

The Effects of the COVID-19 Pandemic on Exports and Imports Values from China: Evidence from Time Series Model

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Abstract. The COVID-19 pandemic, which began in late 2019, caused significant disruptions in global economy, affecting commercial operations globally. China, a key factor in global commerce, encountered substantial obstacles due to disruptions in supply chains, a sharp decline in demand, and the implementation of containment measures. Using time series analytic methodologies such as the Autoregressive Moving Average (ARMA) models, this study presents an exhaustive analysis of the influence that the COVID-19 pandemic has had on the values of China's imports and exports. This research sheds light on the subtle dynamics of China's commercial environment in the middle of the pandemic by conducting a comprehensive examination of data spanning from January 1, 2010, to December 1, 2023. This paper highlights China's import and export volumes were significantly impacted by the COVID-19 pandemic, especially noticeable during the early phase of the crisis. The decrease in import quantities in April and May 2020 highlights the many economic impacts of the epidemic on business, highlighting the pivotal role of supply chains in facilitating economic recovery. Policymakers must prioritize supply network resilience and implement targeted policies like employment subsidies and job training to mitigate the unemployment effects of pandemic-induced economic downturns and reduced import volumes, promoting economic recovery and stability after crises.

Keywords: Covid-19; Import; Export.

1. Introduction

Due to the fact that the COVID-19 epidemic occurred, countries worldwide have seen significant economic disruptions, which has fundamentally altered the structure of international trade. During the time when countries were dealing with the health crisis and enacting stringent measures to prevent the virus from spreading, there was a major reduction in the transit of goods and services. There were some of the most severe drops in output and trade that occurred in the year 2020 since World War II. During the Great Financial Crisis, the year 2020 had a wider variety of trade repercussions across the main product categories than any other year in the preceding 20 years, and this was true even more so than during the Great Depression [1]. A crisis was commonly recognized as having occurred during the COVID outbreak as a result of short-term supply delays and shortages that were caused by the interruption of international commerce [2].

As the largest exporter and primary importer in the world, China was at the center of this global financial crisis that was brought on by the COVID-19 pandemic outbreak in the year 2020. This pandemic had a substantial influence on the general trends of worldwide trade. The manufacturing sector in China produced an estimated 26.9 trillion dollars in value in 2019, representing 28.1% of the total value produced globally. [3].

Scholars researched the effects of the epidemic on the Chinese economy. McKibbin and Fernando have presented their findings from their research with regard to the balance between the containment of the pandemic and the performance of the economy, as well as the significant influence that transmission uncertainties have on the economic activity. The scenarios presented in the research provide evidence that even a confined epidemic has the potential to have a large effect on the economy of the whole world in a short time [4]. Furthermore, domestic consumption decreased substantially during the outbreak period. Additional heterogeneity analysis reveals that urban households experience a reduction in consumption due to the pandemic, while rural households are comparatively less impacted. [5]. This has also affected the savings strategies of Chinese families. Households facing

increasingly severe effects of the epidemic are showing a notable trend towards prioritizing long-term savings above short-term savings or immediate savings [6]. All sectors' output for the transportation economy decreases further as the pandemic intensifies. The transportation sector experiences the most substantial decline in output (10.17%), with the railway sector following closely behind (1.76%) and the aviation sector falling at 1.53%. [7]. The economic impact of the COVID-19 epidemic extends to the oil market. There was a decline in the global price of crude oil. The precipitous decline in petroleum oil prices negatively affects the low-carbon economy in a substantial way. [8]. However, the pandemic has significantly impacted the growth of e-commerce. In the immediate term, digital technology enabled the implementation of the pandemic response strategy. China's digital economy is progressing in the direction of sustained expansion. [9]. The digital economy of China has contributed to the country's sustainable social and economic development by driving fast economic expansion, enhancing living standards, optimizing resource consumption, and reinforcing environmental conservation efforts [10].

