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The Impact of Economic Policy Uncertainty on the RMB Exchange Rate

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Abstract

Based on the monthly data from July 2005 to August 2021, this paper analyzes the impact of economic policy uncertainty (EPU) on the RMB exchange rate by using VAR model and VECM model in stata16. The results show that there is a two-way interactive causal relationship between the economic policy uncertainty and the fluctuation of the RMB exchange rate between China and the United States. The increased uncertainty of China's economic policy will have a depreciating impact on the RMB exchange rate, and the increased uncertainty of the US economic policy will have an impact on the appreciation of the RMB exchange rate. Through the comparison of the impulse response diagram of the RMB exchange rate from the uncertainty of the economic policy of China and the United States, the impact of China's economic policy uncertainty on the change of the RMB exchange rate is greater than that caused by the uncertainty of the US economic policy, and these conclusions are consistent with the theoretical analysis. The policy implication of this paper is that government departments should strengthen the measurement and monitoring of global EPU, maintain the stability of their own macroeconomy, enhance the transparency and continuity of their own policies, and avoid the adverse impact of large changes in exchange rates on economic development.

Keywords

Economic policy uncertainty; RMB exchange rate fluctuations; Copyright; Sino-US interest rate differentials.

1. Introduction

The International Monetary Fund announced on November 30, 2015 local time that the RMB will be officially included in the IMF Special Drawing Rights (SDR) currency basket, and the resolution will take effect on October 1, 2016. The voting session was chaired by IMF Managing Director Christine Lagarde, and the 188 IMF member countries participated and voted. The SDR is an international reserve asset created by the IMF in 1969 to make up for the shortfall in member countries' official reserves, and its value is determined by a basket of reserve currencies consisting of the US dollar, the euro, the Japanese yen and the British pound, marking a key step in the internationalization of the renminbi.

In the process of RMB internationalization, exchange rate changes have always been an important issue for academic circles and policymakers. Since China's "811 exchange rate reform" in 2015, the central bank has gradually withdrawn from the normalized foreign exchange market intervention, the flexibility of the RMB exchange rate has been significantly enhanced, and two-way fluctuations have become the norm. In today's world economic integration, the dependence and influence of the economic policies of various countries are gradually deepening, and the RMB exchange rate is not only affected by domestic economic policies, but also easily guided by foreign economic policies. It can be seen from the slow global

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economic growth, anti-globalization trade frictions and the frequent occurrence of "black swan" events in the international political arena that the uncertainty of world economic policy is increasing, which may have a more obvious impact on the RMB exchange rate. It is foreseeable that the fluctuation of the RMB exchange rate will have an increasingly significant impact on China's macroeconomy in the future. In this context, understanding the sources of RMB exchange rate fluctuations and improving the tracking and forecasting of RMB exchange rate fluctuations will be of increasing practical significance to the macro decision-making of the Chinese government and the production and investment decisions of micro entities.

Economic policy is the guiding principle and means formulated by the state or government to solve economic problems in order to achieve macroeconomic goals such as economic growth and price level stability, and to increase social and economic welfare. Due to the problem of information asymmetry in the political decision-making process, it is unpredictable for economic agents whether, when, and how the government will change the current economic policy (Gulen et al., 2012), which leads to the emergence of economic policy uncertainty. Since the 2008 financial crisis, in order to stimulate economic recovery and avoid economic recession, governments have stepped up intervention in their real economy and financial market activities. According to the Economic Policy Uncertainty Index (EPU) calculated by Baker et al. (2016) using news media reports on keywords such as "economy", "policy", and "uncertainty", economic policy uncertainty has increased significantly in all countries around the world. For China, because it is in a period of economic transition and will be in a period of economic transition for a long time, a series of economic policies (such as supply-side reform, etc.) to promote economic transformation and upgrading is an important means of China's economic transformation at this stage, and the frequent introduction of economic policies will inevitably lead to the increase of economic policy uncertainty.

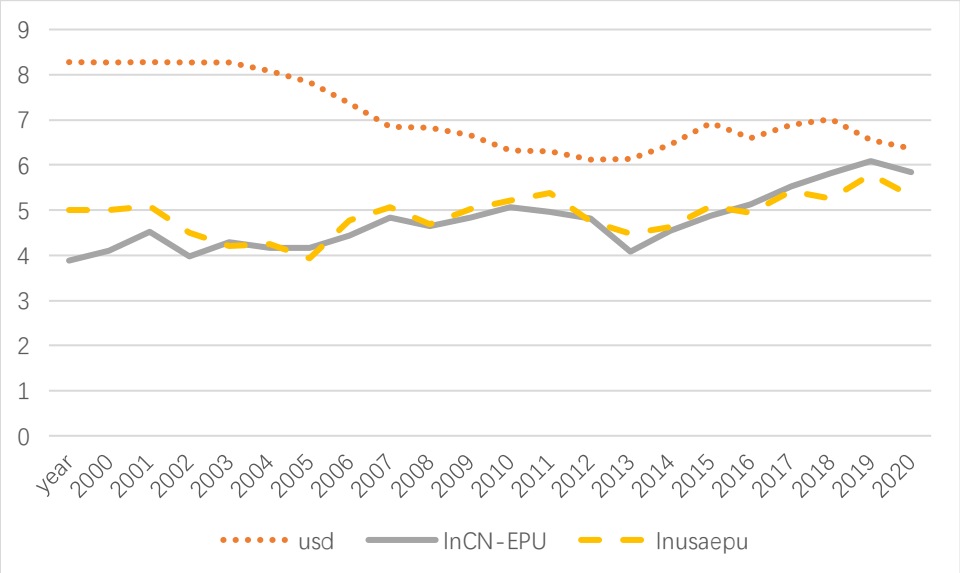

Figure 1: U.S.-China economic policy uncertainty and the RMB exchange rate

The economic policy uncertainty index can better reflect the macroeconomic fluctuations, and several large fluctuations in the index are more consistent with the large adjustment of economic policies. Affected by the economic crisis in 2008, the correlation between economic policy uncertainty and RMB exchange rate changes around 2008 was relatively small, but after 2012, the economic policy uncertainty index showed a certain positive correlation with the RMB exchange rate against the US dollar, and the RMB exchange rate often showed a sharp depreciation in the stage of high economic policy uncertainty. Especially since 2015, with the slowdown of China's economic growth rate and the increase in global economic policy uncertainty, the economic policy uncertainty index has risen significantly, and the RMB

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exchange rate has also depreciated- Appreciation—Depreciation is a large two-way fluctuation. The economic policy uncertainty index fluctuated sharply around 2012, which is closely related to the impact of the change of government in China around 2012, the impact of the European debt crisis, the shock of the stock market crash in 2015, and the Sino-US trade friction that began in 2018. What impact will the change of economic policy uncertainty have on the RMB exchange rate? How to deal with the impact of economic policy uncertainty on the RMB exchange rate? Discuss the impact of economic policy uncertainty on the change of the RMB exchange rate, and effectively identify and manage exchange rate fluctuations can reduce the disturbance of external shocks to the domestic economy, which is of great significance for preventing and resolving financial risks, maintaining the internal and external balance of China's economy, promoting the internationalization of RMB, and stabilizing the macroeconomy.

