

# The Effects of COVID-19 on the Returns and Volatilities of Global Stock Indexes

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## ABSTRACT

At the beginning of 2020, COVID-19 broke out around the world, and its impact on the global economy exceeded expectations. Countries declared states of emergency one after another. The outbreak not only triggered a crisis of supply, demand, investment, and supply chain disruptions but also transmitted to the financial sector. Global risk aversion is rising rapidly, and global stock markets continue to plummet, threatening to trigger further financial crises. To investigate the impact of COVID-19 on the financial sector and to prevent and mitigate financial risks, this paper examines the impact of COVID-19 on global stock markets from a global perspective. Firstly, selected data of seven global stock indices using WRDS and S&P Capital IQ databases. After processing these data, ARMA-GARCH modeling was carried out using the data before the outbreak and the data for the whole sample period respectively. Then, the residuals of the model were subjected to L-B and ARCH-LM tests to determine the fit of the model for different stock indices and different periods. Next, determine if the return and volatility of the equity index have changed during COVID-19 based on the goodness of fit. The results of the study show that: (1) The outbreak of COVID-19 has had a serious impact on the yields and volatility of major global equity indices. As can be seen from the descriptive statistics of the data, particularly around March 2020, each of the sample equity indices experienced high volatility. (2) By fitting the post-outbreak data using the pre-outbreak fitted model, it was found that the fit was poor. This suggests that the outbreak of the new crown epidemic had a significant impact on the process of generating stock data. (3) The results of this paper show that the data for the China SSE Composite Index after the outbreak still fit the pre-outbreak fitted model well. This also indicates that the Chinese mainland stock market has shown greater stability than other markets when all major world stock indices were significantly hit by COVID-19.

## KEYWORDS

Stock Indexes; Covid-19; Earnings yield; Volatility; ARMA-GARCH Models

## 1. INTRODUCTION

### 1.1. Background of the Topic Selection

2020 is destined to go down in history as the “Corona Virus Disease 2019” (COVID-19) spreads across the globe [13]. Corona Virus Disease is an acute respiratory infection caused by a virus. The first case of COVID-19 was reported in Wuhan, China in 2020, and starting in late January 2020, COVID-19 has spread to all continental plates of the world except Antarctica. On March 11, 2020, WHO Director-General Tedros Adhanom Ghebreyesus declared that the current COVID-19 outbreak can be called a global pandemic [22]. This outbreak of COVID-19 is the most serious public health security crisis in the past century. As of the end of 2020, the cumulative number of confirmed cases of COVID-19 in the world has reached 8,1475,053, and the number of deaths has reached 1,798,050. Unlike previous COVID-19s, COVID-19 has led to a global lockdown, with governments imposing

travel restrictions, curfews, stay-at-home orders, and facility closures to prevent the movement of people. Meanwhile, the government has also opened isolation centers and special COVID-19 hospitals to provide patients with appropriate treatment. As of the end of April 2020, more than half of the world's population was restricted by a one- to four-month lockdown [28]. Although these strict quarantine measures are in place to curb the further spread of the COVID -19 virus, there is no doubt that as a result, economic activity globally has been severely restricted, with restricted sectors including air shipping, services, tourism, global Electronics, automobiles, telecommunications, trade, and even agriculture and planting have also experienced serious declines. The International Air Transport Association said COVID-19 had led to a dramatic reduction in the number of air passengers and cost the global airline industry \$113 billion in revenue [22]. Secondly, these quarantine measures caused a rapid drop in consumer demand for goods, which wreaked havoc on global supply chains. Take China as an example. China is a producer of intermediate products. China is the main source of demand for many commodities. China plays a key role in the global supply chain, especially in the transportation of computers, electronic products, medicines, and transportation equipment. and other fields. However, China's General Administration of Customs said China's overall import and export volumes in the first two quarters of 2020 contracted by 17.2% and 4%, respectively (General Administration of Customs of the People's Republic of China, 2020). During this period, China's industrial production volume fell by 13.5%, and industrial profits fell by 38.3% (National Bureau of Statistics of China, 2020). To make matters worse, businesses around the world are dealing with lost revenue and disrupted supply chains as many factories in China have closed during the pandemic. Such a situation could lead to long-term corporate problems such as liquidity crunch, high indebtedness, higher equity volatility, lower Stock returns [2] and high-value bankruptcy cases, among others [22]. As a barometer of economic conditions, the stock market has always been one step ahead of the economy, so from the changes in the stock market, we can better see the impact of COVID-19 on the global economy. According to previous literature, financial markets can experience falling yields or large stock price swings during periods of uncertainty, such as crises or plagues [2]. For example, the peso crisis in Mexico in 1994 [26], the currency crisis in Asia in 1997-1998 [4], the Russian currency crisis in 1998 [12], the sovereign debt default crisis [15] and the subprime mortgage crisis in 2008 [20] have serious implications for stock market returns and volatility. The outbreak of COVID-19 has also undoubtedly caused serious turbulence in stock markets around the world, due to shock and fear. Investors generally use forecasting methods to estimate future stock market conditions and adjust their investment strategies based on these forecasts. However, COVID-19, which can be called a "black swan", has caused a huge panic among investors, and they have withdrawn from the stock market one after another. This is the main reason for the downturn in the stock market during COVID-19. Major stock markets lost more than 15% of their value just days after the World Health Organization (WHO) declared COVID-19 a pandemic. In the more than two months after the outbreak of COVID-19, China's three major stock indexes also suffered a slump. As of February 3, 2020, the Shanghai Composite Index fell by 7.72%, the Shenzhen Component Index fell by 8.45 % and the ChiNext fell by 6.85%. At the same time, the stock indexes of the European and American sectors also fell sharply. On the last day of March 2020, the British Broadcasting Corporation (BBC) released figures and claimed that the FTSE 100 Stock Index and Dow Jones Stock Index fell by 25% and 23% respectively, hitting a record high. It was the biggest quarterly drop since 1987. Over the same period, the S&P 500 also fell 20%, its biggest drop since the 2008 financial crisis. According to Schoenfeld (2020), in the last week of February 2020 alone (ie, February 24-28), the S&P 500 lost more than \$5 trillion in market capitalization [22].

The outbreak of COVID-19 has not only affected the yields of the stock market, but the volatility of various stock indexes has also reached a historically high level [18]. Among them, U.S. stock market volatility reached unprecedented levels in mid-March, surpassing October 1987, December 2008, late 1929, and early 1930s Levels. U.S. stocks saw 4 circuit breakers out of 10 trading rates in March 2020. The first circuit breaker occurred on March 9, 2020. Because the benchmark stock index of the New York Stock Exchange fell by 7%, the NYSE announced that the stock market would suspend

trading for 15 minutes. The second time occurred on March 12, 2020, when the S&P 500 fell 7% and was suspended for 15 minutes. The third time occurred on March 16, 2020, when the S&P 500 fell again by 7%, triggering the circuit breaker mechanism. The fourth time occurred on March 18, 2020, when the U.S. stock market was suspended for 15 minutes again. At the same time, at least 8 countries including Brazil, Canada, Egypt, Thailand, the Philippines, South Korea, Pakistan, and Indonesia also violated the circuit breaker mechanism, and the stock market crash instantly spread around the world. Investors' anxiety about the stock market can lead them to be irrational and exhibit biased behavior. This can lead to falling stock prices and abnormal stock market behavior [14]. Affected by COVID-19, the stock markets of many countries around the world have moved violently, and many scholars lamented that the global economy is on the verge of a crisis. Joseph, the Nobel laureate in economics, warned that COVID-19 could push more emerging market countries into debt crises, triggering a global financial crisis.

