Threshold Model of Japan, U.K. and Canada Stock Market Volatility in Asia Markets' Influence: Empirical Study of Hong Kong Market

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Abstract

The empirical results show that the AIGARCH (1, 1) model is appropriate in evaluating the volatility model of the Hong Kong's stock market. The empirical result also indicates that the Hong Kong's stock market has an asymmetrical effect. The volatility of the Hong Kong stock market receives the influence of the good and bad news of the Japan, the U.K. and the Canada stock markets. For example, under the $RJAPAN_t > 0$ *(good news), the* $RUK_t > 0$ *(good news) and the* $RCANA_t > 0$ *(good news), the variation risk of the Hong Kong stock market is the highest (* $\beta_{81} = 0.9879$ *). Under the* $RJAPAN_t \le 0$ *(bad news), the* $RUK_t > 0$ *(good news) and* $RCANA_t \le 0$ *(bad news), the variation risk of the Hong Kong stock market is the lowest (* $\beta_{31} = 0.8242$ *).*

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

Introduction

Hong Kong has established good economical regulations under the rule of U.K. Since after it was taken back by Mainland China, Hong Kong has become an important part of Mainland China economical entity. According to negotiable securities and stock matter service control commission (Securities and futures commission; Is called SFC) statistics, up to year 2005 at the end of December, the Hong Kong exchange market value is US$1,055 billion, ranked 8th in the world and second in Asia. Apparently, Hong Kong has an important role to play in the global economical financial system. Hong Kong 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. Hong Kong has also a close relationship with the U.K. and the Canada based on the trade and the circulation of capital, and the U.K. and the Canada are also powerful global economical nations. 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 Japan, U.K. and Canada stock markets' change. Therefore, the volatility model of the Hong Kong stock market is worth further discussion with the factors of Japan, U.K. and Canada's stock markets.

The purpose of the present paper is to examine the volatility model of the Hong Kong's stock market. This paper also further discusses the affect of Japan, U.K. and Canada stock prices' volatility rate for the Hong Kong stock market volatilities. And the positive and negative values of Japan, U.K. and Canada stock prices' 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 research sample period was from January, 2001 to December, 2012, and the material origin takes from DataStream, a database in Taiwan. Among them, the Hong Kong's stock price is the TSE weighted stock index, the Japan's stock price is the Tokyo NK-225 index. The U.K.'s stock price is the London FTSE 100 index. The Canada's stock price is the Toronto 300 stock index. In the data processing aspect, the markets do not do business on respective Hong Kong's holidays; therefore when a stock market is closed, this article deletes the identical time stock price material and conforms to the other stock market's common trading day; therefore four variable samples after processing each will be 2,639 from now on.

Returns Calculation and Basic Statistics

To compute the volatility rate of the Hong Kong stock market adopts the natural logarithm difference, rides 100 again. The volatility rate of the Japan stock market also adopts the natural logarithm difference, rides 100 again. The volatility rate of the U.K. and Canada stock markets also adopts the natural logarithm difference, rides 100 again. In Figure 1, the Hong Kong, the Japan, the U.K. and the Canada stock volatility rates 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.

Table 1. Data statistics

Statistics	RHK	RJAPAN	RUK	RCANA
Mean	0.016701	-0.010701	-0.000726	0.012154
S-D	1.670783	1.628966	1.361894	1.242406
Skew	0.120365	-0.555186	-0.043114	-0.574873
Kurtosis	10.85921	8.868202	8.534700	10.70933
J-B N (p-value)	6795.61^{***} (0.0000)	3920.59^{***} (0.0000)	3367.88^{***} (0.0000)	6678.06^{***} (0.0000)
Sample	2638	2638	2638	2638

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%.

