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An Empirical Research on Chinese Stock Market Volatility Based on Garch

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Abstract: Stock market volatility is a major issue in the modern financial field. As China's stock market is immature and volatile, it is particularly important to study the volatility of China's stock market. This paper selects Shanghai Composite Index gains from January 7, 2013 to December 29, 2017, to make an empirical research on stock market volatility based on GARCH model. The results show that there is volatility clustering, durative and leverage effects in stock market. The volatility is largely affected by the past volatility, especially in Chinese stock market. Its influence reaches 0.927.

Keywords: GARCH model, volatility, heteroscedasticity

1. Introduction

At the beginning of the 21st century, China's stock market has made great progress, but some improvement is still required. Compared with the developed western stock market, the risk and volatility of China's stock market are very large, and stock prices are easily affected by many factors, which not only brings great risk to China's immature stock markets and investors, but also influences the healthy development of the national economy and even causes economic crisis. In China, since the stock market is still immature, we must not only qualitatively grasp the trend of stock prices, but also quantitatively study its internal laws, so that we will not be at a loss when the crisis is coming.

Volatility is the basic nature of the securities market, which means that there are risks and benefits. As one of the important tools to measure the risk of the stock market, it has been widely valued by the academic community and the industry. The fluctuation of stock price is a necessary condition for resource allocation in the capital market. For investors, the volatility can be measured to predict the amount of risk that may be exposed. At the same time, the grasp of volatility helps to define the stock price. A possible range. Therefore, volatility is also the basis for investors to obtain income. As an investor, it is concerned with whether it is possible to analyze the price behavior of the securities market as accurately as possible so as to make a reasonable prediction of the future market yield.

In recent years, the changes in the financial market have been changing with each passing day, and the factors affecting the stock price have gradually increased. The traditional ARMA model cannot describe its volatility very well. In this case, the ARCH model is generated, especially the developed GARCH model, which not only reflects The asymmetry of the impact of economic and non-economic factors on stock returns, and also has a significant role in the study of the relationship between stock market uncertainty and yield, which is of great help to investors' investment choices. The GARCH model is very suitable for analyzing and predicting financial volatility and has an important guiding role for investors' decision-making. Therefore, this paper hopes to explore its internal laws by studying the GARCH model and volatility of the Shanghai Composite Index, and to make simple assessments and forecasts of market risks and indices, which will help investors to make comparisons and decisions, and reduce investors' risks and losses.

2. A Review of Domestic and Foreign Rasearch

International research on the characteristics of stock price volatility has been relatively mature. At present, the most popular research method for studying stock price volatility is the ARCH model family. Many financial time series have the characteristics of time-varying variance, that is, the fluctuations in some periods are very intense, while in other periods, the fluctuations are relatively flat. To characterize this feature of the time series, in 1952 Robert Engle proposed an autoregressive conditional heteroscedasticity model. On this basis, Bollerslev (1986) established a generalized autoregressive conditional heteroscedasticity model and established a mean model that uses the conditional variance to represent the expected risk. Zakoian (1990) and Olosten (1993) proposed an ARCH model that reflects asymmetric effects and empirically analyzed the New York stock market weighted index. Nelson (1991) extended the conditional distribution, established the index GARCHA model, and used it to study the volatility of the standard 90 index daily price. Others are PARCH models, ARCH models, and so on. Engle (1993) compared the ability to capture wave asymmetry with EGARCH, GJRGRCH, TGARCH and other models, and used the Japanese TOPIX index price to do empirical analysis.

China has studied more than 10,000 foreign scholars in the fluctuation of stock market returns, but with the growth of China's capital market, the research on related aspects is gradually increasing. Xu Xuchu, Yang Ning (2017) used ARCH model and GARCH model to study the fluctuation of stock index and find the inconsistency of fluctuations in China's stock market, that is, the bad news is more influential than the news. Zhou Liping (2017) selected the Shanghai Composite Index and the Shenzhen Stock Exchange Index to establish a GARCH model. The comparative analysis shows that the Shanghai and Shenzhen stock markets are on the rise, but the difference in market yield is relatively large. The average value of the returns reflects the weak characteristics of Shanghai. .

3. The Basis of Garch Theoey

In the classical linear regression model (CLRM), a very important assumption is that the residuals of the regression model are homoscedastic, which guarantees the unbiasedness, validity and consistency of the regression coefficients. However, in reality, the assumption of the same variance is difficult to satisfy, especially in financial markets.

The yield series of financial assets in financial markets tend to have such characteristics: a high rate of return is followed by a higher rate of return, and a low rate of return is followed by a lower rate of return. This feature is known as the volatility cluster (Mandelbrot, 1963). The volatility cluster indicates that the fluctuation of stock returns is time-varying, that is, there is heteroscedasticity. Although the heteroscedasticity does not affect the unbiasedness of the least squares estimate of the regression coefficient, the validity and consistency of the regression coefficient are difficult to guarantee.

