The Empirical Study on the Market Volatility of Chinese Open-end Funds Based on GARCH Model

Wei Shen
School of Business and Administration, North China Electric Power University, Beijing 102206, China
E-mail: shenwei_1965@126.com

Abstract

In this article, we investigated the volatility of Chinese open-end funds market by using Zhongxin open-end funds index. According to the characteristics of different GARCH models, we empirically studied GARCH, EGARCH and GARCH_M model. The result indicated that GARCH (1, 1) model and GARCH_M (1, 1) model could better fit the characteristics of the index return rate. At the same time, the result of empirical study showed that the volatility-clustering and conditional heteroscedasticity of the return sequence of open-end funds were significant, open-end funds market in China had a strong motive of speculation, exterior impact had sustainable influences to the market fluctuation, the volatility of fund market was notable asymmetry, and the return of fund had obvious risk premium effect.

Keywords: Open-end funds, GARCH model, Volatility

1. Introduction

With the reform and development of China capital market, the open-end funds of China have acquired rapid development. Since the first open-end fund, "Hua'an Innovation", was established in 21 Sep, 2001, there were 307 open-end funds until 30 Jun, 2007, which occupied 88.78% of the total funds equity and indicated that the open-end funds had been the mainstream of the funds market. Since the first edition Basel Agreement was established in 1996, the volatility of the financial assets has been largely noted by investors, administration department and academe. With the continual development of China open-end funds market, it is more and more necessary to study its volatility.

In recent two years, many domestic scholars studied the volatility of the close-end funds market. Niu Fanglei and Lu Xiaoguang (2005) selected the SSE Fund Index as the research objective, and implemented empirical analysis to the closed-end funds by ARCH model group, and the result showed that the return of the SSE Fund Index put up the characters of non-normality and conditional heteroscedasticity, and the GARCH (1, 1) model has good fitting effect to the fluctuation of the funds index. Guo Xiaoting (2006) took three fund indexes including Zhongxin Fund Index as samples and empirically studied the fluctuation characters of clustering and asymmetry, and the result indicated that the volatility of the fund market possessed characters of clustering and leverage effect and had not obvious risk premium effect. But few relative domestic scholars studied the volatility of the open-end fund market, and the limitation of these researches was that they only studied one fund and didn't research the total market volatility of open-end funds.

Starting from the view of the total open-end fund market, through repeat experiments and comparisons, we selected proper model to implement fitting and tried to find out the total market volatility of the open-end funds.

2. Explanation of the model

Many financial time sequences such as the square differences of stock price, inflatable rate, interest rate and foreign exchange rate usually change with the time, but traditional mathematical economic model can not depict this character. In 1982, Engle put forward the ARCH (Auto Regressive Conditional Heteroscedasticity) Model could better depict the change of difference when he studied the problem of British inflation. In 1986, Bollerslev introduced the lagged item of the residual difference into the difference equation of the ARCH model, and got the generalized ARCH model, i.e. the GARCH model. The concrete form of the GARCH (1, 1) is

$$y_t = \beta' x_t + \varepsilon_t$$
$$\varepsilon_t \mid \Psi_{t-1} \sim N(0, h_t)$$
$$h_t = \omega + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1} .$$

Where, Ψ_{t-1} is the information set in the former t-1 terms, $\omega > 0, \alpha \geq 0, \beta \geq 0$ ensures the conditional difference $h_t > 0$, $\alpha + \beta < 1$ ensures the stability of the process.

All parameters of the GARCH module have the non-negative limitation, which increases the difficulty of the estimation. In 1990, Nelson put forward the exponential GARCH model (i.e. EGARCH model) which loosened the non-negative limitation to the parameter, and other conditions didn't change, the conditional difference equation of EGARCH (1, 1) was $\ln h_t = \omega + \alpha \frac{|\varepsilon_{t-1}|}{\sqrt{h_{t-1}}} + \gamma \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \beta \ln h_{t-1}$.

Where, $\gamma \neq 0$ indicates the asymmetry of the information, and when $\gamma < 0$, the leverage effect should be significant.