In general, the outbreak of COVID-19 has not only seriously endangered human health but also quickly impacted the global political economy. According to the Global Economic Outlook (2020) report, the pandemic will drag most of the world's economies into recession, and global output per capita will contract by the most since 1870. The report also noted that global real GDP contracted by 5.2%. GDP contracted by 7% in advanced economies and 2.5% in emerging and developing economies. It is not difficult to see that the destructive power of this COVID-19 far exceeds the "911" incident and the 2008 economic crisis and has brought huge and far-reaching impacts on the world.

## **1.2. Research Significance and Research Objectives**

Unlike traditional economic and financial crises, the impact of COVID-19 on the global economy and financial markets has been greater than expected. COVID-19 has undoubtedly had a huge impact on various industries around the world, especially the foundation of the real economy. Its impact has been more global, longer lasting, and highly uncertain. Emergencies have an irreversible impact on the global economy and people's lives. To effectively prevent and mitigate financial risks and ensure the smooth operation of the economy, various countries have been working to improve the governance mechanism of public health emergencies and strengthen the level of macroeconomic regulation, to effectively respond to public emergencies and maintain macroeconomic and financial market stability.

The securities market has always been regarded as a barometer of economic conditions, and the impact of emergencies often appears in the securities market for the first time [22]. This is of practical importance in helping companies, financial institutions, and individuals to improve their ability to respond to catastrophic events and maintain the stability of the global economy and financial markets.

Therefore, how the global stock market has been affected by COVID-19 is worthy of in-depth study.

The most intuitive variable that reflects the stock market is the daily rate of return of each stock index, and volatility is also an important indicator to study changes in the stock market, which represents the conditional variance of the underlying asset rate of return. In the financial market, whether it is the investment portfolio of financial products, risk management, or asset pricing, volatility plays a very critical role. Therefore, analyzing the characteristics and trends of stock market volatility can help investors measure and avoid market risks. Important research value and practical significance [16].

Therefore, this paper will use the ARMA-GARCH model to analyze the changes in the fitting coefficients of stock index data before and after COVID-19 to analyze the changes in the returns and volatility of major stock indexes in the context of the outbreak, which is very useful for investors to measure and avoid market risks. great significance.

In addition to this, China, the first country to be affected by COVID-19, has seen a small downward movement in its Shanghai Composite Index, but both the magnitude and volatility of the downward

movement have been smaller than in other markets. Therefore, studying the impact of the epidemic on the major stock indices is a topic of both theoretical and practical significance.

This article selects data from 7 representative stock indexes from June 1, 2019, to June 1, 2020, from the global stock market. These stock indexes are the FTSE 100 Index, Nasdaq Index, Dow Jones, S&P 500, Shanghai Composite, Hang Seng, and CAC40. To study the relationship between each stock index and COVID-19, this paper divides these data into data before the outbreak and data after the outbreak and uses the ARMA - GARCH model to fit the data in these two stages respectively. The impact of stock index returns and volatility.

### **1.3. Research Content and Article Structure**

This article will be written in the following five parts:

The first part is the introduction. This part introduces the background, research significance, and structure of this article, highlighting the impact of COVID-19 on the global stock market, the purpose of writing this article, and the specific research content.

The second part is the literature review. This section describes the existing research results of other researchers on this topic and the research results on the use of the ARMA-GARCH model to measure the volatility and returns of stock indexes. In addition to this, this section discusses in detail why and how the COVID-19 outbreak will affect the stock market.

The third part is hypothesis, data, and model research methods. This part will describe the hypothesis that this paper needs to establish, process, and test the data before modeling, perform descriptive statistics on the data, introduce the research method of this paper, and analyze the basic theory of establishing the ARMA-GARCH model. The fourth part is the presentation and interpretation of the empirical results. In this section, the results of the empirical research will be reported, whether the results are consistent with the assumptions of the previous section, and the results will be analyzed and interpreted. The fifth part is the conclusion and outlook. In this part, based on the empirical analysis results of the above models, combined with the actual situation of the global stock market, summarize the relevant conclusions and the research significance of this paper, expound on the inadequacies of the article writing and propose future research directions and prospects.

### **1.4. Research Innovation**

From the perspective of the global stock market, this article explores and analyzes the changes in the global stock market during COVID-19 with the changes in the yield and volatility of stocks as the entry point.

The innovation of this paper mainly has the following two aspects:

#### **(1) Innovation in the field of research**

This article closely follows the changes in the market, selects the current real-time data on COVID-19 pneumonia COVID-19 for analysis, and draws on the latest research results to make the research conclusions more convincing. COVID-19 has magnified the differences between different regimes and systems, exacerbated the differentiation and conflict of interests between different countries, and reflected the consciousness of a community with a shared future for mankind. COVID-19 has gradually formed a global pandemic trend.

In the context of globalization, research on this topic needs to continue.

#### **(2) Innovation in research methods**

In previous articles, many scholars have studied changes in stock indexes by directly measuring the volatility and average returns of the data, or by forecasting the data after the outbreak of COVID-19, and then comparing the predicted value with the actual value. The research idea adopted in this paper

is "model fit". The best fitting model of the data before the outbreak was fitted to the data after the outbreak, and the significant values of the model residuals before and after the outbreak were compared, and further research and analysis were carried out.

## **2. LITERATURE REVIEW**

Incidents in which emergencies, including the COVID-19, have had a serious impact on the stock market have occurred frequently in the past ten years, and have attracted great attention from investors and scholars, because the turmoil in the stock market involves not only the interests of individual investors are also the economic development of the entire country and even the world. Scholars' research on such issues is the demand for economic development and social development, which will promote human beings to face the economic crisis steadily, which is also the key to accelerating human progress. The first part of this section will describe the scholars' research on the impact of some major emergencies on the stock market.

In the research methods of such events, many scholars also use the relatively mature ARMA-GARCH model. The second part of this section will describe the development process of the ARMA-GARCH model.

Not all scholars' research results are that COVID-19 will hurt the stock market, so the third part of this section will present different authors' opinions on whether COVID-19 will have a negative impact on the stock market, and scholars' opinions on research results.

### **2.1. Research on the Impact of other Emergencies on the Stock Market**

COVID-19 is a global outbreak with significant uncertainty and destructive characteristics. There are relatively few empirical studies on the impact of COVID-19 on the stock market, while there are more studies on the impact and channels of action of previous years' emergencies on the stock market, which is more fruitful. Most of the literature examines the impact of natural disasters, financial crises, and disease on the stock market and concludes that they bring significant negative impacts on the stock market. The impact of catastrophic events on the stock market's returns and volatility has been studied by some academics as far back as the last century. Quarterly, (1993) [25] studied the impact of the Soviet Chernobyl nuclear accident on the stock market. Anderson and Cross (1989) [3] examined whether the 1989 California earthquake had a severe impact on the stock prices of listed insurance companies. The study found that insurance company stocks suffered a severe negative shock from the earthquake disaster as investors had pessimistic expectations and uncertainty about the future share prices of insurance companies due to the large compensation payments they would make in the earthquake. However, as the earthquake damage became more certain, the negative shock to stocks gradually decreased.

