

# The Time-varying Impact of Covid-19 pandemic on Consumption: Evidence from China

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**Abstract.** The pandemic, COVID-19 has dropped chaos in the world and is still ongoing around the globe. The economy is one of the areas that is influenced by the epidemic, and there have been various research related to what impact of COVID-19 pandemic has been put on, such as, food consumption, electricity consumption, and consumption behavior. This paper aims to focus on the effect of the pandemic on Chinese consumption. By collecting the data from the CSMAR and applying multiple models to analyze them, it can be concluded that the COVID-19 has both positive and negative influence on the Chinese consumption, and the time the effect lasts varies dependent on the global and domestic pandemic situation. The reason could be that export commodities are affected by the epidemic. The Chinese government could enact and enforce regulations and policies to mitigate the influence of COVID-19 on consumption by reducing the export good and focusing on the domestic good. Plus, future research can aim at how to lower the effect that the pandemic could bring on consumption.

**Keywords:** COVID-19; Consumption; China; Globe; daily infection confirmed cases.

## 1. Introduction

The unprecedented coronavirus disease 2019, COVID-19 has cast chaos on a global scale. Although governments have enforced a series of regulations to keep COVID-19 under control, indeed, COVID-19 has severely impacted the economy of many countries. However, other than negative influences, COVID-19, on the other hand, also brings a positive consequence on the economy. During the COVID-19 pandemic, there are increases and decreases in the consumption of different categories of food [1].

Though the epidemic has lasted for almost three years, the debate on how COVID-19 affects the consumption of a country remains controversial. Three main arguments exist in the field: One view is that the COVID-19 has a negative influence on consumption. As governments enforced mobility restrictions against the spread of COVID-19, there is a reduction in electricity consumption, and the decrease varies, considering different geographic regions [2]. After the outbreak of COVID-19 occurred, there is a decrease in offline spending of all consumption types and categories, accompanied by a reduction in the consumption frequencies [3]. Another view is that COVID-19 positively impacts consumption. There is an augment in the consumption of groceries and decreasing frequencies at the same time due to the fear of COVID-19 [4]. Also, under the context of COVID-19, food consumption increases as the decreasing consideration of healthy food [5]. The other view is that COVID-19 has both positive and negative effects on consumption. There are increase and decrease in consumption of different food categories as people become more selective during quarantine [1].

Prior research and studies have offered empirical evidence on both the positive and negative influence of COVID-19 on consumption. Advantageously, in the U.S., consumption increases due to the scarcity of food, and the mean of purchasing food also change – higher preference for delivery and pick-up due to the fear of pandemic [4]. In Brazil, food consumption increases with less caution about a healthy diet [5]. In Italy, the result of the lockdown, though with the reduction in food consumption, the domestic consumption rises, leading to an overall increasement in expenditure [6]. In China, the food consumption behavior changes the average spending increases due to the increasing order of food and calories; the demand for calories rises, and there is a high frequency of restaurant transactions [7]. Disadvantageously, in Brazil, electricity consumption decreases with the enforcement of mobility restrictions, and the reduction varies among different geographic regions [2].

In the U.S., spending declined after the outbreak of the pandemic [8]. In Denmark, Germany, and Slovenia, the fresh food consumption decreases, but not for the households with children, and the shopping frequency declines due to the increased risk perception of COVID-19 [9]. There is little evidence that indicates that the impact of COVID-19 varies depending on the preference: over 24 countries, food consumption patterns change as there is increasing and decreasing consumption among different categories of food [1].

China, specifically Wuhan City, is the epicenter of the COVID-19, and the Chinese government effectively enforced a series of containment regulations and policies to reduce the health effect of the pandemic after its outbreak [10].

Given that China is the epicenter of the pandemic and the first country to experience and control the epidemic, it is valuable and direct to analyze the impact that the COVID-19 has brought on the consumption of China.

