Research on Identifying Stock Manipulation using GARCH Model

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***Abstract*—Continuous rising of economy and investors' demand for funds give a window to easier market manipulation which includes abusing of one's power to raise or lower the price of securities, colluding to affect the price or volume of securities transactions at a pre-agreed time, price and method. In the study, the article aimed to create a sound investment environment, detect abnormal behaviors in stocks, and avoid risks of intentional manipulation. This study is to identify market manipulation and summarize the accuracy of GARCH model analysis with the help of fluctuation forecast trend chart and construction of GARCH model which calculates the sum of the GARCH-α parameter and the GARCH-β parameter of turnover rate, logarithmic return rate, and the trading volume fluctuation. Through the study of this paper, it is found that the stock market manipulation has the following characteristics: the participants are complex and diverse, the manipulation is opaque and has serious consequences, and the stock market manipulation involves a wide range of aspects.**

***Keywords*—Stock prices; market; manipulation; GARCH model; stock exchange**

I Introduction

Stock manipulation refers to the big players, institutions and institutional groups who control the trend of individual stocks, choose targeted stocks, buying a large number of stocks when the prices are low. Then they control the supply of stocks, creating a false supply and demand, driving up the stock prices, and gradually distribute from the high stock prices to realize capital gains and excess profits. It could lead to disorder of market mechanism, over-speculation, damage of investors' interests and systematic risks. Stock market manipulation damages the fair-trading mechanism and jeopardizes market prices reflection function, which also proves the importance of building a market manipulation detection model. The article collected the stocks of 15 companies and their data of opening price, closing price, ceiling price, floor price, turnover and trading volume from January 4, 2016 to December 31, 2021. And the article utilized GARCH model (Generalized autoregressive conditional heteroskedasticity) in order to solve the problems issuing by Econometrics' second hypothesis upon the constant variance assumption of time series variable. The GARCH model developed by Bollerslev (1986) is called the Generalized ARCH model, which is an extension of the ARCH model. The GARCH model is a regression model specially tailored for financial data which models the variance of error in a more in-depth manner, and is especially suitable for the analysis and forecasts of fluctuation. It plays a very important guiding role for investors' decision-making.

The empirical research of Chou [1], PoonTaylor (1992) et al. [2] found that the GARCH family models often exhibit a high level of persistence. Also, Lamoumux, Lastrages (1990) and the like found that the persistence of fluctuation after considering the structural transformation was indeed reduced. While conducting a theoretical discussion upon the GARCH model, the model has also been extended to other financial subdivided fields. Cai [3] applied the GARCH model to a 3-month T-billi monthly excess return and came to a similar conclusion. Ding [4] used indicators such as rate of return, turnover rate fluctuation, trading volume fluctuation, price change, and net change in cash flow to construct a GARCH model for stock manipulation identification. Zhang [5] based on the characteristics of the time-series GARCH model, simulated the time-series rate of return. He found that if the rate of return is correlated and the variance of the alteration condition of the rate of return is unstable, it is considered that the stock is likely to be at a non-speculative price. Fluctuation of the time-series rate of return could indicate whether the stock is under manipulation. Jiang [6] found the large fluctuations of time series in some sections, while the fluctuations in other sections are relatively small. Therefore, the heteroskedasticity of the time series needs to be taken into consideration. Introducing GARCH model solves the problem of heteroskedasticity in residuals of cointegration equation. Also, the time-varying standard deviation is introduced to more accurately reflect the real changes of fluctuation, and thereby optimizes the trade signals. Guo [7] stated that China Stock Markets has been in operation for 20 years. Index return of China Stock Markets encompasses heteroskedasticity and leptokurtic with fat-tail in financial time series. With purposes of deeply analyzing the nature of the index return, the GARCH model is used for the Market index for empirical analysis. Geng and Liu proposed that the GARCH model is effective to describe the fluctuation of financial data [8]. It is the most commonly used and most convenient time-series heteroscedastic fitting model. Building up GARCH model and later predicting the rate of return and stock prices, could produce results that provide some references for investors' decision making.

Wang and Wu [9] used the GARCH model to conduct empirical research on the fluctuation and rate of return of the CSI 300 Index. They also achieved good results in accomplishment of fitting and prediction of the time series. Nie and Hu concluded the applications of the GARCH model in 10 fields [10], namely, finance, macroeconomic management and sustainable development, investment, securities, mathematics, market research and information, trade economy, industrial economy, agricultural economy industry, oil and natural gas

industry, among which, the GARCH model accounts for the largest proportion in researches of the financial field, and further guides the research on realistic financial issues. Li and Xin [11] pointed out that the GARCH model can not only describe the heteroskedasticity of the time-series rate of return, but also, together with other financial analysis theories, make a more important contribution to the study of practical financial problems. Pan et al. used the GARCH model to fit a line to dynamic data of gold prices [12]. And the outcome which has practical significance for the future prediction and risk control of the market is remarkable.

In Liu's (2004) study [13], two types of models, GARCH model and asymmetric GARCH model, were used to study actual data. He found that Shanghai stock market doesn't have the characteristics of high risk and high return, but the asymmetric GARCH model shows that when the risk is higher than a certain level, there is a positive correlation between the rate of return and the risks. According to the dataset 1 and the penalty bulletins, it is possible to analyze the market manipulation, identifying its characteristics and judge its existence. Also, it can better assist the CSRC (China Securities Regulatory Commission) to supervise, creating a good investment environment, and maintain market orders. So, and TSE use the GARCH model to discover the phenomenon of volatility interaction with the Hong Kong Hang Seng Index and the Hang Seng Index futures market [14]. In terms of linked analysis between the markets, Sibel (2012) believes that financial infection is important for monetary policy [15], risk measurement, asset pricing and investment portfolio allocation. Therefore, the impact of the US subprime mortgage crisis on emerging markets is necessary. The Garch model is used to test the existence of financial infection between foreign exchange markets during the US subprime mortgage crisis. This model has certain advantages than other methods. Sabiruzzaman et al. believes that in addition to considering modeling of stock price fluctuations [16], we must also consider modeling transaction volume fluctuations, and transaction volume plays a key role in the financial market. Among them, they studied the fluctuation of the Hong Kong Stock Exchange's daily transaction volume index, using the GARCH model to simulate the volatility of the transaction volume, and found that the GARCH model was well fitted with the data. BURNS [17] proposes that these commonly used multi-GARCH models are too high at estimates, so they improve the model and propose the PC-Garch model. This model reduces the calculation amount, can better fit the data, enables relevant estimates to be more stable, and better applies to the stock market. Prateek et al. compared the Realized Garch model and GARCH model [18], Egarch model in the prediction of the stock market volatility in 2020, Eric [19] et al. using the Garch-Midas model to use the monthly data of the macroeconomic variables. It proves that China's stock market has speculation characteristics. At the same time, it shows that the volatility of the macroeconomic aspect in the stock market has played a larger and larger role, especially CPI inflation. When modeling the asset income, this article can use the Garch model (GARCH) model with a broad sense. This problem, so more and more scholars consider improving the distribution of model conditions. In order to further describe the nature of financial asset income, different types of partial -state thick tail distribution is in the GARCH model in the application, Mighri, SU, and PHERSbuilt the Garch-SKT model based on SKT distribution [20, 21, 22]. Robert In the discussion on the Garch model [23], the data detection, the number of samples and volume of the data, they analyzed the data within one year of the daily stock trading of an Australian company, and found that Garch corresponds to the corresponding correspondence The analysis results are closely related to the number of samples and the number of transactions. Cathy and Mike proposed a harem difference model [24], It combines the GARCH model and non -linear clusors to study the average and variance volatility of the model of the financial market. The research results show that when the average volatility is high, or when the fluctuations are more lasting, the negative effects will come. Visser [25] proposes the concept of scale model and volatility replacement, combining high -frequency data with the GARCH model within one day to analyze the factors that affect the stock market.