Most studies have shown that financial time series have the following characteristics:

(1) Volatility clusters: The volatility of financial time series has obvious clustering.

(2) The tail state after the spike: Compared with the normal distribution, the actual distribution of the financial time series has a thicker tail and a higher kurtosis.

(3) Leverage effect: There is a negative correlation between financial asset prices and their volatility (Black,

1976). Negative news leads to greater conditional variance than good news.

Engle (1982) proposed the AutoRegressive Conditional Heteroscedasticity Model and the subsequently developed Autoregressive Conditional Heteroscedasticity Model (Bollerslev, 1986) to capture these features of financial time series. Later, after many researchers' efforts, based on GARCH (Bollerslev, 1986), a large family of large GARCH models was developed. The model in this family has become the most commonly used empirical study to measure volatility and profitability. Tool of.

The GARCH model is an improvement and improvement of the ARCH model. Since Engle proposed the ARCH model, Bollerslev proposed the GARCH model based on Engle. The GARCH(p,q) model formula is:

$$Xt = \beta_0 + \beta_1 X_{t-1} + ... + \beta_p X_{t-p} + u_t$$

$$\sigma^2{}_t = \partial_0 + \lambda_1 \sigma^2{}_{t-1} + \lambda_2 \sigma^2{}_{t-2} + ... + \alpha_q u^2{}_{t-q}$$

The GARCHA model can better reflect the long-term memory properties in the actual data. The above equations are the conditional mean equation and the conditional variance equation, respectively, which illustrate the variation characteristics of the time series condition variance.

4. The Statistical Analysis of the Characteristics of the Yield Data

This paper selects the daily closing price of the Shanghai Composite Index as the research object. The time range is from January 4, 2013 to December 29, 2017. The sample size is 1215. The data comes from Netease Finance and studies the fluctuation characteristics of its yield. Therefore, the data is processed by Eviews, and the logarithmic rate of return is used in the processing of daily yield. The formula is:

$$R_t = \ln(P_t \backslash P_{t-1})$$

Among them, P_t represents the daily closing price of the Shanghai index at time t, and R $_t$ represents the rate of return.

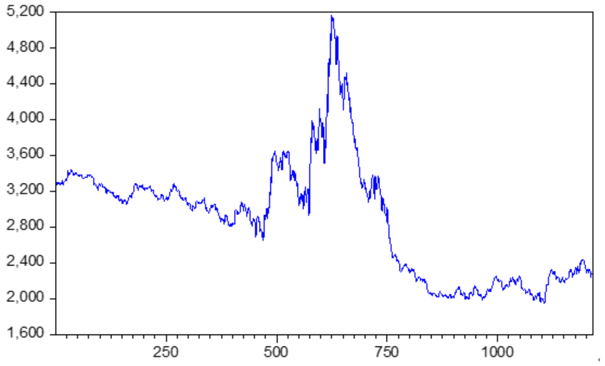

Figure 1 Shanghai Stock Exchange Index

First, it is a basic analysis of the Shanghai Stock Exchange closing price data. The price chart of the closing price of the Shanghai Composite Index can be visually observed through Figure 1.

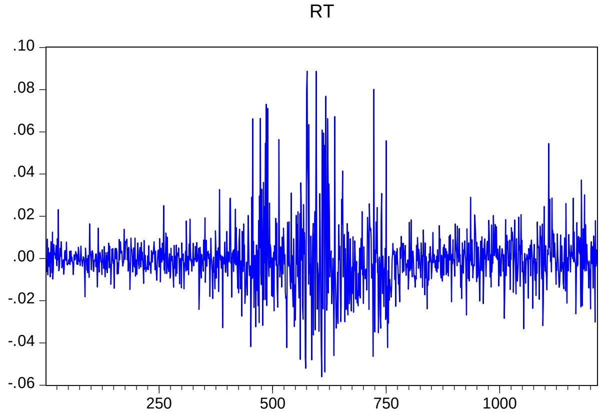

Figure 2 Shanghai Stock Exchange Index Yield Chart

As can be seen from Figure 2, the Shanghai Stock Exchange's return rate has a clear volatility cluster phenomenon, which is characterized by frequent fluctuations in the yield rate at 0, fluctuations are very small in some long periods of time, and very large in other very long periods of time. This also verifies that the variance of the rate of return is related to time and has heteroscedasticity, that is, past fluctuations in yields will affect future yield volatility. For a more in-depth analysis, we do the following basic statistical analysis of the data.

