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DATA-driven shock impact of COVID-19 on the market financial system

Shaoling Li [a], Yuwei Yan [b,*]

[a] School of Economics and Trade, Henan University of Technology, Zhengzhou 450001, China
[b] School of Economics and Management, Taishan University, Taian, 271021, China

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ABSTRACT

The Corona Virus Disease 2019(COVID-19) has a dramatic effect on my country's market and financial system. Although China has controlled the deterioration of the epidemic, this global epidemic will inevitably have an impact on the global economy including China. In order to study the shock effect of the COVID-19 on the market financial system, this paper builds a data model processing system based on the event analysis method, and analyzes the shock effect from three aspects of supply chain finance, financial securities, and corporate financial systems. Moreover, this paper uses crawler technology to obtain valid data from major websites, analyzes model data with mathematical statistics combined with event models, and outputs the results and compares them with the actual situation. Through data analysis, it can be seen that the model constructed in this paper can effectively reflect the shock effect of the COVID-19 on the market financial system. Finally, the comparison method is used to compare the research results with the actual situation. The results show that the two are basically the same. Therefore, it can be seen that the proposed research method has significant effects and has certain reference value for studying the shock effect of the epidemic on the financial system.

1. Introduction

At the beginning of 2020, a new crown pneumonia epidemic broke out globally. Although China has controlled the deterioration of the epidemic, this global epidemic will inevitably have an impact on the global economy including China. At present, the epidemic abroad has spread significantly. As governments of various countries have adopted measures to close the country, states, and cities, production factors cannot flow freely in the market, and many industries around the world have been hit hard. Moreover, many companies are unable to carry out normal production, the global industrial chain is broken, and global market demand is in a declining stage. In addition, the global stock market plummeted, and many countries including the United States, South Korea, and the Philippines experienced stock market circuit breakers. Among them, the US stock market even experienced four circuit breakers.

Contrary to European and American countries, China's economic environment is very different from European and American countries. China's market interest rates have not approached zero, and China has been deleveraging in recent years, which has led to the market's reluctance to lend to risky non-state-owned enterprises. In addition, driven by policies, companies are encouraged to go to the equity market for direct financing, and finally a multi-level equity market structure has been formed. Although China's leverage ratio is still at a relatively high level, China's overall debt-to-asset ratio is smaller than that of European and American countries.

* Corresponding author.
E-mail address: yanyuwei@tsu.edu.cn (Y. Yan).

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China's capital market includes the main board market, the small and medium-sized board, the new third board and the science and technology innovation board, and the regional equity trading market (four board market). Such a capital market structure provides companies with diversified financing tools and broadens their financing channels. The equity in the national balance sheet reflects the net social wealth of a country after deducting liabilities. China's social net wealth accounts for a relatively high proportion, so compared to European and American countries, it has stronger strength to deal with future debt risks. Since my country has controlled the epidemic as soon as possible, the impact of the COVID-19 on my country's debt is smaller than that of European and American countries. At the same time, due to the multi-level equity market structure, my country's stock market has also been in a lower valuation range. Therefore, in the face of the impact of the epidemic, the low-valued stock market has little room to fall, and it has not fallen sharply like European and American countries (Johnson et al., 1986).

Although the epidemic has an impact on the economy, it is only an external variable after all, and endogenous power is the decisive factor that determines a country's economic development. By establishing a historical, rational, and dialectical perspective, we will be able to better grasp the laws and increase our confidence in the long-term positive trend of the Chinese economy (Shao, 2020).

From a rational point of view, the epidemic does have an impact on the economy, but it is only a short-term external variable that affects the economy. However, China's economic growth is driven by long-term internal factors such as endogenous driving force, strong consumption potential, complete industrial structure, and reform dividends brought about by deepening reform and opening up. Moreover, despite the short-term impact of the epidemic on China's economy, China's economy has great resilience, sufficient space, and a strong foundation. The long-term trend of China's economic growth will not change due to an epidemic. From a dialectical point of view, the crisis contains turning points and opportunities. The epidemic is a big test for us, and it is also a stress test before building a well-off society in an all-round way. We should not wait for this crisis to pass. Instead, we must be good at turning crises into opportunities, further advance the supply-side structural reform, further optimize and upgrade the industrial structure, and create a new industry model for China's economy on the basis of ensuring that this year's two major tasks of winning the fight against poverty and building a well-off society in an all-round way (Carrasco et al., 2011).

It can be seen that in the global context of the COVID-19, studying the shock effect of the COVID-19 on the financial system and analyzing the nature of its impact on finance plays an important role in restoring the economy and promoting economic development. Based on this, this paper analyzes the shock effect of the financial system in the context of the COVID-19.

2. Literature review

Research on the impact of major emergencies on the capital market has always been an important content of the capital market research. Emergencies can be divided into natural disasters, social security incidents, accident disasters and public health incidents. The impact of natural disasters on the capital market is short-lived, and the impact is mainly concentrated in the affected areas, and different types of natural disasters have different impacts on the capital market (Bosco & Verney, 2012). The literature (Carpenter et al., 2011) took natural disasters as the research object and found that forest fires have a positive impact on the capital market, but tornadoes and earthquakes have a negative impact on the capital market. The literature (Hernando et al., 2015) studied the impact of the earthquake on the capital market and found that the negative impact on the financial sector in the epicenter was significant. The literature (Fenichel, 2013) believed that natural disasters will have a serious negative impact on the stock prices of local companies, and the average time for the negative impact is 19 days. Social security incidents have a wide range of impacts on the capital market, and even have long-term negative effects. After the "911" terrorist incident, the US stock market fell across the board, and the Dow Jones Index fell by 7.13% (Wandiga et al., 2010). The literature (Luh et al., 2018) investigated the impact of terrorist attacks on the stock prices of local companies and found that such events not only had a short-term negative impact on stock prices, but even affected long-term investment. Through research on the impact of accidents and disasters on the capital market, it is found that the negative impacts are mainly concentrated in sensitive industries related to the incident. The literature (Watkins et al., 2019) analyzed the impact of security incidents on the stock market and found that security incidents had a negative impact on the entire financial industry. Among them, the stock price of liquor companies has fallen the most. The impact of major public health emergencies on the capital market is limited and short-lived. The literature (Wang et al., 2011) studied the impact of major health accidents on the capital market and found that major health accidents led to the deterioration of the financial environment and the increase of investment risks in the short term, but did not affect the long-term stability of the capital market. The literature (Tarragona et al., 2012) pointed out that major health accidents have a particularly serious impact on my country's tourism industry, and tourism stocks have shown an overall downward trend. In order to deal with the financial risks brought by major emergencies and maintain the stability of the capital market, the discussion on the response mechanism of emergencies has attracted the attention of scholars, and the existing research is mainly carried out from the macro and micro levels (Lamontagne et al., 2019).