II METHODOLOGY AND SCHEMES

A Methodology

Literature research methodology: in this study, this article summarized the methods and characteristics of stock market price manipulation and gained a comprehensive and in-depth understanding of its behavior.

Case study: in this study, this article analyzed cases of stock price manipulation in recent years.

Empirical analysis: in this study, this article conducted empirical analysis using data from stock price manipulation cases published by the CSRC (China Securities Regulatory Commission) in recent years.

Quantitative data analysis:

Theoretically, the annual rate of return of the CSI 300 Index acts as the benchmark rate of return. And the annual return of individual stocks is the strategic rate of return.

$$B_r = \left(\frac{B_{end}}{B_{start}}\right)^{(250/n)} - 1 \quad (1)$$

Bend = ending benchmark, Bustard initial benchmark, n= trading days for back testing.

Measuring the systematic risks in the investment process through the β value, reflects the investors' strategic sensitivity to benchmark changes.

$$\beta = \frac{\mathrm{cov}(P_{n,}B_n)}{\sigma^2} \quad (2)$$

P_n = strategic benchmark return, B_n = daily benchmark return, σ^2 = variance of daily benchmark return, $\mathrm{cov}(P_n, B_n)$ = covariance of strategic benchmark return and daily benchmark return

α refers to excess returns irrelevant to the market, that is, non-systematic risk which can make indirect judgment upon market manipulation. Formula as follows:

$$\alpha = R_p - (R_f + \beta_p(R_m - R_f)) \quad (3)$$

R_p= strategic annualized return

R_m= benchmark annualized return

R_f= risk-free rate

β _p= strategic beta value

α >0,when R_p exceeds risks, excess returns gained, manipulation existed.

α =0,when R_p almost equals risks, appropriate returns gained, no manipulation.

α <0,when R_p is less than risks, a small quantity of returns gained, manipulation existed.

Quantitative data analysis: in this study, this article mainly calculated the data of the opening price, closing price, trading volume, and transaction amount, so as to obtain turnover rate, trading volume fluctuation and logarithmic return rate. Eventually this article obtained GARCH-α parameter and GARCH-β parameter in order to carry out data analysis and comparison with actual data. Model schemes are as follows (Fig. 1).

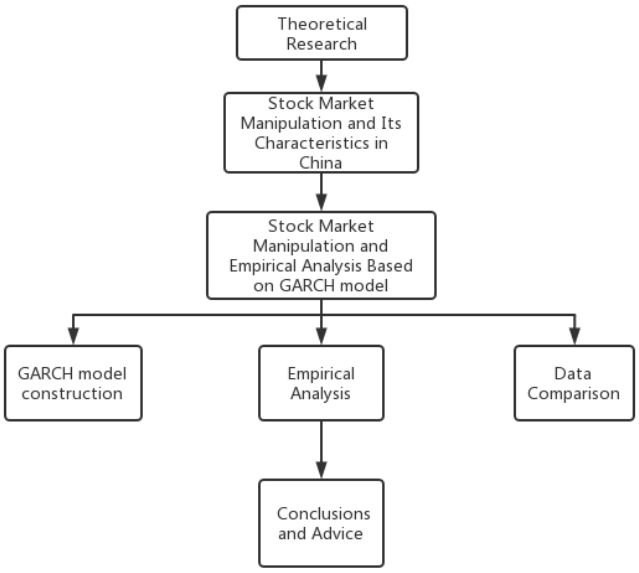

Fig. 1. Model schemes.

Model analysis: In this study, this article utilized GARCH model as identification model of stock price manipulation.

Building up ARCH model is defined of the form:

$$y_t = \gamma_0 + \sum_{i=1}^{k} \gamma_i X_{it} + \mu_t \quad (4)$$

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \mu^2_{t-1} \quad (5)$$

The Premise is that $\mu_t \sim (o, \sigma_t^2)$. ARCH model laid out solid foundations for subsequent analysis, which can better deal with heteroskedasticity and explain changes in market price fluctuations.

Building up GARCH model is defined as:

$$y_t = X_t \pi + \in_t \quad (6)$$

$$\sigma_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta \alpha_{t-1}^2 \quad (7)$$

Variance σ_t^2 is subjective to the former residual ε_{t-1}^2 and the former variance α_{t-1}^2 while the sum of α and β is constantly the root of autoregressive model which determines the continuity of fluctuation shock. In many occasions, the root is very close to 1.

GARCH (p,q) is defined in the form as follows:

$$\sigma_t^2 = \omega + \alpha \sum_{i=1}^{q} \in_{t-1}^2 + \beta \sum_{j=1}^{p} \sigma_{t-j}^2 \quad (8)$$

P refers to the maximum lag of GARCH model while q refers to the maximum lag of ARCH model. In this study, independent testing will be carried out to predict price manipulation using GARCH model. Judgment will be made through the followings:

no manipulation: α + β ≦1

manipulation existed: α + β >1

Research schemes

input stock price data

calculate logarithmic return rate, turnover rate and trading volume fluctuation

draw sequence diagrams

descriptive statistic

stationary test (unit root test)

autocorrelation test

ARCH effect test

GARCH parameter estimation: this study conducted indicators like turnover fluctuation, trading volume fluctuation, prices fluctuation, GARCHA α parameter and GARCHA β parameter. Through comparative analysis, it is verified that GARCHA α parameter and GARCHA β parameter are effective in judging stock market price manipulation.

Calculate the GARCH fluctuation rate, conduct a comparative analysis with former data, and judge time points of manipulation with practical data of the stock.

III Analysis of Empirical Results

A Indicator Analysis

In terms of forecasting model construction, this study collected fifteen stock price data in dataset 1, seven of which had market manipulation, and eight had none. On that data basis this article constructed GARCH model to identify market manipulation. Finally, whether the sum of GARCH- α and

GARCH-β is greater than 1 using logarithmic return rate, trading volume fluctuation, turnover rate along with their fluctuation forecast trend charts will be set as judging standards of manipulation's existence.

Logarithmic return rate formula as follows:

R=ln(closing price on a day)-ln(closing price of the former day)

Trading volume fluctuation formula as follows:

TVF = turnover on a day- turnover of the former day

Turnover rate formula as follows:

TR = turnover/sum of issuing stocks *100%

Abbreviations

R: Logarithmic return rate

TVF: Trading volume fluctuation

TR: Turnover rate

B Trend Chart Analysis

Fig. 2 to 8 shows the four indicator trend comparison.

