

Analysis of China-U.S. Exchange Rate based on U.S. Dollar Rate Hike

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Abstract. Based on the data on the exchange rate of RMB against the U.S. dollar, the ARIMA model is used to forecast the exchange rate of RMB against the US dollar in the coming year. The results show that the RMB will continue to depreciate, but there is no possibility of a large depreciation. The rate hike of the Federal Reserve System (FED) is both a challenge and an opportunity for China. In the context of the dollar's continued appreciation to contain domestic inflation, capital outflows will intensify to some extent. At the same time, because of the impact of COVID-19, China's room for policy adjustment has been narrowed. However, the rate rise of the US dollar has accelerated the process of de-dollarization and local currency settlement, providing opportunities for the internationalization of the RMB. China should seize the opportunity of the interest rate hike on the U.S. dollar and introduce reasonable policies to further promote RMB internationalization and China's economic recovery.

Keywords: The U.S. dollar rate hike; ARIMA model; China-U.S. exchange rate forecast.

1. Introduction

Since March 2021, the U.S. Consumer Price Index (CPI) has exceeded the 2% policy target and has risen sharply month by month, soaring to 7.5% in January 2022, a 40-year high. In the United States, the year-over-year increase reached 9.1 percent in June 2022, the highest since 1981. In addition, because the Federal Reserve System (FED) underestimated the strength and speed of domestic inflation in the United States, there was a significant lag in raising interest rates. The FED did not start raising rates officially until March 2022. This makes the current round of rate hikes an unprecedented intensity, that is, seven 245-basis-point hikes in nine months [1]. The rise in the US dollar has had a huge impact on the exchange rates of emerging countries. In fact, since 2022, with the continuous appreciation of the US dollar, the international financial market has gradually formed a form of "Federal Reserve interest rate hike - depreciation of emerging countries' currencies - international capital return to the United States." In this case, China, as one of the emerging countries, has also suffered a significant depreciation of the Yuan (RMB). The RMB has continued to depreciate since December 2022, falling to 7.242CNY/USD in August 2023, the highest since 2008. Liu and Wu conducted an empirical evaluation of the interaction between interest rates and exchange rates in China and the United States and found that the impact of the change of interest rate policy in the United States on the exchange rate in China and the United States was greater than the impact of the change of interest rate policy in China [2]. Therefore, in the context of the FED's decision to continue to raise interest rates, whether the RMB will continue to depreciate and how China responds to changes in the exchange rate have become a hot topic.

Many scholars have done research on RMB and US dollar exchange rate forecasts. Hui et al. used the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model to forecast the RMB exchange rate [3]. Wang et al. used the NAXR network to forecast RMB exchange rate [4]. Wang et al. predicted the fluctuation of the RMB exchange rate on the basis of multivariate analysis [5]. Chang et al. made an exchange rate prediction based on the Mallat algorithm and heteroscedasticity model [6]. Liu et al. forecasted the trend of the RMB exchange rate by analyzing the time-varying relationship between the FED interest rate and the RMB exchange rate [7].

In dealing with the impact of RMB exchange rate fluctuations, different scholars have reached inconsistent conclusions. Yang believed that in addition to the external factors of the US interest rate

rise, there are also internal factors such as China's economic transformation and RMB exchange rate reform. Therefore, China needs to formulate more reasonable exchange rate regulation policies [8]. Tan and Cheng argued for the use of counter-cyclical policies, such as fiscal and monetary policies, to stabilize the operation of China's economy [9]. Wang and Wu pointed out that since interest rate liberalization would reduce expectations and arbitrage opportunities, China should promote interest rate liberalization reform, gradually relax capital controls, and open and improve the financial market [10]. Unlike Wang and Wu, Wang and Yu believed that China should strengthen the supervision of financial markets, strengthen the authenticity and legitimacy of transactions, and avoid large-scale foreign exchange purchases [1].

On the basis of fully absorbing and referring to the above literature results, this paper uses the relatively advanced method of time series model-Autoregressive Integrated Moving Average (ARIMA) model to forecast the China-US exchange rate in the next year under the background of the Federal Reserve System's continuous interest rate hike. Based on the forecast results, this paper will analyze the risks and opportunities faced by China under the background of the FED's interest rate hike and further put forward relevant policy recommendations.