There is much literature about the impact of unexpected events on stock prices. Nikkinen et al. (2008) [23] researched the returns and volatility of 53 global stock markets after the "911" event and found that this event had a serious impact on the stock markets of developed countries and regions, while the impact on the stocks of some underdeveloped regions was relatively small. Al-Rjoub and Azzam (2012) [1] used the GARCH-M model to study the ASE stock market crash from 1992 to 2009 of seven historical events, the findings show that the crisis has an overall negative impact on stock returns across all industries, with banking being the most affected. The 2008-2009 economic crisis had the worst impact on the ASE stock market crash. Lars Jonung and Werner Roeger (2010) [17] studied the impact of the 2006 pandemic outbreak in the European Union on European countries and estimated that European countries during the pandemic GDP has lost about 1.5%, and the economic structure has also been affected by the pandemic. Righi and Ceretta (2011) [27] used a copula based GARCH model to estimate the conditional variance and covariance of multivariate relationships between UK, German, and French markets. The study found that the European debt crisis in 2010

increased the risk in major European equity markets, particularly the volatility of German, French, and UK stock markets. In addition, many scholars have also studied SARS. The impact of the outbreak on the stock market, SARS broke out in 2003, and like COVID-19, SARS is a respiratory disease that has spread to multiple countries. Nippani and Washer (2004) [24] used conventional t-test and nonparametric Mann-Whitney test to study whether SARS affected stock markets in five global regions, including Canada and China. By comparing stock indices during and before the SARS outbreak, scholars found that SARS had a serious negative impact on stock indices in the China and Vietnam regions. However, stocks in other regions did not experience any significant turbulence as a result. Chen, Jang, and Kim (2007) [8] assessed the impact of the SARS outbreak on Taiwanese hotel stocks. The results show that the prices and yields of hotel stocks in Taiwan, China, fell severely during the SARS outbreak. The study also found that the travel industry was the most affected of all industries, with its share price down about 29%.

Some scholars also used the historical review method to predict the possible impact of the Newcastle pneumonia epidemic on the stock market by analyzing the impact of several epidemics on the stock market, including the Spanish pandemic in 1918, the SARS epidemic in 2003, the H1N1 epidemic in 2009 and the Ebola epidemic in 2014. Among them, Chari and Schott (2020) compared the SARS epidemic with COVID-19 and studied the impact of the two epidemics on the Hong Kong and US stock markets in China.

## **2.2. ARMA - GARCH Model**

To analyze the changes in the returns and volatility of stock indexes before and after the outbreak of COVID-19, this article will use the ARMA-GARCH model. This model can analyze the impact of external shocks on event sequences and is widely used in various time series analyses. Stock market volatility has been the focus of much scholarly research. As early as 1970, Fama (1970) [10] found that stock price movements were characterized by agglomeration. The ARCH model was first mentioned by Engle and Mustafa (1992) [9] and applied to practical studies. Fama, Hageman, and Iau [10] have successively found that return series have characteristics such as spikes and thick tails.

BOLLERSLEV (1986) [7] proposed a GARCH model based on the ARCH model, and Nelson (1996) [21] showed that the GARCH model could solve equity market volatility and was effective. Black proposed that the effect of expected price changes on share price volatility is asymmetric, i.e., share price volatility has a leverage effect. For this phenomenon, GLOSTEN, JAGANNATHAN, and RUNKLE (1993) [11], Zakoian (1994) [31], and Nelson (2013) [21] have proposed asymmetric models, namely GJRT, ARCH, and EGARCH models.

This paper uses the ARMA-GARCH model to analyze seven global equity indices. From 2005 to 2006, Hansen and Alexander et al found that the ARMA - GARCH model has a strong fitting ability for stock market volatility. Since the ARMA - GARCH model was proposed, many scholars have made a lot of expansions and innovations on this basis. For example, the EGARCH model is used to fit asymmetric phenomena in the stock market, and the ARCH - M model can be used to fit the risk premium of an asset. Worthington and Valadkhani (2004) [29] used the ARMA model. Severe natural disaster events such as earthquakes, severe rainstorms, floods, and wind restrictions that occurred in Australia from 1982-2002 were selected to analyze the impact of sudden natural disasters on stock market indices. The study shows that only earthquakes and cyclones have negative short-term shocks on the stock market, which reverse after five days. For the study of the relationship between COVID-19 and the stock market, many scholars have also adopted this type of model. Kusumahadi and Permana (2021) [16] using TGARCH Models to Study the Impact of COVID-19 on Stock -Return Volatility in 15 Countries Worldwide. The authors found that the outbreaks of COVID-19 affect stock return volatility for all sample countries except the United Kingdom. Li et al. (2021) [19] used AR (1) – GARCH (1, 1) models to reliably estimate the impact of COVID-19 fear on the public and the

impact of stock market volatility. The findings suggest that a 1 % increase in COVID-19 diagnoses is associated with a 0.8 % and 0.56 % decline in stock returns and GDP, respectively.

### **2.3. The Impact of COVID-19 on the Stock Market**

#### **2.3.1. The negative impact of COVID-19 on the stock market**

This section will discuss why the COVID-19 pandemic is affecting the stock market and the research in the existing literature. Changes in stock prices over time are consistent with concurrent conditions and information, and both internal and external conditions can have a large impact on stocks. The internal conditions are the operating conditions of the company itself, and the external conditions are mainly the investment information and news that people receive.

##### **(1) Internal Conditions**

This section will discuss the internal condition factors. Firstly, COVID-19 has hit the real economy from the supply side, and many companies have been negatively impacted and even closed. Initially, companies had to shut down because transportation disruptions and supply chain disruptions prevented them from replenishing inventories, and the company's demand for raw materials exceeded supply, so the company's costs went up, which eventually led to a downturn for many brick-and-mortar companies. It will be difficult for the real economy to recover from the downturn until doctors and experts find a cure for the virus and make it less of a threat. And considering world trade, due to the different outbreak times of COVID-19 in different countries, many companies or enterprises may also be seriously affected by the impact of supply chains in importing or exporting countries. Harvard economics professor Barro, Ursua, and Weng (2021) [6] estimated COVID-19 based on flu statistics from 1918 to 1920. The macroeconomic burden of the outbreak claims that the GDP of virus-affected countries has fallen by 6% to 8%. Ludvigson, Ma, and Ng (2020) [19] argue that the COVID-19 pandemic is unlike any other natural disaster in history because it lasts longer, hits both supply and demand, and is highly variable between countries. At the same time, according to the model, if the COVID-19 lasts for three months, the loss of the manufacturing industry will reach 12.75%, and the unemployment rate of the service industry will reach 17%. Alexander (2020) The study of more than 5,800 small businesses in the U.S. found that 43% of them temporarily closed during the pandemic, with sample companies reducing their workforce by an average of 40% compared to pre-pandemic employment.

Secondly, COVID-19 will increase the company's debt default risk. Corresponding to the above-mentioned downturn cycle of the real economy, uncertainty and panic have caused the prices of risky financial assets and commodities to fall and fluctuate greatly. However, the price of risky financial assets began to rise after central banks adopted expansionary monetary and fiscal policies to inject liquidity into the market and stimulate the real economy. However, as the profitability of the real economy declined, valuations of risky financial assets began to adjust downwards, increasing the risk of default on corporate debt and compromising the balance of financial institutions, companies, and households. If COVID-19 continues, financial crises such as the sovereign debt crisis and banking crisis could follow.

Baker, Li, and Dong et al. (2020) found that the COVID-19 pandemic significantly reduced the return on assets and increased the leverage ratios of firms in affected countries. Yilmazkuday (2021) [30] examines the impact of U.S. COVID-19 deaths on the S&P 500 index, with a cumulative 1% daily increase in confirmed COVID-19 cases leading to a cumulative decline in the S&P 500 a day later. About 0.01%, and about 0.03% less after one month.

To sum up, under the influence of COVID-19, the real economy has been hit hard, the company's market value has declined, and the company's debt default risk has increased significantly. The downturn of the real economy and companies quickly led to a crisis in the stock market, which is why and how internal conditions affect the stock market.