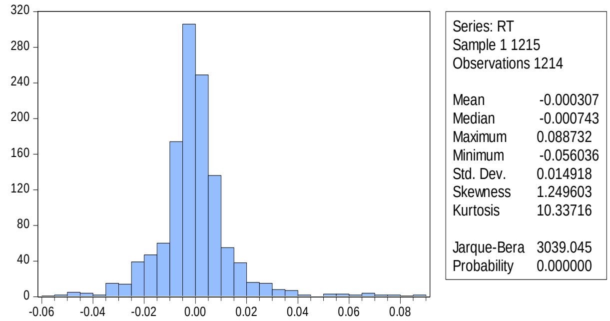

Figure 3 Basic statistical characteristics of the yield of the Shanghai Composite Index

The basic statistical characteristics of Fig. 3 show that the stock yield deviation is 1.249603. The positive value indicates that the distribution has a long right tail, the kurtosis is 10.33716, which is greater than the kurtosis value of the normal distribution, which indicates the distribution of the yield of the Shanghai Stock Index. The tail is thicker than the normal distribution, and its distribution density curve is located above the normal distribution curve at a distance from the mean value. This means that the probability of an outlier in the yield is greater than the probability of a normal distribution. This is called The peak and thick tail phenomenon. It can be seen from the histogram that the distribution of yield is basically symmetrical, but it is obviously higher than the kurtosis of the normal distribution, and the JB statistic is 30390.045, corresponding to the P value of 0.000000, rejecting the SHX index yield sequence obeying the normal distribution. Assumption.

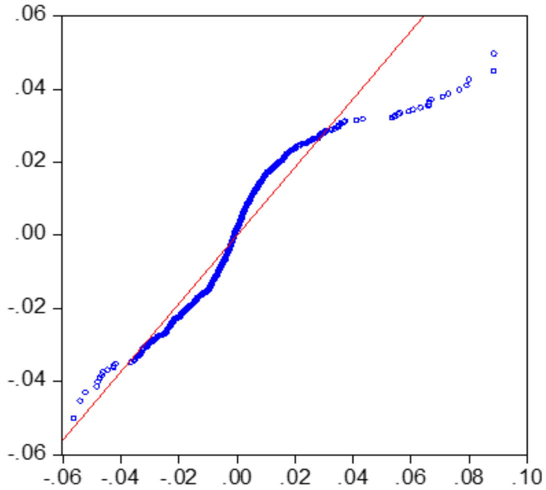

Figure 4 Shanghai Stock Exchange Index Rate of Return QQ Chart

The straight line represents a normal distribution, and the sequence of yields is close to a straight line in the middle segment and a straight line in the two segments, which is a characteristic of a thick tail distribution. There are two reasons for the emergence of the tail-tail feature: the concentration of consciousness information leads to large fluctuations in the index; the second is that the role of information is not immediately displayed in the futures market, and the accumulation of a large amount of information leads to large fluctuations.

5. The Establishment of the Rate of Teturn Model

(1) Stationarity test

The stationarity test of the time series of the Shanghai Stock Exchange's rate of return is tested. The test results are shown in Table 1:

	t-Statistic	**Prob.***
Augmented Dickey-Fuller test statistic	-32.51596	0.0000
Teat Critical values : 1%level	-3.435527	
5%level	-2.863714	
10%level	-2.567978	

Table 1 ADR test of the Shanghai Stock Exchange Index

From the unit root test results, it can be seen that the ADF statistics of the Shanghai Stock Exchange index yields at the significant levels of 1%, 5% and 10% are far less than their critical values, and the P value is 0. According to the ADF test principle, the rejection sequence exists. The null hypothesis of the root, the sequence is a stationary sequence.

(3) Relevance test

The autocorrelation test mainly tests the correlation between the test variable and the lag period, and makes a correlation test on the yield of 1215 SSE stocks. The results are shown in Table 2 below:

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
| |	| |	1	0.068	0.068	5.5875	0.018
| |	| |	2	-0.050	-0.055	8.6351	0.013
| |	| |	3	-0.011	-0.004	8.7796	0.032
|* |	|* |	4	0.116	0.115	25.182	0.000
| |	| |	5	-0.001	-0.018	25.183	0.000
*| |	| |	6	-0.077	-0.065	32.361	0.000
| |	| |	7	0.031	0.045	33.569	0.000
|* |	| |	8	0.082	0.058	41.790	0.000
| |	| |	9	0.046	0.040	44.406	0.000
*| |	| |	10	-0.075	-0.060	51.332	0.000

Table 2 Related Test Table

It can be seen from the relevant test table that the autocorrelation coefficient (AC) and partial autocorrelation coefficient (PAC) of the yield series are significant in the lag phase 4, indicating the existence of autocorrelation and partial autocorrelation.

