

Empirical Study on Stock Return Volatility in China's Stock Market

Diao Yanhua^{1,3,*}, Guo Siliang²

¹Department of Economic Management, Shandong Xiehe University, Ji'nan, China

²Department of Economics, Qilu Normal University, Ji'nan, China

³Dhurakij Pundit University, Chinese International College, Bangkok, Thailand

Email address:

diaodarling@126.com (Diao Yanhua), 99581735@qq.com (Diao Yanhua)

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Abstract: Wave of financial globalization and financial innovation has brought great changes of the international financial market, the traditional measuring method is not well adapt to these new changes, this requires the presence of the new analysis method. This article will link function to copulas connect theory is introduced into the financial analysis. In this paper, the author makes an empirical analysis of Shenzhen composite index using GRCH family model, and the results show that Chinese stock yield has significant peak fat-tailed features, and have volatility clustering.

Keywords: GRCH Model, the Comprehensive Index, Volatility

1. Introduction

The classical capital market theory in describing the yield changes in the securities market, the econometric model generally adopted by the assumed yield variance remains the same. This model conforms to the efficient market theory in financial markets, convenient use, commonly used to predict and estimate the stock price. But on the financial data of a large number of empirical studies show that some assumptions not very reasonable. Some financial time series is often appear volatility clustering phenomenon

In order to seek the stock market price volatility behavior more accurate description and analysis, many financial experts and measurement scientists try to use a different model and the method to deal with this problem.

In 1982, Engle put forward of the ARCH (Auto - regressive Conditional Heteroskedastic) model, is considered to be the most concentrated reflects the characteristic of variance changes is widely applied to financial data time series analysis model.

In recent years, domestic scholars use the ARCH model of China's stock market volatility has a lot of research results. But most are based on the Shanghai stock index as the research object to reveal the characteristics of China's stock market volatility. Domestic research focuses in the Shanghai composite index, using the ARCH model in view of the

Shenzhen index for empirical research literature is less, so this paper tries to use the ARCH model through the analysis of the Shenzhen index to reveal the characteristics of the domestic stock market volatility.

2. The ARCH Model and Promotion

2.1. The Arch Model

There is no uniform definition about the process of the ARCH. The ARCH model is in the process of research UK inflation index was proposed. The model by moving average of the past has a deadline to yield square, to depict the yield sequence of conditional heteroscedasticity properties. In 1982, Engle are defined as follows:

$$\begin{aligned}\varepsilon_t &= \sqrt{h_t} v_t \\ v_t &\sim i.i.d. \\ E(v_t) &= 0, E(v_t^2) = 1 \\ h_t &= \alpha_0 + \sum_{j=1}^q \alpha_j \varepsilon_{t-j}^2\end{aligned}\quad (1)$$

$\{\alpha_j\}$ is unknown parameters. Meet the above process is referred to as q - order autoregressive conditional heteroscedastic model, notes for the ARCH (q). In order to

ensure the conditional variance is positive, we require $\alpha_0 > 0$, $\alpha_j \geq 0, j=1,2,\dots,q$. In order to guarantee $\{\varepsilon_t^2\}$ smooth, we require $\alpha_1 + \dots + \alpha_q < 1$. Return order number q determines the impact of shocks remaining length in the subsequent error variance. q value is larger, the longer the duration of the fluctuation. The main characteristic of this model is set random disturbance of variance under the influence of random fluctuations are past, to reflect the fluctuation of time-varying and cluster.

The model because of its clear economic meaning, and can accurately describe the characteristics of market volatility, soon became a hot issue in academic research. But the ARCH model in practice to get better fitting effect often need a larger p , this not only increases the be estimated the number of parameters, but also can lead to explain variables multicollinearity problem. In order to solve the problems that exist in the ARCH model, GARCH model is put forward.