## (2) External Conditions

This section will discuss the external condition factors. In the capital market, unexpected events often affect investor behavior by affecting investor sentiment, and ultimately affect stock prices. Bae and Andrew Karolyi (1994) [5] found that negative news has a more significant impact on stock prices than positive news. The behavior of individual investors on stock news will develop into collective behavior, even herd behavior. After the outbreak, investors' uncertainty and panic will prompt them to start withdrawing from the stock market to avoid risks. This has led to sharp declines and large fluctuations in the prices of risky financial assets and commodities. This is why and how external conditions can affect the stock market.

### 2.3.2. The positive impact of COVID-19 on the stock market

However, not all COVID-19 brings to the stock market are disasters.

Before COVID-19, mankind also experienced some epidemics, such as SARS, which caused turmoil in the stock market and caused many stocks to fall, but there were still some stocks that rose. From the experience, the epidemic can have a positive impact on some stock markets. And in some of the available literature, many authors have also shown that COVID-19 can have a positive impact on some industries.

Taking China's stock market as an example, He et al. (2020) [13] conducted a study of 18 sub-sectors in China through the event study method. The market value in the context of COVID-19 was studied. This study shows that COVID-19 has had a serious impact on traditional industries in China, including transportation, mining, and electricity. Instead, COVID-19 has increased opportunities for the development of high-tech industries. It has also boosted the manufacturing industry, the IT sector, education, and the health sector.

On the day of the COVID-19 outbreak, stocks in the agriculture, mining, power, heating, and construction sectors all fell sharply. The market value of companies in industries such as transportation, real estate, environmental protection, accommodation and catering, and business services also showed a significant downward trend on the day of COVID-19 and in the following days. However, industries such as manufacturing, public management, information technology, sports, and entertainment not only withstood the negative impact on the day of the incident, but also showed strong coping capabilities, and their stock prices also showed an upward trend to a certain extent. The reason for this may first be that the COVID-19 outbreak boosted the manufacturing stock market's momentum by boosting the production of masks, ventilators, and other medical equipment to fight the pandemic. Because during COVID-19, wearing masks became an effective way to stop the spread of the virus and some special medicines also play a large part in the treatment of patients. This has also led to a rise in the shares of medical companies. Secondly, in the case of population isolation, information technology has played an important role in the prevention and control of digital COVID-19s, and the comprehensive promotion of online courses has promoted stock investors' confidence in the health education industry.

At the same time, the "new infrastructure" strongly supported by the Chinese government, including manufacturing, information technology, and other industries, can now quickly stimulate effective investment, thereby stimulating effective market demand and consumption. The construction of 5G networks, for example, has not only facilitated the upgrading of related products, but also the development of the healthcare industry, the home industry, the education industry, and the travel industry. During COVID-19, hospitals use 5G to drive robots to deliver meals or medicines. Many good doctors are scattered across the country and use 5G for remote diagnosis, which is very effective and visible. Students can learn through distance learning. Tourists can also travel the world in the clouds from their homes using VR. COVID-19 is also forcing the upgrading of China's industrial chain. Big data, cloud computing, and other digital technologies can transform the industrial chain to

achieve accurate sensing, online processing, and intelligent decision-making, helping China breakthrough industrial bottlenecks (He et al., 2020).

### 2.3.3. Summary of the impact of COVID-19 on the stock market

Generally, although some industries bucked the trend against the backdrop of COVID-19, the stock market showed a downward trend, and most industries were strongly negatively affected. Looking at the world, although some high-tech industries can resist the impact of COVID-19 and can even go against the wind under the outbreak, most industries have been severely hit by COVID-19, and the overall stock market tends to be in a downturn.

ZEREN and HIZARCI (2020) [32] tested the impact of COVID-19 on the stock market. Using stock data from China, South Korea, Italy, Germany, and Spain from January 2020 to March 13, 2020, using a cointegration test, they found that the number of deaths from COVID-19 was significantly higher than that of all countries in their sample. There is a long-term relationship between the stock markets. Onal (2020) expanded the research scope to seven countries: the United States, China, France, the United Kingdom, Iran, Italy, and Spain, and the results showed that COVID-19 has a significant impact on stock market volatility. Baker et al. (2020) used a text-based approach in their study, where they sought to observe the stock market's response to the presence of COVID-19. By evaluating US stock market movements from 1900 to April 2020, they found that COVID-19 had a much more severe impact on US stock market volatility than other pandemics including the 1918-1919 Spanish flu pandemic. Also, during the COVID-19 outbreak, the US stock market was much more volatile than during other illnesses such as bird flu, SARS, MERS, and Ebola. They also found a long-term relationship between some COVID-19 cases and most stock markets in the sample.

A review of the existing literature reveals that research on the impact of unexpected events on the stock market has focused on events such as natural disasters and terrorist attacks. Most of the studies concluded that there were short-term negative shocks. The mechanism of impact is mainly reflected in two aspects: firstly, the negative sentiment of investors caused by the outbreak, including excessive panic and pessimism about the expected economic impact caused by the outbreak; secondly, the actual loss caused by the outbreak to the real economy, with most studies indicating that the impact of negative investor sentiment on the stock market is greater than the impact caused by the actual economic loss to the stock market. COVID-19 not only has a sudden and devastating character like natural disasters such as earthquakes and hurricane, but also possesses a negative social and economic impact similar to the financial crisis. The impact on society and the economy will be deeper, and more widespread, and the damage to the real economy will be more severe. Therefore, the question of whether the pattern and mechanism of the impact of COVID-19 on the stock market are consistent with the impact of other contingencies on equities needs to be further explored. The study about the impact of COVID-19 on stock indices can, on the one hand, enhance people's understanding of how COVID-19 affects societies and economies, which can help countries and investors develop responses. On the other hand, it can also help people to grasp the general patterns and mechanisms of the impact of major public health events on stock markets.

## 3. HYPOTHESIS, DATA, AND METHODOLOGY

### 3.1. Hypothesis

This article will propose the following hypotheses to test whether the outbreak of COVID-19 has an impact on each stock index Hypothesis: COVID-19 has no significant impact on the yield and volatility of major stock indexes.

Under this hypothesis, the COVID-19 pandemic has not had a significant impact on stock market returns and volatility. In the empirical analysis, the fitted model before the outbreak can be used to fit the data after the outbreak. If the model can fit the data well, it can be shown that the data generation

process of stock index returns and volatility before and after COVID-19 has no obvious defense, that is, it can be proved that the COVID-19 has no significant impact on stock index returns and volatility.

### 3.2. Data

#### 3.2.1. Data selection and sources

To study the impact of COVID-19 on global stock indexes, this paper selects the FTSE 100 index, Nasdaq index, Dow Jones index, S&P 500 index, and Daily closing price data for the Shanghai Composite, Hang Seng, and CAC40. Finally, the logarithmic daily rate of return is taken as the research object. This article examines changes in stock market returns and volatility before and during the pandemic using data from this year.

Due to the closure of Wuhan, China on January 23, 2020, this article uses the data from June 1, 2019, to January 22, 2020, as the data for the pre- COVID 19 outbreak in mainland China, and the data from January 2020 to the data from -2.3 to June 1, 2020, is for the period of the COVID-19 outbreak in mainland China. Since the WHO declared COVID 19 a pandemic on March 11, 2020 -, this article sets the data from June 1, 2019, to March 10, 2020, as the pre- COVID -19 outbreak outside mainland China. The data from March 11, 2020, to June 1, 2020, is defined as the data during the outbreak of COVID-19 outside mainland China. The specific division is shown in the following table (Table 1):

**Table 1.** Data Phase Breakdown

stage division	Shanghai Composite	other
pre-pandemic	2019.6.1-2020.1.22	2020.6.1-2020.3.10
during a pandemic	2020.1.23-2020.6.1	2020.3.11-2020.6.1

The seven stock index samples selected in this paper include representative stocks in most regions of the world, including the Americas, Asia, and Europe, and cover the stock market data of several important countries, which are highly representative.