2. Theoretical analysis and research hypothesis

2.1. Literature review

2.1.1. Determinants of exchange rate movements

The traditional theory of exchange rate determination has been relatively mature, and the exchange rate changes are explained from the perspective of macro fundamentals such as balance of payments, interest rates, inflation, monetary policy, and economic growth. However, after the disintegration of the Bretton Woods system, the detached exchange rate from economic fundamentals and excessive exchange rate fluctuations have become mysteries that cannot be explained by traditional exchange rate theories (Zhang Biqiong and Gao Huiqing, 2011). Meese and Rogoff (1983) found that structural exchange rate models based on macroeconomic fundamentals are not even as predictive as random walk models. Obstfeld and Rogoff (1995) incorporated monopolistic competition and nominal price stickiness into the DSGE model, and established a macro-consistent OR model with a micro basis, which improved the explanatory power of exchange rate theory to a certain extent. Subsequent scholars have tried to find answers to the mystery of exchange rate detachment by relaxing some assumptions of the OR model, Jian Wang (2010) and others. Some scholars combine the traditional exchange rate determinism with the Taylor rule model to analyze the exchange rate change problem from a dynamic perspective (Jiang Chun et al., 2018), and the introduction of market expectations into the Taylor's rule exchange rate model can explain the mystery of exchange rate separation to a certain extent. Under rational expectations, scholars mostly interpret exchange rate fluctuations based on observable macro variables, while ignoring the influence of unobservable factors (Pozzi and Sadaba, 2018), because market expectations are affected by economic fundamentals and unobservable factors (Fratzscher et al., 2015), the unobserved factors - The inclusion of economic policy uncertainty in the macroeconomic variable model of exchange rate determination may help to better explain exchange rate fluctuations.

2.1.2. Measure of economic policy uncertainty

Knight (1921) introduced uncertainty into economic analysis for the first time, and uncertainty is difficult to quantify because it is unknowable about its objective probability distribution. The rational expectation school represented by Lucas proposes to use "white noise" or random terms to describe the uncertainty factor, but the measure of uncertainty is still too abstract. Some scholars use the volatility of economic variables to measure uncertainty, such as Bloom (2009), but this measurement method is too one-sided to reflect the overall uncertainty of economic policy. Some scholars use the turnover of government officials (Zhang et al., 2017) to measure policy uncertainty, which is closer to political uncertainty. Baker et al. (2016) constructed an economic policy uncertainty index for more than 20 countries and regions around the world based on the word frequency of news newspapers and periodicals, which is

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more comprehensive, does not tend to political uncertainty, and can better reflect the level of economic policy uncertainty in a country, and has become the preferred proxy variable for scholars to study economic policy uncertainty.

2.1.3. The impact of economic policy uncertainty on the RMB exchange rate

The existing literature may focus on the perspective of monetary policy, such as Su Zhi (2019), which explores the impact of economic policy uncertainty on monetary policy, or focus on specific events such as exchange rate reform and financial crisis, such as Wang Panpan (2019). From the perspective of Sino-US trade frictions, this paper reveals the dynamic spillover effect of U.S. economic policy uncertainty on the RMB exchange rate, which cannot fully reflect the continuous impact of economic policy uncertainty on RMB exchange rate changes. There are still few literature on the fluctuation of the RMB exchange rate from the perspective of economic policy uncertainty index. Based on this, this paper selects the economic policy uncertainty index as the proxy variable of economic policy uncertainty, and the exchange rate of RMB against US dollar as the proxy variable of the RMB exchange rate, and uses the VECM and VAR models to reveal the impact of economic policy uncertainty on the RMB exchange rate more comprehensively.

2.2. Theoretical basis

2.2.1. Spillover effect theory

Policy spillovers originated from the Mead conflict problem proposed by economist James Edward Mead in his book "Balance of Payments" in 1951, which mainly emphasizes conflicts within a given country), and Cooper (1968) further pointed out that there are transnational spillover effects in policy behavior between different countries. The so-called spillover effect refers to the fact that when an organization carries out an activity, it will not only produce the desired effect of the activity, but also have an impact on people or society outside the organization. In economics, spillovers represent an externality in which an organization's actions or decisions affect itself as well as other organizations. In finance, the spillover effect between markets refers to the fact that the price and income of a certain product in a financial market are not only affected by the price and income of the previous period in its own market, but also by the price and income of related products in other financial markets. There are two main types of spillover effects referred to in this article, one is the national policy spillover effect, that is, the implementation of other countries' economic policies will have a certain degree of impact on countries other than itself, and the other is the financial market spillover effect, that is, the development trend of one financial market will have a spillover effect on other different financial markets, or the same financial market in other countries.

2.2.2. Expectation theory

The expectation theory was first proposed by Keynes, which mainly emphasizes the role of future uncertainty in determining people's economic behavior. Expectation theories can be divided into the following two categories: one is rational expectations and the other is irrational expectations. Rational expectations were first proposed by the American economist Muth (1961), and then further studied by Lucas of the University of Chicago and Sargent of the University of Minnesota, and gradually formed the rational expectations school. Rational expectation, also known as reasonable expectation, refers to the fact that for a certain economic phenomenon, as a rational person will make the best possible use of all the information available, and make a collation and estimation of this information, and then take action to avoid making systematic mistakes. So to a certain extent, people's expectations should be accurate.

The premise of rational expectation is that there is no asymmetry in market information, and the speed of information transmission is relatively fast, but this is not the case in real financial activities, which leads to many irrational expectations. The main manifestation of irrational

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expectations is the herd effect, that is, when the information is not fully sufficient, people often make behavioral judgments based on the majority of choices, and are unable to think independently. When the market is negatively impacted, in the case of information asymmetry, many investors are unable or unable to think independently, and often follow the behavior of informed investors or other investors, resulting in a herd effect. The herd effect is prevalent in the financial market, if the behavior of a small group of investors in the exchange rate market has a certain impact on the market, other people with less information may follow their investment behavior, which will further increase the impact of investor behavior on the exchange rate market. The marketization level of China's exchange rate market is in the initial stage of development, the government intervention is more, and the market transparency is not high, so that the information that market investors can grasp is very limited, so investors are easy to make investment decisions based on the reaction of other investors to the policy, so as to enhance the impact of policy changes on the exchange rate market.

