

Monetary Policy Uncertainty and China's Consumption Industry: Evidence from Fed's Rate Hike

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Abstract. This paper focuses on the fact that what will China's consumption look like under the influence of Fed's rate hike. Before finding out the result, the background of the Fed's rate hike and China's consumption, and the role of the raising interest rate will be introduced. And then, two data series will be used, which are USD/CNY exchange rate and consumer industry index. After that, based on two data series, two models, namely VAR model and ARMA-GARCH model will be built in order to observe these two data series. However, it is also necessary to check the stability of two data series and two models. In addition, the results of models will be discussed, analyzing how Chinese consumption is influenced by Fed rate hike. At the end of this article, advice will be given for the policymakers to deal with the situation of Fed's rate hike. Hopefully, this article can give some advice and help to policymakers and investors.

Keywords: Chinese consumption; Fed rate hike.

1. Introduction

The Fed's rate hike refers to the decision of the Federal Reserve System Governing Council to boost the federal funds rate following its interest rate meeting in Washington and modify monetary policy. Federal Reserve implements the monetary policy by setting interest rates.

In general, boosting interest rates can result in higher bank interest rates, which will decrease the money supply and strengthen the US currency. In addition, the US dollar exchange rate raised by an interest rate hike will influence the economy. Due to economic globalization, countries' economical relation is strengthened, and changes in one country's economic policies usually have a great impact on many countries, especially developed countries, and the impact is more obvious [1]. And there are mainly three roles of interest rates in the monetary policy process [2]. The first one as the instrument variable is set to implement the policy. The second role is still as the instrument variable, but to pursue an intermediate target. The last one is an information variable. In short, the changes in interest rates are for the sake of coping with economic conditions. However, there's still hard to implement monetary policy because objective things are always changing over time so interest rates are always changing too.

The Fed's rate hike cycle generally begins when the economy stabilizes and recovers, employment data performs well, and the inflation rate rises above the critical point and shows a trending upward trend; when inflation expectations stabilize or decline, the rate hike cycle ends [3]. The Fed usually raises interest rates continuously, which not only gives the market a certain buffer time to avoid the economic shock caused by the rapid reduction of liquidity but also adjusts how quickly interest rates are rising and even changes the direction of monetary policy at any time according to the development of the economy in the process of raising interest rates. The Fed's interest rate increase will encourage the US dollar to strengthen, which will lead to a decrease in global liquidity, a repatriation of foreign money to the US, and changes in the financial markets of nations that experience capital outflows. It shows that the Fed's interest rate hike has a great impact on the global. Since it has such great influence and China's massive global economy, which is closely related to global economic and financial markets, it also affects China in many aspects.

There are mainly six aspects.

The first is to strengthen the expectation of RMB exchange rate depreciation. The relative depreciation of the RMB is conducive to improving the competitiveness of my country's export

products. If the international market is expected to depreciate the RMB, it may trigger large-scale arbitrage transactions and increase the RMB exchange rate's short-term volatility.

The second is to increase the pressure on foreign debt repayment. After the global financial crisis, the US dollar interest rate fell and the RMB appreciated greatly. Chinese companies integrated many US dollars and issued US dollar-denominated debt. Due to expectations of RMB appreciation, Chinese companies are less willing to hedge their foreign exchange exposure risks, and as the Federal Reserve raises interest rates, these companies may have difficulty repaying their dollar debts.

The third will have an impact on domestic asset prices. For example, domestic real estate has a large amount of foreign debt and increases in interest rates will significantly affect it.

The fourth is that it will affect the decline in commodity prices. Due to the low level of inflation and excess production capacity in China, the decline in bulk commodities may further lower the level of producer prices and increase the risk of imported deflation.

Fifth, capital departures accelerated, and foreign currency reserves fell. Under the double squeeze of China's central bank's easing and US interest rate hike expectations, capital outflows and domestic liquidity tightened, which is not conducive to economic recovery.

Sixth, it will make implementing China's monetary policies more challenging. On the one hand, in the face of the Fed raising interest rates, the central bank implements loose monetary policies such as cutting interest rates, which will lead to capital outflows and increase the pressure on RMB depreciation. On the other hand, the release of liquidity by the central bank may push up the current serious asset bubble and make it more difficult to adjust the structure.