The purpose of this article is to explore the link between the pandemic and China's trade dynamics in more depth by using time series analytic approaches, more especially Autoregressive Moving Average (ARMA) models. Providing responses to the following questions: Under what circumstances has the COVID-19 epidemic impacted the values of imports and exports in China throughout the course of time? While the epidemic was going on, what were the primary factors that caused the swings in the values of imports and exports that were observed?

This research will conduct Augmented Dickey–Fuller (ADF) Unit Root Test on the acquired data, followed by setting up the ARIMA model. Through model selection, this paper will establish a suitable ARIMA model to capture the trends and seasonal variations in the data. Ultimately, this paper will utilize the selected model for forecasting and provide explanations and analyses of the forecasted results, shedding light on the impact of the COVID-19 pandemic on China's manufacturing sector. This research endeavors to furnish policymakers, businesses, and academics with valuable insights concerning the complexities presented by the pandemic, as well as to direct forthcoming response strategies. What are the contributions that ARMA and VAR models provide to the understanding of the dynamics of commerce in the middle of the COVID-19 pandemic? This research aims to make use of these analytical frameworks in order to give in-depth insights on the immediate and long-term impacts that the pandemic made on the values of imports and exports, therefore shedding light on the fundamental factors that are responsible for these patterns.

2. Research Design

2.1. Data resource

The research used dataset from the National Bureau of Statistics of China, spanning from January 1, 2010, to December 1, 2023. This website has the primary source for accurate statistical data on several areas of China's economy, such as manufacturing sector indicators, import and export values, and other related variables. The chosen time period includes pre-pandemic, epidemic, and post-pandemic phases, facilitating a comprehensive study on the impacts of the COVID-19 pandemic on the industrial sector of China. By using this official data source, this step guarantees the integrity and quality of the material in our analysis, thereby boosting the credibility and dependability of our study results.

2.2. ADF (Augmented Dickey–Fuller) Unit Root Test

Assessing the stationarity of the data is the first step before proceeding further. This section evaluates the stationarity of the export and import data series through an examination of the ADF (Augmented Dickey–Fuller) unit root test outcomes presented in Table 1. The ADF test statistic for the natural logarithm (Ln) value in the export data series is -6.393, with a p-value of 0.0000. This provides substantial evidence that refutes the null hypothesis of a unit root, showing that the series is stable. After calculating the first-order difference, the ADF test statistic rose to -11.158 with a p-value

of 0.0000, confirming the stationary nature of the series. The ADF test statistic for the Ln value of the import data series is -5.115 by a small p-value, 0.0001, which results in the null hypothesis of a unit root being rejected and showing stationarity. After taking the first difference of the import series, the ADF test statistic significantly rises to -14.520 with a p-value of 0.0000, providing more evidence of the series' stationarity. The findings show that both the export and import data series become stable following the required changes, meeting a crucial condition for time series analysis and model estimation.

Table 1 Weak stationarity test

	t	p
Export		
Ln value	-6.393	0.0000
1st order difference	-11.158	0.0000
Import		
Ln value	-5.115	0.0001
1st order difference	-14.520	0.0000

2.3. ARMA Model

The general expression of the ARMA model is displayed in equation (1). The AR(p) component is given by the formula $\partial_0 + \sum_{i=1}^p \partial_i y_{t-i}$, whereas the remaining part of the equation is MA(q). AR(p) model uses historical data from January 2010 to December 2023 to predict future export and import levels, whereas MA(q) model makes predictions based on an error term.

$$y_t = \partial_0 + \sum_{i=1}^p \partial_i y_{t-i} + e_t + \sum_{i=1}^q \phi_i e_{t-i} \quad (1)$$

3. Empirical Findings and Analysis

3.1. Order Choosing of ARMA model

According to Figure 1, for Export, the first value beyond the critical values is 11 in both PACF and ACF plots of Export, indicating that the order of AR(p) is 11, with the values of p equal to 11. And there is a significant spike in lag 1 in PACF and ACF, but non beyond lag 1, therefore q equals 1.

