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Time Series Analysis of Chinese Agricultural Gross Domestic Product

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Abstract

To forecast Chinese agricultural output value, the ARIMA model was used to fit the quarterly data of Chinese agricultural output value from January 2010 to August 2020, and the optimal model was used to forecast the next six quarters. Finally, ARIMA (3,1,1) (0,1,0) is fitted, and the predicted value is basically consistent with the actual situation in China. The ARIMA model can be used to predict agricultural output value in the short term, which can be used in national macro-control and policy making.

Keywords

Chinese agricultural output value; Time series analysis; ARIMA model.

1. INTRODUCTION

The study of time series analysis can be traced back to the 1920s.In order to estimate the law of time development more accurately, a new applied statistical method, time series analysis, has emerged. This method uses the probability and statistics theory to process and analyze the time-varying data series, establishes its mathematical model, and makes further prediction and adaptive control on the data series. In recent years, with the learning and research of Chinese scholars on time series models, the application of time series models has been rising rapidly in China. All kinds of research reports and papers related to time series model have appeared one after another, and the number is very large. The data category covers a wide range, and almost all aspects of the society can be analyzed and predicted by time series model.

In addition, China is a country with a large population, and agriculture is the basic industry of national economic development. It occupies an important fundamental position in the process of national economic development and plays a great role in promoting Chinese economic growth. Some scholars advocate the development of agriculture, which they believe is a booster of Chinese industrialization and rapid economic growth. As an economic variable, the total output value of agriculture is an important factor to measure economic growth. At the same time, as Chinese largest industry, the stability of agricultural output can ensure the stable and healthy development of the economy. At present, Chinese scholars have mainly analyzed the main factors affecting the total output value of agriculture, but neglected to analyze the development of agriculture itself from the perspective of time series. Therefore, this paper adopts the time series method to analyze and forecast Chinese agricultural gross output value, which is helpful for the government to carry out macro-control on agriculture and formulate relevant policies through the forecast value.

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2. METHODOLOGYTESTS

2.1. The Data Source

The variables used in this study is Chinese agricultural Gross Domestic Product in (billion RMB). Select the quarterly data of January 2010 to August 2020 , and the data were from EPS database.

2.2. Basic Analysis Steps

R software was used to analyze the quarterly data of agricultural gross output value. First, time sequence diagram was drawn to analyze the data stability, and then model identification, parameter estimation, model test and data prediction were carried out.

2.3. Time Series Diagram

According to the data obtained from EPS database, R software was used to draw the time series diagram. It can be seen that the time series diagram of agricultural gross output value is non-stationary and has a trend, that is, agricultural gross output value rises gradually year by year, so the first difference is made to the data.

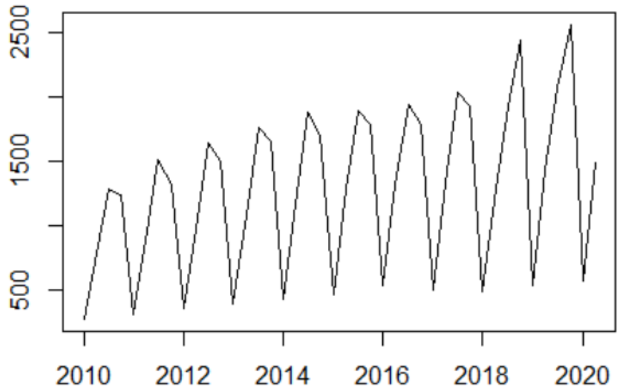

Figure 1. Raw time series

The time series after difference is shown in the figure below. Although the sequence after the first-order difference is smoother than the original sequence, it can be seen that the sequence still has seasonality, and the difference sequence of agricultural gross output value has a peak value every year. Therefore, the first-order seasonal difference is carried out for the sequence after the first-order difference.

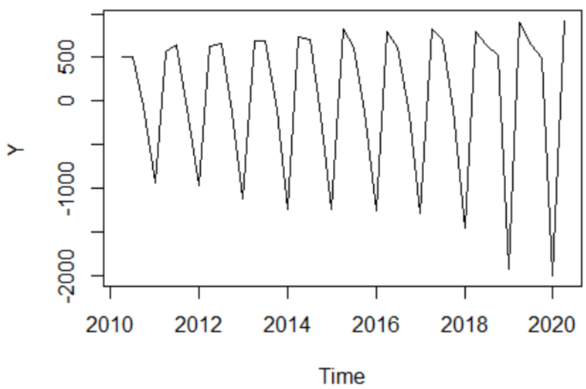

Figure 2. First difference

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It can be seen that after seasonal difference, there is no obvious law of data fluctuation, so the stability can be preliminarily judged.