The negative impact of these Fed rate hikes is controllable with corresponding policy adjustments, such as continuing to promote the internationalization of the RMB.

However, it also affects China's consumption. This paper is going to research China's consumption in the context of Fed rate hike and how the consumption is influenced by Fed rate hike through the data of USD/CNY exchange rate and consumer industry index. In the first place, the two series data's stability with ADF test is tested, which is the basis of setting models. For the second part, a VAR model is built, predicting the value of variables, which are exchange rates in yield and consumption in yield. The stability of VAR model also needs to be tested. The impulse response clearly shows the value of variables. For the final part, an ARMA-GARCH model is built in order to predict consumption yield and volatility at the same time. In addition, GARCH model is only used if there is conditional heteroskedasticity.

2. Research design

2.1 Data source

Data of USD/CNY exchange rate and consumer industry index are both from Choice Financial Terminal [4], which is an investment management and professional financial data analysis software under Orient Fortune, dedicated to providing high-quality financial data and related services for financial institutions, academic research institutions, and professional investors. Choice Financial Terminal has collected many kinds of data, containing commodities, foreign exchange, stocks, fixed income, funds, fixed income, macro-industry, and other disciplines. It also provides application tools such as Excel plug-ins, quantitative interfaces, and portfolio management. It integrates information query, statistical analysis, and application. It is a must for financial market participants. This terminal allows people to follow the newest information on economics all over the world.

In this paper, the USD/CNY exchange rate is the central parity rate, and the data of the consumer industry index and USD/CNY exchange rate are from September 2021 to August 2022. These data are used to research China's consumption under the background of Fed rate hike.

During the research, it will need logarithmic price and logarithmic rate of return which are calculated as:

$$\text{Log price}_t = \text{Log}_t(1 + \text{price}_t) \quad (1)$$

$$Yield_t = \frac{Price_t - Price_{t-1}}{Price_{t-1}} \quad (2)$$

$$Log\ yield_t = Log(1 + Yield_t) \quad (3)$$

2.2 Unit root test

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If a time series is stationary and has a unit root, it passes the unit root test. The time series variable is non-stationary if it has a unit root. Testing stationarity is crucial because if a time series is not stationary, it is difficult to model its past and future, i.e., it is difficult to model. In this case, there will be also a corresponding solution.

According to the test being performed, the alternative hypothesis can either be stationarity, trend stationarity, or explosive root, with the null hypothesis of a unit root test often being that a unit root exists (and is non-stationary) (stationary).

When it comes to the approach to unit root test, assuming that the time series y_t to be tested can be written as:

$$y_t = \alpha_t + \beta y_{t-1} + \sum_{i=1}^{p-1} \phi_i \Delta y_{t-i} + e_i \quad (4)$$

Along with D_t , z_t , and ε_t , which stand for the stationary error process, stochastic component z_t , and deterministic component D_t , respectively.

The test's goal is to determine whether the stochastic component has a unit root or is stationary (non-stationary) [5].

Table 1 is the results of raw data as well as the processed series:

Table 1. ADF test

Variables	t-statistic	p-value
Price		
Consumption	-2.369	0.3963
Exchange rate	-1.458	0.8430
Yield		
Consumption	-10.907	0.0000***
Exchange rate	-13.591	0.0000***

Note: *, **, *** represent the level of significance of 10%, 5% and 1%. $p < 0.1$ is *, $p < 0.05$ is **, $p < 0.01$ is ***.

From the result of ADF test, it can be found that the raw data of consumption and exchange rate in price do not perform well, both are not significantly stationary. But when taking the yield of the raw data, the data get much better: consumption in yield is significantly stationary under over 99% confidence intervals. The following models will be built with the stationary series based on the result of ADF test.

2.3 VAR model setting

When it comes to the prediction of several economic variables at the same time, there are two ways. One of them is that each variable is forecasted separately by using a univariate time series approach. The second option is to combine these variables into a system of predictions that is known as a "multivariate time series" and ensures that each prediction is consistent with the others. Such a strategy is "Vector Autoregression," or VAR, as promoted by Sims [6].