Another model which is extensively applied model is the GARCH_M model, which introduces conditional difference into the mean equation. When other conditions don't change, the mean equation is $y_t = \beta' x_t + \delta \sqrt{h_t} + \varepsilon_t$.

Where, y_t represents the expectative income, h_t represents expectative risk. And this model can reflect the relation between the income and the risk.

3. Empirical analysis

3.1 Data explanation

The adoptive data in this article is the Zhongxin open-end fund index, which is the index computed according to net values of all stock-type and bond-type open-end funds. The data time is from 2 Jan, 2003 to 21 Nov, 2006. All data come from the website of Zhongxin Index Web.

The daily return of the fund index is denoted by the first order difference of the logarithm of the fund index in neighbor business days, i.e. $R_t = \ln(P_t) - \ln(P_{t-1})$. Where, R_t represents the return of fund index in t'th day, P_t represents the fund index in t'th day. We apply the EVIEWS5.0 to implement data processing.

3.2 Depictive statistics of the sample sequence

Implement basic statistical analysis to the return sequence $\{R_t\}$ of open-end funds index, and we can obtain the histogram and the relative statistics of the sequence distribution (Figure 1) and the tendency of the return rate (Figure 2).

From Figure 1, the Skewness of the return sequence, S=0.378513, the Kurtosis, K=7.074750, and comparing with standard normal distribution (S=0, K=3), it presents obvious right skewness and the character of "high kurtosis and fat skewness". The test value of Jarque-Bera is 670.6060, which is far bigger than 5.99, the critical value on 5% of the notable level, so the return sequence doesn't obey the normal distribution.

From Figure 2, the fluctuation with big extents closely follows the large fluctuation of the return sequence, and the fluctuation with small extents closely follows the small fluctuation of the return sequence, i.e. the fluctuation of the time sequence has the character of clustering.

Implement ADF (Augmented Dickey-Fuller) test to the return sequence. The sequence fluctuates around the mean value, and the trend doesn't exist, so we can select the regression model without time tendency to test the sequence. The t statistics of ADF test is -30.25583, which is obviously smaller than the MacKinnon critical value on 1% of the notable level, -3.439531, so this sequence has no unit root, and this sequence is stable.

3.3 Establishment of the model

3.3.1 Analysis of modeling

First, we implement modeling analysis to the return. From Figure 3, the pertinence of the index return is weak, so we can think it has no pertinence, so it is inapplicable to adopt the ARMA (p, q) model. We consider adopt the following regression analysis to the return sequence.

$$R_t = c + \varepsilon_t \tag{1}$$

Further implement the ARCH test to the residual difference of the regression equation (1) by means of the Lagrange Multiplier Method, and the test result of ARCH (1) effect is seen in Table 1.

In Table 1, the F statistics in the first row is not exactly distributed and they can be references, and the LM Obs*R-squared values and the concomitant probabilities of the test are in the second row. The concomitant probability of the ARCH (1) effect test, p=0.000004, which is far smaller than the notable level, 0.05, so the ARCH (1) effect exists in the residual sequence. In the same testing method, when q > 10, the test is still notable, which indicates the high order ARCH (q) effect exists in the residual sequence, and it is applicable to fit by the GARCH type models.

3.3.2 Establishment of the model

From above analysis, we can see that the heteroscedasticity and the GARCH effect exist in the return sequence of open-end fund index, so we can select GARCH (p, q) model to estimate and predict the fluctuation. We use three models, GARCH (1, 1), EGARCH (1, 1) and GARCH_M (1, 1), to implement modeling for the return sequence of open-end fund index.

From Table 2, in the mean equation, the estimation of the constant is outside the confidence limit. But according to Nelson's research result (1990), it doesn't influence the estimation of the model. In the conditional difference equation, GARCH (1, 1), and GARCH_M (1, 1) can better explain the data. In the EGARCH (1, 1) model, the corresponding value of p to the coefficient γ is 0.3467, which is bigger than its corresponding critical value, 0.05, so we can not reject the dummy hypothesis, $H_0 : \gamma = 0$. The EGARCH model can not better explain this sequence.