Similarly, for Import, both the PACF and ACF plots of Import show a first portion beyond the crucial values of 11, indicating that the AR(p) have an order of 11, with the values of p equal to 11. And there is a significant spike in lag 5 in PACF and ACF, but non beyond lag 5, therefore q equals 5.

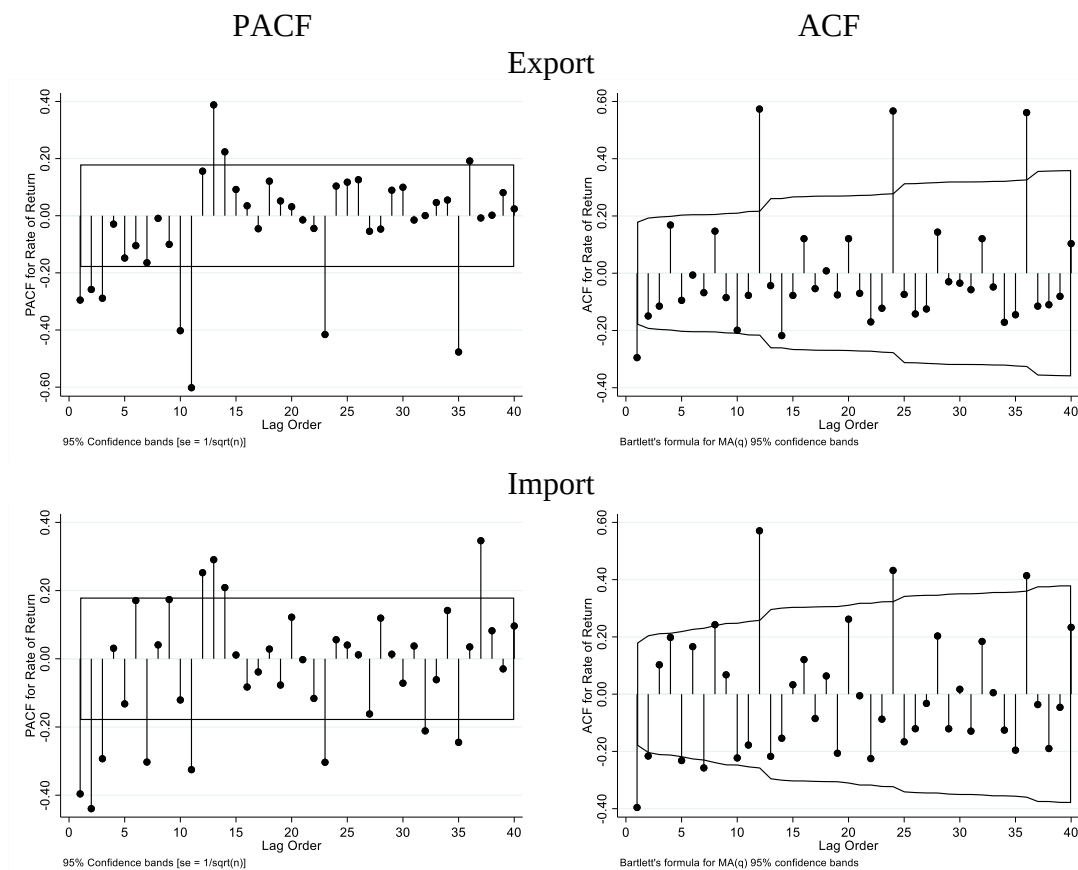


Figure 1 ARMA (p, q) identification

Photo credit: Original

3.2. Projected results and interpretation

3.2.1 Result of ARMA model

The results in Table 2 provide insights into the adequacy of the ARIMA models used for analyzing export and import data in our study with respect to the economic repercussions of the COVID-19 pandemic in China. The ARIMA (11,1,1) model for the export data series shows a significant Portmanteau (Q) statistic of 158.6886, with a p-value of 0.0000. The findings provide strong evidence against the null hypothesis, indicating the existence of autocorrelation in the residuals. This autocorrelation suggests that the model may not accurately include all the time-related patterns present in the export data set, perhaps because of the intricate and diverse impacts caused by the epidemic on China's export operations.

