Analysis and Research on Volatility of China's Internet Financial Market Index——Based on ARMA-GARCH Model

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Abstract. The Internet has brought opportunities and challenges to many industries such as commerce, finance, and industry. Among them, Internet finance makes full use of the advantages of the Internet, improves the allocation of financial resources to a certain extent, and promotes the inclusive development of finance. By examining the probability distribution characteristics of the logarithmic rate of return of the Internet financial market index, this paper uses the fitted ARMA-GARCH model to explore the fluctuation characteristics of the index return of China's Internet financial market, so as to put forward relevant suggestions for the management of the Internet financial market.

Keywords: Internet banking, Volatility, ARMA-GARCH.

1. Introduction

The Internet has brought opportunities and challenges to many industries such as commerce, finance, and industry. Among them, Internet finance makes full use of the advantages of the Internet, improves the allocation of financial resources to a certain extent, and promotes the inclusive development of finance. Internet finance is a new type of business created by the combination of traditional financial industry and Internet technology. It aims to provide financing, payment, investment and information intermediary services with the help of network technology. It is generally believed that Internet payment, P2P online lending, crowdfunding and Internet consumer finance all belong to the category of Internet finance. However, with the popularization of the new model of Internet finance, P2P platform defaults, running away and other Internet financial risk problems frequently occur. The development and risks of Internet finance have become the object of widespread concern. In this paper, the CSI Internet Finance Index is selected as the sample for time series analysis. By examining the fluctuation probability distribution characteristics of the logarithmic return rate of the Internet financial market index, the fitted ARMA-GARCH model is used to explore the fluctuation characteristics of the return rate of the China Internet financial market index. Provide relevant suggestions for the management of the Internet financial market.

The first systematic framework model for volatility modeling was the ARCH model proposed by Engle [1] in 1982, after which Bollerslev [2] proposed a useful generalized model, the generalized ARCH model (GARCH).

In recent years, e-commerce and mobile Internet such as Yu'ebao, WeChat Pay, Renrendai have entered financial enterprises, making Internet finance a new concept, and its related research worldwide is comparable to other financial fields. The high yield brought by Internet finance and the hidden risks behind it have gradually attracted widespread attention. Zhao Wei and Liang Xun[3] conducted a quantitative analysis of the correlation between Internet financial information and yield fluctuations. to explore.. Xie Ping et al discussed the necessity and core principles of Internet financial supervision and put forward his own suggestions: we should not adopt a laissez-faire supervision concept for Internet finance because of immature development, and should encourage Internet financial innovation by promoting development through supervision. Zhang Zhao and Li Anyu [4] conducted an empirical analysis on the price volatility of the Internet financial market based on the GARCH family model. Chen Qianwen analyzed the income volatility of Yu'ebao by introducing the GARCH-VAR model, and found that the current volatility of Internet financial products is relatively high. The market risk is still in the controllable range. Chen Xiao and Ye Dezhu

[5] used the AR-GARCH model to characterize the interest rate volatility characteristics of the P2P network lending market. Guo Pin and Shen Yue (2015) [6] studied the impact of Internet finance on the risk-taking of commercial banks based on the "text mining method", and the results showed that the impact of Internet finance on small commercial banks decreased first and then increased. sensitive. Liu Xiangli and Gu Shuting (2014) [7] used the AR-GARCH method to measure the risk spillover effect of the real estate market on the financial system.

There are few researches on the volatility characteristics of Internet financial market at home and abroad, and most of them are researches on Internet financial risks. Most literatures study the risk spillover of Internet finance to commercial banks, and there are relatively few studies on its own volatility characteristics. The research topic of this paper considers its own volatility properties, and characterizes its volatility properties based on the ARMA-GARCH model.

2. Research methods

The ARMA(p,q) model is generally composed of the linear difference equation AR(p) and the moving average equation MA(q), where AR(p) is expressed as follows:

$$y_t = a_0 + \sum_{i=1}^{p} a_i y_{t-i} + x_t \tag{1}$$

The expression of MA(q) is as follows:

$$x_t = \sum_{i=0}^{q} \beta_i \varepsilon_{t-i} \tag{2}$$

The joint method of formula (1) and formula (2) is, let $\{x_t\}$ represent the MA(q) process of formula (2), the expression is as follows:

$$y_t = a_0 + \sum_{i=1}^{p} a_i y_{t-i} + \sum_{i=0}^{q} \beta_i \varepsilon_{t-i} \tag{3}$$