After use GARCH (1, 1), and GARCH_M (1, 1) to express the difference equation, we implement ARCH (1, 1) effect test to its residual difference, and the ARCH (1) effect test result of the model residual sequence is listed in Table 3.

The concomitance probability of the test statistics, p, is far bigger than the notable level of 0.05, so on the reliability of 95%, we can think the residual difference of GARCH (1, 1) model doesn't possesses the ARCH effect.

In the same way, we implement the ARCH (1) effect test the residual difference of GARCH_M (1, 1) model, and the result shows there is no ARCH effect.

3.4 Analysis of the empirical result

(1) According to Zhou Zhefang and Li Zinai's research result (2000), the kurtosis coefficient (K) of Shanghai stock market and Shenzhen stock market is about 6.89, but this value of US stock market is about 3.8, and comparing with mature stock market, China stock market has strong color of gamble. From Figure 1, the kurtosis coefficient of China open-end fund market is about 7.07, which is close with the kurtosis coefficient of China stock market. That indicates that the open-end fund market of China has strong color of gamble, and investors' investments to the open-end funds are not long-term investments.

(2) The return sequence of fund index doesn't obey the normal distribution, which distribution presents the character of high kurtosis and fat skewness, and has obvious fluctuation clustering and conditional heteroscedasticity.

(3) The GARCH (1, 1) model and GARCH_M (1, 1) model can better fit the return sequence of open-end fund index. From Table 2, we can see that both the value of AIC and the value of SC of the GARCH (1, 1) model and GARCH_M (1, 1) model are less than -6, and the maximum logarithm likelihood function value is very big, which indicates they have better precisions.

(4) The EGARCH (1, 1) model fits very badly, and the coefficient γ is not notably different to 0, which indicates that the open-end fund market has not obvious fluctuation asymmetry, i.e. the price falling information has larger influences to the market fluctuation than the price rising information. That also proves that China institutions and individual investors are not more sensitive to the negative price change than the positive price change, and their investment concepts are not mature, which will easily induce the false high market price and form bubbles.

(5) In the GARCH (1, 1), $\alpha + \beta < 1$, which proves that the model is stable and we can implement various tests to the model. At the same time, it also can be used to measure the durative of the influence to the return from concussion. $\alpha + \beta$ = 0.9669, and the value is very big, which indicates that the reactive function of China open-end fund market volatility to the concussion is a relatively slow speed attenuation. The exterior concussion will influence the return of open-end fund market in a long durative term.

(6) In the GARCH (1, 1), the estimation value of the coefficient δ is 0.292597, which is notably positive, and that indicates the positive pertinence exists between the return and the market volatility, and investors have some certain requirements of compensation to the market risk. This value represents the estimation of relative evadable risk coefficient. Chou's research (1988) showed that in some mature stock markets such as US and England, investors' evadable risk coefficient is in 2~6. So, China investors' evadable risk coefficient is in the very low level and their behaviors possesses very large character of gamble.

4. Conclusions

(1) The open-end fund market of China has strong color of gamble, and investors' investments to the open-end funds are not long-term investments.

(2) The return sequence of fund index doesn't obey the normal distribution, which distribution presents the character of high kurtosis and fat skewness, and has obvious fluctuation clustering and conditional heteroscedasticity. The GARCH (1, 1) model and GARCH_M (1, 1) model can better fit the return sequence of open-end fund index.

(3) The volatility of open-end fund index has no obvious character of asymmetry, so the EGARCH model is not

applicable to used to fit this time sequence.

(4) The exterior concussion will influence the volatility of open-end fund market in a long durative term.

(5) The positive pertinence exists between the return and the market volatility, and investors have some certain requirements of compensation to the market risk but the investor evadable risk coefficient of China is in the very low level.