2. Methods

2.1. Data Sources

This report selects data from the ‘Chinese Yuan Renminbi to U.S. Dollar Spot Exchange Rate’ released by the Board of Governors of the Federal Reserve System (US) and updated in August 2023.

2.2. Data Selection

The database collects monthly exchange rate from January 1981 to August 2023. However, the data before 2000 is different from the data after 2000. Besides, China carried out the reform of the exchange rate system in 2005. Therefore, this report will only use data from 2006 onwards. The monthly exchange rate data from January 2006 to September 2022 are taken as train data to establish the exchange rate forecast model. Then the data from September 2022 to August 2023 were used as test data to test the prediction effect of the model.

2.3. ARIMA Model

Auto Regressive Integrated Moving Average (ARIMA) is a class of models that illustrates a given time series based on its own past values. George Box and Gwilym Jenkins developed the ARIMA model in the 1970s. ARIMA forecasting is achieved by applying time series data to the variable of interest, identifying the appropriate number of lags or amount of differencing to be applied to the data, and checking for stationarity. This is a short-term forecasting method with high forecasting accuracy [11]. In this paper, the ARIMA(p,d,q) model will adopted as a forecasting tool and its form as follows:

$$\begin{cases} \Phi(B)\nabla^d x_t = \Theta(B)\varepsilon_t \\ E(\varepsilon_t) = 0, Var(\varepsilon_t) = \sigma_\varepsilon^2, E(\varepsilon_t, \varepsilon_s) = 0, s \neq t \\ E_{x_s \varepsilon_t} = 0, \forall s < t \end{cases} \quad (1)$$

B is the backward shift operator, $x_{t-1} = Bx_t, \nabla^d = (1 - B)^d$ is the difference of order d, $\Phi(B) = 1 - \phi_1 B - \dots - \phi_p B^p$ is the autoregressive coefficient polynomial of stationary invertible ARIMA (p, q) model, $\Theta(B) = 1 - \theta_1 B - \dots - \theta_q B^q$ is the moving smoothing coefficient polynomial of stationary invertible ARIMA (p, q) model [12].

3. Results and Discussion

3.1. Data Processing

Before building a model, first check whether the data is stationary. If it is not stationary, the data should be differenced to make it a stationary sequence. Based on the time series composed of monthly exchange rate data from January 2006 to September 2022, the time series plot, ACF plot and PACF plot are made (see Figures 1 and 2).

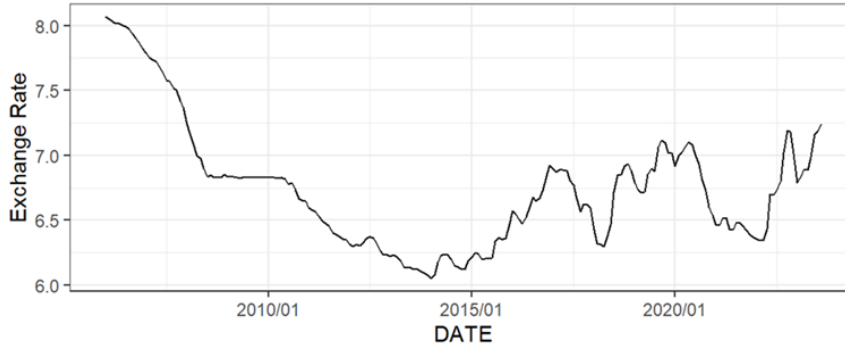


Fig. 1 Plot of Train Data

According to Figure 1, the data have different trends in different periods.

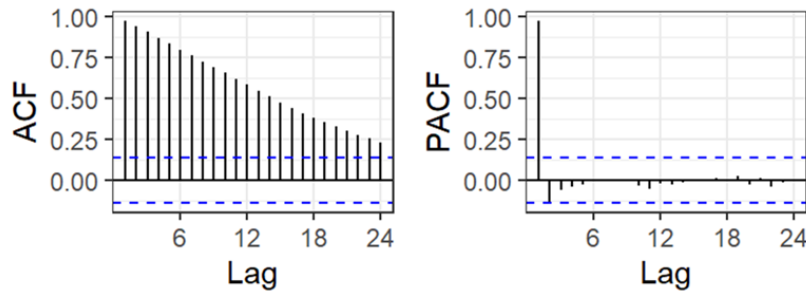


Fig. 2 ACF Plot and PACF Plot for Train Data

According to the ACF plot, data decreases slowly. And the value of r_1 is large and positive. Therefore, the data is non-stationary and needs to be differenced. Besides, as there is no seasonality in data, it does not need to seasonal difference. After a second difference, the data is stationary. The result is shown in Figure 3.

