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Threshold Model of Gold and Oil Price Volatility in Southeast Asia Two Stock Markets: Empirical Study of Thailand and Malaysian 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 Thailand's and the Malaysian's stock markets with two factors of gold price and oil price markets. The empirical result also indicates that the Thailand's and the Malaysian's stock markets is a positive relation. The average estimation value of correlation coefficient equals to 0.4732, which implies that the two stock markets is synchronized influence. Besides, the empirical result also shows that the Thailand's and the Malaysian's stock markets have an asymmetrical effect. The return volatility of the Thailand and the Malaysian stock markets receives the influence of the positive and negative values of the gold price and the oil price volatility rates.

Key Words: *Gold Price, Oil Price, Stock Market, Asymmetric Effect, AIGARCH Model.*

Introduction

We know that Thailand is the major economical financial system in the Association of South-east Asia Nations. We also know that Malaysian is also one of Association of South-east Asian Nations. Based on the Growth Competitiveness Index Rankings in 2003-2004 (it is published in the World Economic Forum), the rank of Malaysia is 29 in the world. Another, also based on the World Competitiveness Yearbook in 2006, the rank of Malaysia is 23 in the world competitiveness. When the investor has an investment in the international stock market, he/she will usually care about the motion situation of the international capital the international politics and the economical situation change, in particular, Thailand and Malaysia stock market change. There is a close relationship for the geographic position based on the trade and the circulation of capital with Thailand and Malaysia, but Thailand and Malaysia may also receive the influence of national gold price and oil price markets. Therefore, the relation between the Thailand's and the Malaysian's stock markets with factors of the gold price and oil price markets is worth further discussion.

The purpose of the present paper is to examine the relations of the Thailand's and the Malaysian's stock markets. This paper also further discusses the affect of the gold price and the oil price volatility rate for the Thailand and the Malaysian stock markets. And the positive and negative values of gold and oil prices' volatility rate are used as the threshold. The organization of this paper is as follows: Section 2 describes the data characteristics; Section 3 presents the proposed model; Section 4 presents the empirical results; Section 5 introduces the asymmetric test of the proposed model, and finally Section 6 summarizes the conclusions of this study.

Data Characteristics

Data sources

The data of this research included the Thailand stock price, the Malaysian stock price, the gold price and the oil price collected between January, 2005 and December, 2011. The source of the stock data was the Taiwan economic Journal (TEJ), a database in Taiwan. The Thailand's stock price refers to the Bangkok set stock index, the Malaysian's stock price refers to the Kuala Lumpur stock index, the gold price refers to KITCO gold market, a database in London, and the oil price refers to the WTI oil price data by the international Energy Information Administration (EIA), a database in U.S.. About the study of the oil price market can refer to the papers of Hammoudeh et al. (2003 and 2004). During the process of data analysis, in case that there was no stock market price available on the side of the Thailand and the Malaysian stock market or on the side of the gold price and the oil price markets due to holidays, the identical time stock price data from one side was deleted. After this, the four variables samples are 1,519.

Returns Calculation and Basic Statistics

To compute the return of the Thailand stock market adopts the natural logarithm difference, rides 100 again. The return of the Malaysian stock market also adopts the natural logarithm difference, rides 100 again. The return of the gold price market also adopts the natural logarithm difference, rides 100 again. The return of the oil price market also adopts the natural logarithm difference, rides 100 again. In Figure 1, the Thailand stock price, the Malaysian stock price, the gold price and the oil price return rate volatility shows the clustering phenomenon, so that we may know the four stock 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 stock markets do have the high correlation in Table 2.