In the study, closing price, R, TVF, and TR in seven stocks with market manipulation in dataset 1 are compared using EViews software. It is found that during the manipulation, closing price, R, TVF, and TR all showed a sharp rise while they experienced an obvious slump after the manipulation. Besides that, there was data loss before and after manipulation. Take Tianjin Futong Information Science& Technology Co., Ltd. (stock code: 000836), its data went missing from May 24, 2017 to November 24, 2017.

By comparing the trend chart and the data analysis of the China Securities Regulatory Commission announcement, it can be seen that the market manipulation has the following characteristics:

The participants in stock market manipulation are complex and diverse.

From the announcement data, this article can know that the main body of the stock manipulation are those who hold significant authority and social status including the the chairman of the board, insiders, legal representatives, general managers, shareholders, the actual controller, managing partners and other administrative seniors.

Manipulation holds characteristics of zero transparency and severe consequences.

To evade the supervision of the China Securities Regulatory Commission, insiders usually adopt relatively covert methods. Specifically, insiders use other people's accounts instead of their own when manipulating. Huang Xiaodiao as one of insiders borrowed other people's accounts and trade stocks of Neoglory Prosperity Inc. (stock code: 002147). The China Securities Regulatory Commission imposes heavy fines on stock market manipulation, and adopts measures to ban the parties from entering the stock market within a specified period, with serious penalties.

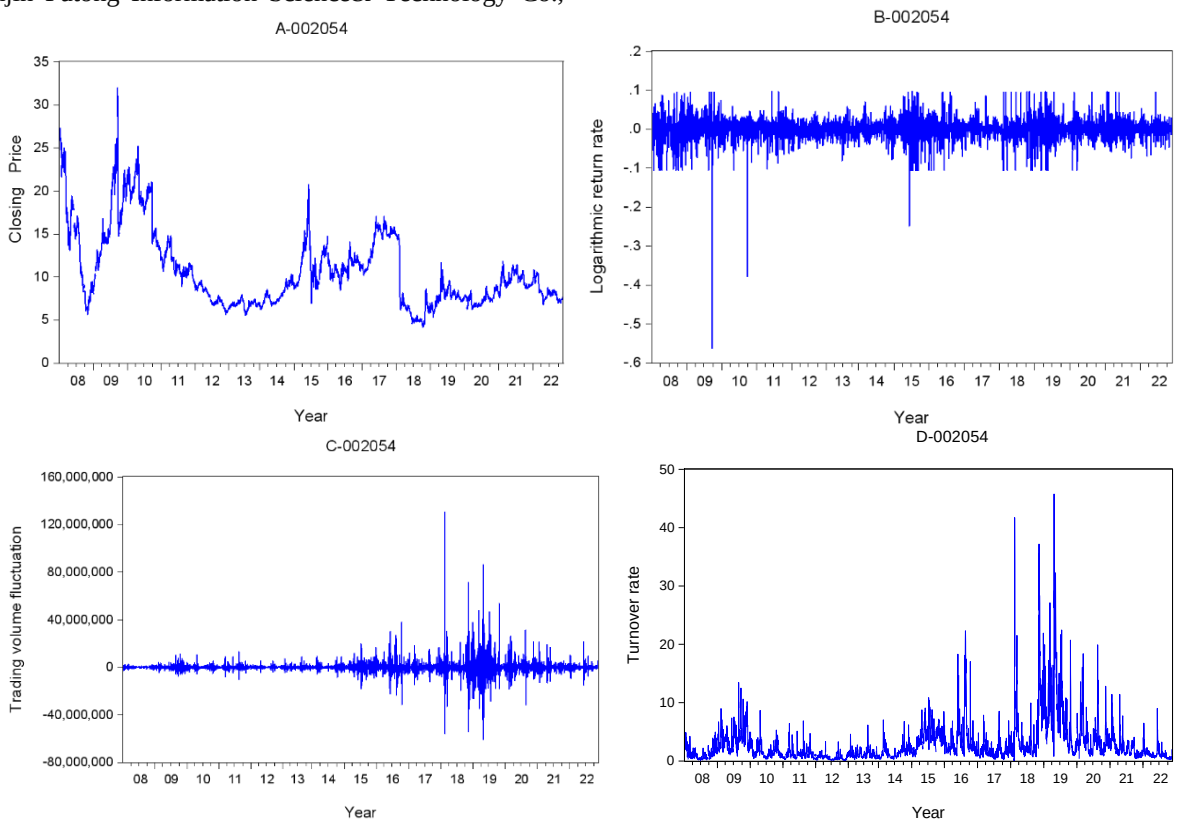

Fig. 2. Stock 002054 four indicator trend comparison.

