高低油價期間之門檻模型在兩股票市場報酬:上海與深圳股票市場之實證研究

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摘要

本文探討上海與深圳股票市場之模型建構與其關聯性，同時本文使用高低油價期間之波動當作門檻。 研究資料期間為 2000 年 1 月至 2004 年 7 月與 2005 年 6 月至 2008 年 10 月，且本文也採用學生 t 分配來分析所提之模型。 實證研究結果顯示這兩股票市場是相互影響，且用動態條件相關與雙變量非對稱 IGARCH(1，2)模型來評估這兩股票市場的關聯性是適當的。實證研究結果也顯示上海與深圳股票市場之間是呈現正相關，其動態條件相關係數之平均值為 0.9642，此也顯示上海與深圳股票市場報酬波動之間是具同步的影響。此外，實證研究結果也顯示上海與深圳股票市場具有不對稱效果。實證研究結果也顯示上海與深圳股票市場報酬將會受到油價期間波動的影響，高油價期間之固定的變異風險是高於低油價期間之固定的變異風險。

關鍵字: 股票市場報酬, 油價, 學生 t 分配, GARCH 模型, 非對稱效果, GJR-GARCH 模型, 雙變量非對稱 IGARCH 模型。.

Threshold Model of High and Low Oil Price Periods for Two Stock Market Returns: Empirical Study of Shanghai and Shenzhen's Stock Markets

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Abstract

This paper discusses the model construction and the association between the Shanghai's and the Shenzhen's stock markets. Simultaneously, this paper uses the high and the low oil price periods' volatility as a threshold for the Shanghai's and the Shenzhen's stock market returns. The study data period is from January, 2000 to July, 2004 and June, 2005 to October, 2008. This paper also utilizes Student's t distribution to analyze the proposed model. The results of this empirical study reveals that the two stock markets mutually affected each other, and the dynamic conditional correlation (DCC) and the bivariate asymmetric-IGARCH (1, 2) model is appropriate in evaluating the relation between them. The empirical result also indicates that the Shanghai and the Shenzhen's stock market is a positive relation. The average of the dynamic conditional correlation coefficient equals to 0.9642, which implies that the two stock markets return volatility has a synchronized influence on each other. In addition to the results implied that there is an asymmetrical effect between the Shanghai's and the Shenzhen's stock markets. The empirical result also shows that the Shanghai's and the Shenzhen's stock market returns will receive the influence of the oil price period's volatility. The fix variation risk of the high oil price periods is higher the fix variation risk of the low oil price periods.

Keywords: Stock market returns, oil price, Student's t distribution, GARCH model, asymmetric effect, GJR-GARCH model, bivariate asymmetric-IGARCH model.

1. Introduction

In recent years, under the influence of internationalization and the liberalization, the international investment, the circulation of capital and the connection between stock market in different countries have increased. We know that Shanghai is a financial center in the global economical financial system and also has been very influential in the global economy. Currently Shanghai and Shenzhen are very important economic and trade area of Mainland China. 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 Shanghai stock market change. There is a close relationship for Shenzhen based on the trade and the circulation of capital with the Shanghai. Therefore, the relation between the Shanghai's stock market and the Shenzhen's stock market is worth further discussion.

Petroleum (oil) is an important energy which in one's daily life is the crucial essential factor of economical development, and its price also affects economic growth and stock markets. Asia is the fastest growing area in the world now. Its petroleum supply quantity only occupies 1/10 of the whole world but its consumption actually occupies more than twice what it delivers. Ever since the events of 911 in the U.S. and the Second Persian Gulf War starting in 2003, the Asian and Pacific area has gone through its own. Mid-east turmoil as the oil crisis has been elevated quite suddenly, as evidenced by a barrel of oil rising to US$74.62 by May 2, 2006. The issue now becomes on whether petroleum prices facing such significant events will in fact impact stock markets' rise and fall. For related oil price research on the influence upon stock markets, one may refer to the papers of , for examples, Hammoudeh, Dibooglu and Aleisa (2004), Hammoudeh, Li and Jeon (2003) and Jones and Kaul (1996). Therefore, the influence factor of the oil prices volatility is considered on the markets of U.S. and Canada.

With the existence of many return volatility methods, researchers commonly used (e.g. autoregressive moving average (ARMA) model) to investigate the relations between two stock markets. Engle (1982) proposes the autoregressive conditionally heteroskedasticity (ARCH) model and Bollerslev (1986) proposes the generalized autoregressive conditionally heteroskedasticity (GARCH) model. According to them, this kind of model is comparatively better at catching the financial property while the conditional variance is not the fixed characteristic. Nelson (1990) looks at stock price changes and discovers that those have both positive and negative relationships with the future stock price volatility. The GARCH model supposes that the settled time conditional variance is function of conditional variance and an error term square term's time lags. Therefore, error term's positive and negative values do not respond to its influence on the conditional variance equation. The conditional variance only can change along with the error term's value, but cannot go along with the error term's positive and negative changes. To improve this flaw, Nelson (1991) presents an exponential GARCH model and Glosten, Jaganathan and Runkle (1993) give a threshold GARCH model. These model are so-called the models of asymmetric GARCH. Their model is adopted by many scholars, while researching on the issue of asymmetric problems such as 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). Research on the relation between stock market and the return volatility method, using multivariate GARCH model, has been growing like mushroom. For examples, Yang (2005), Yang and Doong (2004), Granger, Hung and Yang (2002), Wang and Barrett (2002), and Bollerslev (1990) have applied various bivariate GARCH models analyzing stock market price.

The purpose of the present paper is to examine the relations of the Shanghai and the Shenzhen's stock markets, using the DCC and the bivariate asymmetric GARCH model in constructing the connection of the two stock markets. Based on the idea of Liu, Zhao and Wang (2010), this paper also further discusses the affect of the high and the low oil price periods' volatility for the Shanghai and the Shenzhen's stock market returns. In other words, in this paper is using the low and high values of oil price periods' volatility are as the threshold. The organization of this paper is as follows: Section 2 descibes the series character of the Shanghai's and the Shenzhen's stock prices and its returns volatility; Section 3 introduces the model of the DCC and the bivariate GARCH; Section 4 presents the asymmetric test of the DCC and the bivariate-IGARCH model; Section 5 presents the model of the DCC and the bivariate asymmetric-GARCH and its parameters' estimation, and the analysis between associated of the Shanghai's and the Shenzhen's stock returns; and finally Section 6 summarizes the conclusions of this study.

