# COVID-19 and its Effect on China's CPI: Overall and Medical Care

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**Abstract.** Due to the high incidence of infection, COVID-19 epidemic spread widely after its breakout at the close of 2019. China also implemented the policy of containment and isolation. Since then, China's economic development has begun to regress, with an increase in unemployment rate, causing a catastrophic blow to the health and lives of the entire population. In the early stages of the epidemic, there were still many products experiencing abnormal price fluctuations, such as extremely high-priced masks and various medicines. This paper will use ARIMA model to predict the overall CPI and CPI of Medical Care from February to June 2020 without COVID-19; and compare it with CPIs after the out-break of COVID-19 in the actual situation and analyze the reasons. After comparison, it was found that the actual CPI was lower than the predicted CPI. There are two reasons for this situation, which are the composition structure of China's CPI and the statistical system of CPI. Due to the fact that the top few parts of CPI which have the largest proportion are difficult to operate and generate revenue due to lockdown policies, and abnormal price fluctuations are not included in CPI statistics; therefore, CPI show a downward trend after being affected by the epidemic.

**Keywords:** Overall CPI, CPI of Medical Care, COVID-19 epidemic, ARIMA Model.

## 1    INTRODUCTION

The COVID-19 pandemic that broke out in 2019 caused a huge sensation and affected almost the whole world.

From a macro perspective, the economy of various countries has been severely affected and have declined, with unemployment rates skyrocketing. During the epidemic, many small and medium-sized enterprises went bankrupt, and a large number of citizens became unemployed and have no income. Due to the severe epidemic situation, lockdowns were required and they were unable to go out to work and feed themselves and their families [1]. From an individual perspective, the COVID-19 epidemic has become a serious threat to individual physical and psychological health. COVID-19 is a kind of pneumonia virus, infected people will experience respiratory diseases, and infected people do not need to use special measures to cure. However, for the elderly

and people with potential diseases, COVID-19 is undoubtedly a disaster, and their condition is more likely to become extremely serious [2].

COVID-19 is transmitted through respiration and has a wide range of transmission. As of June 23, 2024, 775,678,432 people had infection with COVID-19, and 7,052,472 people died of the disease [3, 4]. Infection with COVID-19 may be accompanied by long-term sequelae, for instance, persistent exhaustion and damage of organ, which seriously affect the life of infected people. Even after COVID-19 recovers, it will accompany them for a long time [5]. After the outbreak of the epidemic, mental health is also an important part that cannot be underestimated. Psychological health issues are not only caused by concerns about the spread of the epidemic and whether one can recover, but also by a series of social issues that have erupted during the epidemic. The economic downturn and rising unemployment rates during the epidemic have caused some people to become unemployed and lose their sources of income, while the remaining people are also concerned about this issue and afraid of it happening to them. In addition, the isolation of infected individuals during the epidemic makes them feel lonely and isolated; people who have lost loved ones due to the epidemic feel even more sad and find it difficult to get out of their psychological pains [6].

The COVID-19 epidemic has hit the economies of various countries and exacerbated the inequality within and among countries [7]. For example, people with lower education levels are more likely to be fired during this period than those with higher education levels. At the same time, the COVID-19 is also a disaster to China's economy and society. During the epidemic, a large number of foreign-invested enterprises withdrew from China, and a large number of private enterprises went bankrupt, resulting in a decline in China's economic activities such as consumption and production [8]. Most of the existing studies are analyzing the macro impact of COVID-19 on countries, such as economy and unemployment rate; and the impact on individuals, such as physical and mental health. However, not so much thorough analysis of COVID-19's influence on CPI has been done.

This paper will use ARIMA model and data before the COVID-19 outbreak to predict the trend of CPI and CPI of Medical Care that is not affected by COVID-19, and compare it with the actual ones after the COVID-19 outbreak. There will be a presentation of the discrepancy between the actual and expected CPI, and the reasons for these differences will also be analyzed as the effect of COVID-19 to CPI of China by analyzing the structure and the statistical system of CPI of China.

## 2    RESEARCH DESIGN

### 2.1    Source of Data

This paper collected data from the National Data on National Bureau of Statistics of China, a website that collect national data of China. These data can be traced back to 1995. This paper will use the ARIMA model to predict the trends of expected CPIs for overall and Medical Care from February 2020 to June 2020 based on past data, and compare them with actual trends. Combined with the analysis of the national CPI

structure and statistical system, the impact of COVID-19 on CPI and the reasons for such trend of actual CPI are finally analyzed.