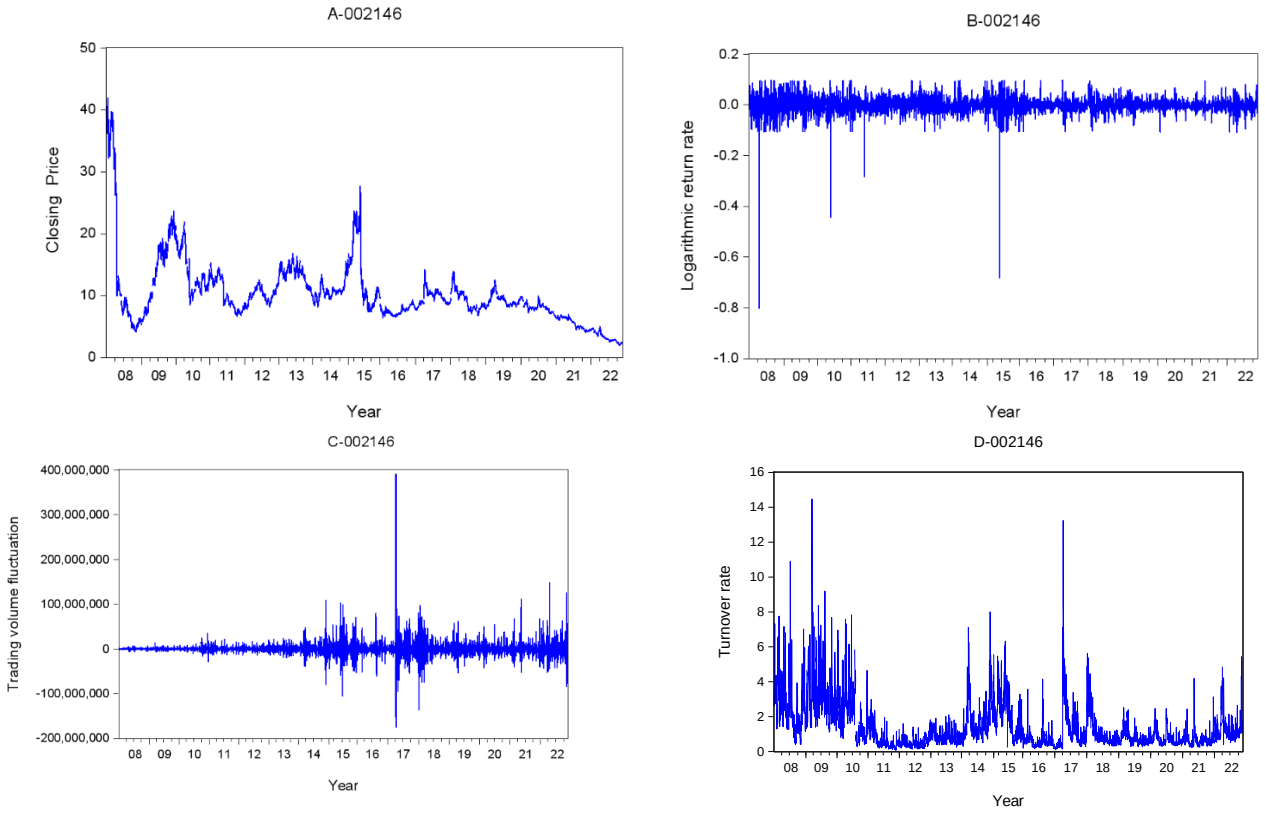

Fig. 3. Stock 002146 four indicator trend comparison.

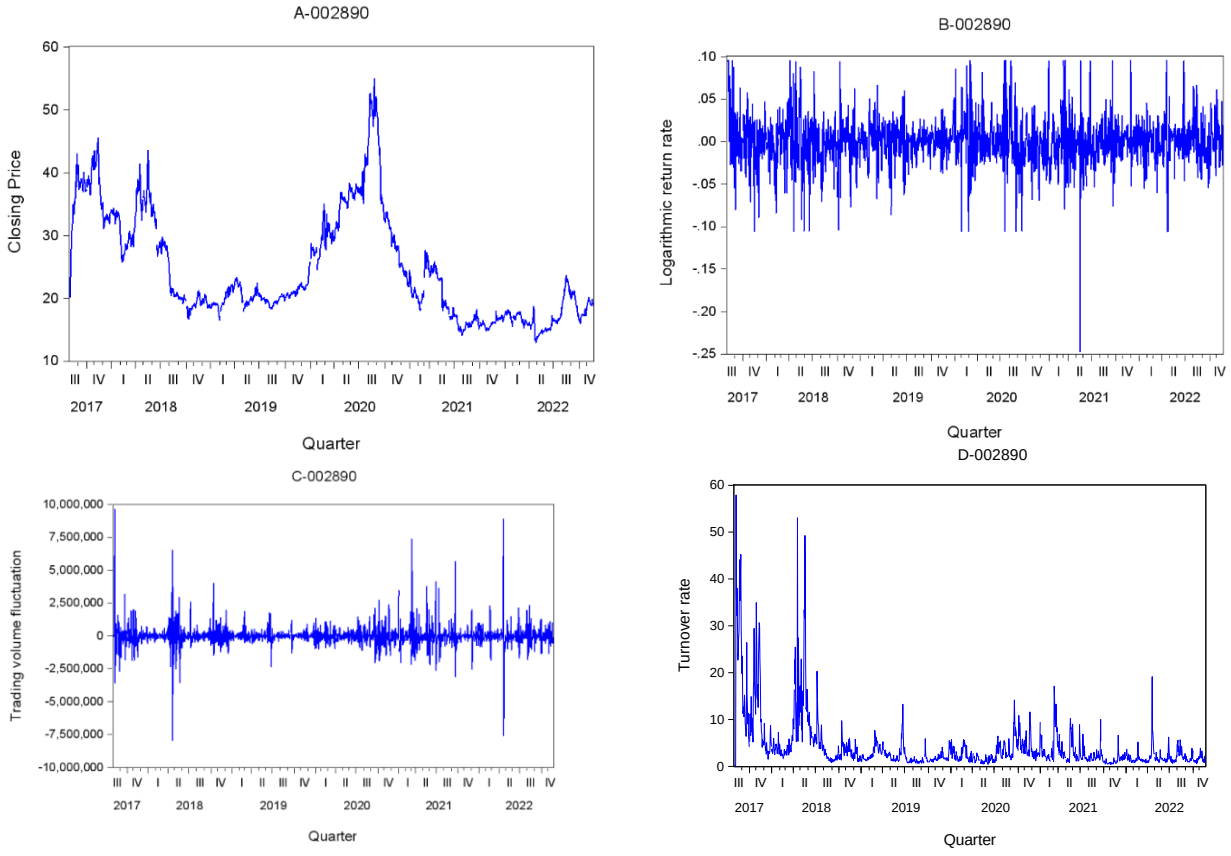

Fig. 4. Stock 002890 four indicator trend comparison.

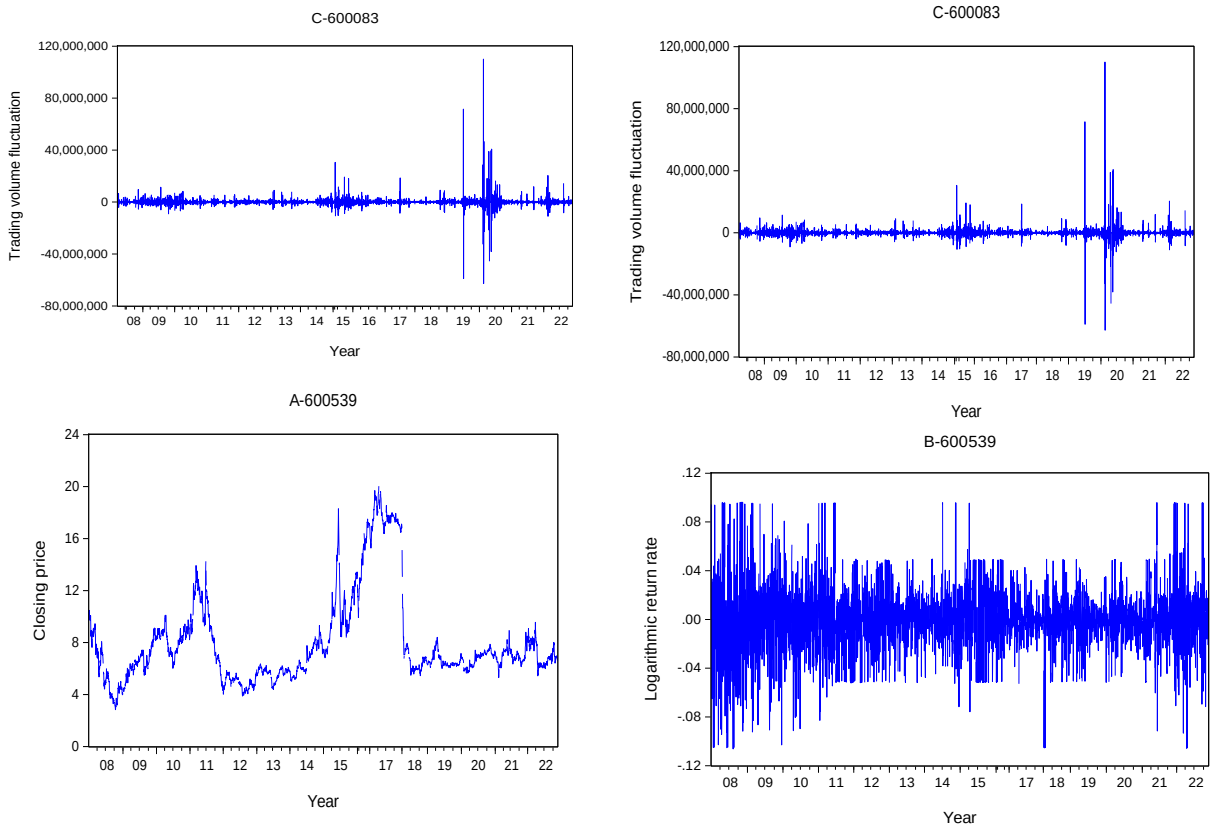

Fig. 5. Stock 600083 four indicator trend comparison.