It plays a fundamental role in preventing financial risks caused by emergencies and responding to financial crises. Both the implemented fiscal policy and monetary policy can have a positive impact on the capital market (Scavette, 2019). Through selective investment, tax reduction and fee reduction, improvement of corporate loan support, and provision of SME funds, the financial shock of emergencies can be smoothed (Santos et al., 2013). At the micro level, corporate behavior will affect the buffering capacity under capital market shocks, and improving accounting robustness and optimizing corporate governance can effectively improve the risk buffering capacity of enterprises to respond to financial crises (Gori et al., 2020). In addition, the confidence of micro-investors in social and economic development and high-quality growth of the capital market is particularly important to deal with the impact of emergencies. As long as this confidence is not overwhelmed by the epidemic, the long-term development trend of the capital market will not be subject to a strong abnormal impact due to emergencies (Anderson et al., 2020). In summary, with regard to the research on the impact of major emergencies on the capital market, there are currently more studies on natural disasters and accidents and disasters, and fewer studies on the shock effect of public health emergencies on the capital market. Therefore, in the face of the sudden COVID-19, in order to control financial risks and maintain the stable development of the capital market, it is urgent to study the shock effect of the COVID-19 on the capital market and the industry heterogeneity effect, and reveal the impact path and consequences of the epidemic on the capital market (Das et al., 2012). This paper will use signal transmission theory, behavioral finance theory, etc., and use relevant stock transaction data in China's capital market as a sample to study the shock effect of the COVID-19 on the capital market. Moreover, on this basis, relevant countermeasures and suggestions are put forward to provide theoretical and practical reference for the healthy development of the capital market in the post-epidemic era.

3. The theoretical framework of event analysis

The basic step of the event analysis method is to first define an event that may generate excess returns. The time period during which the defined event has an impact is called the "event window", and then the impact of the event is measured by analyzing the size of the excess income in the event window. The so-called excess return (abnormal return) is the difference between the actual return in the event window and the expected return assuming that the event did not occur. It can be expressed as follows (Adimora et al., 2009):

$$AR_t = R_t - E[R_t|X_t] \tag{1}$$

Among them, AR_t, R_t and $E[R_t|X_t]$ respectively represent the excess return (abnormal return), actual return and expected return at time T, and X_t is the information as a condition in the expected return model. The expected return is calculated by the selected model, and the model parameters are calculated based on the data in the estimation period. There are many models for calculating expected returns, which are roughly divided into two categories: simple statistical models and economic models. Among statistical models, two models are often used: fixed mean return models and market models. The fixed mean return model mainly assumes that the return on securities in the past period of time is fixed. This method is very simple. In some cases, the effect of using this method to calculate the normal rate of return is very good. However, in some cases, this simple method can cause problems. When the event R of the sample company is very close, we call it an intensive event. The intensive event is usually associated with market-wide events, such as the Federal Reserve's increase in interest rates and changes in accounting standards. Due to the high volatility of the Chinese stock market, the assumption that stock returns are fixed is often not satisfied. Therefore, the results obtained according to this model are not convincing, so we use the market model in this paper. At the same time, it is assumed that asset returns are independent and uniformly distributed. The expected return of security i at time t is (Ball et al., 2013):

$$R_{it} = a_i + \beta_i R_{mt} + \varepsilon_i \tag{2}$$

Among them, R_{mt} represents the market rate of return, and ε_i represents the random disturbance term. They satisfy the following formula:

$$\begin{aligned} &E(\varepsilon_i) = 0 \\ &VAR(\varepsilon_i) = \sigma_i \end{aligned} \tag{3}$$

If the length of the estimation period is assumed to be $L1$, then the rate of return for all estimation periods is:

$$R_i = X_i\theta_i + \varepsilon_i \tag{4}$$

R is an $L1$-row matrix, representing the return of securities during the estimation period, and X_i is an $L1 * 2$ matrix. The first column of the matrix is all 1, and the second column is all composed of market returns:

$$\theta_i = [a_i, \beta_i] \tag{5}$$

The above formula represents the parameter matrix. Unbiased and consistent parameter estimators are obtained by the least square method:

$$\theta_i = (X_i^{'}X_i)^{-1}X_i^{'}R_i \tag{6}$$

$$\widehat{\delta}^2_{\varepsilon_i} = \frac{1}{L1-2}\widehat{\varepsilon}_i^{'}\widehat{\varepsilon}_i \tag{7}$$

$$\widehat{\varepsilon}_i = R_i - X_i\widehat{\theta}_i \tag{8}$$

$$Var\left(\widehat{\theta}_i\right) = (X_i^{'}X_i)^{-1}\delta^2_{\varepsilon_i} \tag{9}$$

$L2$ is the length of the event window. Then, the excess return in this period is:

$$AR_i = R_i^* + \overline{a}_i - \widehat{\beta}_i R_m^* = R_i^* - X_i^*\widehat{\theta}_i \tag{10}$$

In the formula, $R_i^* = [R_{iT1}, R_{iT2}]$ is the $L2 * 2$ vector, which represents the actual income of security i in the event window. X_i^* is a $L2$ $*2$ matrix, the second column of the matrix is composed of 1, and the second column is the market rate of return (Fang, 2014). If it is assumed that there is no change in aviation stocks in the event window, the excess return (abnormal return) vector satisfies:

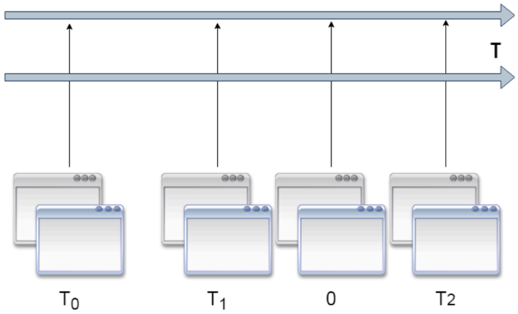

Fig. 1. Time series window of event research.

$$AR_i \sim N(0, V_i) \tag{11}$$

$$V_i = I\sigma_\varepsilon^2 + X_i^*\left(X_i^* X_i\right)^{-1} X_i^* \delta_\varepsilon^2 \tag{12}$$