The ARIMA (11,1,5) model for the import data series has a Portmanteau (Q) statistic of 79.0769 and a p-value of 0.0002. The results additionally present significant evidence that refutes the null hypothesis that the residuals lack autocorrelation. Our study indicates that the ARIMA model may not fully capture the complex temporal relationships present in the import data series due to the diverse effects of the pandemic on China's import activities in various sectors and with different trading partners.

Table 2 Residual test

Model	Portmanteau (Q) statistic	Prob > chi2
Export-ARIMA(11,1,1)	158.6886	0.0000
Import-ARIMA(11,1,5)	79.0769	0.0002

3.3.2 Graph Analyse

Based on the analysis of both actual data and forecasted data presented in the combined curve chart of both import and export value (Figure 2, 3, 4, 5 and 6) , Based on the data presented by the National Bureau of Statistics of China, it is apparent that the import and export volumes experienced a substantial decrease during the pandemic of COVID-19 that broke out in January and February of 2020. The estimated decline in export volume is 33.87%, while the corresponding decline in import volume is -34.54%.

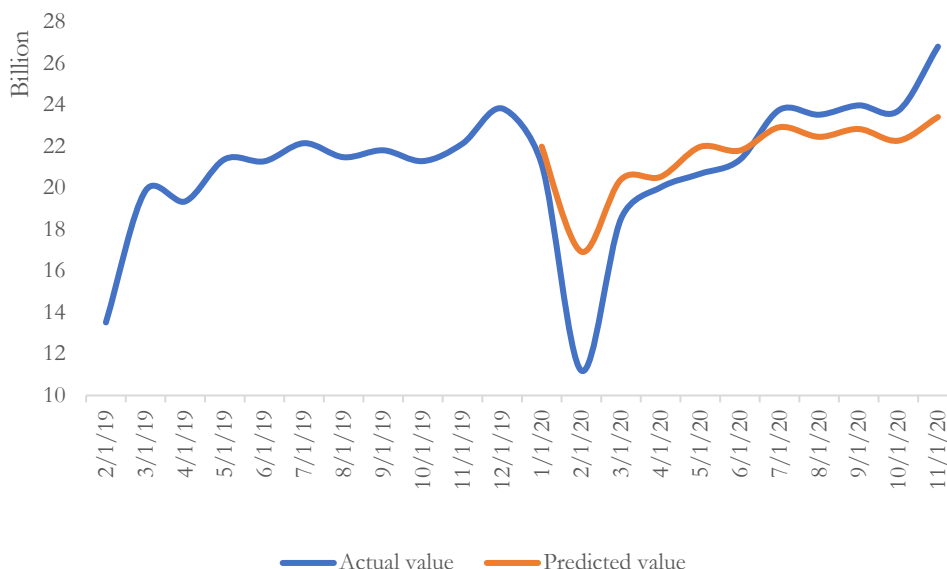


Figure 2 Actual value and predicted value, export

Photo credit: Original

This substantial decrease underscores the significant repercussions of the pandemic on imports and exports, as global economic activities were severely disrupted. However, an interesting observation emerges in March 2020, where export volumes rebounded to normal levels.