2.2.3. Risk management theory

Financial risk management refers to the measurement and control of the gains and losses between risk and reward by for-profit organizations and individuals, and by non-profit organizations and individuals. Financial risk management changes investment behavior through the identification, evaluation and control of financial risks to guide the flow of funds, and in the financial market, the flow of funds will produce the phenomenon of "flight to quality". The concept of "flow to safe assets" was first proposed by Bernanke and Gilchrist (1994) in their paper "The Financial Accelerator and the Flight to Quality" to explain the problem of lending. Gradually, the concept began to be applied to the capital market, and it was believed that when the macroeconomic situation is not good, investors will shift their funds from high-risk assets or markets to relatively low-risk assets or markets. According to the definition of economic policy uncertainty, economic policy uncertainty refers to the uncertainty that people have about the future effects of the economic policies that emerge. As the expected effects of economic policy uncertainty are uncertain, increased economic policy uncertainty increases future risks to assets. The increase in market risk will be perceived by market participants and investors, and most investors are not risk-averse, but risk-averse or risk-neutral, at which time investors will choose to change the investment portfolio of the financial market, and transfer funds from high-risk markets to another financial market with relatively low risk, thus appearing in the so-called "flow to safe assets" phenomenon.

2.2.4. Risk contagion theory

Risk contagion is defined in a narrow and broad sense. Forbes and Rigobon (2002) give a relatively strict and narrow definition of risk contagion, pointing out that relatively smooth fluctuations in one financial market are transmitted to other financial markets, even across borders, leading to an increase in the correlation between two financial markets. Unlike the narrow definition, the broad definition of risk contagion refers to the phenomenon of a shock to one market, organization or country (such as a financial crisis) transmitted to other markets, organizations or countries. Risk contagion in the financial market generally refers to the process of impacting other markets after a market is shocked, resulting in synchronous changes in the trends of various markets, which is often manifested in the convergence of various market trends and the enhancement of correlation between markets. In the context of increasing financial integration and liberalization in the world, the financial markets of the world are becoming more and more closely linked. Financial integration makes the transfer of information between various financial markets faster and more convenient, and the risks between markets are easier to disseminate, and to a certain extent, it will cause a serious financial crisis. For example, the 2008 financial crisis hit the economies of most of the world's countries hard. For the international exchange rate market, after a country's exchange rate

ISSN: 2710-0170

market is shocked, it is transmitted through international trade, international capital flows and macroeconomic channels, and other exchange rate markets related to it will also be affected by the same shock.

2.3. Analysis of the Mechanism of Sino-US Economic Policy Uncertainty on Exchange Rate Stability

2.3.1. The impact of China's economic policy uncertainty index on the RMB exchange rate

On the one hand, economic policy uncertainty has an impact on exchange rate market correlation by influencing investor expectations. Unpredictable uncertainty will lead capital holders to "wait", postpone or reduce current investment, employment and consumption, or even transfer capital to other economies with less economic policy uncertainty and better financial markets (Tan et al., 2018).. The behavior of a country's import and export enterprises will change the supply and demand relationship in the exchange rate market, which will have a certain impact on the exchange rate market. When uncertainty about domestic economic policies rises, the opportunities and costs for corporate investors to make mistakes also increase, and in this case, investors tend to choose to wait and see and reduce their investment in the country. At this time, the phenomenon of domestic capital outflow may occur, which will reduce the demand for local currency and increase the demand for foreign currency, thereby changing market supply and demand and causing the depreciation of local currency. On the contrary, when the uncertainty of the domestic economic policy decreases, corporate investors tend to choose the local currency for investment or business settlement in anticipation of the decline in risk costs, and at this time, the behavior of corporate investors will increase the demand for local currency and reduce the demand for foreign currency, so that the local currency has room for appreciation. Therefore, the investor behavior of import and export enterprises will trigger changes in the exchange rates of different countries, which will have an impact on the correlation between exchange rate markets.

On the other hand, economic policy uncertainty has an impact on exchange rate market correlation by influencing investor demand. When a country implements the "double tight" fiscal and monetary policy, the exchange rate of the national currency to the foreign currency will show an upward trend, and when the "double loose" fiscal and monetary policy is implemented, the exchange rate of the national currency to the foreign currency will show a downward trend. If a country's exchange rate is likely to appreciate, then the country's currency will become more attractive to investors in the international market, and investors will increase their investment in the country's exchange rate market, on the contrary, if a country's exchange rate is likely to depreciate, the country's currency will become less attractive to international investors, and investors will reduce their investment in the country's exchange rate market. As a result, capital flows between the exchange rate markets of different countries are triggered, which further affects the correlation between the exchange rate markets of the two countries. Based on this, the first hypothesis is proposed.

Hypothesis 1: An increase in China's economic policy uncertainty index will lead to a depreciation shock to the RMB.

2.3.2. The impact of the U.S. economic policy uncertainty index on the RMB exchange rate

The "trilemma paradox" proposed by Krugman (1999) states that it is impossible for a country to achieve the three goals of monetary policy independence, exchange rate stability, and free capital movement at the same time. Since the introduction of a managed floating exchange rate system in 2005, China's monetary policy has gradually entered a period of "triple paradox", and the capital account is not fully convertible, but the degree of openness has increased, which

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means that it has become increasingly difficult for monetary authorities to achieve a stable and independent monetary policy at the same time. For an open economy, exchange rate stability requires consideration not only of internal objectives, but also of the impact of external shocks.

According to Keynes's expectation theory, uncertainty can have a decisive impact on people's economic behavior, with the short-term effect being price expectations and the long-term effect being the liquidity preference of capital. On the other hand, the rise in uncertainty will directly affect trade and investment between the two countries, for example, the outbreak of Sino-US trade friction will directly lead to the smooth trade between the two countries, and changes in trade, investment and international capital flows will in turn affect the changes in the value of the dollar and the liquidity of the dollar. The combined effect of these external shocks will directly affect the changes in the exchange rate of the RMB against the US dollar on the one hand, and affect China's macro economy through changes in international trade, direct investment and international capital flows on the other hand, which in turn will cause changes in the value of the RMB and affect the stability of the RMB exchange rate. Based on this, a second hypothesis is proposed.

Hypothesis 2: The increase in the U.S. economic policy uncertainty index will exacerbate the volatility of the RMB exchange rate.

As a comparison between RMB and foreign (regional) currencies, the RMB exchange rate is not only affected by the uncertainty of domestic economic policies, but also easily affected by the uncertainty of foreign (regional) economic policies. However, considering the breadth and depth of China's foreign exchange market, it is relatively limited (Guan Tao, 2018)[22] Compared with major international currencies, the internationalization level of RMB is not high, and the openness of the foreign exchange market is low, which will lead to the transmission of foreign economic policy uncertainty on the RMB exchange rate to be inhibited to a certain extent, so compared with China's economic policy uncertainty, the impact of foreign economic policy uncertainty on the RMB exchange rate should be lower. Based on this, a third hypothesis is proposed.

