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Influence of Japan and U.S. Stock Return Volatility in Asia Two Stock Markets: Empirical Study of Taiwan and Korea Countries

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Abstract

The empirical results show that the dynamic conditional correlation (DCC) and the bivariate AIGARCH (1, 1) model is appropriate in evaluating the relationship of the Taiwan's and the Korea's stock markets. The empirical result also indicates that the Taiwan's and the Korea's stock markets is a positive relation. The average estimation value of correlation coefficient equals to 0.6554, which implies that the two stock markets is synchronized influence. Besides, the empirical result also shows that the Taiwan's and the Korea's stock markets have an asymmetrical effect. The return volatility of the Taiwan and the Korea stock markets receives the influence of the positive and negative values of the Japan and the U.S. stock return volatilities. Under the good news of Japan and U.S. stock markets, the empirical result also shows that the Taiwan and the Korea stock markets can reduce the fixed variation risk.

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

Introduction

We known that Taiwan economical physique belongs an island economy, where positive includes to the foreign trade unfolds where ties between Japan and Korea are close. We also know that Taiwan is one of Asian four dragons, also Taiwan economy of growth in 2006 is 5%, and the forecast value of the grow rate is 4.3% in the future. Taiwan has a close relationship with the Japan based on the trade and the circulation of capital, and the Japan is the most powerful global economic nation in the Asian. Besides, Taiwan and Korea 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 Japan and the U.S. stock market change. There is a close relationship for Taiwan and Korea based on the trade and the circulation of capital with the Japan and the U.S., but the Japan and U.S. are also powerful global economical nations. Therefore, the relationship between the Taiwan and the Korea stock markets are worth further discussion with the factors of the Japan and the U.S. stock markets.

The purpose of the present paper is to examine the relations of the Taiwan's and the Korea's stock markets. This paper also further discusses the affect of the Japan and the U.S. stock returns' volatility rate for the Taiwan and the Korea stock market returns. And the positive and negative values of Japan and U.S. stock returns' 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 5 summarizes the conclusions of this study.

Data Characteristics

Data Sources

The data of this research included the Taiwan, the Korea, the Japan and the U.S. stock price collected between January, 2005 and December, 2012. 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 Korea's stock price refers to the Korea KOSPI stock index, the Japan's stock price refers to NK225 stock index, and the U.S.'s stock price refers to the S&P500 stock index. During the process of data analysis, in case that there was no stock market price available on the side of the Taiwan and the Korea stock market or on the side of the Japan and the U.S. stock markets due to holidays, the identical time stock price data from one side was deleted. After this, the four variables samples are 1,778.

Returns 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 Korea stock market also adopts the natural logarithm difference, rides 100 again. The return rates of the Japan and the U.S. stock markets also adopts the natural logarithm difference, rides 100 again. In Figure 1, the Taiwan, the Korea, the Japan and the U.S. stock return rate volatility shows the clustering phenomenon, so that we may know the four stock markets have certain relevance.

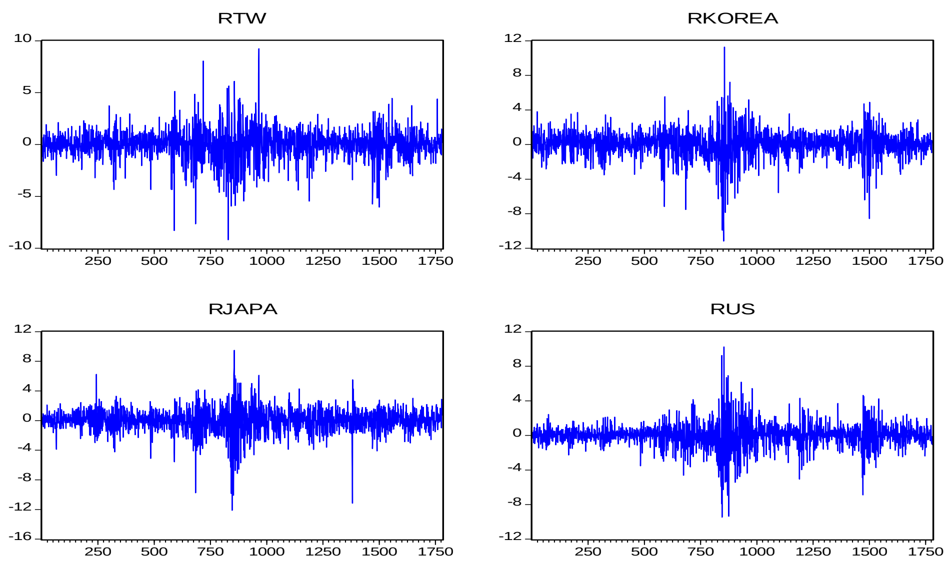

Figure 1. Trend charts of the Taiwan, the Korea, the Japan and the U.S. stock market volatility rates