2.2. The GARCH Model

In 1986, GARCH model is put forward by Bollerslev. And the ARCH model got the promotion. Actually GARCH model can be seen as the ARCH model of infinite order, its lagging has faster convergence than the ARCH model, and is similar to the ARMA model structure. Still represents $\{x_t\}$ as a random process, and it follows an- AR (1) process. The expression for the model $GARCH(p, q)$ is

$$\begin{cases} x_t = \mu + \phi x_{t-1} + \varepsilon_t \\ \varepsilon_t = \sqrt{h_t} z_t \\ h_t = \alpha_0 + \sum_{i=1}^q \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^p \beta_i h_{t-i} \\ z_t | I_{t-1} \sim i.i.d(0,1) \end{cases} \quad (2)$$

Here, $p \geq 0, q \geq 0, \alpha_0 > 0, \alpha_i \geq 0, i=1, \dots, q, \beta_i \geq 0, i=1, \dots, p$,

Standard residual error item z_t generally can choose a standard normal distribution, t distribution or ged distribution. Because the yield of financial time series sequence generally rush thick tail characteristics, so the selection standard residual items subject to the standard normal distribution is not appropriate. We usually choose has fat-tailed distribution t distribution and fitting ged distribution. With characteristics of thick tail yield sequence modeling of financial time series, we generally assume that their standard residuals obey t distribution, namely the GARCH - t model to fitting the yield distribution. Generally, z_t are assumed to be the mean to 0, variance of 1 regularization t distribution, which is

$$f(z_t) = \frac{\Gamma[(v+1)/2]}{\Gamma(v/2)\sqrt{\pi(v-2)}} \left[1 + \frac{z_t^2}{v-2}\right]^{-\frac{v+1}{2}} \quad (3)$$

Here, v degrees of freedom. A large number of empirical studies have shown that GARCH (1, 1) model can be well fitting yield distribution of financial time series, and GARCH - t model, GARCH - ged model, than GARCH - normal model

fitting effect is better.

GARCH model on the basis of the ARCH model extends the conditional heteroscedasticity equation, the expression is as follows:

$$h_t = \alpha_0 + \sum_{i=1}^q \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^p \beta_j h_{t-j} \quad (4)$$

In order to ensure the conditional variance is positive, we require $\alpha_i > 0, \beta_j > 0$. In order to guarantee model is smooth wide, and the presence of parameter constraints $\alpha_1 + \dots + \alpha_q + \beta_1 + \dots + \beta_p < 1$.

2.3. The EGARCH Model

In the financial markets generally there is an asymmetric effect. That is, the bad news is bigger than the good news of fluctuations. In order to reflect the fact in 1991, Nelson began promoting the GARCH model, and he set up the EGARCH model. Compared with the formula (2), the EGARCH model of conditional variances with nonlinear form, namely

$$\ln h_t = \alpha_0 + \sum_{i=1}^q \frac{|\varepsilon_{t-i}| + \gamma \varepsilon_{t-i}}{\sqrt{h_{t-i}}} + \sum_{i=1}^p \beta_i \ln h_{t-i} \quad (5)$$

In reality, we often want γ_i is negative, so can ensure that the bad news of volatility than good news. EGARCH model can not only reflect the volatility asymmetry, and cancelled the GARCH coefficients in the process of nonnegative constraints, therefore has the strong ability of characterization of financial volatility. EGARCH model has been widely used in practice.

Here is a yield sequence, we use AR (1)-EGARCH (1,1)-t model to fitting the yield distribution. Model expression as follows,

$$\begin{cases} r_t = \mu + \phi r_{t-1} + \varepsilon_t \\ \varepsilon_t = \sqrt{h_t} z_t \\ \ln h_t = \alpha_0 + \alpha_1 \frac{|\varepsilon_{t-1}| + \gamma \varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \beta_1 \ln h_{t-1} \\ z_t | I_{t-1} \sim i.i.d(0,1) \end{cases} \quad (6)$$

By the formula (6) we see $r_t | I_{t-1} \sim t_v(\mu + \phi r_{t-1}, h_t)$. In practice, the standard residual error can not directly observed, so we first find out standards and residual items which is

$z_t = \frac{\varepsilon_t}{\sqrt{h_t}}$, and assumes that the standard residual items

subject z_t to the following distribution,

$$\sqrt{\frac{v}{v-2}} z_t \sim t(v) \quad (7)$$

In addition, the ARCH family members including TARCH and GARCH-M model, and so on.

