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Quantifying the impact of the COVID-19 pandemic on container shipping market: a study on the China-Europe route

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Quantifying the impact of the COVID-19 pandemic on Container Shipping Market - A study on the China-Europe Route

by

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DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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ABSTRACT

The rapid transformation of the world economy makes the trade of goods and services of all countries develop rapidly, among which more than 80% of the world's international goods trade and more than 90% of the developing countries' international goods trade are mainly relying on maritime transport, and container shipping is one of the most important segments of China's shipping industry. With the enhancement of China's international status, the Sino-Euro route has gradually become the most mainstream route among China's international routes, far exceeding the trade volume of other international routes. This COVID-19 pandemic has caused huge losses to the global maritime trade, which has affected the supply and demand relationship and container freight rates to different degrees and has also had a large negative impact on the economic development of various countries. Therefore, the crisis response research for container shipping becomes more and more important to reduce the negative impact on the container market and promote economic development by improving and optimizing the crisis response mechanism.

In this paper, a mixed research method combining quantitative and qualitative approaches is adopted to study the container shipping market of the Sino-Euro route under the COVID-19 pandemic. The container shipping market under the impact of the COVID-19 pandemic is analyzed qualitatively from three aspects: the supply side, the demand side and the change in container freight rate index. The quantitative analysis selects the cumulative number of global new cases per week since the outbreak of COVID-19 pandemic in January 2020 and the freight rate index of Sino-Euro routes, and further investigates the correlation between the container freight rate index of Sino-Euro routes and the number of new confirmed cases by using ARIMAX model with time series.

The model empirically concludes that there is an overall negative correlation between the year-on-year rate of change in the CCFI China-Europe freight rate index and the cumulative proportion of confirmed cases of the COVID-19 pandemic, but there is a positive correlation in terms of the gradual control of the epidemic in China. This result illustrates that the impact of the COVID-19 pandemic on CCFI Sino-Euro freight rates is dynamically adjusted, with different effects on the final impact on freight rates due to the different effects of the COVID-19 pandemic on supply and demand in different periods. Finally, the COVID-19 pandemic has resulted in a supply-demand imbalance and price fluctuations, and has provided suggestions for container shipping companies to address the issue.

The main innovations of this paper in the research process are reflected in the

empirical selection of the Sino-Euro route as a case study, the methodological selection of a mixed-method combining quantitative and qualitative approaches, and also the study of the correlation between the freight rate index and the number of confirmed cases in a specific context with different normality.

Key words: Container shipping market; Sino-Euro routes; Freight rate index; Supply; Demand; COVID-19

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1. Introduction

1.1 Research background

Since the early 2020s, COVID-19, a global disease that has rapidly hit the world economy and is characterized by high contagiousness and a long latency period, has had a significant impact on the development of the shipping industry. Various blockade strategies have inhibited global economic growth and led to a significant decline in the maritime industry. It has had a serious negative impact on both our economy and the world economy.

To date, more than 500 million cases of COVID-19 have been diagnosed worldwide, with more than 6.23 million deaths. The cumulative number of confirmed cases in China is more than 580,000 and the cumulative number of deaths is more than 14,000. Although the epidemic situation in China is gradually becoming relatively stable, the early stage still caused a more serious impact, and the recent sudden surge of the epidemic in Shanghai led to the whole closed management, not only people's travel, life,and work style was seriously affected, but also Shanghai as the largest economic center with the largest container port, the port shutdown continues to impact the global industry chain and supply chain, Shipping companies must optimise their crisis response to face the recurring COVID-19 pandemic and future unknown crises.

In 2020, affected by the COVID-19 epidemic, the global economy experienced a sharp decline. the IMF in the《World Economic Outlook Managing Divergent Recoveries》released in October 2020, the global economy is expected to shrink by 4.4% in 2020, which is also the most serious global economic downturn since the 1930s. In the first half of the year, affected by the new crown pneumonia epidemic,

countries around the world strictly guard against epidemic measures, coupled with the lack of terminal consumption demand, the development of international trade is hampered, the container shipping market trend is weak, capacity suspension and space idle situation is serious. In the third quarter, with the global epidemic eased to a certain extent, the container shipping market stabilized and rebounded. In the fourth quarter, the fermentation of the epidemic in Europe and the United States stimulated the release of the immediate demand for living and medical commodities, and the transport demand continued to run at a high level, especially in December 2020, the China Export Container Freight Index (CCFI) went all the way up, hitting a new high since 2005. In the second half of 2020, the global containerized transport driven by the strong recovery of the global market in the second half of 2020, the operating performance of the global container shipping industry has improved significantly, and the performance of many liner companies has also set a new high in recent years.

The epidemic has indirectly impacted the shipping industry by affecting changes in supply and demand in global markets. The shipping industry, as a derivative industry to meet the demand of freight transportation, its boom and bust are largely determined by the macroeconomic environment and the overall demand of the market. While the shipping industry's service upgrades and capacity controls are important, ultimately it is still about meeting the global market demand for cargo. Therefore, analyzing the impact of the epidemic on container freight rates will help explore the impact of the epidemic on the shipping industry. At the same time, it is of great reference value for China's shipping enterprises to better cope with the losses caused by COVID-19.

1.2 Research objectives

At present, the overall research trend in this field is dominated by the impact of the COVID-19 epidemic on the international shipping industry, and there are almost no studies with the Chinese market as an example. In this paper, we will analyze the influencing factors of container freight rates in the context of the structure and current situation of the Chinese shipping market, study the relationship between the container shipping market and the COVID-19 epidemic through the fluctuation of freight rates and the number of confirmed cases. COVID-19 broke out in China first. The impact on China's shipping industry is undoubtedly huge. To adapt to the situation of the Chinese shipping market, the Sino-Euro route is chosen as an example to study the impact of COVID-19 on the container market and to suggest optimization of the means for Chinese container shipping enterprises to cope with the crisis, hoping that this study will help to reduce the negative impact of COVID-19 on the container shipping market.

1.3 Research significance

First, the relationship between the fluctuation rate of freight waves and the number of confirmed cases of the epidemic in China-Europe routes is verified, which providing a favorable argument for studying the impact of COVID-19 on freight rates. At present, most of the analysis on the impact of the COVID-19 epidemic is international, and there is a lack of relevant studies for Chinese container shipping, so it is necessary to study the fluctuation of freight rates on Chinese routes to understand the changes in supply and demand. And Asia-Europe route is one of the three major global liner shipping routes, its status is increasing, and the Sino-Euro route is its main body, so it is important to select the Sino-Euro route as the research

object for the development of China's container shipping industry.

Secondly, at present, the connection between countries and countries is constantly close, the increase in international routes has led to the global nature of the crisis response to various emergencies， the possibility of our country facing the external man-made aggression has become lower and lower, but it doesn't mean that there is no crisis, some unknown different emergencies caused by natural and man-made factors may also produce huge damage, which cannot be easily ignored. If there is no solution to the crisis caused by the unexpected event, it will not be possible to carry out an effective response and control the sudden crisis and reduce the damage caused, which will affect the development of our container shipping industry.

Third, China, as the only major global economy to achieve economic growth in 2020, continues to be a global leader in epidemic prevention and control and economic development. With the slow recovery of the world economy, global trade is gradually picking up. In this context, the global demand for container transport continues to be strong. According to Clarkson's fourth-quarter 2021 shipping market report, the global container volume in 2021 will increase by about 6.3% compared with the previous year, and new variables will emerge in the epidemic with the spread of the mutated strain of Omicron. It is expected that the global container shipping market will continue to face the test of the epidemic in 2022, and there is large uncertainty in the market situation. Therefore, it is important to study the fluctuation of freight rates to seek a balance of supply and demand for the shipping industry to achieve steady growth in China's economy.

1.4 Research structure and methods

1.4.1 Research structure

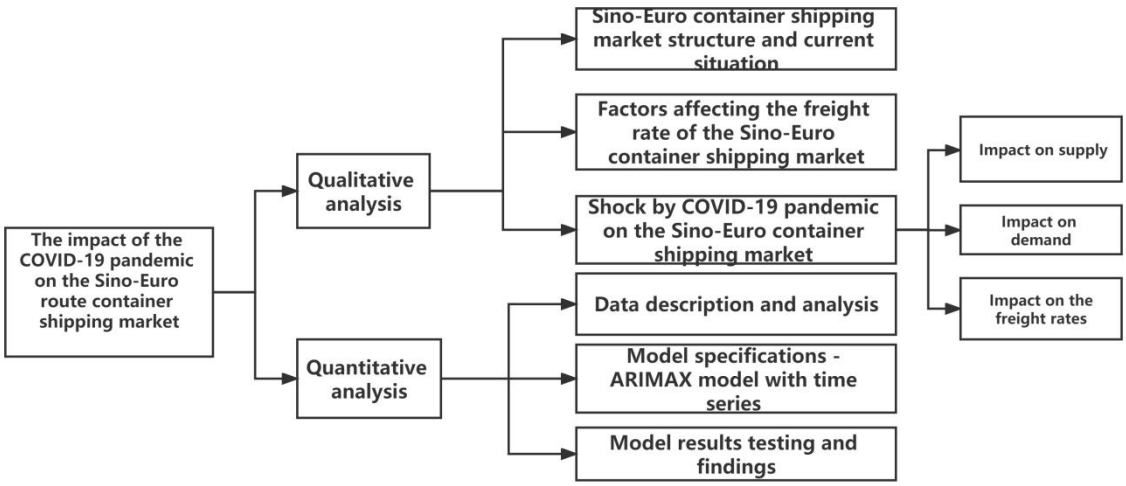


Figure 1.Research Structure

1.4.2 Research methods

In this paper, a mixed research approach through a combination of qualitative and quantitative explanatory series design. The main advantage of the paper is to use qualitative research on the impact of the COVID-19 pandemic on the Central European container shipping market, followed by quantitative research for data collection and analysis and interpretation of the results, which mainly helps to provide better persuasive power to the qualitative research results, as well as to understand the causes and contextual scenarios of the quantitative research results. The main methods utilized in this paper include.

（1）Literature research method

By collecting and organizing the literature and then reading it in detail, we can gain a deeper understanding of the objective facts described in the literature. In this

paper, we mainly look up concepts and theories about container transportation, new crown epidemic, crisis response, etc. in some databases (CNKI, Google Scholar, SCI-Hub, etc.), review relevant domestic and foreign literature, and analyze these materials to initially determine the topic, writing ideas and the overall framework of the paper.

(2) Case study method

By analyzing the price index and the number of confirmed cases, the impact of the COVID-19 incident on the China-Europe route can be obtained.

(3) Comparative analysis method

By comparing the difference in freight rates fluctuations under different time periods of the COVID-19 pandemic, it shows that the impact of the COVID-19 pandemic on container freight rates is dynamically adjusted, and further explains the reasons for the different impacts, reflecting the complexity of the factors affecting freight rates.

2 Literature review

According to the research topic of this paper, I focus on three areas of literature, namely the analysis of the structure of the container shipping market, the impact of COVID-19 on container shipping, and the changes in the container market under similar major shock events .

2.1 Structural characteristics of the container shipping market

Zhang, G.Q. and Lin, B. (2009) analyze the characteristics of the container shipping market from six aspects. From the viewpoint of the fleet's operation mode: the container shipping market then belongs to the regular ship market, each voyage will

operate according to the published schedule regardless of whether it is full or not; in some cases, the container ship regular liner's container space utilization rate is not high, leading to the oversupply of container ship capacity and the decline of enterprise profitability.

In terms of market structure: container liner shipping belongs to the oligopoly type of the four market structures (perfect competition, monopolistic competition, oligopoly ,and monopoly). In terms of sensitivity to changes in world economic development: world economic, and political and military factors have a direct impact on the development of international trade and ultimately on the shipping market. During economic downturns, maritime turnover falls sharply, and when the world economic situation improves, maritime turnover resumes growth; secondly, the degree of elasticity of maritime turnover to the world economy varies, with container maritime turnover being the most sensitive and elastic to the world economy compared to dry bulk and oil. However, the article lacks quantitative analysis of the market structure and does not have enough data to support the conclusions.

In 《Containerization》(2017), the capacity and transport demand in the international and domestic container transport markets are analyzed and the international market structure tends to be concentrated, which could reduce the intensity of competition in the market in the future, while the domestic oversupply situation is difficult to change and the upward market momentum is not strong. However, the study does not compare the domestic transport market with foreign countries and lacks research on improving transport demand, which cannot solve the problem of oversupply in China's transport market.

Gu, L. and Wang, K. (2014) focus on the market structure of China's container ports and argue that the market structure of container ports determines the market behavior of individual ports, which further affects the competitiveness and market performance of the industry and propose a port development strategy that is in line

with China's container market environment. However, the strategy is more oriented towards resource consolidation and operational management transformation, and does not reflect the improvement of the vulnerability of ports as key nodes of the maritime transport network hub.

2.2 Freight rate fluctuation in container shipping routes

The freight rate index reflects the level of freight rates, which can also be described as the price of transportation services specifically compiled based on the freight rates of relevant routes and cargoes in the shipping market (Gong, C.X., 2015). The common freight indices are mainly: China Coastal Bulk Freight Index (CBFI), China Container Freight Index (CCFI), Shanghai Container Freight Index (SCFI), Baltic Dry Index (BDI), Baltic Dirty Tanker Index (BDTI), etc.

Among them, the main study of this paper is the China-Europe container freight rate index, and the current China export container freight index is compiled by 12 basic routes, using the simple arithmetic average method in the compilation formula for the route index and the weighted average for the composite index (Fu, D.F., 2015). Koopmans (1939) bases on the previous research results, makes a further study on Liang, W. et al. (2016) argue that the tariff index can be regarded as time-series data that integrally reflects all factors affecting tariff fluctuations, and study the construction of a tariff forecasting model based on the neural network of EL-Man, and analyze that the forecasting model is more effective than the traditional Arima model and BP neural network model.

Li (2015) analyzes the international oil transportation market's freight index and development trend, and also combine the development trend of the international oil transportation industry with the current operating situation of China's oil transportation industry, further analyze the crisis and challenges encountered, and

propose more realistic regulation and management measures for relevant government departments, etc.

Qiu, X.Z. (2019) uses the EMD method to study the changes of the freight index at different fluctuation frequencies to obtain its change pattern and correlation and further proved that the model combining EMD with BP neural network can significantly improve the prediction quality, which can be helpful for the prediction of the fluctuation trend of China export container freight index.

Based on the background of the Internet technology revolution and the rise of e-commerce platforms, Fu, D.F. (2015) studies the price index theory and the existing freight indices, analyze and summarized the possible problems of Shanghai export container freight index in developing related derivatives, and put forward target suggestions for solutions. Feng, Y.W. (2018) explores the process, model, and method of international container shipping rate forecasting base on data mining method from intelligence forecasting, and successfully explore the realization path and prove that the forecasting effect is better than the forecasting result of traditional time series method. Tang, X. (2021) introduces the complex network theory into the analysis of complex fluctuation characteristics of the container liner shipping market, and study the transmission dynamics of market price fluctuation in a time dimension, space dimension, and financial attribute dimension respectively, and reveal the transmission law of the inner fluctuation of container liner shipping market, and make relevant suggestions to market participants and government departments respectively.

In studying the fluctuation of China's export container freight index, Dong, Y. (2001) analyzes it from the perspective of total foreign trade exports and find that the total export value has a strong explanatory power for the composite index of China's export container freight index. Gong, C.X. (2015) uses two indicators of Shanghai export container freight rate index and export trade to analyze Shanghai container

shipping market, and through a VAR model, using impulse response function and Granger causality test, etc., it is concluded that Shanghai export container freight rate index composite index and Shanghai export value show a negative correlation. Liu, X.D. (2018) uses the ADF unit root test, Johansen cointegration test,OLS-Regression model, and other methods for empirical analysis, and conclude that: 1. China's export container freight rate index and import and export trade volume present a negative relationship; 2. Port foreign trade cargo throughput and import and export trade volume present a positive relationship. Therefore, the correlation between the export container freight rate index and throughput in Shanghai under the COVID-19 pandemic is further explored in this paper, which further enriches the relationship between the freight rate index and throughput under specific circumstances.

2.3 The impact of epidemic situation on container shipping market

The advent of the COVID-19 pandemic has created new challenges for shipping operations management. For example, security inspections at ports may result in additional waiting times for berthing operations, inland seaport transshipment operations, hinterland transport management, etc., and changes in trade volumes may also affect future freight rates and charter rates in the container shipping market.

Past research has focused on the exploration of case-specific treatment processes, and in-depth research on the market response strategies of the container shipping industry during the disease outbreak remains limited. Michail and Melas (2020) use a generalized autoregressive conditional heteroskedasticity model (GARCH) and impulse responses to capture the shipping market response to COVID -19. Devran,Y. and Bekir, Ş.(2020) combine all the comprehensive literature relate to the impact of the COVID-19 pandemic on the shipping industry to inform solutions for the shipping industry to cope with the disease shock.

Kevin, C. and Hercules, H.(2021) combine the impact of COVID-19 on container shipping is divided into two categories: container liner shipping and container ports. The liner shipping side is mainly reflected in the change in supply and demand leading to an increase in freight rates and empty container running time, while the port impact is mainly in the congestion index and changes in container throughput and port networks.

In order to verify the relationship between the outbreak of COVID-19 pandemic and the changes of container market, this is mainly reflected in the short-term prediction of CCFI,port congestion and container throughput. RASH et al. (2017) use a univariate time series approach (seasonal autoregressive integrated moving average model) to forecast container throughput,while Kaan et al. (2021) compare the seasonal autoregressive integrated moving average (SARIMA) and exponentially smoothed state-space models (Zhao, H.M. and He, H.D., 2022) applies the exponential smoothing model to short-term forecasting of BDI, CCBFI and container throughput. Zhou, J. (2021) selects covid-19 Shanghai port as an example, use VAR model to study the correlation between container freight index, throughput and production efficiency, and put forward optimization suggestions for the crisis response mechanism of Shanghai port.