In order to test whether the assumptions are true, the cumulative excess return rate CAR is introduced. We define $CAR_i = (\tau_1, \tau_2)$ as the cumulative excess return rate of stock i from τ_1 to τ_2 in the event window, and γ as the $L2 * 1$ vector. Among them, the value from τ_1 to τ_2 is a constant l, and the rest are 0. Then there are:

$$CAR_i(\tau_1, \tau_2) = \gamma' AR_i \tag{13}$$

$$Var\left(CA\widehat{R}_i(\tau_1, \tau_2)\right) = \gamma' V_i \gamma \tag{14}$$

If the assumption that the event has no effect on the return of stock i is true, then:

$$CA\widehat{R}_i(\tau_1, \tau_2) \approx N\left(0, \delta_i^2(\tau_1, \tau_2)\right) \tag{15}$$

$$\delta_i^2(\tau_1, \tau_2) = (\tau_2, \tau_1 + 1)\delta_{\varepsilon_i}^2 \tag{16}$$

After the cumulative abnormal return rate is standardized, the standard cumulative abnormal return rate is obtained:

$$SCA\widehat{R}_i(\tau_1, \tau_2) = \frac{CA\widehat{R}_i(\tau_1, \tau_2)}{\widehat{\delta}_i(\tau_1, \tau_2)} \sim t(L1 - 2) \tag{17}$$

$SCA\widehat{R}_i(\tau_1, \tau_2)$ obeys the $t(L1 - 2)$ distribution. When $L1$ is greater than 30, it approximately obeys the normal distribution, and the test statistic of the average cumulative abnormal return rate is constructed. The statistics of $J1, J2$ are:

$$J1 = \frac{CA\overline{R}(\tau_1, \tau_2)}{\widehat{\overline{\delta}}(\tau_1, \tau_2)} \sim N(0, 1) \tag{18}$$

$$\widehat{\overline{\delta}}^2(\tau_1, \tau_2) = \frac{1}{N^2}\sum_{i=1}^{N} \delta_i^2(\tau_1, \tau_2) \tag{19}$$

$$J2 = \left(\frac{N(L1 - 4)}{L1 - 2}\right)^{1/2} SCA\overline{R}(\tau_1, \tau_2) \tag{20}$$

$$SCA\overline{R}(\tau_1, \tau_2) = \frac{1}{N}\sum_{i=1}^{N} SCA\widehat{R}_i(\tau_1, \tau_2) \tag{21}$$

The event research method is to study the impact of sudden events (such as mergers, acquisitions, earnings announcements or refinancing behaviors) on stock prices (or corporate values), and is widely used in financial market research (Shamseddeen et al., 2011).

Generally speaking, event research includes six steps, namely, defining the event, determining the selection criteria, choosing a model for estimating normal returns, estimating normal and abnormal returns, testing the significance of abnormal returns, explaining the empirical results and drawing conclusions.

That is to define the event to be studied. The windows to be involved in the event research include estimation windows, event windows, and post-event windows (Kalemli-Ozcan, 2012). We use τ as the sign of the event time, $\tau = 0$ as the sign of the event day, and $\tau = T_1 + 1$ to $\tau = T_2$ as the sign of the event window. $L_1 = T_2 - T_1$ is a sign that measures the length of the event window, $\tau = T_0 + 1$ to τ

$= T_1$ is the interval of the estimation window, and $L_2 = T_1 - T_0$ is a sign that measures the length of the estimation window. Next, we represent the time series on the time axis in Fig. 1.

We use the data in the estimation window to calculate the normal return. Generally speaking, the length (L_2) of the selected corresponding estimation window should be no less than 120 data. Since the event window is a window used to test whether an event has an impact on the stock price, it can be seen that the length of the event window is uncertain, and its length mainly depends on the different research purposes.

After the event is defined, it is necessary to determine the research sample selected for the event research. Specifically, the selection criterion is to select a sample that is related to the occurrence of the event from the stock price information of a large number of listed companies to analyze the impact of the event on the stock price. This standard should include considerations that limit the availability of data, such as the availability of data from listed companies on the Shanghai Stock Exchange or the Shenzhen Stock Exchange. In addition, the consideration of industry restrictions should also be included. At this stage, what remains to be done is to summarize some characteristics of the data sample (such as the capitalization of the company's market, the representativeness of the industry, and the distribution of events throughout the period). Moreover, it is necessary to pay attention to the possible bias in sample selection.

In order to estimate the impact of the event on the stock price, the necessary work is to measure the normal return and abnormal return data in the event window. The so-called normal return refers to the expected return based on the situation when the event did not occur, and the abnormal return refers to the difference between the actual return in the event window and the estimated expected return.

We set R_{it} as the sign of actual income, E_{it} as the sign of normal income, and ε_{it} as the sign of abnormal income. According to the above definition of abnormal returns, it can be concluded (Ahn et al., 2014):

$$\varepsilon_{it} = R_{it} - E_{it} \tag{22}$$

Although there are many methods to calculate the normal return of stock prices, they can be divided into two categories: statistical methods and economic methods. The statistical method takes the statistical assumptions about asset returns as a basis for measuring normal returns, but does not consider the impact of economic theory on normal returns. The economic method takes the assumptions about investor behavior in economics as the basis for measuring normal returns, and does not rely solely on statistical assumptions. However, in the actual operation process, we must make relevant statistical assumptions when using economic models. Therefore, the significant advantage of the economic model lies in the fact that various constraints in economics can be used to precisely limit normal returns.

4. Statistical model

This model defines the average return of stocks in the estimation window as a measure of the normal return of stocks in the event window (SASAKI et al., 2019). We set μ_{it} to be a sign of the average return of the stock in the estimation window. According to the constant mean return model, the above formula can be transformed into:

$$\varepsilon_{it} = R_{it} - \mu_{it} \tag{23}$$

Each variable meets the following conditions:

$$\begin{aligned} &E[\varepsilon_{it}] = 0 \\ &Var[\varepsilon_{it}] = \sigma^2_{\varepsilon_t} \\ &\mu_{it} = \overline{R} \end{aligned} \tag{24}$$

R_{it} is the sign of the actual return of security i at time t, and ε_{it} is the sign of the abnormal return of security i at time t.

The market model is a statistical model based on the assumption that there is a certain correlation between the return rate of a certain security in the market and the return rate of the market security portfolio. According to the market model, the following formula holds.

$$R_{it} = \alpha_i + \beta_i \cdot R_{mt} + \varepsilon_{it} \tag{25}$$

Each variable meets the following conditions:

$$\begin{aligned} &E[\varepsilon_{it}] = 0 \\ &Var[\varepsilon_{it}] = \sigma^2_{\varepsilon_t} \end{aligned} \tag{26}$$

R_{it} is the sign of the actual income of the security i at time t, R_{mt} is the sign of the actual income of the market securities portfolio at time t, and α_i, β_i and $\sigma^2_{\varepsilon_t}$ are the signs of the parameters obtained when estimating the market model.