Hypothesis 3: The impact of China's economic policy uncertainty on the RMB exchange rate is greater than that of the U.S. economic policy uncertainty.

3. Empirical analysis

3.1. Sample selection and data sources

In terms of sample frequency, since the impact of policy uncertainty on the macroeconomy is short-term, the frequency of data should be high in order to analyze it more accurately, and a large number of data sets are required when using VAR models to analyze the macroeconomy. Referring to the practice of using monthly data modeling in previous literature (Krol, 2014, Balcilar et al., 2016, Kido, 2016, Zhu Mengnan and Chuangshuai, 2015), this paper selects monthly RMB exchange rate data and EPU index modeling.

In terms of sample intervals, before the RMB exchange rate reform, the planned management of the RMB exchange rate was more serious, and the effect of the market role could not be well reflected, so the sample interval in this paper was taken from the data after the exchange rate reform in July 2005. For the time being, interest rates and other data are only updated to August 2021, so the sample period in this paper is from July 2005 to August 2021, and the sample number of observations is 194. The specific data selection and indicator construction process is as follows:

(1) There are two different teams in China that provide the China Economic Policy Uncertainty Index, the first being Scott Baker, Nick Bloom, Steven J. Davis, and Xiaoxi (Sophie) Wang, who developed the China Economic Policy Uncertainty Index based on the South China Morning Post.

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The index is monthly, from January 1995 to the present. Others, Steven J. Davis, Dingqian Liu, and Xuguang S. Sheng, based on mainland newspapers, developed an index of China's economic policy uncertainty and trade policy uncertainty. From October 1949 to the present, their overall EPU index for China is monthly. Their monthly trade policy uncertainty index for China covers the period from January 2000 to the present. Both teams follow the newspaper-based approach of Scott R. Baker, Nicholas Bloom, and Steven J. Davis in "Measuring Economic Policy Uncertainty," and the second team draws on monthly data from July 2005 to August 2021.

(2) The data on U.S. economic policy uncertainty are from Baker et al. (2016). Baker et al. (2016) constructed a monthly and daily EPU index based on the text analysis method, and the daily EPU index is constructed by calculating the average number of times the keyword "economic policy uncertainty" is mentioned in the relevant newspapers published daily. Baker et al. (2016) published the monthly EPU index of major countries or regions in the world, but only the daily EPU index of the United States and the United Kingdom.

(3) In view of the influence of the U.S. economy on the world and the global hegemony of the U.S. dollar, and the fact that the exchange rates of countries with the U.S. dollar as the benchmark exchange rate are more readily available, the author also follows the recommendations of most scholars (Salehizadeh and Taylor, 1999) to choose the U.S. dollar as the benchmark exchange rate. The RMB exchange rate data against the US dollar is based on the monthly average currency exchange rate, and the data is derived from the data provided by the Organisation for Economic Co-operation and Development compiled by the EPS database. The time horizon chosen covers different exchange rate regimes and is long enough to carry out a cointegration test of the long-term equilibrium relationship of the impact of economic policy uncertainty on the RMB exchange rate.

3.2. Variable definition and selection

Explanatory variable: RMB exchange rate (LNEXR). In this paper, the logarithm of the monthly average exchange rate of the nominal exchange rate of USD/RMB is selected as the explanatory variable of the paper, and the direct pricing method is adopted in accordance with international practice.

Explanatory variables: China's economic policy uncertainty (lncnepu) and U.S. economic policy uncertainty (lnusaepu), these two variables are the core explanatory variables of this paper, and the logarithm of the monthly data of the U.S.-China economic policy uncertainty index is obtained from the logarithm.

Control variable: China's inflation rate (LNNCNCPI), which is obtained by taking the logarithm of China's monthly consumer price index (100 in 2010), also from the Organisation for Economic Co-operation and Development.

Considering the complexity of CPI data in other countries, this paper selects the weighted consumer price index of three countries that have a greater impact on China and takes the logarithm to obtain this data. They are the United States, the European Union, and Japan, and the weights are determined by the ratio of each country's total import and export trade with China from 2004 to the present.

Considering the availability of data, this paper uses the difference between the Chinese and U.S. interbank lending rates as a measure of the interest rate differential between China and the United States.

This data is obtained by taking China's total monthly import and export volume as the logarithm of the total volume of trade (LNTRADE).

chart 2Descriptive statistics of variables

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Table 1: Descriptive statistics of variables

variable	N	mean	sd	min	p50	max
lnexr	194	1.910	0.0800	1.810	1.910	2.110
lncnepu	194	4.850	0.640	3.210	4.810	6.500
lnusaepu	194	4.870	0.440	3.800	4.840	6.220
lncncpi	194	4.450	0.120	4.200	4.480	4.620
lncpi	194	4.670	0.0400	4.580	4.660	4.780
lntrade	138	7.810	0.350	6.960	7.910	8.310
rate	189	1.830	1.620	-1.930	2.600	3.180

From the above table, the economic policy uncertainty index of China and the United States is relatively close, and it can be seen from Figure 1 that the economic policy uncertainty index of China and the United States has a similar change trend, which may be due to the reduction of heteroskedasticity after taking the logarithm, which is more stable data, or it may be the spillover effect and risk contagion, as described in these two theories, in the context of more and more significant world financial integration and financial liberalization, the financial markets of the world are becoming more and more closely linked. Financial integration makes the information transmission between various financial markets faster and more convenient, and the risks between markets are also easier to disseminate, and the economic policy uncertainty of one country may be transmitted to other countries in a short period of time, and the economic policy uncertainty index between various countries will have a certain correlation.

From the perspective of inflation rate, after taking the logarithm, the average value of the consumer price index of China (LNCNCPI) and other countries (LNCPI) is relatively close, but the standard deviation gap is relatively large, and China's consumer price index is significantly higher than that of other countries, indicating that China's price fluctuations are relatively large. Of course, this is also due to the special calculation method of the consumer price index of other countries, which uses the weighted average of the consumer price index of the United States, the European Union, and Japan, which can reduce its variance to a certain extent.

3.3. Sample selection and data sources

In this paper, the VAR model and the VECM model are selected for empirical analysis, mainly because the VAR model contains more explanatory variables and explanatory variables than the AR model, MA model or ARIMA model, so VAR is more explanatory when studying the same topic, and can also investigate and reflect more possibilities.

Vector autoregressive model (VAR), an unstructured multi-equation model, constructs the model by taking every endogenous variable in the system as a function of the lag value of all endogenous variables in the system, so as to generalize the univariate autoregressive model to the "vector" autoregressive model composed of multiple time series (Gao Tiemei, 2014), which can analyze the dynamic relationship between variables.

