Analysis and Forecast of Chinese Government Bond Yields During the COVID-19 Pandemic Period--Based on ARIMA Model

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Abstract: COVID-19 has impacted the global economy and China's financial markets. China has implemented measures to contain the virus, but some companies have shut down, causing a slowdown. Investors have turned to Treasury bonds, leading to increased demand and bond yields. An ARIMA model is used to forecast and analyze Chinese government bond yields. The model provides insights into behavior and can assist investors in formulating trading strategies. The study has practical implications for investors seeking to hedge bond risks and increase yields, contributing to the stability of Chinese financial markets.

Keywords: COVID-19; China's Bond Yields; ARIMA; Rate of Return; Analysis; Forecast

1. Introduction

COVID-19 declared a global pandemic on 11 March 2020, causing significant economic impacts in over 170 countries. Bonds are marketable securities issued by debtors to raise money, and the pandemic has affected global financial markets, leading to economic stagnation. Chinese government bond yields dropped sharply as investors sought safe-haven assets amid economic uncertainty. Treasury bonds are increasingly chosen by investors for their yield, safety, and liquidity. The Ministry of Finance issued a notice initiating the issuance of special treasury bonds for the fight against the pandemic in 2020. This article studies and forecasts the yield of Chinese government bonds during the pandemic period and helps investors plan and formulate strategies for future government bond transactions.

2. Literature review

China's bond market has grown rapidly in recent years, becoming an increasingly important part of the country's financial market and an important means of corporate financing. However, the outbreak in early 2020 has put heavy pressure on investors and companies. The epidemic has disrupted people's pace of life and the production order of enterprises, and has had a negative impact on China's overall economic development. The epidemic is not only a health crisis, it has also led to a slowdown in China's economic growth, rising debt, falling internal demand, and the impact of competitive US interest rates on China. China's GDP shrank by 6.8% in the first quarter of 2020 compared with the same period last year. The impact of the outbreak on China's stock and credit markets is discussed in an article. The study found that the epidemic had a significant negative impact on the stock market and a significant positive impact on the bond market. In addition, the economic policy response adopted by the government has also affected the stock and bond markets. The study also found that monetary policy responses lead to greater volatility in the stock market than fiscal policy responses, while fiscal policy responses lead to greater volatility in the bond market than monetary policy responses. The fiscal policy response has a more positive impact on the stock market, while the monetary policy response has a more positive impact on the bond market. These results are valuable for understanding the mechanism of the impact of the pandemic on the stock and bond markets, and have important practical implications for government decision-making. China's bond market has also seen some success

in opening up during the pandemic. The main performance is that the proportion of foreign investors has increased significantly, the term structure and currency composition of foreign debt have been optimized, and the safe asset attribute of national debt has gradually emerged. Bond yields not only represent people's expectations of interest rates and inflation, but also reflect the trend of social and macroeconomic development. The bond market is an important part of China's financial system and can play an important role in supporting economic development. In order to achieve this goal, it is necessary to promote the opening of the bond market through major channels, including creating a level playing field for domestic and foreign investors, strengthening the regulatory framework, and enhancing market liquidity. The importance of foreign investment in the bond market was emphasized, and measures to attract foreign investors were suggested to improve market infrastructure, expand investment channels, and provide competitive returns. At the same time, it is necessary to balance risk management and market development, and propose a risk-based regulatory approach to ensure the stability and sustainability of the bond market. The movement of bond yields is an important trading information that all investors always watch. The yield curve is a graphical representation of a change in yield that shows a distinct pattern over time and is an important basis for financial choice. This paper is based on the ARMA model to predict the yield of Treasury bonds, helping investors to create and modify appropriate Treasury bond trading strategies according to the expected results, so as to continuously improve their ability to reduce bond risks and improve bond returns.

3. Methodology Data

3.1 Data set

The 10-year Treasury yield is a long-term bond backed by state credit and is commonly used as a risk-free yield. It is the asset price in the equity market, including the futures market and the real estate market, that depends on the 10-year Treasury yield. In the Chinese bond market, the 10-year Treasury yield is the basis for pricing RMB assets with high bond activity. In this paper, we use the data of 1-year treasury bond maturity, 5-year treasury bond maturity and 10-year treasury bond maturity in the Chinese bond market to estimate the treasury yield curve and use it to forecast the treasury yield curve, selecting data from the Chinese bond yield situation table from 1 December 2019 to 31 December 2022. The basic statistical information of the data is shown in Table 3.1.