The market model's work to improve the constant mean return model removes the content of the income part related to changes in market returns, thereby reducing the content of the variance of abnormal returns and enhancing the work of testing the validity of event results. The advantage of using the market model depends on the difference of the R^2 value obtained when the market model is regressed. The larger the R^2 value, the more content in the event window where the normal return can be correctly estimated, and the more content the variance of the abnormal return decreases. From this perspective, the market model has more advantages.

There are many other statistical models that can be used to model normal returns, among which factor models are more commonly used. Since people consider many factors when buying and selling securities, the factor model can explain more the content of people's

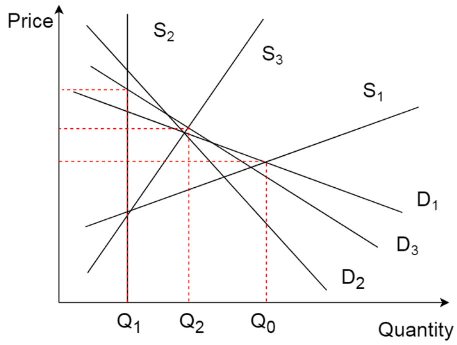

Fig. 2. The impact of the epidemic on supply and demand.

buying and selling activities. Therefore, the factor model can better explain the work of the variance of normal returns, and thus can reduce the content of the variance of abnormal returns. When considering the factor model, the multi-factor model is also used by more scholars to estimate the work of normal returns. For example, foreign scholars discuss the testing of multi-factor index models based on industry classification. In the factor model, another variable is the work of the difference between the actual income of companies of the same size and the investment portfolio, and the size of the company is divided according to the existing market value of the relevant equity. In this method, usually we must consider ten groups of companies, and assume that the expected return is related to the market value of equity.

In practice, a multi-factor model is used to study events. The advantages available from this perspective are very limited. The reason is that in addition to market factors, other additional factors have a limited scope for explaining the event, and cannot significantly reduce the variance of abnormal returns. However, if our sample companies have common characteristics, such as the unique situation that they all belong to the same industry or are concentrated in the same market capitalization group, the variance will be markedly reduced. At this time, the use of multi-factor models should be considered.

5. Analysis of the shock effect of the epidemic on the market financial system

5.1. The shock effect of the epidemic on market supply and demand

Affected by the new crown pneumonia, my country is now facing a severe situation where total supply and demand are both set back. In the early stage of the epidemic, due to the closure of the city, total demand fell, and the price elasticity of demand became smaller. The demand curve shifts from D1 to D2, the aggregate supply curve shifts to the left, and the price elasticity becomes completely inelastic (moving from S1 to S2) while shifting to the left. The equilibrium price increases from P0 to P1, and total output decreases from Q0 to Q1. The total social demand includes consumer demand, investment demand, government demand and exports, among which consumer demand is the most stable driving force for China's economic growth. During the lockdown period, the whole society was filled with panic, various consumer places were closed, and people saved money to deal with the uncertainty of the future. At this time, consumer demand was severely frustrated, and the price changes were not as sensitive as before the epidemic, and the price elasticity of demand became smaller. In order to control the epidemic as soon as possible, many Chinese enterprises have suspended work and production, and the production factors of the whole society have stopped flowing, enterprise production has been blocked, and the total social supply has decreased. In the short term, producers cannot use price increases to increase output, the elasticity of supply prices becomes smaller, and the supply curve becomes a vertical curve. Therefore, during the lockdown period, total social supply decreased and prices rose. With China's control of the epidemic, companies began to resume work and production, and consumer demand began to recover. The aggregate demand curve moved to D3, the supply curve moved to S3, the equilibrium price moved to P2, and the equilibrium output increased to Q3.

After the epidemic was control, as regions begin to unblock, production factors flowed freely in the market, and the government increased its support for enterprises. At this time, enterprises increased production, supply increased, and supply price elasticity increased. Although the whole society is in the process of resuming work and production, the supply curve still does not return to the position before the epidemic. Because the foreign epidemic has not been controlled, it will have a serious impact on my country's imports and exports. In particular, small and micro enterprises in import and export have experienced a shortage of funds, and some have even closed down. Secondly, the products produced by many Chinese enterprises have to rely on imported raw materials, such as automobiles, mobile phones, energy and other industries. Unsatisfactory production factors will push up the production costs of enterprises and reduce their production efficiency. Furthermore, low production efficiency will force companies to lay off a large number of employees in order to survive, which will aggravate my country's unemployment risk and increase the unemployment rate. After the epidemic, various localities have launched consumption stimulus programs, such as issuing consumer vouchers and subsidies for car purchases to encourage consumption. At this time, consumer demand began to rise, the demand curve shifted to the right, the equilibrium price fell compared to the period of the lockdown, and total social demand began to increase. However, due to the spread of the foreign epidemic, the consumer confidence of Chinese residents has not fully recovered, and they remain cautious, and their

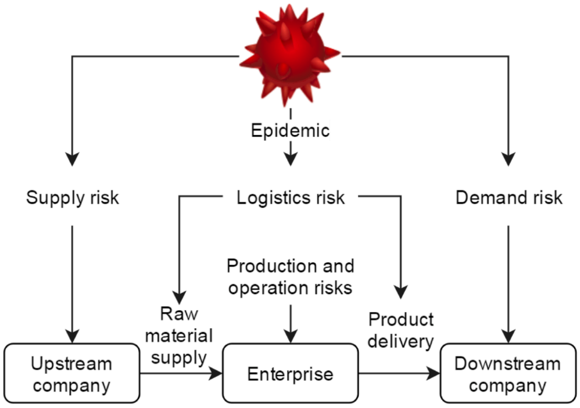

Fig. 3. The multi-dimensional impact of the epidemic on the supply chain.