This study aims to focus on first, whether the pandemic of COVID-19 would affect the Chinese consumption; second, what is the relationship between the Chinese consumption and the global pandemic situation and what is the relationship between the Chinese consumption and the domestic pandemic situation; third, how strong does the global and domestic pandemic situation impact the Chinese consumption; fourth, how long will the effect lasts. After applying several models to analyze the data, this study reveals that the global pandemic circumstance negatively influences the Chinese consumption, and the global pandemic circumstance fluctuates the Chinese consumption; the effect of the domestic COVID-19 situation on the consumption is stronger than the effect of the global COVID-19 situation; the effect of global pandemic situation lasts more than one month, and the effect of domestic pandemic situation lasts no more than 3 days.

This study is the first literature that analyzes only the consumption index as the dependent variable. The contribution of this paper can be concluded into two parts: it confirms the relationship between Chinese consumption and the global and domestic epidemic infection cases; it also approves the intensity to which the global and domestic epidemic infection cases might affect the Chinese consumption.

The remaining of this paper is organized as follows. The research questions are presented at the beginning of section 2 and followed by the sources of data and models applied to analyze the data. Then, the empirical results and the interpretation are shown in section 3. Afterward, the discussion for this study is displaced in section 4. Finally, section 5 is to conclude the whole study. The last part is the reference for this paper.

## 2. Research Design

### 2.1 Data Sources

The consumption data is collected from the Choice, which is a financial terminal, and the consumption data is composed of the stocks from more than two hundred companies that produce daily consuming products in the three main cities of China, Shanghai, Shenzhen, and Beijing. The data that is used to measure the COVID-19 pandemic is the global daily new confirmed infection of COVID-19 and the Chinese daily new confirmed infection of COVID-19. This data is collected from a website, CSMAR.

### 2.2 Unit Root Test

To ensure the data is effective, not a function of time, the Unit Root Test has been used to examine the stationarity of the data over a time trend. The results are shown in section 3.1. To determine whether these variables are stationary, the augmented Dickey-Fuller test (ADF test) of the Unit Root Test is applied. The equation is:

$$x_t = c_t + \beta x_{t-1} + \sum_{i=1}^{p-1} \phi_i \Delta x_{t-i} + e_t \quad (1)$$

Where  $x_t$  is the variable, whose stationarity is tested;  $c$  is a constant;  $\beta$  is the coefficient on the time trend;  $p$  is the lag order of the autoregressive process, and  $e$  is an error term. The null hypothesis is that the data is non-stationary over the time trend, and the alternative hypothesis is that the data is stationary over the time trend. If the  $p$ -value of the result is greater than 10%, then the null hypothesis is accepted, or rejected otherwise.

### 2.3 VAR Model

To analyze how the global pandemic confirmed cases and the domestic pandemic confirmed cases are related to Chinese consumption, and consider multivariable as a system, the Vector Autoregression (VAR) model is applied in order to predict what relationship is between the consumption index and the global daily new infection of COVID-19 and what relationship is between the consumption index and the Chinese daily new infection of COVID-19. In such a way, the prediction of these variables can be mutually consistent. The result is shown in 3.3. The equation of VAR is:

$$y_t = \Gamma_0 + \Gamma_1 y_{t-1} + \dots + \Gamma_p y_{t-p} + \varepsilon_t \quad (2)$$

Where  $y_t$  is the vector of variables, which, in this study, are the rate of the return of the consumption index, global daily new confirmed cases, and China's daily new confirmed cases; in this equation,  $y_t$  is dependent on the lag orders themselves.  $\Gamma$  is a  $n \times n$  matrix;  $\varepsilon$  is the vector white noise process.

### 2.4 The Impulse and Response

The Impulse Response is the virtual image of the results from the VAR model. It shows how the dependent variable, which is the rate of return of consumption index, in this case, would react based on the impact of the other variables, which are the global daily new infection cases and China's daily new infection cases in this study. The graph follows the results of the VAR model and is shown in section 3.4.