Data for the FTSE 100, Nasdaq, Dow, S&P 500, Hang Seng, and CAC40 were obtained from S&P Capital IQ, and data for the Shanghai Composite was pulled from the WRDS database. S&P Capital IQ is one of the world's most authoritative databases. It is the research arm of S&P Global, one of the world's largest providers of ratings, data, research, and S&P Dow Jones Indices. S&P Capital IQ facilitates research for a variety of investment stakeholders by providing them with detailed stock market-related data. WRDS is backed by the credibility and leadership of the Wharton School. This database is the global gold standard for data management, data analysis, innovative tools, and research services and is the absolute authority. It provides data support to more than 500 institutions in 35 countries, with over 75,000 users.

#### 3.2.2. Data processing and inspection

##### (1) Stationarity processing of data

Stationarity is a unique term used to describe the statistical behavior of time series data. If a time series has no systematic change in mean (no trend), no systematic change in variance, and strict elimination of periodic changes, Call it stable. Stationary time series is the most important special type of time series analysis. So far, time series analysis is based on stationary time series, and its methods and theories are limited for statistical analysis of non-stationary time series.

Therefore, to avoid the non-stationarity in financial data causing bias in the results of subsequent empirical research, this paper's logarithmic rate of return is processed on the data of each stock index.

Calculated as follows:

$$X_t = (P_{t+1} - P_t) / P_t$$

In the above formula,  $P_{t+1}$  is the stock price one day after  $t$ ,  $X_t$  is the stock price  $t$  the logarithmic return of  $P_t$  the day is the stock price on day  $t$ .

(2) Data verification

Firstly, to ensure that the data has statistical and analytical significance and increase the persuasiveness of the empirical research, it is necessary to test the stationarity of the relevant data. This paper adopts the ADF unit root test method to test the stationarity of the data. Through the P value in the ADF test, it is judged whether there is a unit root in the data. If there is no unit root, the data is stable and meets the modeling requirements.

As shown in the following table (Table 2), the test results all reject the null hypothesis, so the sequence does not have a unit root and is a stationary sequence, so the time series of logarithmic rate of return can be used for modeling.

**Table 2.** Stationarity Tests for Log Returns

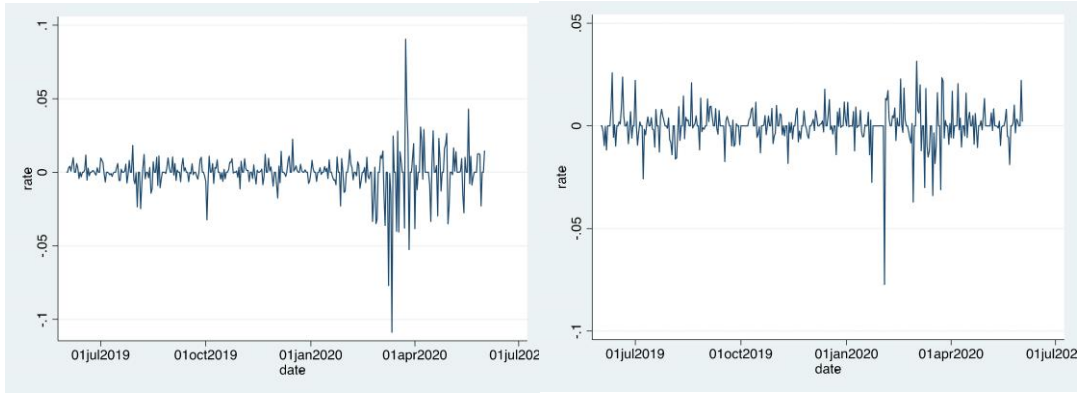
Stock Index	Yield series	
	ADF test -P value	Unit root
FTSE 100,	< 0.01	No unit root
NASDAQ	< 0.01	No unit root
Dow Jones	< 0.01	No unit root
s&p 500	<0.01	No unit root
Hang Seng	<0.01	No unit root
CAC 40	<0.01	No unit root
SSEC	<0.01	No unit root

Secondly, it is not difficult to see from the basic statistical characteristics of the data that the data has the characteristics of partial front and fat tail. and from Jarque-Ber a It can be seen from the statistics that the statistics of all indices are far greater than 0, rejecting the assumption of normal distribution, which means that the data obviously do not obey the normal distribution.

3.2.3. Descriptive statistics of the data

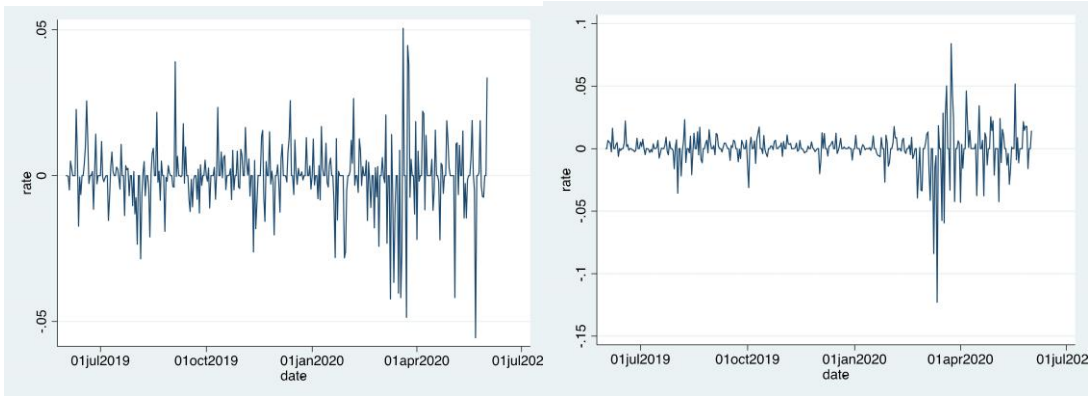
(1) Time series plot of daily logarithmic returns

The following is a time series chart of returns for each stock index:



(1) FTSE 100 Yield:

(2) Shanghai Composite Yield:



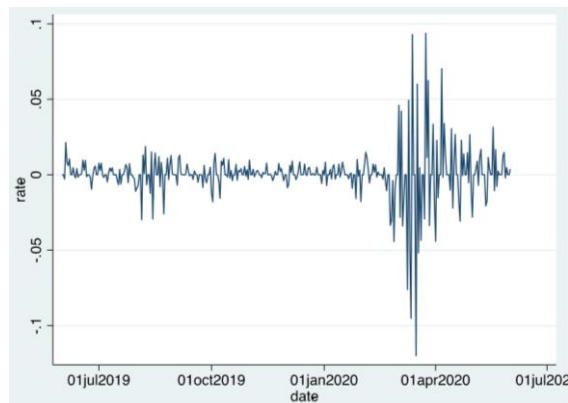
(3) Hong Kong Hang Seng Index Yield:

(4) CAC40 Yield:



(5) Dow Jones Yield:

(6) Nasdaq Index Yield:



(7) S&P 500 Index Yield:

**Figure 1.** Time series chart of daily returns of global stock indexes

(Time series chart of daily returns of global stock indexes) It can be seen from the figure that the volatility of each stock index began to increase sharply around February 2020.