Despite the unprecedented impact of the COVID-19 on maritime transport, it is not the first global shock to the container network and shares some important features with the 2008/2009 crisis (Notteboom et al., 2021). Gonzalez Laxe et al. (2012) use the AIS dataset to study changes in the container transport network to assess changes in the global maritime network following global shocks such as the 2008/2009 crisis .David Guerrero et al. (2022) use the COVID-19 and OxCGRT datasets (AIS data and ASPI) to measure the impact of COVID-19 mitigation policies on regional and global port hierarchies. Theo Notteboom et al. (2021) examine time series and spatial series of supply and demand fluctuations in

COVID-19 and compare these events to the 2008-2009 sub-financial crisis. Ge, Y.E. and Yang, J.L. (2020) compare SARS epidemic with COVID-19, and the impact of two kinds of pandemic on shipping trade is analyzed from three aspects: dry bulk shipping market, oil tanker transport market and container shipping market.

2.4 Literature review conclusion and research gap

Combining the relevant literature found so far, the following conclusions are made regarding the current situation of the container shipping industry: The emergence of COVID-19 not only has a direct impact on the shipping industry but also has certain long-term effects. This disease has led to a shortage of container shipments to many countries around the world, which will have a negative impact that cannot be easily reversed. One such future effect would be an economic crisis due to the shortage, which would raise the price of seaborne commodities in demand. Container liner transportation will need to be adjusted rapidly to adapt to the relationship between supply and demand, because the obvious shortage and the sharp rise of port congestion index around the world lead to the rapid rise of freight rates and transportation costs.

Therefore, the container shipping industry must consider how to optimize its crisis response mechanism to deal with the special impact of each crisis on the shipping industry.The focus of the global container shipping industry has been steadily shifting outwards from China in recent years. The shipping industry can use the knowledge gained from this new crisis to better prepare for the next one when it occurs. It is hoped that this study will provide some input into the development of a more resilient port strategy and transport policy in China.

There are two innovative points in this paper:

1) empirical innovation: the impact of COVID-19 on the Chinese shipping industry is undoubtedly huge as it broke out in China first, however, there is almost no research on the China-Europe shipping routes under the pandemic, in order to adapt to the Chinese shipping market, the China-Europe shipping routes are chosen as an example to study the impact of COVID-19 on the container market, which is somewhat innovative.

2) Methodological innovation: In order to avoid the shortcomings caused by quantitative and qualitative research respectively, this paper adopts a combination of both methods, firstly using quantitative analysis to collect and analyse data, and then using qualitative analysis to explain the results of quantitative research.

Research gap：COVID-19 pandemic is a new topic in academia and worldwide, and data from the container shipping market has rarely been used to analyze the impact of COVID-19 on the shipping industry and is currently largely unused in studies of the Chinese container shipping market. Besides, there is no research directly linking the number of newly confirmed cases with the fluctuation of container freight rate.

3 Methodology

3.1 ARIMA Model

The ARIMA model, known as the Autoregressive Integrated Moving Average Model, is an extension of the ARMA model (Auto Regression Moving Average Model). The ARIMA model is made up of two components, the AutoRegression Model, AR model, and the Moving Average Model, MA model. In the ARIMA model, “I” stands for difference, which represents the differencing of the unsteady time-series data, and then the ARMA model is built on the differenced time series data, which is described

in more detail below.

1. AR（p）Model

The AR(p) model, a p-order autoregressive model, has the following structure:

$$x_t = c + \phi_1 x_{t-1} + \phi_2 x_{t-2} + ... + \phi_p x_{t-p} + \varepsilon_t \quad (3\text{-}1)$$

where c is a constant term and ε_t is a random error term with zero mean and standard deviation σ. The highest order of the model is p and the random disturbance series ε_t is a white noise series with zero mean. The AR(p) model is a method of dealing with time series in which the value of the cu-rrent period is determined using the previous or earlier period of the same v-ariable, assuming a linear relationship between the values. For example, the value of the period x_t to x_{t-p} is used to predict the value of the x_t period.

When the delay operator B is introduced, i.e $B^n x_t = x_{t-n}$ and the AR(p) model is centralized, it can be abbreviated as:

$$\phi(B)x_t = \varepsilon_t \quad (3\text{-}2)$$

$\forall\phi(B) = 1 - \phi_1 B - \phi_2 B^2 - ... - \phi_p B^p$ is known as the p^{th} autoregressive coefficient polynomial. When analysing the correlation of the AR(p) model, it is necessary to simplify the study to its centralised model.

2. MA（q）Model

The MA(q) model, the qth order moving average model, has the following structure

$$x_t = \mu + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + ... + \theta_q \varepsilon_{t-q} \quad (3\text{-}3)$$

where μ is the mean of the series, $\theta_1 \cdots, \theta_q$ are the parameters, and , ε_t , $\cdots$, ε_{t-q}, are white noise. The highest order of the model is q; the random disturbance

sequence ε_t is zero-mean and white noise.

When the delay operator B is introduced, $B^n x_t = x_{t-n}$ is obtained and the MA(q) model is centred, which can be abbreviated as：

$$x_t = \theta(B)\varepsilon_t \tag{3-4}$$

Where $\theta(B) = 1 - \theta_1 B - \theta_2 B^2 - ... - \theta_p B^p$ is called the q^{th} order moving average polynomial. The analysis of the MA(q) model correlations is also reduced to a study of its centralised model.

3. ARMA(p ， q)Model

The ARMA (p , q) model, the autoregressive sliding average model model, has the following structure：

$$x_t = \phi_0 + \phi_1 x_{t-1} + \phi_2 x_{t-2} + ... + \phi_p x_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - ... - \theta_q \varepsilon_{t-q} \tag{3-5}$$

The highest order of the model is p and q respectively; the random disturbance sequence ε_t is a white noise sequence with zero mean; the random disturbance in the current period is independent of the previous sequence value. If we make ϕ_0 = 0，The model is called the centralised ARMA(p, q) model. As with the AR(p) model and the MA(q) model described above, the analysis of the correlations in the ARMA(p, q) model needs to be reduced to a study of its centralised model.

3.2 ARIMAX Model

The ARIMAX model is an ARIMA model with exogenous variables and is constructed by assuming that the response series y_t and the input variables series x_{1t} ， x_{2t} ，⋯， x_{kt} are smooth and first constructing a regression model for the response series and the input variables series.

$$y_t = \mu + \sum_{i=}^{k} 1 \frac{\theta_i(B)}{\phi_i(B)} B^{li} x_{it} + \varepsilon_t \tag{3-6}$$

where B is the delay factor, i.e. $B^n x_t = x_{t-n}$; $\phi_i(B)$ is the autoregressive coefficient polynomial for the i^{th} input variable; $\theta_i(B)$ is the moving average coefficient polynomial for the i^{th} input variable l_i is the order of delay of the i^{th} input variable; and ε_t is the regression residual series.

Since y_t 和 x_{1t} , x_{2t} , $\cdots$, x_{kt} are smooth, and the linear combination of the smooth series is still smooth, the residual series ε_t is a smooth series.

$$\varepsilon_t = y_t - (\mu + \sum_{i=}^{k} 1 \frac{\theta_i(B)}{\phi_i(B)} B^{li} x_{it}) \tag{3-7}$$

The ARMA model continues to provide relevant information in the residual series, resulting in the following model.

$$\begin{cases} y_t = \mu + \sum_{i=}^{k} 1 \frac{\theta_i(B)}{\phi_i(B)} B^{li} x_{it} + \varepsilon_t \\ \varepsilon_t = \frac{\theta_i(B)}{\phi_i(B)} \alpha_t \end{cases} \tag{3-8}$$

Where $\phi_i(B)$ is a polynomial of the autoregressive coefficients of the residual series; $\phi_i(B)$ is a polynomial of the moving average coefficients of the residual series; and a_t is a zero-mean white noise series.

4 Quanlifying impacts of COVID-19 pandemic on China's container shipping market

4.1 Analysis of Sino-Euro container shipping market structure and current situation

The China-Europe route is a route from China to Europe via the Indian Ocean and the Atlantic Ocean, of which the two main routes are Suez and Cape of Good Hope. The specific course of the China-Europe route through the Suez Canal is: from the

Chinese coastal ports, southward through the Strait of Malacca to the waters of the Indian Ocean, into the Red Sea, through the Suez Canal and the Mediterranean Sea, through the Strait of Gibraltar into the Atlantic Ocean, northward to Northwest Europe. At present, the Suez route is the most important route for China-Europe trade. The China-Europe route via the Cape of Good Hope is: from China, through the Strait of Malacca to the Indian Ocean, south through the Mozambique Channel, around the Cape of Good Hope (Cape Town) into the Atlantic Ocean, northbound to Western Europe. Since the Suez Canal is restricted by the tonnage of ships (below 210,000 tons), oversized ships need to choose the Cape of Good Hope route.

The capacity of the Sino-Euro route From the viewpoint of China's exports, China's exports to the EU are growing strongly, which is the main driving force for the growth of cargo volume of China-Europe route. From the perspective of European imports, the growth of cargo volume mainly comes from the Mediterranean region, especially Russia and Eastern Europe.

① Current status of freight rates on China-European routes:

In 2021, China's export container freight rates on major routes followed a similar trend, showing a generally downward and then upward trend, and maintained a high level at the end of the year. In the first quarter, the market sentiment was adjusted downward; from the second to the third quarter, the market sentiment continued to climb; in the fourth quarter, the market sentiment was slightly downward.

Before the Chinese New Year, the transportation market was in its peak season and the gains of the 2020 freight rate increase were consolidated; after the Chinese New Year, the transportation market entered the off-season, and market sentiment slowly declined. In the second quarter, as the world economy slowly recovered and global trade began to pick up, the demand for transportation gradually rose and the transportation market became more active, with market rates slowly moving upward.

Due to the recurrence of the epidemic around the world, port congestion has been occurring one after another, among which the congestion in European and American ports has been the longest and most serious, resulting in market effective capacity loss, capacity supply and demand situation intensified, a cabin difficult to find and a box difficult to find situation occurred from time to time, Shanghai port departure of Europe and the United States and other major routes ship average space utilization rate close to 100% for a long time, thus supporting the upward movement of market prices. In the fourth quarter, while the Christmas cargo source pushed up the market transportation demand, the congestion in European and American ports still did not get effective improvement, the shortage of space and empty container supply still existed, and the market freight rate of most routes remained high.

In terms of container transportation on the China-Europe route, the market demand for transportation remained strong before the Spring Festival in 2021; after the Spring Festival, the market entered the traditional off-season and the transportation demand dropped slightly. In the first quarter, the market price generally maintains the high level of 2020 and slightly consolidates, oscillating above and below the level of USD 4,000/TEU. from April to August, the market price continues to climb at a fast pace before slowing down. In the fourth quarter, due to the overall poor situation of epidemic prevention and control in Europe, the local demand for epidemic prevention materials and daily necessities was large, driving the market transport demand to hover at a high level, coupled with the continuous congestion at ports, leading to the tight supply and demand fundamentals in the market, with the average space utilization rate of ships reaching 100% and the market freight rate maintaining a high level.

After the efforts of shipping companies and ports and other parties, port congestion has slightly improved; however, with the spread of Omicron mutant strain, economic recovery and supply chain repair are again facing uncertainty. On

December 31, 2021, Clarkson published the China-Europe container freight rate index at 5114.92 points, up 378.45% from the beginning of 2020 (see Figure 2). 2021 (The average value of the China-Europe freight rate index in 2021 (as of December 31, 2021) is 4,250.2 points, up 297.56% compared to 2020.

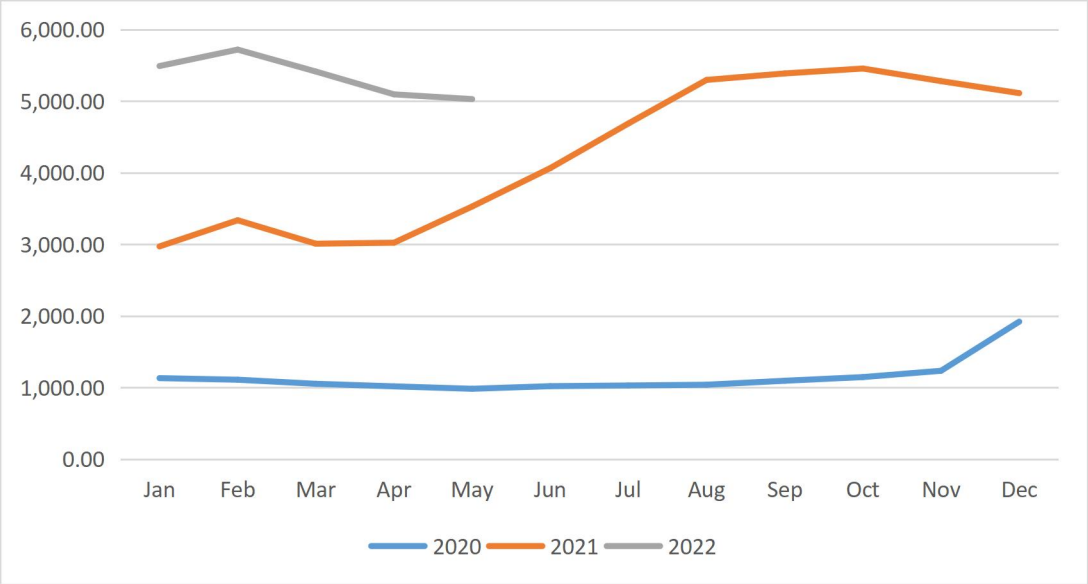


Figure 2. 2020-2021 China-Europe Container Freight Rate Index
Source: Clarkson Research Services Limited 2022

② Major liner companies on the China-Europe route：

Capacity on the China-Europe route has been growing extremely rapidly over the past few years, with major liner companies (Maersk, CMA CGM, COSCO, etc.) taking a keen interest in the route and increasing capacity by opening new routes and upgrading vessels. Alphaliner's data also shows that the vast majority of ships of over 13,300 TEU in the liner market have been placed on the Asian route, but they are more inclined to the smaller ultra-panamax vessels.

There are currently three main shipping alliances on the China-Europe route. In 2011, three major alliances were formed in the China-Europe route container liner market, namely CKYH, Dirigible and G6; in 2013, Evergreen Marine joined CKYH

to form CKYHE and Dirigible joined Maersk Line to form the new P3 alliance; in 2015, the former China Shipping Container Line, Duffy Shipping and United Arabian Shipping formed the new O3 alliance. In 2016 OOCL was acquired by Duffy Shipping of France, and COSCO and China Shipping were reorganised and merged and renamed COSCO Shipping; in 2017 Hamburg Süd was acquired by Maersk Line; in 2018 OOCL was acquired by COSCO Shipping, while a new joint operating company, ONE, was established in Japan.

The top 10 liner companies in 2022 have been selected for capacity deployment analysis, as shown in Table 1. The growth rate of capacity deployment of China-Europe route liner companies has remained positive and small since the COVID-19 pandemic outbreak.

Table 1.Top 10 Container Operators in terms of capacity in 2022

	Top Container Operators	**Containerships Deoloyed (teu)**
1	MSC	4,273,108
2	Maersk	4,269,721
3	CMA CGM	3,237,833
4	China COSCO Shipping	2,869,705
5	Hapag-Lloyd	1,726,991
6	ONE	1,516,845
7	Evergreen	1,496,444
8	HMM	815,761
9	Yang Ming	664,298
10	Wan Hai	448,062

Source:Clarkson Research Services Limited 2022

③ The characteristics of the China-Europe route :

(1) The route distance is long, and there are many ports of call

Here is an example of COSCO Asia-Europe route, COSCO Asia-Europe route through China has 8 European routes, and 6 Mediterranean routes. Take 2 of these routes as examples.

AEU3:

This route covers the three most important ports in North China: Tianjin, Dalian and Qingdao, providing express service to Rotterdam, one of the faste st delivery routes from Piraeus, providing fast and stable service from Europe to Shanghai and North China. The route is connected to Tianjin-Dalian-Qingd ao-Shanghai-Ningbo-Singapore-Piraeus-Rotterdam-Hamburg, with a total of 39 days for a one-way trip.

AEM1:

Asia to the western Mediterranean fine line, providing market-leading Piraeus direct service, comprehensive coverage of the Far East North China, East China, South China, Taiwan, Southeast Asia ports, providing Italy, France Forsyth advantageous services, Spain return advantageous services, providing the Mediterranean to South Asia Colombo direct service. The route calls: Qingdao-Shanghai-Ningbo-Kaohsiung-HongKong-Yantian-Singapore-Piraeus-La Spezia, a total of 31 days for a one-way trip.

On the other hand, although there are as many inland transportation points in Europe as in the United States and Canada, there are many ports of call, and at the same time, European countries are relatively small, and land transportation is very developed, so most of the goods only need to be transported to the basic port of the corresponding country, and the operation of overseas agents of liner companies is very convenient and flexible. On the contrary, the United States and Canada are vast and sparsely populated, and many cargoes have to be transported to small inland cities. Therefore, in order to operate the Pacific route, it is necessary to have a more

mature foreign agency network in the country, so as to meet the service requirements of some inland transportation points.

(2) Changing climate and congested ports

The climate in these areas is very changeable, especially in summer when typhoons are common, and the schedule is often delayed due to wind avoidance. In recent years, due to the decline in air quality, the number of foggy days on the ship also has a significant upward trend.

