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Forecasting China's Monetary Over-Issuance After the Pandemic Based on ARIMA Model and Exponential Smoothing Model

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Abstract: The excessive issuance of a country's currency will lead to the decline of the purchasing power of the currency and the rise of prices, which will lead to the reduction of the living standard of the people and the widening of the gap between the rich and the poor. In order to ensure the economic growth rate after the epidemic, most countries choose to issue more currency, and China's currency issue is particularly serious. This paper aims to predict the Monetary Over-issuance (MOI) in China after the epidemic by means of time series analysis. In this experiment, some basic time series model prediction methods such as ARIMA model and exponential smoothing model were used to predict the MOI situation in China in the post-epidemic era, aiming to explore the impact of the epidemic on China's MOI. The forecast results show that the Chinese government's stimulus actions for economic phenomena such as the decrease of GDP growth caused by the epidemic have increased China's MOI, and compared with before the epidemic, China's MOI will still maintain a steady growth in the future.

Keywords: Monetary Over-issuance, Time Series, Auto ARIMA Model, Exponential Smoothing Model.

1. Introduction

1.1. Research Background and Significance

Whether China is in the midst of currency over development has always been a hot topic in academic circles. Since the subprime crisis in 2008, China's M2 growth rate has continued to rise at a high growth rate. If the traditional judgment method is used, there is no doubt that China is in a state of currency oversupply for a long time. But some Chinese scholars have other ideas.

Among them, two views have a higher audience. The first is the Chinese economist Wen Bin proposed that the excess of money and inflation rate is related, China's CPI growth rate continues to be less than 2%, indicating that China's current inflation rate is relatively low, and there is no excess of money [1]. The other, put forward by Ximiao Dong, chief researcher at China Merchants Bank, is that unlike other countries, China's money supply is mainly affected by commercial bank credit, rather than cash injection by the central bank. Thus, there is no currency overshoot in China [1].

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Although the traditional method of judging the excess of money has been questioned, it has to be admitted that China's M2 growth rate has been growing at an alarming rate since the subprime crisis in 2008, and for the country, too fast M2 growth is not a good thing. As a developing country, the government often needs to consider more about the trade-off between economic growth and inflation. Excessive currency over-issuance may lead to high inflation or even economic crisis. Based on this, the prediction of China's currency over-issuance can determine whether the government's economic stimulus to the epidemic is reasonable, and if China's MOI after economic stimulus is significantly different from that before the epidemic, how the government should make countermeasures according to the two different economic structures.

Therefore, the subsequent prediction of MOI in this paper is still based on the traditional view, that is, the recognition that China is currently in a state of monetary over-issuance.

1.2. Literature Review

This paper aims to predict the situation of currency over-issuance in China after the epidemic. Recent studies and some on monetary excess have revealed the relationship between national monetary policy and inflation. Many scholars have realized that the epidemic is highly likely to have a correlation with China's currency over-issuance. For example, Chinese scholar Cui Baisheng et al. predicted and warned China's MOI in the post-epidemic era by studying the American economy [2]. However, these studies have not separated from the binary relationship between MOI and CPI. In fact, due to the differences between China and the United States in economic system and national financial control policies, China's MOI and CPI seem to have almost no correlation [3]. Therefore, this paper starts from the Chinese MOI itself and predicts it according to the historical data of MOI, which can reduce the importance of CPI in experiments in previous studies by scholars, which will help deepen the understanding of MOI itself [4-6].

2. Methodology

2.1. Data Source and Interpretation

MOI needs to be calculated by M2 data and GDP data. All the data in this experiment were selected from the data of the National Bureau of Statistics of China (https://data.stats.gov.cn). Due to the complexity of GDP growth statistics, there is no monthly GDP growth data available, in order to obtain more data sets to improve the accuracy of the forecast, the data of M2 and GDP will be used as quarterly data instead of one year.

The MOI growth rate is equal to the ratio of the M2 growth rate to the nominal GDP growth rate. Plugging the acquired data into this formula can be used to plot Figure 1.

