

# The Application of Time Series in SME Board Volatility Based on GARCH Model

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## Abstract

Since the SME board was launched in 2004, it is playing a more and more important role. The volatility of the stock market has been the focus of economic researchers and investors. Many researches show there are clustering effect and heavy-tail effect in financial data, which means that normal ARMA related models are not compatible with the financial data. GARCH model is a powerful tool for analyzing financial data, and the parametric GARCH models are the most commonly used models. In this paper, we use SSE SME COMPOSITE as the study object and estimate the parameters of the GARCH model for empirical research to analyze the dynamic characteristics of the volatility in China's SME Board.

**Key Words:** SSE SME COMPOSITE, Stock Price Volatility, GARCH model

## 1 . Introduction

Since the launch of SME Board on June 25, 2004, SME Board market has developed rapidly, but still in the immature market. The stock price is affected by many economic and non-economic factors, and the higher yield determines its higher risk characteristics. Volatility is an important indicator of risk measurement in financial market. For the study of volatility, we can explore the influencing factors caused by volatility, such as from government policy, financial crisis and so on. We can also carry out empirical modeling research from the perspective of data-driven. Because the factors that affect the volatility is complex and uncertain, this research method has great uncertainty and limitations. In contrast, the data-driven approach uses historical data to construct a model that is more objective and the research results are presented and applied by rigorous mathematical forms. So this article we take empirical modeling data-driven research method.

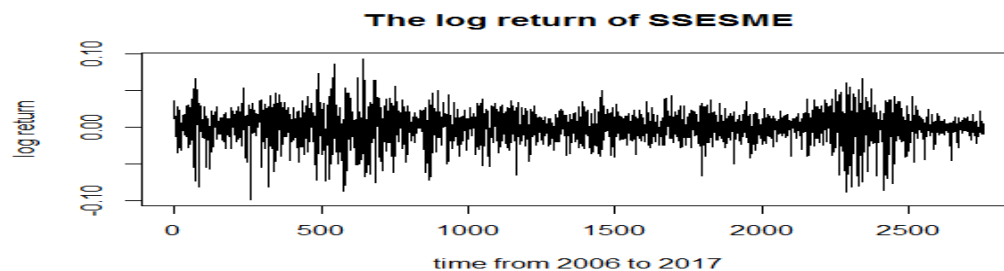
The early classical model is the ARMA time series model, but a large number of empirical studies show that there are volatility clustering and spikes in financial data. Yang Jincheng (2016) used the ARCH model to take the empirical analysis of the Shanghai Composite Index showing that there are obvious spikes in the stock market. So it is not appropriate to use the general time series model to fit the volatility of financial data. In 1986, Bollerslev [1] proposed the GARCH model, which can more effectively capture the dynamic characteristics of conditional variance, so as to better describe the characteristics of the peak of the asset yield. Therefore, we construct the GARCH model [3] and estimate the parameters based on the maximum likelihood.

## 2.The basic statistical description of the yield of the SME board index

We start with the study yield rate sequence.

This is the log return of SEM board index.

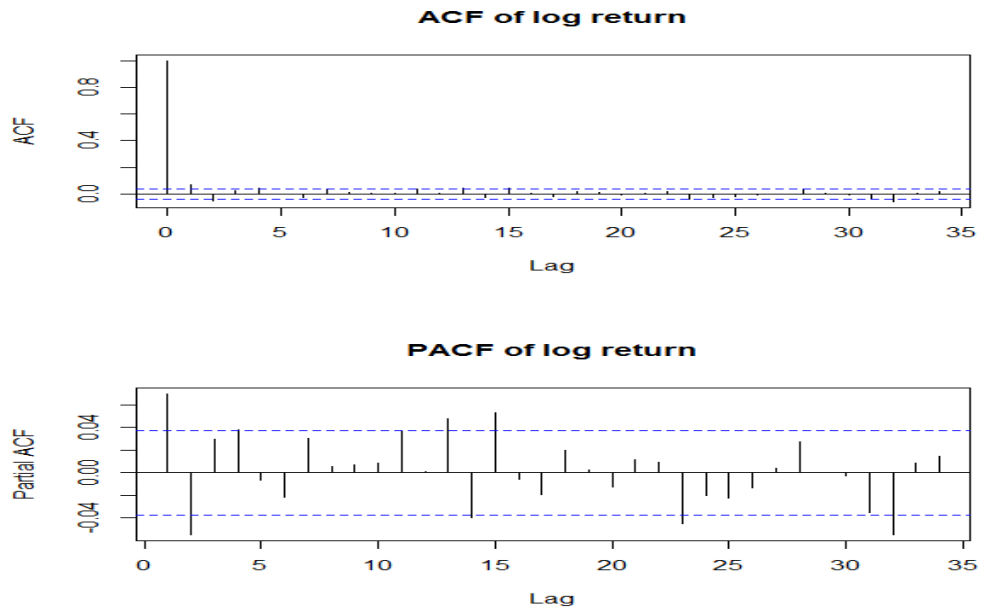
Figure 1



It can be seen that the volatility of the yield sequence has a significant aggregation and the yield is essentially zero.

