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A DCC Analysis of Two Exchange Rate Market Returns Volatility with an Japan Dollars Factor: Study of Taiwan and Korea's Exchange Rate Markets

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Abstract

This paper discuss the associations and model construction between Taiwan and Korea's exchange rate markets during the period from January 2000 to July 2008. The empirical results show that the mutual effects of the Taiwan and the Korea's exchange rate markets may construct in bivariate IGARCH (1, 1) model. The empirical result also shows that there exists the positive relations between Taiwan and Korea's exchange rate markets - namely two exchange rate market return's volatility are synchronized influenced, and the average estimation value of the DCC coefficient of two exchange rate markets equals to 0.4073. The Japan's exchange rate return's volatility will also affect the variation risk of the Taiwan's exchange rate market, but the Japan's exchange rate return's volatility will not affect the variation risk of the Korea's exchange rate market. Furthermore, Taiwan and Korea's exchange rate markets do not have the asymmetrical effect in the research period.

Keyword

Exchange rate market returns, DCC, bivariate IGARCH model, Student's t distribution, asymmetrical effect.

1. Introduction

In recent years, under the internationalization and a liberalized tidal current, and urging the international investment and the circulation of capital increase, experts also caused between the country and the country the exchange rate market a related ascension. Taiwan's economical physique belongs partly to an island economy, where positive includes to the foreign trade unfolds where ties between Korea and Japan are close. We know that Korea is one of Asian four dragons, also Korea economy of growth in 2006 is 7.9%, and the forecast value of the grow rate is 5.5-7.5% in the future. And Japan is also the Asia main financial center, its foreign exchange market is the fourth big trading market in the world. We also know that Also, Taiwan is geographically close to Korea, therefore the relation between Taiwan and Korea exchange rate markets is worth further discussing.

Between the research stock market the return volatility method has many models, such as autoregressive moving average (ARMA) model, but from scholar Engle (1982) proposes the autoregressive conditionally heteroskedasticity (ARCH) model and Bollerslev (1986) proposes the generalized autoregressive conditionally heteroskedasticity (GARCH) model. Yet where this kind of model comparatively may catch the financial property the variation number is not the fixed characteristic. But afterwards, scholars like Nelson (1990) discovered that negative direction in the markets will have a different influence on the future stock price volatility. But the GARCH model supposes the settled time conditional variance for the preceding issue of conditional variance, with error term a square function; therefore, error terms both the positive and negative did not exist to the conditional variance influence. Therefore, several condition variations can change along with error term size value, but cannot change along with the positive and negative marks. To improve this flaw, Nelson (1991) proposes the so-called exponential GARCH model and Glosten, Jaganathan and Runkle (1993) propose the so-called threshold GARCH model. For the research of asymmetric problems, one may also refer to Horng and Lee (2008), Poon and Fung (2000), Christie (1982), French, Schwert and Stambaugh (1987), Campell and Hentschel (1992), Koutmos and Booth (1995), and Koutmos (1996). Afterwards, studies of the return volatility method grew vigorously, proposing such things as the multivariate GARCH model. For examples, see Yang (2005), Yang and Doong (2004), Granger, Hung and Yang (2002), and Bollerslev (1990) for the application of bivariate GARCH model.

In this paper, the Student's t distribution is adopted and 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. Beside, one also discusses the influence of the Japan's exchange rate return on the Taiwan and Korea's exchange rate markets. This paper is organized as follows. Section 2 descibes the data characteristics of Taiwan's and Korea's exchange rate and the volatility of their returns, and the data characteristics of Japan's exchange rate; Section 3 gives the asymmetric test of bivariate GARCH model with a DCC; Section 4 gives the propoded model of bivariate GARCH with a DCC and its estimated parameters, and an analysis of related Taiwan's and Korea's exchange rate returns; Section 5 gives the empirical results of the proposed model; Section 6 gives the conclusions.

