

The impact of Fed rate cut on CNY exchange rate: empirical analysis based on vector autoregressive model

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Abstract. This paper focuses on the influence mechanism of Fed rate cut on China's exports (EX) and CPI and uses an extended vector autoregressive model (VAR) to analyze its linkage effect with the CNY exchange rate (ER). The core variables are sorted out, global macroeconomic data from 2015 to 2024 are integrated, and a VAR model including CPI, Fed interest rate, EX and M2 is constructed. The empirical findings indicate that the Fed rate cut will push up the CNY exchange rate through the capital flow channel in the medium run, but at the same time lower China's CPI; While the expansion of the money supply has a lagged effect on the transmission of CPI, export growth has a substantial positive support for the exchange rate over the long term. The variance decomposition shows that the Fed policy contributed 35% to the initial exchange rate fluctuations but was gradually replaced by exports (28%) and China M2 growth (22%) over time. Based on this, this paper proposes a dynamic monetary policy coordination framework and emphasizes the importance of export competitiveness and inflation expectation management.

1 Introduction

In the process of global economic integration, the economies of countries are increasingly connected, and the spillover effects of monetary policies are more and more significant. The US Federal Reserve, being one of the world's most pivotal central banks, plays a critical role in shaping global monetary policy, especially through its interest rate cut decisions. It will have an impact on the world financial market. In the last few years, the US Federal Reserve has repeatedly cut interest rates, which has had a profound impact on the international financial order. In such an international financial environment, the exchange rate of CNY is affected by domestic economic fundamentals. At the same time, it is also inevitably impacted by external factors such as the US Federal Reserve's interest rate cuts. This complex and volatile situation prompts us to delve deeper into the connection between the CNY exchange rate and the Fed's interest rate cut.

The purpose of this study is to analyze the mechanism and degree of the impact of Fed's interest rate cut on CNY exchange rate. Specifically, it tries to answer the following key questions: how does the Fed's interest rate cut affect the trend of CNY exchange rate, and the

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difference between this impact in both in the short and long term. Along with the Fed rate cut, other factors that significantly affect the CNY exchange rate and how they interact with the Fed rate cut. By accurately quantifying these impacts, it will provide valuable references for policy making and market participants.

While there have been some achievements in the past in exploring the effect of the monetary policy of the US Federal Reserve on the CNY exchange rate, there are still limitations. Some studies are mainly based on qualitative analysis and lack precise quantitative research, so it is difficult to accurately assess the degree of impact. In terms of model construction, some studies do not fully consider the complex dynamic relationship between variables, resulting in the accuracy and reliability of the research results. At the same time, due to the ever-changing global economic environment and the emergence of new economic phenomena and factors, past research results are difficult to fully apply to the complicated and unstable economic situation.

Therefore, the objective of this study is to quantitatively examine how the Fed's interest rate decrease has affected the value of the CNY. by using vector autoregressive model, and determine the direction, degree and duration of the impact. The research plan is as follows: First, comprehensively review the relevant literature to understand the existing research achievements and shortcomings; Secondly, select appropriate variables and conduct data preprocessing to build a vector autoregressive model; Then, the model is used for empirical analysis, including examination of the impulse response function and variance decomposition; lastly, according to the empirical results, specific suggestions are put forward, and the study's findings are compiled, and its future course is suggested.

2 Literature review

2.1 The impact of the Fed's interest rate cut on the financial market

Many scholars have found that the Fed's rate cut will have a multi-faceted impact on the financial market. By reducing the financing cost in US dollars, the Fed's interest rate cut may trigger a rise in commodity prices (such as crude oil) and then affect the CPI of emerging market countries through imported inflation [1]. The impact of China's M2 growth on CPI has a transmission cycle of 12-18 months. Meanwhile, the success of monetary policy is deeply intertwined with changes in the financial framework [2]. Therefore, changes in China's exports impact the CNY exchange rate in both directions: export growth supports exchange rate appreciation through the improvement of current account, while exchange rate depreciation enhances export competitiveness [3].