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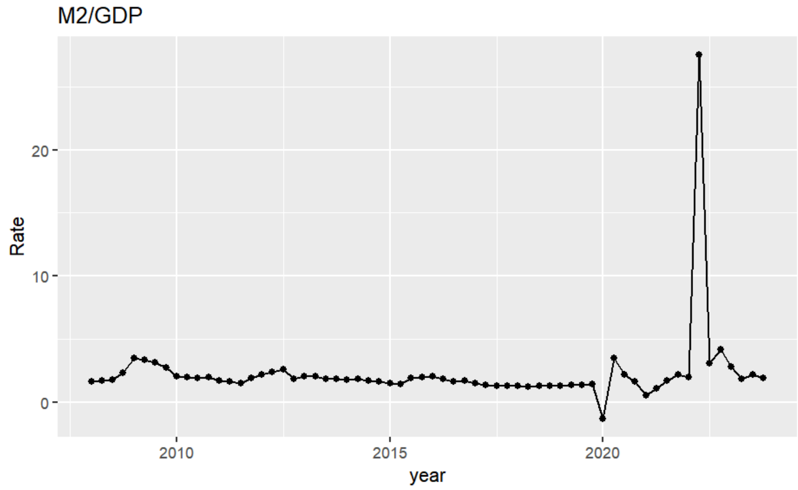

Figure 1: M2/GDP (MOI Growth rate).

This time series covers the period from 2008 to the first quarter of 2008. Several fluctuations in the figure have corresponding historical events, such as the subprime mortgage crisis in 2008, the epidemic in 2020 and the government's regulation behavior after the epidemic. Excluding the outliers for these particular time periods, the MOI for the rest of the time appears to be very stable.

2.2. Model Selection and Establishment

2.2.1. Auto ARIMA Model

ARIMA model is called auto regressive moving average model, which regards the data series formed by the prediction object over time as a random sequence. The advantage of ARIMA model is that it can consider the influence of historical data, especially for the series with more historical data and a long time line, the prediction has a high accuracy.

The ARMA model is a simple combination of Auto Regression Model (AR) and Moving Average Model (MA), containing both historical value terms and error terms. Since AR model has the stationarity requirement for time series, and ARMA model also has this limitation, the author extend it to ARIMA model and introduce the difference concept as a method to obtain time series. One of the most commonly used difference methods is to calculate the difference between the current term and the previous term to obtain a new set of time series. The mathematical formula is as follows. In the actual analysis process, the ARIMA model is usually used, because AR, MA, ARMA are a special case of it. ARIMA has three parameters p, d and q, written as ARIMA (p,d,q), where p stands for AR(p), auto regressive order, d stands for Integrated (d), difference order, q stands for MA(q), moving average order. The operation should ensure that these three parameters as small as possible to avoid overfitting, a criterion for parameters is, do not let d exceed 2, p and q exceed 5, and p and q try to ensure that one is the dominant term of the model and the other is relatively small [7,8].

While the time series of MOI data covers a period of more than ten years, the ARIMA model has a finer processing of the details of such series.

As mentioned above, the MOI growth rate data during the epidemic period are relatively extreme, so before the difference, the author removes these extreme values and performs first-order difference for the sake of stationary and universality.

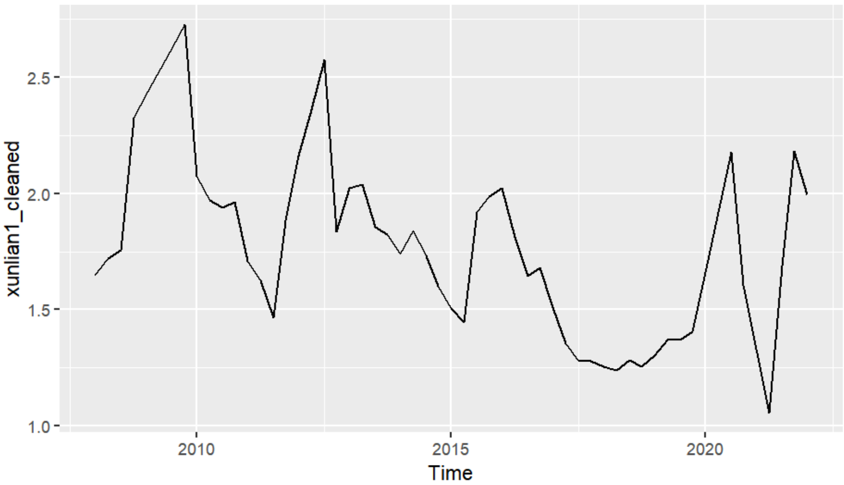

Figure 2: Difference plot with extreme values removed.