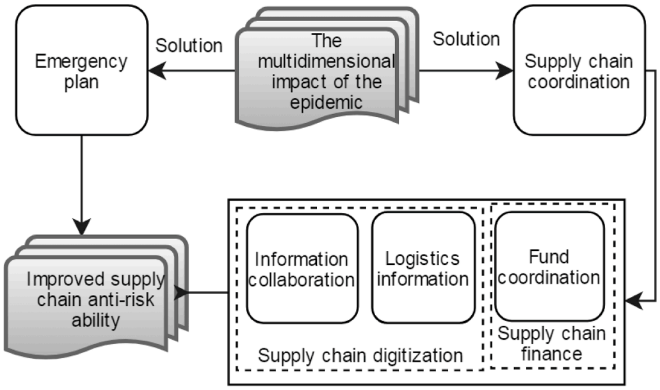

Fig. 4. Two roles of core enterprises in supply chain finance.

spending power cannot reach the state before the epidemic. Our country has adopted a lot of fiscal policies. Therefore, due to the double shocks of supply and demand, the equilibrium price will still be higher than the P0 before the epidemic, and the total output of the society will still be lower than the total output before the epidemic. The global economic downturn caused by the continuous fermentation of the epidemic will be a continuous process. Even if the global epidemic is controlled, it will still take a long time from the control of the epidemic to the normal production order of the world. Under the concept of economic globalization and a community with a shared future for mankind, China cannot completely avoid external shocks. In addition to stimulating domestic supply and demand, it also needs to be alert to the impact of external shocks on my country's supply and demand, especially on the supply side. The impact of the epidemic on the supply side may bring greater risks to the economy. If the government blindly stimulates demand while ignoring the supply side, it will lead to insufficient total supply in society and cause economic stagnation, which will lead to an increase in unemployment, rising prices, and a decline in total social output. In addition, some state-owned enterprises in my country have low production efficiency. Due to the support of the state, these enterprises are equipped with a large number of limited social resources, but they have not produced corresponding economic value and have not provided sufficient and high-quality supply for the society. Instead, they have squeezed out the investment and creative enthusiasm of some private enterprises. This is also one of the factors restricting the growth of the total supply of our society, as shown in Fig. 2.

The impact of the epidemic on the supply chain is a simultaneous multidimensional impact (as shown in Fig. 3), which makes the impact of the epidemic on the supply chain very different from risk factors such as natural disasters. Under the new crown pneumonia epidemic, risk times such as "supply interruption risk" and "demand shrinking risk" have swarmed for a time, and the duration is unpredictable.

In supply chain finance, core enterprises play a "credit role" on the one hand to provide "credit enhancement" to their upstream and downstream enterprises. On the other hand, it plays an "information role" and enhances the bank's understanding of upstream and downstream companies in the supply chain by sharing transaction information on the upstream and downstream of the supply chain. Moreover, supply chain finance provides financing support for the entire supply chain by giving full play to the role of core enterprises in financing. From the perspective of capital supply and demand, supply chain finance is a powerful tool for the supply chain to respond to the financial pressure of the entire chain caused by the epidemic and to strengthen the financial coordination of the supply chain (Fig. 4).

Table 1
Statistical table of the number of transactions of major bond types.

Time	2019.12	2020.1	2020.2	2020.3	2020.4	2020.5	2020.6	2020.7	2020.8	2020.9
Book-entry national debt	54988	34426	46224	61404	49062	49050	59681	93348	61276	56571
Local government debt	1976	238	156	235	170	95	176	231	259	372
Financial debt	15552	16368	15720	15830	13171	10925	14972	23668	10862	7701
Corporate debt	10716	9293	8410	9737	9892	6872	7182	8260	19850	10447
SME private placement bonds	7129	5058	5243	8836	9569	8197	9243	10894	10190	10894
Public issue of corporate bonds	46143	26786	29354	40710	43092	23331	25898	28860	24239	41818
Non-public issuance of corporate bonds	820	644	679	1033	1085	878	894	1064	901	926
Convertible bond	3116388	6094661	5598473	12096407	13040173	7413393	7749529	17382927	21452344	14039681
Exchangeable debt	92944	53303	53151	61509	39961	41334	34323	75588	37251	63764
Segregated debt	0	0	0	0	0	0	0	0	0	0
Corporate asset-backed securities	798	520	563	620	804	729	937	1068	1037	1401
Credit asset backed securities	0	0	0	0	0	0	0	0	0	0
Other bonds	0	0	0	0	0	0	0	0	0	0
Pledge repo	10241920	8325036	10612411	9702579	8878295	7763931	10423824	12606325	12482421	12396414
Offer repurchase	2524398	1913523	2194235	2707508	2797771	2615360	2925890	2961240	2888515	3196352
Repurchase agreement	9323	7528	8476	11903	12742	10845	12139	16424	15434	16220
total	16123095	16487384	18573095	24718311	24895787	17944940	21264688	33209897	37004579	29842561
Time	2020.10	2020.11	2020.12	2021.1	2021.2	2021.3	2021.4	2021.5	2021.6	2021.7
Book-entry national debt	39303	54661	66712	65604	44748	67298	59402	46212	46212	65463
Local government debt	158	192	308	181	75	169	182	211	211	302
Financial debt	4791	7846	12025	10727	5837	10608	10450	4600	4600	6228
Corporate debt	4612	7858	8402	6919	4442	8004	6572	6092	6092	6519
SME private placement bonds	8543	12177	13456	10098	8404	13325	13485	12447	12447	15494
Public issue of corporate bonds	31892	55918	44220	42553	29622	53428	47357	35421	35421	46195
Non-public issuance of corporate bonds	661	1122	985	1155	1277	992	697	416	416	259
Convertible bond	10306787	18927622	19697364	23423458	19105472	26170490	31748295	31260437	31260437	35141183
Exchangeable debt	19998	48698	43146	46190	37917	116422	66110	24827	24827	34988
Segregated debt	0	0	0	0	0	0	0	0	0	0
Corporate asset-backed securities	1117	1209	1481	950	648	1309	1134	877	877	1148
Credit asset backed securities	0	0	0	0	0	0	0	0	0	0
Other bonds	0	0	0	0	0	0	0	0	0	0
Pledge repo	9980040	12400628	13100194	11354707	8439894	11972798	11225457	10330722	10330722	12843092
Offer repurchase	2299540	3101675	3475612	3180563	2528961	4126749	4159016	3897199	3897199	5630845
Repurchase agreement	13052	19224	20780	19462	13226	22297	21565	20172	20172	28377
total	22710494	34638830	36484685	38162567	30220523	42563889	47359722	45639633	45639633	53820093

Table 2
Statistical table of transaction amount (10,000 Yuan) of major bond types

