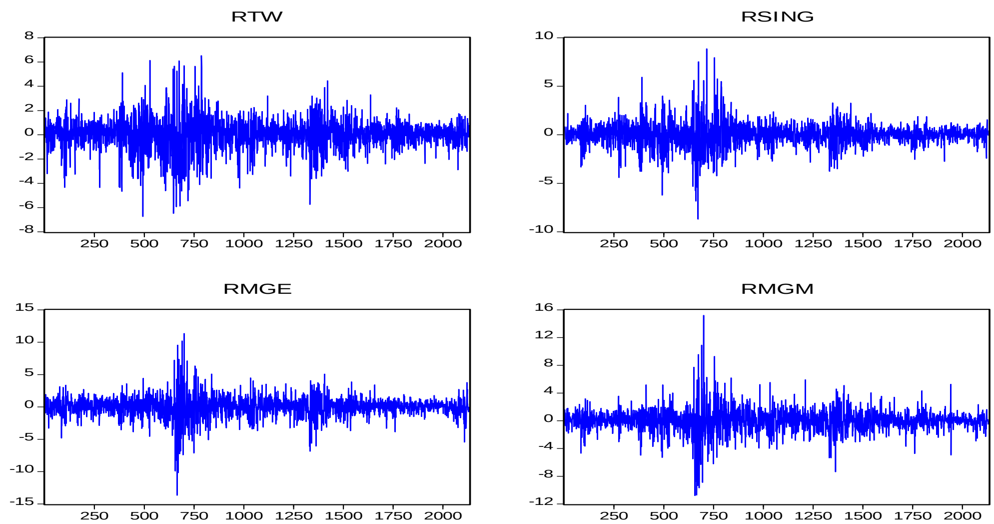

Figure 1. Trend charts of the Taiwan, the Singapore, the global energy index and the global material index market volatility rates

Table 1. Data statistics

Statistics	*RTW*	*RSING*	*RMGE*	*RMGM*
Mean	0.016211	0.016487	0.005456	0.009085
S-D	1.315400	1.233633	1.597636	1.668554
Skew	-0.306294	0.003627	-0.424434	0.001450
Kurtosis	6.560101	9.762335	11.60483	12.55113
J-B N (*p-value*)	*1157.06**** (*0.0000*)	*4054.66**** (*0.0000*)	*6629.04**** (*0.0000*)	*8088.54**** (*0.0000*)
Sample	*2128*	*2128*	*2128*	*2128*

Notes: (1) J-B N is the normal distribution test of Jarque-Bera. (2) S-D is denoted the standard deviation. (3) *** denote significance at the level 1%.

Table 2. Unconditional correlation coefficient

Coefficient	*TW*	*SING*	*MGE*	*MGM*
TW	1	0.9157	0.7726	0.8099
SING	0.9157	1	0.7576	0.8030
MGE	0.7726	0.7576	1	0.8608
MGM	0.8099	0.8030	0.8608	1

Unit root and co-integration tests

This paper further uses the unit root test of KSS (Kapetanios et. al., 2003) to determine the stability of the time series data. The KSS examination result is listed in Table 3. It shows that the Taiwan stock returns, the Singapore stock returns, the global energy index and the global material index returns do not have the unit root characteristic, this is, the four markets are stationary series data, under $\alpha = 1\%$ significance level.

Using Johansen's (1991) co-integration test as illustrated in Table 4 at the significance level of 0.05 (α =5%) does not reveal of $\lambda_{\max}$ statistic. This indicated that the Taiwan stock market, the Singapore stock market, the global energy index and the global material index markets do not have a co-integration relation. Therefore, we do not need to consider the model of error correction.

Table 3. Unit Root test of KSS for the study data

KSS	*RTW*	*RSING*	*RMGE*	*RMGM*
Statistic	*-21.962****	*-22.503****	*-21.877****	*-19.289****
Critical value	*-2.82*	*-2.22*	*-1.92*	
Significant level	α =1%	α =5%	α =10%	

Notes: *** denote significance at the level 1%.