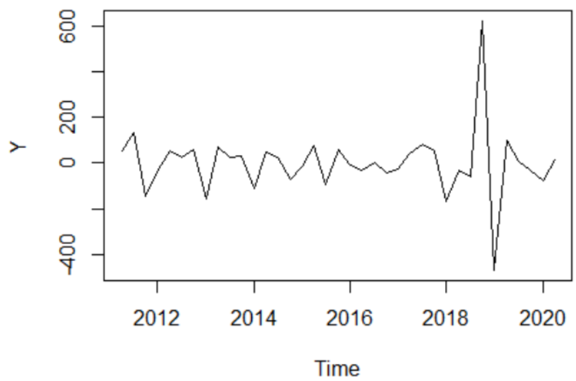

Figure 3. Seasonal difference

The data of the time series model must be stable, so it is necessary to do ADF test for the processed sequence. Upon examination, P-value=0.01<0.05,So we can reject the null hypothesis at α=0.05.We determine that the sequence is stationary and that there is no unit root.

Table 1. Augmented Dickey-Fuller test

Dickey-Fuller = -5.2	Lag order = 3	p-value = 0.01

2.4. Model Identification

We judge the order of the model according to the autocorrelation and partial autocorrelation graphs after the first four-step difference. First, consider the seasonal ARIMA model, namely ARIMA(P,1,Q) (P,1,Q).According to the ACF diagram, it can be seen that the autocorrelation coefficient is in the 1st order truncation, and the partial autocorrelation coefficient is in the 3rd order truncation according to the PACF diagram. Therefore, the model p is considered to be from 0 to 3, q is from 0 to 1, P is from 0 to 1, and q is from 0 to 1. In the next step, the auto. arima ( ) function in the R software forecast package can be used to automatically select the optimal ARIMA model.

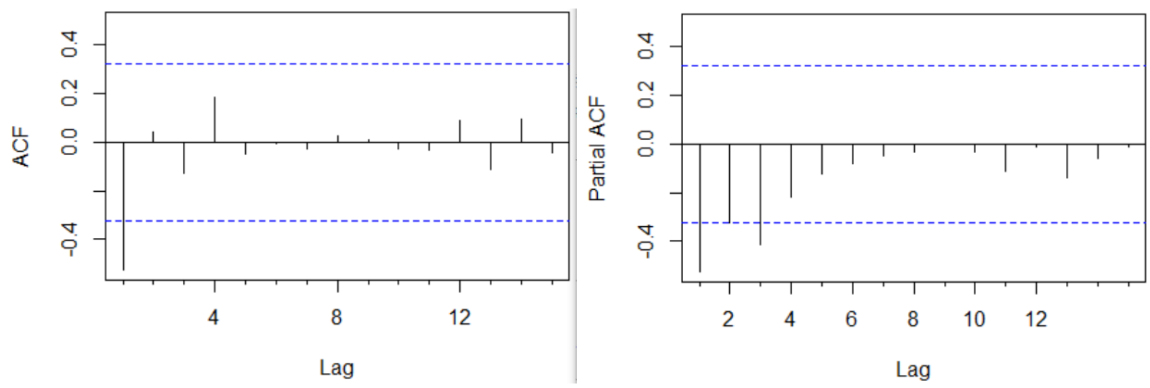

Figure 4. ACF and PACF

2.5. Parameter Estimation

According to the auto. arima ( ) function, the optimal model is ARIMA(3,1,1)(0,1,0), which is consistent with the model estimated by ACF and PACF graphs in the previous step. The specific estimated parameters are shown in the table below.

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Table 2. Estimate of coefficients

	ar1	ar2	ar3	ma1
coefficients	-0.345	-0.293	-0.254	-0.699
s.e.	0.238	0.228	0.201	0.217

Among them χ^2=966998, Log Likelihood=-308.4, AIC=626.7.

2.6. Evaluation of Fitting Model

If the model is properly selected, then the residual of the model we fit should be the white noise sequence, that is, for any lag order, the residual autocorrelation coefficient is zero, and it satisfies the independent normal distribution. According to the Q-Q figure, most of the points in the data fall on the line in the figure, indicating that the data meets the normal distribution. According to the box-test ( ) function in R software, the autocorrelation coefficients of the residuals can be verified to be zero. The results show that P-Value=0.9>0.05, did not pass the significance test, that is, the autocorrelation coefficient of the residual is zero. In conclusion, the ARIMA(3,1,1)(0,1,0) model is reasonably selected and can fit the data well.