## 2.2    ADF Unit Root Test

To check based on the null hypothesis that the existence of a unit root, the ADF test will be performed. If the dataset for the time series is non-stationary, it will result in a large value of test statistic. In contrast, a stationary time series dataset will form a small value of test statistic [9]. Upon executing the code on Stata, it is evident that the p-value for the two sets of values is 0, which can reject the null hypothesis that the model is stable. It is noteworthy to emphasize that Table 1 illustrates the data of CPI have been done with second order difference because the order after first order difference is too low and need the continue of differential to help with the subsequent order determination task.

**Table 1.** Weak stationarity test

|  | t | p |
|---|---|---|
| CPI | | |
| Ln value | -4.523 | 0.0014 |
| 1st order difference | -10.220 | 0.0000 |
| 2nd order difference | -20.366 | 0.0000 |
| CPIMC | | |
| Ln value | -2.171 | 0.5059 |
| 1st order difference | -8.819 | 0.0000 |

## 2.3    ARIMA Model

ARIMA model is a model used in Statistics study and Economics study to predict the prospective value based on past datasets. Its full name is Autoregressive Integrated Moving Average Model. It can be divided in three parts: Autoregressive(AR), which is used to describe a model that displays a variable that is changing and is regression based on its own lag value or previous value; Integrated(I), which symbolizes the raw observations' differencing in order to make the time series steady; Moving Average(MA), utilizes a model of moving average applied to lagged observations and takes into account the relationship between an observation and a residual error [10]. In ARIMA (p, d, q) model:

p represents "Autoregressive", which is the number of autoregressive terms and it can be determined by observing the number of points not in the significant level on PACF figure [11].

d represents "Integrated", which is the order of difference to make the model stationary [11].

q represents "Moving Average", which means the prediction model's lagged value for the forecast mistakes, and it can be indicated by the number of points not in the significant level on ACF figure [11].
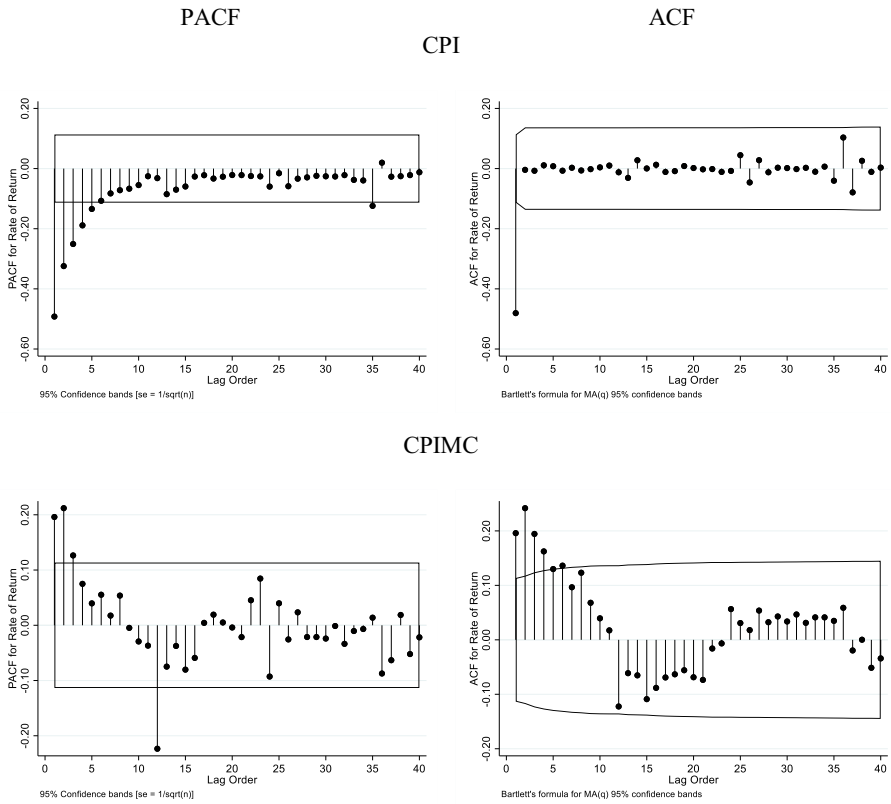
PACF                                             ACF

CPI



CPIMC



**Fig. 1.** ARMA (p, q) identification (Photo credit: Original)

# 3    EMPIRICAL FINDINGS AND ANALYSIS

## 3.1    Order Determination

For overall CPI, to guarantee the order determination is facilitated successfully, the second order difference is required. Figure 1 illustrates that, following the second order difference, there are five points not in the significant level on PACF figure; and there is one point not in the significant level on ACF figure. Therefore, p is 5, d is 2 and q is 1 for CPI.