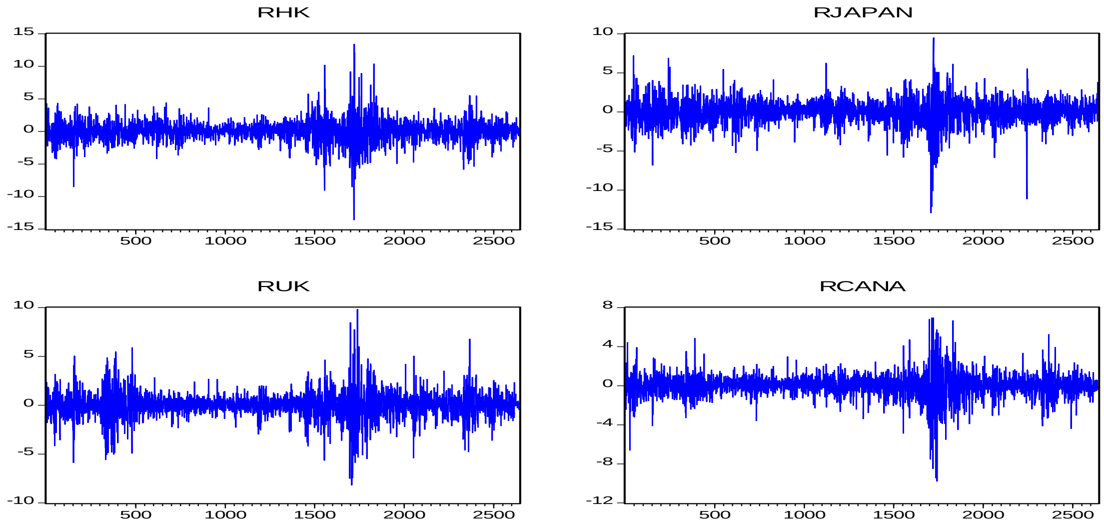

Figure 1. Trend charts of the Hong Kong, the Japan, the U.K. and the Canada stock market volatility rates.

Table 2. Unconditional correlation coefficient

Coefficient	RHK	RJAPAN	RUK	RCANA
RHK	1	0.6358	0.4040	0.3485
RJAPAN	0.6358	1	0.3623	0.2789
RUK	0.4040	0.3623	1	0.5995
RCANA	0.3485	0.2789	0.5995	1

Unit Root and Co-integration Tests

This paper further uses the unit root tests of ADF (Dickey, 1979 and 1981) and KSS (Kapetanios et. al., 2003) to determine the stability of the time series data. The ADF and KSS examination results are listed in Table 3. It shows that the Hong Kong stock market volatility, the Japan stock market volatility, the U.K. stock market volatility, and the Canada stock market volatility 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 λ_{max} statistic. This indicated that the Hong Kong stock market volatility does 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

ADF	RHK	RJAPAN	RUK	RCANA
Statistic	-51.781^{***}	-31.181^{***}	-13.389^{***}	-9.257^{***}
Critical value	-3.962	-3.412	-3.128	
Significant level	α =1%	α =5%	α =10%	
KSS	RHK	RJAPAN	RUK	RCANA
Statistic	-25.998^{***}	-21.787^{***}	-23.569^{***}	-27.374^{***}
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	λ_{max}	Critical value
None	23.3849	32.1183
At most 1	15.1927	25.8232
At most 2	7.4893	19.3870
At most 3	3.1707	12.5180

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 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

RHK	Engle LM test	Tsay F test
Statistic	829.147***	30.739***
(p-value)	(0.0000)	(0.0000)

