Analysis and Prediction of China's Total National Health Expenditure Time Series Model Before and After the COVID-19 Epidemic

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Abstract. Under the influence of the novel coronavirus epidemic, China's total health expenditure has been affected to some extent, especially after the novel coronavirus epidemic has led to people's attention to health care. This paper uses time series analysis methods, including unit root test, difference processing, and ARIMA model. Data processing of China's total health expenditure before the epidemic (1979-2019) and prediction of China's total health expenditure after the epidemic in the future. The changing trend of China's total health expenditure and its impact on economic growth is obtained, and a scientific basis is provided to formulate reasonable health expenditure policies. The results show that China's total health expenditure will show a slight upward trend. The government can optimize health resources and improve policies based on this conclusion and future trends, such as increasing the research and development and application support for medical technology, improving the hierarchical diagnosis and treatment system, and controlling drug prices.

Keywords: COVID-19 pandemic; China; Total health expenditure; Forecast.

1 INTRODUCTION

Since the outbreak of COVID-19, China's total health spending has changed significantly. This global public health crisis forced the Chinese government to invest many resources in the health sector to deal with the spread of the epidemic and protect public health [1]. The following are several aspects to explore the impact of COVID-19 on China's total health spending. First, implementing epidemic prevention and control measures requires much capital investment. To curb the transmission of the virus, the Chinese government has implemented a range of preventive and control strategies, such as imposing extensive quarantine restrictions, conducting statewide nucleic acid testing, and implementing health code tracking. The implementation of these measures requires substantial financial support. For example, universal nucleic acid testing requires the purchase of testing equipment and kits and the payment of medical staff salaries and protective equipment costs [2]—secondly, the expansion and optimization of medical resources. During the outbreak, China quickly built multiple makeshift hospitals and temporary medical facilities to cope with the sudden increase

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in patients. The construction and operation of these temporary facilities require substantial financial support. In addition, to improve the capacity of medical services, the government has also increased the procurement and renewal of medical equipment and increased investment in hospital infrastructure. In addition, vaccine development and vaccination. The research and development, production, and mass vaccination of COVID-19 vaccines are essential links in epidemic prevention and control. The Chinese government invested much money supporting vaccine research and development and launched large-scale vaccination work quickly after the vaccine's success [3]. This includes not only the production and procurement costs of vaccines, the transportation and storage of vaccines, and the training and subsidies of vaccinators—finally, the long-term construction and reform of the public health system. The COVID-19 epidemic has exposed some deficiencies in the public health system, and the Chinese government has realized the importance of strengthening the public health system. After the epidemic, China increased investment in its public health system, including constructing the Center for Disease Control and Prevention.

Overall, China's health has improved dramatically over the past three decades due to the reduction of some traditional infectious diseases. However, the death rate from chronic diseases has been rising. Public institutions provide the vast majority of medical services, and hospitals absorb increasing resources. There has been a tremendous increase in the number of doctors, but, the qualifications of the current doctors are frequently inadequate. The budgets of hospitals and the income of doctors may be influenced by the pharmaceuticals they prescribe and sell, which are subject to regulation and contain significant cross-subsidies. Faced with these problems, the government introduced a series of reforms. New insurance schemes have been introduced in both rural and urban areas. In 2009, China announced a series of new reforms aimed at achieving universal, safe, affordable and effective basic health care. These reforms include investments in health infrastructure, universal coverage, a greater focus on prevention, a new regime for essential medicines, and far-reaching restructuring, including hospital reform. It is important to ensure that primary health care plays a greater role and that hospitals are managed more effectively and less hierarchically. To make progress, the relative price of treatment will also need to change, increasing doctors' salaries and tobacco prices [4].

Although studies have revealed many factors that influence health spending, most of these studies use cross-sectional or panel data and lack in-depth analysis of time series data. Time series analysis can better reveal the dynamic changes of health expenditure at different time points, so as to provide more accurate forecasts and suggestions for policy making. Therefore, this study intends to use time series data and ARIMA model to conduct an empirical analysis of China's health expenditure, explore its change rules and influencing factors, and provide a basis for the government to formulate scientific and reasonable health policies.

2 RESEARCH DESIGN

Based on the empirical analysis of the time series data of China's health expenditure, this paper discusses its changing rules and influencing factors. The study will use the ARIMA model to forecast health expenditure and analyze the implications of the results for policy making.

2.1 Data Sources

The study used data on total national health expenditure from the Office for National Statistics covering the period 1979 to 2019. In order to ensure the accuracy and consistency of the data, logarithmic transformation is performed on the data. The National Bureau of Statistics of the People's Republic of China is a government agency that operates under the direct authority of The State Council. It was founded in August 1952. The responsibilities include overseeing national statistics and national economic accounting, developing legislation and regulations for statistical work, formulating plans for statistical reform and modernization, as well as national statistical investigation plans. Additionally, the role involves organizing, leading, supervising, and inspecting the statistical and national economic accounting work carried out by different regions and departments. Furthermore, it entails supervising and inspecting the implementation of statistical laws and regulations [5]. As a commonly used indicator in the field of health financing, total health expenditure refers to the total amount of funds used by the whole society in a country or region for disease prevention, treatment, rehabilitation and other medical and health services in a certain period [5]. Total health expenditure corresponds to medical and health services based on medical and health science and technology, mainly including treatment services, rehabilitation services, long-term care services, auxiliary services, drug and medical device retail services, preventive services, health administration and medical insurance management and other medical service activities and preventive services.