In the face of the continued rapid growth of container cargo, the handling capacity of global ports is undergoing a great test. Domestic due to the opening of Yangshan deep-water port, China-Europe route container ships in and out of Shanghai port are no longer subject to drought restrictions, without waiting for the tide, temporarily alleviating part of the pressure. However, European port congestion is worsening, and the major ports in Europe, such as the Port of Rotterdam, have experienced unprecedented pressure. Liner companies have to change the order of call or switch to other ports, such as the port of Amsterdam. However, these solutions cannot fundamentally solve the situation of schedule delays. The opening of the French port of Le Havre, which is facing saturation in the northwest European ports, has allowed the port of Le Havre to be used both in the northwest and the south. Let Le Havre port either in the present or the future can accept the world's major liner companies of large container ships, not only France, Belgium's Antwerp, Rotterdam, the Netherlands, Germany's Hamburg, and other ports, have also accelerated the pace of construction.

(3) Two-way cargo imbalance, seasonal factors fade

The international trade imbalance is the current global economic activity under the norm, because the EU exports to China are mainly capital and technology-intensive products, while China exports a large number of labor-intensive products, and there is also a trade deficit. Therefore, the imbalance between the

two-way cargo volume of China-Europe routes will continue to intensify, and it is difficult to change this phenomenon in the short term. In order to ensure the shipment of liner companies, empty containers are bound to be shipped back in large quantities, and the increase in transportation costs is inevitable.

The seasonal factor of shipping volume is getting diluted with the rapidly growing bilateral trade between China and Europe. Westbound routes, in addition to the Western Christmas caused by the third quarter of each year to become the traditional peak season, the other three quarters but the off-season is not light, but also only the Spring Festival, May Day, Dragon Boat Festival and November holidays will cause a short period of "lack of blood" to the market. The recent price decline and loss of cabin phenomenon are mainly due to the major liner companies crazy to the Central European routes into the capacity caused by the overall shipments are still in the non-stop growth. The situation in the eastbound market is slightly different, the third quarter is the traditional vacation season in the European region, the shipment volume plummeted, is the lowest point of the annual volume, other times, this situation will be improved, the volume of goods back up.

(4) The advantages of China-Europe route are becoming more and more obvious

Asia-Europe container line will dominate the stable development of the container shipping market, making the status of China-Europe route rise. The major liner companies have been optimistic about the China-Europe route, and its reasons, in addition to its supply and demand form better than the Pacific route, there are the following reasons:

1).The risk of strikes by liner company employees is much lower in Europe than in the United States.

2). terrorist activities and attacks, such risks are also much smaller in Europe than in the United States, and recently the risk of such attacks on the United States

has increased the feeling.

3). In the United States related to the ship, cargo, and crew the regulations are many, strict enforcement, heavy penalties, few accommodations, and new regulations are constantly emerging, while in Europe are relatively more lenient.

4). The cost of the liner is relatively high in the United States in terms of labor, materials and rates.

4.2 Factors affecting the freight rate of the Sino-Euro container shipping market

Freight rate volatility is not only affected by the market supply and demand, but also by the cost of transport, market structure, the world economy, especially the international trade situation and government and other factors, Chu, S.Y.(2011) also innovatively proposed the role of science and technology on the impact of CCFI index. The following analysis of three aspects of the influence of container freight fluctuations.

(i) Shipping market supply and demand

The market supply is the fundamental factor influencing the shipping price index, and the supply situation of the shipping market mainly depends on several aspects: crude oil price, freight agreement, ship capacity and so on. These influencing factors are closely related to the transportation cost of the shipping market, and when the transportation cost of the shipping market increases, the freight index will naturally rise. The demand of the shipping market is the decisive factor affecting its price change. The demand for import and export trade is mainly influenced by consumer income level, price index, etc. The occurrence of unexpected events is an extremely important factor in the fluctuation of the freight index, one is a natural disaster and the other is an epidemic outbreak. Every time there is an

emergency, it will greatly affect international trade, import and export trade is restricted demand will fall, resulting in drastic shocks in the freight index. Furthermore, there is a change in national policies. National policies will affect the import and export trade through the price level, consumer prices and other ways. Rising prices and currency depreciation also exacerbate the volatility of the freight index.

Since 2020, the spread of the COVID-19 epidemic has caused a global shortage of empty container supply and a shortage of slots for major shipping companies, with the booking advance period for the China-Europe route being around two weeks, while the China-US route has seen a tight situation of sold-out slots. The supply of empty containers and the lack of capacity directly led to the rapid rise in container freight rates, CCFI obvious up. The reasons for this situation can be broadly summarized as follows: low transport efficiency, increased consumer demand and the regional siphon effect.

First, the spread of the COVID-19 epidemic has seriously affected the operation of the global container transport system, with ports, rail and road transport all experiencing understaffing, inefficiencies and declining turnover rates. Because ports, transport providers and shippers must comply with health regulations and maintain social distances, turnaround times for containers, trailers and ships, etc. at ports, and in one part of intermodal transport, are slower than normal, workers and truckers need to work in shifts, the number of available people becomes half or less than normal, and inefficiencies arise, resulting in severe port congestion. As the foreign COVID-19 pandemic was not under control, the reduction in effective labor force greatly depleted effective capacity, resulting in inefficient supply and thus severe port congestion.

Second, the COVID-19 epidemic affected the normal operations of the global tourism and service industries, forcing people to travel less frequently and work from

home instead, with a consequent significant increase in demand for consumer goods. The growth in consumption and the spread of the epidemic have exacerbated the imbalance between supply and demand for consumer goods. Capacity supply capacity has not grown as fast as demand, and ports are more constrained in their ability to adjust than shipping companies. China's rapid response to the epidemic crisis has set a benchmark for global epidemic prevention and control. After China resumed work and production, a large number of orders poured into China, but the growth of capacity supply could not catch up with demand, and the adjustment capacity of ports was more restricted than shipping companies, leading to congestion at export ports. These factors have exacerbated congestion at key ports and shipping nodes, with increased delays, reduced shipping visibility increased freight surcharges, increased blanket sailings, overall shipping costs and increased trade friction. European and U.S. ports are busy emptying containers and shipping cargo to their home markets, with piles of empty containers sitting untouched on terminals. In the case of oversupply, the global container freight rates soared, shipping companies for higher profit margins and even choose to unload the cargo after the empty ship directly away from the port to transport the next container, so that the container "there is no return" situation.

Finally, in sociology, the siphoning effect refers to a certain region will be other regional resources all attracted to the past, thus making itself more attractive than other places, and thus continuing and strengthening the process of the phenomenon. The international container shipping industry today is also experiencing a serious siphon effect. Due to the difference in consumer demand and purchasing power, the profit of European and American routes is much higher than other routes, and many ships on other routes are transferred to the high profit European and American routes, resulting in the empty containers of other routes cannot be transported to the place of product manufacturing, thus intensifying the shortage of global containers.

(ii) Transportation cost

For container liner shipping enterprises, transportation costs, taxes, and profits make up the tariff, and the proportion of transportation costs in the tariff is very high, generally above 90%, which is the main component of the tariff. The increase in transportation costs since the outbreak of the COVID-19 epidemic is not only affected by market supply and demand but also related to the increase in operation and management costs of liner companies.

First of all, the price of fuel has been rising rapidly. The average price of low-sulfur fuel oil in Singapore port reached US$535.11 per ton, up 44.2% from the average value in 2020. To a certain extent, this has prompted liner companies to increase their tariffs, and many container liner companies have taken measures to reduce speed and fuel to reduce costs.

Second, crew shortage and wage increases. Since the outbreak of the epidemic, crew members are facing the "four difficulties" of "difficult to change shifts, difficult to go home, difficult to see a doctor and difficult to receive vaccination".

Thirdly, the epidemic prevention policy has slowed down the ship turnover, increased the cost in port and increased the cost of purchasing epidemic prevention materials.

Fourth, the container shipping market due to the climbing freight prices, promoting new shipbuilding prices, charter prices.

Fifth, the exchange rate factor, the depreciation of the U.S. dollar also increased the cost of container liner companies. Up to now, the exchange rate of the U.S. dollar has fallen below 6.3, the continued depreciation of the U.S. dollar, prices, wages, raw materials will rise, thus causing such costs as fuel, loading and unloading fees, port fees, transshipment fees, shipping agency fees, etc., resulting in increased operating costs of liner companies; the depreciation of the U.S. dollar may also cause such costs as maintenance, spare parts, materials, crew wages, ship inspection, etc.,

resulting in increased management costs of liner companies.

Moreover, the freight revenue of the liner industry is settled in U.S. dollars, and the depreciation of the U.S. dollar causes a decrease in the net profit after conversion into national currency.

(iii) Macro policy factors

First, the shipping alliance has increased its control ability over the market. At present, the access and competition threshold of the container shipping market has been raised, and the alliance operation has been deepened. The three major liner conferences (2M+HMM, OCEAN, THE) occupy more than 80% of the global capacity (including 100% of the European routes), accounting for 80.9% in July 2020 and expanding to 82.3% in July 2021. With the gradual expansion of alliance cooperation, future alliance-based operations will continue to expand and freight rates will be higher than the pre-epidemic level.

Secondly, as the concentration of the industry increases, market competition will also become more rational. Liner companies have gradually moved away from the business strategy of lowering freight rates and capturing market share, and the focus of market industry competition has shifted from a single price-driven market share to value creation. Liner companies will change from single carriers to comprehensive logistics service providers, and industry services will change from homogeneity to differentiation, and the competitive pattern of the industry will be further optimized.

Third, the international supply chain system will be reshaped. Trade fragmentation is getting higher and higher, participation is getting wider and wider, and global industry collaboration ushers in new ideas. Customers will pay a higher premium for reliable and stable services, leading to higher freight costs.

4.3 Shock by COVID-19 pandemic on the Sino-Euro container shipping market

The maritime industry plays an important role in stabilizing foreign trade and smooth international logistics and makes great contributions. At present, the global demand for maritime transport is gradually recovering, but the unbalanced demand caused by the epidemic, poor consolidation and distribution, port congestion, and other problems, resulting in a decline in the efficiency of ship operations, thus causing an imbalance between supply and demand in the market, resulting in a continuous and substantial increase in container liner shipping rates has caused widespread concern in society.

Since the outbreak of COVID-19, along with the changes in global supply and demand, the vulnerability of China's import and export supply chain has been gradually exposed, sounding the alarm for the independent control of China's industrial chain supply chain. The five different stages of China's container import and export supply chain development have highlighted the necessity and urgency of autonomous controllability.

The first stage is the stage of a serious epidemic in China and latent epidemic abroad: from the outbreak of the epidemic in Wuhan to February 2020, China became the hardest hit area of the global COVID-19 pandemic, and the large-scale shutdown of the society led to the shortage of China's export capacity and interruption of the supply chain, which had an impact on the global supply, and China's export foreign trade declined seriously and the export supply chain was hindered.

The second stage is the stage of epidemic mitigation in China and outbreaks abroad: From March to June 2020, China took effective measures to control the domestic epidemic, but along with the outbreak of the global epidemic in developed countries such as Korea, Japan, Italy, Germany, the United Kingdom, France, the

United States, and other countries, developed countries have taken measures to stop work, production, quarantine, cut off flights, etc. China's export trade suffered from order delays, and cancellation crises The import trade was hit hard, and the import and export supply chain was seriously affected.

The third stage is the stabilization of the COVID-19 pandemic in China and the seriousness of the epidemic abroad: in the second half of 2020, the COVID-19 pandemic in China gradually stabilizes and improves, and the domestic industry chain recovers on a large scale, but the COVID-19 pandemic spreads further in other countries around the world and is even difficult to control, the global economy stagnates, and China faces the double pressure of a sharp decrease in demand for export and foreign trade and the interruption of supply of imported foreign trade.

The fourth stage is from the beginning of 2021 to November 2021, when the epidemic in China becomes more stable, countries' efforts to fight the epidemic are increasing, the promotion of the vaccine for the new coronavirus is accelerating, and the global economy gradually becomes relatively stable, but at this time, the trend of counter-globalization in various countries has been opened, and the disadvantages of the lack of core technology, weak industrial foundation and low level of modernization of industrial chain in some industries in China are magnified, so it is urgent to enhance the import and export supply chain, Therefore, it is urgent to improve the competitiveness of the import and export supply chain.

The fifth stage is from the end of 2021, due to the outbreak of the new strain of Omicron, resulting in the global container trade market beginning to fluctuate again, especially in Shanghai in March this year due to the blockade of the epidemic, many orders flowed to Southeast Asia. Therefore, the changes in supply and demand at each stage of development are testing the resilience and flexibility of China's import and export supply chain to varying degrees, and as the world's largest import and export trading country, the need to improve the independent and controllable

capacity of China's supply chain is increasingly prominent.

4.3.1 Impact on supply

1) Impact on capacity supply

In the early days of the COVID-19 pandemic, there was a short-term oversupply of capacity on the Sino-Euro route, and liner companies took a series of capacity reduction measures, which to some extent prevented serious unhealthy competition among the Sino-Euro route liner companies and alleviated the overcapacity situation on the Sino-Euro route. These measures have, to a certain extent, prevented serious competition among the Sino-Euro route liner companies and have reduced the overcapacity of the Sino-Euro route. As the impact of the COVID-19 pandemic faded, the Sino-Euro route maritime trade gradually recovered and capacity became "in short supply", with freight rates on the route "skyrocketing" for a short period of time, making the shipping market more difficult to judge. Available global capacity growth rates for 2018-2022 are as follows.（see Figure 3)

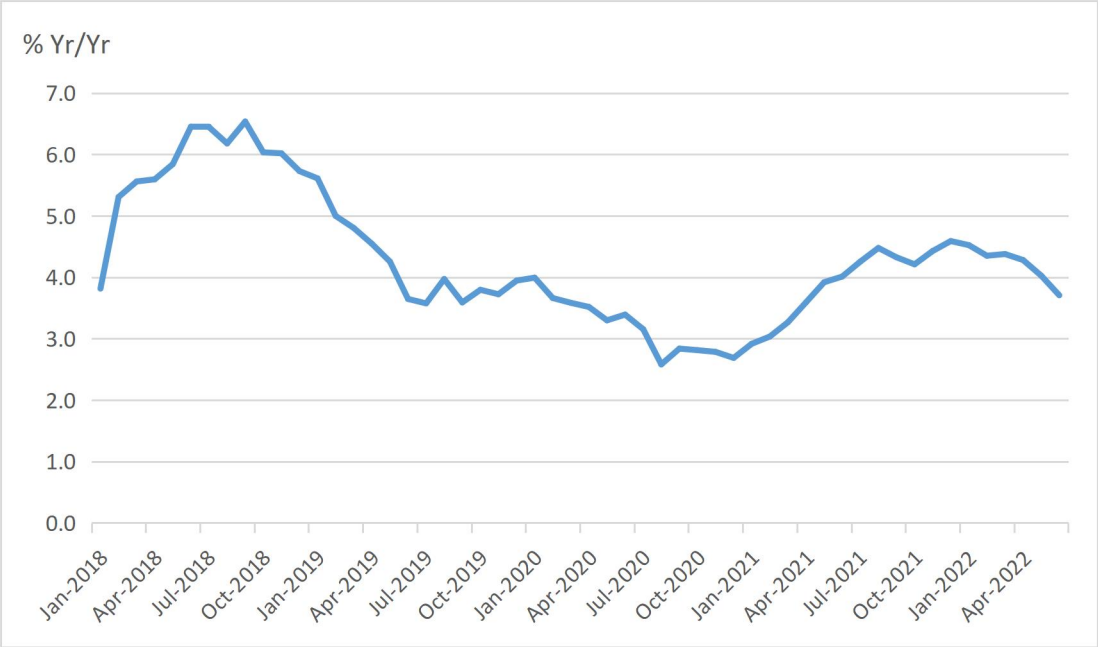


Figure 3. 2018-2022 Containership Fleet Growth

Source: Clarkson Research Services Limited 2022

According to the above graph, the average capacity growth rate of the container transport market before the COVID-19 pandemic outbreak (2018-2019) is 4.9%, while the average capacity growth rate of the container transport market after the outbreak (2020-2021) decreases to 3.5%. The decrease in the number of shipyards and capacity due to the social shutdowns caused by the COVID-19 pandemic has led to a reduction in the workforce.From 2019-2021, the global containerships demolition volume grows year by year due to complex factors such as rising scrap prices and COVID-19 pandemic.(see Figure 4) It can be seen that at the beginning of the outbreak of the epidemic in early 2020, the volume of containerships demolition declined, and from May 2020, when China lifted the first level of crisis response to fully resume work and production, the volume of containerships demolition began to surge, while from the end of 2020, the container ship market saw a significant decline in the volume of containerships demolition. Dismantling of container vessels fell from 83 vessels in 2020 to 11 vessels in 2021, a decrease of

87% and represents only 2% of the dismantled fleet.

