The Impact of Fed's Interest Rate Hike on RMB Exchange Rate: Based on Stepwise Regression Modelling

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Abstract. In the late stage of the epidemic, the Federal Reserve raised interest rates several times in a row in response to domestic inflation, which had a significant impact on the international financial environment, as exemplified by the fluctuation of the RMB exchange rate. Although several worldwide and domestic scholars have used various models to study the relationship between them, there are no studies that have used linear regression models t to clarify how the two are connected. This study uses stepwise regression on the basis of linear regression to establish an optimal model for studying RMB exchange rate fluctuations and the Fed's monetary policy adjustment, which fills this research gap. It is found that Fed rate hikes cause the RMB exchange rate to decline., while the RMB exchange rate is also negatively affected by the seven-day repo rate in China's interbank market and the People's Bank of China's foreign exchange reserves. Therefore, this study concludes by recommending that investors, Chinese foreign trade firms and People's bank of China take appropriate measures to minimize the impact of RMB depreciation in anticipation of the Fed's interest rate hike.

Keywords: The Federal Reserve System, Monetary policy, RMB exchange rate, stepwise regression.

1. Introduction

The Fed has increased interest rates 11 times straight since March 2022. By 20 September 2023, the Federal Reserve held a rate meeting and announced that it would keep the federal funds rate fluctuating between 5.25 and 5%. and that the cap on tapering would remain at $95 billion per month as planned. So far, nearly a year and a half of the Fed's successive interest rate hikes to press the "pause button". As for the reasons for the Fed's interest rate hike, it was mainly due to the global supply chain disruption after the epidemic, which led to rising prices and inflationary pressure. The Federal Reserve plans to control inflation by adopting a tight monetary policy and raising interest rates, thereby dampening consumer demand and lowering prices. And since March 2022, the renminbi has entered a depreciation cycle, by June 2023, the renminbi exchange rate had fallen below 7, and by September it had fallen below 7.3. Against this background, this paper examines the association and impact on the RMB exchange rate of the Fed's increase in interest rates float.

Due to the lofty international status of the Federal Reserve and the increasing internationalization of the RMB, substantial literature has examined the volatility of the Fed's monetary policy and the RMB exchange rate. As Copper (1969) suggests, a country's monetary policy is not closed and independent, and adjustments in national monetary policy are transmitted to other countries through various channels. Sun Yanlin and Zhang Qianting (2016) establish a TVP-VAR model to analyze how Fed's increase in interest rates affects China from the perspective of exchange rate and interest rate. By founding a DSGE model for the economies of America and China, Guangmin Fu (2017) concluded that a Fed interest rate hike would lead to a reduction in China's inflation rate, a fall in stock prices, and a depreciation of the RMB exchange rate. Sun Xinxin and Lu Xinsheng (2017), on the other hand, used a two-variable VECM-GJR-MVGARCH (1, 1) -BEKK extended model to analyze that the Federal Reserve's monetary policy shocks have an impact on both the forward exchange rate and the onshore spot exchange rate. Using different models, scholars have tried to establish a link between the adjustment of the Fed's interest rate and the fluctuation of the RMB exchange rate. Moreover, Yang Guangqing and Du Haipeng (2015) obtained that the import and

export commerce will be impacted by the RMB exchange rate fluctuation., especially the import and export in the nations and areas bounded by the "Belt and Road". Based on this, it is crucial to research how the Federal Reserve's monetary policy changes affect the RMB exchange rate's volatility.

This study will use stepwise regression to construct an optimal regression model to investigate the direction and magnitude of the influence of changes in the Federal Reserve's interest rate on the volatility of the RMB exchange rate, and to give corresponding suggestions to different objects and groups.

2. Method

2.1. Sample data selection and description

Table 1. Descriptive Statistics 1.0.

