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# Research on the Influence of COVID-19 on the Fluctuation of China Household Electrical Appliances' Index in the Context of Economic Globalization

Yang Jing-Xu <sup>a\*</sup>

<sup>a</sup> Zhejiang Wan Li University, Ningbo, China.

## Author's contribution

*The sole author designed, analyzed, interpreted and prepared the manuscript.*

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## ABSTRACT

In order to deal effectively with the impact of the COVID-19 on China's domestic appliance industry in the context of economic globalization, by analyzing the upstream copper futures index (CFI) and the downstream household appliance Futures Price Index (HAFPI) from January, 2020 to October 2021, the degree of response to the COVID-19, to consider how to steadily promote the high quality development of China's domestic appliance industry. A new COVID-19 public opinion index (POI) was constructed, which was used as the proxy variable of the COVID-19 situation, and the VAR model was established based on the CFI and HAFPI. These COVID-19 in the home appliances industry chain at different points in the product price refers to the large fluctuations, each link price fluctuations are different. The price fluctuation of the upstream raw material link is the biggest, and the price index of the downstream consumption environment fluctuates little. The general impact of COVID-19 on the production link of China's household appliances industry is great, but the impact on the consumption link is not obvious, mainly because the production enterprises bear the increase of the upstream raw material cost, which leads to the decrease of their profits. In view of the problems existing in each link of household electrical appliances industry chain under the epidemic situation, this paper puts forward some suggestions on strengthening the prevention and control of epidemic disease, industry support, Futures lock-in of raw material prices and the construction of Logistics System.

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\*Corresponding author: E-mail: yjfirst@163.com;

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## 1. INTRODUCTION

In December 2019, a case of viral pneumonia was found in Wuhan, Hubei Province, China, and on January 7, 2020, initial progress was made in the etiological identification of the viral pneumonia epidemic situation [1]. On January 10, 2020, the detection of pathogenic nucleic acid was completed, and COVID-19 was declared a pandemic by the World Health Organization (WHO) on March 11, 2020, which caused the epidemic of pneumonia in Wuhan [2].

Since then, COVID-19 has been wreaking havoc globally. The national economies of all countries were severely damaged [3]. In particular, the emergence of a new variant strain of COVID-19 caused severe turbulence in many industries around the world [4]. At present, affected by the international supply of raw materials, China's household appliances industry is facing a severe challenge. To study how COVID-19 affects the price level fluctuation and the price response difference in each link of China's household electrical appliances industry chain to ensure the actual level of consumption and reduce the impact of COVID-19 on China's national economy, accelerating economic recovery is of great significance for the prevention and control of the epidemic.

Although there are different methods to study the impact mechanism of unexpected events on the market, they do not reach the scientific quantification of unexpected events. As such, they ignore the different impacts of unexpected events on the market at different time points and different degrees. To solve this problem, domestic scholars established the Avian Influenza Public Opinion Index, and used the *ms-var* model to analyze the market situation of the broiler industry at different time points considering the background of avian influenza [5]. Over the past 2 years, scholars have focused on the identification of COVID-19, clinical features, and vaccine research [6-8]. Severe challenges were posed by the pneumonia outbreak on China's economic development, such as the downturn in economic expectations, financial market turmoil, and the impact of the real economy [9]. However, limited empirical research has been undertaken on the impact of pneumonia on an economic fluctuation. The methods of scientific quantitative research on emergencies mainly focus on other industries,

such as clothing, furniture, and animal husbandry, but less on the household appliance industry. Therefore, based on the research ideas of the above scholars, this paper uses Baidu's search engine to construct the public opinion index (POI) of COVID-19, and uses it as an independent variable. In this paper, the influence of pneumonia on different production links of the home appliance industry chain was discussed by constructing a vector autoregressive model. It is expected that it will provide a scientific basis for the government's policy choice on the promotion of high-quality development of China's home appliance industry under the background of pneumonia.

## 2. DATA SOURCE AND MODEL CONSTRUCTION

### 2.1 Construction and Acquisition of POI

The COVID-19 POI is a quantitative time-series index based on Internet big data, which can comprehensively reflect the prevalence of COVID-19 [10]. With the help of the Baidu index platform, the data was captured and statistically analyzed using the mouse on the trend curve based on the search volume of "Novel coronavirus pneumonia" [11]. For the study, the monthly data are logarithms at the base of 10. Fig. 1 shows the trend in the POI for pneumonia prevalence. As observed in Fig. 1, four peak searches have occurred for COVID-19 in the past 2 years; the first in February 2020, when the WHO declared the coronavirus disease as a public health emergency of international concern, the second in June 2020, after the International Workers' Day, the third in January 2021, before the traditional Chinese holiday of spring, and the fourth in August 2021. These are the peaks for the 2020–2021 outbreak of the coronavirus disease in China.