Assuming that the two regression equations' explained variables are the p-order lag values of the two time series variables y_{1t} and y_{2t} , respectively, constituting a binary VAR(p) system, then the explained variables are as follows:

$$\begin{cases} y_{1t} = \beta_{10} + \beta_{11}y_{1,t-1} + \dots + \beta_{1p}y_{1,t-p} + \gamma_{11}y_{2,t-1} + \dots + \gamma_{1p}y_{2,t-p} + \varepsilon_{1t} \\ y_{2t} = \beta_{20} + \beta_{21}y_{1,t-1} + \dots + \beta_{2p}y_{1,t-p} + \gamma_{21}y_{2,t-1} + \dots + \gamma_{2p}y_{2,t-p} + \varepsilon_{2t} \end{cases} \quad (5)$$

And $\{\varepsilon_{1t}\}$ and $\{\varepsilon_{2t}\}$ are white noise processes, so there is no self-correlation. But they allow for contemporaneous correlation between the disturbance terms of the two equations:

$$Cov(\varepsilon_{1t}, \varepsilon_{2t}) = \begin{cases} \sigma_{12}, & t = s \\ 0, & \text{others} \end{cases} \quad (6)$$

Put (5) and (6) together:

$$\begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix} = \begin{pmatrix} \beta_{10} \\ \beta_{20} \end{pmatrix} + \begin{pmatrix} \beta_{11} \\ \beta_{21} \end{pmatrix} y_{1,t-1} + \dots + \begin{pmatrix} \beta_{1p} \\ \beta_{2p} \end{pmatrix} y_{1,t-p} + \begin{pmatrix} \gamma_{11} \\ \gamma_{21} \end{pmatrix} y_{2,t-1} + \dots + \begin{pmatrix} \gamma_{1p} \\ \gamma_{2p} \end{pmatrix} y_{2,t-p} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \quad (7)$$

And get:

$$\begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix} = \begin{pmatrix} \beta_{10} \\ \beta_{20} \end{pmatrix} + \begin{pmatrix} \beta_{11} & \gamma_{11} \\ \beta_{21} & \gamma_{21} \end{pmatrix} \begin{pmatrix} y_{1,t-1} \\ y_{2,t-1} \end{pmatrix} + \dots + \begin{pmatrix} \beta_{1p} & \gamma_{1p} \\ \beta_{2p} & \gamma_{2p} \end{pmatrix} \begin{pmatrix} y_{1,t-p} \\ y_{2,t-p} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \quad (8)$$

Write $y_t \equiv \begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix}$, $\varepsilon_t \equiv \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix}$, and get:

$$y_t = \begin{pmatrix} \beta_{10} \\ \beta_{20} \end{pmatrix} + \begin{pmatrix} \beta_{11} & \gamma_{11} \\ \beta_{21} & \gamma_{21} \end{pmatrix} y_{t-1} + \dots + \begin{pmatrix} \beta_{1p} & \gamma_{1p} \\ \beta_{2p} & \gamma_{2p} \end{pmatrix} y_{t-p} + \varepsilon_t \quad (9)$$

Define the corresponding coefficient matrix as $\begin{pmatrix} \beta_{10} \\ \beta_{20} \end{pmatrix} = \Gamma_0$, $\begin{pmatrix} \beta_{11} & \gamma_{11} \\ \beta_{21} & \gamma_{21} \end{pmatrix} = \Gamma_1, \dots$, $\begin{pmatrix} \beta_{1p} & \gamma_{1p} \\ \beta_{2p} & \gamma_{2p} \end{pmatrix} = \Gamma_p$ and get:

$$y_t = \Gamma_0 + \Gamma_1 y_{t-1} + \dots + \Gamma_p y_{t-p} + \varepsilon_t \quad (10)$$

And $\{\varepsilon_t\}$ is called vector white noise process.

After setting the VAR model, it needs to test whether the residuals have self-correlation and follow a normal distribution.