2. Data characteristics

2.1 Basic statistics and trend charts

The research sample period was from January 3, 2000 to July 31, 2008, and the material origin takes from Taiwan economy journal (TEJ), a database in Taiwan. Among them, the Taiwan's exchange rate price is the Taiwan dollars (US dollars) in New York market, the Korea's exchange rate price is the Korea dollars (US dollars) in the New York market. The Japan's exchange rate price is the Japan dollars (US dollars) in the New York market. In the data processing aspect, the markets do not do business on respective Taiwan's and Korea'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 two variable samples after processing each will be 2175 from now on. The Taiwan's exchange rate market return ($RTER_t$) for every day closing price natural logarithm difference, rides 100 again, this namely

$$RTER_t = 100 \times (\log(TER_t / TER_{t-1})),$$

in which TER_t represents the t-th date the Taiwan's exchange rate closing price; The Korea's exchange rate market return ($RKER_t$) for every day closing price natural logarithm difference, rides 100 again, this namely

$$RKER_t = 100 \times (\log(KER_t / KER_{t-1})),$$

in which KER_t represents the t-th date of the Korea's exchange rate closing price. ; The Japan's exchange rate market return ($RJER_t$) for every day closing price natural logarithm difference, rides 100 again, this namely

$$RJER_t = 100 \times (\log(JER_t / JER_{t-1})),$$

in which JER_t represents the t-th date of the Japan's exchange rate closing price.

In Figure 1, the Taiwan's and Korea's exchange rate return volatility shows the clustering phenomenon, so that we may know the Taiwan exchange rate market and Korea's stock market have certain relevance. And return rate of Japan's exchange rate can also affect the exchange rate market. By the unit root test as below, the return rate of the Taiwan's exchange rate, the return rate of the Korea exchange rate, and the return rate of the Japan's exchange rate are all stationary sequences. The basic statistics of these sequences are stated in Table 1.

From Table 1, the average return rate of the Taiwan's exchange rate is -0.0011, the average return rate of the Korea's exchange rate is -0.0054, and the average return rate of the Japan's exchange rate is 0.0028. The variation risk of the Taiwan's exchange rate return rate is 0.2999, the variation risk of the Korea's exchange rate return rate is 0.4772, and the variation risk of the Japan's exchange rate return rate is 0.6166, and therefore the variation risk of the Japan's exchange rate return rate is the highest.

According to Table 1, as shown by the Jarque-Bera statistics under the null hypotheses of normal distribution, those three markets do not obey the assumption of normal distribution. Therefore, the heavy tails distribution is used to evaluate the proposed model.

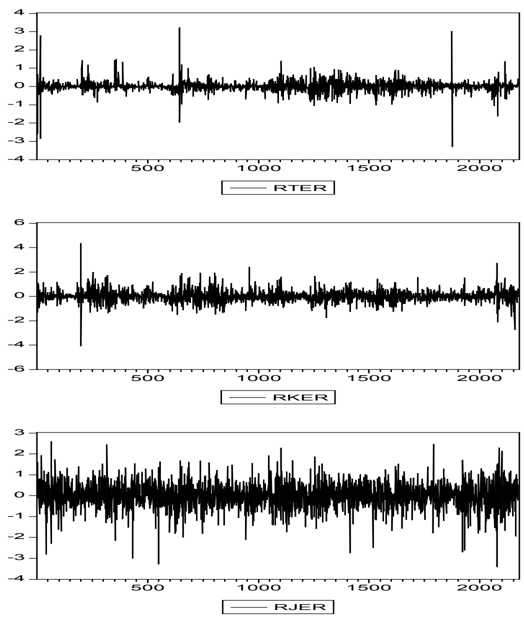

Figure 1. Tend charts of Taiwan's and Korea's exchange rate return rate, and the return rate of Japan's exchange rate.