3. The Empirical Analysis

3.1. Sample Data, and the Preliminary Statistical Analysis

3.1.1. The Sample Data

Based on the Shenzhen stock exchange composite index as the research object, the data selection of the Shenzhen composite index of the day's closing price from January 4, 2012 to June 20, 2015 a total of 742 data. Data from the securities of the station. Stock return to the logarithmic first-order difference between two day closing index, calculation formula is:

$$R_t = \ln(p_t) - \ln(p_{t-1}) \tag{8}$$

In this paper, the data by Eviews5.0 statistical software for processing.

3.1.2. The Description of the Sample Sequence Statistical Analysis

Index return form new sample time series. Basic statistical analysis was carried out on the new sequence, get the return sequence diagram and descriptive analysis results.

Table 1. Basic analysis results and the sequence diagram.

The mean	standard deviation	skewness
0.000524	0.012852	0.445915
kurtosis	JB test	P values
5.494873	275.2328	0.0000

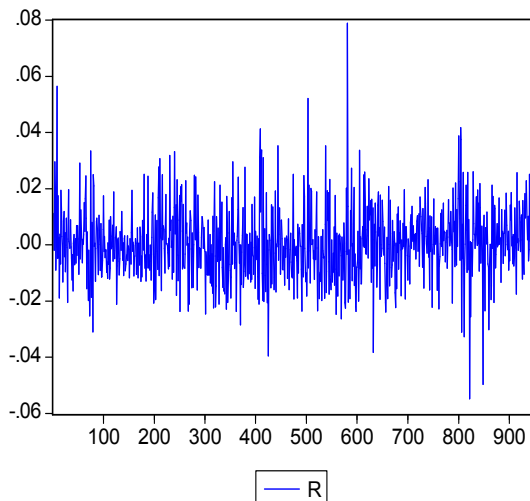


Figure 1. Basic analysis results.

Shown in table 1, the return sequence of skewness is 0.445915, distribution present mild right, the right of skewness distribution. That yields have a long tail, right but distribution is symmetrical; Kurtosis is 5.494873, a significant peak fat-tailed features show that sequence.

With JB statistics inspection to check whether the sequence is normal distribution, the probability value is 0, reject the null hypothesis, that sequence does not obey the normal distribution.

Can be seen from table 1 big fluctuations followed by a significant fluctuations, the characteristics of small wave followed by the characteristics of smaller amplitude fluctuations. This shows that present day returns volatility clustering. ARCH model can well describe the characteristics of the time series.

3.2. The Family of the Arch Model Analysis

By judgment sample yield sequence R_t autocorrelation function and partial autocorrelation function, we found that the yield is a three order autoregressive process. The R_t AR (3) model is established. So the estimated yield about themselves lagging of autoregressive model is:

$$R_t = 0.079918R_{t-3} + \varepsilon_t$$

$$(2.449713)$$

$$R^2 = 0.0063$$

$$DW = 1.9594$$

When considering using the ARCH model for modeling, we first presence of conditional heteroscedasticity testing residual sequence. The ARCH effect of residual error sequence LM test, we found that the inspection order q concomitant probability p are close to zero, the high order residual sequence are the ARCH effect.

Because the residual error of higher order ARCH effect, so it can build GARCH model. According to the rule of ATC and SC, and cooperate with the residual independence test, through comparing the can get more suitable model. This article select the GARCH (1, 1) model, the mean equation and the conditional variance equation can be represented as:

$$R_t = 0.073314R_{t-3} + \varepsilon_t$$

$$(1.119)$$

$$h_t = 0.00000703 + 0.059516\varepsilon_{t-1}^2 + 0.897780h_{t-1}$$

$$(2.7048) (4.344) (39.778)$$

$$AIC = -5.91 \quad SC = -5.88$$

We can be seen from the estimated results, parameter estimation is significant, showed that the yield sequence of R_t has significant volatility clustering. In the conditional variance equation, coefficient and less than 1, satisfy the constraint conditions, shows that GARCH (1, 1) is the covariance stationary, that is, the future effects of fluctuations in the past is gradually decline, thus the model predictability. Model of AIC and SC are small and can be thought of as good fitting the model and the data.