VarName	Obs	Mean	SD	Min
ER	97	6.716	0.251	6.298
FFFR	97	0.013	0.014	0.000
CHIBOR	97	0.025	0.005	0.016
REPO	97	35.794	4598.614	-1.03e+04
FOREX	97	31513.064	984.831	29982.040
CSI	97	0.001	0.055	-0.210
SPX	97	0.009	0.046	-0.125
IRS	97	-0.012	0.015	-0.027

Table 2. Descriptive Statistics 2.0

VarName	Max	Skewness	Kurtosis
ER	7.173	0.016	1.819
FFFR	0.053	1.281	3.927
CHIBOR	0.037	0.370	2.870
REPO	17050.000	0.627	4.458
FOREX	35573.810	1.925	8.463
CSI	0.146	-0.306	4.482
SPX	0.127	-0.399	3.387
IRS	0.034	1.525	4.397

For a total of 97 samples, monthly data from August 2015 to August 2023 were collected for this study. Data collection started in August 2015 because China implemented exchange rate reform measures on 11 August 2015, which facilitated the RMB's internationalization. The RMB exchange rate's erratic behavior in August 2015 and thereafter is therefore more susceptible to the international economic environment.

In this paper, the median exchange rate (ER) of the RMB against the US dollar is chosen to measure the exchange rate level of the RMB; the Federal Reserve Federal Funds Rate (FFFR) is chosen to reflect the Federal Reserve's policy of raising or lowering interest rates, and thus to measure the status of the Federal Reserve's monetary policy. As for the selection of control variables, according to existing studies, domestic monetary policy adjustments and capital market changes also affect the short-term RMB exchange rate [6]. Based on the availability of data and the approach of the existing literature, this paper controls for monetary policy adjustments and capital market movements in China.

In terms of monetary policy, this paper selects the seven-day repo rate in the interbank market (CHIBOR) to reflect the domestic monetary policy, the net money injection in the People's Bank Of China’s (subsequently abbreviated as PBC) open market operation (REPO) to reflect the money injection by the PBC, and the foreign exchange reserves (FOREX) to reflect the degree of the Chinese central bank's intervention in foreign exchange. In terms of capital market, this paper chooses CSI 300 index return (CSI) to reflect China's capital market and S&P 500 index return (SPX) to reflect the U.S. capital market. In addition, this paper also makes a difference between the Federal Reserve's federal funds rate and China's interbank pledged repo weighted rate to obtain the US-China interest

rate spread (IRS), thus reflecting the difference in the adjustment direction of monetary policy between China and the US.

As for the detailed analysis of the data, firstly, in terms of standard deviation, the standard deviation of the Federal Reserve's Federal Funds Rate, the CSI 300 Index return and the S&P 500 Index return is small, suggesting that they are more concentrated and less discrete. While the standard deviation of the PBOC's net open market operation money injection and China's foreign exchange reserves are relatively large, the extreme deviation also shows that the range of these two data is large, indicating that the data distribution is more discrete. Secondly, in terms of skewness, the skewness of the mid-rate of the RMB/USD exchange rate is close to 0, which can be regarded as a normal distribution. Both the Deep 300 index returns and the S&P 500 index returns have negative skewness and show negatively skewed distributions. All other data are positively skewed. All of the above data have kurtosis greater than 0, showing high peaks.

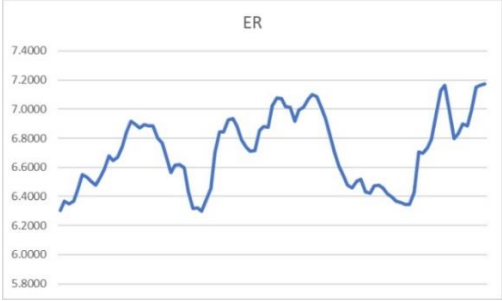

Figure 1. 2015.8-2023.8 RMB to US Dollar exchange rate median price folding chart

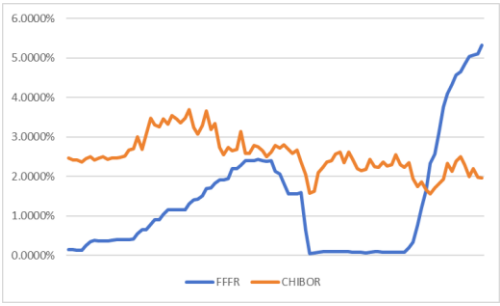

Figure 2. 2015.8-2023.8 Line graph of interest rates in China and the US

All the above data are from Wind database, the data is more authoritative and reliable.