Table 1. Basic statistics of the research data

Statistics	TER	RTER	KER	RKER
Mean	32.941	-0.001	1105.8	-0.005
Standard deviation	1.331	0.300	126.45	0.477
J-B (p-value)	100.68 (0.000)	77704 *** (0.000)	145.10 (0.000)	5472 *** (0.000)
Sample	2175	2174	2175	2174
Statistics	JER	RJER		
Mean	114.59	0.003		
Standard deviation	7.233	0.617		
J-B (p-value)	53.810 (0.000)	535.4 *** (0.000)		
Sample	2175	2174		

Note: (1) J-B denotes the normal distribution test of Jarque-Bera. (2) *** denotes significance at level α =1%.

2.2 Unit root test and Co-integration test

This paper further uses the unit root tests of ADF (Dickey and Fuller, 1979 and 1981) and KSS (Kapetanios et al., 2003) to determine the stability of the time series data. The ADF and KSS examination results is listed in Table 2. It shows that the return rate of the Taiwan's exchange rate, the return rate of the Korea's exchange rate, and the return rate of the Japan's exchange rate do not have the unit root characteristic- namely, the three markets are stationary time series data, under $\alpha = 1\%$ significance level.

Table 2. Unit root test of ADF and KSS methods

ADF	RTER	RKER
Statistic	-54.189 ***	-33.086 ***
Critical value	-3.962 (α =1%), -3.412 (α =5%)	
KSS	RTER	RKER
Statistic	-31.576 ***	-22.733 ***
Critical value	-2.82 (α =1%), -2.22 (α =5%)	
ADF	RJER	
Statistic	-47.924 ***	
Critical value	-3.962 (α =1%), -3.412 (α =5%)	
KSS	RJER	
Statistic	-25.981 ***	
Critical value	-2.82 (α =1%), -2.22 (α =5%)	

Note: *** denotes significance at the 1% level.

By the cointegration test of Johansen (1991), we know that the statistics of $\lambda_{\max}$ is not significant under the level $\alpha = 5\%$ in Table 3. This demonstrates that those three markets of the the return rate of the Taiwan's exchange rate, the return rate of the Korea's exchange rate, and the return rate of the Japan's exchange rate do not have co-integration of their relations. Therefore, we are not considered the model of error correction in this paper. In Table 4, these three exchange rate markets can really affect one another. Therefore, we go a step further to understand the interactions of the three exchange rate markets.

Table 3. Johansen co-integration test (VAR lag=1)

Null H_0	$\lambda_{\max}$	Critical value
None	12.3294	23.78
At most 1	5.9860	16.87
At most 2	1.1578	3.74

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

Table 4. Unconditional correlation matrix

Coefficient	RTER	RKER	RJER
RTER	1	0.3672	0.1598
RKER	0.3672	1	0.2035
RJER	0.1598	0.2035	1

2.3 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 these two markets have the conditionally heteroskedasticity phenomenon exists. This result suggests that we can use the GARCH model to match and analyze it. The detail is omitted here.

Table 5. ARCH effect test

RTER	Engle LM test	Tsay F test
Statistics	432.653***	14.758***
(p-value)	(0.0000)	(0.0000)
RKER	Engle LM test	Tsay F test
Statistics	469.250***	11.695***
(p-value)	(0.0000)	(0.0000)

Note：*** denotes significance at level α =1%.

3. Asymmetric test of the bivariate ARCH model with a DCC

The bivariate IGARCH(1, 1) model with a DCC can be constructed in the next section. The asymmetric test methods (Engle and Ng, 1993) are used the following two methods as: negative size bias test and joint test.

Table 6 asymmetrically examines the result for the Taiwan's exchange rate market as: (1) The positive size bias test does not reveal (α =10%). (2) The joint test does not reveal (α =10%). Table 6 asymmetrically examines the result for the Korea's exchange rate market as: (1) The positive size bias test does not reveal (α =10%). (2) The joint test does not reveal (α =10%). The results of asymmetric test suggest that the proposed model does not need to use the asymmetric GARCH model.