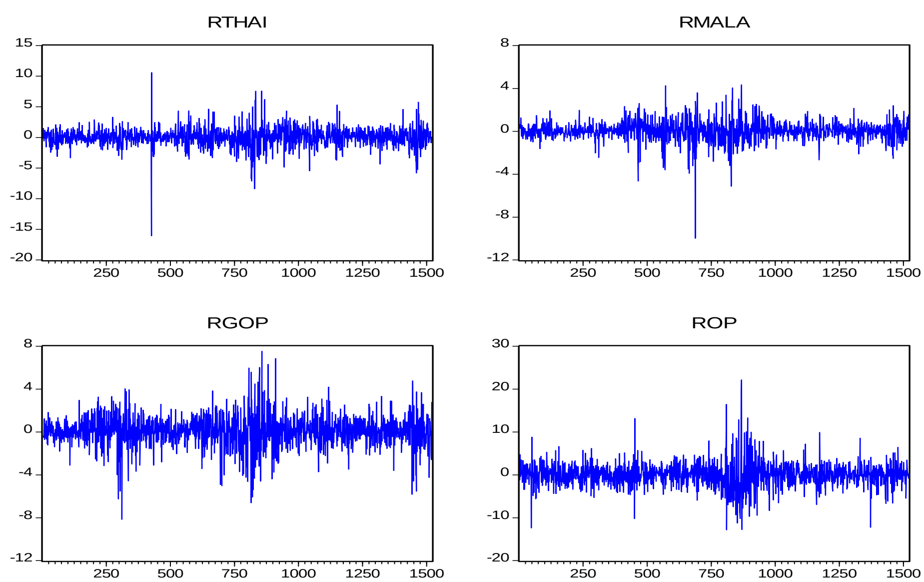

Figure 1. Trend charts of the Thailand, the Malaysian, the gold price and the oil price market volatility rates.

Table 1. Data statistics

Statistics	RTHAI	RMALA	RGOP	ROP
Mean	0.0266	0.0348	0.0858	0.0534
S-D	1.5392	0.9167	1.4427	2.8206
Skew	-0.6905	-1.0857	-0.2669	0.4117
Kurtosis	14.7086	15.2449	6.7159	9.4103
J-B N (p-value)	8791.60*** (0.0000)	9781.75*** (0.0000)	891.39*** (0.0000)	2641.90*** (0.0000)
Sample	1518	1518	1518	1518

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	THAI	MALA	GOP	OP
THAI	1	0.8137	0.6419	0.5942
MALA	0.8137	1	0.7825	0.6099
GOP	0.6419	0.7825	1	0.5080
OP	0.5942	0.6099	0.5080	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 Thailand stock return rates, the Malaysian stock return rates, the gold price volatility rates, and the oil price volatility rates do not have the unit root characteristic, this is, those 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 λ_{max} statistic. This indicated that the Thailand stock market, the Malaysian stock market, the gold price market and the oil price market do not have a co-integration relation. Therefore, we do not need to consider the model of error correction.

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 markets have the conditionally heteroskedasticity phenomenon exists. This result suggests that we can use the GARCH model to match and analyze it.

Table 3. Unit root test of KSS for the return data

KSS	RTHAI	RMALA	RGOP	ROP
Statistic	-19.324***	-15.407***	-21.820***	-16.208***
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=1) under the exogenous variables of gold price and oil price

H_0	λ_{max}	Critical value
None	10.1043	17.1477
At most 1	0.0879	3.8415

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

Table 5. ARCH effect test

RTHAI	Engle LM test	Tsay F test
Statistic	272.826***	6.865***
(p-value)	(0.0000)	(0.0000)
RMALA	Engle LM test	Tsay F test
Statistic	208.304***	4.299***
(p-value)	(0.0000)	(0.0000)

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

Proposed Model

Based on the gold price and the oil price markets will affect the return rate volatility of the Thailand and the Malaysian stock markets, and the gold price and the oil price markets do have the high correlations for the Thailand and the Malaysian stock markets. We follows the idea of self-exciting threshold autoregressive (SETAR) model (Tsay, 1989 and 2004), 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 gold price and oil price 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 Thailand's and the Malaysian's stock market returns, the AGARCH(1, 1) model is illustrated as follows:

$$RTHAI_t = \phi_{10} + \sum_{j=1}^{2}(\phi_{j1} RTHAI_{t-j} + \phi_{j2} RMALA_{t-j} + \phi_{j3} RGOP_{t-j} + \phi_{j4} ROP_{t-j}) + a_{1,t} \quad (1)$$

$$RMALA_t = \varphi_{10} + \sum_{j=1}^{2}(\varphi_{j1} RTHAI_{t-j} + \varphi_{j2} RMALA_{t-j} + \varphi_{j3} RGOP_{t-j} + \varphi_{j4} ROP_{t-j}) + a_{2,t}, \quad (2)$$