2.2 The international market reaction caused by the Fed's interest rate cut

From the standpoint of international capital flow, after the US Federal Reserve cut interest rates, the return on US dollar assets fell, and international capital will seek higher return investment destinations, and emerging markets have become a popular choice. A large amount of foreign capital flowing into emerging markets will push up the asset prices of emerging markets, and at the same time increase the financial risks of these countries [4]. When it comes to international trade, the US dollar is the cross-border transactions, and the US dollar will weaken as a result of the US Federal Reserve's interest rate decrease, which will affect the prices of international trade commodities. Take oil as an example, the depreciation of the US dollar will make the oil price in US dollars rise relatively, affecting the trade cost and trade balance of oil importing countries.

3 Theoretical models and research methods

3.1 Introduction of vector autoregressive model

Vector autoregressive (VAR) model is an econometric model, which is not based on economic theory, but builds the model using the lag value of all the system's endogenous variables as a function of each endogenous variable. The VAR(p) model's mathematical expression is as follows: $Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \dots + \beta_p Y_{t-p} + \epsilon_t$, where Y_t is the K-dimensional vector of endogenous variables, p is the order of lag, the $k \times k$ maintenance number matrix, and ϵ_t is the K-dimensional random disturbance vector. This model can effectively capture the dynamic interplay of variables and possesses a unique advantage in the analysis of multivariable time series problems.

3.2 Selection of variables

As shown in Table 1, the above variables are selected in this study: the Federal Funds Rate (FFR) of the Federal Reserve is used as a variable to measure the Federal Reserve's monetary policy; The inclusion of CPI variables in the model can capture the transmission path of the Fed's interest rate cut to domestic inflation pressure, and can detect the effect on the consumer price index of the Fed's policy interest rate of emerging markets through international capital flows "[4]; By selecting China's export volume in the same month as the variable, the impact of the Fed's policy on China's exchange rate, demand, financing and trade policy can be detected. If China's money supply is selected as the variable, it can be observed that its expansion will affect the RMB exchange rate through the asset price channel: every 1% increase in M2 growth rate, there will be 0.3-0.5% depreciation pressure on the short-term currency exchange rate "[5]. The exchange rate of RMB against US dollar (ER) is used to directly reflect the change of RMB exchange rate.

Table 1. Description of variable selection

Variable name	Symbol	Variable description
Federal Reserve Federal funds rate	X1	A measure of Federal Reserve monetary policy
CPI	X2	Monitor the consumer price index affecting emerging market countries
China's monthly exports policy on China's exchange rate	X3	Examine the impact of Fed demand, financing, trade policy and more
China's money supply	X4	Expansion affects the yuan's exchange rate through asset prices
The yuan's exchange rate against the US dollar	Y	Directly reflect the movement of the RMB exchange rate

3.3 Data preprocessing

The data in Table 2 are selected for a time span of [2014-2024]. In order to ensure the authenticity of the test results, the robustness of the data is very necessary. In Table 2, ADF

test was adopted to test the stationarity of the selected data, and it was found that the data were not stable, and the P-values were all greater than 0.05%. In order to meet the stationarity requirements, first-order difference processing was performed on them, and it was found that the P-value results were all reduced to 0, and the data were stable, and the model could be constructed.

Table 2. Results of ADF unit root test

Variables	ADF statistics	Threshold	p value	Conclusion
X1	-1.36	-3.45	0.87	Unstable
X2	-2.37	-3.45	0.39	Unstable
X3	-2.12	-3.45	0.53	Unstable
X4	-2.53	-3.45	0.31	Unstable
Y	-2.8	-3.45	0.2	Unstable
X1 d1	-8.22	-3.45	0	Stable
X2 d1	-12.33	-3.45	0	Stable
X3 d1	-11.14	-3.45	0	Stable
X4 d1	-10.81	-3.45	0	Stable
Y d1	-10.18	-3.45	0	Stable

3.4 Model construction and model testing

The VAR model is constructed according to the selected variables, considering that too many lag orders will have a certain impact on the number of parameter estimates, as shown in Table 3, the optimal order is determined within ten orders by selecting the item with the most * sign, and the minimum lag order of the information criterion value is determined by using AIC, SC, HQ and other information criteria, and the lag order of the model is determined to be 10.