Table 6. Asymmetric test of the bivariate IGARCH

	Asymmetric test	Positive size bias test	Joint test
RTER	F statistic	0.4721	0.8589
	(p-value)	(0.4921)	(0.4618)
	Asymmetric test	Positive size bias test	Joint test
RKER	F statistic	0.9101	0.7235
	(p-value)	(0.3402)	(0.5379)

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

4. Proposed model

A dynamic conditional correlation (DCC) and the bivariate GARCH(1, 1) model with a factor of Japan' exchange rate return is proposed in this section, its model may be expressed as

$$RTER_t = \phi_{10} + \phi_{11} RTER_{t-1} + \phi_{21} RKER_{t-1} + \phi_{31} RJER_{t-1} + a_{1,t} \quad (1)$$

$$RKER_t = \varphi_{10} + \varphi_{11} RKER_{t-1} + \varphi_{21} RTER_{t-1} + \varphi_{31} RJER_{t-1} + a_{2,t} \quad (2)$$

$$\vec{a}_t^{'} = (a_{1,t}, a_{2,t}) \sim T_v(\vec{0}, (v-2)H_t / v) \quad (3)$$

$$h_{11,t} = \alpha_{10} + \alpha_{11} a_{1,t-1}^2 + \beta_{11} h_{11,t-1} + \eta_1 RJER_{t-1}^2 \quad (4)$$

$$h_{22,t} = \alpha_{20} + \alpha_{21} a_{2,t-1}^2 + \beta_{21} h_{22,t-1} + \eta_2 RJER_{t-1}^2 \quad (5)$$

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

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

$$h_{12,t} = \rho_t \sqrt{h_{11,t}} \sqrt{h_{22,t}} \quad (7)$$

Where $T_v(\vec{0}, (v-2)H_t / v)$ denotes the bivariate Student's t distribution, its mean is equal to 0 and its covariance matrix is equal to $(v-2)H_t / v$, and v is the degree of freedom. The DCC and the bivariate GARCH model can also refer to the papers of Engle (2002) and Tse and Tsui (2001).

5. Empirical results

Table 7 shows the estimate results for the Taiwan's exchange rate return rate and Korea's exchange rate return rate by the DCC and the bivariate IGARCH(1, 1) model. we know that the estimated value of its coefficient whether remarkable, examines each coefficient significance by the P-value. In selects in sample period, the Taiwan's exchange rate return receives the previous one periods' impact of the Taiwan's exchange rate return (ϕ_{11} =-0.0745), the Taiwan's exchange rate return receives the previous one periods' impact of the Korea's exchange rate return (ϕ_{21} =0.0150), and it also receives the previous one periods' impact of the Japan's exchange rate return (ϕ_{31} =0.0397); The Korea's exchange rate return receives the previous one periods' impact of the Korea's exchange rate return (φ_{11} =-0.1197), and it also receives the previous one periods' impact of the Taiwan's exchange rate return(φ_{21} =0.1307). The Korea's exchange rate return also receives the previous one periods' impact of the Japan's exchange rate return (φ_{31} =0.0821). On the other hand, the average estimation value ($\hat{\bar{\rho}}_t$ =0.4073) of the DCC coefficient of the Taiwan's exchange rate return and the Korea's exchange rate return volatility is significant, and shows the Korea's exchange rate return the volatility is a positive influence on Taiwan's exchange rate return volatility. The synchronized mutual influence, when variation of risk of the Korea's exchange rate return increases, enables the money market investor to see risk of the Taiwan's exchange rate return also increase; likewise, when variation of risk of the Korea's exchange rate return reduces, the investor sees the risk of the Taiwan's exchange rate return reduce as well. In addition, estimated value of the degree of freedom for the Student's t distribution is 3.4688, under the significance level α =1%. This is remarkable, and shows this research material has the thick tail distribution.

