Research on the Raising Rates Policy of the Fed

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Abstract. Due to the unique status of the U.S. dollar in the world, every time the Federal Reserve raises interest rates on the U.S. dollar, it will arouse global attention to it and will also affect the global economy. Raising the federal funds rate is the usual means for the United States to quell its inflation. In the process, as the U.S. dollar raises interest rates and returns to the country, it will cause currency depreciation and credit crises in many economies, which has led to many countries in the world. Questioning the intention of the US dollar to raise interest rates, some scholars in the academic circle believe that raising the federal funds rate is the last step for the US dollar to harvest the world. This paper selects relevant variables and uses methods such as vector autoregression and Granger causality test to try to explore which variables will be affected by the Fed's interest rate hike.

Keywords: Fed, CPI, Granger, VAR, time series.

1   INTRODUCTION

On May 4, 2023, the Federal Reserve System has raised interest rates for the tenth time, but its inflation rate remains high. Since then, on May 16 of the same year, U.S. Treasury Secretary Yellen once again issued a warning on debt default, and U.S. debt will usher in a default in early June. Specifically, the Fed raised interest rates by selling treasury bonds and withdrawing funds through open market operations to raise the federal funds rate. Today, the United States is in such an embarrassing situation. They can only give up raising interest rates and continue to maintain a high inflation rate; and if they want to choose to quell inflation, people have to continue to raise interest rates, which will continue to increase the amount of US debt. being threatened. It seems that there is only one way to choose to raise the debt ceiling, but continuously raising the debt ceiling will not only increase the government's debt, but also lead to serious financial problems; at the same time, the long-term high debt level will also affect the image and reputation of the United States, which will also lead to the decline of the dollar's status. Therefore, it is important to understand why the Fed is raising rates and how to deal with the impact of their rate hikes.

In a study of the global impact of the federal funds rate hikes, the Fed claimed that raising the federal funds was to calm inflation. In the existing research, Wang et al.

analyzed the correlation between inflation and the Fed's monetary policy by demonstrating the reason and rationality of CPI as an inflation research indicator, and by splitting CPI and constructing a regression model between CPI's sub-items and the benchmark interest rate [1]. According to the current academic circles, the influence of raising the federal funds rate is far beyond the United States, and it will also affect other economies through the spillover effect of monetary policy. Especially since 2022, Yu and Wang believed that with the continuous strong appreciation of the U.S. dollar, the international financial market has formed a spiral superimposed cycle model of "Fed rate hike-dollar appreciation-emerging market countries' currency decline-international capital rapid return to the United States" [2]. Therefore, the international capital flow caused by raising the federal funds rate will continue to have a negative impact on emerging market countries. There are two main research frameworks when it comes to the spillover effects of monetary policy, one is the New open-economy Macroeconomics (NOEM) model, and the other is the Mundell-Fleming-Dornbusch (MFD) model [3]. Based on these two models, many scholars use empirical methods to study the influence of monetary policy on the economy and have achieved a lot of results. One of the methods used is vector autoregressive modeling.

In the research on the spillover of monetary policy, there are three main channels of its theoretical mechanism, which are exchange rate transmission channel, interest rate transmission channel and credit channel [4]. Specifically, in the exchange rate transmission channel, according to Keynes's Interest Rate Parity Theory, if an interest rate differential exists between two countries, capital will flow from countries with lower interest rates to those with higher interest rates in order to seek profits. Raising the federal funds rate will lead dollar exchange rate rising, so that the dollar becomes more valuable than other currencies. In this way, there will be a risk of large capital outflows to some economies other than the United States, which in turn will exacerbate the depreciation of currencies in other countries. Hu constructed a Structural Vector Autoregression (SVAR) model by selecting variables such as USD/CNY exchange rate and the scale of cross-border capital to analyze the risk of cross-border capital flows in China from the Fed's interest rate hikes and found that the Fed's interest rate hikes have generated cross-border capital flow risks, leading to Increased exchange rate volatility, resulting in an economic downturn [5]. In addition, Yu believed that although changes in the US monetary policy will have an influence on the national economy of some emerging countries through exchange rates, in practice these countries can avoid some risks through exchange rate controls and restrictions on cross-border capital flows [6]. From the perspective of asset prices, raising the federal funds rate has a restraining effect internally, and at the same time, it will also attract a large number of foreign capital to sell domestic assets to invest in US stocks, resulting in a decline in asset prices such as stocks in emerging economies. Wu used the SVAR model to study the spillover effect of raising the federal funds rate and found that it would have a negative impact on the Shanghai Composite Index and have a significant inhibitory effect on the Chinese stock market [7]. Bowman et al. studied the impact of US monetary policy on the yields and stock prices of sovereign bonds in emerging countries, and the results showed that U.S. monetary policy has a significant impact on sovereign bond yields in most emerging market countries [8]. Combining the above two channels, Chortareas