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 stock markets do have the high correlation in Table 2.

Table 1. Data Statistics

Statistics	*RTW*	*RKOREA*	*RJAPA*	*RUS*
Mean	0.013470	0.045678	-0.005377	0.009336
S-D	1.450718	1.573194	1.640969	1.451278
Skew	-0.422065	-0.66509	-0.836098	-0.27906
Kurtosis	8.186094	9.607004	10.05167	10.57563
J-B N (*p-value*)	*2044.15**** *(0.0000)*	*3363.11**** *(0.0000)*	*3888.84**** *(0.0000)*	*4272.32**** *(0.0000)*
Sample	*1777*	*1777*	*1777*	*1777*

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	*RTW*	*RKOREA*	*RJAPA*	*RUS*
RTW	*1*	*0.7182*	*0.6305*	*0.2097*
RKOREA	*0.7182*	*1*	*0.7018*	*0.2642*
RJAPA	*0.6305*	*0.7018*	*1*	*0.2069*
RUS	*0.2097*	*0.2642*	*0.2069*	*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 Korea stock returns, the Japan stock returns, and the U.S. stock 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 Korea stock market, the Japan stock market and the U.S. stock market 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 Return Data

KSS	*RTW*	*RKOREA*	*RJAPA*	*RUS*
Statistic	*-19.557****	*-18.607****	*-20.238****	*-26.839****
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=3)

H_0	$\lambda_{\max}$	*Critical value*
None	*27.0010*	*30.8151*
At most 1	*10.1349*	*24.2520*
At most 2	*6.4263*	*17.1477*
At most 3	*1.7930*	*3.8415*

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	*348.374****	*6.398****
(p-value)	*(0.0000)*	*(0.0000)*
RKOREA	*Engle LM test*	*Tsay F test*
Statistic	*588.556****	*21.3030****
(p-value)	*(0.0000)*	*(0.0000)*

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

Proposed Model

Based on the Japan and the U.S. stock markets will affect the return rate volatility of the Taiwan and the Korea stock markets, and the Japan and the U.S. stock markets do have the high correlations for the Taiwan and the Korea 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 Japan and U.S. stock 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 Korea's stock market returns, the AGARCH(1, 1) model is illustrated as follows:

$$RTW_t = \phi_{10} + \sum_{j=1}^{2} (\phi_{j1} RTW_{t-j} + \phi_{j2} RKOREA_{t-j} + \phi_{j3} RJAPA_{t-j} + \phi_{j4} RUS_{t-j}) + a_{1,t} \quad (1)$$

$$RKOREA_t = \varphi_{10} + \sum_{j=1}^{2} (\varphi_{j1} RTW_{t-j} + \varphi_{j2} RKOREA_{t-j} + \varphi_{j3} RJAPA_{t-j} + \varphi_{j4} RUS_{t-j}) + a_{2,t}, \quad (2)$$

$$h_{11,t} = \sum_{j=1}^{4} u_{j,t-1} (\alpha_{j0} + \alpha_{j1} a_{1,t-1}^2 + \beta_{j1} h_{11,t-1}), \quad (3)$$

$$h_{22,t} = \sum_{j=1}^{4} u_{j,t-1} (\alpha'_{j0} + \alpha'_{j1} a_{2,t-1}^2 + \beta'_{j1} h_{22,t-1}), \quad (4)$$

$$h_{12,t} = \rho_t \sqrt{h_{11,t}} \sqrt{h_{22,t}}, \quad (5)$$

$$\rho_t = \exp(q_t)/(\exp(q_t)+1), \quad (6)$$

$$q_t = \gamma_0 + \gamma_1 \rho_{t-1} + \gamma_2 a_{1,t-1} a_{2,t-1} / \sqrt{h_{11,t-1} h_{22,t-1}}, \quad (7)$$