And the model we use is the ARIMA model. The ARIMA (Autoregressive Integrated Moving Average) model is a widely used time-series forecasting technique. It is a statistical model that takes into account past data to predict future trends. The model uses three parameters to determine the patterns in the time series data: p, d, and q.

The ARIMA model is suitable for analyzing data with autocorrelation and seasonality, which are often present in financial time-series data. The model can be used to forecast future values based on the patterns observed in the past data. The model's accuracy can be evaluated by comparing the predicted values with the actual values and measuring the forecast error.

In this paper, we will use the R language to carry out data analysis.

Table 3.1: Descriptive analysis of Treasury Yield

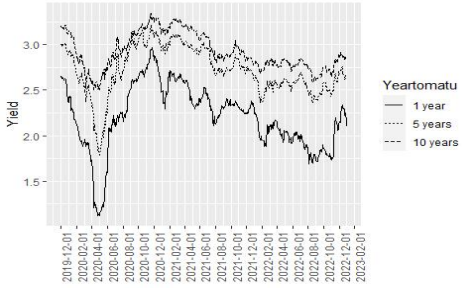
Trddt	Cvtype	Yeartomatu	Yield
Min. :2019-12-02	Min. :1	1 year :771	Min. :1.118
1st Qu.:2020-09-08	1st Qu.:1	5 years :771	1st Qu.:2.362
Median :2021-06-21	Median :1	10 years:771	Median :2.682
Mean :2021-06-18	Mean :1		Mean :2.610
3rd Qu.:2022-03-29	3rd Qu.:1		3rd Qu.:2.900
Max. :2022-12-31	Max. :1		Max. :3.349

3.2 Yield curve analysis

As can be seen from the yield curve in Figure 3.2, the 1-year Treasury yield, the 5-year Treasury yield and the 10-year Treasury yield all fluctuate and move in a generally consistent manner during the pandemic. Between the outbreak in December, 2019 and 1 May, 2020, the 1-year Treasury yields, 5-year Treasury yields and 10-year Treasury yields gradually

decline, then from 1 May, 2020 to 1 December 2020, the 1-year Treasury yields, 5-year Treasury yields and 10-year Treasury yields begin to trend upwards. Then after December 1, 2020, the 1-year Treasury yields, 5-year Treasury yields and 10-year Treasury yields begin to trend slowly downward.

Figure3.2: Yield curves for 1-year, 5-year and 10-year government bond yields during the COVID-19 pandemic period



3.3.1 1-Year Treasury Yield Analysis

From Figure 3.2 above, it can be concluded that the yields are clearly unstable, so a first-order difference is made for the 1-year Treasury yields, and then autocorrelation and partial autocorrelation plots are made, and from the autocorrelation and partial autocorrelation plots in figure 3.3.1.1 shows, it can be seen that there is autocorrelation between the yields.

The autocorrelation and partial autocorrelation plots of the residuals in Figure 3.3.1.2 shows that the residuals are basically white noise series, so the model is able to fit the series effectively.

The best ARIMA model for the 1-year Treasury bond during the pandemic is, ARIMA(1,1,0), with the model expression:

$$y_t = 1.2801y_{t-1} - 0.2801y_{t-2} + \varepsilon_t$$

Figure 3.3.1.1: Autocorrelation and partial autocorrelation coefficients of 1-year Treasury yields

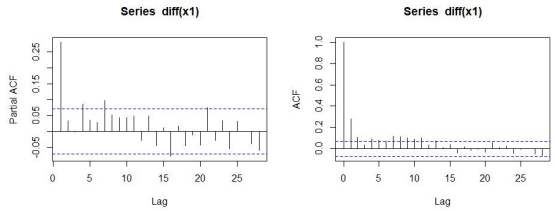
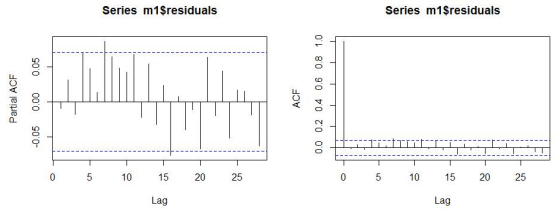


Figure 3.3.1.2: Residual series plot of 1-year Treasury yields



3.3.2 5-Year Treasury Yield Analysis

From Figure 3.2 above, it can be concluded that the yields are clearly unstable, so a first-order difference is made for the 5-year Treasury yields, and then autocorrelation and partial autocorrelation plots are made, and from the autocorrelation and partial autocorrelation plots in figure 3.3.2.1 shows, it can be seen that there is autocorrelation between the yields.