2.2 Unit Root Test

Before performing Arima, it is important that the data is stationary, which guarantees the validity of the model, because if the time is not stationary, the parameter estimates and predictions of the model may be skewed or inaccurate, and the predictions of stationary time series are generally more stable than those of non-stationary time series. Start with a stationarity check using adf.test()tseries.

Through testing, it can be seen from table 1 that all p values are 0 and less than 0.1, so the original value can be rejected. That is, the model is assumed to be stable and feasible.

Table 1. ADF test results

Variables	T value	P value
none	1.1725	2.2e-16
trend	-1.416	2.104e-05

2.3 ARIMA Model Settings

The ARIMA model, also known as the autoregressive integral moving average model, is a commonly employed statistical model for time series forecasting. The ARIMA(p,d,q) model is characterized by its general form, where p denotes the number of autonomous terms, d denotes the number of differences, and q is the number of moving average terms. Based on the outcome of the unit root test, the value of d is determined to be 1, indicating that a first-order difference is applied to the data.Through the ACF and PACF diagrams, the optimal model parameters p=10 and q=1 can be determined according to the principle of taking the maximum order within 10, namely: ARIMA(10,1,1). The ACF and PACF diagrams are shown in Figure 1 and 2.

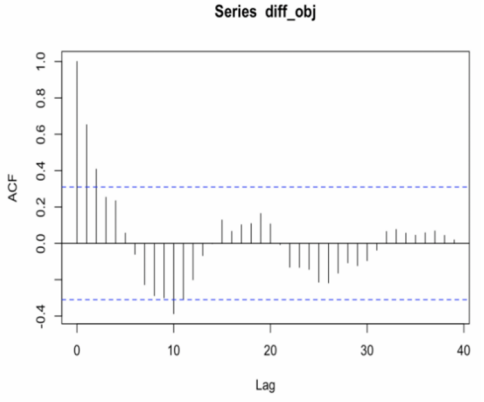

Fig. 1. ACF

Photo credit: Original

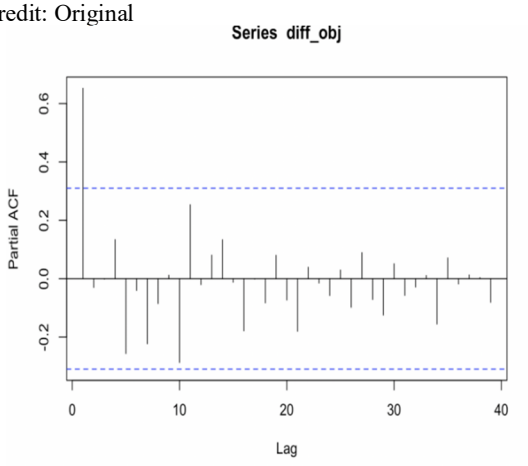

Fig. 2. PACF

Photo credit: Original

3 EMPIRICAL RESULTS AND ANALYSIS

3.1 Order Determination

ARIMA (10,1,1) can be determined as the optimal model by comparing the models of different orders. The residual value test results are shown in Figure 3.

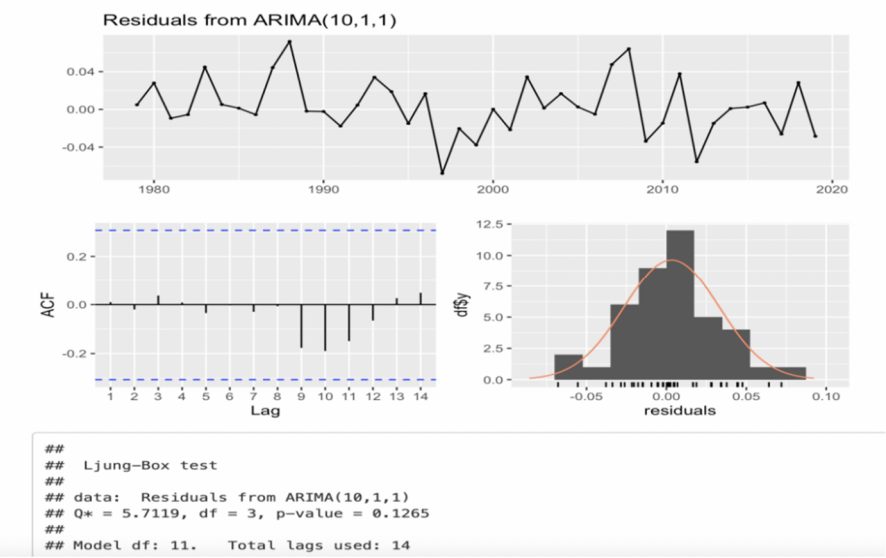

Fig. 3. Check Residuals

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Figure 3 shows the residual analysis of the ARIMA (10,1,1) model.