When it comes to examining how much a shock of one unit causes other variables to change over time, it needs impulse response function, IRF.

$$\frac{\partial y_{t+s}}{\partial \varepsilon_t^j} = \psi_s \quad (11)$$

This formula shows the influence of value $y_{i,t+s}$ of the (t+s) period's i variable, when the disturbance term ε_{jt} of the j variable in the t period increases by one unit while remaining unchanged are other variables and the disturbance terms from earlier times. The impulse response function, or IRF, is a function that treats $(\frac{\sigma y_{i,t+s}}{\sigma \varepsilon_{jt}})$ as a function of the time interval s.

2.4 ARMA-GARCH Model setting

Engel noted that time series data also exhibit a unique type of variation known as "Autoregressive Conditional Heteroskedasticity," or ARCH. [7].

The ARCH model's fundamental tenet is that, given the available data, the incidence of noise at a given time follows a normal distribution with a zero mean value and a time-varying variance (i.e., conditional heteroskedasticity). Additionally, this time-varying variance is an autoregressive conditional heteroscedasticity model made up of a linear combination of the squares of the prior finite-term noise values.

Consider general linear regression model:

$$y_t = \mathbf{x}_t' \boldsymbol{\beta} + \varepsilon_t \quad (12)$$

Note that the conditional variance of the disturbance term ε_t is $\sigma_t^2 \equiv \text{Var}(\varepsilon_t | \varepsilon_{t-1}, \dots)$, t from σ_t^2 shows that conditional variance can vary over time. Influenced by the phenomenon of volatility agglomeration, we assume that σ_t^2 depends on the square of the disturbance term in the previous p periods:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \dots + \alpha_p \varepsilon_{t-p}^2 \quad (13)$$

Since there are several factors that must be calculated, and sample size will be reduced if p is big. Bollerslev then brought up GARCH, which minimizes the number of parameters to be estimated while improving the accuracy of future conditional variance forecasts. [8]. GARCH is the model based on ARCH(p) and plus the self-regressive part of σ_t^2 , i.e., σ_t^2 is also a function of $\{\sigma_{t-1}^2, \dots, \sigma_{t-p}^2\}$. GARCH (p, q) is defined as:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \dots + \alpha_q \varepsilon_{t-q}^2 + \gamma_1 \sigma_{t-1}^2 + \dots + \gamma_p \sigma_{t-p}^2 \quad (14)$$

And $\alpha_1 \varepsilon_{t-1}^2 + \dots + \alpha_q \varepsilon_{t-q}^2$ is the term of ARCH, $\gamma_1 \sigma_{t-1}^2 + \dots + \gamma_p \sigma_{t-p}^2$ is the term of GARCH. For GARCH (1, 1), using the iterative method:

$$\sigma_t^2 = \frac{\alpha_0}{1-\gamma_1} + \alpha_1 (\varepsilon_{t-1}^2 + \gamma_1 \varepsilon_{t-2}^2 + \gamma_1^2 \varepsilon_{t-3}^2 + \dots) \quad (15)$$

3. Empirical result

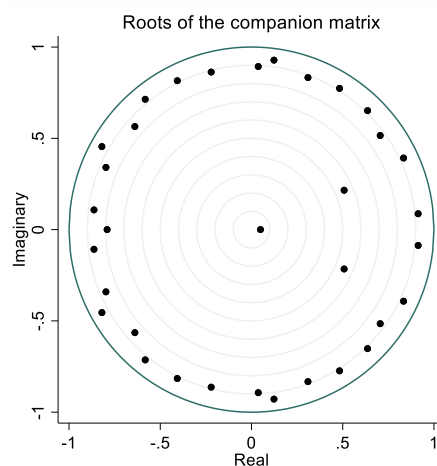
3.1 VAR order selection

For VAR order selection there are two series: consumption in yield and exchange rate in yield into VAR. Different information criteria are used to find a suitable p -value, by finding the minimum value of the information criterion. For example, according to FPE, it is clear that proper value of p is 0.032. Table 2 presents the findings.

After setting VAR Model, it should be checked whether VAR system is stationary. In Figure 1, there is a unit circle and several eigenvalues. A process is stationary if all eigenvalues are inside the unit circle. The result is shown in figure 1. Figure 1 shows that the VAR system is stationary and that all eigenvalues are contained inside the unit circle.