### 2.5 ARMA-GARCH Model

To discover the intensity to which global and domestic daily new confirmed cases have impacted the Chinese consumption index, ARMA-GARCH model is constructed to forecast the rate of return and volatility of the consumption index based on the global and Chinese daily new infection of COVID-19. The ARMA-GARCH model is a combination of two models: ARMA model and GARCH model. The result is shown in 3.5. The variance equation of GARCH model is:

$$x_t = \phi_0 + \sum_{i=1}^p \phi_i x_{t-i} + \alpha_t - \sum_{i=1}^q \theta_i \alpha_{t-i} \quad (3)$$

ARMA model is composed of two models: AR model and MA model. In the equation,  $\sum_{i=1}^p \phi_i x_{t-i}$  can be treated as the AR part, and  $\sum_{i=1}^q \theta_i \alpha_{t-i}$  can be treated as the MA part. ARMA model is used to predict the future value of the time series data based on the past data and the past volatility. In the ARMA model,  $x_t$  is the variable, to be predicted its future value, which in this study is the rate of return of the consumption index, global daily new infection, and China daily new infection.

The equation of GARCH model is:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \dots + \alpha_q \varepsilon_{t-q}^2 + \gamma_1 \sigma_{t-1}^2 + \dots + \gamma_p \sigma_{t-p}^2 \quad (4)$$

Where the  $\alpha_1 \varepsilon_{t-1}^2 + \dots + \alpha_q \varepsilon_{t-q}^2$  is ARCH term of the equation.  $\sigma_t^2$ , the variance of the disturbance term  $\varepsilon_t$ , depends on the square of the disturbance term over  $p$  periods.

Where  $\gamma_1\sigma_{t-1}^2 + \dots + \gamma_p\sigma_{t-q}^2$  is the GARCH part of the equation. Based on the ARCH model, the GARCH part is set up with an additional autoregression of  $\sigma_t^2$ .

### 3. Empirical Results

#### 3.1 Stationarity

After applying ADF test of the Unit Root Test, the result is shown in Table 1.

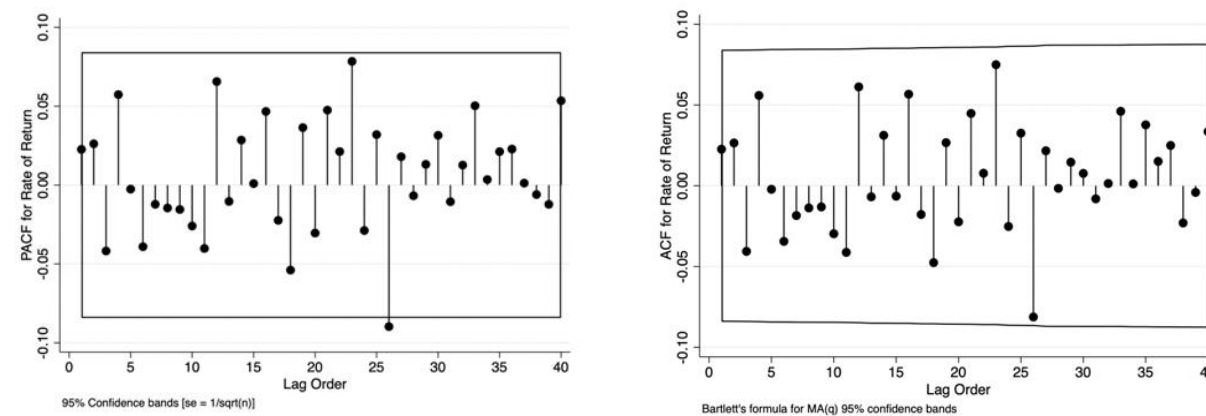
**Table 1.** ADF test

Variables	t-statistic	p-value
Consumption index	-1.645	0.7744
Consumption, yield	-16.000	0.0000***
Global new confirmed cases	-4.906	0.0003***
China new confirmed cases	-7.921	0.0000***

Based on the table, while the consumption index is non-stationary with a p-value of 0,7744 which is larger than 0.1, the return rate of the consumption index, global new confirmed cases, and China's new confirmed cases are stationary – meaning they are not a function of time – with p-value of 0.0000, 0.0003, and 0.0000 respectively.