The general mathematical expression for a VAR(p) model is as follows:

$$"y_i = \Phi_1 y_{t-1} + \cdots + \Phi_p y_{t-p} + Hx_i + \varepsilon_i \quad t = 1,2 \ldots T" \tag{1}$$

y_i is the k-dimensional endogenous variable, x_i is the d-dimensional exogenous, p is the lag order, and T is the number of samples. ε_i is the k-dimensional perturbation vectors.

When analyzing economic phenomena, the VAR model first needs to select appropriate endogenous and exogenous variables according to economic theory, and then study all variables as a whole, which can not only reflect the dynamic relationship between endogenous variables, but also consider the impact of exogenous variables on the whole. The coefficients of the variables in the VAR model cannot fully explain the whole model because they can only reflect local information, so the impulse response function and variance decomposition analysis

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can be used in the analysis. The impulse response function can reflect the dynamic change of the variable after being impacted by one unit of other variables, while the variance decomposition analysis can reflect the contribution of each variable to the structural impact of the explanatory variable.

3.4. The impact of China's economic policy uncertainty on the RMB exchange rate: based on the VECM model

3.4.1. Unit root test

Firstly, it is necessary to test the stationarity of each economic variable in this paper to avoid the occurrence of pseudo-regression results. The method commonly used to test the stationarity of time series is the ADF unit root test. The test null hypothesis is that the tested variable contains unit roots and is a non-stationary series. The judgment method is as follows: if the test statistic is greater than the critical value at the significance level, the null hypothesis cannot be rejected, indicating that the variable has a unit root and is non-stationary, and then the stationarity test is carried out on the difference variable, and only when the statistic is less than the critical value can the null hypothesis be rejected and the stationary order of the time series variable is finally determined.

Table 2: Unit root test

variable	ADF test value	The cut-off value is 1%.	Cut-off value 5%.	P-value	Smoothness
lnexr	-2.903	-3.479	-2.884	0.045	Unsteady
d.lnexr	-8.252	-3.479	-2.884	0.000	smooth
lncnepu	-4.006	-3.479	-2.884	0.0014	smooth
d.lncnepu	-22.396	-3.479	-2.884	0.000	smooth
lnusaepu	-4.984	-3.479	-2.884	0.0000	smooth
d.lnusaepu	-18.190	-3.479	-2.884	0.0000	smooth
lncncpi	-1.621	-3.479	-2.884	0.4724	Unsteady
d.lncncpi	-9.139	-3.479	-2.884	0.0000	smooth
lncpi	-2.211	-3.479	-2.884	0.2021	Unsteady
d.lncpi	-10.430	-3.479	-2.884	0.0000	smooth
lntrade	-2.513	-3.498	-2.888	0.1123	Unsteady
d.lntrade	-14.788	-3.498	-2.888	0.0000	smooth
rate	-1.029	-3.481	-2.884	0.7426	Unsteady
d.rate	-8.305	-3.481	-2.884	0.0000	smooth

Through the ADF test, we find that the original time series is basically unstationary. The unit root test for the first-order difference variables was continued, and it was found that the statistics were all less than the critical value at the 5% significance level, so the first-order difference variables were all stable, and there may be a long-term cointegration relationship between the variables, so the cointegration test could be performed on the selected data.

3.4.2. Cointegration test

The process of trace testing is to first determine the lag order of the variable according to the information criterion. The concept of information criterion is for the number of variables, scholars believe that only the number of appropriate variables is reasonable, if there are too few variables, a lot of information will be missed, resulting in the model is not enough to explain the dependent variable, if there are too many variables, it will lead to overlapping information, which will also lead to distortion of modeling. After determining the lag order, we need to determine the cointegration rank, which represents the number of cointegration relations.

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There are often multiple long-term equilibrium relationships between variables, so the cointegration rank is not necessarily equal to 1. After determining the cointegration rank, we can build the corresponding model and write the cointegration equation.

(1)Determine the cointegration hysteresis order L

Table 3: Lag order

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	569.11				7.00E-12	-8.66323	-8.60945	-8.53088
1	1490.37	1842.5	36	0	8.50E-18	-22.2826	-21.9062*	-21.3562*
2	1541.66	102.58	36	0	6.70E-18	-22.5178	-21.8187	-20.7973
3	1585	86.687	36	0	6.10E-18	-22.6308	-21.609	-20.1162
4	1623.56	77.122	36	0	5.9e-18*	-22.6702*	-21.3258	-19.3615
5	1645.36	43.596	36	0.18	7.60E-18	-22.4517	-20.7846	-18.3489
6	1672.06	53.39	36	0.031	9.10E-18	-22.3086	-20.3188	-17.4117
7	1692.78	41.448	36	0.245	1.20E-17	-22.0735	-19.7611	-16.3826
8	1734.41	83.266*	36	0	1.20E-17	-22.1602	-19.5251	-15.6752

First, the cointegration test needs to determine a reasonable cointegration lag order to ensure the statistical reliability of the cointegration relationship. Under the condition of unrestricted VAR(P) model, the optimal autoregressive order of VAR(P) can be obtained by testing the corresponding values of different VAR (P) models according to LR, FPE, AIC, SC, HQ and other test criteria. Table 3 shows the respective detection values for the lag order L from 0 to 8. At the significant level of 5%, FPE and AIC showed that the optimal regression order was 4.

(2)Non-constrained cointegration relationship test

Table 4: Cointegration rank

maximum rank	parms	LL	eigenvalue	trace statistic	critical value
0	114	1600.653	.	130.3838	94.15
1	125	1625.674	0.31164	80.3431	68.52
2	134	1646.775	0.27017	38.1412*	47.21
3	141	1656.306	0.1326	19.0789	29.68
4	146	1661.935	0.08059	7.8202	15.41
5	149	1665.614	0.05343	0.4616	3.76
6	150	1665.845	0.00344		

The table above shows the result of determining the cointegration rank based on the lag order determined earlier. The most direct way to analyze this result is to find the trace statistic with the "*" sign, the optimal value in this example is 38.1412, and the corresponding cointegration rank is 2, indicating that there are two cointegration relationships between the variables in this example.

(3)For trace testing, a corresponding model can be constructed to describe the long-term cointegration relationship.

Table 5: Long-term cointegration equations

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnexr	1	.	.	.	.	.
lncnepu	-0.26972	0.213575	-1.26	0.207	-0.68832	0.1488806
lncncpi	3.983264	0.565929	7.04	0	2.874064	5.092463
lncpi	8.047883	1.841528	4.37	0	4.438555	11.65721
lntrade	0.780554	0.277206	2.82	0.005	0.23724	1.323869

ISSN: 2710-0170

rate	-0.06643	0.041527	-1.6	0.11	-0.14782	0.0149656
_cons	-61.8193	.	.	.	.	.