and Noikokyris found that A country's monetary policy will determine whether a U.S. monetary policy shock will have an impact on its stock market. When the country's interest rate changes are synchronized with U.S. interest rate changes, U.S. monetary policy has little effect on these countries' stock markets [9]. In terms of credit channels, Rey believed that the US monetary policy has a more significant impact on some peripheral countries [10]. When the Fed raises interest rates, it will lead to higher borrowing costs for other countries, and it will also cause some countries to increase their debt and face the risk of debt default and financial crisis, which may weaken global prosperity. Bruno and Shin pointed out that for some cross-border banks, when these banks finance US dollar liabilities and issue loans to the local currency in their own currency, and the Fed raises interest rates to make the US dollar appreciate, then bank liabilities denominated in local currency will undoubtedly increase, which will lead to Increased chances of bank failure [11].

To sum up, this paper starts from the above three channels, focusing on the first channel, and selects the exchange rate of USD/RMB, EUR, and JPY as the representative variables of the exchange rate. The S&P index is used as a representative variable representing the US stock market, and the U.S. Consumer Price Index is used to measure the extent of inflation. Construct the VARM model and conduct the Granger causality test on the above variables, so as to explore the reasons for the Fed's interest rate hike and its impact.

2   METHOD

2.1   Data origin and related processing

This paper selects the federal funds rate, the US dollar money supply M1, the US consumer price index, the Standard & Poor's index, USD/CNY exchange rate, dollar to euro exchange rate, and USD/JPY exchange rate from January 2000 to April 2023. For analysis, in the data analysis, the logarithmic processing of M1, the US consumer price index S&P index, and the USD/JPY exchange rate was first performed to smooth the data and narrow the data range.

Table 1. Descriptive statistics of each indicator.

Statistics	SP	M1	RMB	RATE	JPY	EURO	CPI
Mean	1906.786	4326.34	7.130214	1.695679	108.1801	1.196714	224.1479
Median	1433.67	2117.7	6.84	1.045	109.315	1.195	226.095
Maximum	4766.18	20665.1	8.28	6.86	147.05	1.58	303.36
Minimum	735.09	1088.6	6.05	0.04	76.64	0.85	168.8
Std. Dev.	995.1517	5802.705	0.786747	1.916585	13.73309	0.159034	32.5311
Skewness	1.194661	2.145996	0.450961	1.082563	-0.37749	-0.11696	0.269259
Kurtosis	3.398826	5.84716	1.629185	2.987995	3.226756	2.631567	2.49207
coefficient of variation	0.521900 05	1.341250 34	0.110339 89	1.130275 84	0.126946 55	0.132892 24	0.1451323

It can be seen from Table 1 that the largest coefficient of variation of the money supply M1 and the federal funds rate indicates that the data fluctuates more violently, and the variation range of the S&P index is next. It is worth noting that the coefficient of variation of the relevant variables of the exchange rate is at a low level, indicating that the fluctuation of the exchange rate is small, and the overall stability is relatively stable.

2.2   Model setting

The VAR model adopts the form of multi-equation simultaneous, which makes it possible to model and predict the relationship between multiple economic variables. Compared to the traditional autoregressive model (AR), it considers the interrelationships among multiple variables, and can more accurately describe the dynamic evolution process of macroeconomic phenomena. Therefore, it has been widely used, especially in the fields of macroeconomic analysis, policy formulation and financial risk management. The mathematical expression of the VAR(p) model is:

$$y_t = \varphi_1 y_{t-1} + \cdots + \varphi_p y_{t-p} + H x_t + \varepsilon_t, t = 1, \cdots T \qquad (1)$$

VAR models generally include three key elements: variable set, lag order, and model evaluation. Among them, the variable set is to select the economic variables that need to be modeled, the lag order refers to the lag period included in each variable in the VAR model, and the model evaluation includes the stability test of the model, residual diagnosis, information criterion selection, etc. However, it should be noted that the VAR model also has some limitations. For example, the selection of variables in the equation and the determination of the lag order need to take into account the characteristics of the actual problem and the characteristics of the data.

2.3   Stationarity test

When modeling the vector autoregressive model, whether the variables are stationary is crucial. The VAR model is used to describe the dynamic relationship between multiple endogenous variables. It represents the current observed value of each endogenous variable as a linear combination of all endogenous variables in the past several periods, where each endogenous variable can be a lagged value of other variables. Compared with the traditional univariate autoregressive model, the strengths of the VAR model are that it can analyze the complex interaction between multiple variables and it can also explore the variable relationship in the immature economic theory. However, when applying the VAR model, the inevitable problem is to ensure the stability of the data, because the appearance of non-stationary time series will lead to false regression phenomenon, which will lead to errors in the analysis results. Therefore, the data stationarity test is very important. Usually, stationarity testing is often done with unit root tests.