3.3. TAR(1, 1) Model

In order to explain the leverage effect, we can use asymmetric ARCH model, the variance and the conditional variance equation can be expressed as:

$$R_t = \beta R_{t-3} + \varepsilon_t \quad h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \phi \varepsilon_{t-1}^2 d_{t-1} \theta_1 h_{t-1}$$

Here , d_t is a virtual variable, when $\varepsilon_t < 0$, $d_t = 1$, when $\varepsilon_t \geq 0$, $d_t = 0$. Due to the introduction of d_t , rose information ($\varepsilon_t \geq 0$) and decline information ($\varepsilon_t < 0$) of conditional variance function is different. when rise $\phi \varepsilon_{t-1}^2 d_{t-1} = 0$, we can use coefficient $\sum_{i=1}^q \alpha_i$ on behalf of its impact, when decline, we can use coefficient $\sum_{i=1}^q \alpha_i + \phi$ on behalf of its impact. If $\phi \neq 0$, means information is Asymmetric. If $\phi > 0$, We believe there is leverage.

For the parameter estimation results:

$$R_t = 0.007220R_{t-3} + \varepsilon_t$$

$$(1.995)$$

$$h_t = 0.00000640 + 0.056823\varepsilon_{t-1}^2 + 0.904778\varepsilon_{t-1}^2 d_{t-1} + 0.795\theta_1 h_{t-1} \quad (8.67)$$

$$(6.35) \quad (6.58) \quad (39.28)$$

$$AIC = -5.93 \quad SC = -5.86$$

Looked from the type, the model of asymmetric TARCH (1, 1), ϕ estimate is 0.904778. The t statistic value is 6.58, significantly positive, reflecting the Chinese stock market information asymmetry and leverage.

4. Countermeasures and Suggestions

Price fluctuation is the basis of the normal operation of the stock market, but the risk resulting from excessive price fluctuations can cause damage to the healthy development of stock market.

The Chinese stock market is an emerging market, its history is still short, at the same time, and in the economic reform and the transformation from planned economy to market economy in the process of operation and development.

Because of the influence of the specific historical environment, on the structure specificity on the running mechanism, which makes have the features of its own on the market price risk. Compared with foreign mature stock markets, Chinese stock market on the price volatility is larger and the characteristics of explosive.

The lagging of the volatility of the stock market, yields, from another Angle shows that China's stock market prices reflect the information of sensitive enough to information exists in the transmission delay.

But in the period of time in the model can be seen that the development of China's stock market to mature gradually. China's stock market is still in the primary stage of development, at present China's securities market there are a lot of noise traders, their access to information and analysis of information ability is limited, for the performance of listed companies and the law of development ability lack of sufficient information for a long time, it was not until after the market trend to react.

Moreover, China's stock market "follow suit" phenomenon is serious, the market investors' investment and risk concept is still very immature. When the market does not have validity, when there is a great obstacles and cost information, the basis of the government intervention is reasonable. In the early stages of the development of Chinese stock market, therefore, must be a special emphasis on the establishment of the government policy on the stock market and the operation, to avoid excessive price volatility and invalid resource allocation as well as possible financial panic and crisis.

The stock market should be given to protect the interests of the investors, improve information disclosure system, ensure the equal right to obtain information, to punish insider information insider trading behavior such as false statement, prompting the rapid and accurate in the stock market information flow, promote stock market steady development and perfection.

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Biography



Diao Yanhua: 1983-, female, PhD student, lecturer, mainly engaged in industrial economy, regional economy.



Guo Siliang: 1981-, male, lecturer, mainly engaged in technical and economic evaluation, econometrics.