We examined the ACF and PACF of the yield series.

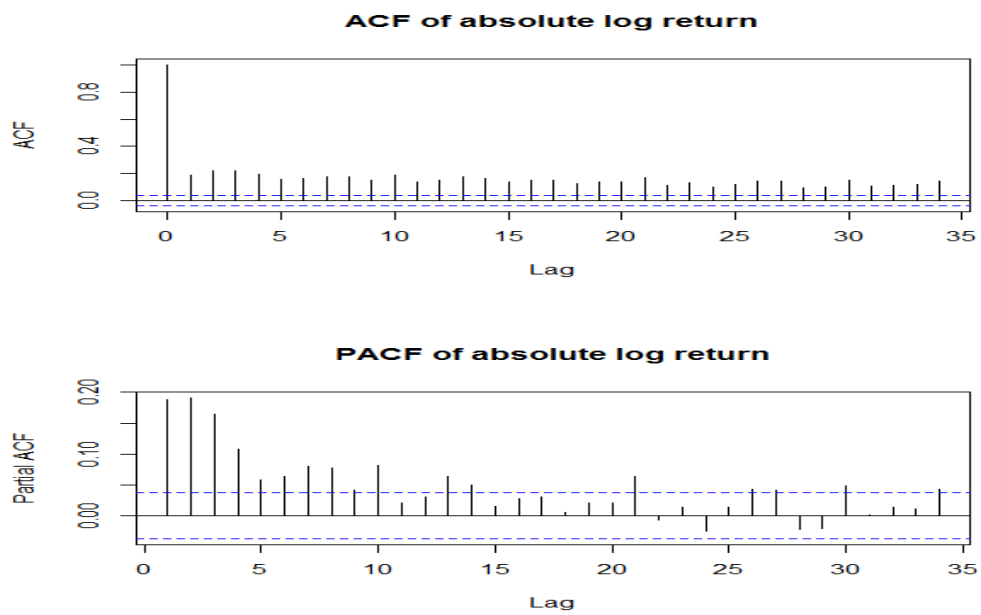
Figure 2



We can know that the rate of return has a self-correlation.

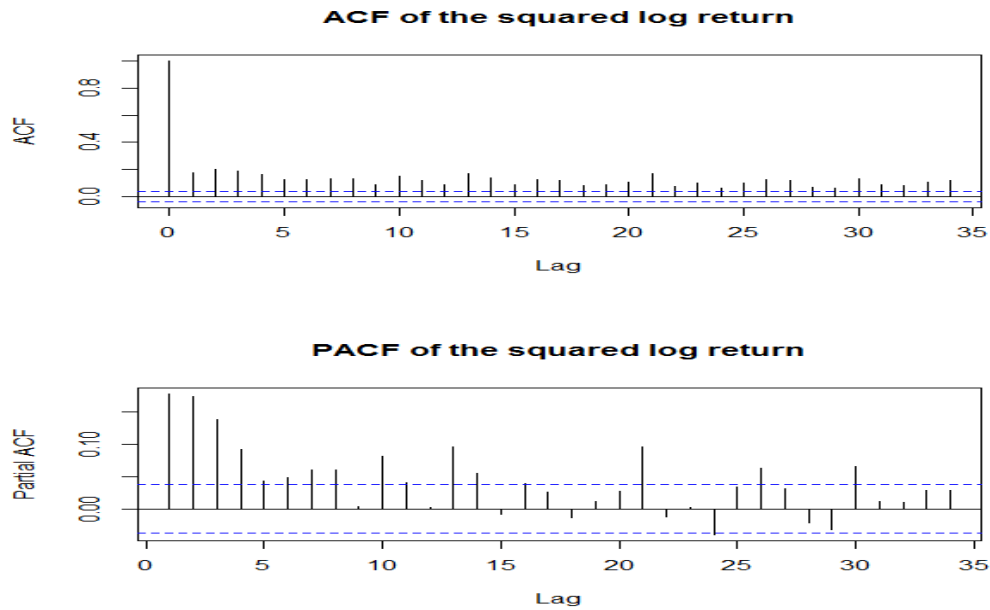
Then we draw the absolute yield of the ACF and PACF.

Figure 3



Draw the squared yield of the ACF and PACF.

Figure 4



We can see that the absolute value of the yield and the sequence after the square show a significant sequence dependency. This also indicates that the possible yield sequence exists in the ARCH effect, which we will discuss next.