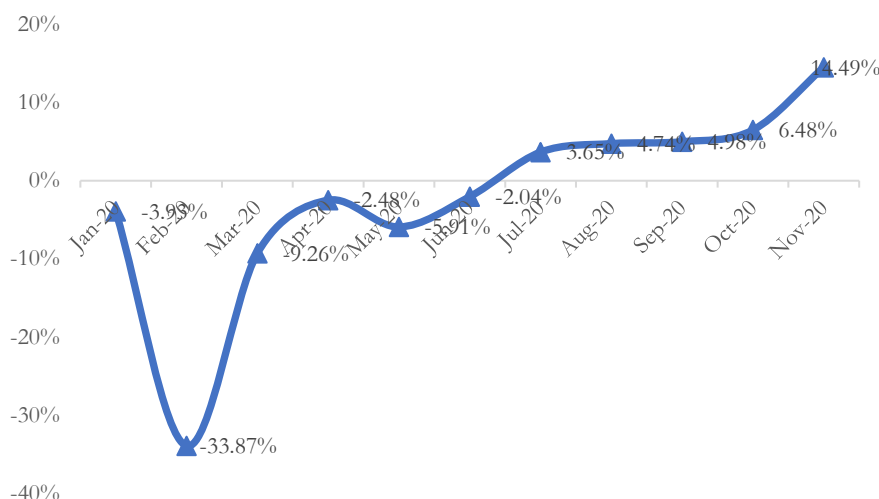


Figure 3 Difference (%), export

Photo credit: Original

Our forecast analysis is surprisingly broadly consistent with this trend, predicting a slight decline in export and import volumes in January and February 2020, followed by a return to normal levels in March. This raises the question: why is there this pattern of declining and then recovering export volumes even in the absence of an outbreak? One possible reason for this phenomenon is that factories

and related air and sea transportation are closed before the Chinese New Year holiday. After a period of time, factories and reopen, production activities resume, and businesses gradually resume operations. In addition, with the implementation of containment measures and security protocols, the transportation and logistics network gradually resumes operations after the closure, contributing to the resumption of export volume and import volume.

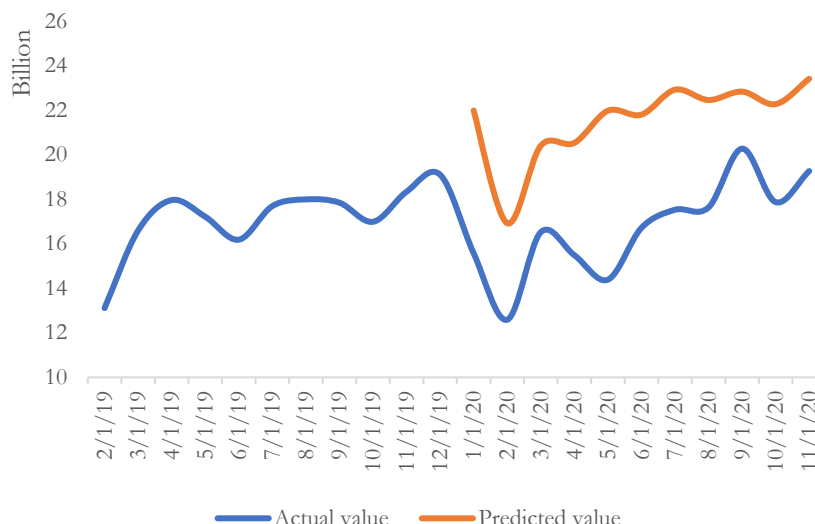


Figure 4 Actual value and predicted value, import

Photo credit: Original

This interpretation is consistent with prior research indicating How Chinese Lunar New Year Will Affect Imports and Exports [11]. Another interesting phenomenon is that for import. There is a minor decrease in the amount of imports during the months of April and May of 2020, as shown by the observation from the graphical depiction. It is possible that this reduction might be due to the economic implications that the COVID-19 pandemic has had, namely the increase in unemployment rates that has been caused by lockdown measures and the slowing in economic activity. During the time when firms were struggling to deal with decreased customer demand and supply chain disruptions, there may have been a comparable fall in the amount of import activities done. According to Kawohl and Nordt's research from 2020, the COVID-19 pandemic caused extensive employment losses across a variety of industries, which subsequently resulted in a decrease in consumer spending and overall economic activity [12].

