

The Overflow Effect of Covid-19 Pandemic: Evidence from China and US Stock Market

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Abstract. Since 2019, the new crown pandemic has spread around the world, causing immeasurable direct and indirect losses. Among them, the economic losses incurred by various countries are even more astronomical. It can be said that this is a heavy blow to the stock markets of various countries and even the global economic market. Therefore, this paper hopes to study the correlation between stock markets in different economies in response to the outbreak. Among them, this paper takes China and the United States as examples, and uses VAR, ARCH, ARMA and other economic quantitative analysis models to analyze the impact of the pandemic in other countries on their own economy, and finally draws a conclusion that it has a certain correlation. Therefore, investors should fully refer to the opinions given in this article when making investment planning. In addition to paying attention to the major events in the local market where the stock market is located, they cannot ignore the mutual influence of strongly correlated economies. Taking these two impact factors into consideration, this paper believes that a better investment portfolio can be obtained.

Keywords: China, US, Covid-19, VAR model, ARMA-GARCH model.

1. Introduction

The pneumonia brought on by the 2019 new coronavirus infection is known as new coronavirus pneumonia, sometimes known as "new coronary pneumonia," and designated as the "2019 coronavirus disease" by the World Health Organization. Since December 2019, numerous cases of pneumonia of unknown origin with a history of exposure to the Guangdong seafood market have been reported at various hospitals in Wuhan City, Hubei Province. This paper has now confirmed that these cases of pneumonia are actually acute respiratory infectious diseases brought on by the 2019 novel coronavirus infection.

The pneumonia brought on by the new coronavirus will be known as "COVID-19," according to Tedros Adhanom Ghebreyesus, Chief of the World Health Organization, who made the announcement in Geneva, Switzerland, on February 11, 2020[1]. The National Health Commission announced on February 22 that "COVID-19" has replaced "new coronavirus pneumonia" as the English nomenclature for the disease. The current COVID-19 epidemic was deemed a worldwide pandemic by the World Health Organization on March 11. A day of national mourning was observed in China on April 4. The updated and finished coronavirus pneumonia treatment and diagnosis plan was made public on August 18 by the National Health and Medical Commission (trial version 8). Zhong Nanshan was chosen when the list of members of the expert group was revealed on September 3 during a briefing for member states by the founder of the WHO's new crown pneumonia epidemic response assessment expert group.

There were 5,970 confirmed cases (including 24 severe cases) as of 24:00 on September 10, 2022, according to reports from 31 provinces (autonomous regions and municipalities) and the Xinjiang Production and Construction Corps, as well as 235,656 cured and discharged cases and one cumulative death case. There have been 5,226 instances recorded, 246,852 confirmed cases overall, and 0 active suspected cases. 5,680,863 close connections have been identified in all, and 255,050 of those people are currently being monitored by doctors.

Since the beginning of 2020, the global financial market has been under pressure due to the impact of the Covid-19 pandemic [2]. The capital market, which serves as a proxy for the global financial sector, had a dramatic decline, particularly when the new crown pneumonia epidemic spread quickly

around the world in semi 2020. Within eight trading days, the US stock market suffered four major circuit breakers, with risky assets and hedge funds emerging in the midst [3]. It is rare in history for risk assets to fall at the same time. Individuals from all walks of life have begun to pay close attention to whether a financial crisis would develop as a result of the United States and other nations using unorthodox monetary policies and increasing fiscal measures to support them. The actual economy is currently being impacted by the new crown pneumonia epidemic, which is what is causing the financial market to see such drastic changes. The way the epidemic is handled also greatly influences whether it turns into a worldwide financial disaster.

The Covid-19 epidemic has had a significant negative impact on the global economy, seriously harming both the actual economic growth and asset prices and liquidity on the global financial market [4]. However, the present epidemic has only been going on for a short while, as well as the central banks and other financial institutions of the globe have reacted swiftly, offering the market with enough liquidity and prompt and extensive relief for the actual economy. The financial system will be permanently harmed.

At the same time, a country's performance in fighting the new crown pandemic can also be reflected in the stock market. This is because the ups and downs of the broader market can reflect the market's confidence in the current round of the pandemic to a huge extent. Both at once, the author believes that due to the increasing degree of economic globalization, the pandemic in a single country can also affect the economic trend of other countries to a huge extent. As the top two economies in the world, the United States and China for instance, will see greater correlations in stock price fluctuations as a result of the fact that a significant worldwide event will have an important bearing here on stock markets of both the two nations.