(2) Descriptive statistics

**Table 3.** Descriptive statistics

	Mean	SD	Skewness	Kurtois
Panel A: Full sample period				
FTSE 100,	-0.0003125	0.0138441	-1.361659	21.12038
NASDAQ	0.0008275	0.0171987	-0.7707984	17.89348
Dow Jones	0.0002346	0.0180876	-0.4936019	20.42677
S&P 500	0.0004311	0.0170404	-0.5744112	18.94594
Hang Seng	-0.0002717	0.011689	-0.4634546	8.109349
CAC 40	-0.0001245	0.0153107	-1.743625	20.2054
SSEC	0.0000636	0.0091698	-1.804273	18.32964
	Mean	SD	Skewness	Kurtois
Panel B: Pre-pandemic period				
FTSE 100	-0.0006085	0.0088506	-3.207338	24.4264
NASDAQ	0.0004595	0.0109365	-1.156636	13.88836
Dow Jones	0.0000817	0.0103743	-1.333079	20.11433
S&P 500	0.0002144	0.0101471	-1.432452	19.58149
Hang Seng	-0.0001588	0.0092444	-0.3277861	6.665061
CAC 40	-0.0003613	0.0097402	-3.250635	24.33056
SSEC	0.0002521	0.0067095	0.1546664	5.725132
	Mean	SD	Skewness	Kurtois
Panel C: During-pandemic period				
FTSE 100	0.0007	0.0241614	-0.7117031	8.808135
NASDAQ	0.0020867	0.0300897	-0.5625296	7.83548
Dow Jones	0.0007578	0.0329916	-0.264192	7.642784
S&P 500	0.0011723	0.0306593	-0.3271903	7.350937
Hang Seng	-0.0006578	0.0177403	-0.3860412	5.143006
CAC 40	0.0006855	0.0267959	-0.9965826	8.320953
SSEC	-0.0002924	0.0124799	-2.003917	14.02612

(The table reports selective descriptive statistics of stock index returns for the entire sample period (June 1, 2019, to June 1, 2020))

The following table (Table 3) reports descriptive statistics for the entire sample interval (Panel A), before the COVID-19 outbreak (Panel B), and during the COVID-19 outbreak (Panel C).

In Panel A, the NASDAQ had the highest average daily return (0.08275%), followed by the S& P 500 (0.04311%). The lowest average was the UK's FTSE 100 (-0.03125 %), followed by Hong Kong's Hang Seng (-0.02717 %). The US Dow has the highest standard deviation (0.0180876), while China's Shanghai Composite has the lowest standard deviation (0.0091698). The skewness of all sample stock indices is negative, which indicates that all stock market indices have long-left-tailed distributions. From the kurtosis value, the distributions of stock indices are all kurtotic, and the kurtosis values of all stock indices are greater than 3, which indicates that the distribution of returns of these stock indices has shorter tails than the normal distribution.

In Panel B, the UK's FTSE 100, Hong Kong's Hang Seng, and France's CAC40 had negative yields before the outbreak, while the US NASDAQ, Dow, s &p500, and China's Shanghai Composite had negative returns before the outbreak. The rate of return is positive. The US NASDAQ index has the

highest average daily return (0.04595%), and the lowest average return is the FTSE 100 index (-0.06085%). The US NASDAQ index (0.0109365) had the highest standard deviation, while China's Shanghai Composite had the lowest standard deviation again (0.0067095). Except for China's Shanghai Composite Index, the other sample stock market indices have a left long-tailed distribution and are kurtotic for all stock market indices.

In Panel C, the daily average change of the US NASDAQ index remains the highest (0.20867%), while the lowest average is the Hong Kong Hang Seng Index (-0.06578%). The US Dow Jones (0.0329916) had the highest standard deviation, while China's Shanghai Composite had the lowest standard deviation again (0.0124799). All sample indices have negative skewness, indicating that all stock market indices have left-tailed distributions. Significant kurtosis statistics show that the distributions of all stock market indices are kurtotic. Comparing the pre-COVID-19 outbreak and during the outbreak, we found that in 7 cases, the standard deviation of all stock indices increased after the COVID-19 outbreak, implying that the COVID-19 outbreak caused a substantial increase in stock volatility. Secondly, except for the Shanghai Composite Index and Hang Seng Index, the average daily yields of other stock indexes have increased, which shows that the outbreak of COVID-19 has not had a great negative impact on the stock yields of some Western countries, and even contributed to the rise of stock yields, however, the outbreak of the COVID-19 had a significant negative impact on the stock indices in mainland China and Hong Kong, China.

### 3.3. Methodology

#### 3.3.1. Literature Research Method

This paper collates and summarizes news reports core journal papers and book materials on the impact of COVID-19 on financial markets and stock markets, stock market returns and volatility, etc. through both internet searches and library material reviews. The existing research results in academia were fully borrowed to analyze possible future research directions, to determine the research ideas and research methods of this paper.

#### 3.3.2. Qualitative analysis method

Based on traditional financial theory, efficient market theory, economic fundamentals theory, behavioral finance theory and stock market theory, this paper analyses the changes in the returns and volatilities of seven major global stock indices against the backdrop of the onslaught of the epidemic from a macro perspective and a micro perspective.

#### 3.3.3. Empirical analysis method

This paper uses intervention analysis combined with the ARMA-GARCH framework to analyze the returns and volatility of various stock indexes under the impact of the COVID-19. ARMA model combines the autoregressive model (A, R) and the moving average model (M, A) to obtain the autoregressive moving average model ARMA (p, q) model, the formula is as follows:

$$X_t = c + \phi_1 x_{t-1} + \phi_2 x_{t-2} + \dots + \phi_p x_{t-p} + u_t + \theta_1 u_{t-1} + \theta_2 u_{t-2} + \dots + \theta_q u_{t-q}$$

Among them, p is the order of the autoregressive model, q is the order of the moving average model,  $\phi_i$  (i=1, 2, p) and  $\theta_j$  (j=1, 2, q) are the parameters of the model,  $x_t$  is the observed value and  $u_t$  is the residual term. For the autoregressive moving average model, the general non-seasonal time series data are weakly non-stationary, that is, when the characteristic root falls on the unit circle, we call the characteristic root the unit root. A time series contains d unit roots, and the time series can be changed into a stationary time series after d differences. If a time series {y<sub>t</sub>} becomes a stationary time series {x<sub>t</sub>} after d differences, then {y<sub>t</sub>} is said to obey the autoregressive summation moving average model, that is, ARMA (p, d, q).

The expression for the GARCH (p, q) model is as follows:

$$X_t = a_0 + a_1 y_{t-1} + a_2 y_{t-2} + \dots + a_p y_{t-p} + u_t$$

$$\sigma_t^2 = \phi_0 + \phi_1 u_{t-1}^2 + \phi_2 u_{t-2}^2 + \dots + \phi_q u_{t-q}^2$$

Among them,  $\sigma_t^2$  is the conditional variance, then it is said to  $u_t$  obey q order ARCH process.