The specific model of the cointegration equation can be seen in the table above:
lnexr-0.26972lncnepu+3.983264lncncpi+8.047883lncpi+0.780554lntrade-0.06643rate-61.8193=0
If we take D1.lnlne as the dependent variable and deform the above equation, the result is:
Lnexr=0.26972lncnepu-3.983264lncncpi-8.047883lncpi-0.780554lntrade+0.06643rate+61.8193

3.4.3. Diagnostic testing of the VECM model

The necessary diagnostic tests need to be performed before the impulse response function and variance decomposition can be derived from the VECM. The autocorrelation test showed that LM1=37.7956, P value=0.38723, LM2=33.2613, P value=0.59954, so there was no autocorrelation.

Table 6: Autocorrelation test

lag	chi2	df	Prob > chi2
1	37.7956	36	0.38723
2	33.2613	36	0.59954

Figure 2 shows that one root is 1 (since the VECM model setup contains 1 unit root) falls on the unit circle, and the others are within the unit circle, so the stability condition of the VECM model is satisfied.

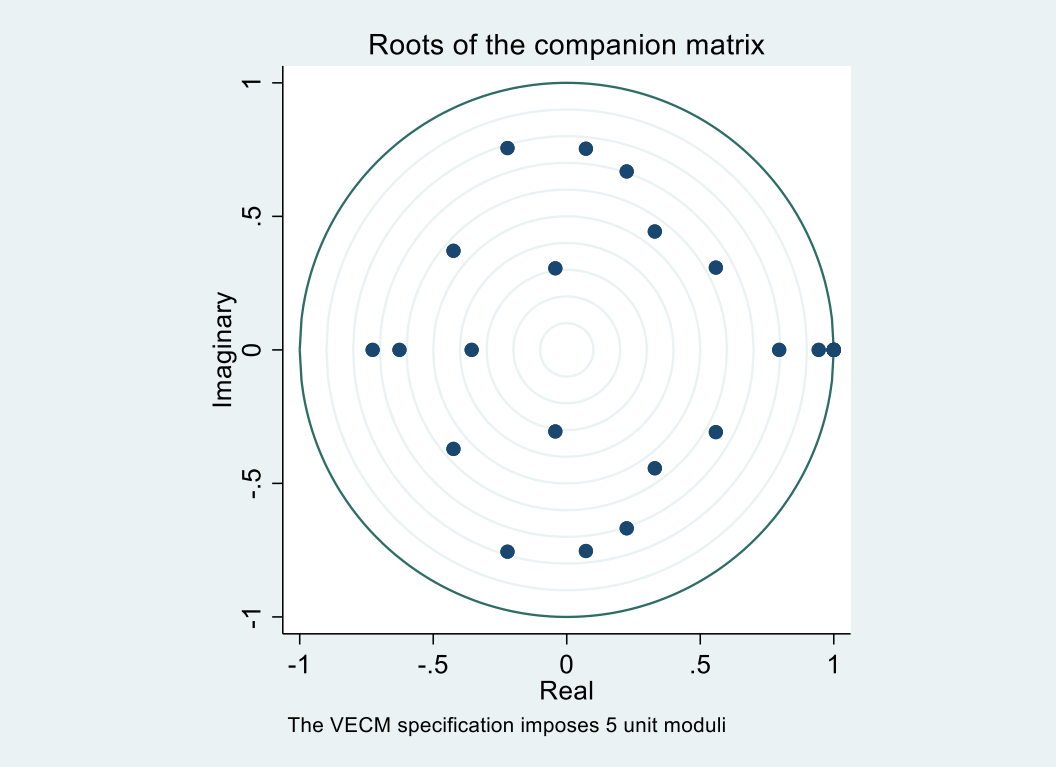

Figure 2: stationarity test

3.4.4. Impulse response

Impulse response analysis is the response of one variable to a positive shock in the VAR model. As can be seen from the impulse response function diagram in Figure 3, the current period has a positive effect on the USD/RMB exchange rate after a positive impact on the uncertainty of the economic policy, which is consistent with the conclusion of the previous cointegration test. In other words, the increase in uncertainty of China's economic policy will lead to the

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depreciation of the RMB exchange rate, which is also consistent with the previous theoretical analysis. The impact of economic policy uncertainty on the RMB exchange rate became negative in the fourth period, but the impact was not strong, and gradually converged in the fifth period.

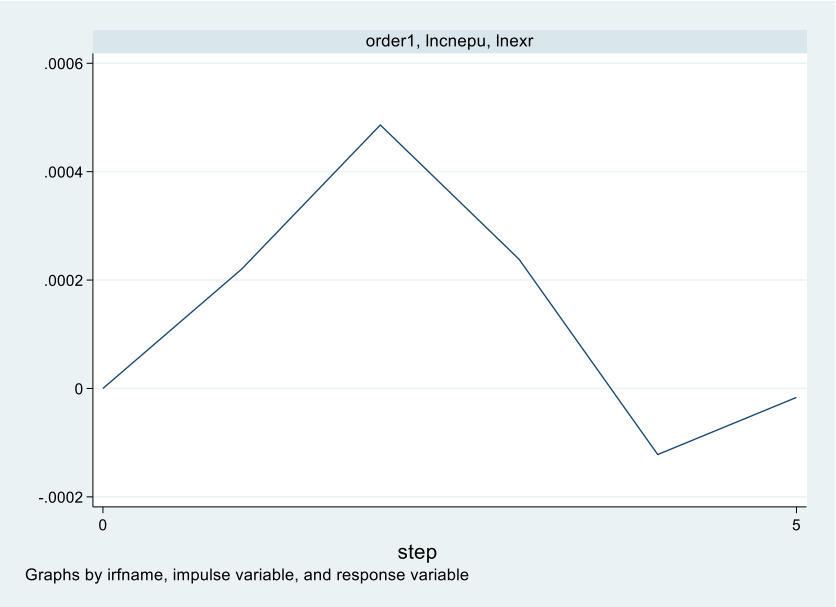

Figure 3: The impulse response of the exchange rate to China's EPU

3.5. The impact of economic policy uncertainty in the United States on the RMB exchange rate - based on the VAR model

3.5.1. Unit root inspection

Traditional VAR theoretical modeling requires that each variable is a stationary sequence, and if the original sequence is non-stationary, the original sequence needs to be differentially obtained to obtain a stationary sequence before establishing a VAR model (Yu et al., 2011).

Considering the difference between the variables used in this paper, it can be regarded as the rate of change (fluctuation) of the RMB exchange rate, the uncertainty fluctuation of economic policy, the rate of change of inflation, the rate of change of trade volume, the rate of change of interest rate differential, etc., which has a good economic meaning.

3.5.2. Cointegration test

On the one hand, economic policy uncertainty has an impact on exchange rate market correlation by influencing investor expectations.