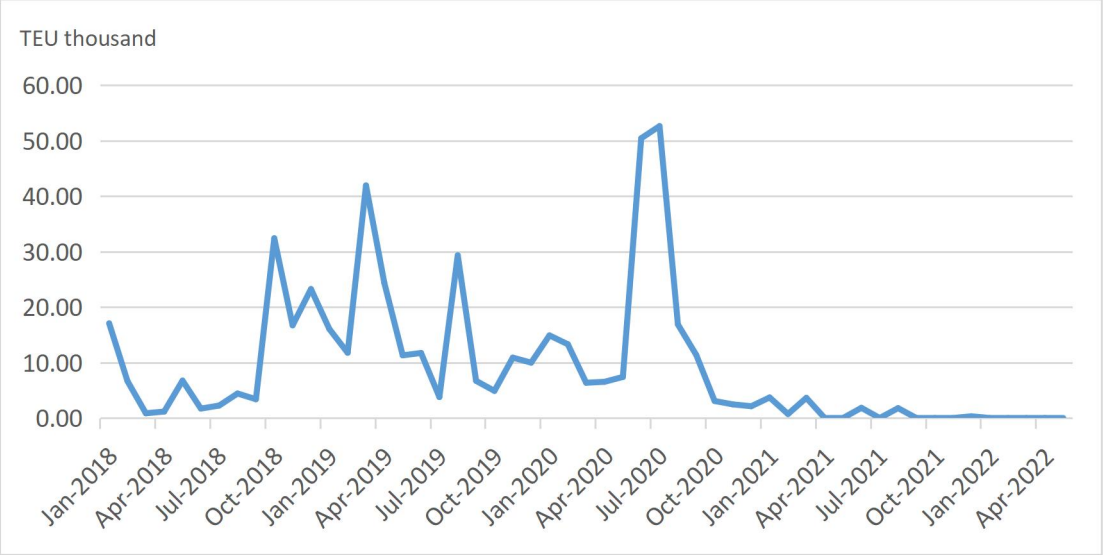


Figure 4. 2018-2022 Total Containerships Demolition

Source:Clarkson Research Services Limited 2022

Correspondingly, newbuilding contracting volumes began to decrease from the COVID-19 pandemic outbreak in early 2020, then began to pick up in the second half of 2020, at the end of 2020 began to surge and the period since has fluctuated but remained at a higher level than before the COVID-19 pandemic outbreak.(See Figure 5)

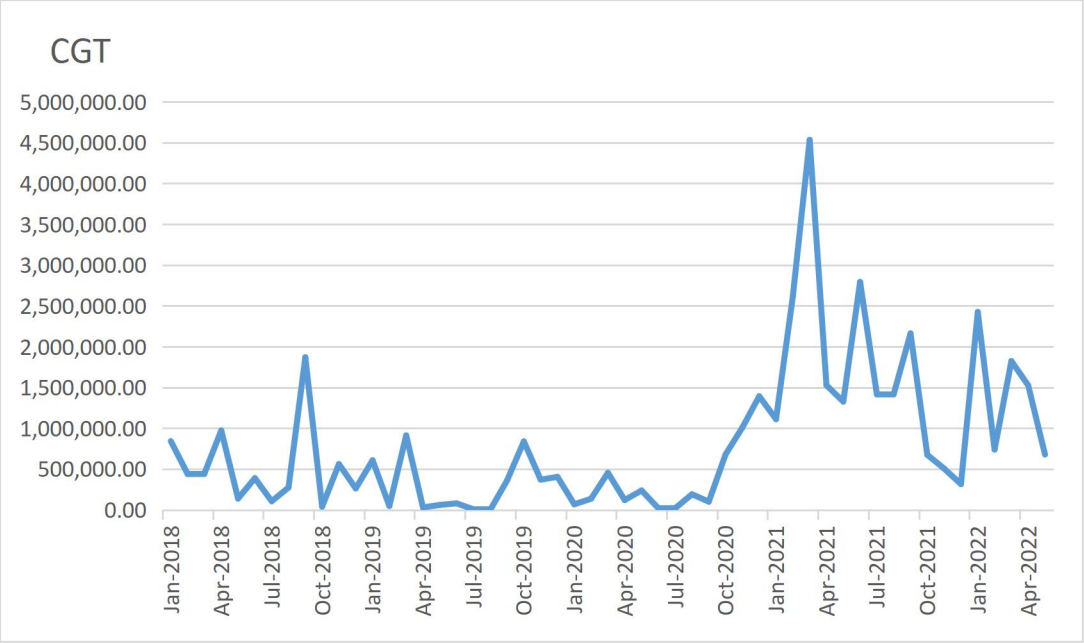


Figure 5. 2018-2022 Total Containerships Contracting
Source:Clarkson Research Services Limited 2022

Clarkson pointed out that containerships' newbuilding orders in 2021 reached 569 4.3 million TEU, the contract value of $42.8 billion, writing a new record high, this order level even higher than the previous record level of 3.3 million TEU in 2007 by 29%, more than the 2020 orderbook volume increased by 320%. Going into 2022, the containership market has another 124 new vessels on order, with a total capacity of approximately 857,600 TEU.

The shipbuilding market is closely linked to the shipping market, as the epidemic disrupted the balance of the global supply chain, with a slow decline in orderbook from early 2020 and a "restorative growth" in the newbuilding market from the second half of 2020 onwards, as container freight rates continued to soar. The containerships orderbook has been growing since October 2020. (See Figure 6)

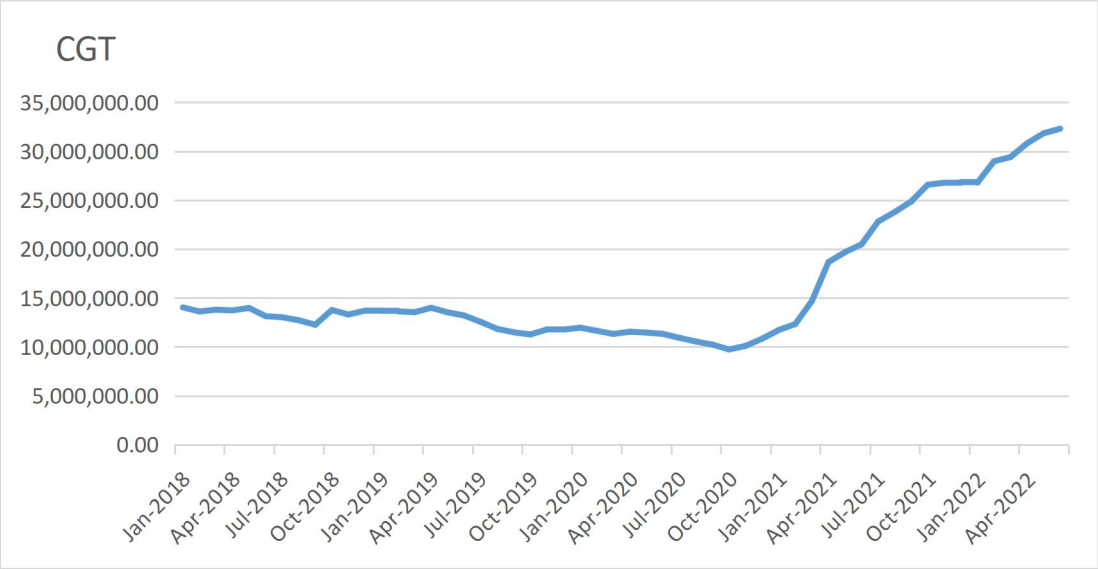


Figure 6. 2018-2022 Containerships Orderbook
Source:Clarkson Research Services Limited 2022

COVID-19 pandemic also has a significant impact on the orderbook of liner companies, China Ocean Shipping (Group) Company (COSCO) in the first quarter of 2020, except for North America and Asia, the year-on-year growth rate of container operations is negative, compared to the fourth quarter of 2019, the orderbook volume growth rate is negative.

The following is the example of COSCO, selected from 2019 to February 2022 monthly data for analysis, the details are shown in Figure 7, 2019 a whole year of order data except for May and June basically in a relatively stable state, and from March 2020, that is, the global COVID-19 pandemic began to explode, the order volume began to soar, since the resumption of work and production The order volume started to soar, and then started to fall gradually after the resumption of production. In the second half of 2021, due to the outbreak of the Omicron strain, orders began to increase again and even surpassed the previous level. Since the outbreak of the COVID-19 pandemic, both import and export cargoes on the Sino-Euro route have dropped to different degrees, and only Cosco has achieved

positive growth in export cargoes. This is related to the better control of the COVID-19 pandemic in China.

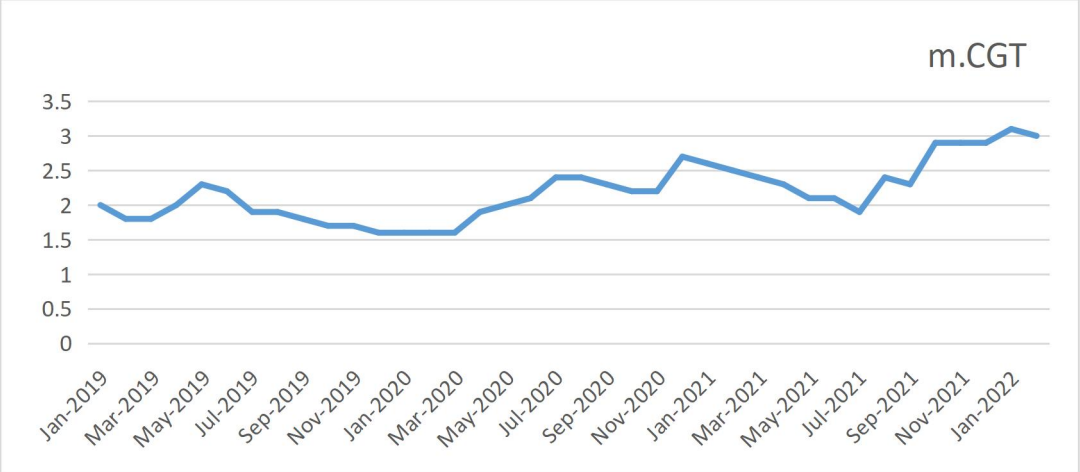


Figure 7. 2019-2022 Orderbook by COSCO

Source: Clarkson Research Services Limited 2022

It can be concluded that at the beginning of the COVID-19 pandemic outbreak, the vast majority of Sino-Euro route liner companies experience varying degrees of decline in orderbook. In 2021, it starts to rise steadily. The market share of the Sino-Euro route is more concentrated in large liner companies, and large brand liner companies are more competitive than small liner companies, and the outbreak of the COVID-19 pandemic makes many small liner companies lose competitiveness or even go bankrupt, and cargo owners (or shippers) prefer larger and stronger large liner companies when choosing liner companies. At the same time, COVID-19 pandemic control has a great impact on the operating condition of liner companies.

2) Port congestion

The impact of the COVID-19 pandemic on the container shipping market is not only reflected in changes in capacity, but also in port congestion. Port congestion is a key driver of high freight rates in the container shipping market, and any port congestion in the container liner market will have a ripple effect on the global supply

chain. After the COVID-19 pandemic outbreak, the congestion index of major ports on the China-Europe route averaged 6.36% in 2021, much higher than the pre-epidemic average of 5.23% in 2019, and port congestion led to a significant drop in the on-time rate of vessels in the operating fleet. According to the Shanghai Shipping Exchange, before the epidemic, the combined on-time index of global trunk routes was above 70%, while in 2021 it will be only 17%. This ultimately led to a significant reduction in effective container ship capacity.

The Figure 8 shows the congestion data of Shanghai port and four European basic ports from 2019 to 2022. As seen from the figure, the congestion data of Shanghai port is much higher than that of European ports, which is due to the fact that the domestic epidemic control situation is better than that of foreign countries, and a large number of orders flow back to China, but the growth rate of capacity is far from the growth rate of demand, resulting in capacity oversupply and serious congestion in export ports. The congestion in European ports is due to the seriousness of the epidemic abroad and the fact that many countries are still at the stage of shutting down production and the lack of labour leading to inefficient supply and a serious lack of effective capacity leading to congestion in port.

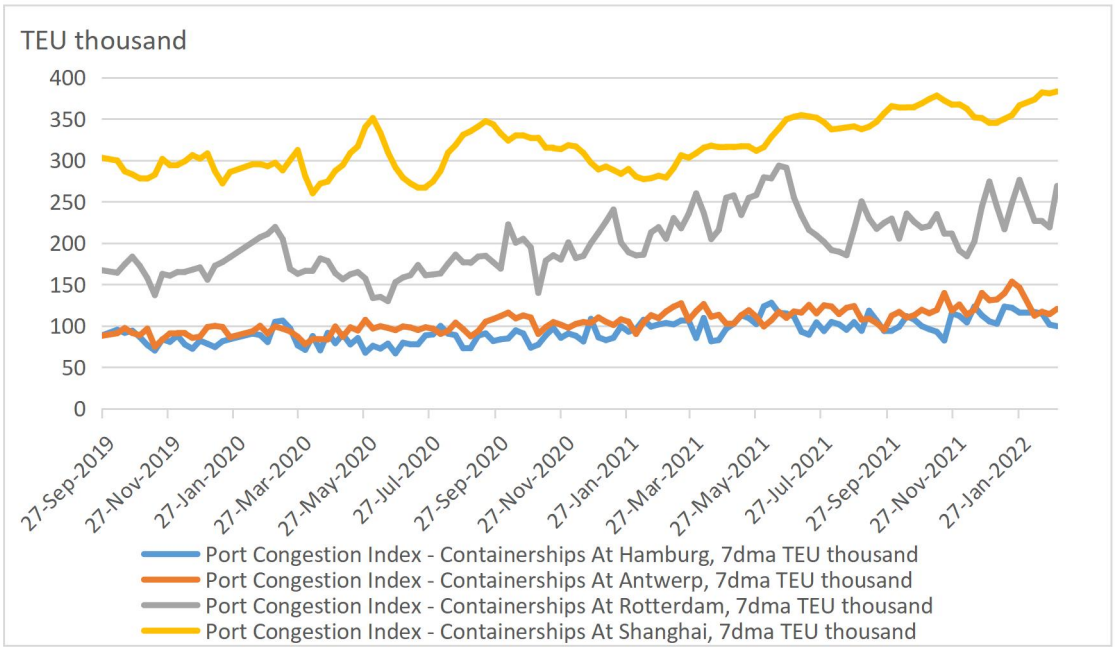


Figure 8. 2019-2022 Port Congestion Index

Source:Clarkson Research Services Limited 2022

In summary, the rapid spread of COVID-19 pandemic has resulted in port congestion, reduced vessel availability, high newbuilding costs and a reduction in the growth rate of new vessels, ultimately leading to a reduction in the effective supply of capacity in the container transport market.

4.3.2 Impact on demand

In addition to the impact of the COVID-19 pandemic on the supply of the Sino-Euro route container transport market, the impact on demand has been dramatic. the demand impact on the Sino-Euro route since the outbreak of the COVID-19 pandemic consists mainly of the impact of the COVID-19 pandemic on the volume of maritime transport on the Sino-Euro route The volume of seaborne trade on the Sino-Euro route from 2020 to 2021 is lower in the first half of 2020 compared to 2018-2019, and starts to increase significantly after the outbreak is gradually brought

under control. The change in the industrial production index, which also represents the change in demand, decreases rapidly in the first half of 2020 due to the COVID-19 pandemic, then rises rapidly, peaks in May 2021 and then falls back, remaining stable after the fall. The COVID-19 pandemic on demand is specifically manifested in the following aspects:

1) Impact on Sino-Euro route maritime trade volume

Since the second half of 2020, with full national vaccination coverage and the COVID-19 pandemic under control, global trade has gradually returned to normal and demand for trade has increased rapidly across the container shipping market. In particular, China's import and export trade volumes increased rapidly in the second half of 2020, directly contributing to the recovery in global economic activity, as COVID-19 pandemic prevention and control measures were in place and the resumption of production was smoother than in other countries. This is shown in the Figure 9 below: China's monthly import and export trade volumes remained cyclical and stable before the outbreak (2018-2019), and after the outbreak (2020-2021) China's import and export trade volumes first decreased in the first half of 2020 due to the impact of the epidemic, and then increased rapidly in the second half of 2020 when production resumed in full.

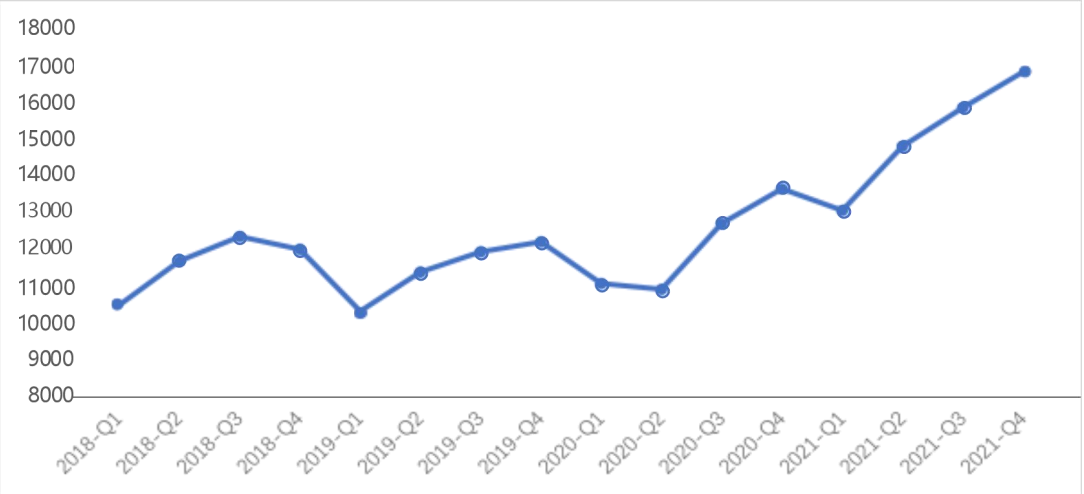


Figure 9. Quarterly China Import and Export Trade 2018-2021 (US$ billion)

Source：National Bureau of Statistics

Since 2020, especially driven by the strong recovery of the global container shipping market in the second half of 2020, the operating performance of the global container shipping industry has improved significantly, and the performance of many liner companies has also set a new high in recent years. Comparing the seaborne trade volume of the Sino-Euro route from 2018 to 2022, the trade volume declined significantly in 2020 due to the impact of the COVID-19 pandemic, and the year-on-year growth rate was negative, while the trade volume achieved significant growth in 2021 due to the proper control of COVID-19 pandemic and the recovery of seaborne demand. The details are shown in Table 2.