The empirical method used in this paper is the intervention analysis combined with ARMA-GARCH. First, fit the time series before the intervention (before the outbreak) to find the model with the strongest fitting ability. In the model setting, use ARMA (1, 1), ARMA (1, 2), ARMA (2, 1), ARMA (2, 2) as the alternative mean model; GARCH (1, 1), EGARCH (1, 1) and GARCH (1, 1)-M as alternatives for the volatility model. Considering the economic significance of the GARCH model and the assumption of volatility convergence, the models with non-convergence volatility were excluded from the fitting, and the BIC information criterion was used to obtain the best fitting settings. After searching for the optimal pre-forecast model, it is combined with the intervention shock (COVID-19-related variables) to estimate the direction and significance of the impact of the intervention (COVID-19) on the returns and volatility of each stock index. Taking ARMA (1, 0)-GARCH (1, 1) as an example, the model after adding the intervention shock is as follows:

$$r_t = \mu + a_1 r_{t-1} + \beta_m d_t + u_t \quad u_t = \epsilon_t \quad \epsilon_t \sim N(0, \sigma_t^2) \quad \sigma_t^2 = \omega + \phi_1 \sigma_{t-1}^2 + \rho \sqrt{\sigma_{t-1}^2} + \beta_v d_t$$

Above formula, it  $r_t$  is the logarithmic difference sequence of the first period returns.  $\epsilon_t$  is a white noise sequence with a mean of 0 and a variance of 1,  $d_t$  is the COVID-19-related variable (Ct, It, Dt),  $\beta_m, \beta_v$  and is the impact of the COVID-19-related variables on the stock index return and volatility. Its significance and sign determine whether COVID-19 will affect the return and volatility. The expected mean has an effect.

## 4. EMPIRICAL RESULTS AND EXPLANATIONS

### 4.1. Model Selection

Analysis requires fitting the time series before the intervention, and its parameters are required to be significant, and the fitting effect is good. As mentioned in the model section, there are four options for the mean model in this paper: ARMA (1, 1), ARMA (1, 2), ARMA (2, 1), and ARMA (2, 2). For the volatility model, select one of the best fitting models from GARCH (1, 1), E-GARCH (1, 1), and GARCH (1, 1)-M models. After fitting each candidate model, the optimal model is selected according to the BIC information criterion. The following tables (Table 4 and Table 5) shows the BIC information criterion values for the fitted data of each model.

**Table 4.** BIC Information Criteria for ARMA Class Models

	ARMA(1, 1)	ARMA (1, 2)	ARMA (2, 1)	ARMA (2, 2)
FTSE 100	-1862.122	-1860.237	-1860.547	-1857.287
NASDAQ	-1752.076	-1752.64	-1749.1	-1748.346
Dow Jones	-1787.796	-1786.327	-1783.457	-1781.265
S&P 500	-1795.552	-1799.623	-1794.516	-1795.108
Hang Seng	-1833.546	-1828,944	-1828,785	-1826,839
CAC 40	-1816,788	-1811.632	-1812.146	-1809,804
S SEC	-1671.887	-1667.663	-1667.532	-1675.393

It can be seen from the BIC information criterion results of the ARMA class model that the ARMA (1, 1) model is effective for FTSE 100, Dow Jones, Hang Seng, and CAC40. The exponential fit works best. The ARMA (1, 2) model fits the NASDAQ and S&P 500 indices best. ARMA (2, 2) has the best fitting effect on SSEC.

**Table 5.** BIC Information Criterion Values for GARCH-like Models

	GARCH (1, 1)	E - GARCH (1, 1)	GARCH (1, 1)-M
FTSE 100	-1962.914	-1922.052	-1958.530
NASDAQ	-1898.339	-1943,709	-1893.126
Dow Jones	-1985.424	-2043,7	-1980.449
S&P 500	-2011.119	- 2009,4	-2006,770
Hang Seng	-1833,867	-1829,302	-1828,681
CAC 40	-1918,674	-2065,8	-1913.122
SSEC	-1678,8	-1673,885	-1673,436

It can be seen from the BIC information criterion of the GARCH-like model that the GARCH (1, 1) model is very effective for FTSE 100, S&P 500, Hang Seng, and SSEC. The exponential fit works best. E-GARCH (1,1) model for NASDAQ, Dow Jones, and CAC40 indices gave the best fit.

## 4.2. Intervention Analysis

Performing an intervention analysis requires fitting into the sequence of events preceding the event. In this paper, the method of judging the degree of fit is to carry out L-B test and ARCH-LM test for the residuals of the model with different lag orders. If the residuals of the model are white noise and the ARCH - LM test is not significant, the model fits well. If the residuals of the model reject the white noise hypothesis and the ARCH-LM test is significant, the model fits poorly. First, fit the time series of daily log-difference returns before the outbreak.

The fitting results of the stock indices of various countries before COVID-19 are shown in the following table (Table 6):

**Table 6.** Fitting results of pre-COVID-19 data

	Specification	L-B 20	ARCH-LM 2
FTSE 100	ARMA (1, 1)-GARCH (1, 1)	51.2579	0.085
NASDAQ	ARMA (1, 2)-EGARCH (1, 1)	46.3445	33.764
Dow Jones	ARMA (1, 1)-EGARCH (1, 1)	50.4814	37.906
S&P 500	ARMA (1, 2)-GARCH (1, 1)	48.5890	39.130
Hang Seng	ARMA (1, 1)-GARCH (1, 1)	12.4205	0.970
CAC 40	ARMA (1, 1) – EGARCH (1, 1)	54.7198	0.531
SSEC	ARMA (2, 2) - GARCH (1, 1)	23.4556	3.649

ARCH- LM test of the model residuals with different lag periods, the results show that the model has a strong ability to fit each stock index. It shows a certain ARCH effect. The strong model fitting ability can show that each model before COVID-19 can well simulate the data generation process before COVID-19 and can also provide empirical evidence for the impact of subsequent COVID-19 shocks.

In the fitting process of pre-COVID-19 data, it is found that the above model has a better fitting effect. Now, the data after COVID-19 is added to the above model again to fit the data to determine whether the data generation process of each stock index has changed after COVID-19, that is, the content of the hypothesis.

The fitting results of the data after adding the COVID-19 are shown in the following table (Table 7):

**Table 7.** Fitting results of data after adding the COVID-19

	Specification	L-B 20	ARCH – LM 2
FTSE 100	ARMA (1, 1)-GARCH (1, 1)	54.5129	6.642
NASDAQ	ARMA (1, 2)-EGARCH (1, 1)	197.9877	38.625
Dow Jones	ARMA (1, 1)-EGARCH (1, 1)	199.5553	38.013
S&P 500	ARMA (1, 2)-GARCH (1, 1)	203.9112	42.788
Hang Seng	ARMA (1, 1)-GARCH (1, 1)	18.2334	13.615
CAC 40	ARMA (1, 1)-EGARCH (1, 1)	55.0567	2.779
SSEC	ARMA (2, 2)-GARCH (1, 1)	2.856	0.031

From Table 7 that after adding the data after COVID-19, although the coefficients still show strong significance, the fitting ability of most models is poor. The model fitting residual L-B statistic is significant, indicating that the residual has significant autocorrelation. At the same time, the ARCH-LM test is significant, indicating that the model volatility series has an autocorrelation phenomenon, which means that the data is not well fitted. To sum up, after the outbreak of COVID-19, the data generation process of the major stock indexes has indeed changed significantly, that is, hypothesis 1 is rejected. Second, China's Shanghai Composite Index shows low sensitivity to COVID-19. After adding stock index data during COVID-19, the pre-COVID-19 model settings can still effectively fit the data. Among them, Jung-Box statistic and ARCH-LM test can reject residual autocorrelation and ARCH effect. This shows that while the world's major stock indexes have been significantly impacted by COVID-19, the Chinese mainland stock market has shown greater stability than other markets. On the one hand, it is related to China's rapid response to the rapid control of COVID-19, and on the other hand, it also benefits from China's stock market stabilization policy. For the Chinese stock market, although the pre-COVID-19 model can better fit the post-COVID-19 data, its coefficients still change to a certain extent, so the unchanged setting in Hypothesis 1 cannot be accepted, and the specific results still need further analysis.