where β_0 error process:

$$\varepsilon_t = v_t \sqrt{h_t}, \quad s.t.\sigma_v^2 = 1 \tag{4}$$

$$h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \lambda_i h_{t-i} \tag{5}$$

where $\{v_t\}$ represents the white noise process, and the mean of ε_t is 0. The GARCH(p,q) model is shown in the above formula (6), including the moving average components of autoregression and heteroscedasticity, and its characteristic root is in the unit circle, so that the conditional variance of the interference term of the sequence $\{y_t\}$ constitutes an ARMA process; therefore, GARCH The model can better fit the long-term autocorrelation process of time series with heteroscedasticity.

To sum up, the ARMA-GARCH model for estimating the return time series of the Internet financial market index can mine the residual information while setting the mean and variance equations, making up for the shortcomings of the ARMA equation. The general form of the ARMA(r,s)-GARCH(p,q) model in this paper is as follows:

$$\begin{cases} r_t = \mu + \sum_{i=1}^{r} \varphi_i r_{t-i} + \sum_{j=1}^{s} \theta_i \varepsilon_{t-j} \\ \delta_t^2 = \alpha_0 + \sum_{h=1}^{p} \alpha_h \varepsilon_{t-h}^2 + \sum_{k=1}^{q} \lambda_k \delta_{t-k}^2 \\ \varepsilon_t | I_{t-1} = \delta_t \eta_t, \quad \eta_t \sim i.i.d(0,1) \end{cases} \tag{6}$$

where $\{r_t\}$ represents the logarithmic return sequence of the Internet financial market index, $\{\varepsilon_t\}$ is its residual sequence, μ and α_0 are constants, μ is the mean value, α_0 and λ_k are both greater than or equal to 0, and δ_t^2 is the condition of ε_t variance. I_{t-1} is all information sets before time t, and r, s, p, and q are all non-negative integers.

3. Empirical Analysis

3.1 Data selection and description

At present, it is difficult to find indicators that can fully describe the state of the Internet financial market. The existing research results mainly use a single P2P online loan index, payment index or crowdfunding index to represent the Internet financial market, which has certain defects. In this paper, the CSI Internet Finance Index (399805) is selected as the Internet financial market indicator. The CSI Internet Finance Index selects representative listings related to payment, financing, investment, insurance, financial information services and other Internet finance related to the Shanghai and Shenzhen markets. Company securities are used as index samples to reflect the overall performance of the securities of listed companies on the theme of Internet finance. Select the closing price data of the weekday index from May 25, 2017 to May 23, 2022, with a total of 1214 sample data. The data are all from the official website of China Securities Index. Obtain the daily logarithmic rate of return of the Internet financial market by calculation:

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

Obtained 1213 logarithmic rate data, this paper uses MATLAB software for modeling.

It can be seen from Figure 1 that the yield sequence of the Internet financial market index fluctuates around the 0 value, with a large fluctuation range, no obvious trend change, and shows "aggregation".

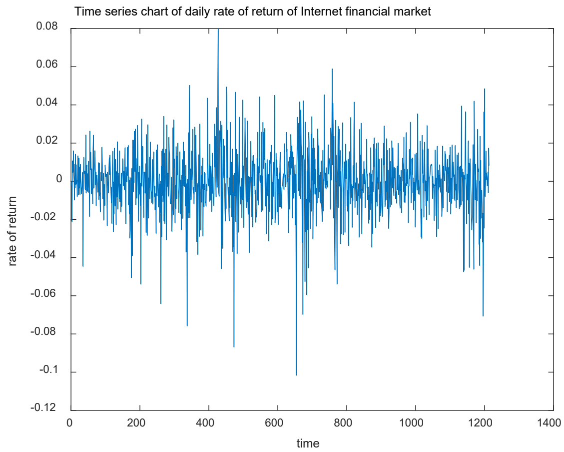

Figure 1. Time series chart of yield fluctuation of Internet financial market index

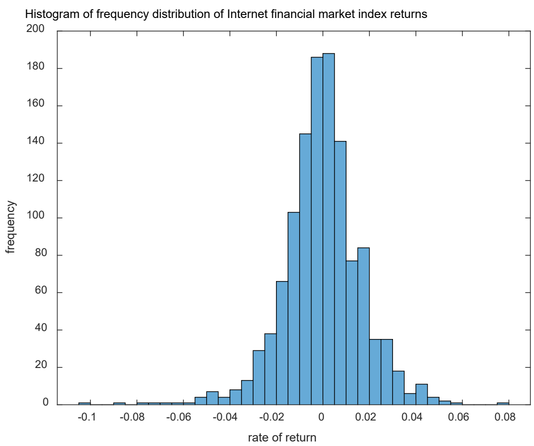

Figure 2. Histogram of frequency distribution of Internet financial market index returns