#### ARCH and GARCH model

We tested LM for the yield sequence to determine if there was an ARCH effect. For this purpose, choose to lag 4, 8, 12 order to calculate, the results are as follows:

**Table 1 LM test of SSESME**

	Lag 4	Lag 8	Lag 12
Chi-squared	237.06	265.06	285.64
p-value	< 2.2e-16	< 2.2e-16	< 2.2e-16

According to Table 1, P value is less than 2.2e-16, Reject the original hypothesis, It is further proved that the yield sequence exists ARCH effect.

Here we explore the order problem of ARCH or GARCH, as follows: First, the ARMA model is established for the conditional mean, and then the GARCH model is further studied by the result of the residual sequence of the ARMA model.

Establish conditional mean ARMA model. We establish the ARMA (0,0), ARMA (1,0), ARMA (0,1), ARMA (1,1) models for the conditional mean values. The four AIC values are:

**Table 2 AIC value of ARMA**

	ARMA (0,0)	ARMA (1,0)	ARMA (0,1)	ARMA (1,1)
AIC	13751.62	13764.75	13763.11	13768.63

It can be seen that the AIC value of ARMA (0,0) is the smallest, so the conditional mean should be ARMA (0,0) model.

Then we establish the GARCH model. We first determine the order of the GARCH model, describe the stock return sequence with the ARMA (0,0) + GARCH (p, q) model, where p and q are 1 to 3, and the appropriate model is selected according to the AIC value. The results are as follows:

**Table 3 AIC value of GARCH**

model	GARCH(1,1)	GARCH(1,2)	GARCH(1,3)
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AIC	-5.209770	-5.209314	-5.208767
model	GARCH(2,1)	GARCH(2,2)	GARCH(2,3)
AIC	-5.209183	-5.208588	-5.208046
model	GARCH(3,1)	GARCH(3,2)	GARCH(3,3)
AIC	-5.208428	-5.207832	-5.207320

According to the results in Table 3, we can see that for the small plate yield data, the AIC value of the GARCH model is -5,209770, which is the smallest, so the GARCH (1,1) model is selected.

And this is the Standardized Residuals Tests of GARCH (1, 1) model:

**Table 4 Standardized Residuals Tests**

			Statistic	p-value
Jarque-Bera Test	R	Chi <sup>2</sup>	464.9117	0
Shapiro-wilk Test	R	w	0.9767459	0
Ljung-Box Test	R	Q(10)	26.97139	0.002631614
Ljung-Box Test	R	Q(15)	36.26838	0.001616782
Ljung-Box Test	R	Q(20)	40.02091	0.004965101
Ljung-Box Test	R <sup>2</sup>	Q(10)	6.107173	0.8061801
Ljung-Box Test	R <sup>2</sup>	Q(15)	9.77121	0.8338793
Ljung-Box Test	R <sup>2</sup>	Q(20)	11.07668	0.9442096
LM Arch Test	R	TR <sup>2</sup>	8.004575	0.7847728

**Table 5 Information Criterion Statistics:**

AIC	BIC	SIC	HQIC
-5.209770	-5.201173	-5.209774	-5.206664

So, GARCH(1,1) model is appropriate for SME board.

Estimate the parameters of GARCH ( 1 , 1 ) ,here is the result:

**Table 6 Parameters of GARCH (1, 1)**

	Estimate	Std. Error	t value	Pr(> t )
Mu	1.923e-04	3.017e-04	0.637	0.52381
Omega	2.542e-06	7.738e-07	3.285	0.00102 **
Alpha1	5.508e-02	6.837e-03	8.056	8.88e-16 ***
Beta1	9.388e-01	7.507e-03	125.060	< 2e-16 ***

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1.

We can get that the sum of the parameters of the CARCH model is equal to  $\alpha + \beta = 5.508e-02 + 9.388e-01 = 0.9896$ . The sum is larger than 0.95, indicating that SME board have strong fluctuations in aggregation and sustainability.

### 3 . Conclusions

The GARCH model is used to analyze the volatility of the yield of SSE SME COMPOSITE. Through analysis, the following conclusions can be drawn:

Firstly, the volatility of the SSE SME COMPOSITE has a significant conditional heteroscedasticity [4]. The yield of the SSE SME COMPOSITE has obvious ARCH effect, which has the characteristics of clustering effect and heavy-tail effect. There is no correlation between the yields of SSE SME COMPOSITE, and there is a significant GARCH effect. GARCH (1, 1) model can successfully eliminate the ARCH effect of exponential volatility, which is more suitable for further study on the volatility of SSE SME COMPOSITE.

Secondly, the yield of SME Board is positive, indicating that the SSE SME COMPOSITE is in the gradual growth and SME Board has a good momentum of development. From the GARCH model we can see that the SME Board does have a serious leverage effect, which is the larger volatility is followed by a relatively large volatility, and the impact of past volatility on the future is gradually declining. The serious phenomenon of leverage effect in SSE SME COMPOSITE reflect SME Board has poor absorption of information shock.

### References

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