Table 4. Co-integration test (Var Lag=5)

H_0	$\lambda_{\max}$	*Critical value*
None	*25.2530*	*27.5843*
At most 1	*11.7629*	*21.1316*
At most 2	*8.5496*	*14.2646*
At most 3	*2.2081*	*3.8415*

Notes: The lag of VAR is selected by the AIC rule (Akaike, 1973).
The critical value is given under the level 5%.

ARCH Effect test

Based on the formula (1) and (2) as below, we uses the methods of LM test (Engle, 1982) and F test (Tsay, 2004) to test the conditionally heteroskedasticity phenomenon. In Table 5, the results of the ARCH effect test show that the two study markets have the conditionally heteroskedasticity phenomenon exists. This result suggests that we can use the GARCH model to match and analyze it.

Table 5. ARCH effect test

RTW	*Engle LM test*	*Tsay F test*
Statistic	*589.372****	*12.579****
(p-value)	*(0.0000)*	*(0.0000)*
RSING	*Engle LM test*	*Tsay F test*
Statistic	*557.581****	*16.076****
(p-value)	*(0.0000)*	*(0.0000)*

Notes： *** denote significance at the level 1%.

Proposed Model

Based on the global energy index and the global material index markets will affect the return rate volatility of the Taiwan and the Singapore stock markets, and the global energy index and the global material index markets do have the high correlations for the Taiwan and the Singapore stock markets. We follows the idea of self-exciting threshold autoregressive (SETAR) model (Tsay, 1989), the idea of double threshold GARCH model (Brooks, 2001), and the ideas of the papers of Engle (2002) and Tse & Tusi (2002), and uses the positive and negative value of global energy index and the global material index returns' volatility rate is as a threshold. After model process selection, in this paper, we may use the bivariate asymmetric GARCH (called AGARCH) model to construct the relationships of the Taiwan's and the Singapore's stock market returns, the AGARCH (1, 1) model is illustrated as follows:

$$RTW_t = \phi_{10} + \sum_{j=1}^{2}(\phi_{j1}RTW_{t-j} + \phi_{j2}RSING_{t-j}$$
$$+\phi_{j3}RMGE_{t-j} + \phi_{j4}RMGM_{t-j}) + a_{1,t}\,, \quad (1)$$
$$RSING_t = \varphi_{10} + \sum_{j=1}^{2}(\varphi_{j1}RTW_{t-j} + \varphi_{j2}RSING_{t-j}$$
$$+\varphi_{j3}RMGE_{t-j} + \varphi_{j4}RMGM_{t-j}) + a_{2,t}\,, \quad (2)$$
$$h_{11,t} = \sum_{j=1}^{4}u_{j,t-1}(\alpha_{j0} + \alpha_{j1}a_{1,t-1}^2 + \beta_{j1}h_{11,t-1} + \eta_{j1}a_{2,t-1}^2)\,, \quad (3)$$
$$h_{22,t} = \sum_{j=1}^{4}u_{j,t-1}(\alpha'_{j0} + \alpha'_{j1}a_{2,t-1}^2 + \beta'_{j1}h_{22,t-1} + \eta_{j2}a_{1,t-1}^2)\,, \quad (4)$$
$$h_{12,t} = \rho_t\sqrt{h_{11,t}}\sqrt{h_{22,t}}\,, \quad (5)$$
$$\rho_t = \exp(q_t)/(\exp(q_t)+1)\,, \quad (6)$$
$$q_t = \gamma_0 + \gamma_1\rho_{t-1} + \gamma_2 a_{1,t-1}a_{2,t-1}/\sqrt{h_{11,t-1}h_{22,t-1}}\,, \quad (7)$$
$$u_{1,t} = \begin{cases}1, & if\ \ RMGE_t \le 0; RMGM_t \le 0\\ 0, & if\ \ others\end{cases}, \quad (8)$$
$$u_{2,t} = \begin{cases}1, & if\ \ RMGE_t \le 0; RMGM_t > 0\\ 0, & if\ \ others\end{cases}, \quad (9)$$
$$u_{3,t} = \begin{cases}1, & if\ \ RMGE_t > 0; RMGM_t \le 0\\ 0, & if\ \ others\end{cases}, \quad (10)$$
$$u_{4,t} = \begin{cases}1, & if\ \ RMGE_t > 0; RMGM_t > 0\\ 0, & if\ \ others\end{cases}, \quad (11)$$