Time	2019.12	2020.1	2020.2	2020.3	2020.4	2020.5	2020.6	2020.7	2020.8	2020.9
Book-entry national debt	2591417.35	819475.05	1452583.73	2596342.51	2181340.9	2428295.15	2506804.76	3117307.64	2755549.18	3761523.56
Local government debt	923202.79	280984.98	249990.16	906984.09	330571.73	243980.7	836415.64	404841.77	203828.42	226625.66
Financial debt	1885392.25	1010019.2	981222.04	1235653.93	907757.52	652287.51	763021.61	2011562.39	612616.14	494256.63
Corporate debt	3572043.5	2505566.19	2686578.76	4014482.46	4420791.88	4151304.11	3974986.55	4956003.62	4297783.15	3870100.63
SME private placement bonds	18128968.62	14138404.18	12538765.23	24498914.15	24303963.65	20635525.43	23090623.06	30719985.33	25336297.39	29918594.39
Public issue of corporate bonds	29092892.8	19082919.47	18348695.21	33956128.89	38283655.3	30331671.04	35870849.61	40722579.58	32004009.42	35546478.71
Non-public issuance of corporate bonds	2036377.13	1551928.25	1561595.96	2533170.78	2546433.84	2104651.69	2280295.37	2343741.09	2136361.63	2241496.41
Convertible bond	7185665.54	8340062.99	13676981.91	28492972.99	18420355.7	11949540.1	14919233.69	39943532.4	31026242.11	19269370.85
Exchangeable debt	1493100.64	1038984.56	1197436.98	1480289.04	1264286.57	1163041.31	1437814.46	2025109.12	1133209.82	965553.73
Segregated debt	0	0	0	0	0	0	0	0	0	0
Corporate asset-backed securities	2800581.52	1683718.2	2339572.63	2323617	2481784.78	1994166.7	3255450.7	3909248.03	4652675.95	5656936.44
Credit asset backed securities	0	0	0	0	0	0	0	0	0	0
Other bonds	0	0	0	0	0	0	0	0	0	0
Pledge repo	1811138310	1612736180	1839170170	2092976240	1975796760	1757825990	2062912160	2316122750	2193395490	2364110260
Offer repurchase	26376536	19906722	27077436.9	32597468.9	33346823.3	29845757.8	33376705	41595521.2	40656961.4	40497332
Repurchase agreement	15658882.9	12579552.2	13821978.7	18074044.1	18342001	14835059.9	16362406	20225577.7	18157670.4	19548552.7
total	1922883371	1695674517	1935103008	2245686308	2122626526	1878161271	2201586766	2508097760	2356368695	2526107082
Time	2020.10	2020.11	2020.12	2021.1	2021.2	2021.3	2021.4	2021.5	2021.6	2021.7
Book-entry national debt	3853685.1	4209289.75	5250327.62	6319907.69	3306168.61	4516572.66	3647180.75	3443167.01	3443167.01	7091159.76
Local government debt	277426.47	794287.95	1360286.51	484352.89	194316.66	454685.91	517835.59	356826.19	356826.19	551252.65
Financial debt	133945.68	219197.29	324622.98	519810.54	169343.15	944698.24	1459004.83	145686	145686	182557.44
Corporate debt	3034430.97	4959057.89	4771819.37	4175713.34	3107586.68	5954251.56	4935632.87	4109000.95	4109000.95	6295231.17
SME private placement bonds	24310805.99	34344425.93	39573365.46	23689804.7	21784656.79	31741282.05	32663548.7	29451453.9	29451453.9	35534831.61
Public issue of corporate bonds	27188098.36	44647019.1	46251984.26	39400374.96	25924312.92	42723071.63	39162581.18	35759253.78	35759253.78	46398233.46
Non-public issuance of corporate bonds	1732659.18	2919071.56	2672071.38	1782721.93	1157161.78	1453525.53	1434745.05	894945.45	894945.45	544111.42
Convertible bond	18318717.38	25420172.75	30944820.91	33611968.21	22533871.83	39381398.17	46448065.65	47098766.19	47098766.19	39683898.44
Exchangeable debt	644835.62	1044903.71	854863.23	830490.82	750866.04	1435597.69	979060.26	650698.21	650698.21	891010.12
Segregated debt	0	0	0	0	0	0	0	0	0	0
Corporate asset-backed securities	5677681.15	5006207.23	5834716.53	3699247.77	2584561.6	4712942.22	3464045.56	2459897.14	2459897.14	3686793.03
Credit asset backed securities	0	0	0	0	0	0	0	0	0	0
Other bonds	0	0	0	0	0	0	0	0	0	0
Pledge repo	1909255910	2442061580	2715986680	2299998930	1774888580	2577034730	2335015260	2132270260	2132270260	2690259380
Offer repurchase	29859607.9	39806596	41546433.5	35173750.8	26845420.7	45133989.9	44529095.7	40017367.9	40017367.9	53216861.4
Repurchase agreement	15799291.1	21349614	23530417	19657947.4	13488776	21412952.6	20707820.9	19697346.4	19697346.4	27180407.3
total	2040087095	2626781423	2918902409	2469345021	1896735623	2776899698	2534963877	2316354669	2316354669	2911515728

Table 3
Statistical table of the weighted average transaction price (yuan) of major bond types

Time	2019.12	2020.1	2020.2	2020.3	2020.4	2020.5	2020.6	2020.7	2020.8	2020.9
Book-entry national debt	101.533	101.942	103.643	103.643	104.173	103.9	102.452	102.061	101.91	101.303
Local government debt	101.355	100.941	102.963	102.963	103.268	103.728	101.996	102.034	101.162	100.014
Financial debt	103.179	103.926	104.374	104.374	105.23	104.783	103.648	102.308	102.688	101.878
Corporate debt	76.147	76.805	78.939	78.939	77.449	76.848	75.335	74.108	74.936	75.535
SME private placement bonds	100.105	100.196	100.622	100.622	100.495	100.708	100.283	100.04	100.028	99.799
Public issue of corporate bonds	99.733	99.647	100.58	100.58	100.759	100.84	99.981	99.325	99.383	98.986
Non-public issuance of corporate bonds	99.58	99.104	99.263	99.263	99.475	100.431	99.396	98.904	99.494	98.284
Convertible bond	114.214	120.607	124.546	124.546	121.814	117.866	118.469	130.203	134.709	128.518
Exchangeable debt	102.871	106.176	104.277	104.277	104.837	105.663	106.584	105.21	106.545	105.336
Segregated debt	0	0	0	0	0	0	0	0	0	0
Corporate asset-backed securities	97.506	98.906	97.11	97.11	96.436	95.955	95.459	95.404	95.632	92.533
Credit asset backed securities	0	0	0	0	0	0	0	0	0	0
Other bonds	0	0	0	0	0	0	0	0	0	0
Pledge repo	2.83	2.953	2.066	2.066	1.637	1.627	2.427	2.224	2.399	2.761
Offer repurchase	3.195	3.247	3.004	3.004	2.63	2.318	2.486	2.616	2.798	2.978
Repurchase agreement	5.48	5.936	5.39	5.39	5.104	5.335	4.856	5.431	5.299	4.871
total	95.826	96.259	96.385	97.29	97.112	97.097	96.709	96.297	96.847	96.305
Time	2020.10	2020.11	2020.12	2021.1	2021.2	2021.3	2021.4	2021.5	2021.6	2021.7
Book-entry national debt	100.554	100.084	100.209	100.739	100.692	100.674	101.154	101.362	101.362	101.769
Local government debt	99.642	100.078	99.979	100.606	100.067	100.117	100.837	100.696	100.696	100.889
Financial debt	102.017	102.131	102.309	102.76	102.1	101.907	102.429	102.702	102.702	102.96
Corporate debt	75.691	75.074	75.223	76.109	75.94	75.179	75.27	74.827	74.827	78.681
SME private placement bonds	99.961	99.802	99.432	99.753	99.479	99.55	99.625	99.708	99.708	100.056
Public issue of corporate bonds	99.04	98.572	98.507	98.879	98.177	98.536	98.662	98.614	98.614	99.102
Non-public issuance of corporate bonds	98.447	97.884	97.149	96.553	93.439	95.8	95.194	94.522	94.522	93.523
Convertible bond	130.391	129.183	126.273	125.542	115.337	119.283	120.812	123.407	123.407	130.296
Exchangeable debt	104.119	104.349	106.257	106.19	107.606	102.823	106.337	106.932	106.932	108.151
Segregated debt	0	0	0	0	0	0	0	0	0	0
Corporate asset-backed securities	97.301	96.03	96.19	95.973	92.781	94.938	96.179	95.843	95.843	93.221
Credit asset backed securities	0	0	0	0	0	0	0	0	0	0
Other bonds	0	0	0	0	0	0	0	0	0	0
Pledge repo	2.864	2.694	2.888	2.766	2.595	2.333	2.209	2.302	2.302	2.318
Offer repurchase	3.037	3.036	3.231	3.034	3.002	2.939	2.88	2.837	2.837	2.835
Repurchase agreement	5.341	5.988	6.18	6.031	6.559	5.689	5.322	4.997	4.997	5.518
total	96.964	96.193	96.065	96.6	95.689	95.791	96.139	96.209	96.209	97.054