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

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

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

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

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

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

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

$$u_{3,t} = \begin{cases} 1, & if \quad RGOP_t > 0; ROP_t \le 0 \\ 0 & if \quad others \end{cases}, \tag{10}$$

$$u_{4,t} = \begin{cases} 1, & if \quad RGOP_t > 0; ROP_t > 0 \\ 0 & if \quad others \end{cases}, \tag{11}$$

with $RGOP_t > 0$ and $ROP_t > 0$ denote good news, $RGOP_t \le 0$ and $ROP_t \le 0$ 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,

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

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 Thailand's and the Malaysian'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 gold price and the oil price returns' volatility will produce the different stock price return volatilities on the Thailand and the Malaysian stock markets. The Thailand stock price return volatility does not receive before 2 period's impact of the Thailand stock return volatility. The Thailand stock return volatility does not receive before 2 period's impact of the Malaysian stock return volatility. The Thailand stock return volatility does not receive before 1 period's impact of the gold price return volatility rates. The Thailand stock return volatility receives before 1 period's impact of the oil price return volatility rates (ϕ_{14}=0.0389). The Thailand stock return volatility also receives 2nd period's impact of the gold price return volatility rates (ϕ_{23}=-0.0417). The Malaysian stock return volatility receives before 1 period's impact of the Thailand stock return volatility (φ_{11}=0.0354). And the Malaysian stock return volatility also receives before 1 period's impact of the Malaysian stock return volatility (φ_{12}=0.0560). The Malaysian stock return volatility also receives before 1 period's impact of the gold price return volatility rates (φ_{13}=0.0214). The Malaysian stock return volatility also receives before 2 period's impact of the oil price return volatility rates (φ_{14}=0.0241 and φ_{24}=-0.0198). The Malaysian stock return does not receive before 2nd period's impact of the gold price return volatility rates. The return rate volatilities of the gold price and the oil price are truly influent the return volatility of the Thailand and the Malaysian stock markets.

On the other hand, the correlation coefficient average estimation value ($\hat{\bar{\rho}}_t$=0.4732) of the Thailand and the Malaysian stock return volatility is significant. This result also shows the Thailand and the Malaysian stock return's volatility is mutually synchronized influence. In additional, estimated value of the degree of freedom for the Student's t distribution is 4.6071, and is significant under the significance level of 0.01($\alpha = 1\%$). This also demonstrates that this research data has the heavy tailed distribution.

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 Thailand and Malaysian stock markets. The empirical results show that the Thailand stock market conforms the conditionally supposition of the AIGARCH model. The empirical results also show that the Malaysian stock market is also the AIGARCH model. This result also demonstrates the DCC and the bivariate AIGARCH (1, 1) model may catch the Thailand and the Malaysian stock return volatilities' process. Under the good news of gold price and oil price markets ($RGOP_t > 0$ and $ROP_t > 0$), the empirical result shows that the Thailand stock market has the fixed variation risk. Under the good news of gold price market and the bad news of oil price market ($RGOP_t > 0$ and $ROP_t \leq 0$), the Malaysian stock market has also a fixed variation risk. In Table 6, the Thailand and the Malaysian stock market return volatilities have the different conditional variation risks.