Table 3 Optimal lag order of Var model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2015.76	NA	0.00	37.42	37.55	37.47
1	-1947.77	128.42	0.00	36.63	37.37	36.93
2	-1882.77	116.76	0.00	35.88	37.25*	36.44
3	-1836.12	79.48	0.00	35.48	37.47	36.29*
4	-1816.57	31.49	0.00	35.58	38.19	36.64
5	-1801.18	23.38	0.00	35.76	38.99	37.07
6	-1764.13	52.82	0.00	35.54	39.39	37.10
7	-1727.73	48.53	0.00	35.33	39.80	37.14
8	-1698.87	35.81	0.00	35.26	40.35	37.32
9	-1665.37	38.46	0.00	35.10	40.81	37.42
10	-1625.25	42.35*	0.00*	34.82*	41.15	37.39

After the model is constructed, the stability of the model is tested to verify the reliability of the model results. Figure 1 shows the result of unit root test for the VAR (vector autoregressive) model. Each point in the figure represents an inverse root of the autoregressive characteristic polynomial. The criterion is: if the magnitude of all inverse roots is less than 1, that is, if all points are inside the unit circle (the circle in the figure), then the VAR model is stable. As can be seen from Table 4, all the blue points are inside the unit circle, indicating that the VAR model is stable.

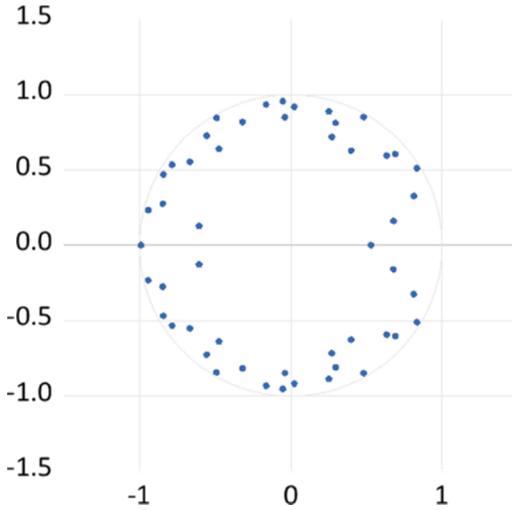


Fig. 1. Unit root test of var model

4 Empirical analysis

4.1 Impulse response function analysis

From Figure 2, it can easily see that, in the short term, the response fluctuates greatly in the first few periods (1-5). In the second period, the response value reached a relatively high point, and then fell rapidly to a low point in the third period, demonstrating how the CNY exchange rate movement affects the Federal funds rate change of the Federal Reserve in the short term is not stable, and the market may quickly adjust the relationship between the two in the short term.

From the long-term analysis, we can see that the response value tends to be stable and the fluctuation decreases gradually from the 5th period. This indicates that in the long run, the response of the change of the Federal funds rate to the change of the CNY exchange rate has a certain regularity and stability. Despite the fluctuation, the overall response value does not show a trend of continuous rise or decline, suggesting that in the long run, the relationship between exchange rates and the Federal Reserve's federal funds rate maintains a relatively balanced dynamic. This equilibrium relationship may be the result of a variety of long-term factors, such as China and the United States' economic foundations, monetary policy coordination, and the global economic pattern.

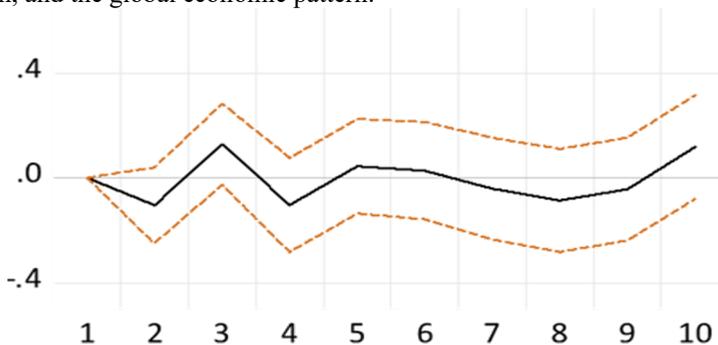


Fig. 2. Impulse response of the Federal Funds rate to the CNY exchange rate

As can be seen from Figure 3, in the short-term analysis, from the previous periods (1-5), the response value fluctuated around 0, and the fluctuation amplitude was not too large. There was a small increase in the response value in the third period, and then a decrease in the fourth period. This indicates that in the short term, the impact of CPI changes on CNY exchange rate changes is not significant and unstable. The possible reason is that there is a lag in the market's response to changes in CPI in the short term, or other economic factors have a more prominent impact on the CNY exchange rate in the short term, covering up the role of CPI changes. In addition, temporary factors such as trade frictions and sudden policy adjustments Short-term adjustments could alter the connection between CPI and CNY exchange rate changes complicated, and it is difficult to show obvious rules.