2. Data characteristics

2.1 Data sources

The data of this research included the WTI oil price, the Shanghai and the Shenzhen's stock price collected between from January, 2000 to July, 2004 and from June, 2005 to October, 2008. The source of the stock data was the Taiwan economic Journal (TEJ), a database in Taiwan. The source of the WTI oil price data was the international Energy Information Administration (EIA), a database in U.S. The Shanghai stock price refers to the Shanghai Synthesis stock index, the Shenzhen's stock price refers to Shenzhen Synthesis stock index. During the process of data analysis, in case that there was no stock market price available on the side of the Shanghai's stock market or on the side of the Shenzhen's stock market due to holidays, the identical time stock price data from one side was deleted. After this, the three variables samples are 1,928.

2.2 Returns calculation and trend charts

To compute the return of the Shanghai's stock market adopts the natural logarithm difference, rides 100 again. The return of the Shenzhen's stock market also adopts the natural logarithm difference, rides 100 again. Figure 1 is the trend charts of the Shanghai's stock price index (SHAN1) and the Shenzhen's stock price index (SHEN1), and the trend charts of the Shanghai's stock price index return (RSHAN1) and the Shenzhen's stock price index return (RSHEN1) in the sample study period from January, 2000 to July, 2004. Figure 2 is the trend charts of the Shanghai's stock price index (SHAN2) and the Shenzhen's stock price index

(SHEN2), and the trend charts of the Shanghai's stock price index return (RSHAN2) and the Shenzhen's stock price index return (RSHEN2) in the sample study period from June, 2005 to October, 2008.

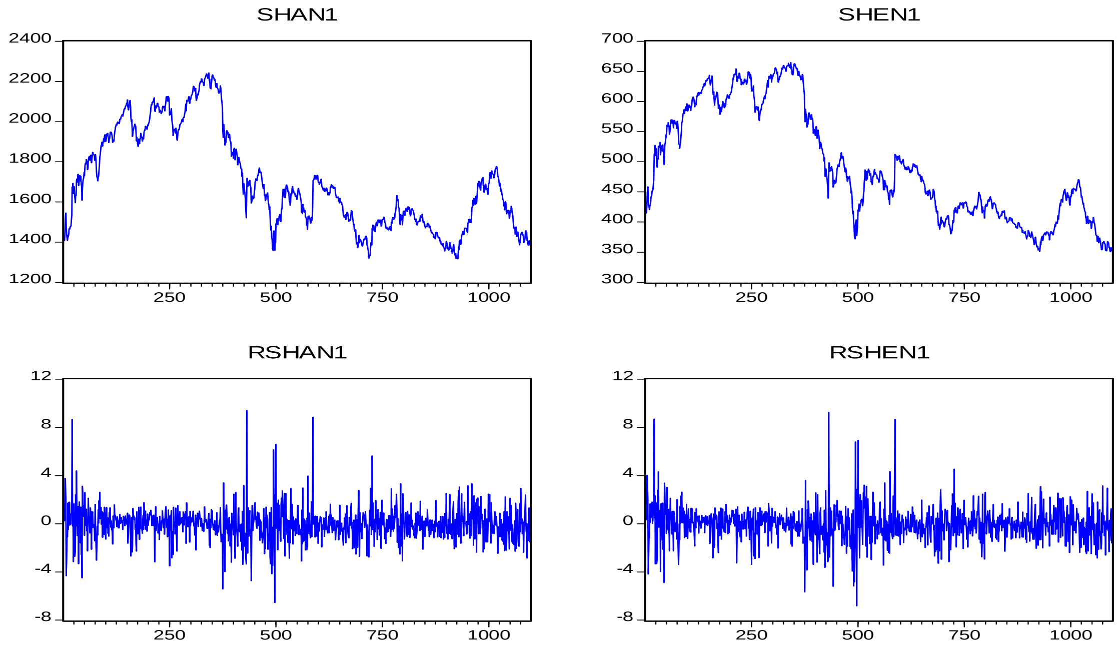

Figure 1. Trend charts of the Shanghai's stock price index and the Shenzhen's stock price index, and trend charts of the Shanghai's stock price index return and the Shenzhen's stock price index return in the sample study period is from January, 2000 to July, 2004. .

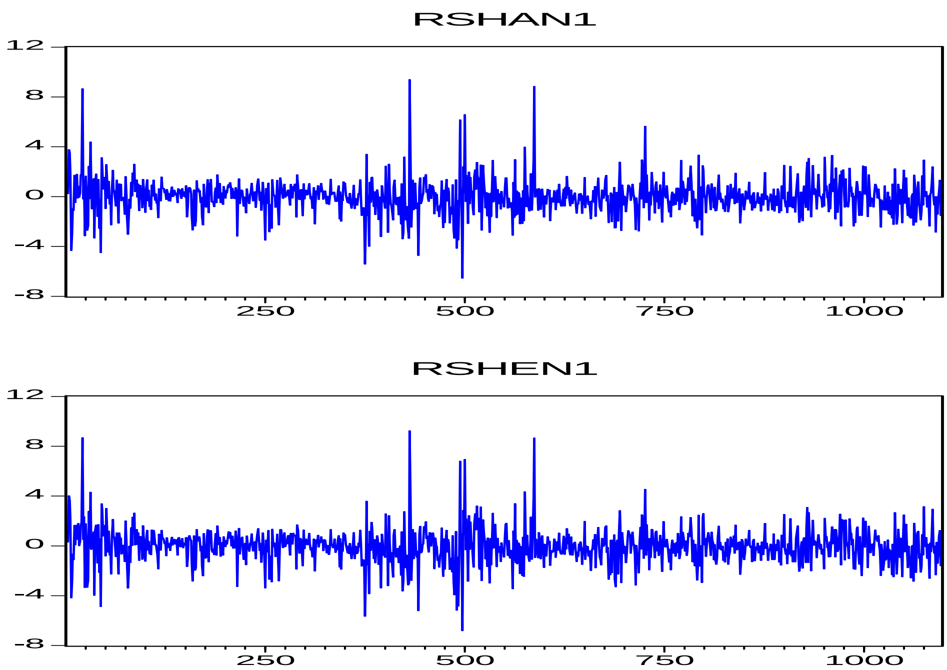

Figure 1. Trend charts of the Shanghai's stock price index return and the Shenzhen's stock price index return in the sample study period is from January, 2000 to July, 2004. .