with $RMGE_t > 0$ and $RMGM_t > 0$ denote good news, $RMGE_t \le 0$ and $RMGM_t \le 0$ denote bad news. The white noise of $\vec{a}'_t = (a_{1,t}, a_{2,t})$ is obey the bivariate Student's t distribution, this is,

$$\vec{a}_t \sim T_v(\vec{0}, (v-2)H_t/v)\,, \quad (12)$$

among $\vec{0}' = (0,0)$ and H_t is the covariance matrix of $\vec{a}'_t = (a_{1,t}, a_{2,t})$, and ρ_t is the dynamic conditional correlation coefficient of $a_{1,t}$ and $a_{2,t}$. The maximum likelihood algorithm method of BHHH (Berndt et. al., 1974) is used to estimate the model's unknown parameters. The programs of RATS and EVIEWS are used in this paper.

Empirical Results

From the empirical results, we know that the Taiwan's and the Singapore's stock return volatility may be constructed on the DCC and the bivariate AIGARCH (1, 1) model. Its estimate result is stated in Table 6. The empirical results show that the good news and bad news of the global energy index and the global material index returns' volatility will produce the different stock return rates on the Taiwan and the Singapore stock markets. And the stock return volatilities of the global energy index and the global material index will also affect the variation risks of the Taiwan and the Singapore stock markets. The Taiwan stock return volatility receives fist period's impact of the Taiwan stock return volatility (ϕ_{11} =-0.0904). The Taiwan stock return does not also receive before two period's impact of the Singapore stock return volatility. The Taiwan stock return receives first period's impact of the global energy index return volatility (ϕ_{13} =0.1300). The Taiwan stock return does not receive 2nd period's impact of the global energy index return volatility. The Taiwan stock return volatility also receives before two period's impact of the global material index return volatility (ϕ_{14} =0.1261 and ϕ_{24} =0.0546). The Singapore stock return volatility receives before 1 period's impact of the Taiwan stock return volatility (φ_{11} =-0.0825). And the Singapore stock return volatility does not receive 2nd period's impact of the Taiwan stock return volatility. The Singapore stock return volatility also receives before 1 period's impact of the global energy index return volatility (φ_{13} =0.1194). The Singapore stock return does not receive 2nd period's impact of the global energy index return volatility rates. The Singapore stock return volatility also receives before two period's impact of the global material index return volatility (φ_{14} =0.1244 and φ_{24} = 0.0587). The stock return volatilities of the global energy index and the global material index are also truly influent the return volatility of the Taiwan and the Singapore stock markets.

On the other hand, the correlation coefficient average estimation value ($\hat{\bar{\rho}}_t$ =0.5597) of the Taiwan and the Singapore stock return volatility is significant. This result also shows the Taiwan and the Singapore stock return's volatility is mutually synchronized influence. In additional, estimated value of the degree of freedom for the Student's t distribution is 7.5854, and is significant under the significance level of 0.01($\alpha = 1\%$). This also demonstrates that this research data has the heavy tailed distribution.