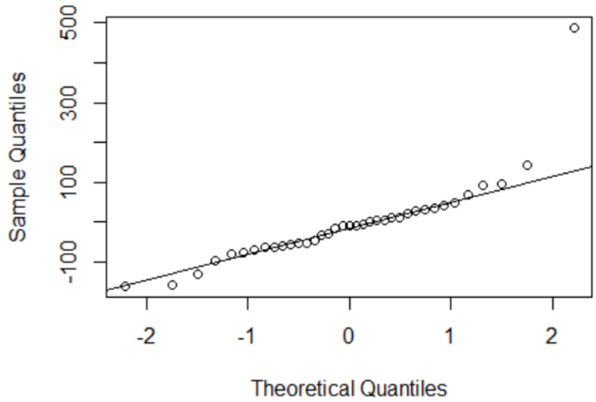

Figure 5. Q-Qfigure

2.7. Model to Predict

According to the fitting seasonal ARIMA model, R software was used to predict the total agricultural output value of China, and the confidence intervals of the predicted value were 80% and 95% respectively. According to the forecast data we can see that in the third quarter of 2020 predicted value of agricultural output is 2210.1 billion yuan, up 6.345% from a year earlier, in the fourth quarter forecast for 2685.4 billion yuan, up 4.711% from a year earlier, the projections in the first quarter of 2021 to 666.6 billion yuan, up 17.211% from a year earlier, in the second quarter forecast for 1576.2 billion yuan, up 5.989% from a year earlier, the projections in the third quarter to 231.18 billion yuan, up 4.602% from a year earlier, in the fourth quarter forecast for 2791.1 billion yuan, up 3.936% from a year earlier. Through the forecast, we can conclude that Chinese total agricultural output will continue to grow slowly in the next year, and the fourth quarter will still be the peak of one year. The obtained forecast results are in line with Chinese actual situation, and the established model is of practical significance.

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Table 3. Forecast

Time	Forecast	Lo 80	Hi 80	Lo 95	Hi 95
2020 Q3	2210.1	2084.1	2336.2	2017.4	2402.9
2020 Q4	2685.4	2559.2	2811.5	2492.5	2878.3
2021 Q1	666.6	540.4	792.8	473.6	859.6
2021 Q2	1576.2	1449.9	1702.6	1383.0	1769.4
2021 Q3	2311.8	2106.2	2517.4	1997.3	2626.3
2021 Q4	2791.1	2584.7	2997.5	2475.5	3106.7

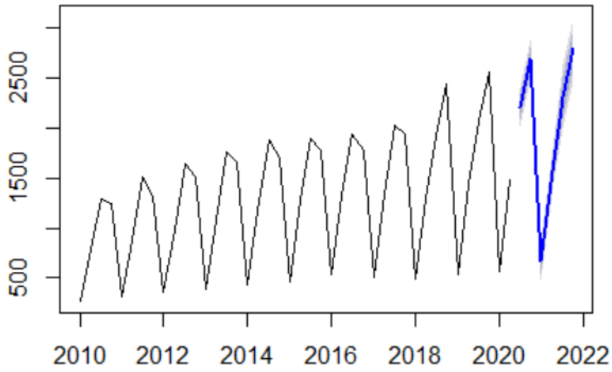

Figure 6. Forecast

3. CONCLUSION

Using R software, this paper applied the basic theory of time series analysis, in January 2010 to August 2020 in the quarterly data of Chinese agricultural output has carried on the empirical research, and established in accordance with Chinese actual seasonal ARIMA model, at last, by fitting the model to September 2020 to December 2021, a total of six quarters of Chinese agricultural output. Through the prediction, we found that in the future, the total agricultural output value will still be seasonal and show a general trend of gradual growth, which is consistent with the actual economic situation of China, indicating that the model has a good fitting effect and has a good reference function. By establishing a time series model of agricultural gross output value, it can provide reference basis for the government to effectively carry out macro-control on agriculture and formulate relevant policies.

In addition, the total output value of agriculture may also be affected by climate factors such as temperature, rainfall and macroeconomic factors, which were not taken into account in the research process of this paper, so the accuracy of prediction may be reduced. On the other hand, ARIMA model is more suitable for short-term prediction. Therefore, when using ARIMA model to make prediction, data need to be constantly updated and dynamically modified to ensure the accuracy of the model.

In future studies, we can establish a more accurate statistical model through big data and data mining, so as to provide a more scientific and accurate theoretical basis for the government's macro-control of agriculture.

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