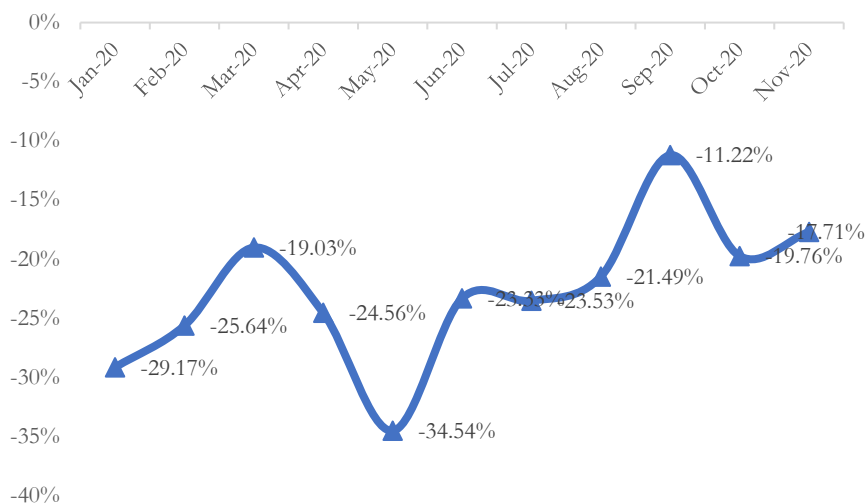


Figure 5 Difference (%), import

Photo credit: Original

In light of the fact that domestic demand has been declining and the level of uncertainty surrounding the future economic prospects has increased, it is possible that enterprises have reduced their operations related to imports. There is a possibility that the installation of containment measures and travel restrictions further hampered the processes of importation, which contributed to the reported decrease in import quantities during this time period. And this is consistent with the direction of the data in Figure 5 (China's 2020 unemployment rate)

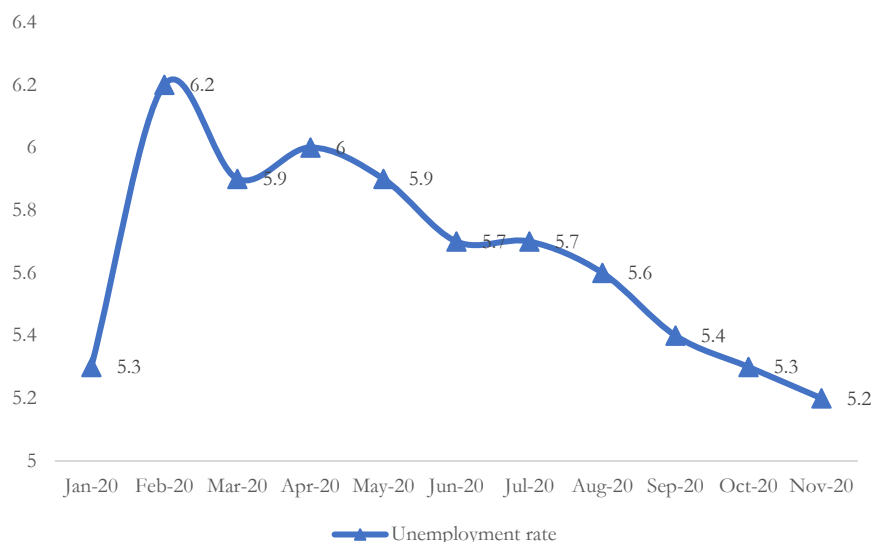


Figure 6 Rate of unemployment in China from Jan 2020 to Nov, 2020

Photo credit: Original

4. Discussion

The study of the data makes it abundantly clear that despite the fact that COVID-19 pandemic-related effects on both the operations of import and export commerce were substantial, the trade volumes returned to normal levels in a very short amount of time. Based on this study, it seems that China's commerce sector has a remarkable capacity for resilience and flexibility in the face of external shocks, such as pandemics and the containment efforts that are connected with them. Although some global supply networks faced challenges at the beginning of the pandemic, research indicates that supply chains played a crucial role in restarting economic operations [1]. International commerce will experience growth despite the COVID-19 pandemic, further facilitated by technological adaptation and big data technologies. [13].