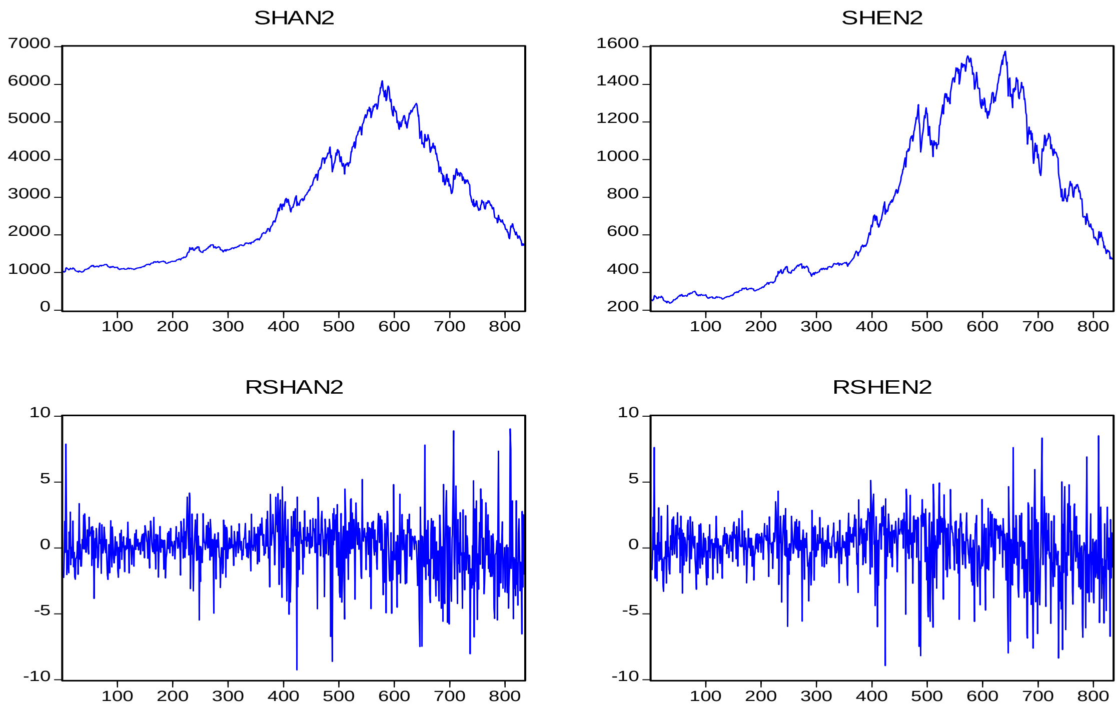

Figure 2. Trend charts of the Shanghai's stock price index and the Shenzhen's stock price index, and trend charts of the Shanghai's stock price index return and the Shenzhen's stock price index return in the sample study period is from June, 2005 to October, 2008.

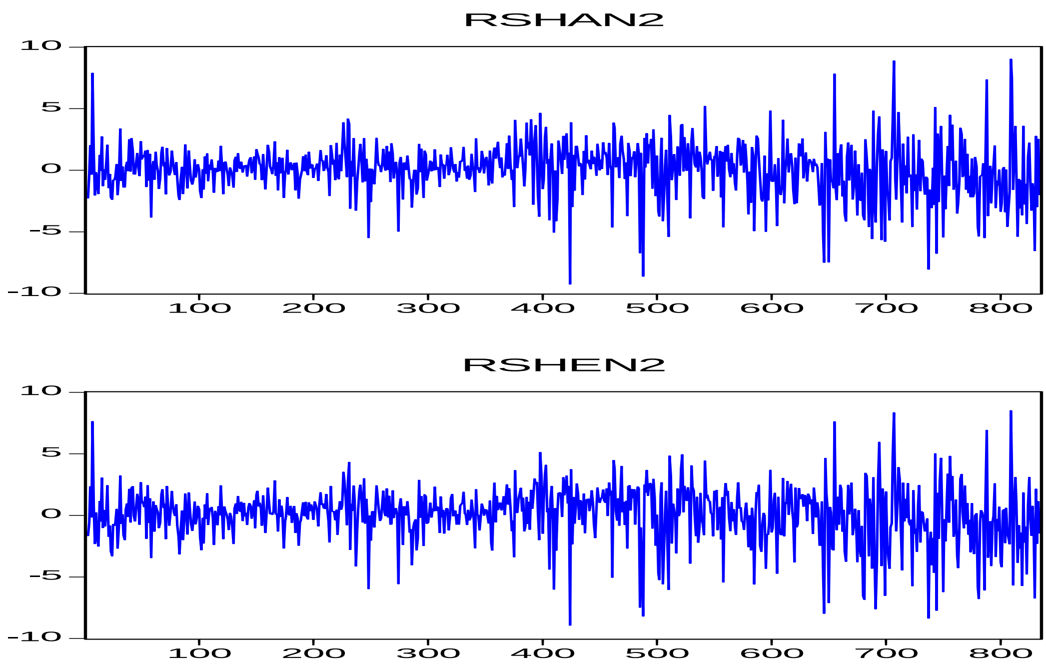

Figure 2. Trend charts of the Singapore's stock price index return and the Hong Kong's stock price index return in the sample study period is from June, 2005 to October, 2008.

As can been seen in figure 1-2, in the selected sample period, the Shanghai's stock price index and the Shenzhen's stock price index obviously show the same direction of the trend. When the fluctuation of the Shanghai's stock price index grew bigger, the Shenzhen's market return volatility degree also became bigger. In addition, the clustering of the Shanghai's and the Shenzhen's stock price return volatility showed the same pattern in Figure 1-2. It seems that the two stock markets have a certain level of relevance. In other words, the two stock prices markets seemed to be interdependent. This is also the main motive for discussing the relationships of the Shanghai's and the Shenzhen's stock price returns.

2.3 Basic statistics

Table 1.1-2 presents the basic statistics of the analysis including the mean values, standard deviations, skewed coefficients, kurtosis coefficients, and the Jarque-Bera normal distribution test for the sampled period of the oil price volatility, the Shanghai's and the Shenzhen's stock market returns. The kurtosis coefficients were worth mentioning. The two sequences kurtosis coefficients are both bigger than 3, which this result implies that the normal distribution test of Jarque-Bera is not normal distribution. Although the violation of normal distribution is not uncommon for financial commodity variable, it is more appropriate to carry out the analysis, using the heavy tail distribution and the GARCH model. Also the result from ADF and KSS unit root tests indicated the two stock markets return variables were in a stable sequence. The stable characteristic analyzes the essential condition of the GARCH model.

Table 1.1 Data statistics (The sample period is from January, 2000 to July, 2004.)

Statistics	SHAN1	RSHAN1	SHEN1	RSHEN1	OP1
Mean	1701.952	-0.001320	493.0090	-0.015003	29.53980
S-D	244.3116	1.353250	92.11220	1.411071	4.794574
Skewed	0.536878	0.730787	0.401892	0.524577	0.116979
Kurtosis	2.124197	9.883051	1.811390	9.046763	3.217708
J-B N	87.5992	2256.949	93.9357	1716.854	4.8683
(p-value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0877)
sample	1095	1094	1095	1094	1144

Notes: (1) J-B N is the normal distribution test of Jarque-Bera.(2) S-D is denoted the standard deviation (3)p-value < α denote significance (α =1%, α =5%, α =10%).

Table 1.2 Data statistics (The sample period is from June, 2005 to October, 2008.)