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

Proposed Model

Based on the Japan, the U.K. and the Canada stock markets can affect the stock price volatility of the Hong Kong stock market, and the Japan, the U.K. and the Canada stock markets do have the trade correlations for the Hong Kong stock market. 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 values of Japan, U.K. and Canada stock prices' volatility are as a threshold. After model process selection, in this paper, we may use the asymmetric GARCH (called AGARCH) model to construct the volatility model of the Hong Kong's stock market, the AGARCH(1, 1) model is illustrated as follows:

$$RHK_t = \sum_{j=1}^{8} u_{j,t-1}(\phi_{j0} + \phi_{j1}RHK_{t-j} + \phi_{j2}RHK_{t-2}$$
$$+ \phi_{j3}RHK_{t-3} + \phi_{j4}RHK_{t-4}) + a_{1,t} \quad (1)$$

$$h_{1,t} = \sum_{j=1}^{8} u_{j,t-1}(\alpha_{j0} + \alpha_{j1}a_{1,t-1}^2 + \beta_{j1}h_{1,t-1}), \quad (2)$$

$$u_{1,t} = \begin{cases} 1 & if \quad RJAPAN \le 0, RUK_t \le 0; RCANA_t \le 0 \\ 0 & if \quad others \end{cases}, \quad (3)$$

$$u_{2,t} = \begin{cases} 1 & if \quad RJAPAN \le 0, RUK_t \le 0; RCANA_t > 0 \\ 0 & if \quad others \end{cases}, \quad (4)$$

$$u_{3,t} = \begin{cases} 1 & if \quad RJAPAN \le 0, RUK_t > 0; RCANA_t \le 0 \\ 0 & if \quad others \end{cases}, \quad (5)$$

$$u_{4,t} = \begin{cases} 1, & if \quad RJAPAN > 0, RUK_t \le 0; RCANA_t \le 0 \\ 0, & if \quad others \end{cases}, \tag{6}$$

$$u_{5,t} = \begin{cases} 1, & if \quad RJAPAN > 0, RUK_t > 0; RCANA_t \le 0 \\ 0, & if \quad others \end{cases}, \tag{7}$$

$$u_{6,t} = \begin{cases} 1, & if \quad RJAPAN > 0, RUK_t \le 0; RCANA_t > 0 \\ 0, & if \quad others \end{cases}, \tag{8}$$

$$u_{7,t} = \begin{cases} 1, & if \quad RJAPAN \le 0, RUK_t > 0; RCANA_t > 0 \\ 0, & if \quad others \end{cases}, \tag{9}$$

$$u_{8,t} = \begin{cases} 1, & if \quad RJAPAN > 0, RUK_t > 0; RCANA_t > 0 \\ 0, & if \quad others \end{cases}, \tag{10}$$

with $RJAPAN_t > 0$, $RUK_t > 0$ and $RCANA_t > 0$ denote good news, $RJAPAN_t \le 0$, $RUK_t \le 0$ and $RCANA_t \le 0$ denote bad news. The white noise of $a_{1,t}$ is obey the Student's t distribution, this is,

$$a_{1,t} \sim T_v(0, (v-2)h_{1,t} / v), \tag{11}$$

among v is the degree freedom of $a_{1,t}$. 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 Hong Kong's stock price return volatility may be constructed on the 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 Japan, the U.K. and the Canada stock market prices' volatility will produce the different stock price returns on the Hong Kong's stock market. And the stock price return volatilities of the Japan, the U.K. and the Canada also affects the variation risks of the Hong Kong stock market. Under the $RJAPAN_t > 0$ (good news), the $RUK_t \le 0$ (bad news) and $RCANA_t \le 0$ (bad news), the Hong Kong stock price return volatility receives second period's impact of the Hong Kong stock price return volatility (ϕ_{42} =0.0992). The Hong Kong stock price return volatility also receives fourth period's impact of the Hong Kong stock price volatility (ϕ_{44} =0.0999). Under the $RJAPAN_t > 0$ (good news), the $RUK_t \le 0$ (bad news) and $RCANA_t > 0$ (good news), the Hong Kong stock price return volatility also receives first period's impact of the Hong Kong stock price return volatility (ϕ_{61} =-0.1571). Under the $RJAPAN_t \le 0$ (bad news), the $RUK_t > 0$ (good news) and $RCANA_t > 0$ (good news), the Hong Kong stock price return volatility also receives first period's impact of the Hong Kong stock price return volatility (ϕ_{71}=-0.2057). The Hong Kong stock price return volatility also receives third period's impact of the Hong Kong stock price return volatility (ϕ_{73}=0.0929).