For CPI of Medical Care, the first order difference is enough for the order determination. It can be observed from Figure 1 that after the first order difference, there are three points not in the significant level on PACF figure; and there are six points not in the significant level on ACF figure. Therefore, p is 3, d is 1 and q is 6 for CPI of Medical Care.

**Table 2.** Residual test

| Model | Portmanteau (Q) statistic | Prob > chi2 |
|---|---|---|
| CPI - ARIMA(5,2,1) | 17.7710 | 0.9991 |
| CPIMC-ARIMA(3,1,6) | 18.3968 | 0.9986 |

The model passed the residual test and rejected the null hypothesis, as shown in Table 2. Therefore, the error term is consistent with white noise, which is random and unpredictable.

### 3.2    Anticipated Outcomes and Explanation

Figure 2 shows the CPI before COVID-19 and the predicted CPI and actual CPI after COVID-19. It can be seen that if COVID-19 did not occur, the CPI would rise but actually, CPI was in the trend of decline. With time, there was a growing discrepancy between the expected and actual values.
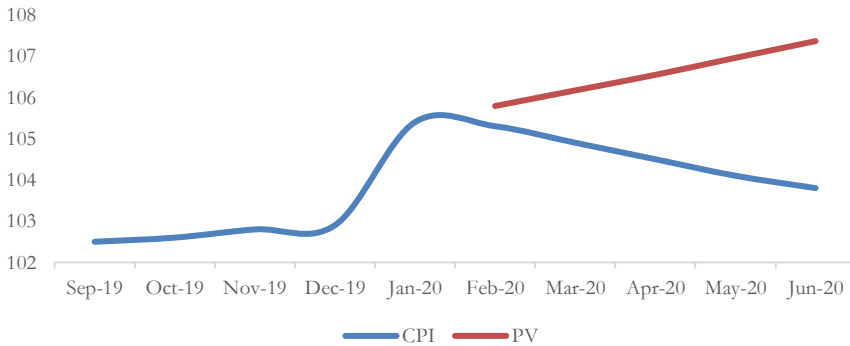


**Fig. 2.** CPI before and after Covid-19 (Photo credit: Original)

Table 3 intuitively displays the numerical difference and percentage difference of predicted CPI and actual CPI. In fact, during that period, China implemented a lockdown policy, and most people were quarantined at home, which also led to many offline physical stores closing down due to a lack of customers. In China's CPI structure, the food industry accounts for the largest proportion, followed by housing and entertainment. Residents are not allowed to go out, and offline businesses are not allowed to operate, making the tourism industry even worse. Therefore, during that period, various industries were more or less hit, especially offline industries; At the same time, the socio-economic situation is regressing, the unemployment rate is also rising, and people lack economic sources. In this situation, most people will choose to save money instead of spending, so the decline in CPI has entered a vicious cycle.

**Table 3.** CPI Difference

|  | CPI | PV | Difference | % |
|---|---|---|---|---|
| Sep-19 | 102.5 |  |  |  |

| Oct-19 | 102.6 | | | |
|--------|-------|---|---|---|
| Nov-19 | 102.8 | | | |
| Dec-19 | 102.9 | | | |
| Jan-20 | 105.4 | | | |
| Feb-20 | 105.3 | 105.8 | -0.49047 | -0.46% |
| Mar-20 | 104.9 | 106.2 | -1.26855 | -1.19% |
| Apr-20 | 104.5 | 106.5 | -2.04588 | -1.92% |
| May-20 | 104.1 | 107 | -2.8583 | -2.67% |
| Jun-20 | 103.8 | 107.4 | -3.5631 | -3.32% |