It can be seen that the time series in the Figure 2 is relatively stable. The author conducted stationary test and Lygung-Box test for this time series. The time series did pass the stationary test, but surprisingly the differential time series did not pass the Lygung-Box test, meaning that the differential image was an unpredictable white noise sequence. So, the deleted points were restored, and rerunning the stationary test and the Lygung-Box test. The plot is shown as Figure 3.

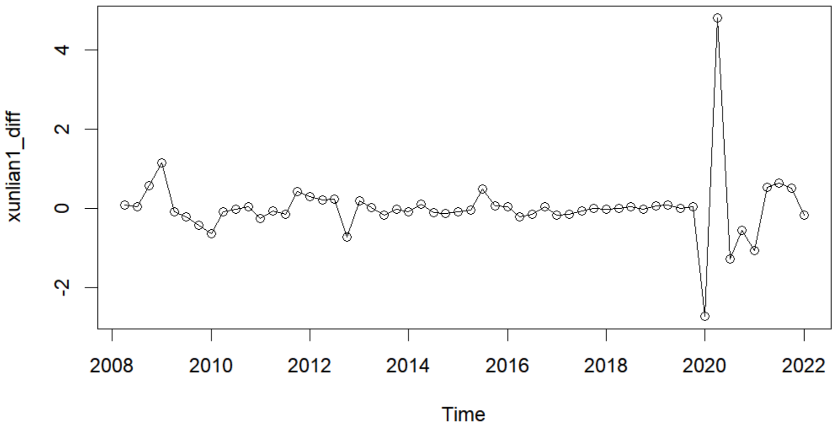

Figure 3: The difference graph retains the initial data.

It can be seen from the test results that the time series after difference can pass the stationary test and white noise test after the outlier recovery. After the parameters are given by Auto ARIMA model, the Figure 4 shows the forecasting result.

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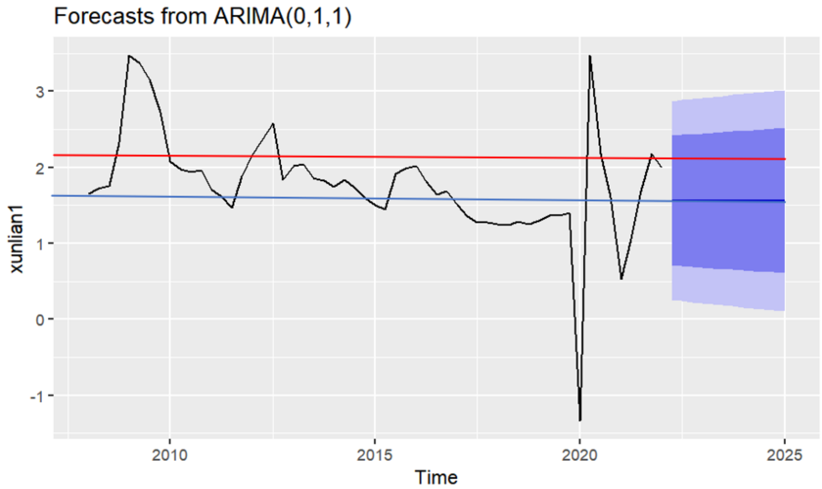

Figure 4: Auto ARIMA Model.

The accuracy of prediction was verified by the images. The blue line of Figure 4 is the ARIMA model's prediction of the future growth rate of MOI, with an average value of about 1.56, and the red line is the true value retained in the test set, with a value of about 2.1. The red line of Figure 4 is within the 95% confidence interval of the prediction, indicating that the prediction is valid.