The autocorrelation and partial autocorrelation plots of the residuals in Figure 3.3.2.2 shows that the residuals are basically white noise series, so the model is able to fit the series effectively.

The best ARIMA model for the 5-year Treasury bond during the pandemic is, ARIMA(0,1,2), with the model expression:

$$y_t = y_{t-1} + \varepsilon_t + 0.1764\varepsilon_{t-1} - 0.0829\varepsilon_{t-2}$$

Figure 3.3.2.1: Autocorrelation and partial autocorrelation coefficients of 5-year Treasury yields

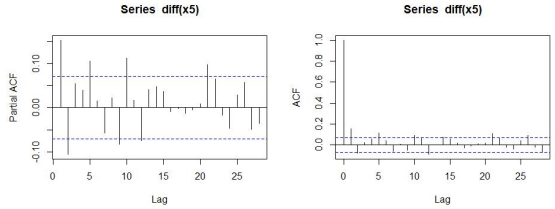
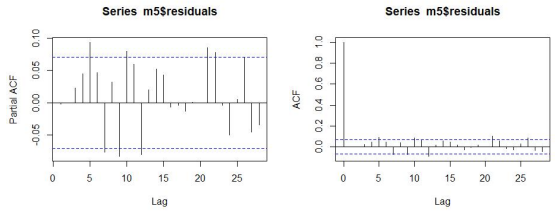


Figure 3.3.2.2: Residual series plot of 5-year Treasury yields



3.3.2 10-Year Treasury Yield Analysis

From Figure 3.2 above, it can be concluded that the yields are clearly unstable, so a first-order difference is made for the 10-year Treasury yields, and then autocorrelation and partial autocorrelation plots are made, and from the autocorrelation and partial autocorrelation plots in figure 3.3.3.1 shows, it can be seen that there is autocorrelation between the yields.

The autocorrelation and partial autocorrelation plots of the residuals in Figure 3.3.3.2 shows that the residuals are basically white noise series, so the model is able to fit the series effectively.

The best ARIMA model for the 10-year Treasury bond during the pandemic is, ARIMA(0,1,3), with the model expression:

$$y_t = y_{t-1} + \varepsilon_t + 0.08\varepsilon_{t-1} - 0.1031\varepsilon_{t-2} + 0.0592\varepsilon_{t-3}$$

Figure 3.3.3.1: Autocorrelation and partial autocorrelation coefficients of 10-year Treasury yields

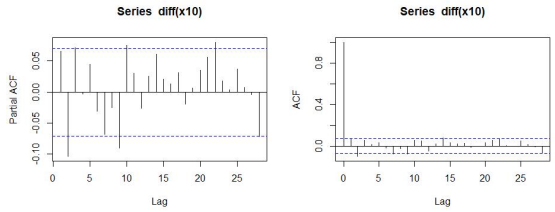
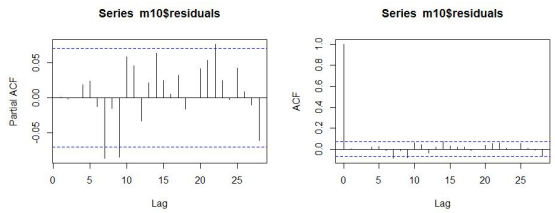


Figure 3.3.3.2: Residual series plot of 5-year Treasury yields



Conclusion

The COVID-19 pandemic has had a significant impact on global financial markets, including the Chinese bond market. During the pandemic period, from December 1, 2019, to December 31, 2022, the Chinese bond yields experienced volatility and uncertainty, with many investors unsure of how to develop appropriate trading strategies. As a result, there is a growing

need to develop accurate forecasting models that can help investors to make informed decisions.

In this paper, we analyze and forecast the Chinese bond yields during the pandemic period. Specifically, we examine the volatility and trend of the 1-year, 5-year, and 10-year bond yields and find that they are essentially the same. To provide more accurate forecasts, we construct an ARIMA model that estimates the parameters for the Treasury yield curve from December 2019 to December 2022. We find that our model fits well for the 1-, 5-, and 10-year Treasury yield curves, allowing us to provide reliable forecasts for selected Treasury yield curve movements and yields after the pandemic has passed.

The findings of this study have important implications for investors looking to reduce bond risks and raise bond yields in the post-pandemic period. Our results can assist investors in developing and modifying appropriate Treasury trading strategies based on the anticipated outcomes after the pandemic has passed. By providing accurate forecasts and insights into the behavior of the Chinese bond market during the pandemic, this study can help investors make informed decisions and achieve better investment outcomes.

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