This research will investigate the effects of a concentrated epidemic in either China or the US here on stock markets of both the two nations based on this supposition. The remaining parts of this paper will be organized as follows: Part 2 is research design, which includes data sources, unit root test and model specification; Part 3 is Empirical Results and Analysis, which includes estimation results and some analysis; And the last part is discussion and my conclusion.

2. Research Design

To describe how economic variables are related to one another, traditional econometrics frequently relies its models on the pertinent economic theory. For instance, in the 1950s and 1960s, the simultaneous equation system model with linear equations put out by Koopmans and Hood-poOKmans caused a sensation. The instrumental variable approach, the two-stage least squares method, the three-stage least squares technique, the restricted content likelihood method, and the complete information maximum likelihood method are all suggested after taking into account all of the residuals and explanatory variables of these equations. technique for parameter estimation. Using this modeling technique, complicated macroeconomic issues with up to 10,000 endogenous variables are sometimes studied. At the time, forecasting and policy analysis were its principal uses.

The dynamic link between variables in this structural model, which was developed under the supervision of economic theory, is not explicitly presented. In addition, if the statistic is non-stationary, then this will break the assumption and result in more severe pseudo-regression issues. As a result, the VAR model, which this article chooses to utilize, is critically needed for this study in order to examine the trajectory of the financial market.

2.1. Data Sources

The basic data used in this article are: the daily number of newly diagnosed cases in China, the number of daily diagnosed cases in the US, and the daily and closing prices of the S&P 500 Index and the Shanghai Composite Index. These raw data are obtained from the Choice financial terminal.

2.2. Unit Root Test (ADF)

In general, the first step in evaluating a time series is to perform a stationarity test before using different time-series methods, including ARMA and ARIMA, which require the time - series data to be stationary, as well as the approach of visual examination. The most often used rigorous statistical test methodology is the ADF test, also known as the unit root test. The existence of a unit root creates a non-stationary time series, hence the unit root test checks to see if one exists in the series [5].

The ADF test table for the dataset is shown in Table 1.

Table 1. ADF test

Variables	t-statistic	p-value
Price		
SSEC	-2.310	0.4283
S&P 500	-1.573	0.8029
Yield		
SSEC	-16.777	0.0000***
S&P 500	-16.528	0.0000***
New daily confirmed cases		
China	-4.021	0.0082***
US	-12.408	0.0000***

Since the p-values obtained from the tests in the table are all less than 0.1, it can be rejected that the null hypothesis and consider that these series are stationary.

2.3. VAR Model Specification

The lag order test must take into account two issues: first, if the lag order p is small, the random standard error will have an autocorrelation issue; furthermore, in practical applications, it is typically wished that the lag order p is huge enough to better reflect the dynamic features of the constructed model; however, if the lag order p is too huge, the model will need to estimate further parameters, and there will be an issue with the degree of autocorrelation. If there are not enough samples, it will be difficult to determine the necessary estimated parameters.

In order to verify the validity of the test findings, several criteria must be considered before performing the lag order test. Lag order tests can be carried out in one of two ways: The first technique evaluates a number of factors before determining the final prediction error (FPE), lag order, AIC, SC, HQ, and Log L criteria. The second method, which evaluates the likelihood ratio, does not provide the incorrect findings of the first method. The first approach is the most popular with academics. The lag time of the model is chosen to be the estimated value of the five indicators in the first approach at each order and the order with the greatest number of minimum values of the five test criteria.

If two autoregressive models are built independently, it is hard to comprehend the connection between the two variables, assuming there is a relationship between $y_{1,t}$ and $y_{2,t}$. If the simultaneous form is used, it is possible to identify the connection between the two variables. The structure of the VAR model is tied to two parameters. N is the total number of variables, while k is the highest possible order. Take the VAR model with $y_{1,t}, y_{2,t}$ lagging one minimum period as an example:

$$\begin{cases} y_{1,t} = \mu_1 + \pi_{11.1}y_{1,t-1} + \pi_{12.1}y_{2,t-1} + u_{1t} \\ y_{2,t} = \mu_2 + \pi_{21.1}y_{1,t-1} + \pi_{22.1}y_{2,t-1} + u_{2t} \end{cases} \tag{1}$$