5.2. The shock effect of the epidemic on stock securities

The shock effect of major emergencies on the capital market is usually analyzed by using the event research method, that is, to test the capital market's response to the event by calculating and analyzing the changes in stock returns before and after the event. This paper draws on existing research and adopts the event research method to systematically investigate the shock effect of the capital market of typical events during the epidemic.

This paper uses the model constructed in this paper for data processing, and uses crawler technology to obtain data from the Internet. Moreover, this paper uses the bond data of the Shanghai Stock Exchange as an example to analyze the shock effect of the COVID-19 on the financial system. The number of transactions, transaction amount (ten thousand yuan), weighted average price, etc. of various bonds obtained after processing are statistically analyzed. The data output in this paper after processing by the model is mainly from December 2019 to September 2020, that is, the entire cycle range from the occurrence of the COVID-19 to the present. The results are shown in Table 2, 3 and 4.

It can be seen that the capital market has a keen response to emergencies. With the aggravation of the COVID-19, investor pessimism and panic sentiment increased, and the cumulative panic effect of the Spring Festival holiday led to a sharp decline in January. Since then, as the country has adopted various measures to control the epidemic and introduced a series of control policies to stabilize the financial market, it has gradually stabilized and recovered after February. By the second half of this year, the level of various parameters of the overall financial bonds has basically returned to the level before the epidemic.This paper summarizes the number of transactions and transaction amounts of major bond types, and the results are shown in Fig. 5.

It can be seen from Fig. 5 that the amount of money drops sharply in January 2020. The epidemic situation in my country is at its worst in January 2020, and the people across the country are in a home quarantine state. Therefore, although the number of transactions does not fluctuate significantly compared with December 2019, the decline in transaction amount indicates that the financial market is at a trough at this time, and the impact of the epidemic is more serious. The rebound begins after February 2020, and there is a significant increase in April 2020 and May 2020. At this time, the country is already in the final stage of resuming work and production. The increase in the number of transactions and the value of transactions indicates that my country's financial market is gradually reducing the impact of the epidemic. After a trough in the curve in June, it shows a continuous upward trend.

Table 4
Statistical table of shock effect parameters of enterprises

Time	2021.7	2021.6	2021.5	2021.4	2021.3	2021.2	2021.1	2020.12	2020.11	2020.10
Index	50.4	50.9	51	51.1	51.9	50.6	51.3	51.9	52.1	51.4
Manufacturing Purchasing Manager Index (%)	51	51.9	52.7	52.2	53.9	51.9	53.5	54.2	54.7	53.9
Production index (%)	50.9	51.5	51.3	52	53.6	51.5	52.3	53.6	53.9	52.8
New order index (%)	47.7	48.1	48.3	50.4	51.2	48.8	50.2	51.3	51.5	51
New export order index (%)	46.1	46.6	45.9	46.4	46.6	46.1	47.3	47.1	46.7	47.2
In-hand order index (%)	47.6	47.1	46.5	46.8	46.7	48	49	46.2	45.7	44.9
Finished product inventory index (%)	50.8	51.7	51.9	51.7	53.1	51.6	52	53.2	53.7	53.1
Purchase volume index (%)	49.4	49.7	50.9	50.6	51.1	49.6	49.8	50.4	50.9	50.8
Import index (%)	53.8	51.4	60.6	57.3	59.8	58.5	57.2	58.9	56.5	53.2
Ex-factory price index (%)	62.9	61.2	72.8	66.9	69.4	66.7	67.1	68	62.6	58.8
Main raw material purchase price index (%)	47.7	48	47.7	48.3	48.4	47.7	49	48.6	48.6	48
Raw material inventory index (%)	49.6	49.2	48.9	49.6	50.1	48.1	48.4	49.6	49.5	49.3
Employment index (%)	48.9	47.9	47.6	48.7	50	47.9	48.8	49.9	50.1	50.6
Supplier delivery time index (%)	57.8	57.9	58.2	58.3	58.5	59.2	57.9	59.8	60.1	59.3
Time	2020.9	2020.8	2020.7	2020.6	2020.5	2020.4	2020.3	2020.2	2020.1	2019.12
Index	51.5	51	51.1	50.9	50.6	50.8	52	35.7	50	50.2
Manufacturing Purchasing Manager Index (%)	54	53.5	54	53.9	53.2	53.7	54.1	27.8	51.3	53.2
Production index (%)	52.8	52	51.7	51.4	50.9	50.2	52	29.3	51.4	51.2
New order index (%)	50.8	49.1	48.4	42.6	35.3	33.5	46.4	28.7	48.7	50.3
New export order index (%)	46.1	46	45.6	44.8	44.1	43.6	46.3	35.6	46.3	45
In-hand order index (%)	48.4	47.1	47.6	46.8	47.3	49.3	49.1	46.1	46	45.6
Finished product inventory index (%)	53.6	51.7	52.4	51.8	50.8	52	52.7	29.3	51.6	51.3
Purchase volume index (%)	50.4	49	49.1	47	45.3	43.9	48.4	31.9	49	49.9
Import index (%)	52.5	53.2	52.2	52.4	48.7	42.2	43.8	44.3	49	49.2
Ex-factory price index (%)	58.5	58.3	58.1	56.8	51.6	42.5	45.5	51.4	53.8	51.8
Main raw material purchase price index (%)	48.5	47.3	47.9	47.6	47.3	48.2	49	33.9	47.1	47.2
Raw material inventory index (%)	49.6	49.4	49.3	49.1	49.4	50.2	50.9	31.8	47.5	47.3
Employment index (%)	50.7	50.4	50.4	50.5	50.5	50.1	48.2	32.1	49.9	51.1
Supplier delivery time index (%)	58.7	58.6	57.8	57.5	57.9	54	54.4	41.8	57.9	54.4