### 2.2 Household Appliance Futures Price Index (HAFPI) and Copper Futures Index (CFI) of Upstream Raw Material

According to the characteristics of the household appliance industry, the futures price of copper in the upstream link and the price index of household appliances in the downstream link are selected as the basis for the purchase and processing of the market price of the household appliance industry. Logarithmic processing of

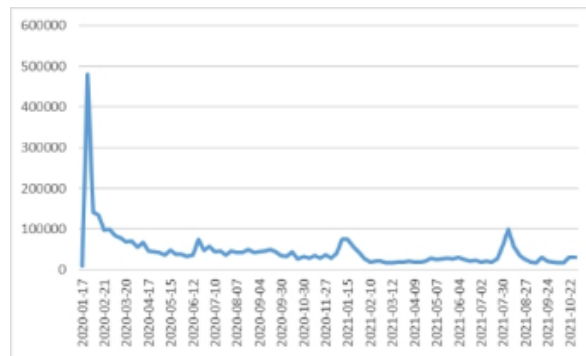


Fig. 1. Public opinion index of the pneumonia epidemic

these two provides the data interval as January 2020 to October 2021. The above data are from the China Futures Network.

**2.3 Model Construction**

As the change of the logarithm of the data does not change the original cointegration relation, can eliminate the heteroscedasticity in the time-series, and reduce the fluctuation of the data, the original data is processed using logarithms. The growth rate is calculated by making first-order differences in the data. Each variable is recorded

as the new coronavirus pneumonia epidemic POI, upstream CFI, and downstream HAFPI. A VAR model was established to study the impact of COVID-19 on the price fluctuation of the household appliance industry in China. All the operations of the model were implemented under E10.0.

**2.4 Empirical Test**

**A. Unit Root Test:** To judge the stationarity of the data, a unit root test was performed on the time-series, and the results are shown in Table 1.

Table 1. Unit root test

Variable	Test type	ADF statistics	Critical value	Conclusion
Lnpoi	(c,t,0)	-7.524335	-3.459397	stable
DLncfi	(0,0,0)	-6.210619	-1.944404	stable
DLnhafpi	(c,0,0)	-8.238998	-2.893589	stable

**B. Johansen Cointegration Test:** In this paper, Johansen’s test is used as a cointegration test. The results show that the first-order difference in time-series reject the null hypothesis and have four cointegration relationships. The results are shown in Table 2.

Table 2. Johansen cointegration test

NO. of CE (s)	Hypothesized	Trace	0.05	
	Eigenvalue	Statistic	Critical Value	Prob**
None *	0.484223	124.9222	29.79707	0.0000
At most 1 *	0.376889	64.67283	15.49471	0.0000
At most 2 *	0.211529	21.62699	3.841466	0.0000

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level

**C. Granger Causality:** The Granger Causality test was performed in the paper and the results are shown in Table3, which shows that robability is less than 0.05 and there is a causal relationship.

Table 3. Granger causality test

Granger Causality Test Null Hypothesis:	Obs	F-Statistic	Prob.
DLNHAFPI does not Granger Cause DLNCFI	91	4.17497	0.0440
DLNCFI does not Granger Cause DLNHAFPI		0.05197	0.8202
LNPOI does not Granger Cause DLNCFI	91	7.40517	0.0078
DLNCFI does not Granger Cause LNPOI		0.76813	0.3832
LNPOI does not Granger Cause DLNHAFPI	91	0.01767	0.8945
DLNHAFPI does not Granger Cause LNPOI		0.14167	0.7075

**D. Determination of Lag Order:** Through the above analysis, the VAR model can be established. The optimal lag order is determined according to AIC criterion and SC criterion. According to the minimization principle of information criterion, the parameter values of different lag orders are compared. The results are shown in Table 4. The optimal lag order is the first order.

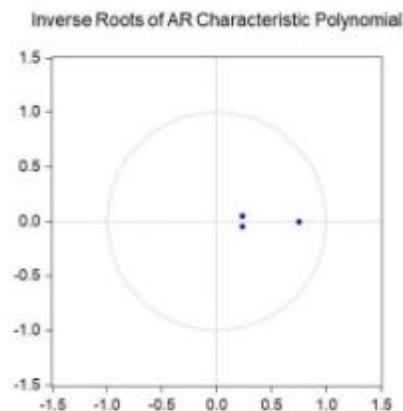
**Table 4. Lag order selection table**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	350.2146	NA	6.86e-08	-7.981946	-7.896914	-7.947706
1	413.3334	120.4335*	1.98e-08*	-9.22605*	-8.88593*	-9.08909*
2	416.4616	5.752991	2.26e-08	-9.091071	-8.495852	-8.851394
3	421.2639	8.500631	2.50e-08	-8.994572	-8.144259	-8.652177
4	424.3282	5.212895	2.87e-08	-8.858120	-7.752713	-8.413007
5	430.6783	10.36445	3.07e-08	-8.797202	-7.436701	-8.249370

\* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

**E. Estimation of the VAR Model:** The risk model was established using evIEWS10.0 software and the fifth-order lag interval was selected. The result is shown in Fig. 2, where all unit roots are in the unit circle.