In which $u_{1t}, u_{2t} \sim IID(0, \sigma^2)$, $Cov(u_{1t}, u_{2t}) = 0$, written in matrix form as:

$$\begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = \begin{bmatrix} \mu_1 \\ \mu_2 \end{bmatrix} + \begin{bmatrix} \pi_{11.1} & \pi_{12.1} \\ \pi_{21.1} & \pi_{22.1} \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix} \tag{2}$$

Assume $Y_t = \begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix}$, $\mu = \begin{bmatrix} \mu_1 \\ \mu_2 \end{bmatrix}$, $\Pi_1 = \begin{bmatrix} \pi_{11.1} & \pi_{12.1} \\ \pi_{21.1} & \pi_{22.1} \end{bmatrix}$, $u_t = \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix}$, then there are $Y_t = \mu + \Pi_1 Y_{t-1} + u_t$.

Then, the VAR model with N variables lag k period is expressed as follows:

$$Y_t = \mu + \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} + \dots + \Pi_k Y_{t-k} + u_t, u_t \sim IID(0, \sigma^2) \tag{3}$$

In which $Y_t = (y_{1,t} \ y_{2,t} \ y_{3,t} \ \dots \ y_{N,t})'$, $\mu = (\mu_1 \ \mu_2 \ \mu_3 \ \dots \ \mu_N)$.

$$\Pi_j = \begin{bmatrix} \pi_{11,j} & \dots & \pi_{1N,j} \\ \vdots & \ddots & \vdots \\ \pi_{N1,j} & \dots & \pi_{NN,j} \end{bmatrix}, j = 1, 2, 3 \dots k \tag{4}$$

While there may be connections between the random error parts corresponding to various equations, none of these components are autocorrelated. The OLS technique may be used to estimate each equation separately, and the results show consistent parameter estimators since the right hand side of each equation in the VAR model just includes the lag part of the endogenous variable, which really is uncorrelated with u_t [6].

2.4. ARMA-GARCHX Model Specification

To estimate an ARMA-GARCH model, it is first necessary to determine the order of the ARMA model, which can be determined according to the relevant order model. However, for the determination of the volatility order q, it is a must that first check the sequence $\{\varepsilon_t\}$ does have a significant ARCH effect, and then determine q according to the partial autocorrelation function (PACF). After the order is determined, in order to estimate the model parameters, when $\{\mu_t\}$ obeys normality distribution, this paper can use least squares maximum likelihood estimation to estimate the model parameters [7]. Therefore:

$$ARMA(p, q) : \begin{cases} x_t = \phi_0 + \phi_1 x_{t-1} + \dots + \phi_p x_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-q} \\ \phi_p \neq 0, \theta_q \neq 0 \\ E(\varepsilon_t) = 0, Var(\varepsilon_t) = \sigma_\varepsilon^2, E(\varepsilon_t \varepsilon_s) = 0, s \neq t \\ E(x_s \varepsilon_t) = 0, \forall s < t \end{cases} \tag{5}$$

ARCH is also known as auto regressive conditional heterosexuality model. The variance of the interference component is frequently specified as a constant in classical econometrics, but in reality, this is not the best method to handle it. The variation of asset returns fluctuates over time, and volatility frequently occurs in clusters. For instance, volatility is prevalent right now because of the financial crisis [8]. So, the following formula can be written as:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \alpha_{t-1}^2 + \alpha_2 \alpha_{t-2}^2 + \dots + \alpha_p \alpha_{t-p}^2 \tag{6}$$

At the same time, the GARCH (1,1) model is currently the most popular and best used GARCH model, and GARCH (1,1) is [9]:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \alpha_{t-1}^2 + \beta_1 \sigma_{t-1}^2 (\alpha_1 \beta_1 \geq 0, \alpha_0 > 0, \alpha_1 + \beta_1 < 1) \tag{7}$$

Therefore, this part first performs the stationarity and white noise test on the sequence. If the white noise test is passed, then the ARCH(q) partial autocorrelation function is used to determine the order, otherwise there is no ARCH effect.

3. Empirical Results and Analysis

3.1. VAR Order

Through the steps introduced above, the test table for the order of VAR is shown in Table 2.