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Table 1. The test result of ARCH (1) effect of residual sequence

F-statistic	*21.60002*	*Probability*	0.000004
Obs*R-squared	21.15699	Probability	0.000004

Table 2. Model fitting of return sequence of open-end funds index

		GARCH(1,1)	EGARCH(1,1)	GARCH_M(1,1)
Mean equation	c	0.000358 [0.0973]	0.000387 [0.1016]	-0.001663 [0.0843]
	δ	-	-	0.292597 [0.0380]
Conditional difference equation	ω	2.27E-06 [0.0000]	-0.568048 [0.0000]	2.18E-06 [0.0000]
	α	0.087887 [0.0000]	0.195284 [0.0000]	0.092188 [0.0000]
	γ	-	0.013714 [0.3467]	-
	β	0.878987 [0.0000]	0.956548 [0.0000]	0.876105 [0.0000]
Value of AIC		-6.961704	-6.963215	-6.965030
Value of SC		-6.941031	-6.937374	-6.939188
Maximum logarithm likelihood function value		3265.558	3267.266	3268.116

Note: The values in [] are the values of P.

Table 3. The test result of residual sequence ARCH(1) effect of GARCH(1,1)

F-statistic	*0.522862*	*Probability*	0.469805
Obs*R-squared	0.523688	Probability	0.469273

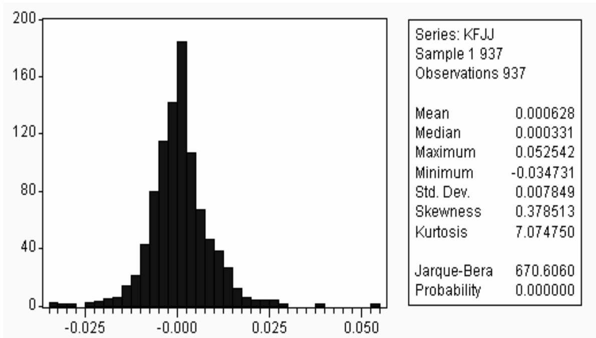

Figure 1. Histogram of the Return Sequence of Open-end Funds Index

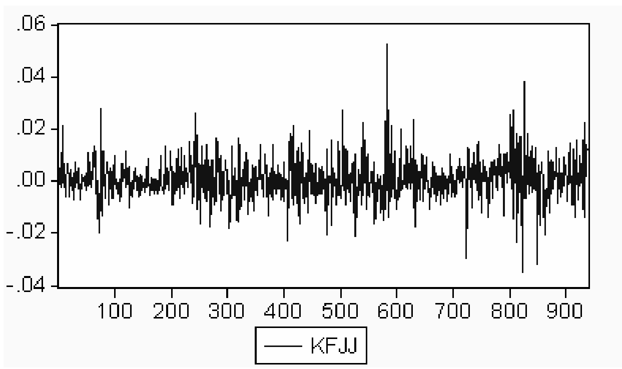

Figure 2. Tendency of the Return of Open-end Funds Index

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.006	0.006	0.0394	0.843
		2	0.009	0.009	0.1105	0.946
		3	0.026	0.026	0.7690	0.857
		4	-0.026	-0.027	1.4158	0.841
		5	-0.012	-0.012	1.5588	0.906
		6	-0.035	-0.035	2.7007	0.845
		7	0.013	0.015	2.8699	0.897
		8	0.005	0.005	2.8907	0.941
		9	0.044	0.045	4.7208	0.858
		10	0.049	0.046	7.0158	0.724
		11	0.077	0.076	12.617	0.319
		12	-0.012	-0.016	12.750	0.387
		13	0.017	0.017	13.036	0.445
		14	0.062	0.062	16.653	0.275
		15	0.030	0.039	17.522	0.289
		16	-0.007	-0.006	17.571	0.350
		17	-0.077	-0.078	23.314	0.139
		18	0.024	0.021	23.874	0.159
		19	-0.055	-0.055	26.748	0.111
		20	0.014	0.013	26.931	0.137
		21	-0.060	-0.073	30.382	0.085

Figure 3. Relation of the Return Sequence of Open-end Funds Index