Despite the success in building a predictive model for MOI, something is till confusing: why can a training set with outliers be able to successfully build a predictive model, but an image with a difference is displayed as a white noise sequence when outliers are removed? After reviewing the test process, the author put forward the idea: It is not difficult to find from the growth rate image of MOI that if the impact of special historical events (such as subprime crisis, currency crisis and epidemic, etc.) is removed, the growth rate of MOI appears to be very stable, which actually conforms to the law of macroeconomics, that is, if there is no abnormal situation, the growth rate of GDP, currency and other macro indexes will be quite stable. The growth rate of MOI, calculated by GDP and M2 growth, should also be stable [9]. Allowing a certain amount of error, when M2 and GDP growth rates are close to each other, MOI growth rate will approach a fixed average, and its trend cannot be judged by the model in the short term, but in the long run, MOI growth rate will remain stable or even parallel to the X-axis. For a country, too fast growth of MOI is not a good thing, China is still in a period of rapid economic development, even if the government does not reduce the growth rate of MOI in order to ensure GDP growth, it will not be allowed to grow wantonly. However, due to the impact of the epidemic, the GDP growth rate plummeted. In order to ensure the GDP growth rate, the government must stimulate the economy, which is shown in the figure, the growth rate of MOI rose sharply after reaching the trough, and the increase was unprecedented. The author believes that this stimulus behavior changes the growth rate of MOI from a stable series to a series with an upward trend in the long run, which shows that the mean value of real data is higher than the previous mean value. That's why the addition of these so-called outliers changed the image from a sequence of white noise to predictable.

2.3. Exponential Smoothing Model

To confirm the above view, the authors construct a new MOI growth time series model using four exponential smoothing models using the same data set. The exponential smoothing model was chosen because it amplifies the impact of events near the timeline on the overall model, and in recent years, there have been events such as epidemics and government stimulus actions. The author will discuss them by category.

2.3.1. Holt Damped Forecast Method & Simple Exponential Smoothing Forecast Method

By performing exponential smoothing model prediction on the original data, The Figures 5-6 of these two models are followed. It is surprised to find that the prediction results given by the simple exponential smoothing model and the damped Holt model are basically consistent, and the two sets of results are almost consistent with the results given by the ARIMA model, with an error of less than 0.2. This result confirms the conjecture. First of all, ARIMA model and exponential smoothing model give almost the same prediction results, which means that exponential smoothing does not cause large errors in the overall prediction when increasing the influence weight of short-term events. In other words, the epidemic and government stimulus have changed the nature of MOI growth rate in both the long and short term. The growth rate of MOI has increased significantly compared with that before the epidemic, and will remain stable in the future after the increase. Additionally, in general, the forecast result of simple exponential smoothing model should have a far clearer trend than that of damped Holt model, if these two models are similar to each other means that although there is a upward trend in the figures 5-6, it's too gentle to be noticed [10].

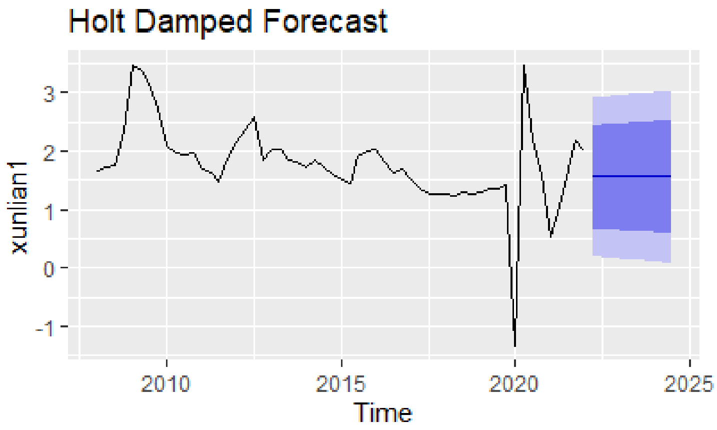

Figure 5: Holt Damped Forecast Method.

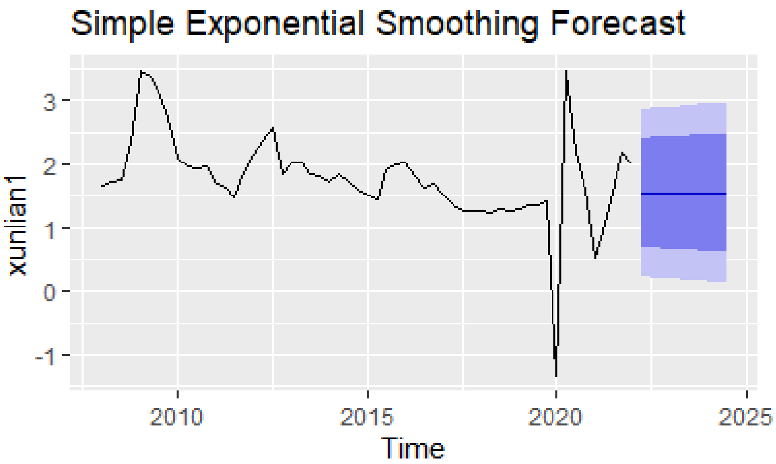

Figure 6: Simple Exponential Smoothing Forecast Method.