Table 2. VAR model identification

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	1514.88				7.3e-10	-15.3592	-15.3457*	-15.3259*
1	1520.18	10.59	4	0.032	7.2e-10*	-15.3723*	-15.3319	-15.2723
2	1522.54	4.7264	4	0.317	7.3e-10	-15.3557	-15.2883	-15.1891
3	1525.36	5.6435	4	0.227	7.4e-10	-15.3438	-15.2493	-15.1104
4	1527.89	5.0617	4	0.281	7.5e-10	-15.3288	-15.2074	-15.0289
5	1528.8	1.8146	4	0.770	7.8e-10	-15.2974	-15.149	-14.9308
6	1531.47	5.3441	4	0.254	7.9e-10	-15.284	-15.1086	-14.8506
7	1533.7	4.4625	4	0.347	8.0e-10	-15.266	-15.0636	-14.766
8	1535.27	3.1348	4	0.536	8.2e-10	-15.2413	-15.0119	-14.6747
9	1536.67	2.795	4	0.593	8.5e-10	-15.2149	-14.9585	-14.5816
10	1538.33	3.3305	4	0.504	8.7e-10	-15.1912	-14.9078	-14.4912
11	1541.58	6.498	4	0.165	8.7e-10	-15.1836	-14.8732	-14.4169
12	1543.09	3.0132	4	0.556	9.0e-10	-15.1582	-14.8209	-14.3249
13	1545.61	5.0482	4	0.282	9.1e-10	-15.1433	-14.779	-14.2433
14	1547.89	4.563	4	0.335	9.3e-10	-15.1258	-14.7345	-14.1592
15	1549.13	2.4644	4	0.651	9.6e-10	-15.0977	-14.6794	-14.0644
16	1550.56	2.862	4	0.581	9.8e-10	-15.0716	-14.6264	-13.9717
17	1555.59	10.076*	4	0.039	9.7e-10	-15.0822	-14.6099	-13.9156
18	1559.7	8.2096	4	0.084	9.7e-10	-15.0832	-14.584	-13.85
19	1561.83	4.2687	4	0.371	9.9e-10	-15.0643	-14.5381	-13.7643
20	1565.55	7.4281	4	0.115	1.0e-09	-15.0614	-14.5082	-13.6948
21	1566.94	2.7769	4	0.596	1.0e-09	-15.0349	-14.4547	-13.6016
22	1567.12	.37851	4	0.984	1.1e-09	-14.9962	-14.389	-13.4963
23	1568.81	3.3726	4	0.498	1.1e-09	-14.9727	-14.3385	-13.4061
24	1573.21	8.7922	4	0.067	1.1e-09	-14.9767	-14.3156	-13.3435


Fig. 1 VAR stability

3.2 Impulse response

From the outcomes of the impulse response (Figure 2), the exchange rate shock of 1 unit in the period $t=0$ will quickly reflect the current rate of return of the consumer industry, and the impact is negative, with a magnitude of about 0.2%. The effects of the first four periods can almost cancel each other out, but negative effects dominate for future periods.

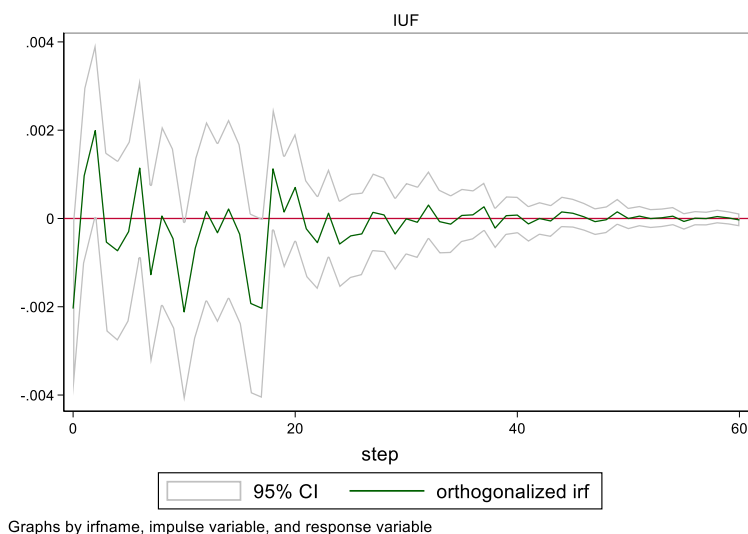


Fig. 2 Impulse and response

3.3 ARMA order selection

This part is going to find out the suitable AR and MA part of consumption in yield.