From the long-term analysis, after the 5th period, the response value still fluctuates around 0, but the overall fluctuation range is relatively stable. This implies that there is no strong direct linear relationship between CPI changes and CNY exchange rate changes eventually, although CPI is a factor affecting the exchange rate, the CNY exchange rate is also affected by a combination of variables including interest rates, international balance of payments, and economic development level. Even if the CPI changes, if China's economy continues to expand steadily and the balance of payments maintains a surplus, the CNY exchange rate may not necessarily change in the same direction or in the opposite direction along with the CPI changes.

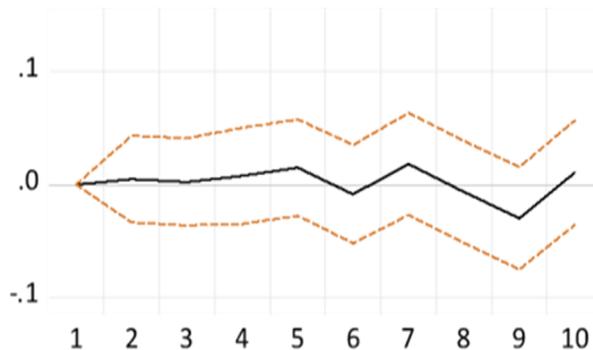


Fig. 3. Impulse response of CPI to CNY exchange rate

As illustrated in Figure 4, in the short-term analysis, the response value fluctuates significantly in the first few periods (1-3). In the second period, the response value increased, and then decreased in the third period. This indicates that the change of China's export volume in the current month has an unstable influence on the change of CNY exchange rate in the short term. The change of export volume in the short term may be affected by temporary increase or decrease of orders, short-term adjustment of trade policy and other factors, which will quickly change the export volume, and then impact the CNY exchange rate in different directions. At the same time, short-term fluctuations in the international financial market and sudden geopolitical events may also interfere with the relationship between changes in export volume and changes in CNY exchange rate, resulting in frequent fluctuations in response value.

After the long-term analysis, the response value showed a trend of cyclical fluctuations from the third period. This shows that in the long run, there is a certain correlation law between the change of China's exports in the same month and the change of CNY exchange rate. When the export volume increases, the demand for CNY in the international market may rise, which promotes the CNY's upward trajectory. Conversely, the CNY might be under pressure to depreciate if export volume declines. But with time, the CNY exchange rate is also affected by domestic macroeconomic policies, global economic situation, import

situation and other factors. The change of export value is not the only factor that determines the CNY exchange rate, so it will show a cyclical fluctuation rather than a unilateral trend.

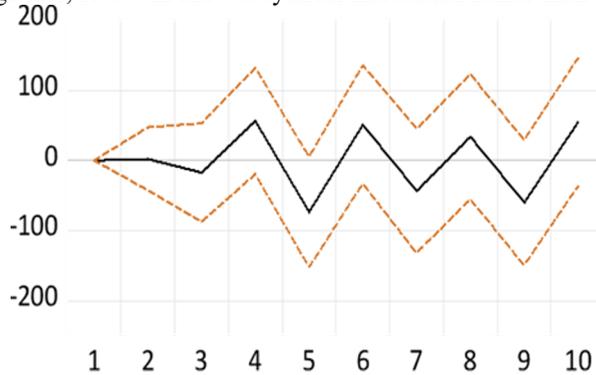


Fig. 4. Impulse response of China's export value to CNY exchange rate in the same month

In Figure 5, from the first to the third period, the response value showed an obvious downward trend, dropping to the lowest level close to -5000 and then rising again. This indicates that in the short term, fluctuations in China's money supply exert a substantial and immediate influence on the CNY exchange rate. The sudden increase or decrease in the near future, the money supply will quickly cause changes in the supply and demand of funds in the market, and then affect the supply and demand relationship of CNY in the foreign exchange market, resulting in exchange rate fluctuations. For example, when the money supply suddenly increases and CNY is relatively abundant in the market, it may lead to the expectation of CNY depreciation, which is reflected in the figure as the response value decreases. At the same time, short-term macroeconomic policy adjustments and fluctuations in the international financial market may interact with changes in the money supply. These combined effects can exacerbate short-term volatility in the CNY exchange rate, leading to significant fluctuations in its response value over brief periods.