Table 2. VAR model identification

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	642.248				9.9e-07	-2.47383	-2.46093	-2.44091
1	1212.82	1141.1	16	0.000	1.2e-07	-4.62333	-4.55884	-4.45875
2	1263.87	102.11	16	0.000	1.0e-07	-4.7592	-4.64311	-4.46296*
3	1281.46	35.177	16	0.004	1.0e-07	-4.76535	-4.59767	-4.33745
4	1300.38	37.848	16	0.002	9.9e-08	-4.77669	-4.55741	-4.21712
5	1381.23	161.68	16	0.000	7.7e-08*	-5.02801*	-4.75714*	-4.33679
6	1396.04	29.62	16	0.020	7.7e-08	-5.0234	-4.70093	-4.20051
7	1411.83	31.595*	16	0.011	7.7e-08	-5.02261	-4.64856	-4.06806
8	1420.01	16.355	16	0.428	8.0e-08	-4.99229	-4.56664	-3.90608
9	1429.51	19.003	16	0.269	8.2e-08	-4.96711	-4.48986	-3.74923
10	1441.38	23.735	16	0.095	8.3e-08	-4.95109	-4.42225	-3.60155
11	1450.3	17.831	16	0.334	8.6e-08	-4.92363	-4.34319	-3.44243
12	1456.93	13.268	16	0.653	8.9e-08	-4.88733	-4.2553	-3.27447

The data marked with yellow in the table is the position of the minimum value of the single item, consequently it can be concluded that the model's lag order is 7.

At the same time, due to the generalization of the ADF test, if the characteristic equation

$$|I_N \lambda^p - \Phi_1 \lambda^p - \Phi_2 \lambda^p - \dots - \Phi_p| = 0 \tag{8}$$

The unit circle encompasses all of the eigenvalues, that is, $|\lambda_i| < 1$, then the VAR(p) model is said to be covariance stable, and below is the unit circle test (Figure 1).

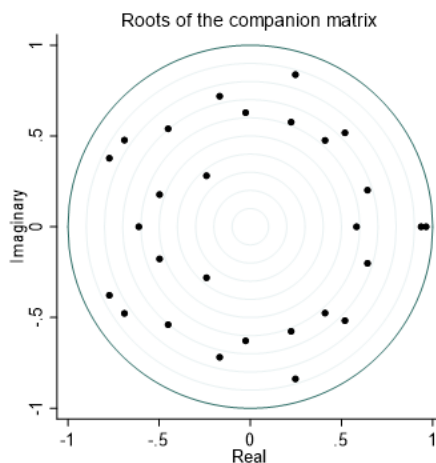


Figure 1. VAR stability (Photo credit: Original)

3.2. Impulse Analysis

The graphs and analysis obtained from the pulse analysis are given below (Figure 3).

From a fundamental point of view, the outbreak of the new crown pneumonia pandemic in early 2020 has caused turmoil in global financial markets. Whether it is the Chinese market, the US market, or the European market, in the short term after the rapid spread of the new crown pandemic, investors have panicked, and the risk-averse tendency of funds has led to a large amount of capital "fleeing" from the financial market, and then the financial market indexes have appeared cliffs fall. This is a common phenomenon in both China and the United States, but whether the decline in China and the United States stock prices is related requires further research.

In mid-2020, after the COVID-19 pandemic became normalized in China and globally, stock markets in both China and the United States began to climb.

In the long run, with the deepening of people's awareness of the new crown pneumonia, whether the behavior returns to rationality, and whether the pandemic situation in China and the United States has an impact on each other's stock market is worth exploring.

Figure 2 depicts the impulse response function for the daily logarithmic addition of China and the response variable for the S&P 500 return. It can be found that the number of newly diagnosed cases in China increased by 1% during the period of $t=0$, which has a positive net effect on the S&P 500 return. The impact on S&P 500 returns is positive from $t=1$ to $t=5$, and then turns negative.