#### 3.2 Lag Order of the Rate of Return of Consumption Index by PACF and ACF

After confirming the stationarity of the data, the lag order of the AR model can be determined by applying the Partial Autocorrelation Function (PACF).



**Figure 1.** PACF and ACF for ARMA identification

Note: For both PACF and ACF, the y-axis is the PACF and ACF respectively of the log of the rate of return of consumption index; the x-axis is the time lag order. The area is bounded by  $y = \pm 2 \times \text{Standard error}$ , referring to the confidence interval of 95%.

It can be concluded from the PACF of Figure 1 that the lag order for AR model is 26 since PACF does not fall into the confidence interval until the lag order = 26. Plus, it can be seen from the ACF in Figure 1 that the lag order for MA model is undetermined since ACF does not fall into the confidence interval before the lag order = 40.

#### 3.3 Lag Order of the Rate of Return of Consumption Index by VAR Model

Table 2 shows that LR reaches the minimum at lag order =11 with significant level of 10%; both FPE and AIC reach the minimum at lag order =11 with significant level of 10%; HQIC reaches the minimum at lag order = 7 with significant level of 10%, and SBIC reaches the minimum at lag order = 4 with significant level of 10%.

**Table 2.** VAR model identification

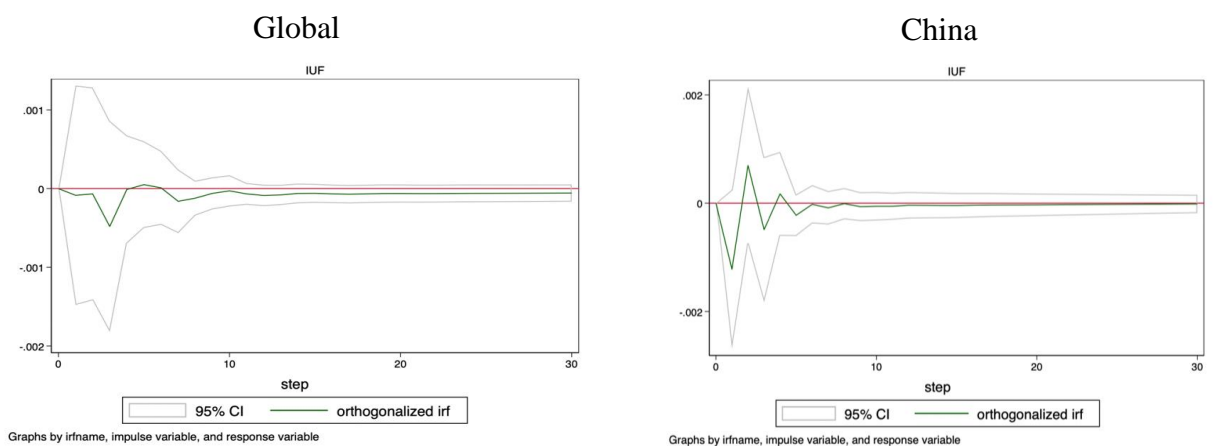
Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-438.335				.001065	1.66856	1.67804	1.69278
1	1104.54	3085.8	9	0.000	3.2e-06	-4.1306	-4.09267	-4.03371
2	1155.72	102.36	9	0.000	2.8e-06	-4.29006	-4.22369	-4.12052
3	1181.71	51.981	9	0.000	2.6e-06	-4.3543	-4.25949	-4.11209
4	1222.93	82.428	9	0.000	2.3e-06	-4.47609	-4.35283	-4.16122*
5	1230.53	15.203	9	0.086	2.3e-06	-4.4708	-4.3191	-4.08327
6	1267.28	73.512	9	0.000	2.1e-06	-4.57574	-4.3956	-4.11554
7	1296.8	59.028	9	0.000	1.9e-06	-4.6533	-4.44471*	-4.12043
8	1300.9	8.2143	9	0.513	1.9e-06	-4.6348	-4.39777	-4.02927
9	1307.45	13.087	9	0.159	2.0e-06	-4.62551	-4.36004	-3.94732
10	1317.37	19.838	9	0.019	2.0e-06	-4.62899	-4.33507	-3.87813
11	1338.16	41.591*	9	0.000	1.9e-06*	4.67358*	-4.35122	-3.85007
12	1346.04	15.762	9	0.072	1.9e-06	-4.66935	-4.31854	-3.77317

**3.4 Impact of Global and Chinses Daily New Case on Consumption Index**

Based on the impulse and response figure, the impulse of COVID-19 exists and is acting on the consumption index.