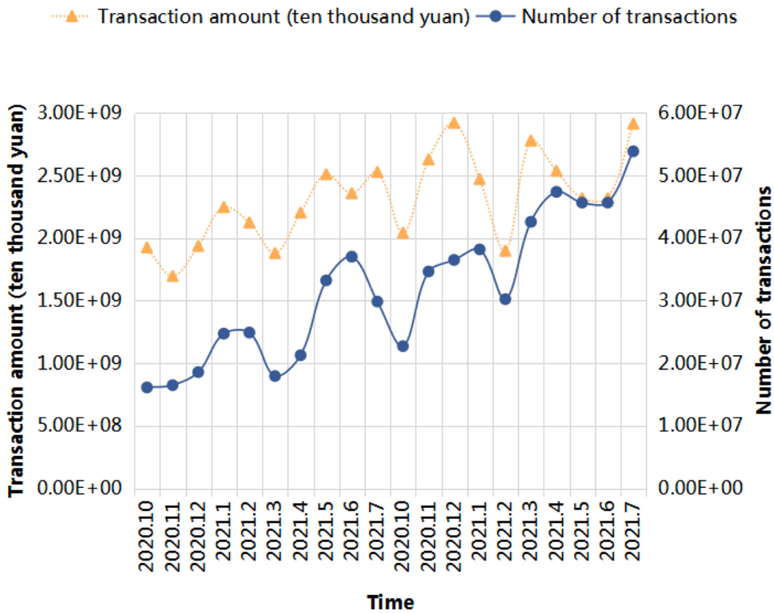

Fig. 5. Statistical diagram of monthly summary data of the number of transactions and transaction amounts of major bond types.

This is consistent with the law of the market economy. After rising, it will inevitably fall. After the market stabilizes, investors will follow suit. Since then, the financial level has been at a relatively high level. This shows that my country's finance has fully recovered. The current impact of the epidemic is relatively low.

5.3. The shock effect of the epidemic on business operations

This paper analyzes the shock effect of the epidemic on enterprises. This paper analyzes the data through the model and selects the

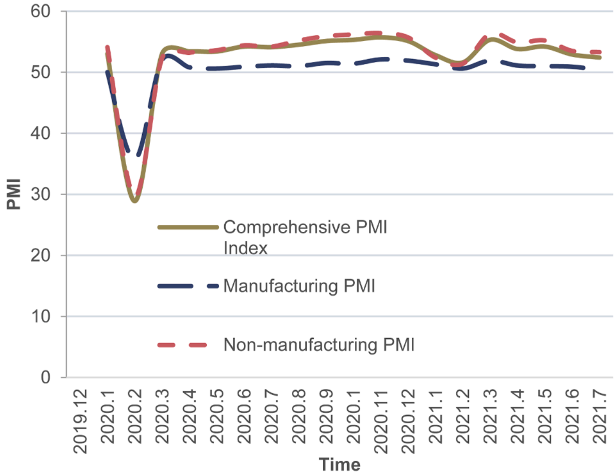

Fig. 6. Statistical diagram of PMI index.

manufacturing purchasing manager index (%), production index (%), new order index (%), new export order index (%), in-hand order index (%), finished product inventory index (%), purchase volume index (%), import index (%), ex-factory price index (%),purchase price index of main raw materials (%), raw material inventory index (%),employee index (%),supplier delivery time index (%), expected index of production and operation activities (%) and other parameters as the basis. After that, the data is obtained from the network through the crawler and processed by the model, and the results shown in Table 1 are obtained.

Fig. 6 shows the statistical chart of the comprehensive PMI index, manufacturing PMI, and non-manufacturing PMI index.

Judging from the PMI and multiple indexes of enterprises, it can be seen that the impact of the epidemic on business operations occurs in February 2020. The main reason is that companies first enters the wait-and-see state after being affected by the epidemic. Before the epidemic completely broke out, Chinese companies mostly hold the Spring Festival holiday according to the original plan. However, when the epidemic broke out during the holiday, most of the companies are in a state of suspension, and the company could not predict the resumption of work. The PMI in February 2020 is an objective reflection of the production situation of enterprises in March 2020. Since my country's resumption of work and production policy is only promulgated at the end of February, the real enterprise recovery is in April 2020. This is pushed forward by one month. The PMI in March should be an objective reflection of the production situation in April 2020. It can be seen that the PMI in February was an inflection point and began to rise in March. Fig. 6 also reflects this conclusion, and after April, PMI has been in a stable state. It can be seen that Chinese enterprises have fully resumed work and production after April, which is consistent with the actual situation.

6. Conclusion

The epidemic will have an immeasurable impact on my country's economic growth and enterprise development. Although the impact is inevitable, we can reduce the impact of the epidemic and minimize the loss. In addition, while reducing internal shocks on the premise of an orderly recovery of the economy, it is also necessary to always pay attention to changes in foreign epidemics and reduce the secondary shocks from foreign countries on the internal. Moreover, based on the event analysis model, this paper analyzes the parameters of the model from the shock effect of the epidemic on market financial demand, the shock effect of the epidemic on financial bonds, and the shock effect of the epidemic on business operations, and counts and analyzes the results and compares the obtained results with the actual situation. From the data analysis point of view, it can be seen that the results of the model constructed in this paper after data drill are basically consistent with the development of my country's financial market during the epidemic, thus verifying the effectiveness of the model in this paper.

Author statement

Shaoling Li and Yuwei Yan designed the research framework and wrote the manuscript, and Yuwei Yan was responsible for proofreading and optimization of the results.

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