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	0.0929	0.0365	-0.0406	0.0293	0.0389
(p-value)	(0.0009)	(0.2320)	(0.2815)	(0.1983)	(0.0010)
Parameters	ϕ_{21}	ϕ_{22}	ϕ_{23}	ϕ_{24}	φ_{10}
Coefficient	0.0188	0.0238	-0.0417	-0.0080	0.0498
(p-value)	(0.5251)	(0.5035)	(0.0604)	(0.4890)	(0.0014)
Parameters	φ_{11}	φ_{12}	φ_{13}	φ_{14}	φ_{21}
Coefficient	0.0354	0.0560	0.0214	0.0241	0.0070
(p-value)	(0.0036)	(0.0508)	(0.0832)	(0.0003)	(0.5992)
Parameters	φ_{22}	φ_{23}	φ_{24}	α_{10}	α_{11}
Coefficient	0.0334	-0.0060	-0.0198	0.1197	0.1933
(p-value)	(0.2252)	(0.6321)	(0.0044)	(0.1506)	(0.0001)
Parameters	β_{11}	α_{20}	α_{21}	β_{21}	α_{30}
Coefficient	0.8067	0.0147	0.1771	0.8229	0.0912
(p-value)	(0.0000)	(0.8739)	(0.0060)	(0.0000)	(0. 3124)
Parameters	α_{31}	β_{31}	α_{40}	α_{41}	β_{41}
Coefficient	0.2641	0.7359	0.1478	0.1527	0.8473
(p-value)	(0.0000)	(0.0000)	(0.0363)	(0.0004)	(0.0000)
Parameters	α'_{10}	α'_{11}	β'_{11}	α'_{20}	α'_{21}
Coefficient	0.0153	0.1496	0.8504	0.0484	0.2342
(p-value)	(0.4323)	(0.0000)	(0.0000)	(0.1070)	(0.0000)
Parameters	β'_{21}	α'_{30}	α'_{31}	β'_{31}	α'_{40}
Coefficient	0.7658	0.0517	0.2667	0.7333	0.0106
(p-value)	(0.0000)	(0.0362)	(0.0000)	(0.0000)	(0.5819)
Parameters	α'_{41}	β'_{41}	γ_0	γ_1	γ_2
Coefficient	0.1679	0.8321	-1.8240	3.4537	0.2121
(p-value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Parameters	v	$\bar{\rho}_t$	min ρ_t	max ρ_t	
Coefficient	4.6071	0.4732	0.2063	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 .

This result demonstrates that the good news and bad news of the gold price and the oil price markets will produce the different variation risks on the Thailand and the Malaysian stock markets. Under the good news of gold price and oil price markets, the variation risk of the Thailand's stock market is larger than the variation risk of Malaysian's stock market. Under the $RGOP_t \leq 0$ and $ROP_t > 0$, the empirical result shows that the variation risk of the Thailand's stock market is larger than the variation risk of the Malaysian's stock market. Under the $RGOP_t \leq 0$ and $ROP_t \leq 0$, the variation risk of Malaysian's stock market is larger than the variation risk of the Thailand's 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.

To test the inappropriateness of the DCC and the bivariate asymmetric IGARCH(1, 2) model, the test method of Ljung & Box (1978) is used to examine autocorrelation of the standard residual error. This model does not show an autocorrelation of the standard residual error. Therefore, the DCC and the bivariate asymmetric IGARCH(1, 2) model are more appropriate.

Asymmetric Test of the Bivariate AIGARCH(1, 1) Model

The bivariate AIGARCH(1, 1) model is proposed as above. The asymmetric test methods (Engle and Ng, 1993) are used the following two methods as: the positive size bias test and the joint test. By the positive size bias test and the joint test shows that the Thailand stock market does not have the asymmetrical effect and the Malaysian stock market does not also have the asymmetrical effect in Table 7.

Table 7. Asymmetric test of the DCC and the Bivariate-AIGARCH(1, 1)

RTHAI	Positive size bias test	Joint test
F statistic	0.0142	0.4775
(p-value)	(0. 9051)	(0.6980)
RMALA	Positive size bias test	Joint test
F statistic	0.1896	1.1922
(p-value)	(0.6633)	(0.3114)

Notes: p-value < α denote significance. (α =5%).

Conclusions

The empirical results show that the Thailand stock market return's volatility does have an asymmetric effect and the Malaysian stock market return's volatility does also have the asymmetric effect. The Thailand and the Malaysian stock market return volatility may construct in the DCC and the bivariate AIGARCH (1, 1) model with a positive and negative threshold of gold price and oil price return volatility rates. From the empirical result also obtains that the dynamic conditional correlation coefficient estimation value ($\hat{\rho}_t$ =0.4732) of the Thailand and the Malaysian stock markets is positive. The positive and negative values of the gold price and the oil price volatility rates truly affects the stock price return volatilities of the Thailand and the Malaysian stock markets. Under the $RGOP_t > 0$ and $ROP_t > 0$ (good news), the empirical result shows that the variation risk of the Thailand's stock market is larger than the variation risk of the Malaysian's stock market. Under the $RGOP_t \leq 0$ and $ROP_t \leq 0$ (bad news), the variation risk of Malaysian's stock market is larger than the variation risk of the Thailand's stock market. Under the $RGOP_t \leq 0$ (bad news)and $ROP_t > 0$ (good news), the empirical result shows that the variation risk of the Thailand's stock market is larger than the variation risk of the Malaysian's stock market.

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