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

Parameters	ϕ_{10}	ϕ_{11}	ϕ_{12}	ϕ_{13}	ϕ_{14}
Coefficient	-0.3274	-0.0392	-0.0186	0.0089	0.0443
(p-value)	(0.0000)	(0.3959)	(0.6468)	(0.8352)	(0.2677)
Parameters	ϕ_{20}	ϕ_{21}	ϕ_{22}	ϕ_{23}	ϕ_{24}
Coefficient	0.1247	-0.0420	0.0801	-0.0458	0.0373
(p-value)	(0.1197)	(0.6241)	(0.3123)	(0.4909)	(0.6021)
Parameters	ϕ_{30}	ϕ_{31}	ϕ_{32}	ϕ_{33}	ϕ_{34}
Coefficient	-0.0137	0.0067	0.1072	-0.0036	-0.0074
(p-value)	(0.8555)	(0.9420)	(0.1329)	(0.9602)	(0.9067)
Parameters	ϕ_{40}	ϕ_{41}	ϕ_{42}	ϕ_{43}	ϕ_{44}
Coefficient	-0.4027	-0.0089	0.0992	0.0105	0.0999
(p-value)	(0.0000)	(0.8875)	(0.0657)	(0.8430)	(0.0597)
Parameters	ϕ_{50}	ϕ_{51}	ϕ_{52}	ϕ_{53}	ϕ_{54}
Coefficient	-0.1975	0.0941	0.0918	0.0552	-0.0287
(p-value)	(0.0104)	(0.2685)	(0.1928)	(0.4511)	(0.6718)
Parameters	ϕ_{60}	ϕ_{61}	ϕ_{62}	ϕ_{63}	ϕ_{64}
Coefficient	0.1475	-0.1571	0.0323	0.0450	0.0108
(p-value)	(0.0857)	(0.0488)	(0.6456)	(0.4751)	(0.8844)
Parameters	ϕ_{70}	ϕ_{71}	ϕ_{72}	ϕ_{73}	ϕ_{74}
Coefficient	0.4817	-0.2057	-0.0445	0.0929	-0.0076
(p-value)	(0.0000)	(0.0011)	(0.4369)	(0.0771)	(0.8838)
Parameters	ϕ_{80}	ϕ_{81}	ϕ_{82}	ϕ_{83}	ϕ_{84}
Coefficient	0.2901	-0.0251	-0.0623	-0.0449	-0.0708
(p-value)	(0.0000)	(0.5946)	(0.1192)	(0.2360)	(0.0829)
Parameters	α_{10}	α_{11}	β_{11}	α_{20}	α_{21}
Coefficient	0.0329	0.1083	0.8917	0.0941	0.0853
(p-value)	(0.3088)	(0.0000)	(0.0000)	(0.0564)	(0.0641)
Parameters	β_{21}	α_{30}	α_{31}	β_{31}	α_{40}
Coefficient	0.9147	-0.0182	0.1758	0.8242	0.0412
(p-value)	(0.0000)	(0. 7626)	(0.0010)	(0.0000)	(0.3637)
Parameters	α_{41}	β_{41}	α_{50}	α_{51}	β_{51}
Coefficient	0.0580	0.9420	0.0080	0.0585	0.9415
(p-value)	(0.0704)	(0.0000)	(0.9848)	(0.0988)	(0.0000)
Parameters	α_{60}	α_{61}	β_{61}	α_{70}	α_{71}
Coefficient	-0.0997	0.0413	0.9587	0.0525	0.0788
(p-value)	(0.0374)	(0.3031)	(0.0000)	(0.2825)	(0.0054)
Parameters	β_{71}	α_{80}	α_{81}	β_{81}	v
Coefficient	0.9212	-0.0132	0.0121	0.9879	6.6558
(p-value)	(0.0000)	(0.6452)	(0.3321)	(0.0000)	(0.0000)

Notes：p-value< α denotes significance. (α =1%, α =5%).