Statistics	SHAN2	RSHAN2	SHEN2	RSHEN2	OP2
Mean	2692.629	0.061176	727.9724	0.073251	77.70904
S-D	1444.743	2.111649	421.6408	2.232699	22.21533
Skewed	0.609324	-0.375066	0.501265	-0.654188	1.234942
Kurtosis	2.109794	5.600965	1.777870	5.172964	3.504091

J-B N	79.0506	254.0275	86.7246	223.0322	227.9653
(p-value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
sample	833	832	833	832	861

Notes: (1) J-B N is the normal distribution test of Jarque-Bera.(2) S-D is denoted the standard deviation (3)p-value < α denote significance (α =1%, α =5%, α =10%).

Table 2. The nonparametric test of the low and the high oil price periods:

H_0 : the median of OP1= the median of OP2

H_1 : the median of OP1 $\neq$ the median of OP2

Test methods	Statistics	P-value
Wilcoxon Rank Sum test	654940.000	0.000
Wilcoxon Z test	-38.683	0.000
Kolmogorov-Smirnov Z test	22.164	0.000

2.4 Unit root test

Furthermore, this study uses ADF (Augmented Dickey and Fuller, 1979 and 1981) and KSS (Kapetanios et al., 2003) the unit root when examining the Shanghai's stock price index and the Shenzhen's stock price index and deciding whether the unit root characteristic, used to examine the time series data has stability, not as for appears the false return (spurious regression). As shown in Table 3, the first order difference after the time series data was analyzed at the significance level of 0.01(α =1%). The material the researchers used were in a stable condition. This is, the stock returns of the Shanghai and the Shenzhen are the stationary sequences. The volatility of the oil price is also the stationary sequence.

Table 3. Unit root tests of ADF and KSS for the return data

ADF	RSHAN1	RSHEN1	RSHAN2	RSHEN2
Statistic	-32.0492^{***}	-31.5243^{***}	-6.4102^{***}	-7.6096^{***}
Critical value	-3.9665	-3.4139	-3.1291	
(Significant level)	(α =1%)	(α =5%)	(α =10%)	
KSS	**RSHAN1**	**RSHEN1**	**RSHAN2**	**RSHEN2**
Statistic	-14.1153^{***}	-14.5345^{***}	-18.2305^{***}	-18.5323^{***}
Critical value	-2.820	-2.220	-2.820	
(Significant level)	(α =1%)	(α =5%)	(α =10%)	

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

2.5 Co-integration test

Using Johansen's (1991) co-integration test as illustrated in Table 4.1-2 at the significance level of 0.05(α =5%) does not reveal of $\lambda_{\max}$ and Trace statistics. This indicated that the Shanghai's stock market and the Shenzhen's stock market do not have a co-integration relation. Although the two markets do not seem to have a long-term co-integration relation, but the three markets may mutually affect. Therefore, it is necessary to further understand the gearing relation between the two markets. And the oil prices can also produce the impact on the Shanghai's and the Shenzhen's stock markets.

Table 4.1 Johansen co-integration test with the low oil price periods (The lag of VAR is 8).

H_0	$\lambda_{\max}$	Critical value ($\alpha = 5\%$)	Trace	Critical value ($\alpha = 5\%$)
None	7.1433	14.2646	7.3686	15.4947
At most 1	0.2254	3.8415	0.2254	3.8415

Notes：(1)The lags of VAR is selected by the AIC rule (Akaike, 1973).

(2) The sample period is from January, 2000 to July, 2004.

Table 4.2 Johansen co-integration test with the low oil price periods (The lag of VAR is 5).

H_0	$\lambda_{\max}$	Critical value ($\alpha = 5\%$)	Trace	Critical value ($\alpha = 5\%$)
None	8.1476	14.2646	9.4950	15.4947
At most 1	1.3473	3.8415	1.3473	3.8415

Notes：(1) The lags of VAR is selected by the AIC rule (Akaike, 1973).

(2) The sample period is from June, 2005 to October, 2008.

2.6 ARCH effect test

Further examination, using the ARCH effect test, was conducted to determine whether the stock return volatility whether has the conditionally heteroskedasticity. This research used the Ljung-Box (1978) test method, the Lagrange Multiplier (LM) test method proposed by Engle (1982) and the F distribution test method proposed by Tsay (2004). These methods were used to further confirm residual error sequence variance and decide whether there was the ARCH effect. In case of the presence of the ARCH effect, the GARCH model would be used to match suitably. The ARCH effect test uses the past q time lags of the residual error square to carry out the regression analysis. The ARCH effect test is based on the AR(2) model in Table 6 as below. Its mathematics form is follows:

$$\hat{a}_t^2 = d_0 + d_1\hat{a}_{t-1}^2 + \cdots + d_q\hat{a}_{t-q}^2 + v_t , \tag{1}$$

We test the null hypotheses $H_0 : d_1 = d_2 = \cdots = d_q = 0$ by (1) as illustrated above. When H_0 is rejected, it implies that there is no effect of ARCH- that is, we can use the model of the GARCH to fit it.

LM, F and Ljung-Box (L-B) test methods were employed to examine the stock price date return and examine whether there was the conditionally heteroskedasticity phenomenon. The examination result of the ARCH effect test is listed in Table 5.1-2. As illustrated in these two tables, the Shanghai's and the Shenzhen's stock price return analysis model revealed that the series at the level of 0.05(α =5%) has the conditionally heteroskedasticity phenomenon. This suggested that matches suitably analysis model may use the GARCH model.

Table 5.1 ARCH effect test (lag=30)

RSHAN1. Lag=10	Engle LM test	Tsay F test	L-B test $LB^2(2)$	L-B test $LB^2(3)$
Statistic	58.5380	2.0048	2.1401	3.4217
(p-value)	(0.0014)	(0.0011)	(0.0326)	(0.0006)
RSHEN1 Lag=3	Engle LM test	Tsay F test	L-B test $LB^2(2)$	L-B test $LB^2(3)$
Statistic	95.6780	3.4027	3.6707	4.0175
(p-value)	(0.0000)	(0.0000)	(0.0003)	(0.0001)

Notes：p-value < α denote significance (α =1%, α =5%, α =10%).

Table 5.2 ARCH effect test (lag=30)

RSHAN2. Lag=10	Engle LM test	Tsay F test	L-B test $LB^2(1)$	L-B test $LB^2(21)$
Statistic	74.1574	2.6189	2.2554	2.3103
(p-value)	(0.0000)	(0.0000)	(0.0244)	(0.0211)
RSHEN2 Lag=10	Engle LM test	Tsay F test	L-B test $LB^2(1)$	L-B test $LB^2(8)$
Statistic	89.5727	3.2319	3.2177	2.9885
(p-value)	(0.0000)	(0.0000)	(0.0013)	(0.0029)

Notes：p-value < α denote significance (α =1%, α =5%, α =10%).