2.2. Research methodology

This paper focuses on whether the adjustment of the Fed's monetary policy has an impact on the volatility of the RMB exchange rate and intends to get the direction of the impact. Therefore, this paper chooses stepwise regression for empirical analysis. Because stepwise regression operates on the basis of linear regression, a linear regression model is first established with the formula shown below:

$$ER_t = \beta_0 + \beta_1 FFFR_t + \beta_2 CHIBOR_t + \beta_3 REPO_t + \beta_4 FOREX_t + \beta_5 CSI_t + \beta_6 SPX_t + u_t \quad (1)$$

$$ER_t = \beta_0 + \beta_1 IRS_t + \beta_2 CHIBOR_t + \beta_3 REPO_t + \beta_4 FOREX_t + \beta_5 CSI_t + \beta_6 SPX_t + u_t \quad (2)$$

In this paper, the Federal Reserve Federal Funds Rate (FFFR) and the interest rate differential (IRS) between China and America are used as explanatory variables respectively, the former is intended to examine how the RMB exchange rate is affected by the Fed's monetary policy moves, and the latter can reflect the impact of the disparity between the directions of the monetary policy adjustments of America and China on the RMB exchange rate. And u_t is an unobserved random perturbation factor.

Because large order of magnitude differences between the data can affect the regression coefficients, this paper uses standardization to transform all the data into standardized values that are dimensionless and without order of magnitude differences. The specific standardization method is the Extreme Difference Standardization method, which is performed as follows:

In the first place, find out the maximum (X_{max}) and minimum (X_{min}) values of the indicator and calculate the extreme variance ($R = X_{max} - X_{min}$). After that, the minimum value (X_{min}) will be subtracted from each observed value (X) of the variable and divide it by the extreme variance (R), ie:

$$X' = \frac{X - X_{\min}}{X_{\max} - X_{\min}} \tag{3}$$

Because the linear regression model is an initial model, its variables have not been selected. Stepwise regression needs to be used to perform variable selection and eventually build the optimal model. When performing stepwise regression, forward selection and backward elimination need to be crossed.

Firstly, the existing n variables are introduced to build a regression model with the dependent variable separately, and finally n models will be obtained along with the F-statistics of the variables in each model and their p-values. After that, if none of the n models are significant, choose the independent variable that corresponds to the significant model with the biggest F-statistic; this independent variable is then incorporated to the model. By this step a significance variable has been obtained and the model now includes this variable. The other variables are then added to each model one by one until there are n-1 models, at which point the variable with the highest and most significant F-value is chosen to be added to the model.

Backward culling is then performed. If there are m variables selected forward to be added to the model, each independent variable is removed separately to obtain m models containing m-1 variables. Compare these m models and find the variable whose removal reduces the sum of squares of the residuals the least, this variable is the one with the least effect and this variable needs to be removed from the model.

The selection and elimination process should be repeated until the final addition of variables does not cause the residual sum of squares to decrease. At this point, all the independent variables left are significant, i.e., they have a non-negligible effect on the explanatory variables, and again there is no multicollinearity [7].

3. Result

The following results were obtained by stepwise regression:

Table 3. Regression results

	(1)	(2)
VARIABLES	ER	ER
EFFR	0.425***	/
	(0.0752)	/
CHIBOR	-0.362***	/
	(0.0875)	/
FOREX	-0.854***	-0.785***
	(0.117)	(0.113)
IRS	/	0.562***
	/	(0.0786)
Constant	0.775***	0.555***
	(0.0672)	(0.0435)
Observations	97	97
R-squared	0.574	0.557

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Column (1) is a regression with the Federal Reserve Federal Funds Rate as the main independent variable and the interbank market's seven-day repo rate and foreign currency reserves as control variables. The purpose is to examine how the Fed's monetary policy will affect the RMB exchange rate. Column (2) is a regression with the U.S.-China interest rate differential as the main independent variable and foreign exchange reserves as the control variable. The objective is to study the impact of the gap in the direction of monetary policy implementation between the US and China on the RMB exchange rate.

The optimal model obtained is shown below:

$$ER_t = \underset{(0.0672)}{0.775} + \underset{(0.0725)}{0.425}\,FFFR_t - \underset{(0.0875)}{0.362}\,CHIBOR_t - \underset{(0.117)}{0.854}\,FOREX_t, R^2 = 0.574 \tag{4}$$

$$ER_t = \underset{(0.0435)}{0.555} + \underset{(0.0786)}{0.562}\,IRS_t - \underset{(0.113)}{0.785}\,FOREX_t, \quad R^2 = 0.557 \tag{5}$$

After a stepwise regression, net monetary injections from the PBC's open market operations, CSI 300 index returns and S&P 500 index returns are excluded, which indicates that these control variables have a small effect on the RMB exchange rate. The PBC's open market operations can have an impact on the money supply, mainly affecting the domestic economic environment and having less of an impact on international finance. As for changes in stock index yields in the capital markets of the two countries, they would mainly affect domestic financial markets and have a smaller impact on exchange rates.