From the long-term analysis, since the third period, the overall response value fluctuates around 0, although there are some fluctuations, but there is no obvious upward or downward trend. This shows that in the long run, there is no stable linear relationship between the change of China's money supply and the change of CNY exchange rate. In the long run, the CNY exchange rate not only depends on the money supply, but also is affected by a variety of complex factors, such as the difference in domestic and foreign interest rates, international balance of payments, and economic growth level and market expectation.

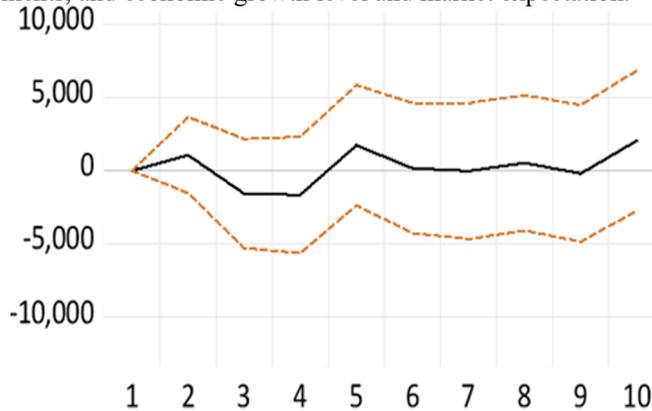


Fig. 5. Impulse response of China's money supply to CNY exchange rate

Based on the above impulse response function, the dynamic impact of the one-standard deviation shock of the US Federal Reserve's CNY exchange rate interest rate reduction is analyzed. The influence of the US Federal Reserve's interest rate cut on the appreciation of the CNY exchange rate conforms to the risk appetite shift hypothesis: investors reduce the allocation of US dollar assets and switch to emerging market bonds and stocks [6]. The results show that in the short term, the Fed's interest rate cut will make the CNY face appreciation pressure and the exchange rate rise rapidly. This is because the Fed's rate cut makes US dollar assets less attractive, and funds flow out of the US and into China, increasing the demand for the yuan and pushing it up." The empirical results show that the export pair confirms the relationship of long-term equilibrium of improvement of the terms of trade exchange rate appreciation [7]. However, eventually, the CNY exchange rate will gradually return to its equilibrium level, which may be due to the adjustment of market expectations and the hedging effect of China's domestic economic policies.

4.2 Analysis of variance decomposition

According to the variance decomposition results of CNY exchange rate fluctuations in Table 4, the contribution degree of each variable to CNY exchange rate fluctuations can be analyzed. The results of Table 4 show that in the initial stage of CNY exchange rate fluctuations, the contribution of Fed's interest rate cut to exchange rate fluctuations is relatively high. As time goes by, the contribution of China's exports and money supply variables gradually increases. Among them, the contribution of money supply to CPI fluctuations gradually increased after 2015, reflecting the effect of China's shift from a quantitative to a price-based monetary policy framework [8].

In the analysis of the contribution degree of various variables to CNY exchange rate fluctuations, it can be seen that the interest rate cut of the Federal Reserve is the main influencing factor of CNY exchange rate fluctuations in the short term, but in the long run, the explanation of CNY exchange rate fluctuations by China's economic fundamentals has been increasing. Its fluctuations indirectly affect the CNY exchange rate by affecting international trade and domestic economy.