3. GJR-GARCH and bivariate GARCH models

If only single variable GARCH model analysis is conducted, then the stock return volatility is only allowed to change as necessary. In case like this, it is easy to neglect the Shanghai's and the Shenzhen's stock price return volatility variance structure. It is likely to create the estimate not to have the efficiency and the deduction harms. Two stocks returns volatility conditional variance both favors changes as necessary. The bivariate GARCH model simultaneously considered two stock markets volatility on the time dependence. Therefore this paper uses the bivariate GARCH model to discuss the impact the Shanghai's stock market return volatility has on the Shenzhen's stock market return and the relation between the two stock price markets. Simultaneously, this paper also further studies the affect of the oil prices' volatility for the Shanghai's and the Shenzhen's stock market returns

3.1 Introduction of GJR-GARCH model

Glosten, Jaganathan and Runkle (1993) also propose the GJR-GARCH model. This model has the difference influence of the good and bad news on the material volatility. The general form of GJR-GARCH model may be established as follows:

$$h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i a_{t-i}^2 + \eta D_{t-1} a_{t-1}^2 + \sum_{j=1}^{p} \beta_j h_{t-j} \quad , \tag{2}$$

where $$D_t = \begin{cases} 0 \ , & if \ \ a_t > 0 \\ 1 & if \ \ a_t \leq 0 \end{cases} \ , \tag{3}$$

with a_t is white noise, and a_t >0 denote good news, $a_t \leq 0$ denote bad news.

Regarding the GJR-GARCH model, under the good news and bad news, the influences of the condition error square item are dissimilar. As an example with q=1. When appears the good news, the error square items' volatility coefficient is α_1; when appears the bad news, the error square items' volatility coefficient is $\alpha_1 + \eta$. When $\eta = 0$, the impact response of the condition error square item is symmetrical. When $\eta \neq 0$, the impact response of the condition error square item is asymmetrical, at this time, the effect is called the asymmetric effect.

3.2 DCC and Bivariate GARCH model

From the inspectation of the results from the above- mentioned tables, it is known that the Shanghai's and the Shenzhen's stock return both have the conditionally heteroskedasticity, Lepokurtic and the stationary sequence statistical characteristic. Therefore, it is suggested that the bivariate GARCH model be used to analyze the relations between the Shanghai's and the Shenzhen's stock market returns. In this paper, the DCC and bivariate GARCH model proposed by Engle (2002) and Tse and Tusi (2002) are used to analyze the connection between the Shanghai's and the Shenzhen's stock price returns. From the result of the normal distribution test of Jarque-Bera shows that the study data is not a normal distribution. In additional to the kurtosis coefficients are bigger than 3, we should use distribution of the heavy tails and it is comparatively suitable. Therefore, this paper is uses the Student's t distribution of heavy tails, and uses the maximum likelihood algorithm method of BHHH (Berndt et. al., 1974) to estimate the unknown parameters. The bivariate GARCH model may be constructed in the formula of (4)-(11). This model is used as a baseline to discuss the Shenzhen's stock price return volatility and its impact on the Shanghai's stock price return. The bivariate GARCH model does have two conditional mean equations of stock return; and the explanation variables include two conditional variance equations, used altogether to estimate the influence of the Shanghai's stock return on the Shenzhen's stock return. In this paper will not further consider the influence of the oil price periods' volatility for the Shanghai and the Shenzhen's stock market returns.

$$RSHAN_t = \phi_0 + \sum_{j=1}^{n} \phi_{1j} RSHAN_{t-j} + \sum_{j=1}^{n} \phi_{2j} RSHEN_{t-j} + a_{1,t}\,, \tag{4}$$

$$RSHEN_t = \varphi_0 + \sum_{j=1}^{n} \varphi_{1j} RSHAN_{t-j} + \sum_{j=1}^{n} \varphi_{2j} RSHEN_{t-j} + a_{2,t}\,, \tag{5}$$

$$h_{11,t} = \alpha_{10} + \alpha_{11} a_{1,t-1}^2 + \alpha_{12} a_{1,t-2}^2 + \beta_{11} h_{11,t-1}\,, \tag{6}$$

$$h_{22,t} = \alpha_{20} + \alpha_{21} a_{2,t-1}^2 + \alpha_{22} a_{2,t-2}^2 + \beta_{21} h_{22,t-1}\,, \tag{7}$$

$$h_{12,t} = \rho_t \sqrt{h_{11,t}} \sqrt{h_{22,t}}\,, \tag{8}$$

$$\rho_t = \exp(q_t)/(\exp(q_t)+1)\,, \tag{9}$$

$$q_t = \gamma_0 + \gamma_1 \rho_{t-1} + \gamma_2 a_{1,t-1} a_{2,t-1} / \sqrt{h_{11,t-1} h_{22,t-1}}\,, \tag{10}$$

$\vec{a}_t' = (a_{1,t}, a_{2,t})$ is obey the bivariate Student's t distribution, this is, $T_v(\vec{0}, (v-2)H_t / v)$, among

$\vec{0}' = (0,0)$ and

$H_t = \begin{bmatrix} h_{11,t} & h_{12,t} \\ h_{21,t} & h_{22,t} \end{bmatrix}$, $h_{12,t} = h_{21,t}$, and v is the degree of freedom of Student's t distribution.

The probability density function of $\vec{a}_t$ is

$$f(a_{1,t}, a_{2,t} \mid H_t) = \frac{\Gamma((v+2)/2)}{((v-2)\pi)\Gamma(v/2)\left|H_t\right|^{1/2}} [1 + \frac{1}{v-2} \vec{a}_t' H_t^{-1} \vec{a}_t]^{-(v+2)/2}$$

$$= \frac{\Gamma((v+2)/2)}{((v-2)\pi)\Gamma(v/2)\sqrt{h_{11,t} h_{22,t} (1-\rho^2)}}$$

$$[1 + \frac{1}{(v-2)(1-\rho^2)} \{(\frac{a_{1,t}}{\sqrt{h_{11,t}}})^2 + (\frac{a_{2,t}}{\sqrt{h_{22,t}}})^2 - 2\rho(\frac{a_{1,t}}{\sqrt{h_{11,t}}})(\frac{a_{2,t}}{\sqrt{h_{22,t}}})\}]^{-(v+2)/2} \tag{11}$$

where ρ_t is the dynamic conditional correlation coefficient of $a_{1,t}$ and $a_{2,t}$. In additional, $\Gamma(\bullet)$ is the Gamma function and H_t^{-1} is the inverse matrix of H_t.