Under the $RJAPAN_t > 0$ (good news), the $RUK_t > 0$ (good news) and $RCANA_t > 0$ (good news), the Hong Kong stock price return volatility also receives fourth period's impact of the Hong Kong stock price return volatility (ϕ_{84}=-0.0708). The stock price return volatility of the Japan, the U.K. and the Canada stock price markets are also truly influent the stock price return volatility of the Hong Kong stock market. In additional, estimated value of the degree of freedom for the Student's t distribution is 6.6558, 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 of Japan, U.K. and Canada stock markets. The empirical results show that the Hong Kong stock market conforms the conditionally supposition of the AIGARCH model. This result also demonstrates the AIGARCH (1, 1) model may catch the Hong Kong stock market price volatilities' process. The empirical result shows that the Hong Kong stock market has the fixed variation risk under the $RJAPAN_t \le 0$ (bad news), the $RUK_t \le 0$ (bad news) and $RCANA_t > 0$ (good news). The Hong Kong stock market has also the fixed variation risk under the $RJAPAN_t > 0$ (good news), the $RUK_t > 0$ (bad news) and $RCANA_t > 0$ (good news). In Table 6, the Hong Kong stock market does have the different conditional variation risks under the good and bad news. This result demonstrates that the good news and bad news of the Japan, the U.K. and the Canada stock markets will produce the different variation risks on the Hong Kong stock market. For example, under the $RJAPAN_t \le 0$ (bad news), the $RUK_t \le 0$ (bad news) and $RCANA_t \le 0$ (bad news), the empirical result shows that the variation risk of the Hong Kong stock market equals $\beta_{11} = 0.8917$. Under the $RJAPAN_t > 0$ (good news), the $RUK_t > 0$ (good news) and $RCANA_t > 0$ (good news), the variation risk of the Hong Kong stock market equals $\beta_{81} = 0.9879$. Under the $RJAPAN_t > 0$ (good news), the $RUK_t > 0$ (good news) and $RCANA_t \le 0$ (bad news), the variation risk of the Hong Kong stock market is the highest ($\beta_{51} = 0.9415$). Under the $RJAPAN_t > 0$ (good news), the $RUK_t \le 0$ (bad news) and $RCANA_t > 0$ (good news), the variation risk of the Hong Kong stock market is the lowest ($\beta_{61} = 0.9587$). Therefore, the explanatory ability of the student t distribution and the AIGARCH(1, 1) model is better than the traditional model of the GARCH.

To test the inappropriateness of the AIGARCH(1, 1) 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 AIGARCH(1, 1) model are more appropriate.

Conclusions

The empirical results show that the Hong Kong stock markets' volatility does have an asymmetric effect. The Hong Kong stock market volatility may construct in the AIGARCH (1, 1) model with a positive and negative threshold of Japan, U.K. and Canada stock price volatilities. The good and bad news of Japan, U.K. and Canada stock markets affects the stock price volatility of the Hong Kong stock market. For example, under the $RJAPAN_t > 0$ (good news), the $RUK_t > 0$ (good news) and $RCANA_t > 0$ (good news), the variation risk of the Hong Kong stock market is the highest ($\beta_{81} = 0.9879$). Under the $RJAPAN_t > 0$ (bad news), the $RUK_t \le 0$ (good news) and $RCANA_t > 0$ (bad news), the variation risk of the Hong Kong stock market is the lowest ($\beta_{31} = 0.8242$). The empirical result shows that the variation risk of the Hong Kong stock market receives the influence of others stock markets. Therefore, the explanation ability of the AIGARCH (1, 1) is better than the traditional model of GARCH.

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