Table 7: Cointegration rank

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	55	1504.217	.	86.6164	68.52
1	64	1524.018	0.25423	47.0150*	47.21
2	71	1538.195	0.18943	18.6618	29.68
3	76	1543.164	0.07097	8.7237	15.41
4	79	1547.19	0.05791	0.6704	3.76
5	80	1547.526	0.00495		

The table above shows the result of determining the cointegration rank based on the lag order determined earlier. The most direct way to analyze this result is to find the trace statistic with the "*" sign, the optimal value in this example is 47.0150, and the corresponding cointegration rank is 1, indicating that there is a cointegration relationship between the variables in this example.

ISSN: 2710-0170

Table 8: Lag order

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	1339.86				7.10E-16	-20.6955	-20.6505	-20.5847*
1	1395.72	111.72	25	0	4.40E-16	-21.174	-20.9037*	-20.5089
2	1433.88	76.324	25	0	3.60E-16	-21.378	-20.8826	-20.1587
3	1462.35	56.939	25	0	3.4e-16*	-21.4318*	-20.7112	-19.6583
4	1477.3	29.902	25	0.228	4.00E-16	-21.276	-20.3302	-18.9483
5	1504.35	54.102	25	0.001	3.90E-16	-21.3078	-20.1368	-18.4258
6	1522.88	37.056	25	0.057	4.40E-16	-21.2075	-19.8113	-17.7713
7	1557.63	69.498	25	0	3.90E-16	-21.3586	-19.7372	-17.3682
8	1581.53	47.795*	25	0.004	4.20E-16	-21.3415	-19.4949	-16.7969

Table 8 shows the values for each of the hysteresis orders L from 0 to 8. At the 5% significant level, FPE and AIC indicate that the optimal regression order is 3.

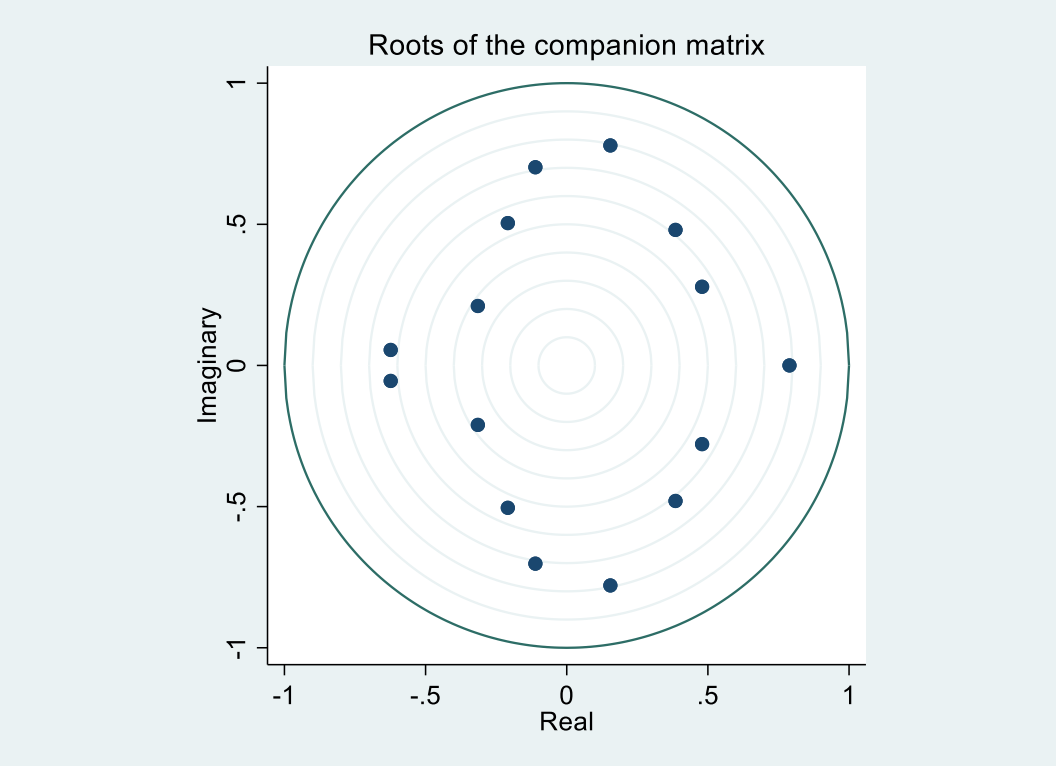

Figure 4: Stability testing

The stability of the VAR model is a prerequisite to ensure that the model results are valid, and the instability of the model will lead to some results such as the standard error of the impulse response function not being valid. Therefore, if the reciprocal of the polynomial root of the AR feature polynomial is within the unit circle, indicating that the reciprocal of the AR feature root is less than 1, then the model can be concluded to be stable. Through the stability test, it is found that all the points, that is, the reciprocal of all AR feature polynomial roots are in the unit circle, and the feature roots are less than 1, indicating that there is no unit root, and the VAR model is stationary, indicating that the built VAR model is stable and can be analyzed for impulse response.

3.5.3. Impulse response function diagram

Impulse response analysis is the response of one variable to a positive shock in the VAR model. As can be seen from the impulse response function diagram in Figure 5, the current period has a negative effect on the exchange rate of the US dollar against the RMB after a positive impact

ISSN: 2710-0170

on the uncertainty of the US economic policy, that is to say, the increase in the uncertainty of the US economic policy will lead to the decline of the US dollar against the RMB exchange rate, that is, the appreciation of the RMB, which is also consistent with the previous theoretical analysis. The impact of economic policy uncertainty on the RMB exchange rate became a positive impact in the fourth period, but the impact was not strong and fluctuated, and gradually converged in the seventh period.

As can be seen from Figure 6, in terms of the impact of other control variables on the RMB exchange rate, the impact of the price index and the rate of change of trade volume on the RMB exchange rate fluctuates up and down, and generally tends to stabilize after the fifth period. It can be seen from the chart that a positive impact on the interest rate differential between China and the United States will quickly have a negative impact on the exchange rate of the US dollar against the RMB, and although the impact will be narrowed in a short time, it will still last for a long time.