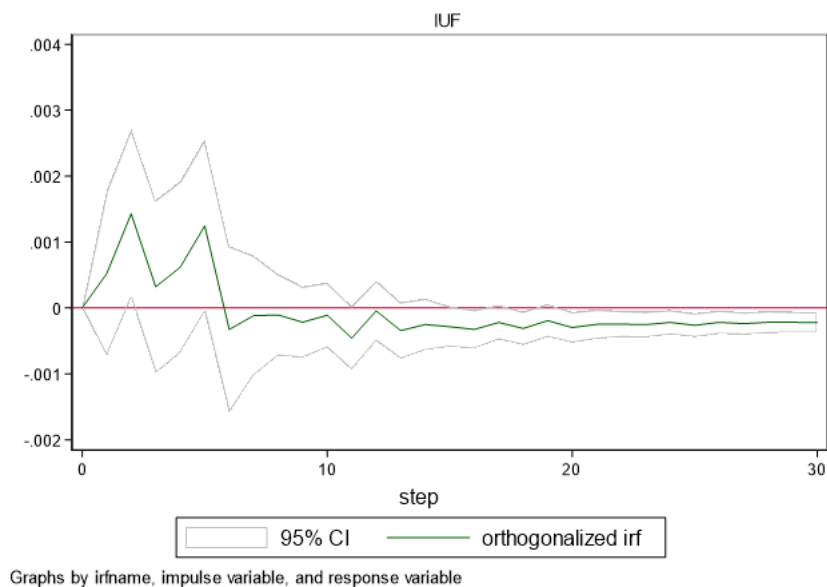


Figure 2. Impulse and response (Photo credit: Original)
 Impulse variable: new daily confirmed cases in US
 Response variable: SSEC log yield

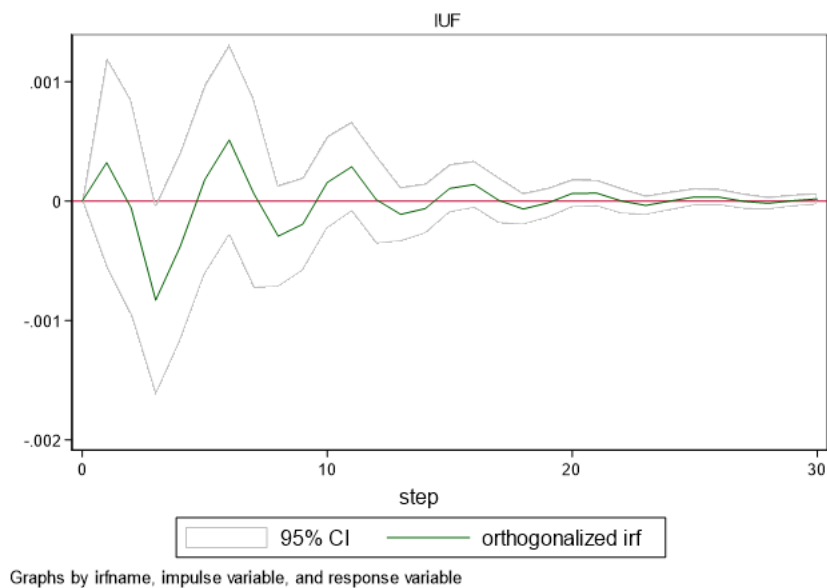


Figure 3. Impulse and response (Photo credit: Original)

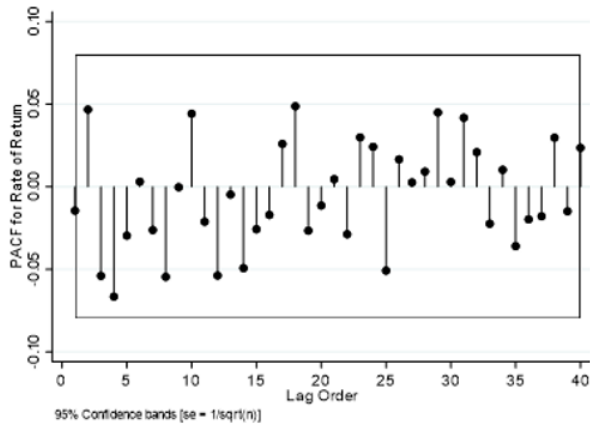
This article argues that this is related to the behavior of Chinese investors. It is a general consensus in academia that Chinese investors' investment behavior is easily dominated by emotions and lacks rationality. Long-term, the rise in the number of newly discovered cases in China will continue to

frighten Chinese investors, who will then divert their money to other markets. This shows that the Covid-19 epidemic has an ongoing effect on Chinese investors' actions.