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2.3.2. Holt Linear Trend Forecast & Holt-Winters Seasonal Forecast

The Figures 7-8 illustrate the reason why Holt Linear Trend Forecast and Holt-Winters Seasonal Forecast Method are abandoned.

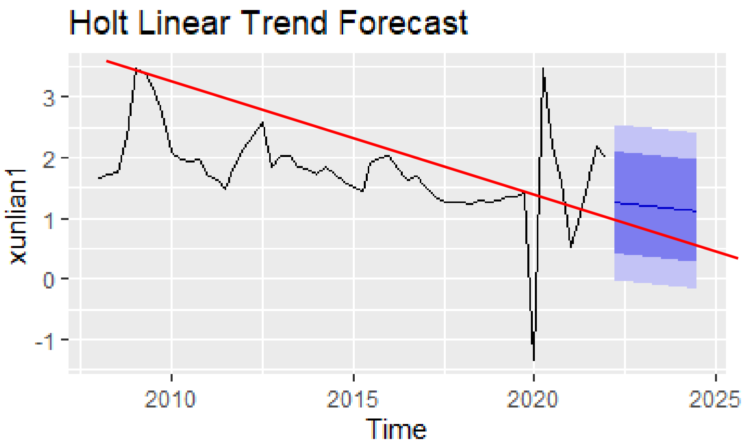

Figure 7: Holt Linear Trend Forecast Method.

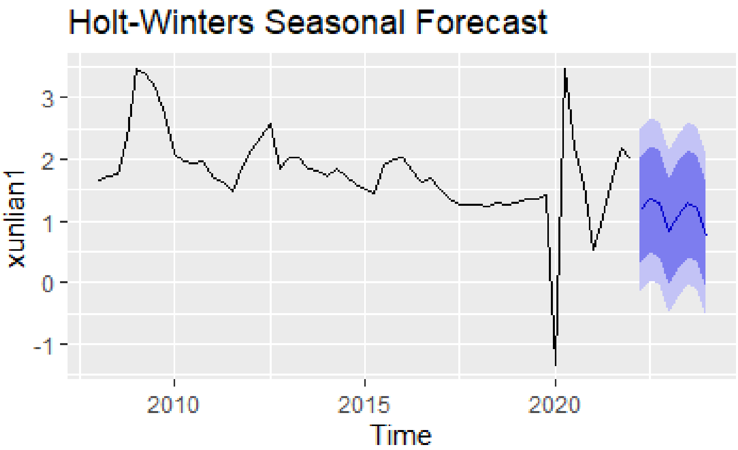

Figure 8: Holt-Winter Seasonal Forecast Method.

Although both time series pictures are stationary, compared to the simple exponential smoothing method and damped Holt method, they have very clear trend. It's against the result author got that the MOI growth rate will increase very gently in the future. The Holt linear trend method take every stimulation behavior of the government into account, and these peaks are accidentally generate a downward trend. By contrast, the Holt winters seasonal method exaggerate the impact of the pandemic and the stimulation, which is shown as frequent fluctuations in the graph, also playing against with the conclusion of the MOI growth rate should be a straight and stationary line.

In addition to the subjective analysis, the numerical data can also support the author's view. As mentioned above, the mean of the training set is about 2.1, and this line is only within the 80% confidence interval of the prediction in the two exponentially smoothing models below. It can be seen that the prediction accuracy of these two smoothing models is much lower than that of the simple smoothing model and the damped Holt model.

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3. Conclusion

To sum up, the models and data show that the epidemic and the government's stimulus behavior have a great impact on the growth rate of MOI, and the growth rate of MOI will maintain a very low growth rate and steady growth in the future after a short-term surge. Although China's CPI growth rate continues to be below 2%, and there is still a long way to go from high inflation, the Chinese government should control M2 growth to avoid unknown risks. This article focuses on MOI itself and makes predictions about it.

In terms of data selection, the sample interval in this article is relatively insufficient due to the availability of data. Meanwhile, only the ARIMA model was used in the research methodology. In the future, with the availability of data resources, the sample size can be increased and research methods can be enriched to deepen the content and richness of this study.

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