Moreover, Taiwan's exchange rate return conditional variance and the Korea's exchange rate return conditional variance all can affect the Taiwan's and Korea's exchange rate return volatility. Also models seen in Table 6 that, in the conditional variance equation, we have $\alpha_{11} + \beta_{11} + \eta_1 = 1$ and $\alpha_{21} + \beta_{21} + \eta_2 = 1$ with both equals to 1, conforms to parameter of the IGARCH model condition supposition. And the Japan's exchange rate return's volatility (η_1 =0.0024) will also affect the variation risk of the Taiwan's exchange rate market, but the Japan's exchange rate return's volatility will not affect the variation risk of the Korea's exchange rate market. This also demonstrates the bivariate IGARCH(1, 1) model with a DCC may catch between the Taiwan's exchange rate return and the Korea's exchange rate return volatility process.

Table 7. Parameter estimation of the DCC and the bivariate IGARCH(1, 2) model

Parameter	ϕ_{10}	ϕ_{11}	ϕ_{21}
Coefficient	-0.0007	-0.0745	0.0150
(p-value)	(0.8224)	(0.0003)	(0.0343)
Parameter	ϕ_{31}	φ_{10}	φ_{11}
Coefficient	0.0397	-0.0230	-0.1197
(p-value)	(0.0000)	(0.0006)	(0.0000)
Parameter	φ_{21}	φ_{31}	
Coefficient	0.1307	0.0821	
(p-value)	(0.0000)	(0.0000)	
Parameter	α_{10}	α_{11}	β_{11}
Coefficient	0.0030	0.3115	0.6861
(p-value)	(0.0000)	(0.0000)	(0.0000)
Parameter	η_1	α_{20}	α_{21}
Coefficient	0.0024	0.0153	0.2628
(p-value)	(0.0661)	(0.0000)	(0.0000)
Parameter	β_{21}	η_2	v
Coefficient	0.7328	0.0044	3.4688
(p-value)	(0.0000)	(0.4632)	(0.0000)
Parameter	γ_0	γ_1	γ_2
Coefficient	-1.9415	3.7642	0.0739
(p-value)	(0.0000)	(0.0000)	(0.0061)
Parameter	$\bar{\rho}_t$	min ρ_t	max ρ_t
Coefficient	0.4073	0.2539	0.7840
(p-value)	(0.0000)		

Note: p-value< α denotes significance.
(α =1%, α =5%, α =10%); α is the significance level.
min ρ_t denotes the minimum value of ρ_t and
max ρ_t denotes the maximum value of ρ_t .

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

6. Conclusions

The empirical diagnosis result shows that regarding Taiwan's and Korea's exchange rate return volatility, the reciprocity may construct in the bivariate Student's t distribution and the bivariate IGARCH(1, 1) model with a DCC; this model also passes through a standard residual error relevance and ARCH effect examination showing the use of bivariate IGARCH(1, 1) model with a DCC, which evaluates two exchange rate markets' return the volatility processes is appropriate. The empirical diagnosis result also shows that the average estimation value ($\hat{\bar{\rho}}_t$ =0.4073) of the DCC coefficient of two exchange rate markets' return is the positive relation- the Korea's exchange rate return volatility is affecting the Taiwan's exchange rate return, also the Taiwan's exchange rate return volatility is affecting the Korea's exchange rate return, bringing forth a synchronization. The empirical result also shows that Taiwan's and Korea's exchange rate market return volatility receives the impact of the Japan's exchange rate return volatility. The empirical results present that the volatility process do not have asymmetrical in the Taiwan's and Korea's exchange rate markets. The empirical results also show that the Taiwan exchange rate return rate's volatility rate truly has an affect on the Korea's exchange rate market return rate's volatility. And the Japan's exchange rate return's volatility will also affect the variation risk of the Taiwan's exchange rate market, but the Japan's exchange rate return's volatility will not affect the variation risk of the Korea's exchange rate market. However, the proposed model is different from the model of the bivariate GARCH with a constant conditional correlation (CCC). Based on the paper of (Engle, 2002), the DCC and the bivariate GARCH model have a better explanatory ability compared to the traditional bivariate GARCH model with a CCC.

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