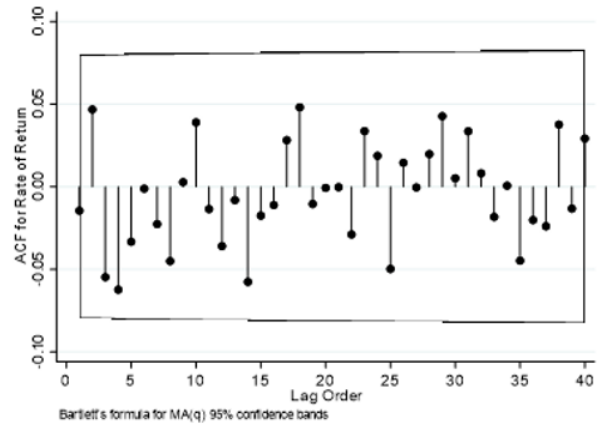
Figure 3 shows a response variable as the impulse response function of the return of the Shanghai Composite Index, and the impulse variable as the daily new diagnoses in the United States. The Shanghai Composite Index's yield will merely vary around zero as a result of the rise in new diagnoses across the United States, with no comparable effect on the index's yield.

3.3. ARMA Order

PACF
 SSEC



ACF



S&P 500

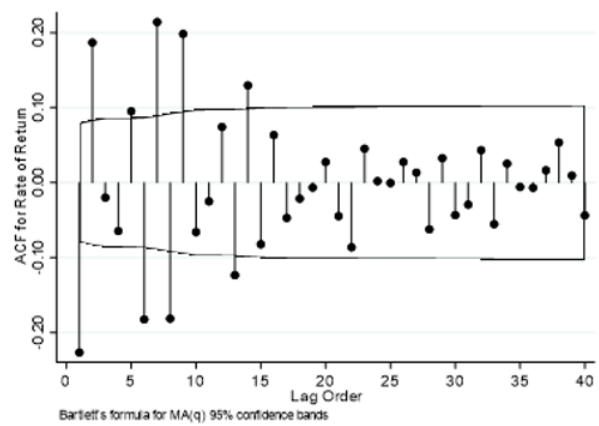
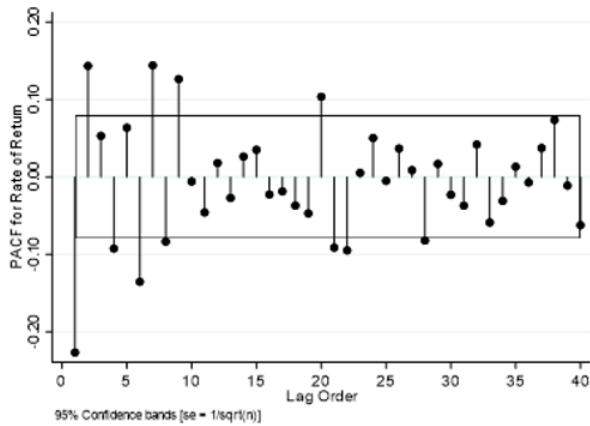


Figure 4. PACF and ACF (Photo credit: Original)

Through the fixed-order diagrams drawn by PACF and ACF above, this part can draw the conclusion that the order in both figures is 1, which is the order of the AR and MA parts (please see Figure 4).