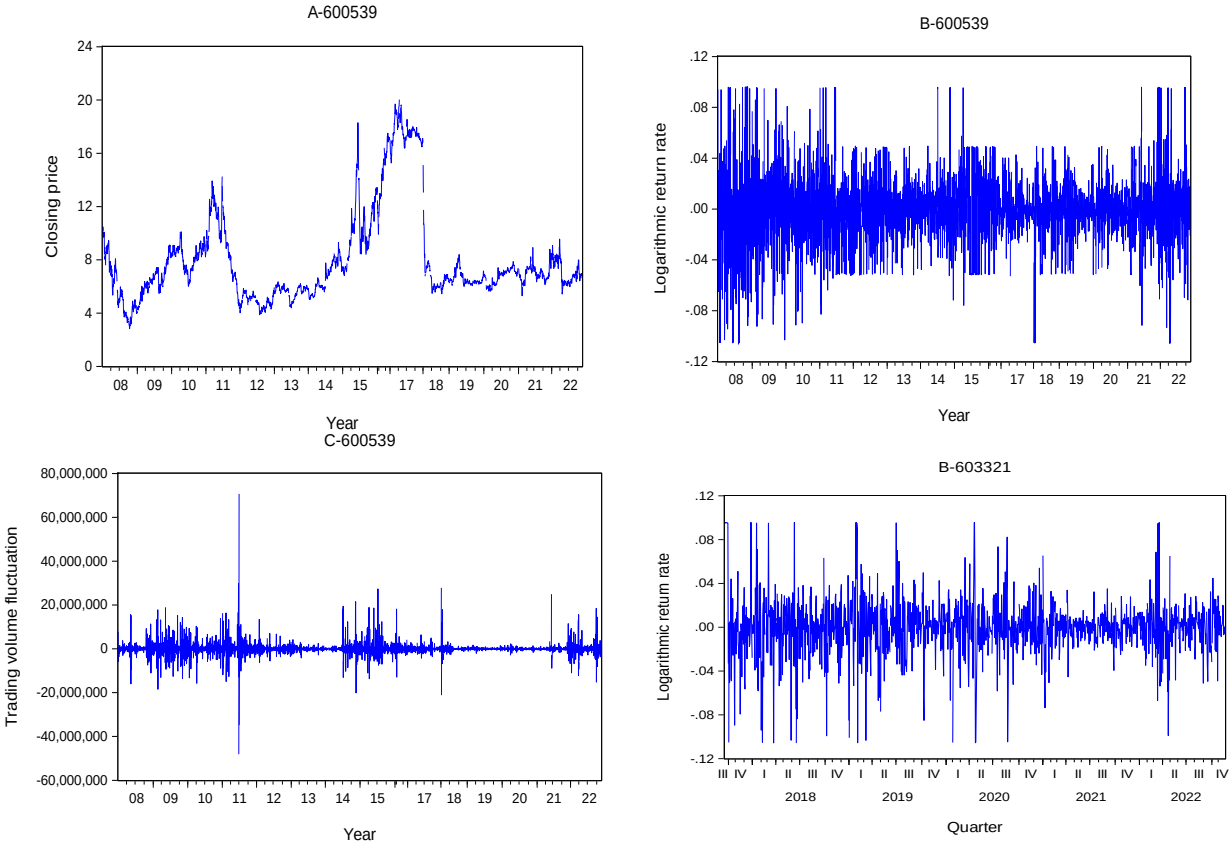

Fig. 6. Stock 600539 four indicator trend comparison.

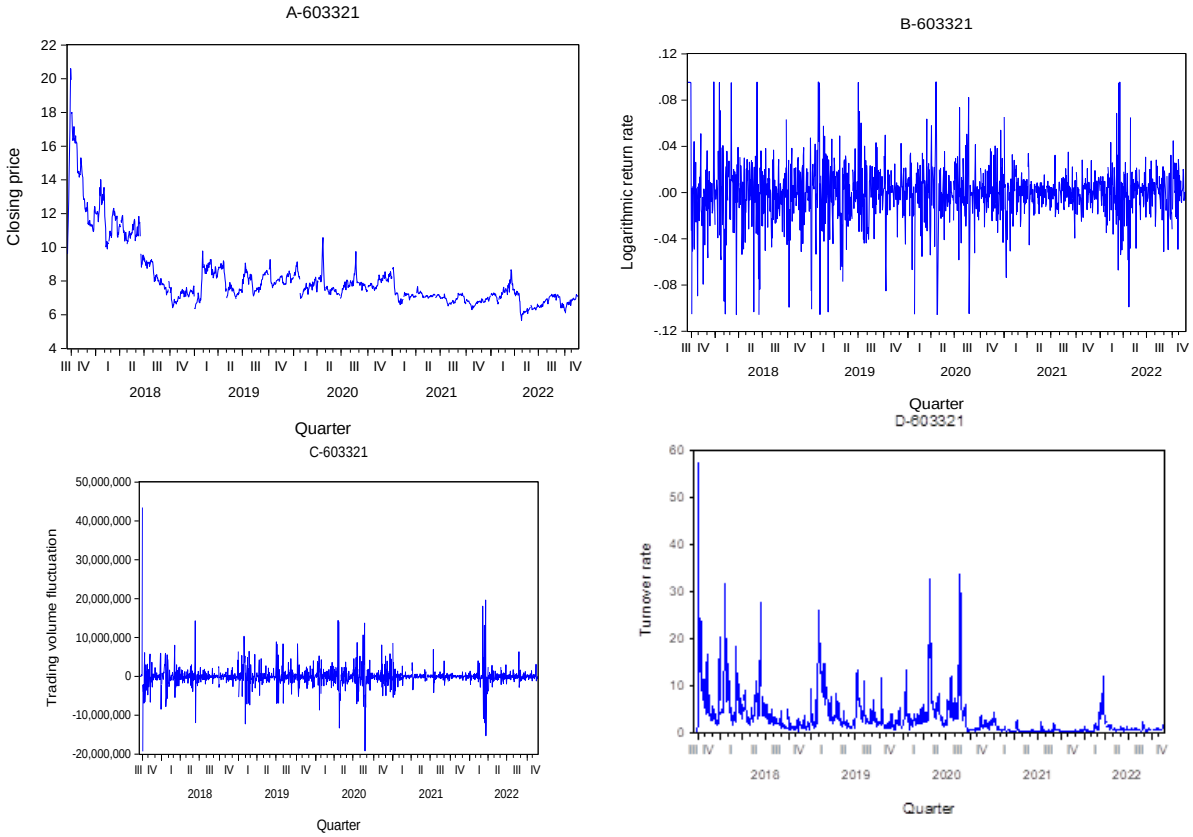

Fig. 7. Stock 603321 four indicator trend comparison.