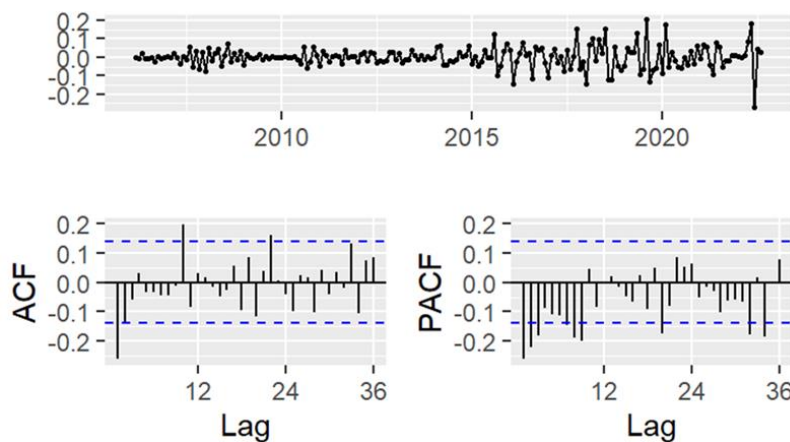


Fig. 3 The Result after Differencing

3.2. ARIMA Model Establishment

According to the autocorrelation and partial autocorrelation of the second-order difference time series and BIC criterion, ARIMA (1,2,1) model (see Figure 4 and Table 1) is built.

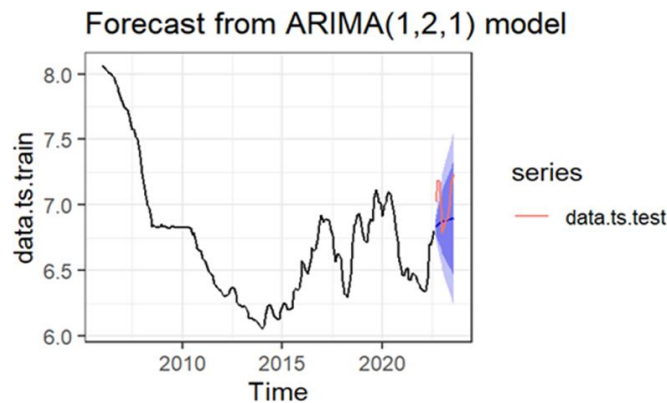


Fig. 4 Forecast from ARIMA (1,2,1) Model

Table 1. Basic information

Date	Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
Sep 2022	6.8336	6.77	6.90	6.74	6.93
Oct 2022	6.8511	6.74	6.97	6.68	7.03
Nov 2022	6.8613	6.70	7.02	6.62	7.11
Dec 2022	6.8681	6.67	7.07	6.56	7.18
Jan 2023	6.8732	6.64	7.11	6.51	7.24
Feb 2023	6.8775	6.61	7.15	6.46	7.29
Mar 2023	6.8815	6.58	7.18	6.42	7.34
Apr 2023	6.8852	6.55	7.22	6.38	7.39
May 2023	6.8889	6.53	7.25	6.34	7.44
Jun 2023	6.8926	6.51	7.28	6.30	7.48
Jul 2023	6.8962	6.48	7.31	6.27	7.53
Aug 2023	6.8999	6.46	7.34	6.23	7.57

3.3. Residual Diagnostics

The residual error of the model is tested to verify the validity of the model estimation (Figure 5).