Table 2.Far East-Europe route trade volume growth

	Far East - Europe Container Trade Growth y-o-y	Far East - Europe Container Trade	Europe - Far East Container Trade
Date	% Yr/Yr	Million TEU	Million TEU
2018	2.0	16.19	7.65
2019	3.0	16.67	8.17
2020	-5.4	15.77	8.21
2021	8.2	17.07	7.75

Source: Clarkson Research Services Limited 2022

2) Changes in the industrial production

In addition to China, demand for seaborne trade in Europe, one of the world's top three economies, is also increasing rapidly. In the context of economic development, the magnitude of the change in the Index of Industrial Production (IDI) is an accurate indicator of the extent of economic and trade growth and decline, and changes in the IDI directly affect national production output and the volume of container trade. In Figure 10 we can see that both Europe and China's Index of Industrial Production moved in a similar direction, with both falling rapidly in the first half of 2020 due to the epidemic, then rising rapidly back to positive levels, peaking in May 2021 and then falling back to a stable level afterward.

Figure 10. 2018-2022 IDI China & Europe

Source: Clarkson Research Services Limited 2022

In early 2020, the COVID-19 pandemic spread across the country at multiple points and the situation of prevention and control of the epidemic was severe, causing a large short-term impact on industrial production and a decline in the value-added of industries above the national scale. Subsequently, covid-19 spread globally and the lack of optimism in prevention and control abroad led to a greater drop in the industrial production index in Europe than in China.

In the face of the impact of the epidemic, under China's effective prevention and

control measures, all regions co-ordinated the prevention and control of the epidemic and economic and social development, accelerated the work of logistics to ensure smooth passage, energy supply continued to be effective, people's livelihood products to ensure strong protection, the general situation of industrial production is generally stable. Although the decline in industrial production was significant at the beginning of the epidemic, it was a fluctuation brought about by the short-term impact of the epidemic, and the industrial production index began to surge in May 2020 when China lifted the crisis level 1 response. As the vaccination rate rose countries gradually controlled the trend of the epidemic and the industrial index began to change to a steady rise.

4.3.3 Impact on the freight rates of China-Europe routes

1) Freight rates paid by cargo owners (or shippers) keep rising

Due to the impact of the COVID-19 pandemic outbreak, the world trade and container transport have negative growth, among which China, as the country with the largest trade and container shipping demand, the foreign trade import and export dropped 8% in the first five months of 2020, and the demand for container shipping dropped simultaneously. The supply-demand imbalance has caused the CCFI on European routes to fall to 970 points in May 2020, down 5% from the level at the end of 2019. However, with the development of the COVID-19 pandemic, the demand for epidemic prevention supplies and home class demand is growing rapidly, which in turn will drive container traffic demand. In particular, China's foreign trade started to grow positively in June 2020, with positive container shipping demand growth in July and double-digit growth in the fourth quarter, which is traditionally the peak season. With the consequent improvement in market supply and demand, coupled with the decline in vessel turnover efficiency, the average CCFI for

European routes reached 1,256 points in the second half of 2020, reaching a record high of more than 2,300 points in late December.

In 2021, driven by the recovery of global trade rebound, container shipping demand grew rapidly, and China's foreign trade achieved 35% growth in the first seven months, leading to double-digit growth in demand for container shipping on international routes, exceeding market expectations. However, due to the decline in logistics efficiency, the imbalance between supply and demand has led to a round of crazy increases in shipping prices, and even if liner companies put in all available capacity, they could not ease the capacity tension, especially the supply and demand in the spot market, which led to a significant increase in freight rates, and the CCFI of European routes rose to 5,200 points in August.

China-Europe route container liner shipping was affected by the global economic crisis in 2008, the Central Europe route freight rate index saw a continuous 10-year plunge to 2019, a few months before the COVID-19 pandemic broke out, the freight rate per TEU was close to 950 U.S. dollars per TEU. from the supply point of view, that is, the liner company's point of view, the freight rate is struggling to support. But from the shipper's (or shipper's) perspective, it was a "golden" period of 10 years of low freight rates. From the end of the COVID-19 pandemic, until around April 2020, freight rates exceeded 1000 USD/TEU, in April 2020 the container liner freight rate of the China-Europe route dropped to below 1000, and from May began to rise steadily, and until December 2020, the growth trend of China-Europe route freight index and China composite freight index From December 2020 onwards, the container liner freight rate index of China-Europe route will start to rise continuously and far exceed the comprehensive freight rate index.

The situation of the Sino-Euro route Container Freight Rate Index and the CCFI Freight Rate Index in 2018-2022 is shown in Figure 11.

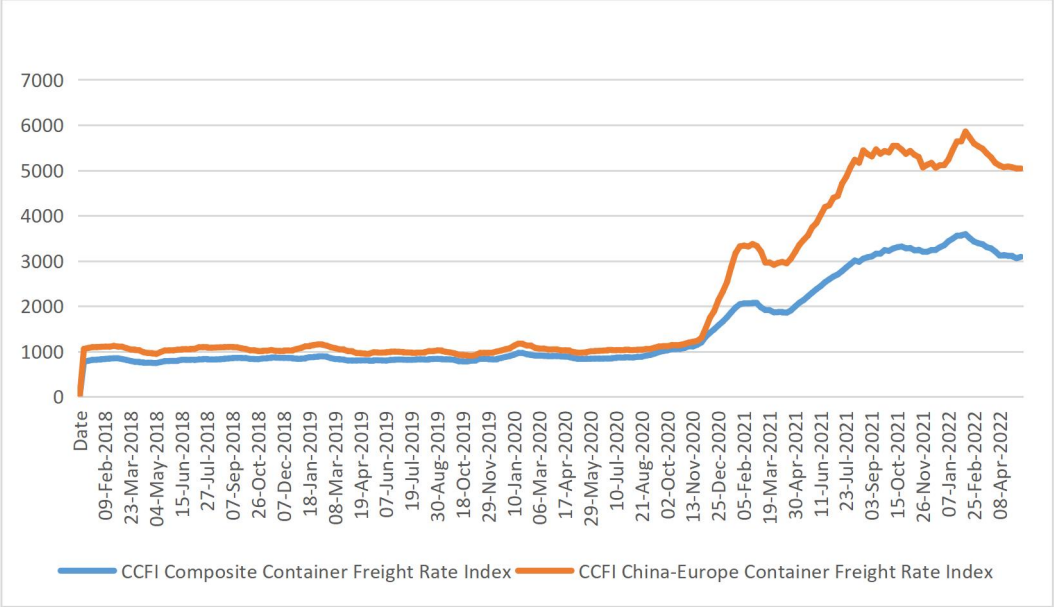


Figure 11.2018-2022 CCFI Composite & Sino-Euro Container Freight Rate Index
Source: Clarkson Research Services Limited 2022

Starting from the COVID-19 pandemic outbreak in January 2020, the container freight rate of the Sino-Euro route dropped sharply. Among them, on January 3, 2020, the comprehensive index of Shanghai to Europe basic port freight rate was 1124 USD/TEU, after that, the comprehensive index of container freight rate was decreasing every week by Apr 30. From May.1. China lifted the first level of crisis response and began to rebound in freight rates, with China gradually controlling the trend of the epidemic, while Europe has always been in the serious stage of the epidemic, a large number of orders into China, Sino-Euro route container freight rates from November 2020 began to skyrocket.Until November 2020, they start to rise sharply. In February 2021 began to gradually decline, April began to rise, from July has been maintained at a very high level, although there are fluctuations, the integrated freight index of the China-Europe route has always exceeded $ 5,000 / TEU, it is worth mentioning that the integrated freight index from the port of Shanghai to the European basic port from July has exceeded $ 7,000 / TEU, but from

March this year, Shanghai closed the city, a large number of However, since the closure of Shanghai in March this year, a large number of orders flowed to Southeast Asia, and in just two months the freight rate has fallen to $5955/TEU. A comparison of the CCFI Sino-Euro,SCFI European basic port container freight rate index during 2020-2022 is shown in Figure 12.

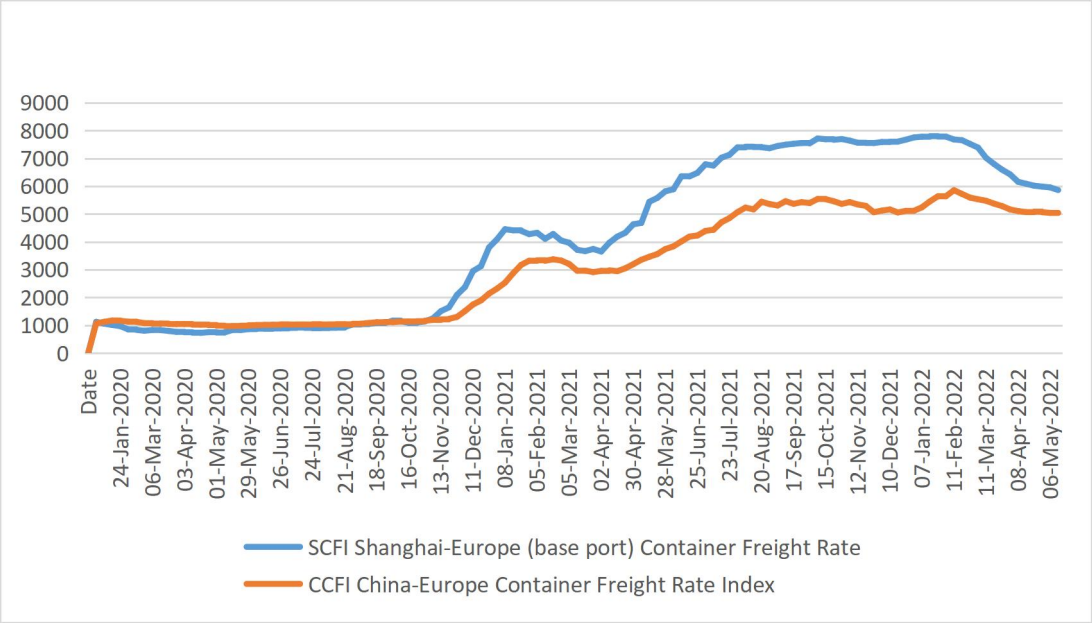


Figure 12. 2020-2022 SCFI & CCFI

Source: Clarkson Research Services Limited 2022

2) Rising shipping costs lead to the surcharge surge

Before the COVID-19 pandemic broke out, the cost of container liner shipping on the Sino-Euro route was already rising year on year, and the rise in costs would indirectly lead to an increase in freight rates. The increase in demand for containers for export and the shortage of new containers in the short term have led to an increase in demand for containers and a significant increase in raw material prices. With the rapid increase in container prices, the long-term charter rates offered by charterers to liner companies are also increased accordingly.

To maximize profits, liner companies continue to reduce costs through

economies of scale. under the COVID-19 pandemic, containers stranded in Europe and the United States cannot return to the Far East in time, and liner companies have to invest in new container equipment, thus causing a shortage of domestic export containers. From May 2020, Chinese manufacturing recovered rapidly as China effectively controlled the COVID-19 pandemic. At the same time, the rapid spread of the COVID-19 pandemic overseas led to a significant reduction in social production capacity and high demand for epidemic prevention supplies, indoor household goods and office goods, which led to a rapid increase in China's export trade and a spurt of goods of all kinds being shipped to European countries in containers.

However, in the context of the COVID-19 pandemic in European countries, there is a relative shortage of effective capacity, inefficient operation of terminals, railway stations and container yards, serious congestion at major basic ports, a significant decrease in the turnover of container equipment, a significant extension of the time for unloading heavy containers and returning empty containers, resulting in the number of containers stranded in overseas areas that cannot be returned to the Far East in time for shipment. As a result, the number of containers stranded in overseas areas that could not be returned to the Far East in time for shipment increased sharply and the container equipment turnover operation encountered a serious bottleneck. The continued deterioration in container turnover efficiency has led to a growing shortage of containers available for export. With a large number of containers stranded overseas and unable to return, major liner companies around the world are facing a shortage of containers for China's exports. In order to meet the huge demand for domestic exports, companies are competing to expand their container holdings by ordering new containers from major global container builders and charterers, despite high costs.

The demand for containers has also influenced the changes in the prices of raw materials for new containers.The main costs of new containers such as steel and

flooring have been relatively stable until June 2020, while from June 2020 onwards, the market demand for new containers has increased and the prices of raw materials have shown a significant upward trend. With the rapid increase in container prices, the long term charter rates offered by charterers to liner companies have also increased accordingly.

Capacity growth has been rising gradually since the end of 2020, at the same time as the surge in the freight rate index. Newbuilding prices have risen by 20% since the beginning of 2021, with newbuilding containership prices reaching their highest level in almost a decade, driven by a combination of higher commodity prices such as steel and a reduction in shipbuilding companies.(see Figure 13)

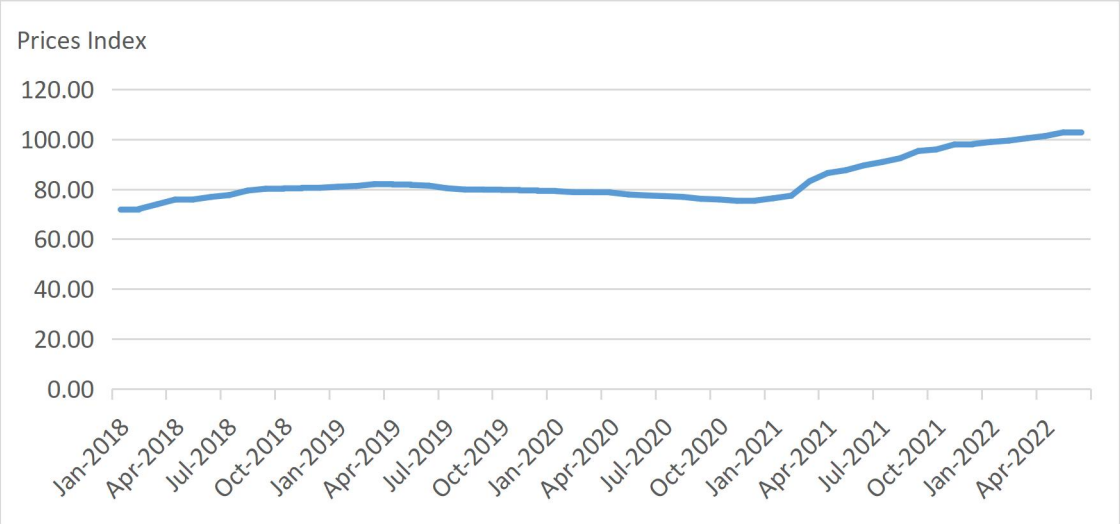


Figure 13. 2018-2022 Containership Newbuilding Prices Index
Source: Clarkson Research Services Limited 2022

In addition to the base rate increase, shippers will have to bear a variety of surcharges. Firstly, from July to December 2020, container liner companies have imposed surcharges on their base rates to make up for the loss in costs. From July to December 2020, container liner companies will add various surcharges on top of the base rate increase to make up for the losses incurred in costs.

First, from July to December 2020, container liner companies will add various surcharges on top of the base rate increase to compensate for cost losses. For example, the Priority Delivery Surcharge (PDS) is a surcharge of 1,000 FEUs per FEU on top of the base rate for shippers.

This is a surcharge of $1000-3000 per FEU to ensure that the shipper's cargo is delivered on time to its destination. The shipper has to pay an additional surcharge of $1000-3000 per FEU to ensure that the shipper's cargo reaches its destination on time. Otherwise, the shipment may be delayed by two weeks or even a month or more to reach its destination. In addition to the surcharge for priority delivery to the destination. In addition to the surcharge for priority delivery, on the Sino-Euro route, Duffy and Star Line also offer a surcharge for "operating expedited routes", i.e., the shipowner's "space" and "box space" for the shipper's cargo to ensure the shipper's "space" and "box space" for the cargo. ", to ensure that the shipper's container cargo can be "fast", "accurate" to the large destination of the port of receipt, and priority loading and unloading and the establishment of a surcharge. Hapag-Lloyd of Germany, Hyundai Merchant Marine of Korea, Ocean Netlink of Japan, Yang Ming Marine of Taiwan, and other liner companies also levied another surcharge on shippers, namely the "guarantee" service surcharge, the shipper pays the "guarantee" surcharge to ensure that The shopper pays this "guarantee" surcharge to ensure that the shipper's "booking" arrangements are in place.

In addition, higher crude oil prices have led to increased bunker surcharges by several shipping lines.After the world economy recovered, world demand for crude oil increased significantly compared to the beginning of the COVID-19 pandemic, but these oil-producing countries did not restore crude oil yield to the same level before the COVID-19 outbreak, resulting in an oversupply of crude oil on the market, so prices rose rapidly, even surpassing the price before COVID-19 pandemic outbreak (see Figure 14). MSC issued a notice on March 14 stating that effective

April 15, 2022, MSC will recalculate the global bunker surcharge for all spot and quarterly contracts traded in Asia on a biweekly rather than monthly basis until further notice, until conditions stabilize. Koryo Shipping has also previously notified that an adjusted second-quarter LESS will be implemented from April 1, with the second quarter surcharge already higher than the first quarter. According to the report, most maritime carriers in Northern Europe will add a 25% fuel surcharge to their route transportation costs as of April 1.

Figure 14. 2018-2022 Brent Crude Oil Price

Source: Clarkson Research Services Limited 2022

5 Empirical analysis of impacts of COVID-19 on the Sino-Euro container shipping market

5.1 Data description and analysis

5.1.1 Data selection

For the container shipping market, the freight rate can reflect the supply and demand of the market, CCFI freight index the world's most well-known index reflecting the container freight rate can reflect the development of the container liner shipping

market, and nowadays, among all the international routes in China, the Sino-Euro route is the most representative, so this chapter selects CCFI China-Europe route container freight rate index as the representative of the freight rate. The CCFI is used to reflect the market information. After the outbreak of COVID-19 pandemic in early 2020, container liner shipping prices went through two phases, namely, the downturn in the first half of 2020 and the spike since the second half， and the prices continued to rise after a short decline.