(4) Autoregressive model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RT(-1)	0.069819	0.028505	2.449394	0.0145
RT(-4)	0.117067	0.028499	4.107731	0.0000

Table 3 Autoregressive model

Select the test term to build the equation:

$$r_t = 0.069819 r_{t-1} + 0.116333 r_{t-4} + \varepsilon_t$$

(0.0145) (0.000)

(5) ARCH model establishment

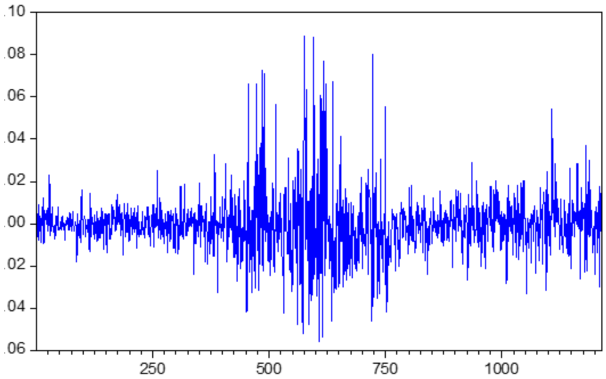

Table 5 residual diagram

Observing the residual map and finding the “cluster” phenomenon of fluctuations: the fluctuation is small for a period of time, and the fluctuation is very large for another period of time, which indicates that the error term may have conditional heteroscedasticity.

F-statistic	64.4580	Prob. F(1,12807)	0.0000
Obs*R-squared	61.2916	Prob. Chi-Square(91)	0.0000

Table 4 Conditional Heteroscedasticity Test

It can be concluded from the test that the P value approaches 0, rejecting the null hypothesis, indicating that there is a significant ARCH effect in the SE series.

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.000558	0.000286	-1.951239	0.0510
	Variance Equation			
C	5.84E-05	3.31E-06	17.65224	0.0000
RESID(-1)^2	0.139031	0.021176	6.565551	0.0000
RESID(-2)^2	0.222873	0.028266	7.884880	0.0000
RESID(-3)^2	0.207775	0.030255	6.867502	0.0000
RESID(-4)^2	0.206705	0.029075	7.109421	0.0000

Table 5 ARCH model

The ARCH model can establish equations:

$$r_t = 5.84\times10^{-5} + 0.139031\text{resid}_{t-1}{}^{-2} + 0.222873 resid_{t-2}{}^{-2} + 0.20775 resid_{t-3}{}^{-2} + 0.206705 resid_{t-4}{}^{-2}$$

(4) Establishment of the GRACH model

To determine the order of the GARCH model, the AIC and SC obtained by combining different coefficients are listed below.

	AIC	SC
GARCH(1,1)	-6.125297	-6.120550
GARCH(1,2)	-6.123904	-6.107095
GARCH(1,3)	-6.125027	-6.104015
GARCH(2,1)	-6.124197	-6.107388
GARCH(2,2)	-6.123599	-6.102587
GARCH(2,3)	-6.132352	-6.107138
GARCH(3,1)	-6.124696	-6.103684

Table 6 Summary of GARCH model results with different coefficients

By comparing AIC and SC, we choose GARCH (1,1) model for parameter estimation.

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	7.61E-07	2.21E-07	3.435899	0.0006
RESID(-1)^2	0.067353	0.008084	8.332109	0.0000
GARCH(-1)	0.931846	0.007963	117.0235	0.0000

The regression results are expressed as:

$$\sigma_t^2 = 7.48 \times 10^{-7} + 0.0657\,\varepsilon_{t-1}^2 + 0.9269\,\sigma_{t-1}^2$$

Usually called μ_{t-1}^2 For the ARCH item, and σ_{t-1}^2 For the GACH term, the coefficient ARCH(1) (α_1) and GARCH(1)(β_1) are positive numbers, and $\alpha_1 + \beta_1$=0.0657+0.9269<1, very close to 1, meet the parameter constraints, indicating that past fluctuations have a positive long-term impact on future fluctuations, that is, the sustainability of stock price fluctuations.

6. Conclusion

Through statistical analysis of data characteristics, it shows that the Shanghai Composite Index has strong volatility agglomeration, which fully illustrates that investors' short-term investment preference is clear. The yield series has autocorrelation and heteroscedasticity, and there is obvious ARCH effect. The GARCH model is suitable for fitting the daily yield series. The GARCH model passes the significance test. The sum of the volatility persistence coefficient is equal to the sum of the ARCH and GACH terms in the variance equation. The parameter constraint is close to 1, which indicates that the stock price of the Shanghai Stock Index has "long-term memory". The volatility persists strongly, that is, the fluctuation of the previous stock price has a certain impact on the size of the stock price fluctuation in the later period. At the same time, it indicates that the Shanghai Stock Index has a higher risk premium, that is, the greater the stock market volatility, the more the risk exists. Large, and the higher the rate of return.

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