The CPI of Medical Care before to COVID-19, as well as the actual and expected CPI following COVID-19, are displayed in Figure 3. The CPI would increase in the absence of COVID-19, as can be observed. In actuality, however, the CPI was declining. With time, there was a growing discrepancy between the expected and actual values.
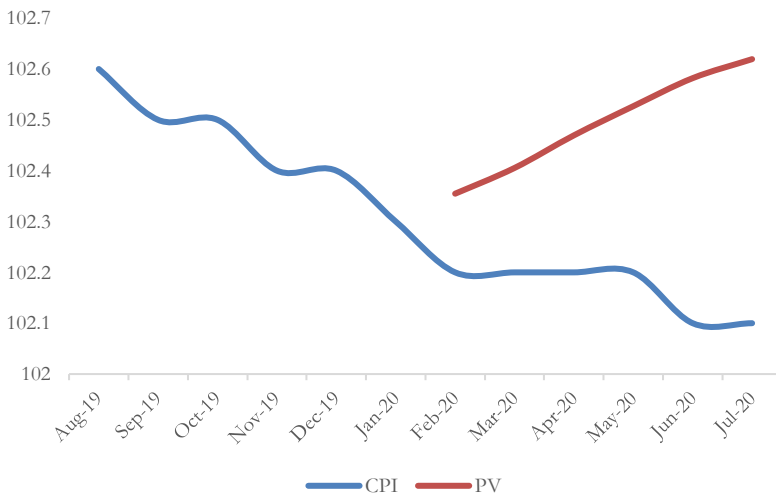


**Fig. 3.** CPIMC before and after Covid-19

The discrepancies in the actual and expected CPIs for medical care is presented in Table 4 in numerical and percentage format. In the early stages of the epidemic outbreak, people were frantically hoarding masks and various medicines due to panic, resulting in a shortage of supply in the market. As a result, masks were even sold at extremely high prices, and the prices of medicines were much higher than usual. However, the CPI of Medical Care had not increased but decreased. This is because China does not record outliers when compiling data of CPI which means this short-term and unsustainable abnormal market price will not be recorded. Therefore, the CPI of Medical Care did not rise due to these abnormal price increases, but instead gradually decreased over time, showing a downward trend.

**Table 4.** Difference of CPI of Medical Care

|        | CPIMC | PV    | Difference | %      |
|--------|-------|-------|------------|--------|
| Aug-19 | 102.6 |       |            |        |
| Sep-19 | 102.5 |       |            |        |
| Oct-19 | 102.5 |       |            |        |
| Nov-19 | 102.4 |       |            |        |
| Dec-19 | 102.4 |       |            |        |
| Jan-20 | 102.3 |       |            |        |
| Feb-20 | 102.2 | 102.4 | -0.1548    | -0.15% |
| Mar-20 | 102.2 | 102.4 | -0.20538   | -0.20% |
| Apr-20 | 102.2 | 102.5 | -0.26955   | -0.26% |
| May-20 | 102.2 | 102.5 | -0.32688   | -0.32% |
| Jun-20 | 102.1 | 102.6 | -0.48205   | -0.47% |
| Jul-20 | 102.1 | 102.6 | -0.51939   | -0.51% |

## 4    CONCLUSION

The influence of COVID-19 on the overall CPI and CPI of medical care is the primary topic of discussion in this paper. By analyzing the structure and statistical system of CPI, and comparing the actual CPI with the predicted value, reasons for the trend of CPI after the outbreak of COVID-19 are finally found. The first reason is that in the composition structure of CPI, the food industry accounts for the largest proportion, followed by the housing, and the third is entertainment. The lockdown measures put in place by China following the COVID-19 outbreak have caused a major catastrophe for the offline entity market. In addition, the statistical system of China's CPI is also a reason that cannot be ignored. In China's CPI statistical system, abnormal prices are not included. Therefore, the consumption of expensive masks and various medicines that are much more expensive than usual by consumers in the early days of the outbreak due to short supply will not be included in the CPI data. Therefore, after the outbreak of COVID-19, from February 2020 to June 2020, the difference between the actual and predicted CPI has become larger over time; affected by the epidemic, CPI has also been showing a downward trend. The limitation of this paper is that it did not predict a longer-term CPI and analyze it with the actual situation. As the time after the outbreak of the COVID-19 continues, there are also more and more uncontrollable factors, such as the different policies of the government at different times, the economic situation of the country, and the tension or easing of relations with other countries, all of which will affect the change of trends of CPI. Future research can extend time span and incorporate more considerations to predict longer periods of CPI and compare it with actual CPI, in order to analyze the various reasons for the trend changes of CPI in different time periods.

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