$$u_{1,t} = \begin{cases} 1, & if \ \ RJAPA_t \le 0; RUS_t \le 0 \\ 0, & if \ \ others \end{cases}, \quad (8)$$

$$u_{2,t} = \begin{cases} 1 & if \quad RJAPA_t \le 0; RUS_t > 0 \\ 0 & if \quad others \end{cases}, \qquad (9)$$

$$u_{3,t} = \begin{cases} 1 & if \quad RJAPA_t > 0; RUS_t \le 0 \\ 0 & if \quad others \end{cases}, \qquad (10)$$

$$u_{4,t} = \begin{cases} 1 & if \quad RJAPA_t > 0; RUS_t > 0 \\ 0 & if \quad others \end{cases}, \qquad (11)$$

with $RJAPA_t > 0$ and $RUS_t > 0$ denote good news, $RJAPA_t \le 0$ and $RUS_t \le 0$ 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,

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

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 Korea'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. Empirical Results.

The empirical results show that the good news and bad news of the Japan and the U.S. stock returns' volatility will produce the different stock return rates on the Taiwan and the Korea stock markets. And the stock return volatilities of the Japan and the U.S. will also affect the variation risks of the Taiwan and the Korea stock markets. The Taiwan stock return does not receive 2nd period's impact of the Japan stock return volatility. The Taiwan stock return volatility receives 2nd period's impact of the Taiwan stock return volatility (ϕ_{21}=-0.0543). The Taiwan stock return also receives before 1 period's impact of the Korea stock return volatility (ϕ_{12}=-0.0456). The Taiwan stock return volatility also receives before 1 period's impact of the U.S. stock return volatility (ϕ_{14}=0.3999). The Taiwan stock return also receives 2nd period's impact of the U.S. stock return volatility (ϕ_{24}=0.1377). The Korea stock return volatility does not receive before 1 period's impact of the Taiwan stock return volatility. And the Korea stock return volatility receives 2nd period's impact of the Taiwan stock return volatility (φ_{21}=-0.0562). The Korea stock return volatility also receives before 1 period's impact of the Japan stock return volatility (φ_{13}=-0.1075). The Korea stock return volatility also receives before 2 period's impact of the U.S. stock return volatility (φ_{14}=0.4894, φ_{24}= 0.1824). The Korea stock return does not receive 2nd period's impact of the Japan stock return volatility rates. The stock return volatilities of the Japan and the U.S. are also truly influent the return volatility of the Taiwan and the Korea stock markets.

On the other hand, the correlation coefficient average estimation value ($\bar{\rho}_t$=0.6554) of the Taiwan and the Korea stock return volatility is significant. This result also shows the Taiwan and the Korea stock return's volatility is mutually synchronized influence. In additional, estimated value of the degree of freedom for the

Student's t distribution is 3.9862, 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 Bivariate AIGARCH(1, 1) Model