5. Conclusion

This paper conducted a thorough examination of data collected from January 1, 2010, to December 1, 2023, sourced from the National Bureau of Statistics of China. Our analysis revealed a substantial impact of the pandemic on import and export quantities, showing notable variations particularly during the initial phases of the pandemic. The decrease in import volumes in April and May 2020 was due to economic factors such as rising unemployment and supply chain disruptions, highlighting the many effects of the epidemic on commerce. The research underlines the crucial significance of supply chains in aiding economic recovery and underscores the possibility of technological adaption and big data technologies to enhance international commerce, especially during the pandemic.

This study enhances comprehension of the intricacies present in China's trade dynamics amidst the COVID-19 epidemic, providing insightful observations for addressing future problems and uncertainties in the global trade environment. In conjunction with the synthesis, policymakers should focus on improving the resilience of supply networks, especially in vital sectors, to reduce the effects

of future disruptions. Measures to bolster economic recovery should be put into effect, concentrating on tackling unemployment and boosting consumer demand. Policymakers should consider implementing targeted policies like Employment Subsidies, Job Training, and Reskilling Programs to address the unemployment implications caused by the pandemic-induced economic slump and lower import volumes. This research lacks a detailed investigation of other variables that might impact import and export volumes, such as variations in exchange rates and changes in trade policy. The data's limited time period may not completely include long-term economic trends and volatility. Future study might explore other crucial topics. The effect of digital technology and e-commerce on global trade during the pandemic. Furthermore, the commercial links between China and its primary trading allies.

References

- [1] Arriola C, Kowalski P, van Tongeren F. The impact of COVID-19 on directions and structure of international trade. 2021. OECD Trade Policy Papers, No. 252, OECD Publishing, Paris,
- [2] Goldberg P K, Reed T. Growing Threats to Global Trade. 2023.
- [3] Song Y, Hao X, Hu Y, et al. The Impact of the COVID-19 pandemic on China's manufacturing sector: a global value chain perspective. *Frontiers in public health*, 2021, 9: 683821.
- [4] McKibbin W, Fernando R. The global economic impacts of the COVID-19 pandemic. *Economic Modelling*, 2023, 129: 106551.
- [5] Liu T, Pan B, Yin Z. Pandemic, mobile payment, and household consumption: Micro-evidence from China. *Emerging Markets Finance and Trade*, 2020, 56(10): 2378-2389.
- [6] Peng C, Xiao J, Qiu W, et al. The impact of the COVID-19 pandemic on household savings plan and the underlying driving forces: evidence from China. *Applied Economics*, 2024: 1-21.
- [7] Zhang Q, Tong Q. The economic impacts of traffic consumption during the COVID-19 pandemic in China: A CGE analysis. *Transport policy*, 2021, 114: 330-337.
- [8] Jia Z, Wen S, Lin B. The effects and reacts of COVID-19 pandemic and international oil price on energy, economy, and environment in China. *Applied Energy*, 2021, 302: 117612.
- [9] Jiang X. Digital economy in the post-pandemic era. *Journal of Chinese Economic and Business Studies*, 2020, 18(4): 333-339.
- [10] Song M, Zheng C, Wang J. The role of digital economy in China's sustainable development in a post-pandemic environment. *Journal of Enterprise Information Management*, 2022, 35(1): 58-77.
- [11] David Rae. How Chinese Lunar New Year Will Affect Imports and Exports [EB/OL]. (2023-01-10). [2024-02-23]. <https://baxterfreight.com/how-chinese-lunar-new-year-will-affect-imports-and-exports/>
- [12] Kawohl W, Nordt C. COVID-19, unemployment, and suicide [EB/OL]. (2020-05). [2024-02-23]. <https://pubmed.ncbi.nlm.nih.gov/32353269/>
- [13] Zhao S. Impact of COVID 19 Pandemic and Big Data on China's International Trade: Challenges and Countermeasures. *Frontiers in public health*, 2022, 10: 888335.