Table 2. Variable stationarity test results

Variable	ADF	1% level	5% level	p-value	conclusion
rate	-3.649	-3.454	-2.872	0.005	Yes
M1	1.289	-2.573	-1.942	0.950	No
lnM1	2.352	-2.573	-1.942	0.996	No
DlnM1	-14.987	-3.454	-2.872	0.000	Yes
cpi	5.242	-2.573	-1.942	1.000	No
lncpi	5.344	-2.573	-1.942	1.000	No
Dlncpi	-10.305	-3.454	-2.872	0.000	Yes
sp	2.205	-2.573	-1.942	0.994	No
lnsp	1.475	-2.573	-1.942	0.965	No
Dlnsp	-16.228	-2.573	-1.942	0.000	Yes
euro	-0.050	-2.573	-1.942	0.665	No
Deuro	-12.229	-2.573	-1.942	0.000	Yes
rmb	-1.050	-2.573	-1.942	0.265	No
Drmb	-9.621	-2.573	-1.942	0.000	Yes
jpy	0.235	-2.573	-1.942	0.754	No
lnjpy	0.343	-2.573	-1.942	0.784	No
Dlnjpy	-12.997	-2.573	-1.942	0.000	Yes

In this paper, the ADF test is adopted and the unit root test is performed on each data using the SIC criterion. From Table 2, the results show that the federal funds rate is a stationary time series, the money supply M1, the CPI, the S&P index, dollar to euro exchange rate, USD/JPY exchange rate, and USD/CNY exchange rate are all non-stationary time series. After the first-order difference processing is performed on the non-stationary data, the obtained variable series are all stationary time series.

2.4   Optimal lag order selection

For the VAR model, the lagging order reflects the dynamic characteristic of the model, but it is important that in the process of pursuing the integrity of the reflection, its degree of freedom will decrease accordingly. Therefore, when choosing the lag order, not only the degree of response to dynamic characteristics, but also the related issues of degrees of freedom should be considered. Commonly established methods include LR test, AIC, and SC criteria. According to Table 3, under the FPE, AIC, SIC, and HQ information criteria, the optimal choice of the lag order of the model is 1.

Table 3. Information Criteria Judgment Result

Lag	LogL	LR	FPE	AIC	SC	HQ
0.000	3055.433	NA	0.000	-22.498	-22.405	-22.460
1.000	3701.511	1254.011	4.88e-21*	-26.904*	-26.159*	-26.605*
2.000	3738.074	69.080	0.000	-26.812	-25.417	-26.252
3.000	3782.517	81.669	0.000	-26.779	-24.732	-25.957
4.000	3829.560	84.018	0.000	-26.764	-24.066	-25.681
5.000	3865.277	61.944	0.000	-26.666	-23.317	-25.321
6.000	3904.878	66.635*	0.000	-26.597	-22.596	-24.990
7.000	3930.308	41.477	0.000	-26.423	-21.771	-24.555
8.000	3960.422	47.559	0.000	-26.284	-20.980	-24.154

3   RESULT AND DISCUSSION

3.1   Model stationarity test

The method often used to test the VAR model is the unit root diagram test. The specific test standard is that when it is found that no unit root is located on the unit circle or outside the circle, then we can judge that the VAR model is stationary. According to Figure 1, all unit roots are located in the unit circle, which proves that the established VAR(1) model is stable. Therefore, according to EViews, the estimated results of the model parameters are as follows:

$$
\begin{pmatrix}
DEURO_t \\
DLNCPI_t \\
DLNSP_t \\
DLNM1_t \\
DLNJPY_t \\
DRMB_t \\
RATE_t
\end{pmatrix}
=
\begin{pmatrix}
0.278 & -0.603 & 0.053 & 0.026 & -0.050 & 0.003 & 0.001 \\
0.025 & 0.470 & 0.007 & 0.003 & 0.023 & -0.002 & 3.674 \\
0.171 & -0.029 & -0.032 & 0.014 & 0.290 & -0.011 & -0.002 \\
-0.095 & -2.782 & 0.240 & 0.076 & -0.094 & 0.072 & -0.002 \\
0.003 & 0.900 & 0.002 & 0.003 & 0.227 & 0.007 & -0.0003 \\
-0.112 & 0.971 & -0.090 & -0.023 & 0.138 & 0.468 & -0.002 \\
0.269 & 4.478 & 0.831 & -0.083 & 1.206 & 0.572 & 0.987
\end{pmatrix}
\begin{pmatrix}
DEURO_{t-1} \\
DLNCPI_{t-1} \\
DLNSP_{t-1} \\
DLNM1_{t-1} \\
DLNJPY_{t-1} \\
DRMB_{t-1} \\
RATE_{t-1}
\end{pmatrix}
+
\begin{pmatrix}
-0.001 \\
0.001 \\
0.008 \\
0.019 \\
-0.001 \\
0.001 \\
0.008
\end{pmatrix}
+
\begin{pmatrix}
e_{1t} \\
e_{2t} \\
e_{3t} \\
e_{4t} \\
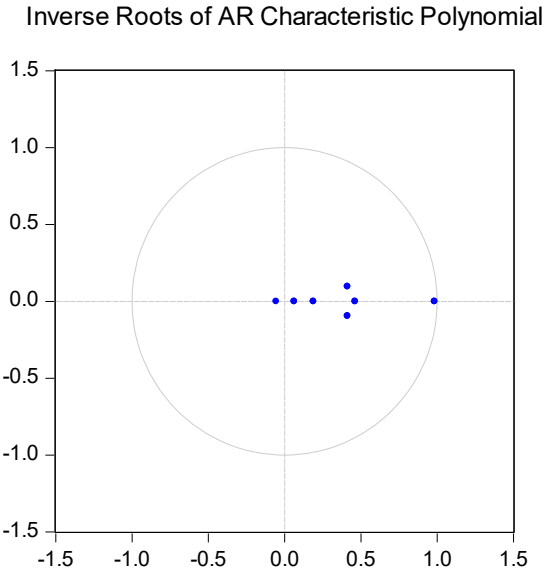e_{5t} \\
e_{6t} \\
e_{7t}
\end{pmatrix}
\tag{2}
$$

Inverse Roots of AR Characteristic Polynomial

Fig. 1. Model Stability Test Results

3.2   Granger causality test

According to the Granger causality test in Table 4, the following conclusions can be drawn:

Table 4. Granger causality test.

Has no Granger Cause	Chi-sq	Prob.
DEURO-DLNCPI	9.3244	0.0023
DLNJPY-DLNCPI	5.5277	0.0187
DLNCPI-DLNJPY	6.8009	0.0091
DLNCPI-DLNM1	5.8667	0.0154
DLNJPY-DLNSP	4.7904	0.0286
DLNSP-DLNM1	5.5504	0.0185
RATE-DLNSP	2.8651	0.0905
DLNSP-RATE	4.8901	0.0270
DRMB-RATE	3.3526	0.0671

At the 10% significance level: The federal funds rate and the S&P index are Granger causes for each other, which shows that there is a mutual influence between the two, and the federal funds rate and the S&P index can mutually predict the next data.

US dollar to RMB exchange rate is the Granger reason for the federal funds rate, which shows that the former will affect the latter. At the 5% significance level: There is only a single Granger cause for the federal funds rate and the S&P index, and it is believed that the S&P index has a single effect on the federal funds rate.

USD/JPY exchange rate and USD/EUR exchange rate are the one-way Granger reasons for the U.S.CPI. It is believed that the above two interest rates can have an impact on the U.S.CPI. At the same time, the CPI is also the Granger reason for USD/JPY exchange rate. It is believed that the CPI of the United States will have an impact on USD/JPY exchange rate.

The CPI is the money supply Granger reason thinks that the consumer price index will have an impact on the money supply M1. The dollar-yen exchange rate is the Granger reason for the S&P index that the dollar-yen exchange rate will have some impact on the US stock market.

4   CONCLUSION

According to the above test results, it can be concluded that, on the whole, changes in the US dollar-related exchange rate will cause adjustments to the federal funds rate and changes in the consumer price index, thereby affecting the US stock market and the US economic environment. Specifically, USD/CNY exchange rate will affect the federal funds rate and then the US stock market. At the same time, the US stock market, as one of the important factors reflecting the US economic situation, will also have a certain impact on the federal funds rate; The exchange rate of the euro and the yen will affect the US CPI and then affect the US dollar money supply M1.

In the foreign exchange market, changes in the exchange rate of the U.S. dollar exist all the time, and in order to maintain its hegemony, the U.S. dollar often takes certain measures to maintain its hegemony when the exchange rate of the dollar changes. In this paper, exchange rate changes will make an influence on interest rates and the consumer price index, but there is not enough evidence to show that there is an impact relationship between the CPI and the federal funds rate, so the argument that the Fed raises interest rates to calm inflation is still open to debate. Similarly, for countries, exchange rate fluctuations exist all the time. Countries should always pay attention to exchange rate fluctuations and guard against exchange rate risks. Only by stabilizing exchange rates can the economy develop steadily.

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