4. DCC and Bivariate Asymmetric-IGARCH Model and Model Checking

4.1 DCC and Bivariate asymmetric-IGARCH model and parameter estimation

Based on the results of the nonparametric test in Table 2, the oil prices of OP1 and the oil prices of OP2 are belong to two different oil price periods. The period of $2000.01 \sim 2004.07$ denotes low oil price periods, the period of $2005.06 \sim 2008.10$ denotes high oil price periods. Follows the idea of GJR-GARCH model, using the oil price volatility of the low and high periods is as a threshold. We may use the asymmetric GARCH model to discuss the Shanghai's and the Shenzhen's stock price return volatility process. After model process selection, in this paper, we may use the asymmetric-GARCH (1, 2) model to discuss the volatility model construction of the Shanghai's and the Shenzhen's stock price return, the model is illustrated as follows:

$$\begin{aligned} RSHAN_t &= u_{t-1}(\phi_0 + \sum_{j=1}^{2}\phi_{1j} RSHAN1_{t-j} + \sum_{j=1}^{2}\phi_{2j} RSHEN1_{t-j} + a_{1,t}) + \\ &\quad (1-u_{t-1})(\phi_{20} + \sum_{j=1}^{2}\phi'_{1j} RSHAN2_{t-j} + \sum_{j=1}^{2}\phi'_{2j} RSHEN2_{t-j} + a_{1,t}), \end{aligned} \tag{12}$$

$$\begin{aligned} RSHEN_t &= u_{t-1}(\varphi_0 + \sum_{j=1}^{2}\varphi_{1j} RSHAN1_{t-j} + \sum_{j=1}^{2}\varphi_{2j} RSHEN1_{t-j} + a_{2,t}) + \\ &\quad (1-u_{t-1})(\varphi_{20} + \sum_{j=1}^{2}\varphi'_{1j} RSHAN2_{t-j} + \sum_{j=1}^{2}\varphi'_{2j} RSHEN2_{t-j} + a_{2,t}), \end{aligned} \tag{13}$$

$$\begin{aligned} h_{11,t} &= u_{t-1}(\alpha_{10} + \alpha_{11}a_{1,t-1}^2 + \alpha_{12}a_{1,t-2}^2 + \beta_{11}h_{11,t-1}) + \\ &\quad (1-u_{t-1})(\alpha'_{10} + \alpha'_{11}a_{1,t-1}^2 + \alpha'_{12}a_{1,t-2}^2 + \beta'_{11}h_{11,t-1}), \end{aligned} \tag{14}$$

$$\begin{aligned} h_{22,t} &= w_{t-1}(\alpha_{20} + \alpha_{21}a_{2,t-1}^2 + \alpha_{22}a_{2,t-2}^2 + \beta_{21}h_{22,t-1}) + \\ &\quad (1-w_{t-1})(\alpha'_{20} + \alpha'_{21}a_{2,t-1}^2 + \alpha'_{22}a_{2,t-2}^2 + \beta'_{21}h_{22,t-1}), \end{aligned} \tag{15}$$

$$h_{12,t} = \rho_t \sqrt{h_{11,t}}\sqrt{h_{22,t}}\ , \tag{16}$$

$$\rho_t = \exp(q_t)/(\exp(q_t)+1), \tag{17}$$

$$q_t = \gamma_0 + \gamma_1\rho_{t-1} + \gamma_2 a_{1,t-1}a_{2,t-1}/\sqrt{h_{11,t-1}h_{22,t-1}}\ , \tag{18}$$

$$u_t = \begin{cases} 1\ , & if\ \ 2000.01 \sim 2004.07 \\ 0 & if\ \ 2005.06 \sim 2008.10 \end{cases},\quad w_t = \begin{cases} 1\ , & if\ \ 2000.01 \sim 2004.07 \\ 0 & if\ \ 2005.06 \sim 2008.10 \end{cases}, \tag{19}$$

with $2001.01 \sim 2004.07$ denotes the low oil price periods, $2005.06 \sim 2008.10$ denotes the high oil price periods. The white noise of $\vec{a}'_t = (a_{1,t}, a_{2,t})$ is also obey the bivariate Student's t distribution and its function form is defined as above.

This section uses the DCC and the bivariate asymmetric-GARCH model, namely uses (12)-(19) formula to discuss the Shanghai's and the Shenzhen's stock price return volatilities' relatedness analysis. Parameter estimation first considers a general model, and bases on the estimated results. And then, we delete some not significant explanation variables. Finally, we obtain a simplification model for the Shanghai's and the Shenzhen's stock price return volatilities' relatedness analysis. From the empirical diagnosis result, we know that the Shanghai's and the Shenzhen's stock price return volatility may be constructed on the DCC and bivariate asymmetric-IGARCH (1, 2) model. Its estimate result is stated in Table 6. Based on the estimated results of the DCC and the bivariate asymmetric-IGARCH (1, 2) model in Table 6, we test the estimated value of parameters' coefficient to be significant or not with a P-value.

Under the low oil price periods, the observed mean equation of the estimated coefficient demonstrates that the observation condition's constant term coefficient does not have significant influence under the 10% significance level in Shanghai. When the investor has a long-term view on an investment stock in Shanghai, they are unable to obtain a certain fixed of return. Under the high oil price periods, the observed mean equation of the estimated coefficient demonstrates that the observation condition's constant term coefficient does have significant influence under the 1% significance level in Shanghai. When the investor has a long-term view on an investment stock in Shanghai, they are able to obtain a certain fixed of return. Under the low oil price periods, the Shanghai's stock price return does not receive before 1 period's impact of the Shanghai's stock market return, and the Shanghai's stock price return receives before 2 period's impact of the Shanghai's stock market return (ϕ_{12}=0.2741). And the Shanghai's stock price return does not receive before 1 period's impact of the Shenzhen's stock market return, the Shanghai's stock price return receives before 2 period's impact of the Shenzhen's stock market return (ϕ_{22}=-0.2695). Under the high oil price periods, the Shanghai's stock price return receives before 1 period's impact of the Shanghai's stock market return (ϕ'_{11}=-0.1488). And the Shanghai's stock price return does not receive before 1 period's impact of the Shenzhen's stock market return, the Shanghai's stock price return does not also receive before 2 period's impact of the Shenzhen's stock market return.

Under the low oil price periods, the observed mean equation of the estimated coefficient demonstrates that the observation condition's constant term coefficient does not have significant influence under the 10% significance level in Shenzhen. When the investor has a long-term view on an investment stock in Shenzhen, they are unable to obtain a certain fixed of return. Under the high oil price period, the observation condition's constant term coefficient does have significant influence under the 1% significance level in Shenzhen. When the investor has a long-term view on an investment stock in Shenzhen, they are able to obtain a certain fixed of return. Under the low oil price period, the Shenzhen's stock price return receives before 2 period's impact of the Shanghai's stock market return (φ_{12}=0.2864). The Shenzhen's stock price return receives before 2 period's impact of the Shenzhen's stock market return (φ_{22}=-0.2832). Under the high oil price period, the Shenzhen's stock price return volatility receives before 1 period's influence of the Shanghai's stock market return (φ'_{11}=-0.3061). And the Shenzhen's stock price return volatility receives before 1 period's influence of the Shenzhen's stock market return (φ'_{21}=0.3172).