Table 6. Parameter estimation of the DCC and the bivariate AIGARCH(1, 1) model

Parameters	ϕ_{10}	ϕ_{11}	ϕ_{12}	ϕ_{13}	ϕ_{14}
Coefficient	*0.0579*	*-0.0904*	*0.0351*	*0.1300*	*0.1261*
(p-value)	*(0.0031)*	*(0.0009)*	*(0.2537)*	*(0.0000)*	*(0.0000)*
Parameters	ϕ_{21}	ϕ_{22}	ϕ_{23}	ϕ_{24}	φ_{10}
Coefficient	*-0.0368*	*0.0088*	*-0.0047*	*0.0546*	*0.0542*
(p-value)	*(0.1618)*	*(0.7714)*	*(0.8606)*	*(0.0409)*	*(0.0008)*
Parameters	φ_{11}	φ_{12}	φ_{13}	φ_{14}	φ_{21}
Coefficient	*-0.0825*	*-0.0956*	*0.1194*	*0.1244*	*0.0166*
(p-value)	*(0.0001)*	*(0.0006)*	*(0.0000)*	*(0.0000)*	*(0.4442)*
Parameters	φ_{22}	φ_{23}	φ_{24}	α_{10}	α_{11}
Coefficient	*-0.0365*	*-0.0134*	*0.0587*	*0.0752*	*0.0726*
(p-value)	*(0.1723)*	*(0.5707)*	*(0.0086)*	*(0.0000)*	*(0.0003)*
Parameters	β_{11}	η_{11}	α_{20}	α_{21}	β_{21}
Coefficient	*0.8928*	*0.0346*	*-0.0200*	*0.1306*	*0.7962*
(p-value)	*(0.0000)*	*(0.0588)*	*(0.5830)*	*(0.0065)*	*(0.0000)*
Parameters	η_{21}	α_{30}	α_{31}	β_{31}	η_{31}
Coefficient	*0.0732*	*0.1186*	*0.1931*	*0.6631*	*0.1438*
(p-value)	*(0.2074)*	*(0. 0101)*	*(0.0018)*	*(0.0000)*	*(0.0163)*
Parameters	α_{40}	α_{41}	β_{41}	η_{41}	α'_{10}
Coefficient	*-0.0231*	*0.0106*	*0.9163*	*0.0731*	*0.0285*
(p-value)	*(0.1168)*	*(0.6079)*	*(0.0000)*	*(0.0018)*	*(0.0140)*

Parameters	α'_{11}	β'_{11}	η'_{11}	α'_{20}	α'_{21}
Coefficient	0.1244	0.8595	0.0161	-0.0024	0.0855
(p-value)	(0.0000)	(0.0000)	(0.2356)	(0.9381)	(0.1153)
Parameters	β'_{21}	η'_{21}	α'_{30}	α'_{31}	β'_{31}
Coefficient	0.9219	-0.0074	0.0104	0.1673	0.8220
(p-value)	(0.0000)	(0.7973)	(0.6868)	(0.0021)	(0.0000)
Parameters	η'_{31}	α'_{40}	α'_{41}	β'_{41}	η'_{41}
Coefficient	0.0107	-0.0049	0.1216	0.8499	0.0285
(p-value)	(0.7754)	(0.6421)	(0.0000)	(0.0000)	(0.0737)
Parameters	γ_0	γ_1	γ_2	v	$\bar{\rho}_t$
Coefficient	-2.0034	3.9640	0.0547	7.5854	0.5597
(p-value)	(0.0000)	(0.0000)	(0.0017)	(0.0000)	(0.0000)
Parameters	min ρ_t	max ρ_t			
Coefficient	0.3212	0.7840			
(p-value)					

Notes：p-value< α denotes significance. (α =1%, α =5%).
min ρ_t denotes the minimum ρ_t and max ρ_t denotes the maximum ρ_t .

From the Table 6, the estimated coefficients of the conditional variance equation will produce the different variation risks under the bad news and good news in Taiwan and Singapore stock markets. The empirical results show that the Taiwan stock market conforms the conditionally supposition of the AIGARCH model. The empirical results also show that the Singapore stock market return is the AIGARCH model. This result also demonstrates the DCC and the bivariate AIGARCH (1, 1) model may catch the Taiwan and the Singapore stock return volatilities' process. Under the bad news of the global energy and the global material indices, the empirical result shows that the Taiwan and Singapore stock markets have the fixed variation risk. In Table 6, the Taiwan and the Singapore stock market returns have the different conditional variation risks. This result demonstrates that the good news and bad news of the global energy index and the global material index markets will produce the different variation risks on the Taiwan and the Singapore stock markets. Under the good news of the global energy index and the global material index, the variation risk of the Taiwan's stock market is larger than the variation risk of Singapore's stock market. Under the $RMGE_t \leq 0$ (bad news) and $RMGM_t \leq 0$ (bad news), the empirical result shows that the variation risk of the Taiwan stock market is larger than the variation risk of the Singapore stock market. Besides, under the $RMGE_t > 0$ (good news) and $RMGM_t > 0$ (good news), the empirical result also shows that the variation risk of Taiwan stock market will affect the variation risk of the Singapore stock market. And the variation risk of the Singapore will also affect the variation risk of the Taiwan stock market. Therefore, the explanatory ability of the DCC and the bivariate AIGARCH (1, 1) model is better than the traditional model of the bivariate GARCH (1, 1).