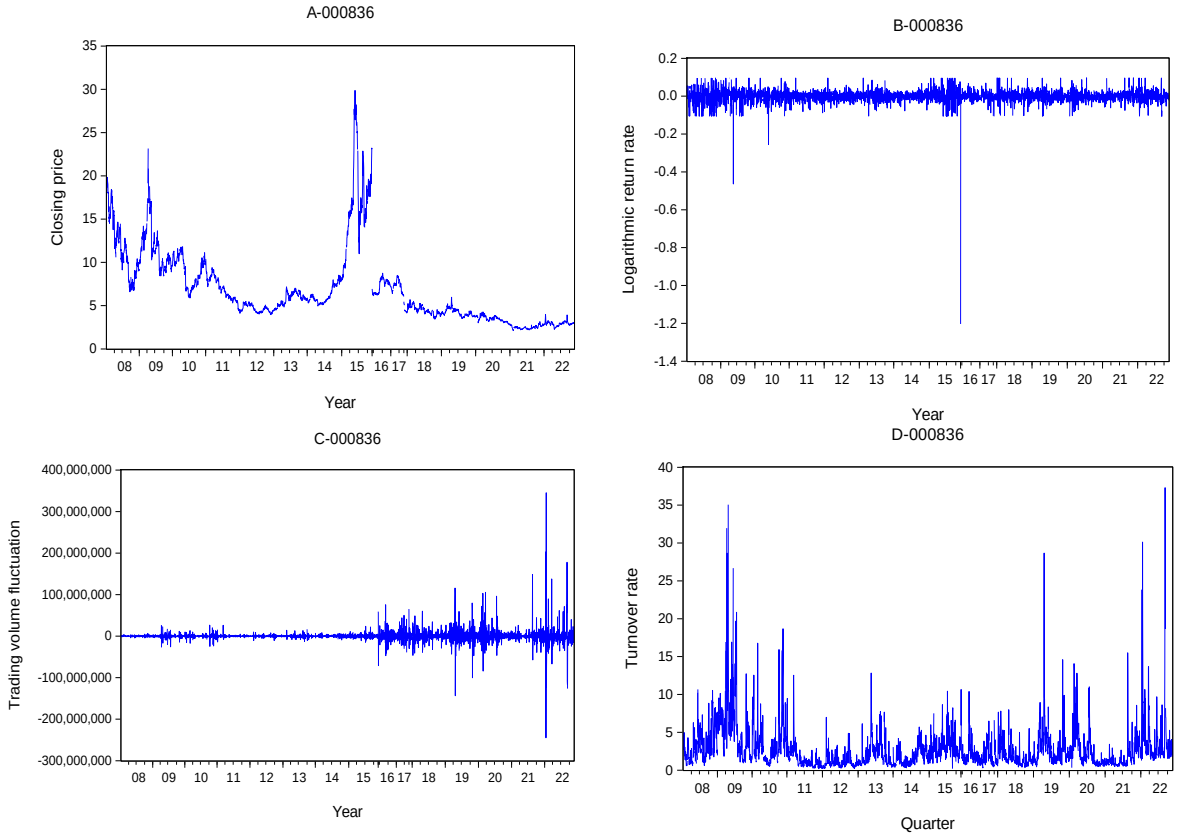

Fig. 8. Stock 000836 four indicator trend comparison

Stock market manipulation is widespread in many industries.

Based on the stock data of dataset 1 and the China Securities Regulatory Commission's penalty announcement, stock market manipulation can be seen in the tourism real estate industry and machinery manufacturing industry (Neoglory Prosperity Inc. stock code: 002147), in optical fibre and cable industry and quartz-fibre manometer ware industry(Tianjin Futong Information Science& Technology Co., Ltd, stock code: 000836), in elevator industry (Zhejiang Meilun Elevator Co.,Ltd, stock code: 603321), in real estate industry (RiseSun Real Estate Development Co., Ltd, stock code: 002146), in main business of shipping and terminal operation(COSCO SHIPPING Holdings Co., Ltd, stock code: 601919), in construction and building materials industry (Taiyuan Lionhead Cement Co., Ltd, stock code: 600539). They are the lively examples indicating wide ranges of manipulation.

Stock market manipulation takes various forms:

By controlling the account information and accounts that in full charge to engage in securities transactions. Liu Xiaodong from Dymatic Chemicals,Inc (stock code:002054) colluded with Hu Kan from Zhejiang Meilun Elevator Co.,Ltd. (stock code:603321) using multiple securities accounts to buy in a concentrated manner, and apply for large orders to drive up the stock prices.

C Empirical Analysis

From Table I, this article can conclude that in two stocks, the sum of GARCH-α and GARCH-β in R, TVF and TR was all greater than 1. While in four stocks, the sum of GARCH-α and GARCH-β in TVF and TR was greater than 1 altogether with the sum of GARCH-α and GARCH-β in R greater than 0.97. The results proved that the model is marvelous in manipulation identification.

From Table II, this article can conclude that in two stocks, the sum of GARCH-α and GARCH-β in R, TVF and TR was less than 1. While in two stocks the sum of GARCH-α and GARCH-β in R and TR was less than 1. And in other two stocks the sum of GARCH-α and GARCH-β in R and TVF was less than 1.

D Model Checking

This study collects five stocks in dataset 2, and conducted GARCH model detection and identification on R and TVF, so as to predict and judge the existence of manipulation along with its time points and characteristics.

With identification and detection of GARCH model, evaluation results of two indicators for five stocks in dataset 2 were showed in Table III. From the table above, this article can conclude that in the first and third stocks, the sum of GARCH-α and GARCH-β in R and TVF was less than 1. In other 3 stocks, the sum of GARCH-α and GARCH-β in R was less than 1 while the sum of GARCH-α and GARCH-β in TVF was greater than 1. To improve the accuracy of the model, this study splits the six-year stock data of five stocks into annual data for re-testing. The evaluation results are as follows (see Tables IV-VIII).