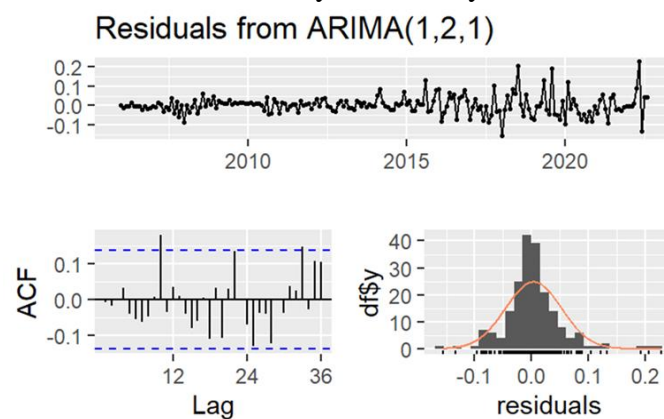


Fig. 5 Residual from ARIMA (1,2,1)

The ACF shows that all autocorrelations are within the dash line.

Table 2. Ljung-Box Test of ARIMA (1,2,1)

Q*	df	p-value	Model df	Total Lag Used
23.624	2	0.3673	22	24

The value of p is 0.3673 which is large. Therefore, the residual behaves like white noise. The ARIMA (1,2,1) model is reasonable (Table 2).

3.4. Model Test

According to ARIMA (1,2,1) model, the RMB - USD exchange rate from September 2022 to August 2023 is predicted and compared with the actual value. The result is shown in Table 3. Mean Square Error (MSE) and predicted interval is also used to evaluate the forecast accuracy (see Table 4).

Table 3. Actual Value vs Forecast Value

Date	Actual Value	Forecast Value	Error	Percentage Error
2022/9/1	7.020	6.834	0.186	2.65%
2022/10/1	7.190	6.851	0.339	4.72%
2022/11/1	7.181	6.861	0.320	4.45%
2022/12/1	6.972	6.868	0.104	1.49%
2023/1/1	6.790	6.873	-0.083	-1.22%
2023/2/1	6.838	6.878	-0.039	-0.58%
2023/3/1	6.891	6.881	0.009	0.14%
2023/4/1	6.888	6.885	0.002	0.03%
2023/5/1	6.985	6.889	0.096	1.38%
2023/6/1	7.161	6.893	0.269	3.75%
2023/7/1	7.186	6.896	0.290	4.04%
2023/8/1	7.242	6.900	0.343	4.73%

As can be seen from the errors of the real and predicted values and percentage errors in Table 3, the predicted results of this model are basically close to the actual values, and the relative errors are controlled within 5%.

Table 4. Results of MSE and Prediction Interval

Method	MSE	Prediction Interval
ARIMA (1,2,1) Model	0.0461	0.8346

The result of MSE is close to 0, and the range of the prediction period is small, indicating that the prediction result is relatively accurate. Therefore, the forecast result is ideal.

3.5. Model Results

According to ARIMA (1,2,1) model, the RMB exchange rate in the coming year is predicted, and the result is shown in Figure 6.

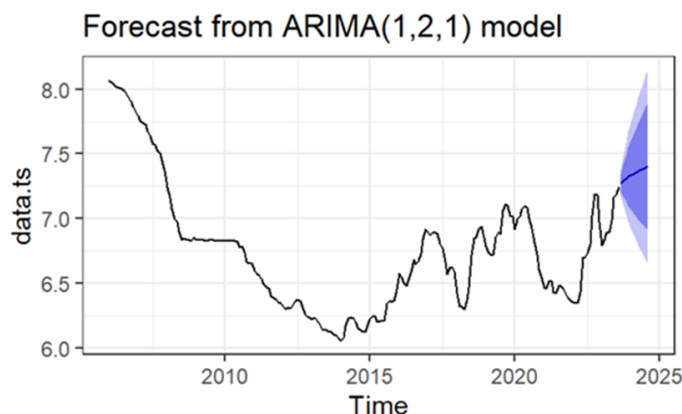


Fig. 6 Forecast from ARIMA (1,2,1) Model

According to the predictions, the tenth interest rate hike in the United States, which ended in May 2023, and the gradual intensification of decoupling between China and the U.S. still have some influence on the depreciation of the Chinese Yuan (RMB). According to the forecast results, the RMB will continue to depreciate in the next year. However, the situation is still basically stable in the short

term of the future, and there is no possibility of substantial depreciation. This may have something to do with China's conservative fiscal policy.