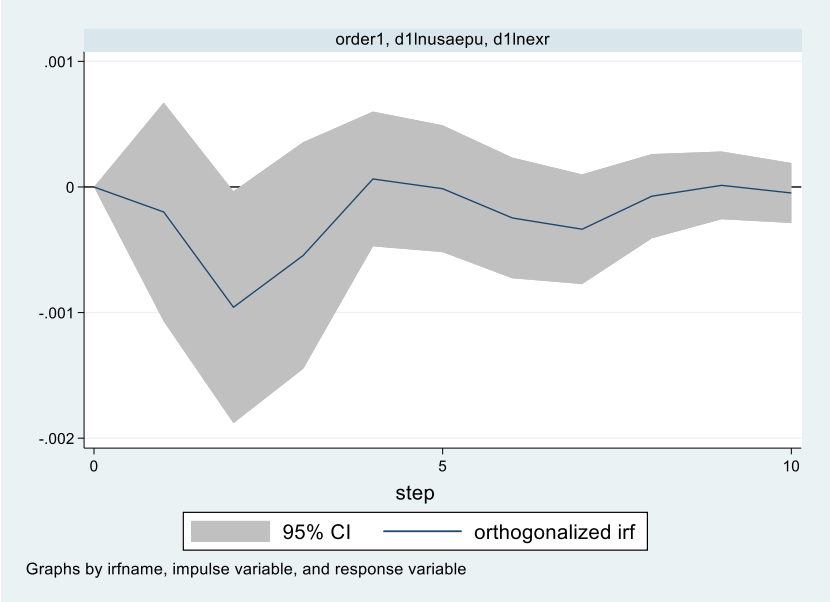

Figure 5: U.S. EPU

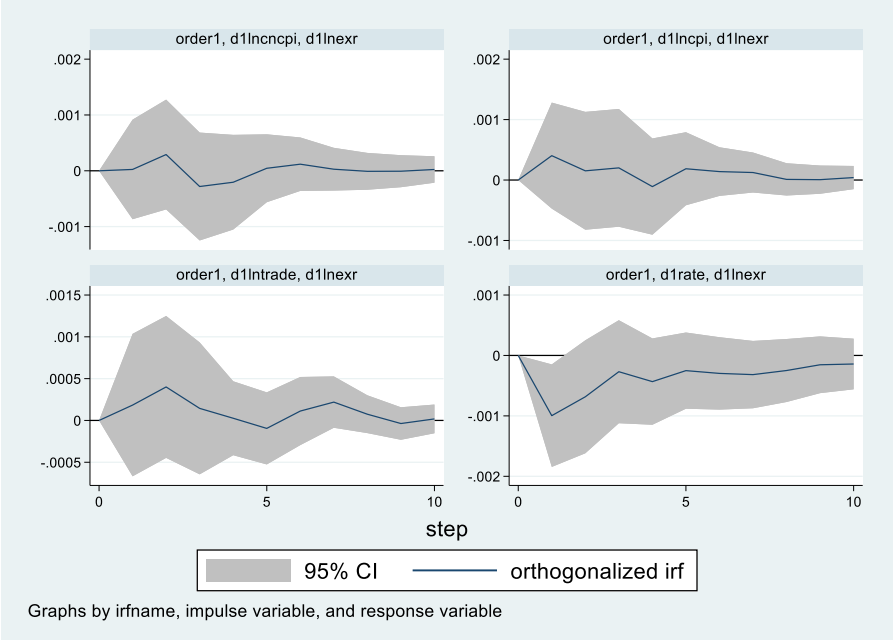

Figure 6: Control variables

ISSN: 2710-0170

3.5.4. Variance decomposition

As can be seen from Table 9, as the number of periods increases, the explanatory effect of the exchange rate on its own fluctuations gradually decreases, reaching 89% at the end of the 30th period. The explanatory power of the remaining variables for exchange rate fluctuations gradually increased, totaling 11% in 30 periods. Among them, the variance explanation of interest rate spread changes at the end of the period reached 5.22%, which reached the maximum value among all explanatory variables, followed by the uncertainty index of U.S. economic policy at 3.65%, which shows that the change of interest rate differentials and the uncertainty of U.S. policy are the main reasons for exchange rate fluctuations. Inflation and the rate of change in trade volume explain exchange rate fluctuations to a lesser extent, and the variance at the end of the period is less than 1%.

Table 9: Variance decomposition

perid	d1lnexr	d1lnusaepu	d1lncncpi	d1lncpi	d1lntrade	d1rate
|0	0	0	0	0	0	0
|1	1	0	0	0	0	0
|2	0.961	0.00127	1.90e-05	0.00522	0.00108	0.0318
|3	0.915	0.0283	0.00252	0.00550	0.00574	0.0432
|4	0.903	0.0357	0.00469	0.00645	0.00612	0.0436
|5	0.900	0.0345	0.00566	0.00654	0.00591	0.0471
|6	0.900	0.0334	0.00554	0.00726	0.00597	0.0474
|7	0.897	0.0343	0.00579	0.00762	0.00618	0.0487
|8	0.892	0.0368	0.00574	0.00791	0.00733	0.0506
|9	0.890	0.0367	0.00570	0.00787	0.00743	0.0519
|10	0.890	0.0365	0.00568	0.00783	0.00743	0.0522

4. Conclusion

This paper theoretically analyzes the mechanism of the impact of Sino-US economic policy uncertainty on the fluctuation of the RMB exchange rate. We find that the impact of economic policy uncertainty on the fluctuation of the RMB exchange rate has the following two transmission pathways. On the one hand, the rise of economic policy uncertainty in the world's major economies, such as the United States, will change people's expectations of the value of the dollar, and the change in the value of the dollar will affect the international trade and foreign direct investment between China and the United States, thereby triggering changes in international capital flows, while the formulation of China's domestic economic policy will be affected by the uncertainty of external economic policies, and then indirectly cause RMB exchange rate fluctuations through interest rates, money supply and other channels. On the other hand, the increasing uncertainty of China's own economic policy will directly affect investors' expectations and demand, thereby causing fluctuations in the RMB exchange rate.

In terms of empirical testing, this paper uses the VAR model and the VECM model to investigate the impact of Sino-US economic policy uncertainty on the RMB exchange rate, and considers the effects of four variables: China's inflation rate, foreign inflation rate, China-US interest rate differential, and China's foreign trade volume change rate on the fluctuation of the RMB exchange rate. The overall analysis of the entire sample range shows the following conclusions: First, there is a two-way interactive causal relationship between the economic policy uncertainty of China and the United States and the fluctuation of the RMB exchange rate. The increased uncertainty of China's economic policy will have a depreciating impact on the RMB

ISSN: 2710-0170

exchange rate, and the increased uncertainty of the US economic policy will have an impact on the appreciation of the RMB exchange rate. Through the comparison of the impulse response diagram of the RMB exchange rate from the uncertainty of the economic policy of China and the United States, the impact of China's economic policy uncertainty on the change of the RMB exchange rate is greater than that caused by the uncertainty of the US economic policy, and these conclusions are consistent with the theoretical analysis.

Second, the impulse response function analysis shows that after the positive impact of the interest rate differential between China and the United States in the short term, the exchange rate of the US dollar against the RMB will be inversely affected, that is, the RMB will appreciate.

Thirdly, through variance decomposition, it is found that the interest rate differential between China and the United States has the greatest explanatory effect on exchange rate fluctuations, with an explanatory degree of 5.22% at the end of the period. The explanatory role of U.S. economic policy uncertainty ranked second, with an explanatory degree of 3.65% at the end of the period.

Acknowledgements

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