**Fig. 2. Inverse root of characteristic polynomial of VAR model**

**F. Impulse Response Analysis:** On this basis, the 20-period impulse response function is established, and the result is shown in Fig. 3. CFI is in the prophase to the first phase of the positive influence of the unit standard deviation on the epidemic consensus index from the response to the COVID-19 POI. In the third stage, the reaction was negative and the reaction degree was -0.0029. After phase 17, the response level is close to zero. This suggests that the outbreak of pneumonia triggered a short-term change in the price of copper that is an upstream component of the industrial chain, but that has waned as the epidemic is under control. According to the Hafpi response to POI, from Phase I to Phase II, CFI has a negative impact on the epidemic. The third stage of the response was the most positive, which was 0.002. After

phase 13, the reaction level is near zero, which is mostly a symptom of pneumonia.

Considering the response of the wholesale price to the POI, the wholesale price is the first period after the unit standard deviation has a positive effect on the POI. This mainly shows that when compared with the upstream household appliances, the impact of the pneumonia epidemic on the lower consumption link of household appliances prices is the greatest. This can also be explained from another aspect: home appliance consumption cycle is long, upstream price adjustment cycle is long, downstream price adjustment is fast. In other words, the short-term emergency has a greater impact on the downstream consumption of household appliances, but a smaller impact on

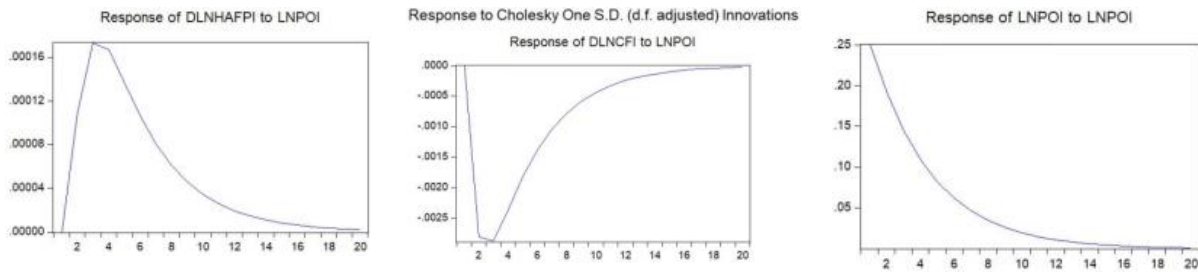


Fig. 3. Results of impulse response function

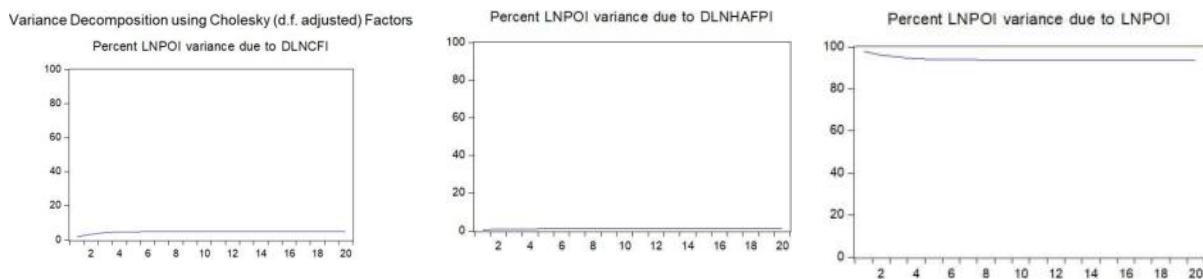


Fig. 4. ANOVA results

the upstream raw materials. However, if the emergency lasts for a long time, it will have a greater impact on the upstream raw and processed materials sector, mainly taking into account the impact of the international exchange rate, especially the US financial policy, on the upstream raw and processed materials sector, indirectly leading to the home appliance downstream consumption link of the price index.