On the other hand, the correlation coefficient's average estimation value ($\hat{\bar{\rho}}_t$=0.9642) of the Shanghai's and the Shenzhen's stock price return volatility is significant. This result also shows the Shanghai's stock price return's volatility is the positive influence to the Shenzhen's stock price return's volatility, and they are precisely the synchronized mutual influence. When the variation risks of the Shanghai's stock price return increases, the investors' risk of the Shenzhen's stock price return is able to increase. Likewise, when the variation risks of the Shanghai's stock price return reduce, the investors' risk of the Shenzhen's stock price return is also able to reduce. In additional, estimated value of the degree of freedom for the Student's t distribution is 3.3743, and is significant under the significance level of 0.01(α =1%). This also demonstrates that this research data has the heavy tail distribution.

From the Table 6, the estimated coefficients of the conditional variance equation will produce the different variation risks under the low oil price periods and high oil price periods. We have the results of $\alpha_{11} + \alpha_{12} + \beta_{11} = 1$, $\alpha'_{11} + \alpha'_{12} + \beta'_{11} = 1$, $\alpha_{21} + \alpha_{22} + \beta_{21} = 1$ and $\alpha'_{21} + \alpha'_{22} + \beta'_{21} = 1$. This results conforms the condition supposition of the IGARCH model, respectively. This result also demonstrates the DCC and the bivariate asymmetric-IGARCH (1, 2) model may catch the Shanghai's and the Shenzhen's stock price return volatilities' process. But this model also needs further to carry on the diagnostic analysis of the standard residual error, the detail will be provided as below. Under the high oil price period, the Shanghai's stock market has a fixed variation risk (α'_{10}=0.7534), and the Shenzhen's stock market has also the fixed variation risk (α'_{20}=0.6384). Besides, under the high oil price period as a sample, the Shanghai and the Shenzhen stock market returns have the different conditional variation risks (respectively $\beta'_{11} = 0.7366$ and $\beta'_{21} = 0.8069$）. This demonstrates that the low oil price and high oil price periods' volatility will produce the different variation risks of the Shanghai's and the Shenzhen's stock price markets. Therefore, the explanatory ability of the DCC and the bivariate asymmetric-IGARCH (1, 2) model is better than the model of the DCC and the bivariate GARCH (1, 2).

Table 6. Parameter estimation of the DCC and the bivariate asymmetric-IGARCH(1, 2) model

Parameters	ϕ_{10}	ϕ_{11}	ϕ_{12}	ϕ_{21}	ϕ_{22}	ϕ_{20}
Coefficient	-0.0093	0.0175	0.2741	0.0077	-0.2695	0.1371
(p-value)	(0.7105)	(0.8643)	(0.0043)	(0.9376)	(0.0034)	(0.0052)
Parameters	ϕ'_{11}	ϕ'_{12}	ϕ'_{21}	ϕ'_{22}	φ_{10}	φ_{11}
Coefficient	-0.1488	-0.0235	0.1126	0.0285	-0.0162	-0.0548
(p-value)	(0.0778)	(0.7664)	(0.1514)	(0.7025)	(0.5302)	(0.5971)
Parameters	φ_{12}	φ_{21}	φ_{22}	φ_{20}	φ'_{11}	φ'_{12}
Coefficient	0.2864	0.0871	-0.2832	0.2220	-0.3061	-0.0683
(p-value)	(0.0014)	(0.3853)	(0.0016)	(0.0010)	(0.0003)	(0.3960)
Parameters	φ'_{21}	φ'_{22}	α_{10}	α_{11}	α_{12}	β_{11}
Coefficient	0.3172	0.0553	0.0854	0.0255	0.1611	0.8134

(p-value)	(0.0001)	(0.4883)	(0.0002)	(0.4080)	(0.0000)	(0.0000)
Parameters	α'_{10}	α'_{11}	α'_{12}	β'_{11}	α_{20}	α_{21}
Coefficient	0.7534	0.1462	0.1172	0.7366	0.0797	0.0501
(p-value)	(0.0000)	(0.0002)	(0.0157)	(0.0157)	(0.0003)	(0.1582)
Parameters	α_{22}	β_{21}	α'_{20}	α'_{21}	α'_{22}	β'_{21}
Coefficient	0.1191	0.8308	0.6384	0.1908	0.0023	0.8069
(p-value)	(0.0051)	(0.0051)	(0.0000)	(0.0000)	(0.9511)	(0.0000)
Parameters	γ_0	γ_1	γ_2	$\bar{\rho}_t$	v	
Coefficient	13.8308	10.9244	-0.0062	0.9642	3.3743	
(p-value)	(0.5721)	(0.6670)	(0.8202)	(0.0000)	(0.0000)	

Notes：(1) p-value< α denote significance(α =1%， α =5%， α =10%)。

(2) The minimum estimation value of conditional correlation coefficient equals to $\hat{\bar{\rho}}_t$ =0.9482 and the maximum estimation value of conditional correlation coefficient equals to $\hat{\bar{\rho}}_t$ =1.0000.

4.2 Model checking of the Standard residual for the DCC and bivariate asymmetric-IGARCH model

To mend the inappropriateness of the DCC and the bivariate asymmetric-IGARCH model, Ljung-Box test method is used to further examine the standard residual error and a standard residual error square item and see whether there exists still auto-correlation. Table 7 show the Q test of the standard residual error and Q test of the standard residual error square item with a P-value. Clearly, this model does not have the auto-correlation. From Table 8, we can see that the proposed model does not have the ARCH effects of standard residual error square item. Therefore, the DCC and bivariate asymmetric-IGARCH (1, 2) model matches quite suitably and is more appropriate.

Table 7. L-B Q test of standard residual and standard residual square item of the DCC and bivariate asymmetric-IGARCH(1, 2).

Shanghai	$LB(5)$	$LB(10)$	$LB(15)$	$LB(20)$	$LB(25)$	$LB(30)$
Q statistic	10.3681	18.1538	24.8722	27.8973	36.6074	39.1323
(p-value)	(0.0655)	(0.0524)	(0.0517)	(0.1119)	(0.0629)	(0.1228)
L-B test	$LB^2(5)$	$LB^2(10)$	$LB^2(15)$	$LB^2(20)$	$LB^2(25)$	$LB(30)$
Q statistic	0.1012	0.3504	0.4888	0.6431	0.8120	0.9263
(p-value)	(0.9998)	(1.0000)	(1.0000)	(1.0000)	(1.0000)	(1.0000)
Shenzhen	$LB(5)$	$LB(10)$	$LB(15)$	$LB(20)$	$LB(25)$	$LB(30)$
Q statistic	9.2017	17.2971	21.6538	23.3661	31.0683	33.8580
(p-value)	(0.1013)	(0.0680)	(0.1172)	(0.2712)	(0.1868)	(0.2865)
L-B test	$LB^2(5)$	$LB^2(10)$	$LB^2(15)$	$LB^2(20)$	$LB^2(25)$	$LB(30)$
Q statistic	0.0490	0.1509	0.2980	0.3940	0.5518	0.6158

(p-value)	(1.0000)	(1.0000)	(1.0000)	(1.0000)	(1.0000)	(1.0000)

Notes: p-value < α denote significance (α =1%, α =5%, α =10%).