The data used in this study are the weekly CCFI China-Europe freight rate index and the cumulative number of global COVID-19 confirmed cases per week from January 2020 to March 2022 for a total of 114 weeks. Figure 15 and Figure 16 plot the weekly data plotting the time series of the CCFI China-Europe freight rate index and the number of confirmed cases from January 2020 to March 2022, respectively, showing that freight rates initially decreased as the number of confirmed cases increased, but then increased after adapting to the epidemic, relieved first-level public health emergency response (mechanism), and fully resuming work and production. Overall, both the CCFI China-Europe freight rate index and the cumulative number of confirmed cases show an increasing trend.

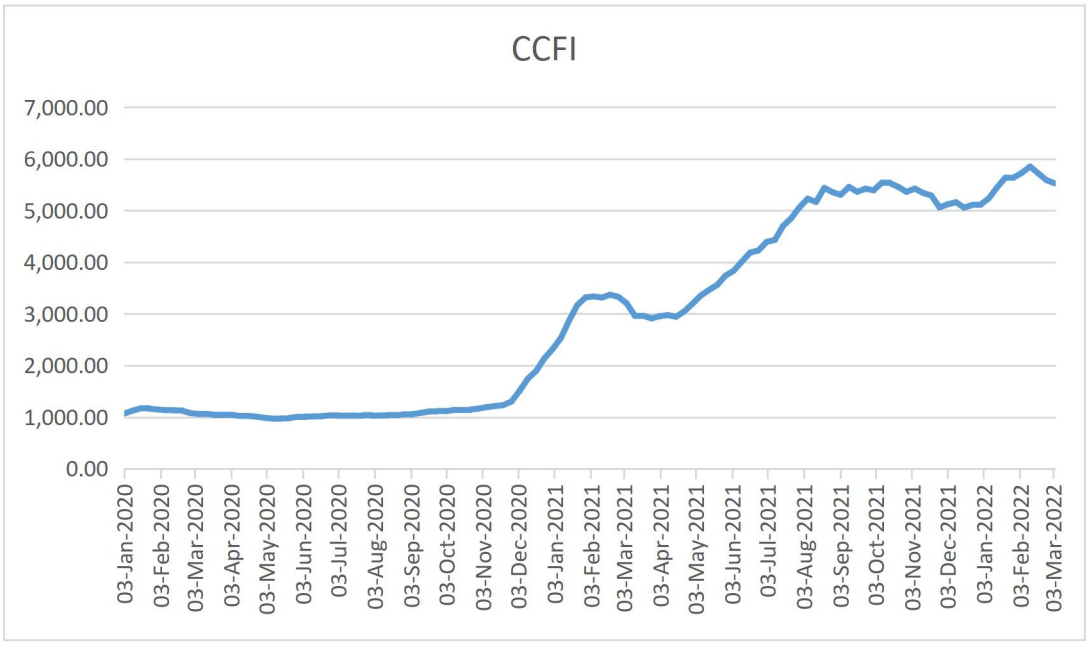


Figure 15. 2020-2022 CCFI China-Europe route freight rate index

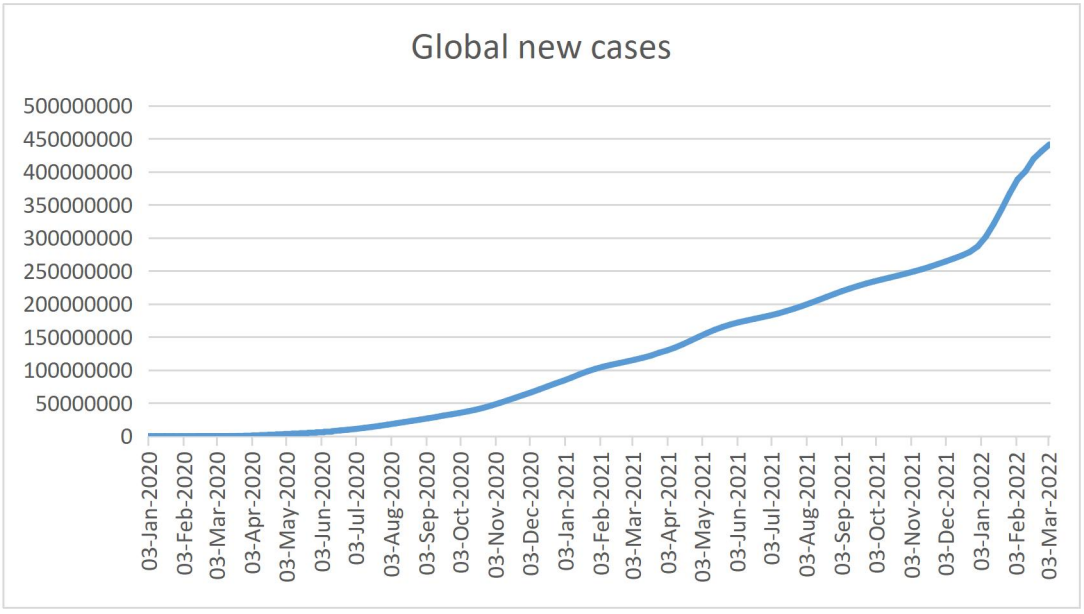


Figure 16. 2020-2022 global new confirmed cases weekly

5.1.2 Data Processing

To avoid the confusion of variable names, the series codes are named uniformly. The

names are as follows: CCFI and COVID denote the original series of CCFI China-Europe and the number of confirmed new cases, respectively; lnCCFI and lnCOVID denote the logarithm of CCFI and COVID, respectively; dlnccfi and dlncovid denote the first-order difference of lnccfi and lncovid, respectively.See Table 3:

Table 3. Serial Code

Meaning	CCFI Serial Code	COVID Serial Code
Primitive series	CCFI	COVID
Logarithmically processed series	LnCCFI	LnCOVID
First order difference of logarithmic series	Dlnccfi	Dlncovid

1.Descriptive Statistics

In data analysis, descriptive statistical analysis is generally performed first to discover the patterns inherent in the data and then to select methods for further analysis. Descriptive statistical analysis is to make statistical descriptions of the data related to all variables in the survey, mainly including Mean, Median, Maximum, Minimum, Std. Dev., Skewness, Kurtosis, Jarque-Bera test. Therefore, the relevant data information is statistically presented in Table 4.

Table 4. Data descriptive statistics

	lnccfi	lncovid	dlnccfi	dlncovid
n	113	113	112	112
Mean	7.760127	17.21760	0.014541	0.166434
Median	7.990875	18.46955	0.007850	0.053557

Maximum	8.674904	19.90563	0.150062	2.718522
Minimum.	6.877389	1.791759	-0.078382	0.012124
Std. Dev.	0.708244	3.181073	0.035979	0.421334
Skewness	-0.046249	-2.443432	1.397777	4.662068
Kurtosis	1.249767	9.934461	6.278655	25.48501
Jarque-Bera	14.46340	338.8502	87.40877	2789.760

2.Stability test

Since the CCFI China-Europe freight rate index and the number of confirmed cases both show exponential and rapid growth, in order to make the two time series data easier to be stable, we need to log the original series data and conduct the ADF test results of lnccfi and lncovid, and propose the corresponding original hypothesis: lnccfi and lncovid series are non-stationary. Then, the ADF test statistic is constructed in Eviews software, and the p-values of lnccfi and lncovid series are 0.9193 and 0.9961 respectively, so the original hypothesis is rejected and the lnccfi and lncovid series are considered as non-stationary series.

The lnccfi and lncovid series are not stable series, so it is necessary to differ the data of the two series, and after differencing, the first-order differenced lnccfi and lncovid are then tested. The ADF test results show that the ADF test results for the logarithmic CCFI China-Europe freight rate index dlny and the logarithmic number of confirmed new cases lncovid after first-order differencing are 0.0020 and 0.0000, respectively, which are less than 0.05. Therefore, the original hypothesis that the series are not stable is rejected, and the dlnccfi and dlncovid series after first-order differencing are considered to be stable, so they can be used to construct the ARIMAX model. (see Table 5).

Table 5. ADF test results

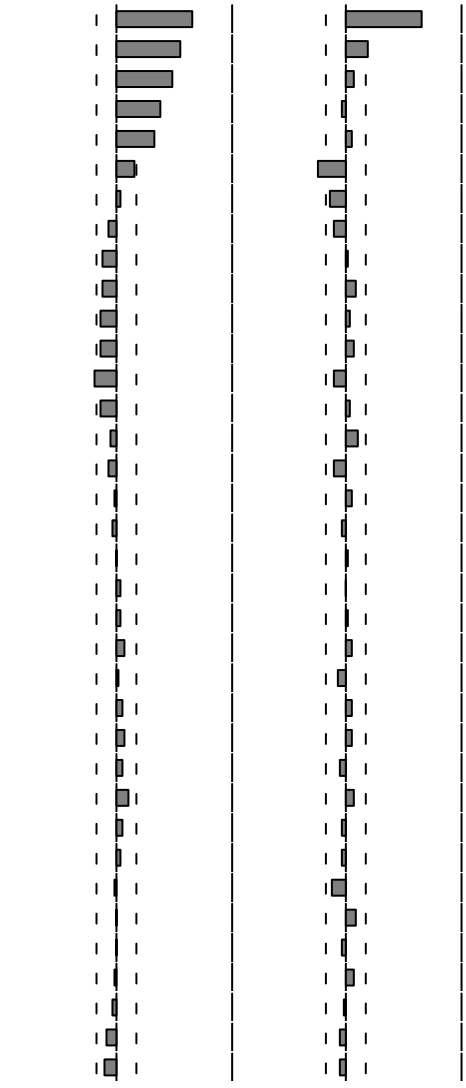
	t-Statistic	10% level	5% level	1% level	Prob.*
lnccfi	1.026357	- 1.614818	- 1.943741	-2.585962	0.9193
dlnccfi	-3.122948	- 1.614818	- 1.943741	-2.585962	0.0020
lncovid	2.410495	- 1.614694	- 1.943943	-2.587387	0.9961
dlncovid	-6.625352	- 1.614749	- 1.943853	-2.586753	0.0000

5.2 Model specifications - ARIMAX model with time series

After the stability test, the first-order differenced CCFI China-Europe freight rate index dlnccfi and the number of confirmed cases dlncovid are stable, and a ARIMAX model can be built. First, to construct the regression model of CCFI freight rate index and the number of confirmed new cases, the first step is to determine the values of the autoregressive coefficient p and the moving average order q of the ARIMAX model: by calculating and comparing the values of Akaike info criterion, AIC, and Schwarz criterion, SC, of different orders to minimize the corresponding order. The corresponding order is called the optimal p and q values of the model.

The procedure in the software is as follows: First, the autocorrelation and partial autocorrelation plots of the first-order difference of the CCFI China-Europe freight rate index after the series dlnccfi are made by Eviews software, as shown in Figure 17:

Date: 06/05/22 Time: 17:15
Sample: 1/03/2020 3/04/2022
Included observations: 113



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.689	0.689	55.001	0.000
		2	0.579	0.199	94.194	0.000
		3	0.496	0.078	123.21	0.000
		4	0.390	-0.039	141.33	0.000
		5	0.348	0.055	155.93	0.000
		6	0.164	-0.256	159.20	0.000
		7	0.036	-0.149	159.36	0.000
		8	-0.069	-0.112	159.94	0.000
		9	-0.120	0.022	161.74	0.000
		10	-0.115	0.086	163.42	0.000
		11	-0.155	0.032	166.47	0.000
		12	-0.142	0.074	169.07	0.000
		13	-0.189	-0.110	173.72	0.000
		14	-0.147	0.026	176.56	0.000
		15	-0.050	0.101	176.89	0.000
		16	-0.074	-0.104	177.62	0.000
		17	-0.015	0.042	177.66	0.000
		18	-0.033	-0.048	177.81	0.000
		19	-0.006	0.014	177.81	0.000
		20	0.038	-0.005	178.02	0.000
		21	0.031	0.012	178.16	0.000
		22	0.073	0.063	178.93	0.000
		23	0.020	-0.072	178.98	0.000
		24	0.048	0.064	179.32	0.000
		25	0.077	0.048	180.18	0.000
		26	0.047	-0.054	180.51	0.000
		27	0.102	0.080	182.07	0.000
		28	0.045	-0.038	182.37	0.000
		29	0.036	-0.045	182.57	0.000
		30	-0.008	-0.130	182.58	0.000
		31	-0.003	0.086	182.58	0.000
		32	-0.002	-0.037	182.58	0.000
		33	-0.023	0.074	182.67	0.000
		34	-0.036	-0.014	182.88	0.000
		35	-0.095	-0.060	184.38	0.000
		36	-0.105	-0.064	186.25	0.000

Figure 17. dlny autocorrelation and bias correlation plots

By observing the autocorrelation and partial autocorrelation plots of dlnccfi, it is found that the partial autocorrelation function of the CCFI index data after taking logarithm shows truncated tails and the autocorrelation letter shows strong trailing tails. Therefore, the AR model was used.

For this purpose, the AIC and SC values of various p q combinations were calculated separately (see Tables 7 and Table 8 for details), and the table was used to find the combination of p and q with the smallest AIC value of (3, 2) and the combination of p and q with the smallest BC value of (2, 0), and the combination was determined to be (2, 0) corresponding to the AIC and SC results of -4.442727 and -4.346183.

Table 6. AIC Guidelines

AR/MA	0	1	2	3	4	5
0	-3.802963	-4.158547	-4.274346	-4.354288	-4.338556	-4.414413
1	-4.417082	-4.444682	-4.428607	-4.422032	-4.421978	-4.487991
2	-4.442727	-4.428049	-4.466625	-4.496024	-4.486853	-4.471067
3	-4.430016	-4.427832	-4.508355*	-4.491848	-4.477791	-4.480379
4	-4.415836	-4.423170	-4.425148	-4.491901	-4.477700	-4.467357
5	-4.399931	-4.397294	-4.407566	-4.478630	-4.498122	-4.475768

Table 7. SC Guidelines

AR/MA	0	1	2	3	4	5
0	-3.778827	-4.086138	-4.177802	-4.233607	-4.193739	-4.245460
1	-4.344673	-4.341137	-4.307926	-4.277215	-4.253025	-4.294901
2	-4.346183*	-4.307368	-4.321808	-4.327071	-4.293764	-4.253841
3	-4.309335	-4.283015	-4.339402	-4.298758	-4.260566	-4.239017
4	-4.271019	-4.254217	-4.232058	-4.274676	-4.236338	-4.201859
5	-4.230977	-4.204205	-4.190340	-4.237268	-4.232624	-4.186134

The next step was to determine the lag of the impact of the number of

COVID-19 confirmed cases on the CCFI freight rate index by comparing the AIC and SC values of the equation after dlncovid lags 0, 1, 2, and 3 periods in Eviews software, respectively, and found that the dlncovid of the current period made the AIC and SC values of the regression equation the smallest; and the largest after adjustment (Table 9).

Therefore, the equation uses the current value of dlncovid as an exogenous variable.

Table 8. dlncovid lag number AIC , SC value

	AIC	SC	R^2	$Adjusted\ R^2$
Lag 0 period	-4.467293	-4.369653	0.514481	0.500868
Lag 1 period	-4.461399	-4.363759	0.511611	0.497917
Lag 2 period	-4.453097	-4.355456	0.507539	0.493731
Lag 3 period	-4.464501	-4.366301	0.516163	0.502469

Finally, the current series of dlnccfi and dlncovid are brought into the ARIMAX model and the correlation equations are fitted in Eviews using the Maximum Likehood Estimate Method to obtain the corresponding parameter values (Table 9). After adding the exogenous variable dlncovid, the AIC and SC values of the model are -4.460861 and -4.387630, both of which are smaller than the AIC and SC values of the autoregressive CCFI China-Europe freight rate index only, so the model fit is more accurate after adding dlncovid. The final model according to Table 8 can be written as follows in the following form.（see Table 9）

From the results of the first model, the year-on-year rate of change of the CCFI China-Europe route freight rate index seems to be negatively correlated with the growth rate of the cumulative number of confirmed COVID-19 pandemic cases. This is not consistent with the actual situation, so another measurement was carried out

after 2020.7.1 (i.e. when the number of confirmed new cases is in single digits and the vaccination rate is 80%). As the necessary tests have been carried out in the previous section and this data is in the period, it is sufficient to carry out a direct regression analysis.（see Table 10）

$$dlnccfi_t = 0.555294 dlnccfi_{t-1} + 0.243497 dlnccfi_{t-2} - 0.007570 dlncovid_t + u_t \quad (5\text{-}1)$$

Table 9. Model Results 2020.01-2022.03

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Dlnccfi(-1)	0.555294	0.093236	5.955820	0.0000
Dlnccfi(-2)	0.243497	0.093463	2.605267	0.0105
Dlncovid	-0.007570	0.006222	-1.216734	0.2264
AIC	-4.460861	R^2	0.502463	
SC	-4.387630	$Adjusted\ R^2$	0.493250	

$$dlnccfi_t = 0.525063 dlnccfi_{t-1} + 0.220284 dlnccfi_{t-2} + 0.115234 dlncovid_t + u_t \quad (5\text{-}2)$$

Table 10. Model Results 2020.07-2022.03

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Dlnccfi(-1)	0.525063	0.105817	4.961999	0.0000
Dlnccfi(-2)	0.220284	0.104885	2.100249	0.0387
Dlncovid	0.115234	0.064566	1.784745	0.0779
AIC	-4.316664	R^2	0.500875	
SC	-4.231633	$Adjusted\ R^2$	0.488991	

Model Results testing:

After the model estimation results are obtained, the residuals of the model are further tested for stability, autocorrelation and heteroskedasticity. If the test results show that the heteroskedasticity and autocorrelation of the residual series are not significant, it indicates that the ARIMAX model has extracted sufficient information. For this purpose, the ADF unit root test for the residuals is used to test the residuals for stability, the LM test for autocorrelation, and the White test for heteroskedasticity.

1. Autocorrelation test

The results of the LM test for the residuals were obtained in Eviews software. From Table 12, the p-value corresponding to the LM test for the residuals is 0.8489 which is greater than 0.05, so the original hypothesis should be accepted and there is no autocorrelation.