TABLE I. EVALUATION RESULTS OF THREE INDICATORS FOR SEVEN STOCKS WITH MANIPULATION

	000836	600083	2054	2146	2890	600539	603321
R-α	0.2138	0.0779	0.1516	0.1865	0.1767	0.1103	0.1318
R-β	0.8329	0.9008	0.8337	0.8397	0.6244	0.8744	0.8613
sum	1.0467	0.9786	0.9854	1.0262	0.8011	0.9847	0.9931
TVF-α	0.5563	0.8384	0.4355	0.2018	0.3045	1.2759	1.046
TVF-β	0.7095	0.5869	0.7808	0.8927	0.331	0.5369	0.0027
sum	1.2658	1.4253	1.2163	1.0945	0.6356	1.8128	1.0487
TR-α	0.4148	0.8694	0.3827	0.2331	0.4097	1.1418	1.046
TR-β	0.6322	0.533	0.7929	0.7856	0.7133	0.6172	0.0027
sum	1.047	1.4025	1.1756	1.0187	1.123	1.7591	1.0487

TABLE II. EVALUATION RESULTS OF THREE INDICATORS FOR EIGHT STOCKS WITHOUT MANIPULATION

	300075	300274	858	300059	600760	601919	625	713
R-α	0.2704	0.1215	0.0624	0.0569	0.0653	0.0659	0.1816	0.144
R-β	0.6688	-0.0303	0.9173	0.9164	0.918	0.9225	0.8373	0.8097
sum	0.9392	0.0912	0.9796	0.9734	0.9833	0.9884	1.0189	0.9537
TVF-α	0.2977	0.532	0.0537	0.7075	0.2761	0.6196	0.2725	0.2019
TVF-β	0.7805	-0.0084	0.9397	0.6059	0.6479	-0.0028	0.7725	0.8261
sum	1.0782	0.5236	0.9934	1.3134	0.9239	0.6168	1.0449	1.0279
TR-α	0.1995	0.2055	0.0556	0.0937	0.477	0.2904	0.1716	0.246
TR-β	0.7613	0.7763	0.9404	0.8861	0.6032	0.807	0.871	0.7997
sum	0.9608	0.9818	0.9961	0.9798	1.0802	1.0974	1.0426	1.0457

TABLE III. EVALUATION RESULTS OF TWO INDICATORS FOR 5 STOCKS IN DATASET 2

	1	2	3	4	5
R-α	0.1195	0.1499	0.0974	0.0944	0.17447
R-β	0.8222	0.8045	0.8855	0.8453	0.772909
sum	0.9417	0.9544	0.9828	0.9397	0.9474
TVF-α	0.3121	0.9221	0.5972	0.2529	0.221103
TVF-β	0.4799	0.4924	-0.0188	0.7514	0.845225
sum	0.792	1.4145	0.5784	1.0042	1.0663

TABLE IV. ANNUAL EVALUATION RESULTS OF TWO INDICATORS IN STOCK 1

	2016	2017	2018	2019	2020	2021
R-α	0.037108	0.050826	0.305762	0.110901	0.234068	0.028942
R-β	1.025163	1.031713	0.507474	0.872531	0.716099	0.916706
sum	0.988055	0.980887	0.813236	0.983432	0.950167	0.945648
TVF-α	0.73323	0.144921	1.016567	0.12721	0.482486	0.559319
TVF-β	0.413856	0.048914	0.001476	0.89974	0.518359	0.050465
sum	1.147086	0.193835	1.018043	1.02695	1.000845	0.508854

TABLE V. ANNUAL EVALUATION RESULTS OF TWO INDICATORS IN STOCK 2

	2016	2017	2018	2019	2020	2021
R-α	0.060005	0.486671	0.235432	0.118615	0.33448	0.141124
R-β	1.049991	0.329566	0.346146	0.829489	0.726385	0.740907
sum	0.989986	0.816237	0.581578	0.948104	1.060865	0.882031
TVF-α	0.47295	0.128954	1.528713	0.467837	1.396246	0.642267
TVF-β	0.133565	0.020445	0.066155	0.071897	0.425462	0.090602
sum	0.339385	0.108509	1.462558	0.539734	1.821708	0.551665

TABLE VI. ANNUAL EVALUATION RESULTS OF TWO INDICATORS IN STOCK 3

	2016	2017	2018	2019	2020	2021
R-α	0.057664	0.202555	0.027912	0.091298	0.236559	0.100316
R-β	1.023889	0.803294	0.3513	0.872017	0.666382	0.842742
sum	0.966225	1.005849	0.323388	0.963315	0.902941	0.943058
TVF-α	0.625886	0.816549	0.175514	0.294882	0.95409	0.326408
TVF-β	0.068155	0.097357	0.024964	0.568844	0.076571	0.082987
sum	0.694041	0.913906	0.200478	0.863726	0.877519	0.243421

TABLE VII. ANNUAL EVALUATION RESULTS OF TWO INDICATORS IN STOCK 4

	2016	2017	2018	2019	2020	2021
R-α	0.038497	0.219204	0.13059	0.094054	0.101291	0.074151
R-β	0.931862	0.611703	0.458642	0.846511	0.693069	0.890664
sum	0.970359	0.830907	0.589232	0.940565	0.79436	0.964815
TVF-α	0.861852	0.436585	0.544132	0.264732	0.272204	0.120104
TVF-β	0.099919	0.030305	0.220179	0.606584	0.518322	0.720804
sum	0.961771	0.40628	0.764311	0.871316	0.790526	0.840908

TABLE VIII. ANNUAL EVALUATION RESULTS OF TWO INDICATORS IN STOCK 5

	2016	2017	2018	2019	2020	2021
R-α	0.049556	0.005235	0.06662	0.295535	0.177969	0.113084
R-β	1.023353	0.526743	0.885713	0.5255	0.757596	0.848661
sum	0.973797	0.521508	0.952333	0.821035	0.935565	0.961745
TVF-α	0.57346	0.038856	2.602458	0.203553	0.306933	0.149094
TVF-β	0.041831	0.32493	0.111961	0.790593	0.150759	0.08027
sum	0.531629	0.286074	2.714419	0.994146	0.457692	0.229364

After the test, this article found that the sum of GARCH-α and GARCH-β of some indicators was greater than 1 in stock 1 and stock 3. But this article still believed both has no manipulation, considering the total time was less than 1, and fluctuations of indicators could arise from company's thriving development. In all the five years (Table III), the sum of GARCH-α and GARCH-β of R in stock 4 was less than 1 while the sum of GARCH-α and GARCH-β of TVF was greater than 1. However, the sum of GARCH-α and GARCH-β of R and TVF was less than one annually. Therefore, this article believed that there was no manipulation in stock 4.

Besides, the sum of GARCH-α and GARCH-β of R and TVF in 2020 of stock 2 was greater than 1. While the sum of GARCH-α and GARCH-β of TVF in the 5 years (Table III) was greater than 1. Data was abnormal. The sum of GARCH-α and GARCH-β of TVF in 2018 of stock 5 was way greater than 1 while the sum of GARCH-α and GARCH-β of R and TVF was less than 1. Therefore, this article analyzed on stock 2 and stock 5 with the following Fig. 9 and 10.

From Fig. 9, R and TVF of stock 2 was asymmetric in mid-October. However, its TVF had a significant surge in mid-October. Therefore, this article believes manipulation took place in mid-October 2020. R and TVF of stock 5 showing a great opposite trend from mid-March to April could also be the prove that manipulation happened from mid-March to around April in 2018.

Characteristics of the trend charts are as follows:

Opposite trends took place in two indicators' prediction value.

The R prediction value is rather low while the TVF prediction value promptly rises.

The closing price, R and TVF snowballed during the manipulation.