From the global impulse of Figure 2, the pandemic brings a negative influence on the rate of return of the consumption index, and the impact maximizes at about t = 3. Additionally, the negative effect maintains for at least one month.

From the Chinese impulse in Figure 2, the rate of return of the consumption index fluctuates due to the pandemic. However, the influence of the pandemic gradually disappears after t=10.



**Figure 2.** Impulse and response

Note: For the Global impulse, the y-axis is the impulse of the global pandemic on the consumption index; the x-axis is the time.

**3.5 ARMA-GARCH Model Results**

**Table 3.** ARMA-GARCH model estimation results

Variables	(1)		(2)	
	Coef.	Std. err	Coef.	Std. err
Global new confirmed cases	-0.0234	0.0625		
China's new confirmed cases			0.0202	0.0649
ARCH (-1)	0.0868**	0.0340	0.0871**	0.0344
GARCH (-1)	0.8168***	0.0796	0.8168***	0.0802
Constant	-10.1215***	0.9390	-10.4932***	0.6350

Note: the table is estimated result of whether the global and China's daily new infection would influence the rate of return of the Chinese consumption index.

Based on table 3, both the coefficients of the global daily new confirmed cases and the China daily new confirmed cases are not significant. ARMA-GARCH model estimation results show that there is no statistical relationship between new confirmed cases and the volatility of consumption index yield.

#### 4. Discussion

This paper discovers a few findings. First, the impact of COVID-19 on the Chinese consumption index exists; second, the COVID-19 has created both positive and negative influences on the Chinese consumption index; the global pandemic situation has a negative impact on the Chinese return rate of consumption index; third, the influence of domestic pandemic situation is greater than the influence of the global pandemic situation; fourth, the effectiveness of this influence could last more than one month, whereas the domestic pandemic situation fluctuates the Chinese return rate of consumption index, and this impact gradually fades away after ten days.

Future studies and research could focus on the regulation and policies which can help minimize or reduce the influence and fluctuation that the pandemic could bring to the Chinese rate of return of consumption index.

Different from the previous literature, this study is the first literature that takes the consumption index composed of the stocks of more than two hundred companies of daily consuming products in the three major cities of China to interpret the influence of the COVID-19 on consumption index. Indeed, because taking only the consumption index, global and Chinese daily new confirmed cases to analyze the effect, this study does not consider other factors, such as consumption behavior or preference for different commodities, which could potentially alter the result.

Hence, the Chinese government must enforce and enact policies that could avoid or mitigate the impact that the pandemic has put on consumption. The Chinese government could consider lowering the export commodities and focusing on the domestic commodities as the global pandemic circumstance has a negative influence on the consumption index.

#### 5. Conclusion

Though there has been various literature on the effect of COVID-19 on consumption and consumption behavior, there are few papers that consider the consumption index as the data to analyze. Therefore, this study considers the consumption index as one of the variables to interpret the impact of the pandemic on Chinese consumption. By applying the unit root test, VAR model, ARMA-GARCH model, and the impulse and response graph to synthesize and analyze the data, we conclude that first, there is the influence of the pandemic on the Chinese consumption; second, the relationship between the Chinese consumption index and the global daily new infection confirmed cases is negative, and the relationship between the Chinese consumption index and the China daily new infection confirmed cases is positive, though the coefficients are not significant; third, the intensity to which the global pandemic circumstance would affect the Chinese consumption index and the intensity to which the domestic pandemic circumstance would affect the Chinese consumption index; fourth, the time for the effect of global and domestic pandemic situation would last.

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