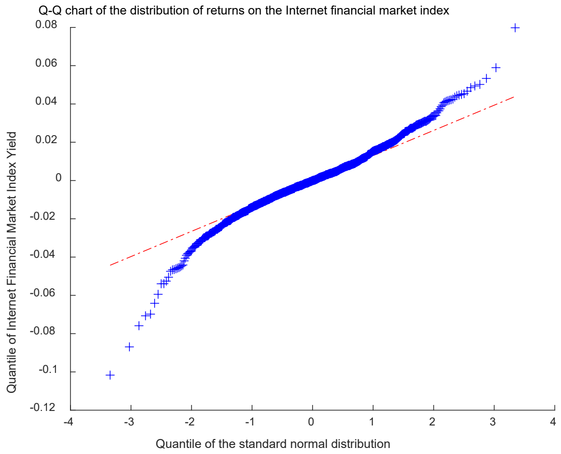

Figure 3. Q-Q chart of the distribution of returns on the Internet financial market index

It can be seen from Figure 2 that the return series of the Internet financial market index does not obey the normal distribution.

3.2 Analysis of experimental results

By selecting the load prediction results of 403 and 411 lines. We can see that the actual values of the lines basically match the predicted values, but there are also some errors, especially in the peak period of electricity consumption, as shown in Table.1.

Table.1. Descriptive Statistics for Return Series

index	mean	maximum	minimum	standard deviation
R_t	-1.4307e-04	0.0798	-0.1017	0.0169
index	Kurtosis	Skewness	JB	P value
R_t	6.1229	-0.3913	523.8708	1.0000e-03

It can be seen from Table 1 that the kurtosis of the Internet financial market index return sequence $\{R_t\}$ is about 6.12, which is greater than the kurtosis 3 of the normal distribution, and the skewness is about -0.39, which is less than 0, indicating that the return sequence has sharp peaks and thick tails, Left-biased phenomenon; the JB statistic is about 523.87, and the P value is significantly smaller than the significant level, so the Internet financial market index return sequence $\{R_t\}$ does not obey the normal distribution. Not only that, but by drawing the Q-Q graph of the distribution of returns on the Internet financial market index, we can see that there are indeed sharp peaks and thick tails.

Before establishing the model, the stationarity of the time series data needs to be tested. In this paper, the ADF unit root is used to test the stationarity of the return series of the Internet financial market index. Using MATLAB to perform the ADF test, the regression logistic value is 1, so the null hypothesis is rejected, that is, the existence of a unit root, that is to say, the return series $\{R_t\}$ is stationary and can be modeled.so the null hypothesis is rejected, that is, the existence of a unit root is rejected, that is to say, the return sequence $\{R_t\}$ is stationary and can be modeled.

To sum up, even though the original data of the Internet financial market index has strong non-stationarity, its logarithmic rate of return has strong stability. Therefore, this paper selects the ARMA-GARCH model to fit the sample data, and studies the fluctuation characteristics of the logarithmic return of the Internet financial market index.

It can be seen from Figure 4 that the lag orders 4 and 6 have obvious autocorrelations; it can be seen from Figure 5 that the lag orders 4 and 6 have obvious partial autocorrelations. Therefore, the Internet financial market index return sequence $\{R_t\}$ has obvious autocorrelation, and the ARMA model is carried out below.

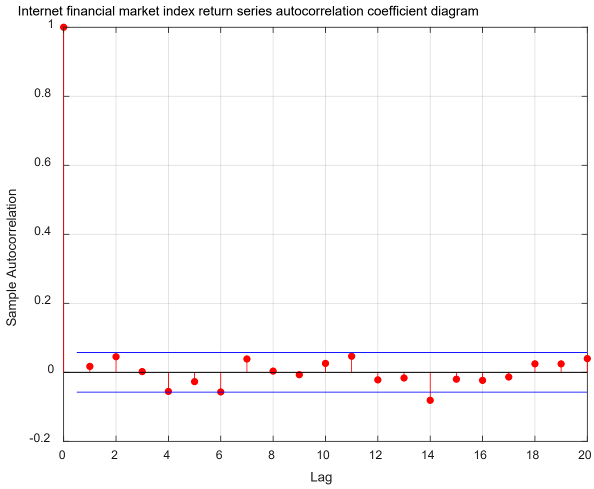

Figure 4. Internet financial market index return autocorrelation coefficient diagram