On the left side of Figure 3 is the partial autocorrelation plot (PACF), which shows that lag 24 and lag 26 terms of the series may have a significant impact. To find out the proper order p of AR part, we use information criterion based on VARSOC, and lag 26 is the better one. On the right side is the autocorrelation plot (ACF) and it indicates that lag 24 is a good choice of order q of MA part. Then get the best ARMA term ARMA (26, 24).

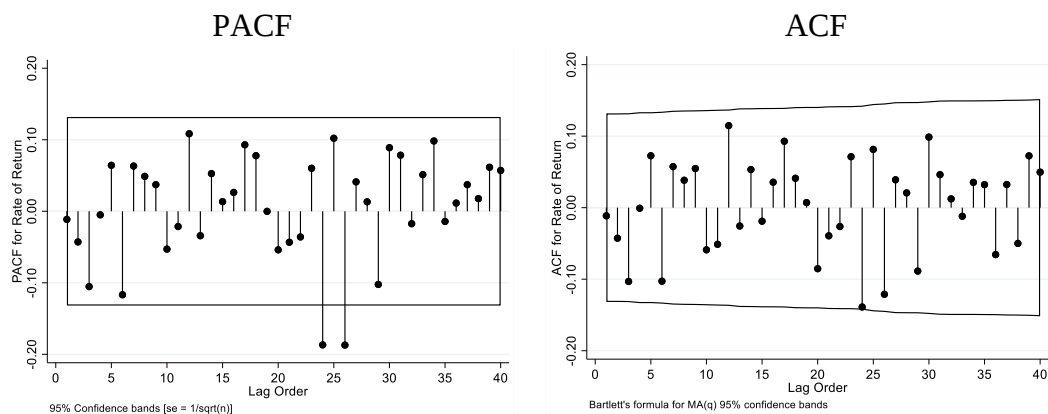
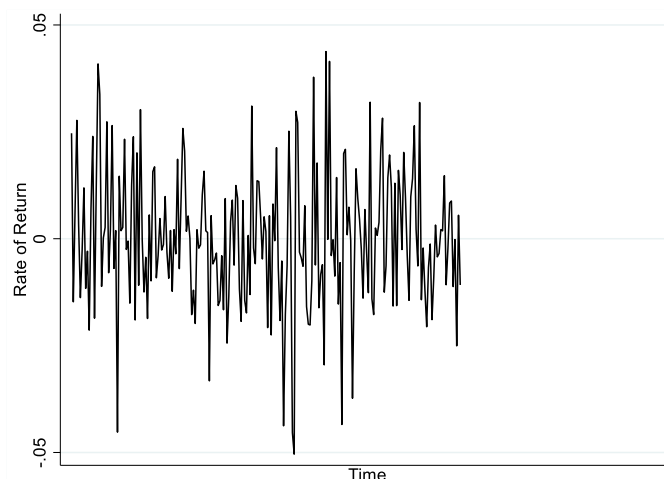


Fig. 3 PACF and ACF

3.4 ARMA-GARCH model result

Only when exists conditional heteroskedasticity, we need GARCH model to reduce the number of parameters from ARCH. So, it should be checked whether exists conditional heteroskedasticity. From figure 4, as can be seen, that it exists conditional heteroskedasticity.

**Fig. 4** Yield trend

For ARMA-GARCH model, ARMA (26, 24)-GARCH (1, 1) is used to predict yield and volatility at the same time. The exchange rate log-return series is an external explanatory variable. From the estimation results of the ARMA-GARCH model in table 3, there is no significant ARCH effect and GARCH effect in the consumer industry, that is, there is no clustering of returns. In addition, after adding the exchange rate logarithmic rate of return, the coefficient is not significant. Combined with the VAR estimation results, this paper argues that although the Fed's interest rate hike has changed the yield of the consumer industry, it has not led to an increase in daily volatility.