## 5. CONCLUSION

Based on the results of the theoretical and empirical analyses above, this chapter summarizes the main ideas and conclusions of this paper's research and puts forward targeted policy recommendations on how to effectively prevent and mitigate systemic financial risks in financial markets and stock market turbulence in the context of COVID-19, and finally suggests directions that can be explored in future research in this area.

### 5.1. Summary of Findings

The sudden outbreak of Newcastle Pneumonia in 2020 has brought a severe test to the global stock market and triggered a "meltdown" mechanism in major stock markets around the world.

From the perspective of the global stock market, this article takes the changes in the yield and volatility of the seven major stock indexes in the world as the entry point to explore and analyze the stock market volatility in the context of COVID-19 pneumonia COVID-19. From the above empirical research, the following conclusions can be drawn:

The COVID-19 outbreak has had a big impact on the yields and volatility of major stock indexes around the world. First, a descriptive analysis of the data shows that during the COVID-19 pandemic, especially around March 2020, the returns of each stock index have exhibited high volatility. The research results directly show that the outbreak of COVID-19 has had a huge impact on the global stock market, which also reflects the impact of COVID-19 on most areas of the world.

This paper establishes the ARMA-GARCH model based on the log-differenced return time series data of seven global sample stock indices. By performing the L-B test and ARCH-LM test on the residuals of the model, it is concluded that the fit of the data before COVID-19 to the model is good, and the fit of the data after COVID-19 is poor. This shows that the outbreak of COVID-19 has had a great impact on the generation process of stock data. That is, reject the hypothesis of this paper.

Through the research of this paper, it is also found that the data of China's Shanghai Composite Index can still fit the model well after the outbreak, which shows that when all major stock indexes in the world have been significantly impacted by COVID-19, the Chinese mainland stock market has performed better than others. Greater stability in the market.

## **5.2. Implication of the Study**

The research in this paper can provide the financial sector, investors, listed companies, and governments with some strategies to deal with the impact of COVID-19.

### **5.2.1. Coping strategies of the financial sector**

In response to the large volatility in the stock market under COVID-19. The financial sector should increase the loan risk compensation mechanism for damaged listed companies, expand the scale of the existing enterprise loan risk compensation fund and the intellectual property pledge risk compensation fund, improve the risk compensation fund assessment mechanism, and improve the assessment of fund use efficiency. Give full play to the role of financial capital in leveraging and risk protection.

Secondly, in the face of the sudden COVID-19, the financial regulatory authorities should introduce positive macro-fiscal policies to guide investors' emotions and advocate a healthy outlook on investment and financial management. At the same time, we must promptly verify and resolutely crack down on deliberate speculation that disrupts the market's autumn order, regulate the market, and create a healthy and stable stock market.

### **5.2.2. Investors ' coping strategies**

The impact of major unexpected events on the stock market is not only manifested in the direct impact on the country's macroeconomic fundamentals, but the irrational behavior of investors may also be an important factor in exacerbating stock market turmoil and triggering financial crises. The cost of irrational investor behavior is even far greater than the losses caused by the external shock itself. Drawing on the experience of the US, it was the US government's proactive and effective measures to alleviate market panic in the face of the sub-prime crisis that ensured the rapid recovery of the US economy in the face of the sub-prime crisis. Therefore, in the process of dealing with the risk contagion in the global stock market triggered by external shocks, governments should rationally and correctly guide the direction of stock market public opinion, disclose stock market information openly and fairly, neither exaggerate the cost of risk spillover in the stock market nor exaggerate the losses brought about by risk abuse and actively announce to investors and financial institutions in the market the measures currently taken by the government and regulators and their next policies. At the same time, it is also necessary to grasp the degree of policy delivery to avoid over-interpretation of policies by investors and financial institutions in the market, and actively send signals to stabilize market sentiment and help investors in the market restore optimistic market expectations. In addition, efficient information delivery channels should be established to increase the transparency of information and reduce the contagion of market sentiment between the government and investors due to information asymmetry.

At this stage of COVID-19, investors, in general, need to be aware that the staged and systematic decline in the stock market crash and market adjustment caused by COVID-19 has been completed. The stock market is likely to fluctuate up and down in the future, but any volatility may constitute an attractive buying point. Of course, the impact of COVID-19 on tourism, hotels, movies, catering, and

other industries is certain. However, with the selection of technology and Internet technology, sub-sectors such as the "home economy" are bred with huge investment opportunities. Therefore, investors do not need to panic and despair in the face of sudden declines. The long-term growth trend of the world economy will not change, and the fundamentals of high-quality listed companies will not change. Short-term declines in the broader market are normal. Investors can pay more attention to Although blue-chip bidders were hit by COVID-19 in the short term, the "mistaken killing" showed the investment value of these blue-chip stocks.

### 5.2.3. Coping strategies of listed companies

First of all, it is necessary to give full play to the advantages of listed companies, properly handle the business affected by COVID-19 and try to restore the company. The loss of the company, and actively appeal to the relevant government departments to give the company preferential policies in taxation, financing, labor compensation, and other aspects. Secondly, taking this COVID-19 as an opportunity, it is necessary to build the company's emergency management mechanism, optimize the work process, reduce unnecessary costs, and timely optimize products and services according to recent market changes, improve the competitiveness of products, and provide the market for the post-COVID-19 market. Be prepared for a rebound in demand. Finally, it is important to maintain regular contact with partners and clients, to change the company's plans on time in response to the changes of COVID-19, and to lay the groundwork and prepare accordingly for business after the end of COVID-19.

### 5.2.4. Coping strategies of national governments

When responding to stock market risk fluctuations caused by external shocks, governments should first grasp the existing domestic financial market conditions, deeply understand the characteristics of the domestic financial market, understand the sentiment and expectations of financial market participants, and formulate macro-prudential fiscal and monetary policies, considering the actual situation of the country's stock market. In addition, it is also necessary to implement pilot projects on a small scale, through reasonable market feedback, to grasp the effectiveness of policy implementation, to ensure that policy implementation is steadily progressing, to prevent the emergence of policy "flooding" on the financial market to produce a secondary impact. In this way, we can effectively manage financial market risks and maintain financial market stability.

## 5.3. Limitations of the Dissertation and Future Outlook

### 5.3.1. Limitation of the dissertation

The research method used in this paper is the empirical research method, with data selected from seven sample stock indices. Empirical research is a form of research in which information from data is collected, processed, and analyzed. Empirical research plays an increasingly important role as a tool in the field of academic research and social studies in modern society. The findings of the empirical research method are reliable, objective, specific and forward-looking. However, there are many limitations throughout the empirical research process. Firstly, the sample size selected in this paper is limited and is not sufficiently representative of the state of change in all markets and all stock indices. Secondly, the volatility of the data may also be influenced by reasons other than COVID-19, so the results of the study may be biased to some extent without other possible variables.

In addition to this, different countries have adopted different policies for COVID-19. This paper does not discuss different policy contexts, so the returns and volatilities of each country's equity indices cannot be put on the same footing for comparison.

### 5.3.2. Future Outlook

First of all, COVID-19 is likely to become a long-term COVID-19 disease that coexists with humans, and it will coexist with humans for a long time. Therefore, the period of high volatility in the global stock market may last longer, and the future stock market must be changing rapidly. In the context of

such a COVID-19 pneumonia COVID-19, each country will adopt many different macro policies to control the stock market. Therefore, future scholars' research on this topic should make corresponding improvements based on the latest national policies and the actual development of COVID-19 pneumonia COVID-19.

Secondly, for the data of the new coronary pneumonia COVID-19, the application of infectious disease models for research can accelerate the understanding of the mechanism behind the infectious disease, formulate reasonable prevention and control measures, and help relevant staff to reduce the threat and harm of the disease to humans as much as possible. has important theoretical significance.

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