The ACF plot shows the autocorrelation of the residuals. Ideally, the residuals should have no significant autocorrelation. The autocorrelation coefficients for all lags are close to zero and within the confidence interval. According to the Ljung-Box test, p-value = 0.1265, more significant than 0.05, indicating that the residual is white noise.

3.2 Forecast Results and Interpretation

The ARIMA (10,1,1) model forecasts health spending over the next ten years. The projections show that health spending will continue to grow in the coming years. Specific predicted values are as follows:

As can be seen from the projected results in Figure 4, the growth trend of health expenditure is on a slight upward trend over the next decade.

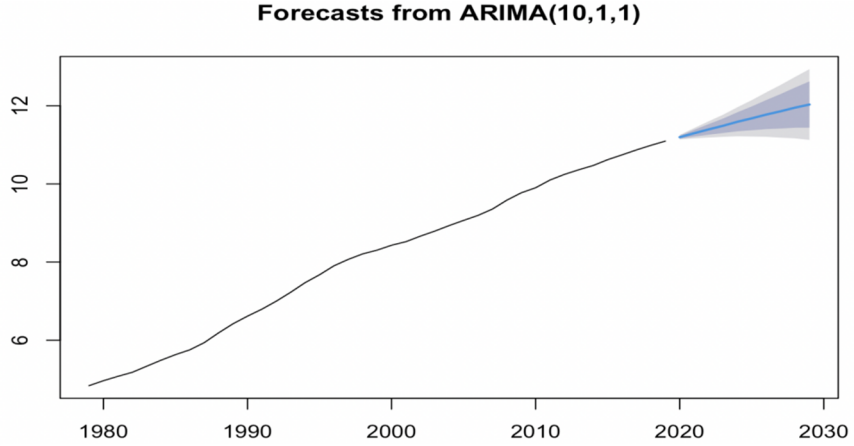

Fig. 4. Forecast

Photo credit: Original

4 DISCUSSION

This paper found that health expenditures showed a trend of continuous growth, which is basically consistent with the results in [6]. However, this paper further quantifies the specific growth of future health expenditures through the ARIMA model, which provides more intuitive data support for policymaking.

The research results of this paper show that the government should fully consider the growth trend of future expenditure when formulating health policies, rationally allocate resources, and improve the efficiency of medical services to cope with the ever-increasing demand for health expenditure [7].

The government should recognize that health expenditure growth is a long-term trend and strengthen medical resource management and optimization [8]. At the same time, excessive health expenditure growth can be controlled by improving medical technology's application efficiency and strengthening preventive healthcare measures [9].

Patients can prevent chronic diseases by strengthening their health management and reducing personal health expenditures. In addition, understanding future trends in health spending allows for better planning of medical expenses for individuals and families. In October 2016, the Chinese government introduced the "Healthy China 2030" plan, which seeks to ensure comprehensive health coverage for every citizen by the year 2030. After evaluating the policy priorities in relation to the current gaps and problems, people can affirm that China's healthcare reform is progressing in the correct direction. In order to successfully carry out these objectives, China can utilize policy experimentation to activate grassroots initiatives and foster innovation [10].

5 CONCLUSION

In conclusion, this essay discussed the time series data of China's health expenditures and uses the ARIMA model to forecast future health expenditures. The study found that health spending will continue to grow in the future. This result has significant reference value for the government in formulating health policies and optimizing the allocation of medical resources. Future research could further explore the relationship between health spending and specific economic indicators to provide more evidence for a comprehensive understanding of the economic effects of health spending.

As the total health expenditure is expected to rise, the state should take corresponding measures and policies:

1. Improve the efficiency of medical services

Medical technology innovation: Increase support for research and development and application of medical technology.

Enhance the hierarchical diagnostic and therapeutic framework, direct patients towards seeking appropriate medical interventions, and alleviate the burden on major healthcare facilities.

2. Control the growth of medical expenses

Strengthen the supervision of drug prices, promote the centralized purchase and use of drugs, and reduce drug costs.

Considering the above potential problems, the government should strengthen policy coordination and implementation. For example, national and local governments should strengthen policy coordination and cooperation to ensure that various measures and policies are effective. The reform and development in the health field should be coordinated through the establishment of specialized coordination bodies or working groups. In addition, the government should continue to increase financial investment in the health field, especially in infrastructure construction, technology research and development, and personnel training, and increase financial support for the sustainable development of the health service system. It is also essential to improve the health laws and regulations system, strengthen legal safeguards and supervision mechanisms, and ensure all policies and measures are implemented within the legal framework. Strengthen law enforcement and crack down on violations of laws and regulations in the medical field.

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