Table 11. LM test for residuals

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.164017	Prob. F(2,105)	0.8489
Obs*R-squared	0.345698	Prob. Chi-Square(2)	0.8413

（* indicates significant at 90% confidence level）

2. Heteroskedasticity test

The results of the White test for the residuals were obtained in Eviews software, and as shown in *Table 13*, the p-value corresponding to the White test for the residuals is 0.6503 which is greater than 0.05, so the original hypothesis should be accepted and there is no heteroskedasticity.

Table 12. White test for residuals

Heteroskedasticity Test: White			
F-statistic	0.763349	Prob. F(9,101)	0.6503
Obs*R-squared	7.069479	Prob. Chi-Square(9)	0.6299

（* indicates significant at 90% confidence level）

5.3 Model results testing and findings

5.3.1 Result findings from two models:

Full sample 2020.01.03-2022.03.04：

$$dlnccfi_t = 0.555294 dlnccfi_{t-1} + 0.243497 dlnccfi_{t-2} - 0.007570 dlncovid_t + u_t$$

Subsample 2020.07.10-2022.03.04：

$$dlnccfi_t = 0.525063 dlnccfi_{t-1} + 0.220284 dlnccfi_{t-2} + 0.115234 dlncovid_t + u_t$$

The modeling analysis found that the CCFI China-Europe route freight rate index is affected by the COVID-19 pandemic confirmed cases series, and when the number of COVID-19 pandemic confirmed cases is included as an exogenous variable in the analysis of the CCFI China-Europe route freight rate index series, smaller AIC, SC values can be obtained. This indicates that there is a significant quantitative relationship between the number of COVID-19 pandemic confirmed cases and the China-Europe route freight rate Index, and that the number of confirmed cases with COVID-19 pandemic is an important factor in the fluctuation of the China-Europe route freight rate index.

The relationship between the year-on-year rate of change in the China-Europe route freight rate index and the cumulative number of COVID-19 pandemic confirmed cases can be observed visually in the two models examined above. The first model shows that the year-on-year rate of change in the China-Europe route freight rate index is negatively correlated with the growth rate of the cumulative number of COVID-19 pandemic confirmed cases over the whole period. However, for the analysis of data after 10 July 2020, the year-on-year rate of change in the China-Europe route freight rate index is positively correlated with the growth rate of the cumulative number of confirmed cases, an increase in the number of COVID-19 pandemic confirmed cases increases the profitability of China's export container shipping, i.e. for every 1% increase in the number of COVID-19 pandemic confirmed cases, the CCFI China-Europe route freight rate index will be increased by 0.115%, indicating that the relationship between the two is not constant but dynamic.

At the beginning of the epidemic outbreak，China has been trying to control the epidemic, dragged down by the impact of the epidemic, suffered a devastating blow shutdown, a big blow to demand, followed by the outbreak of the epidemic in foreign countries, CCFI China-Europe route freight rates plummeted so is a negative correlation. While the reasons for the change from negative to positive correlation in the later part of the analysis combined with the qualitative part of this paper are as follows：

As the epidemic gradually came under control, the vaccination rate rose and the social side resumed work and production all had an effective effect on the control of the epidemic. China's epidemic control situation is good, but still severe in the global scope, resulting in a large number of orders back to China, increased export demand, increased demand for container transport; ships in the port detention time becomes longer, box turnaround time increased, resulting in China's export port congestion,

European countries are generally still in a serious state of the epidemic, effective labor shortage, supply efficiency reduced resulting in effective capacity reduction, the combined effect of the above reasons pushed up the container market freight rates, making the epidemic in the deterioration phase but maintaining a positive correlation with freight rates.

5.3.2 Conclusion:

In this section, the CCFI China-Europe freight rate index and the cumulative number of global confirmed cases are selected for the period January 2020 to March 2022, covering 114 weeks. The logarithmic transformation of the two series was followed by a unit root test, which determined that the original series was non-stationary, so the logarithmic series was first-order differenced to eliminate the non-stationarity.

By observing the sample autocorrelation and partial autocorrelation plots in Eviews software, it was found that the partial autocorrelation function of the CCFI index data after first-order differencing showed a truncated tail and the autocorrelation function showed a strong trailing tail, so the AR model was used. And by comparing the AIC and SC values of various p and q combinations, the combination of p and q with the smallest AIC and BC values was obtained as (2, 0), and ARIMA (2, 1, 0) was identified as the best model. It was then found that with the addition of the exogenous variable dlncovid, the AIC and SC values of the model were smaller than the AIC and SC values of the autoregressive CCFI China-Europe freight rate index only, so it was concluded that the model fit was more accurate with the addition of dlncovid. The model with exogenous variables was then tested for stationarity, heteroskedasticity and autocorrelation of the residuals, and the model residuals were found to be smooth and free of heteroskedasticity and autocorrelation. The model was found to be valid and the best model was ARIMAX (2, 1, 0).

Finally, the model empirically concluded that the year-on-year rate of change of

the CCFI China-Europe freight rate index was negatively correlated with the cumulative proportion of confirmed cases of the COVID-19 pandemic, which was somewhat inconsistent with the actual situation analysis, and conjectured that the impact of the previous period might have been too great for the overall impact, so another regression analysis was conducted using data after 10 Jul 2020. A positive correlation was found between the year-on-year rate of change in the CCFI China-Europe freight rate index and the proportion of cumulative confirmed cases , which is consistent with reality.

The different impact of the epidemic on freight rates can be summarised as the impact of the epidemic on freight rates is dynamically adjusted, and the effect of the epidemic on supply and demand is different at different times, resulting in different effects on freight rates in the end.

6. Suggestions for container shipping companies in response to the COVID-19 crisis

According to the performance of maritime trade volume as well as freight rates for containers on the China-Europe route in 2020, the decline was greater at the peak of the COVID-19 pandemic outbreak, but with the effective control of the COVID-19 pandemic, container trade volume and freight rates kept increasing, in addition, as the worldwide COVID-19 pandemic control degree of COVID-19 pandemic control versus domestic COVID-19 pandemic control, resulting in a reduction in effective capacity and an increase in demand, resulting in a high container freight index that shows a positive correlation with the number of confirmed cases.

Resilience to disruptions remains a central challenge for global container shipping companies. How should they respond to such strong fluctuations in freight

rates, how can they effectively deploy ships and containers in severe port congestion, and how should shipowners adjust their strategies flexibly to reduce losses in response to the dynamic impact of the COVID-19 pandemic on freight rates. The following is from the supply and demand perspective to the container shipping enterprises to put forward countermeasure suggestions to better cope with the COVID-19 pandemic.

1 ） Scientific planning of capacity requirements and adjustment of the appropriate ratio of owned and chartered vessels

Due to the impact of the epidemic, the import and export trade situation of the Sino-Euro route fluctuated greatly, and the freight rate of the route was extremely unstable. The market demand for capacity is elusive and shipowners are unable to accurately judge the market demand for capacity when deploying capacity, making it more difficult to make decisions. Therefore, shipping companies have to plan their capacity needs scientifically under the epidemic trend.

Therefore, shipowners should plan their capacity requirements scientifically and ensure stable production based on effective epidemic prevention and control. On the one hand, this will provide sufficient supplies for those people in the vast epidemic area who are home-isolated, ensure the normal functioning of society as a whole and provide sufficient impetus for the country's economic development. On the other hand, the scientific planning of capacity demand by shipping companies can provide cargo owners with stable freight demand, allowing shipowners to arrange the supply of capacity on the Sino-Euro route with maximum efficiency and avoiding supply chain disruptions on the Sino-Euro route due to the rebound of the epidemic. Once the supply chain has been disrupted, it is very difficult to restore the supply chain. In addition, when the supply side resumes the supply chain after a supply chain disruption, the cost pressure will be transferred to the demand side in the form of freight rates.

Therefore, for liner companies, scientific planning of capacity demand, maintaining stable production and ensuring that the supply chain of materials on the Sino-Euro route is not interrupted are both powerful measures to ensure the rational use of capacity resources and an important means to stabilize freight rates on the Sino-Euro route. If the demand for transport on the Sino-Euro route is unstable, it becomes more difficult for shipowners to make decisions on capacity deployment. If the amount of capacity deployed on the Sino-Euro route is less than the amount of capacity demanded, the market will again fall into a situation where the supply of capacity exceeds the demand, and the freight rates on the route will continue to rise. Euro route supply and demand sides will fall into a vicious circle, unable to achieve the supply and demand sides of the "win-win" situation.

For most shipping companies, space chartering is a way of avoiding the operational risks associated with huge ship investments. Even shipping giants such as Maersk, which leases a large number of its ships, are wary of investment risks. Therefore, Chinese enterprises to become the Sino-Euro route "elite cavalry", should be based on their own fleet structure, reasonable determination of their own ships and chartered ship ratio, so that in the future market downturn, part of the chartered capacity out of the market to reduce losses. At the same time should see the trend of container ship large-scale.

Ship large-scale has become the development strategy of the shipping companies, so in the development of large container ships, adjust the proportion of other medium-sized or small container ships, in order to facilitate the development of the entire container fleet. Due to the large number of large container vessels built by liner companies, the charter rates of small and medium-sized container vessels will remain at a low level in the coming years. Therefore, for these ships can sign short-term time charter contracts to meet the current market demand, while in the market downturn can be returned to reduce losses, while for large container ships, in

order to maintain the liner company's control over capacity, they have to build.

2）To strengthen epidemic control and improve transport efficiency

Given that the epidemic continues to spread worldwide, it will take a long time for the global epidemic to end completely. On the one hand, due to the epidemic, shipowners (or liner companies) have to implement a series of control measures against the epidemic in the process of receiving orders, which mainly include the control of crew, cargo and operation process. Therefore, liner companies must take effective measures to improve transport efficiency to control costs during order acceptance without compromising the quality of transport services. Otherwise, if costs are not controlled and freight rates are only increased, shipowners will still not be able to make a profit even if the freight rates on the routes are high. When the global epidemic control is over and the competition on the supply side starts again, those shipowners (or liner companies) with high freight rates will be the first to be eliminated from the liner market.

On the other hand, if liner companies do not control for the epidemic in the process of accepting shipping orders, the current context of the epidemic will cause the demand side to question the management capabilities of liner companies and the safety and reliability of the services provided, to the detriment of the shipowner's (or liner company's) long-term interests in the shipping industry. In addition, it is the responsibility and obligation of the shipowner (or liner company) to effectively control the crew epidemic and maintain the health of the crew. In the short term, liner companies can improve transport efficiency and reduce transport costs by actively controlling epidemics and preventing the spread of epidemics. In the long run, actively strengthening the control of the epidemic will help the shipowner (or liner company) to stand out from many other suppliers and gain more market share, which can lead to long-term profitability. Therefore, the competitive direction for the supply side in the context of an epidemic is to ensure the safety of the crew and cargo and to

keep them safe from the epidemic.

3） To improve the quality of transport services and participate in alliance strategies to achieve complementary advantages

Due to the background of the epidemic, port loading and unloading, storage and storage, empty containers back to the yard are subject to various unpredictable disruptions. Therefore, the impact of the epidemic on the supply and demand sides of the route mainly includes the extension of cargo delivery dates and the reduction of the quality of transport services. Although the current situation suggests that much of the pressure will eventually be shifted to the demand side due to the shortage of capacity on the Sino-Euro route. While the demand side is affected by the inability to deliver cargo to its destination on time, it also calls into question the business capabilities of the supply side, leaving the demand side with the stereotype of a low level of quality transport services, and when the epidemic is completely over and the Sino-Euro market stabilizes, those liner companies that are unable to provide quality transport services will be eliminated from the market by the demand side.

Shipping alliances are a form often adopted by large container companies in order to avoid unhealthy competition between them. The advantages of this form are obvious.

Firstly, through alliances, the range of services is expanded and higher quality services can be provided to customers. After the alliance, the company can open up new routes more easily, further subdivide the routes, establish and develop a complete market network, thus expanding the scope of services, improving the level of services, greatly enhancing the "flexibility" of shipping to customer needs, services. Secondly, it can increase the density of ship departures. Enterprises through alliances can achieve the purpose of increasing the density of sailing schedules and meeting the requirements of cargo owners without increasing capacity investment. Thirdly, it can share the risk. The shipping industry is characterized by high

investment and low profit, and shipping companies invest a lot of capital, but the return is often poor. The shipping industry is characterized by high investment and low profit, and shipping companies invest a lot of money, but the return is often poor, so they need to take huge risks.

Container transport enterprises join the alliance The alliance can, on the one hand, avoid overcapacity or the use of large amounts of capital on a specific route and, on the other hand, reduce the number of competitors and competition. This, together with the above-mentioned increase in capacity and rationalisation of resource utilisation, allows the company to reduce the risk in its operations. This, together with the increased capacity and rationalisation of resource utilisation mentioned above, allows companies to reduce their risk in the course of their operations. Container companies can implement alliances through booking, chartering, space swap, joint dispatch, joint operation and route merger. The members of the alliance can also cooperate in terminal sharing and equipment management, mainly empty containers and container trucks. The members of the alliance can also cooperate in the areas of terminal sharing and equipment management, mainly empty containers and container trucks, in order to achieve the purpose of complementing each other's advantages.

Through alliances and various cooperation agreements, individual liner companies have the opportunity to operate on a global scale without having to open up their own routes and launch their own vessels on every route. The Alliance and the various cooperation agreements give individual liner companies the opportunity to operate on a global scale without having to open their own routes and launch their own vessels on each route.

In addition, the more the epidemic is over, the more the demand side will demand a higher level of quality of service from the supply side. Because the vast majority of goods are difficult to circulate as easily during an epidemic as they were

before the epidemic, this makes various living resources in the epidemic area scarce and prices much higher than before the epidemic. The increase in the price of a unit container of cargo will lead to an overall increase in the price level of the same amount of cargo, and in the short term， the value of the cargo will follow suit. The quality of transport services provided by the liner companies will directly affect the interests of the cargo owners (or shippers). As a result, cargo owners (or shippers) will be more selective in choosing shipowners (or liner companies) for their cargoes than they were before the epidemic and will demand more punctuality and quality of transport services from the supply side.

Therefore, in addition to controlling the epidemic and reducing costs, liner companies must also work on punctuality and service quality to reduce the incidence of accidents, delayed delivery of cargo and poor cargo quality, and provide a better transport service experience for the demand side in terms of quality and quantity. Some liner companies have already introduced such premium services, aiming to provide better transport services to cargo owners (or shippers). It can be seen that, under the epidemic trend, the competitive advantage of each shipping company is reflected in the provision of high-quality, on-time cargo delivery services for cargo owners (or shippers), and on-time, punctual and quality transport services without cargo damage or delayed delivery will win the trust of cargo owners (or shippers) and lay the foundation for the sustainable development of the Sino-Euro route in the future.

4) To improve premium service tariffs and stabilize freight rates on the route

As a result of the epidemic, freight rates on the Sino-Euro route have fluctuated widely, with the initial outbreak of the epidemic causing the supply side to suffer from falling freight rates, and then the demand side to suffer from a continuous surge in freight rates on the route. Before the outbreak, China‘s export container freight rates were basically stable, but after the outbreak, the China export container freight

index increased significantly for the following reasons: on the one hand, the epidemic broke the short-term supply and demand balance in the market, demand exceeded supply, and market power shifted from "buyers" to "sellers". On the one hand, the epidemic disrupted the short-term supply/demand equilibrium in the market, with demand outstripping supply and market power shifting from "buyers" to "sellers". On the other hand, the impact of the outbreak on the shipping industry was unprecedented in history and container shipping companies had no experience in dealing with some of the contingencies in the context of the epidemic and had to adapt to the market.

Some shipowners (or liner companies), so as to meet the requirements of cargo owners (or shippers) of the Sino-Euro route for high-quality transport services, have introduced some premium services, but due to insufficient experience, the premium service charges introduced are not perfect, for example, there are problems such as unreasonable pricing and lack of a detailed classification of premium services, which may easily lead to conflicts and friction between cargo owners (or shippers) and shipowners This is not conducive to the harmony and stability of the liner market. The increase in freight rates on the routes will definitely lead to an increase in supply, and freight rates will continue to rise under the epidemic trend. As the criteria for setting freight rates are controlled by the supply side, the short-term impact of the epidemic on the supply side may increase the supply side's revenue. However, in the long term, when the epidemic is over, the supply-side advantage will no longer be apparent and when the market rebalances, the demand side will eliminate unqualified and unregulated suppliers.

Therefore, the ability of liner companies to use their pricing power will have a direct bearing on the ultimate interests of shipowners and cargo owners (or shippers). In setting freight rates, the liner company should be guided by the "win-win" criteria, i.e. the sustainability of both the liner company and the shipper (or shipper). In

addition, as the individual requirements of cargo owners (or shippers) for shipping routes are gradually increasing, it can be expected that the individual requirements of cargo owners (or shippers) for shipping routes will be even higher in the future. Therefore, the liner companies should also try to regulate and rationalize the process of setting base rates and collecting surcharges, so as to maintain the stability of the freight rates on the Sino-Euro route, in order to ensure the long-term development of both supply and demand.

7. Conclusions and Future Work

The Sino-Euro route is one of the important and representative routes in China's international shipping lines and occupies an important position in the world shipping lines. The impact of the COVID-19 pandemic on China's container shipping market and the relevant recommendations to address these impacts are of strong relevance to China's international container shipping enterprises.