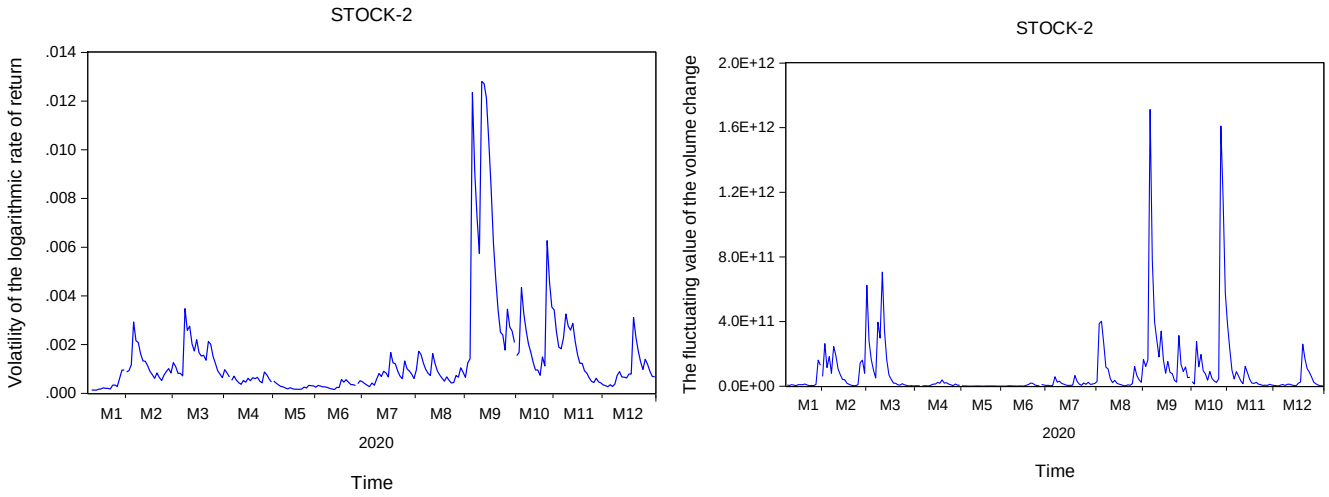

Fig. 9. R and TVF in 2020 of stock 2.

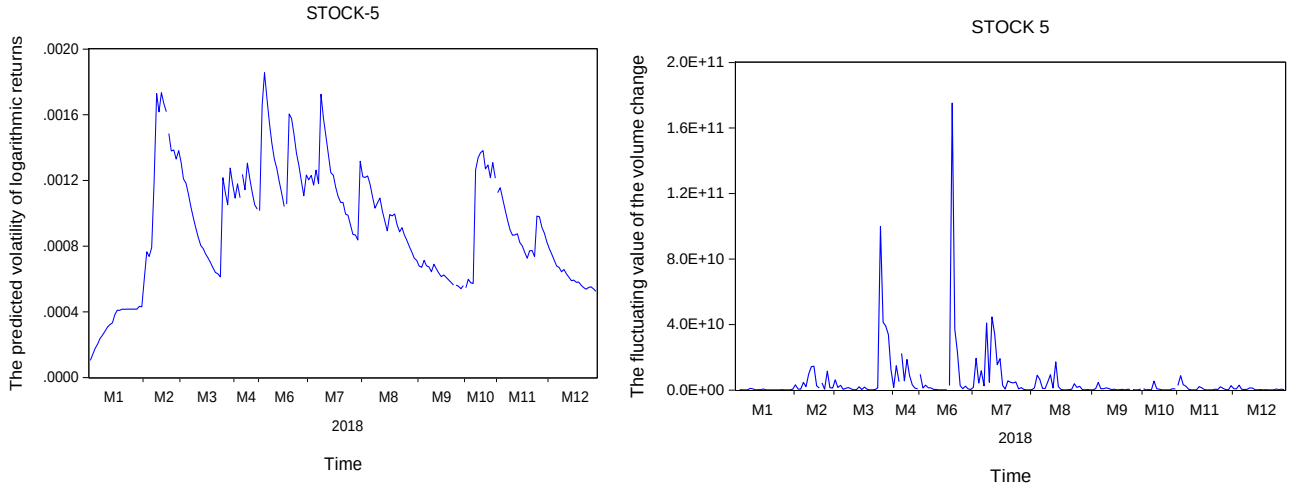

Fig. 10. R and TVF in 2018 of stock 5.

IV Conclusions and Advice

A Conclusions

This paper analyzes the manipulation behavior of the stock market based on relevant theories and GARCH model. On the basis of GARCH model, data analysis is carried out by using EViews software. Meanwhile, indexes such as logarithmic rate of return, turnover rate change, turnover change, GARCH-α and GARCH-β are constructed for manipulation behavior identification.

Analysis of the data obtained in this study shows that when the closing price, logarithmic return rate, trading volume change and turnover rate increase sharply, the market manipulation probability of individual stocks increases significantly, and after the manipulation, the indexes all show a precipitous decline, in which the Fortis information (stock code: 000836) represented by May 24, 2017 to November 24, 2017. This is basically consistent with the empirical analysis of this study. At the same time, Ding (2019) constructed GARCH model, Zhang (2015) based on the GARCH model of time series, Jiang (2022) eliminated the influencing factors of adding heteroskedasticity to time series, and Liu Ning (2004), Wang Wu (2011), Geng, Liu (2019), Nie and Hu (2020) et al. learned from relevant GARCH model construction that the characteristics of high risk and high return in Shanghai stock market do not exist in the basic view of finance. However, according to the asymmetric GARCH model, the above researches show that when the risk is higher than a certain level for a period of time, there is a direct proportional relationship between return rate and risk. This is consistent with the analysis results in this study. Based on the scholars' literature on the application of relevant GARCH model in stock price manipulation analysis and the summary of this paper, it is known that: There are risks in the market, but when the relevant indicators of the stock price fundamentals fluctuate too much, the relevant GARCH model can be used for analysis and research, and the probability risk of stock price manipulation can be obtained, so as to carry out reasonable position planning and market management, and guide managers and investors to make more optimal decisions.

It is known from the empirical results that the prediction accuracy rate is 85.71%, but due to the small number of samples, the reliability of such data analysis results is low. In the subsequent improvement, the sample size can be increased to reduce the error value. 4. The index studied in this paper is mainly based on the price index. In addition to controlling trading volume and changing stock prices, manipulation in the actual market is often filled with information differentiation, which increases the difficulty in detecting market manipulation. Therefore, based on this model, other dimensional models should be added to monitor market stocks combined with multidimensional models, which can effectively enhance the early warning system of advance indicators and achieve better results for regulatory departments to maintain market orderly and regularized.

B Advice

The regulatory authorities should further classify the market manipulation behaviors and establish the benchmark values of various indicators, which is conducive to the faster and more accurate detection of illegal market behaviors in the follow-up monitoring.

The increase of sample size can more effectively reduce errors caused by model data, make model monitoring more accurate, reduce fault tolerance rate and improve accuracy.

The competent authorities should put forward the requirements of strengthening education for all investors in the market, at the same time improve relevant systems and regulations, improve anti-manipulation supervision methods, make the market more legal and systematic, and provide a healthy and green investment environment for market investors.

V Conflicts of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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