Parameters	ϕ_{10}	ϕ_{11}	ϕ_{12}	ϕ_{13}	ϕ_{14}
Coefficient	*0.0501*	*0.0080*	*-0.0456*	*-0.0809*	*0.3999*
(p-value)	*(0.0366)*	*(0.7973)*	*(0.0990)*	*(0.0010)*	*(0.0000)*
Parameters	ϕ_{21}	ϕ_{22}	ϕ_{23}	ϕ_{24}	φ_{10}
Coefficient	*-0.0543*	*-0.0028*	*0.0021*	*0.1377*	*0.0838*
(p-value)	*(0.0661)*	*(0.9175)*	*(0.9326)*	*(0.0000)*	*(0.0006)*
Parameters	φ_{11}	φ_{12}	φ_{13}	φ_{14}	φ_{21}
Coefficient	*-0.0031*	*-0.1154*	*-0.1075*	*0.4894*	*-0.0562*
(p-value)	*(0.9106)*	*(0.0004)*	*(0.0001)*	*(0.0000)*	*(0.0426)*
Parameters	φ_{22}	φ_{23}	φ_{24}	α_{10}	α_{11}
Coefficient	*-0.0149*	*-0.0010*	*0.1824*	*0.0318*	*0.0976*
(p-value)	*(0.6269)*	*(0.9675)*	*(0.0000)*	*(0.5006)*	*(0.0004)*
Parameters	β_{11}	α_{20}	α_{21}	β_{21}	α_{30}
Coefficient	*0.9024*	*0.1899*	*0.2070*	*0.7930*	*0.1368*
(p-value)	*(0.0000)*	*(0.0015)*	*(0.0000)*	*(0.0000)*	*(0. 0295)*
Parameters	α_{31}	β_{31}	α_{40}	α_{41}	β_{41}
Coefficient	*0.1364*	*0.8636*	*-0.0692*	*0.0686*	*0.9314*
(p-value)	*(0.0048)*	*(0.0000)*	*(0.0233)*	*(0.0036)*	*(0.0000)*
Parameters	α'_{10}	α'_{11}	β'_{11}	α'_{20}	α'_{21}
Coefficient	*0.0421*	*0.0921*	*0.9079*	*0.1717*	*0.1969*
(p-value)	*(0.3877)*	*(0.0004)*	*(0.0000)*	*(0.0054)*	*(0.0000)*
Parameters	β'_{21}	α'_{30}	α'_{31}	β'_{31}	α'_{40}
Coefficient	*0.8031*	*0.1689*	*0.0873*	*0.9127*	*-0.0840*
(p-value)	*(0.0000)*	*(0.0228)*	*(0.0482)*	*(0.0000)*	*(0.0128)*
Parameters	α'_{41}	β'_{41}	γ_0	γ_1	γ_2
Coefficient	*0.0698*	*0.9302*	*3.3057*	*-4.0860*	*0.0324*
(p-value)	*(0.0083)*	*(0.0000)*	*(0.0000)*	*(0.0000)*	*(0.2594)*
Parameters	v	$\bar{\rho}_t$	*min* ρ_t	*max* ρ_t	
Coefficient	*3.9862*	*0.6554*	*0.3145*	*1.0000*	
(p-value)	*(0.0000)*	*(0.0000)*			

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 Korea 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 Korea 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 Korea stock return volatilities' process. The empirical result shows that the Taiwan stock market has the fixed variation risk, and the Korea stock market has also a fixed variation risk. In Table 6, the Taiwan and the Korea stock market returns have the different conditional variation risks. This result demonstrates that the good news and bad news of the Japan and the U.S. stock markets will produce the different variation risks on the Taiwan and the Korea stock markets. Under the good news of Japan and U.S. stock markets, the variation risk of the Taiwan's stock market is larger than the variation risk of Korea's stock market. Under the $RJAPA_t \leq 0$ (bad news) and $RUS_t \leq 0$ (bad news), the empirical result shows that the variation risk of the Korea stock market is larger than the variation risk of the Taiwan stock market. Besides, under the $RJAPA_t > 0$ (good news) and $RUS_t > 0$ (good news), the empirical result also shows that the Taiwan and the Korea stock markets can reduce the fixed variation risk. 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 Korea stock market return's volatility does have the asymmetric effect. The Taiwan and the Korea stock market return volatility may construct in the DCC and the bivariate AIGARCH (1, 1) model with a positive (good news) and negative (bad news) threshold of Japan and U.S. stock return volatility rates. From the empirical result also obtains that the dynamic conditional correlation coefficients' average estimation value ($\overline{\rho}_t$ =0.6554) of the Taiwan and the Korea stock return volatility is positive. The positive and negative values of the Japan and the U.S. stock return volatility affects the stock return volatility rates of the Taiwan and the Korea stock markets. The Taiwan and the Korea stock market returns are truly received the impact of the Japan and the U.S. stock return volatility rates. Under the good news of the Japan and the U.S. stock markets, the variation risk of the Korea stock market is larger than the variation risk of the Taiwan stock market. Under the $RJAPA_t \leq 0$ and $RUS_t \leq 0$, the empirical result shows that the variation risk of the Korea stock market is also larger than the variation risk of the Taiwan stock market. Besides, under the $RJAPA_t > 0$ and $RUS_t > 0$, the empirical result also shows that the Taiwan and the Korea stock markets can reduce the fixed variation risk. Therefore, the explanation ability of the bivariate AIGARCH (1, 1) is better than the traditional bivariate GARCH (1, 1) model with a DCC allowed.

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