This paper focuses on the impact of the Sino-Euro route's container shipping service trade under the COVID-19 pandemic, based on two variables: the freight rate index and the number of confirmed cases of the pandemic. Firstly, the current situation of China's international container shipping market and the influencing factors are analyzed, with a focus on the impact on the Sino-Euro container shipping market. Secondly, use ARIMAX model to analyze the correlation between the Sino-Euro route freight rate index and the number of confirmed cases of the COVID-19 pandemic. There is a clear quantitative relationship between the number of confirmed cases of COVID-19 pandemic and the CCFI China-Europe freight rate index, with the year-on-year rate of change of the CCFI China-Europe freight rate index being negatively correlated with the cumulative number of confirmed cases of COVID-19 pandemic in general, but becoming positively correlated since China

gradually controlled the development of the epidemic, thus concluding that the impact of the number of confirmed cases on CCFI China-Europe freight rate index varies dynamically at different stages of the epidemic.

Finally, the impact of the COVID-19 epidemic on China's container shipping market is summarised and recommendations are made to address the impact on China's container shipping enterprises.

The impact of COVID-19 pandemic on the container shipping market is undoubtedly significant, but container freight rates do not change solely due to the impact of the epidemic, but are the result of a complex combination of factors. This thesis is a simple analysis and modelling of data based on a time series since the start of the epidemic, and the conclusions suggest that COVID-19 pandemic and container freight rate index are indeed correlated, but do not take into account the impact of multiple factors. It is hoped that in future studies, more influencing factors should be taken into account, or comparisons should be made with the period before and after the COVID-19 outbreak, and more horizontal analysis should be added to the vertical analysis to make the study more complete and scientific.

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APPENDIX

APPENDIX I The Original Data for VAR

Date	CCFI China-Europe Container Freight Rate Index Index	CCFI Composite Container Freight Rate Index Index	Global new cases weekly	Port Congestion Index - Containerships In Port, China P.R., m.TEU, 7dma Million TEU	Port Congestion Index - Containerships At Southampton, 7dma TEU thousand	Port Congestion Index - Containerships At Hamburg, 7dma TEU thousand	Port Congestion Index - Containerships At Antwerp, 7dma TEU thousand	Port Congestion Index - Containerships At Rotterdam, 7dma TEU thousand
27-Sep-2019	958.15	807.84	0	1.830201429	28.58137857	88.60923429	88.11112714	167.0940386
11-Oct-2019	923.21	783.15	0	1.894755714	20.97666143	95.26332429	91.06446714	164.2338071
18-Oct-2019	914.71	776.92	0	1.977365714	26.31246429	91.58179	97.35705571	174.4252886
25-Oct-2019	904.18	777.36	0	2.134261429	26.17598429	94.20464571	91.36700286	183.5348429
01-Nov-2019	900.60	795.10	0	2.269757143	19.38298286	86.46241286	88.60511	172.5314314
08-Nov-2019	919.41	808.93	0	2.320934286	20.77618286	76.92146714	96.62834	157.8180757
15-Nov-2019	966.06	834.87	0	2.338678571	34.19096714	70.24860857	74.87752	137.1653429
22-Nov-2019	967.68	835.98	0	2.293301429	22.86685857	83.78429	83.41032286	162.7315014
29-Nov-2019	968.17	825.57	0	2.329464286	25.92553857	80.68543143	90.91214571	160.6213429
06-Dec-2019	974.34	822.72	0	2.317751429	21.34707286	88.29954	91.44482571	164.9916286
13-Dec-2019	999.78	836.55	0	2.313325714	29.89089429	77.47680571	90.83148571	165.31627
20-Dec-2019	1,018.63	854.37	0	2.379327143	27.31052143	72.32959286	85.47809	167.8517343
27-Dec-2019	1,049.14	878.86	0	2.315288571	18.52864429	82.15323429	86.91628714	170.62086
03-Jan-2020	1,069.06	897.53	3	2.272974286	14.30125143	78.37689571	98.64957571	155.7898414
10-Jan-2020	1,125.66	927.06	6	2.249377143	22.58941429	74.41012714	99.93653857	172.6865929
17-Jan-2020	1,170.76	964.95	57	2.208501429	36.90443143	81.43843143	98.67287857	177.04411
24-Jan-2020	1,161.34	965.31	864	2.367718571	36.98412714	83.95760857	86.37402286	182.9397871
14-Feb-2020	1,129.12	936.65	64506	2.064691429	15.55495	90.70048429	93.44975143	201.0435571
21-Feb-2020	1,123.51	920.05	76839	2.449864286	26.20357286	88.91478857	100.00452	207.0600557
28-Feb-2020	1,076.03	905.40	83625	2.555822857	31.71910857	80.51619857	90.80411143	210.9681271
06-Mar-2020	1,061.14	904.24	100367	2.6968	34.23905571	104.9001457	99.26144857	219.41159
13-Mar-2020	1,062.29	898.44	141062	2.961851429	27.47135857	106.3859671	96.61735857	205.0134486
20-Mar-2020	1,042.72	894.23	269903	3.131478571	23.30630571	96.90643143	93.28905571	168.7649129
27-Mar-2020	1,044.45	897.69	576195	3.023984286	16.80332429	76.38760857	86.86886143	162.8932714
03-Apr-2020	1,044.90	896.09	1052373	2.892581429	18.99127143	71.05527	77.91198429	166.4459843
10-Apr-2020	1,022.93	886.26	1595308	2.782177143	16.32001857	87.63225286	84.06455714	166.6510743
17-Apr-2020	1,022.66	884.19	2130122	2.675834286	21.54060857	70.54686	83.85437857	181.43793
24-Apr-2020	1,008.58	870.33	2671616	2.556784286	16.05545	91.45202	83.55443143	178.2984843
01-May-2020	986.29	851.10	3230073	2.532192857	18.75252	79.09786	99.21612857	163.5588943
08-May-2020	970.09	834.90	3815427	2.496184286	22.09032571	89.72982571	86.80179	156.3378957
15-May-2020	974.91	834.24	4414094	2.479421429	23.09194857	77.61528857	98.19662714	162.27377
22-May-2020	984.51	836.64	5097109	2.653064286	19.72825286	85.24894714	94.46337714	164.9568957
29-May-2020	1,002.95	839.27	5801769	2.700781429	21.91384143	67.62446857	107.2258429	157.1969657
05-Jun-2020	1,010.52	841.18	6632075	2.700962857	13.77344857	75.88752143	96.81961143	133.60745
12-Jun-2020	1,015.22	839.19	7511060	2.706451429	23.12696714	72.55955714	99.57091571	134.9830571
19-Jun-2020	1,020.07	842.60	8504283	2.69595	15.99950286	78.54698429	97.49237714	129.8848957
26-Jun-2020	1,032.61	841.83	9610449	2.655694286	21.08464429	66.82498571	94.83798429	152.7649843
03-Jul-2020	1,025.66	853.90	10897796	2.54207	31.69504	79.61495	99.28575286	158.4170914
10-Jul-2020	1,029.15	864.72	12307313	2.424295714	21.1132	77.76653857	98.06711	161.2230543
17-Jul-2020	1,026.61	862.11	13855661	2.380408571	23.84730714	77.70980429	95.04029	173.4801986
24-Jul-2020	1,037.86	870.83	15546079	2.384778571	25.76623571	88.56180714	98.28986	161.1693414
31-Jul-2020	1,027.60	865.53	17375477	2.299142857	24.33418143	89.68205429	96.60082286	162.1113043
07-Aug-2020	1,031.48	864.86	19228447	2.113181429	27.70069857	99.87650286	90.29619857	163.3245743
14-Aug-2020	1,038.74	880.53	21111414	2.090492857	25.65866429	90.61614571	93.9087	175.1389314
21-Aug-2020	1,034.93	885.46	22985567	2.081465714	22.60139714	88.78573571	103.8113243	185.9624829
28-Aug-2020	1,053.02	905.23	24836197	2.062601429	26.89073714	73.06725286	96.10032571	176.7282543
04-Sep-2020	1,056.90	922.00	26784905	1.962221429	27.40171857	73.22891286	87.36873571	175.9537871
11-Sep-2020	1,081.14	949.48	28735427	1.952465714	29.90866286	88.10280714	93.63016429	183.7237171
18-Sep-2020	1,108.91	985.44	31133575	1.976027143	30.05034286	90.97957429	105.0420714	184.67377
25-Sep-2020	1,117.66	1,007.44	32937279	1.986538571	27.08541286	81.66441286	108.2527886	176.9105557
02-Oct-2020	1,111.28	1,023.02	35069061	2.090068571	30.77784143	83.77782429	111.8700386	169.1676614
09-Oct-2020	1,137.85	1,050.32	37359251	2.061797143	32.53759143	84.76807286	115.9537357	222.5151643
16-Oct-2020	1,137.18	1,053.80	39891759	1.793785714	34.13187714	94.52657286	109.08686	200.4870757
23-Oct-2020	1,146.36	1,054.34	42859948	1.781912857	26.84882286	90.76737714	112.5689143	205.1026614
30-Oct-2020	1,163.81	1,074.19	46298644	1.786544286	32.26144857	73.69307429	110.1176814	194.81852
06-Nov-2020	1,192.76	1,110.70	50055291	1.76978	32.64605429	77.35868143	90.28325286	139.8911286
13-Nov-2020	1,212.82	1,107.28	53991261	1.781945714	37.22339714	88.57000286	98.63646714	178.8254643
20-Nov-2020	1,232.16	1,145.67	58075426	1.721817143	30.29078714	97.43416286	104.51068	185.2270914
27-Nov-2020	1,300.32	1,198.72	62189080	1.730141429	36.39977143	85.59195	101.3720014	180.10427
04-Dec-2020	1,510.85	1,323.83	66248394	1.670981429	32.82589571	90.78162571	97.68068143	200.7533429
11-Dec-2020	1,745.22	1,411.98	70617731	1.619927143	32.68159	87.98317857	102.3781257	181.9584486
18-Dec-2020	1,893.28	1,488.72	75116132	1.632341429	33.02801857	81.23628857	104.5993071	184.4923429
25-Dec-2020	2,137.27	1,577.20	79600342	1.705064286	33.43036143	108.4154843	103.5642171	200.0025386

01-Jan-2021	2,318.13	1,658.58	83703113	1.683384286	23.78639429	86.11045	110.1724857	212.6256443
08-Jan-2021	2,531.30	1,753.85	88308178	1.78653	34.36186	82.77319857	104.8929143	225.9875229
15-Jan-2021	2,867.73	1,863.84	93313766	1.892275714	33.08593286	85.58968143	101.0414671	240.5305557
22-Jan-2021	3,169.54	1,966.64	97746605	1.874418571	38.18521857	99.42577	107.9191443	200.6915557
29-Jan-2021	3,318.75	2,040.18	101641836	1.864752857	39.23968	92.98544857	105.0983771	188.9547714
05-Feb-2021	3,335.82	2,060.26	105008051	1.82503	34.01455429	96.11443143	90.29541286	185.1428957
12-Feb-2021	3,316.22	2,061.51	107850040	1.798847143	35.65909143	107.3703243	104.2554671	185.9949114
19-Feb-2021	3,371.04	2,071.71	110378045	1.850955714	35.47237714	99.11675286	112.9042157	212.9602186
26-Feb-2021	3,327.50	2,059.52	112974499	1.503374286	35.20045	101.7338057	109.3172886	219.1615743
05-Mar-2021	3,202.18	1,970.58	115669497	1.36252	32.08298286	103.4685029	117.4215029	205.2678243
12-Mar-2021	2,960.77	1,912.13	118546943	1.553784286	31.63821714	101.7806271	123.2101986	230.1126271
19-Mar-2021	2,964.14	1,908.09	121764333	1.612548571	31.67998429	106.4426986	127.2127871	217.8676271
26-Mar-2021	2,911.42	1,863.61	126045255	1.60987	36.86414571	106.22936	107.0608786	235.3939314
02-Apr-2021	2,953.88	1,871.78	129511248	1.744492857	28.16886143	85.34061	117.7161271	260.0189843
09-Apr-2021	2,975.54	1,858.01	133831990	1.797867143	26.34036	109.4848229	126.2849857	236.6237886
16-Apr-2021	2,944.09	1,853.53	138917638	1.811677143	29.38255571	81.42666286	110.9782343	204.8106629
23-Apr-2021	3,047.68	1,903.50	144550760	1.738428571	31.53348429	82.93611	113.3360029	215.78095
30-Apr-2021	3,196.86	1,991.16	150232614	1.660831429	31.74393143	96.55789429	102.6288957	254.7890914
07-May-2021	3,354.56	2,074.35	155756261	1.67217	28.03886	102.5746271	102.9076829	257.5726114
14-May-2021	3,462.84	2,134.37	160850616	1.683777143	36.51662857	112.88768	112.7980929	233.98195
21-May-2021	3,560.66	2,216.63	165222125	1.700842857	30.11521571	109.3700557	118.9195029	254.6073071
28-May-2021	3,739.50	2,296.36	168999703	1.86495	25.59223571	102.1111986	110.9133771	258.0604843
04-Jun-2021	3,835.78	2,373.77	172158980	2.086317143	30.85414571	123.5868043	99.31316429	279.4013586
11-Jun-2021	4,013.86	2,442.57	174843945	2.15649	29.78969714	127.85577	106.7966814	278.1944143
18-Jun-2021	4,187.33	2,526.65	177422647	2.198507143	29.57766143	115.7350557	116.9445386	293.4798957
25-Jun-2021	4,226.75	2,591.41	180017429	2.134987143	31.02187714	114.9157886	109.6850743	290.9904143
02-Jul-2021	4,392.57	2,653.32	182698066	2.003825714	24.44709286	111.3956814	117.3861457	254.97777
09-Jul-2021	4,432.43	2,698.83	185681043	1.94087	21.18893143	92.90673429	116.0156086	233.2588429
16-Jul-2021	4,702.86	2,771.54	189273543	1.839707143	27.49903857	89.32751857	125.2648229	215.9245914
23-Jul-2021	4,853.84	2,854.02	192940270	1.820682857	24.40544857	104.1994829	115.04318	209.3712343
30-Jul-2021	5,066.32	2,930.03	197031471	1.536937143	16.88893143	93.80439571	124.8256643	201.5007157
06-Aug-2021	5,230.11	3,006.82	201366692	1.929502857	22.53048286	104.7030929	123.4433771	191.5213414
13-Aug-2021	5,165.62	2,978.47	205852156	2.002775714	22.83360857	101.8796271	114.2266629	189.5253414
20-Aug-2021	5,439.44	3,047.32	210444113	2.119131429	24.97568143	95.33389571	121.8255029	185.3876286
27-Aug-2021	5,356.26	3,079.04	215008620	2.115871429	24.59277143	104.4752886	123.87511	216.72695
03-Sep-2021	5,305.97	3,097.58	219467630	2.099311429	21.65391429	94.02339714	107.5105929	250.3380029
10-Sep-2021	5,459.48	3,157.60	223511694	2.143228571	18.36844857	118.2561629	108.6737357	229.5662886
17-Sep-2021	5,364.25	3,156.86	227287689	1.912841429	25.42087714	106.3765014	103.3862157	217.1761271
24-Sep-2021	5,424.16	3,235.26	230909432	1.911568571	26.26896714	93.88202143	95.23698429	224.4637171
01-Oct-2021	5,393.79	3,220.55	234104749	2.06774	32.19498429	94.21236	112.29884	229.5790214
08-Oct-2021	5,539.71	3,271.70	237104487	2.145574286	28.75321571	99.05103857	116.8127171	205.4051643
15-Oct-2021	5,530.61	3,300.34	239996691	2.38362	24.19791429	111.6199829	110.0030386	235.6130729
22-Oct-2021	5,457.89	3,315.27	242954612	2.484251429	27.00198571	107.6629486	112.8590557	225.6671814
29-Oct-2021	5,362.27	3,277.71	246013599	2.630675714	25.92366286	99.70418	119.3881986	218.5193957
05-Nov-2021	5,426.49	3,284.93	249181644	2.450047143	31.78332286	95.97705571	115.2558429	220.5761643
12-Nov-2021	5,342.13	3,232.37	252570667	2.35045	34.39482429	92.86886	119.1964486	234.8875743
19-Nov-2021	5,292.40	3,245.59	256274922	2.284565714	27.18661143	82.39389571	139.5457157	211.4610229
26-Nov-2021	5,062.62	3,199.98	260357632	2.075475714	28.57566143	115.3144657	118.2175743	211.3240757
03-Dec-2021	5,121.53	3,199.03	264421841	2.025325714	25.04643143	112.0946814	125.7915557	191.01568
10-Dec-2021	5,161.89	3,238.35	268778579	1.996451429	33.44546714	104.2143943	113.5542	184.1406457
17-Dec-2021	5,055.51	3,245.22	273269922	1.996785714	31.75253857	123.2849486	119.3524843	201.9316086
24-Dec-2021	5,111.98	3,300.19	278660761	2.014848571	30.33571714	112.6450743	139.7163057	243.8742543
31-Dec-2021	5,114.92	3,344.24	287128677	1.917701429	24.24764571	105.4014657	130.9273786	274.2792343
07-Jan-2022	5,239.46	3,432.79	301463636	1.939981429	32.18784	102.5738414	131.88211	244.0439486
14-Jan-2022	5,451.97	3,489.94	321101111	1.919668571	33.55136	123.1824843	139.3933229	216.6940929
21-Jan-2022	5,636.83	3,555.24	343548446	1.892571429	27.47057429	121.8768771	153.3430929	248.3449314
28-Jan-2022	5,639.26	3,565.33	367225131	1.922021429	23.38514	116.0453929	146.2880186	276.3009043
11-Feb-2022	5,854.14	3,587.91	400934787	1.61722	23.07494	116.7001743	112.3318486	226.7573429
18-Feb-2022	5,720.19	3,500.19	419638045	1.499911429	22.44573714	114.8944857	117.02777	226.3147814
25-Feb-2022	5,589.16	3,425.58	431140769	1.6026	27.65878714	101.4929471	114.1254814	219.0473143
04-Mar-2022	5,528.50	3,388.59	441472462	1.818467143	24.75689429	99.65530571	120.5140286	268.9934129