**G. Variance analysis:** As can be observed from Fig. 4, from Phase I to V, the price fluctuation of the upstream segment of the household appliance increased slightly, while the contribution rate of phase V stabilized at 5.02 per cent. The contribution rate of the POI to the fluctuation of the HAFPI in the downstream consumption link of household appliances shows that the contribution rate of the fluctuation of the HAFPI in the downstream consumption link of household appliances shows an upward trend from the first to the fourth period, and phase V's contribution rate was 1.1%. From the 7 to the 13 period, the contribution rate of the epidemic POI to the hafpi is stable at approximately 1.12%. However, after the 13th to 20th period, the contribution rate of the fluctuation of the HAFPI in the upstream consumption link of home appliances shows an upward trend. Combining this with the previous impulse response function, it can be observed that the epidemic of pneumonia will affect the household electric appliance industry in the short-term, but the

overall impact is not big and the epidemic of pneumonia will affect the household electric appliance industry in the long-term.

### 3. RESULTS AND DISCUSSION

The prevalence of pneumonia in the POI is lower than that of downstream consumers. After the fourth stage, the contribution rate of the POI remained stable at 5%. This mainly indicates that the outbreak of pneumonia has a certain impact on upstream raw materials. Production stoppage, blockade, and other preventive measures caused raw material copper mining, transportation restrictions, and other issues. On the other hand, the relative adequacy of copper raw material stocks and the temporary storage of copper played an important role in effectively counteracting the effects of the pneumonia epidemic. The results of variance analysis show that the POI of the pneumonia epidemic showed a stable contribution rate after the fifth stage. The contribution rate was 1.1%. As a result, the effects of the current pneumonia epidemic have created problems in the processing, circulation, and transportation of goods, particularly in the production of household appliances and in the prevention of epidemics in the transport of goods in circulation. The pneumonia epidemic POI has the biggest response to the average CFI in the lower consumption link, which indicates that the outbreak of pneumonia has the biggest and the most lasting influence on the lower consumption

link of household appliances. The eighth stage downstream consumption presents the stable contribution rate of 1.2%. The main reasons for this were the closing of workshops, the closing of shops, difficulties in sales, and the reduction of household electrical appliances consumption during the epidemic. Therefore, in the context of the epidemic of pneumonia, the government should focus on the downstream consumption chain. Overall, the outbreak has a limited short-term impact on China's home appliance industry, which shows that China, as the world's second-largest economy, has great flexibility and adaptability in the face of the impact of the epidemic. China's economy can return to normal operation in a short time. However, due to the rise of raw material prices, this epidemic will have a greater impact on the costs of Chinese household appliance manufacturers, but the impact on the downstream consumption link is not obvious, and the epidemic will not change the fundamentals of China's economy.

In order to better promote the rapid recovery of the Chinese economy, the following recommendations are given:

Upstream production links, focus on strengthening copper raw material reserves, timely responses by the state helps the market to curb the adverse impact of emergencies on the market. According to the above research, it can be observed that unexpected events will have a certain impact on the economy. The U.S. trade war with China in 2018 resulted in a sharp decline in China's copper inventories and imports over the past 2 years. The supply elasticity of copper has increased significantly, the market is in short supply, and the price remains high. This has created huge problems for both consumers and producers.

Second, China's government should focus on strengthening industrial support policies. The government should adopt the policy of reducing import tariffs to realize the recovery of the production capacity of household appliances.

Third, paying attention to strengthening industrial restructuring, accelerating the transformation, and upgrading the household electrical appliances industry should be the focus.

Fourth, through scientific research methods, logistics distribution routes should be optimized and modern distribution equipment should be used, which will ensure the efficient circulation of

products through the opening of the green channel of product transportation to achieve timely distribution of products, and improve circulation and transportation efficiency. In particular, the advantages of direct selling on the Internet should be strengthened and the decrease of profit margin caused by the increase of the cost of raw materials should be reduced.

Fifth, the focus should be on strengthening the supervision of the price market. Price controls will be controlled, which will give full play to the role of state-owned material reserves, stabilize copper prices for raw materials, and safeguard the interests of producers and consumers. The most important aspect is to strengthen the prevention and control of pneumonia. All government departments should strengthen the prevention and control of the epidemic, effectively control the domestic epidemic situation, and strictly prohibit the import of the epidemic situation, "prevention of internal bounce back, prevention of external imports." If the epidemic can be effectively controlled in the long term, the recovery of household consumption, social productive capacity, and the return of long-term macro-economic growth can be achieved.

#### **4. CONCLUSION**

The most important aspect is to strengthen the prevention and control of pneumonia. All government departments should strengthen the prevention and control of the epidemic, effectively control the domestic epidemic situation, and strictly prohibit the import of the epidemic situation, "prevention of internal bounce back, prevention of external imports." If the epidemic can be effectively controlled in the long term, the recovery of household consumption, social productive capacity, and the return of long-term macro-economic growth can be achieved.

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#### **COMPETING INTERESTS**

Author has declared that no competing interests exist.

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