4. Conclusion

The International Monetary Fund (IMF) research suggests that if U.S. interest rates are rising because of the improvement of the domestic economy, the effect on emerging markets is positive. After the U.S. interest rate rises, the import demand and market confidence in the United States have increased. In this case, emerging markets, especially markets that rely on U.S. imports, can profit from American economic demand, which can partially offset the negative effect of rising interest rates. However, if U.S. rate rises are an attempt to curb domestic inflation or a sign that the FED will act more hawkishly, such monetary policy could be disruptive to emerging markets. The appreciation of the dollar and the depreciation of the currencies of emerging countries will increase the external debt pressure of companies in emerging countries and improve the purchasing power of the dollar, which will trigger the harvest of high-quality resources in emerging markets.

The current rate hike in the United States is mainly in response to a domestic inflation crisis, and history shows that such a situation can cause significant capital outflows from emerging markets like China. In the U.S. rate hike policy of 2015-2018, the yuan depreciated by 4.7% in 2015 and 7.0% in 2016. At the same time, the net outflow from China's non-reserve financial accounts in 2015 and 2016 was \$4344.6 billion and \$4,160.7, respectively. China's foreign exchange reserves have also fallen rapidly from \$4 trillion to \$3 trillion during this period. Besides, as China has increased debt and inflationary pressure in response to the COVID-19 epidemic, it has less room to deal with the external shocks. In this context, China may face more severe capital outflows than in 2015-2016.

The U.S. interest rate hike has caused significant fluctuations in the currencies of the world's major economies. Not only the currencies of emerging economies but also the currencies of developed economies such as the euro of Europe and the yen of Japan. For example, the yen broke through 150 yen/dollar in October 2022, the highest level in 32 years. On the one hand, the aggressive monetary policy of the United States has enhanced the ability of the United States to harvest the world's high-quality assets, but on the other hand, it has also intensified the world's de-dollarization trend.

De-dollarization is when countries reduce their reliance on the dollar as a reserve currency, medium of exchange, or unit of account. An important feature of de-dollarization is the decrease in dollar settlement. In the context of the depreciation of the currencies of major economies in the world caused by the US dollar interest rate hike, the pressure of emerging countries' foreign debt has increased, and the phenomenon of capital flight has intensified. To avoid further harvesting of high-quality capital by the U.S. dollar and prevent the payment crisis caused by the surge of foreign debts, some emerging countries, including China, are gradually using local currency settlement to replace the original U.S. dollar settlement system to reduce losses in the wave of US dollar interest rate hike. For example, Brazil announced in March 2023 that it would conduct trade with China in its own currency, instead of using the U.S. dollar as an intermediate currency. In addition, the hawkish trade and investment protectionism of the United States has made trade and financial sanctions generalized, which has seriously impacted the existing international financial and international trade system. This has greatly weakened the security of the dollar as an international reserve currency and overdrawn the credibility of the United States. The stability of the RMB exchange rate and the world's demand for China's complete industrial chain make RMB settlement one of the best ways to avoid the U.S. dollar settlement. Therefore, the move away from the dollar can promote the internationalization of the RMB. In fact, in the trend of global de-dollarization triggered by the US interest rate hike, the internationalization of the RMB has also made certain progress. Russia and Saudi Arabia signed agreements with China to purchase oil in yuan in June and July 2023, respectively. These two agreements greatly promoted the construction of a trading system centered on the RMB. The internationalization of the RMB can further promote China's trade with other countries and reduce the exchange rate risk of the RMB.

The time for the U.S. dollar to raise interest rates is limited. Therefore, China should weaken the negative impact of the United States' aggressive interest rate hike policy and strengthen the positive driving force of the de-dollarization wave.

First, strengthen Monitoring of the RMB Exchange Rate Market: Guide financial institutions to strengthen the supervision of the legitimacy of transactions to avoid large amounts of foreign exchange purchases and settlement of foreign exchange confusion. In addition, the government should improve the inspection of financial institutions' illegal proprietary activities.

Second, guide the Signing of Foreign Debt Agreements of Enterprises: Guide enterprises to use RMB or multi-currency settlement when signing foreign debt agreements to reduce losses caused by fluctuations in the U.S. dollar exchange rate.

Third, keep the Value of RMB Stable: The stability of the value of the RMB not only contributes to the stability of China's outbound investment environment but also enhances the confidence of foreign investors, which will promote the internationalization of the RMB.

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