As can be seen from the coefficients, when holding other control variables constant, the federal funds rate of the Federal Reserve rises by one unit, depreciating the RMB exchange rate by 0.425 units. This suggests that the Fed's federal funds rate is positively correlated with the RMB exchange rate, i.e., a Fed rate hike causes the RMB to depreciate. The Federal Reserve's federal funds rate continues to rise, widening the interest rate differential between China and the United States, making the international capital flow from China to the United States, the investor demand for U.S. dollars increased, the demand for the yuan decreased, which led to the depreciation of the yuan [8].

Meanwhile, as far as the regression coefficient of the control variable CHIBOR is concerned, the median exchange rate of the RMB versus the US dollar is negatively impacted by the seven-day repo rate in the interbank market. Holding all other variables constant, each unit decline in CHIBOR induces a depreciation of 0.362 units of RMB. This indicates that a cut in interest rates by the PBC will lead to a depreciation of the yuan. The reason for this is that when the RMB depreciates, in order to increase their earnings, investors will migrate their money from nations with low interest rates to those with high interest rates., thus leading to massive capital flight [9]. Demand for the RMB in the foreign exchange market has decreased and demand is smaller than supply leading to depreciation pressure on the RMB. At the same time, frequent interest rate cuts will also make the public's confidence in the country's economy weaken, thus generating psychological expectations of a recession and further depreciating pressure on the RMB.

Further, it can also be seen from the results that the control variable FOREX also has a negative effect on the RMB exchange rate. Holding other variables constant, each unit decline in FOREX leads to a depreciation of 0.854 units of RMB. This suggests that a decline in foreign exchange reserves can also lead to a depreciation of the RMB. This is because a decrease in foreign exchange reserves leads to a relative increase in the country's demand for foreign exchange, which leads to a relative decrease in the demand for the local currency, putting pressure on the RMB to depreciate [10].

As for the result in column (2), holding other variables constant, a one-unit increase in the interest rate differential between America and China causes the RMB to depreciate by 0.562 units. This shows a favorable impact of the RMB exchange rate and the difference in US-China interest rates. The RMB will depreciate as the difference in interest rates between China and the US grows.

4. Conclusion

This analysis reveals that the impact of the Fed's interest rate rise on the RMB exchange rate would be more than previously thought. For different groups of people, this article gives the following advice:

For investors investing in exchange rate futures, it is recommended to hold long dollar positions in anticipation of a Fed rate hike. Because the depreciation of the RMB exchange rate means a relative appreciation of the US dollar, profits are made by going long on the US dollar. It is also possible to hold a short position in RMB and profit by shorting RMB in anticipation of a depreciation.

For Chinese companies that often conduct foreign trade business, if the Fed signals an interest rate hike, it is recommended that when signing contracts for cross-border transactions settled in US dollars, they should sign forward contracts with the US dollar as the underlying, so as to avoid loss of interest due to the relative appreciation of the US dollar. At the same time, enterprises can also purchase put options on RMB when conducting foreign exchange transactions to minimise losses during foreign trade transactions.

For the PBC, when the Fed goes through a rate hike cycle, it suggests that the yuan will be hit by depreciation. At this time, in order to stabilise the foreign exchange market and the confidence of domestic investors, it is necessary to adjust domestic monetary policy and foreign exchange reserves to preserve the RMB exchange rate's stability.

The federal funds rate and the RMB-dollar exchange rate are established using a stepwise regression model in this study, which also adds pertinent variables from the money market and the capital market, and clearly, explicitly and directly demonstrates the effect of monetary policy changes made by the Fed on the RMB exchange rate. By excluding variables that have a substantial impact on the RMB exchange rate, the model is able to prevent multicollinearity. Additionally, the regression coefficients allow the model to establish the direction of the independent variables' influence on the RMB exchange rate. However, the number of variables selected in this study is limited, thus having an impact on the explanatory strength of the model, and more variables can be entered vertically and horizontally in the future to improve the explanatory strength of the model.

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