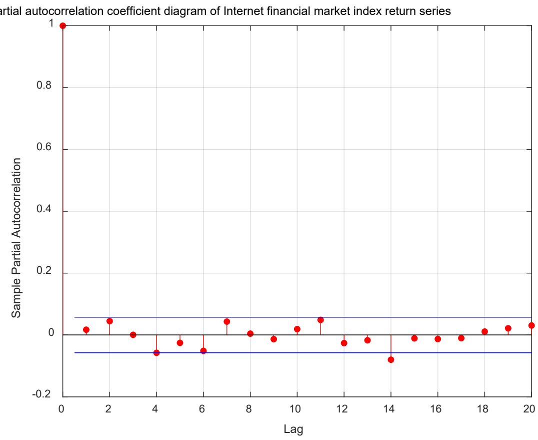

Figure 5. Partial autocorrelation coefficient of Internet financial market index returns

According to the AIC order determination criterion, ARMA(2,2) is the most suitable lag order. The ARCH test was performed on the residual sequence of the ARMA(r,s) model. After analysis by MATLAB software, the ARCH effect test returned a value of 1, indicating that the residual passed the ARCH test, so it can be considered that the residual sequence has conditional heteroscedasticity.

Table.2. AIC value

ARMA(r,s)	AIC	ARMA(r,s)	AIC
ARMA(1,1)	-8.1547	ARMA(3,1)	-8.1565
ARMA(1,2)	-8.1549	ARMA(3,2)	-8.1589
ARMA(1,3)	-8.1568	ARMA(3,3)	-8.1573
ARMA(1,4)	-8.1557	ARMA(3,4)	-8.1578
ARMA(2,1)	-8.1546	ARMA(4,1)	-8.1558
ARMA(2,2)	-8.1606	ARMA(4,2)	-8.1561
ARMA(2,3)	-8.1588	ARMA(4,3)	-8.1580
ARMA(2,4)	-8.1559	ARMA(4,4)	-8.1577

After determining the order of the ARMA model, the model parameters are estimated, and the results are shown in Table 4.

Table.3. ARMA(2,2) model estimation results

ARMA(2,2)				
parameter	Value	StandardError	TStatistic	PValue

a_0	0.04378	0.13257	0.28814	0.77258
a_1	0.3743	0.022542	-39.316	1.5328e-14
a_2	0.9159	0.032832	-8.3435	1.4231e-16
β_1	0.3721	0.020655	-3.4705	5.1928e-08
β_2	0.9551	0.0052635	187.22	0

Table.4. ARMA(2,2)-GARCH(1,1) model estimation results

GARCH(1,1)				
parameter	Value	StandardError	TStatistic	PValue
α_0	9.0218e-06	1.833e-06	4.9218	8.577e-07
α_1	0.06369	0.0085739	7.4283	1.0998e-13
λ_1	0.90637	0.013664	66.333	0

The ARMA(2,2)-GARCH(1,1) model can be obtained:

Mean equation:

$$r_t = 0.04378 + 0.3743r_{t-1} + 0.9159r_{t-2} + 0.3721\varepsilon_{t-1} + 0.9551\varepsilon_{t-2}$$

Volatility equation:

$$\delta_t^2 = 9.0218\mathrm{e} - 06 + 0.06369\varepsilon_{t-1}^2 + 0.90637\delta_t^2$$

4. Conclusions

Through the above statistical analysis of the volatility of the Internet financial market, in general, Internet finance is in the process of gradually improving, and with the expansion of its coverage, it is more and more necessary to pay attention to the market risks it brings: ① The government is in the process of gradually improving While strengthening supervision, it is necessary to encourage the development of Internet-based traditional finance, keep abreast of market development trends and provide timely solutions to emerging problems. ② With the deepening of the development of Internet finance, enterprises need to improve the attractiveness of products to users in order to maintain Due to its steady development speed, enterprises should be oriented by customer needs and closely follow the usage habits of the public. ③For Internet financial investors, high returns correspond to high risks, and they should invest rationally according to their own conditions to cultivate healthy investment philosophy.

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