Table 3. ARMA-GARCH estimation results

	(1)	(2)	(3)
Exchange rate			
T=0	-172.5105 (112.2929)		-161.5454 (116.1358)
T=-1		(129.2942)	-5.6841 (154.6456)
T=-2		-13.6689 (159.9658)	63.6935 (94.0042)
GARCH (1, 1)			
ARCH (-1)	0.0784 (0.0541)	0.0788 (0.0533)	0.0774 (0.0535)
GARCH (-1)	0.1011 (0.3697)	0.0627 (0.5167)	0.0579 (0.4478)
Constant	-8.4831*** (0.5009)	-8.4418*** (0.6497)	-8.4300*** (0.5569)

Note: *, **, *** represent the level of significance of 10%, 5% and 1%. $p < 0.1$ is *, $p < 0.05$ is **, $p < 0.01$ is ***.

4. Discussion

This paper focuses on the relationship between the data of exchange rate and consumption index. From a theoretical analysis point of view, to restrain domestic inflation in the United States, the Federal Reserve increase significantly interest rates several times in 2022. An interest rate hike will lead to an increase in the holdings of the US dollar in the international financial market and international hot money, and then increase the US dollar's exchange rate to the RMB, or the US dollar's appreciation and the RMB's depreciation.

The consequences of this behavior have two impacts on the domestic consumer market.

First, the appreciation of the US dollar means that the purchasing power of the US dollar increases, which is beneficial to US imports and exports to the Chinese market. This is a huge benefit to the consumer industry, especially the consumer industry that relies on exports. Reviewing the fundamentals reveals that China's economic growth and development are heavily reliant on exports. The term "fundamentals" refers to the analysis of the macro-economy, the industry, and the basic situation of the company, including the analysis of the company's business philosophy, strategy, and company reports. From this aspect, the Fed's interest rate hike has a stimulating effect on the export-oriented economy.

Second, the rise in the exchange rate also means capital outflows, and these funds will flee the Chinese market and flow to the international capital market. The impact of net capital outflows on the stock market is obvious.

To sum up, the Fed's interest rate hike has two impacts on China's domestic consumer industry, and obtaining the net effect needs to be done through empirical testing.

With the help of models, it can be concluded that the impact of the exchange rate increase caused by the Fed raising interest rates on China's consumer industry is negative, which means the stock market decline caused by capital flight dominates. Additionally, Fed rate hikes do not lead to higher daily volatility.

However, the results should be paid attention to by policymakers. In general, improving macro-control policies and strengthening the construction of the financial macro-prudential management system is helpful for the Fed raises interest rate [9]. On the one hand, when it comes to monetary policy, the consideration of exchange rate targets helps maintain inflation and exchange rate stability but undermines output, employment, and monetary policy independence. Therefore, in specific monetary policy practice, monetary authorities should According to the actual situation of the country, choose by weighing macroeconomic factors like inflation and currency rates' significance [10]. On the other hand, the effects of capital flight can be hedged by stimulating domestic demand. A feasible way is to promote domestic consumer demand for domestic goods and reduce demand for foreign goods. This is where the framing effect comes into play. The framing effect describes how various descriptions of a problem that was objectively the same resulted in various conclusions. Therefore, when it comes to price pricing, it should be linked to benefits to motivate consumers to buy. Because people value losses far more than equal gains, when prices involve losses, people are more price sensitive and less likely to buy. This is just one way to face this problem, which deserves further research and discussion.

5. Conclusion

This paper focuses on Monetary Policy Uncertainty and China's Consumption Industry. Fed's rate hike has had a great influence on the global economy. Chinese consumption will also be affected by it with no doubt. As can be seen from the two models built on two data series, there is indeed a relationship between the Fed's rate hike and Chinese consumption, which shows that the net impact of the exchange rate increase caused by the Fed rate hike on Chinese consumption is negative. Although there are changes in Chinese consumption, the Fed rate hike does not lead to higher daily volatility. However, policymakers and investors should pay more attention to it, making corresponding response policies and measures according to the latest situation. Of course, Fed's rate hike has an impact not only on economic, but also in many other ways as well. This paper only covers part of the content, this topic still deserves more and more in-depth research and discussion.

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