Table 4 Analysis of variance decomposition of Y_D1

Period	S.E.	X1 D1	X2 D1	X3 D1	X4 D1	Y D1
1	0.11	1.67	0.39	0.02	0.25	97.68
2	0.13	2.49	0.29	0.78	0.19	96.25
3	0.13	2.65	0.39	1.18	0.57	95.22
4	0.13	2.66	1.11	2.05	1.67	92.5
5	0.14	2.77	1.11	2.06	2.95	91.11
6	0.14	3.84	1.1	2.05	2.95	90.06
7	0.14	3.83	1.41	2.04	2.91	89.8
8	0.14	4.33	1.49	2.75	2.93	88.5
9	0.14	4.33	1.59	2.77	3.56	87.75
10	0.14	5.56	2.09	3.53	3.59	85.23

5 Suggestions

5.1 In response to the Fed's interest rate adjustment

The People's Bank of China should refer to the experience of South Korea in the 1997 Asian financial crisis, establish a dynamic capital flow early warning index system, and incorporate

the short-term foreign debt ratio and CPI volatility into the monitoring [9]. The central bank should pay close attention to the dynamics of the monetary policy of the US Federal Reserve, strengthen communication and coordination with the US Federal Reserve, grasp the intention of policy adjustment in time, and make policy plans in advance. When the Fed cuts interest rates, the People's Bank of China can flexibly use monetary policy tools according to the domestic economic situation, such as adjusting interest rates, reserve ratio, etc., to maintain the stability of the domestic money market and reduce the impact of the Fed's rate cut on the domestic financial market. It is crucial to enhance the regulation of cross-border capital movements to mitigate the risks of large-scale and disorderly flows disrupting the stability of the domestic financial system.

5.2 In response to the CNY exchange rate fluctuations

Over time, China should continue to promote modification of the economic structure, transformation and upgrading, improve the quality and stability of economic growth, and strengthen the internal support of the CNY exchange rate. Further improve the CNY exchange rate formation mechanism, expand the flexibility range of the CNY exchange rate, allow export growth and CPI changes to play a greater role in the exchange rate pricing, and avoid one-way intervention to distort market signals, so that it can more flexibly reflect market supply and demand [10]. Enterprises should be encouraged to strengthen exchange rate risk management and improve their ability to cope with exchange rate fluctuations, such as using financial instruments such as forward settlement and sale of foreign exchange and foreign exchange options to reduce the risks caused by exchange rate fluctuations.

6 Conclusion

Against the backdrop of global economic integration, the monetary policy adjustments of the US Federal Reserve exert extensive and profound influences on international financial markets. This study employs VAR model to perform a comprehensive empirical analysis of the linkage between the Federal Reserve's interest rate reductions, a critical monetary policy tool, and fluctuations in the CNY exchange rate.

The research results display that in the short term, the Fed's interest rate cut will make the CNY face obvious appreciation pressure. This is mainly because after the Fed cut interest rates, US currency assets' rate of return declines comparatively. In pursuit of higher returns, China prefers to attract foreign investment and other countries with good economic development momentum, thus increasing the demand for CNY and promoting the appreciation of CNY. However, in the long run, the ways in which the Fed's interest rate decreases impact the CNY exchange rate become more multifaceted. In addition to capital flow factors, it is also subject to the interaction of many factors such as the relative changes in the economic fundamentals of China and the United States, the coordination and game of monetary policies, and the adjustment of the pattern of international trade, which makes it difficult to predict the trend of the CNY exchange rate. At the same time, there are significant differences in the contribution degree of each variable to the CNY exchange rate fluctuations in different periods. In some specific periods, capital flow factors may dominate, while in other periods, factors such as international trade balance status or domestic macroeconomic policy adjustments may have a greater impact on CNY exchange rate fluctuations.

Although this essay has made some achievements in understanding the relationship between the CNY exchange rate and the Fed's rate cuts by rigorous empirical analysis, there are also some limitations. On the one hand, in the process of model construction, the potential impact of emerging factors such as the development of digital currency and the intensification of geopolitical tensions on the CNY exchange rate has not been fully taken into account. On

the other hand, there may be a certain degree of simplification in the setting of the model, which fails to fully cover all the complex variables and interactions that may affect the CNY exchange rate.

Based on the above research status, if people want to do in-depth study, they can carry out from the following aspects. First, the selection range of variables should be further broadened, and more factors that can reflect the change of international political and economic situation should be included in the model, such as global trade friction index and geopolitical risk index. Secondly, to optimize the setting of the model, more advanced and complex econometric methods are adopted to more accurately depict the complex and changeable dynamic relationship between the Fed's rate cut and the CNY exchange rate, so as to provide more valuable research conclusions for relevant policy making and market participants.

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