Table 8. ARCH effect (L-B) test of the standard residual of the DCC and bivariate asymmetric-IGARCH(1, 2).

Shanghai	$LB^2(10)$	$LB^2(20)$	$LB^2(30)$	F test	
Q statistic	-0.2210	-0.0956	-0.0871	Statistic	0.0291
(p-value)	(0.8251)	(0.9239)	(0.9306)	(p-value)	(1.0000)
Shenzhen	$LB^2(10)$	$LB^2(20)$	$LB^2(30)$	F test	
Q statistic	-0.1711	-0.1111	-0.0776	Statistic	0.0194
(p-value)	(0.8642)	(0.9116)	(0.9382)	(p-value)	(1.0000)

Notes: p-value < α denote significance (α =1%, α =5%, α =10%).

5. Diagnosis Analysis of the Asymmetry for the Bivariate IGARCH Model with a DCC

Because of the parameter estimation and the standard residual error diagnosis in the above IGARCH(1, 2) model with a DCC, the examination only can see if the model matches up with the suitable quality, but it is actually unable to look up whether the model has an asymmetrical phenomenon. Therefore, Engle and Ng (1993) develop a diagnosis test to examine whether the model has the asymmetrical risk or not. This research will use this diagnosis test to carry out the examination.

Engle and Ng (1993) believe that by observing the variable's past value, it is possible to forecast the standardized residual error square $(a_t/\sigma_t)^2$, $\sigma_t = ((v-2)h_t/v)^{1/2}$. However, if there is no forecast pattern of the variables of past value, then the expression model may be mistakenly set up. Therefore, the examination method of the model hypotheses has the following four examination methods:

(1) Sign bias test:

$$(a_t/\sqrt{h_t})^2 = b_0 + b_1 S_{t-1}^- + e_t, \tag{20}$$

(2) Negative size bias test:

$$(a_t/\sqrt{h_t})^2 = b_0 + b_1 S_{t-1}^-(a_{t-1}/\sqrt{h_{t-1}}) + e_t, \tag{21}$$

(3) Positive size bias test:

$$(a_t/\sqrt{h_t})^2 = b_0 + b_1(1-S_{t-1}^-)(a_{t-1}/\sqrt{h_{t-1}}) + e_t, \tag{22}$$

(4) Joint test:

$$(a_t / \sqrt{h_t})^2 = b_0 + b_1 S_{t-1}^- + b_2 S_{t-1}^- (a_{t-1} / \sqrt{h_{t-1}}) + b_3 (1 - S_{t-1}^-)(a_{t-1} / \sqrt{h_{t-1}}) + e_t , \qquad (23)$$

where S_{t-1}^- is the dummy variable, as $a_t \le 0$, then S_{t-1}^-=1; $a_t > 0$, then S_{t-1}^-=0.

After the above-mentioned results, Table 9 asymmetrically examines the result for the Shanghai's stock price market as: (1) The sign bias test does not reveal (α =10%). (2) The negative size bias test does not reveal (α =10%). (3) The positive size bias test does not reveal (α =10%). (4) The joint test does not reveal (α =10%). Table 9 asymmetrically examines the result for the Shenzhen's stock price market as: (1) The sign bias test does not reveal (α =10%). (2) The negative size bias test does not reveal (α =10%). (3) The positive size bias test does not reveal (α =10%). (4) The joint test does not reveal (α =10%). By joint test, we know that the Shanghai's stock price market does not have an asymmetrical effect, and the Shenzhen's stock price market does not also have an asymmetrical effect.

Table 9. Asymmetric test of the bivariate IGARCH(1, 2) with a DCC

Shanghai	Sign bias	Negative size bias	Positive size bias	Joint
F statistic	2.0693	0.0922	0.5127	0.8980
(p-value)	(0.1505)	(0.7614)	(0.4740)	(0.4415)
Shenzhen	Sign bias	Negative size bias	Positive size bias	Joint
F statistic	2.2787	0.0810	0.6224	0.9888
(p-value)	(0.1313)	(0.7759)	(0.4302)	(0.3971)

Note：(1) p-value < α denote significance (α =1%, α =5%, α =10%).

(2) * denotes significance at the level 10%, ** denotes significance at the level 5%, and *** denotes significance at the level 1%.

6. Conclusions

There are many factors that might have great influence on stock prices including overall economic agents and overall currency supplies, interest rate, price, and inflation rate. Each factor can have influence to the stock price return. This research discusses two market return volatilities' influence of the Shanghai and the Shenzhen. We use data from January, 2000 to July, 2004 and June, 2005 to October, 2008. The empirical result shows that the Shanghai's and the Shenzhen's stock price market return's volatility have an asymmetric effects, and the Shanghai's and the Shenzhen's stock price return volatility may construct in the DCC and the bivariate asymmetric-IGARCH (1, 2) model with a threshold of oil price volatility. This model also passes through a standard residual error and the ARCH effect test. This situation demonstrates that the DCC and the bivariate asymmetric-IGARCH (1, 2) model's fitting is appropriate. From the empirical result also obtains that the average estimation value of the DCC coefficient ($\hat{\bar{\rho}}_t$ =0.9642) on the Shanghai's and the Shenzhen's stock price return volatility is positive. This result demonstrates that the Shanghai's stock return volatility is affecting the Shenzhen's stock return volatility, and the Shenzhen's stock return volatility is also affecting the Shanghai's stock return volatility. The empirical result also discovers that the Shanghai's and the Shenzhen's stock price market returns' volatility have an asymmetrical phenomenon. The oil price volatility of the low and the high affects the variation risks of the Shanghai's and the Shenzhen's stock markets. The Shanghai's and the Shenzhen's stock market returns is truly received the impact of the low and the high oil price periods' volatility. Therefore, the explanation ability of the bivariate asymmetric-IGARCH (1, 2) is better than the bivariate GARCH (1, 2) model.

However, the theory and the model discussing on the return and volatility property of financial commodity are multitudinous. This research only uses the oil price and the bivariate asymmetric-GARCH model to discuss the two stock markets of the Shanghai and the Shenzhen. For future research, we suggest that the others asymmetric model will be used for further analysis.

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