To test the inappropriateness of the DCC and the bivariate AIGARCH (1, 1) model, the test method of Ljung & Box (1978) is used to examine autocorrelation of the standard residual error. This proposed model does not show an autocorrelation of the standard residual error. Therefore, the DCC and the bivariate AIGARCH (1, 1) model are more appropriate.

Conclusions

The empirical results show that the Taiwan stock market return's volatility does have an asymmetric effect and the Singapore stock market return's volatility does also have an asymmetric effect. The Taiwan and the

Singapore stock market volatilities may construct in the DCC and the bivariate AIGARCH (1, 1) model with a positive (good news) and negative (bad news) threshold of the global energy index and the global material index return volatilities. From the empirical result also obtains that the dynamic conditional correlation coefficients' average estimation value ($\overline{\rho}_t$ =0.5597) of the Taiwan and the Singapore stock return volatility is positive. The positive and negative values of the global energy index and the global material index return volatility affects the stock return volatility rates of the Taiwan and the Singapore stock markets. The Taiwan and the Singapore stock market returns are truly received the impact of the global energy index and the global material index volatilities. For examples, under the good news of the global energy index and the global material index markets, the variation risk of the Taiwan stock market is larger than the variation risk of the Singapore stock market. Under the $RGME_t > 0$ and $RMGM_t \leq 0$, the empirical result shows that the variation risk of the Singapore stock market is larger than the variation risk of the Taiwan stock market. Besides, under the $RGME_t > 0$ and $RMGM_t > 0$, the empirical result also shows that the variation risk of Taiwan stock market will affect the variation risk of the Singapore stock market. And the variation risk of the Singapore will also affect the variation risk of the Taiwan stock market. Under the good news of global energy index and the global material index markets, the empirical result also shows that the Taiwan and the Singapore stock markets can reduce the fixed variation risk.

References

Kapetanios, G., Shin, Y. & Snell, A. 2003. Testing for a unit root in the nonlinear STAR framework. *Journal of Econometrics*, 112(2), 359-379.

Johansen, S. 1991. Estimation and hypothesis testing of cointegration vector in Gaussian vector autoregressive models. *Econometrica*, 52, 389-402.

Engle, R.F. 1982. Autoregressive conditional heteroskedasticity with estimates of the variance of United Kingdom Inflation. *Econometrica*, 50, 987-1007.

Tsay, R.S. 2004. Analysis of Financial Time Series, New York: John Wiley & Sons, Inc.

Akaike, H. 1973. Information theory and an extension of the maximum likelihood principle. In 2nd. International Symposium on Information Theory, edited by B. N. Petrov and F. C. Budapest: Akademiai Kiado, 267-281.

Engle, R.F. & V. K. Ng, V.K. 1993. Measuring and testing the impact of news on volatility. J*ournal of Finance*, 48(5), 1749-1777.

Tsay, R.S. 1989. Testing and modeling threshold autoregressive processes. *Journal of the American Statistical Association*, 84, 231-240.

Brooks, C. 2001. A double-threshold GARCH model for the French Franc / Deutschmark exchange rate. *Journal of Forecasting*, 20, 135-143.

Engle, R.F. 2002. Dynamic conditional correlation- a simple class of multivariate GARCH models. *Journal of Business and Economic Statistics*, 20, 339-350.

Tse, Y.K. & Tsui, Albert K.C. 2002. A multivariate GARCH model with time-varying correlations. *Journal of Business & Economic Statistics*, 20, 351-362.

Berndt, E.K., Hall, B.H., Hall, R.E. & Hausman, J.A. 1974. Estimation and inference in nonlinear structural models. *Annals of Economic and Social Measurement*, 4, 653-665.

Ljung, G.M. & Box, G.E.P. 1978. On a measure of lack of fit in time series models. *Biometrika*, 65(2), 297-303.