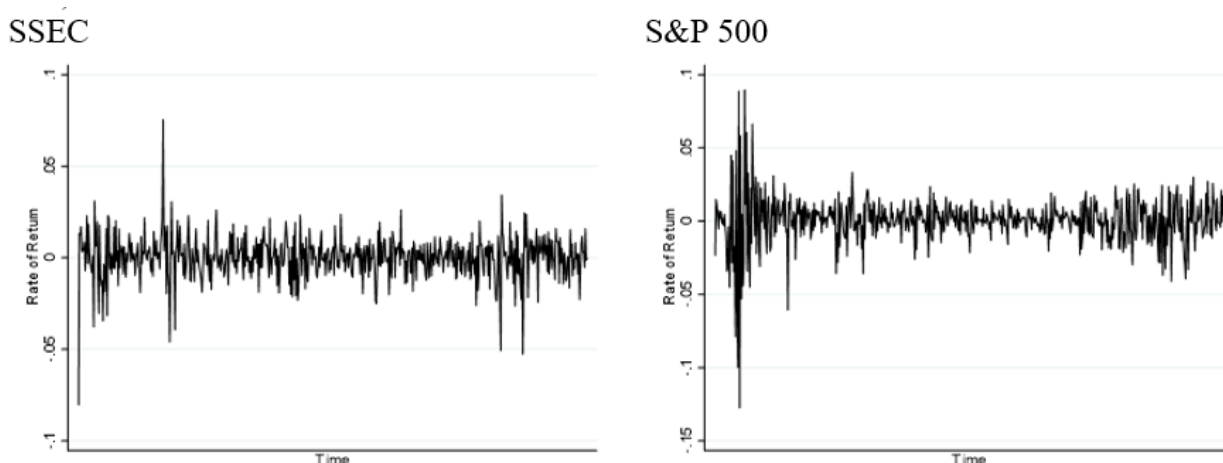


Figure 5. Yield (Photo credit: Original)

The return of the Shanghai Composite Index and the S&P 500 show clear clustering on the time series chart (Figure 5), but more empirical research is still required to determine if this impact is statistically significant.

3.4. ARMA-GARCHX Estimation Results

Judging from the estimation results in Table 3, the ARCH and GARCH terms of the return series of the S&P 500 and Shanghai Composite Index are both significant at the 1% level, that is, there is conditional heteroskedasticity, and GARCH modeling can be carried out.

Judging from the estimated results of external explanatory variables, the daily number of newly diagnosed cases in China increased by 1%, and the volatility of the S&P 500 increased by 0.2655 units, and the coefficient was significant at the 1% level. The Shanghai Composite Index, however, did not have a comparable reaction to the rise in new verified cases in the US.

Table 3. ARMA-GARCHX estimation results

Variables	(1) S&P 500			(2) SSEC		
	Coefficient	Std. err	p> Z	Coefficient	Std. err	p> Z
Mean equation						
AR, L1	-.5493321	.3421242	0.108			
MA, L1	.4761815	.3642999	0.191			
Constant	.0009754	.0003992	0.015	.0001771	.0004411	0.688
Variance equation						
New daily confirmed cases						
China	.2655476	.0793934	0.001			
US				-.1290994	.0352143	0.000
ARCH, L1	.1741446	.0298906	0.000	.1001893	.0190336	0.000
GARCH, L1	.7850698	.0305035	0.000	.8249963	.0368861	0.000
Constant	-12.89499	.403295	0.000	-10.49805	.3238848	0.000

4. Discussion

At present, most of the existing research on the impact of the new crown pandemic on the economy is to study the impact of the pandemic on a single financial market. The study found that the economies of both China and the United States experienced large fluctuations during the outbreak, but also stabilized during the stable period of the pandemic, reflecting a strong correlation[10]. But in this paper, the perspective of economic globalization is innovatively introduced, and the correlation

between the market and the market's feedback on the pandemic is deeply studied, and the degree of lag and the degree of response are given in detail.

The research in this paper illustrates the profound impact of economic globalization. The trend of an isolated economy is no longer only affected by its own economy, but is affected by the cross-influence of multiple economies. The overall reflection is that the global market has an impact on the country's economic trend. Confidence.

When investors face the choice of investment strategy in the future, they should appropriately refer to the conclusions of this article, comprehensively refer to recent major events in multiple similar economies, and take the mutual influence between economies as one of the factors in decision-making. Maximize errors that may occur in investment strategies.

5. Conclusion

In-depth analysis of the effects of a concentrated epidemic in China and the US on another significant economy is provided in this article. According to the study, the volatility of both the S&P 500 increased by 0.2655 units, and the everyday number of newly confirmed cases in China increased by 1%. The coefficient proved significant at the level of 1%. The Shanghai Composite Index, however, did not have a comparable reaction to the rise in new confirmed cases in the United States.

Therefore, it can be inferred that, to a certain extent, the outbreak of the new crown pandemic in China will affect the rise and fall of the S&P 500, not only because China is currently the second largest economy in the world, but also because China is the largest economy in the world. The market and the gross domestic product are increasing year by year. This shows that when investors make investment choices, they should not only consider the trend of the economy itself, but also pay attention to the trend of other closely related economies in a forward-looking manner, which may have a multiplier effect.

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