Original Research Article

Study on the Impact of RMB Exchange Rate Changes on China-Japan-Korea Commodity Trade

ABSTRACT

With the development of economic globalization, the connection between countries has been continuously strengthened. The Chinese government is currently implementing a series of policies to adjust the import and export structure, cultivate the international competitiveness of import and export enterprises, and promote the steady growth of foreign trade.

This paper investigates the relationship between RMB exchange rate fluctuation and commodity trade between China, Japan and South Korea through theoretical and empirical analysis. Firstly, the paper sorts out the mechanism of exchange rate changes affecting trade, and then discusses the trade process and development prospects of China and Japan and South Korea. The empirical analysis is based on the PLSR partial least squares model to investigate the relationship between exchange rate changes and China-Japan-Korea merchandise trade. The empirical results show that GDP has a low impact on the trade between Japan and Korea and China, and in contrast, for every 1% increase in the real exchange rate, the import and export volume decreases by 0.4% and 0.14%, respectively, with a positive contribution relationship.That is, the devaluation of the RMB will boost the import and export commodity trade between China, Japan and Korea.Finally, for the impact of RMB volatility on trade, the author gives appropriate advice to local governments.

Keywords:Exchange rate fluctuations ; China, Japan and South Korea ; foreign trade ; PLSR model

1. INTRODUCTION

1.1Exchange rate fluctuations on the impact of imports and exports increased

As a core price index in an open economy, the exchange rate affects the allocation of resources in a country or even globally. For foreign trade, the exchange rate is an important influencing factor. At present, China is constantly exploring the exchange rate system in line with our national conditions, and the improvement of the exchange rate system will, to a certain extent, not only enhance the flexibility of the RMB exchange rate~~,~~ but also reduce the risk of uncertainty caused by exchange rate fluctuations. China's exchange rate system has undergone several reforms since the reform and opening up, and the market-oriented reform of the RMB exchange rate system has gradually deepened, with exchange rate movements tending to be market-oriented and standardized. The two exchange rate reforms have led to the continuous improvement of the market-based RMB exchange rate formation mechanism and further increase in the flexibility of the RMB exchange rate floating in both directions. According to exchange rate-related theory, the exchange rate will fluctuate up and down due to the influence of supply and demand in the foreign exchange market. Exchange rate fluctuation will make enterprises face different exchange rate risks. China has been promoting the market-oriented reform of the RMB, which makes the RMB exchange rate predictable, but the direction of this influence is uncertain. Because exchange rate fluctuations can bring risks, exchange rate fluctuations can make changes in the cost of import and export, thus having an impact on the import and export decisions made by enterprises. For example, in 2005, China's exchange rate system reform, resulting in huge fluctuations in the exchange rate, resulting in China's foreign trade imports changed for many years than the growth rate of exports, the growth rate fell back quickly, can be very intuitive to see the impact of exchange rate fluctuations on import and export trade is far-reaching. It can be seen that the impact of exchange rate fluctuations on bilateral import and export trade highlights the urgent need to carry out research on the issue ofthe RMB exchange rate, and how it affects the development of Jiangsu's foreign trade.

1.2Relevance of the study

Over the past 40 years of reform and opening up, China's economic and social development has entered a new normal development stage. With the worsening of international competition in recent years and the intensification of RMB exchange rate changes, China is facing huge economic downward pressure. However, with the signing of the Regional Comprehensive Economic Partnership Agreement and the development of the China-Japan-South Korea Free Trade Agreement process, the form of the world economy is also quietly changing. In such an economic and social context of opportunities and challenges, how to effectively ensure the healthy and stable development of China's international trade market, and thus maintain the steady growth of our economy is undoubtedly one of the urgent issues to be solved now. In view of this, this paper uses macro data and time series analysis to explore the impact of RMB exchange rate changes on China's import and export trade.

2. LITERATURE REVIEW

The relationship between exchange rate changes and import and export trade has always been a hot issue of concern and discussion in the academic field. Foreign scholars have done a lot of theoretical and empirical research. At present, ~~the~~ academic research on the impact of exchange rates on imports and export can be divided into two main categories. The first category is the early scholars based on the traditional international trade theory to study the impact of exchange rates on trades balance. This issue was first proposed by Alfred Marshall (Alfred Marshall) and Lerner (Abba Lerner) together with the Marshall-Lerner condition, i.e. ML condition. The second category focused on the relationship between exchange rate fluctuations and trade volume, and this type of research mainly arose after 1973. At that time, the Bretton Woods system gradually collapsed and exchange rate fluctuations of countries increased, so the focus of research gradually shifted to the

relationship between exchange rate volatility and trade volume. On the issue of the impact of exchange rate changes on import and export trade volume, a large number of scholars have done a lot of research both theoretically and empirically, but no definite conclusion has been reached so far.

2.1 Improving or curbing foreign trade

On the impact of exchange rate changes on import and export trade. Akhtar[1] (1984) used an OLS model to verify the negative effect of nominal exchange rate changes on foreign trade turnover. Soleymani& Chua[2] (2013) study the impact of industry-level-based exchange rate level changes and fluctuations on import and export trade, noting that the role of exchange rate effects is more pronounced in the import model. Bahmani-Oskooee& Harvey et al[3] ((2014) study the impact of changes in the dollar to the euro on trade between the United States and Spain, concluding that trade in most industries is affected by exchange rate changes at the industry level and further refined at the firm level to conclude that trade of small-scale firms is more significantly affected. Boyd[4] (2001) study the impact of exchange rate changes on bilateral trade of OECD countries, concluding that in the long run exchange rate changes are the main factor affecting ~~the~~ trade.Cao, Wei and Luo, Jianqiang[5] (2020) studied the impact of changes in the real effective exchange rate level and fluctuations of the RMB industry on China's import trade from countries along the "Belt and Road", and showed that the appreciation of the RMB exchange rate with a lag of 2 periods had a significant positive impact on import trade; CengizTunc&NihatSolakoglu[6] (2018) concluded that bilateral exchange rate fluctuations promote export trade and noted that there is a correlation between the intensity of trade and the degree of economic development of bilateral trading countries and the magnitude of the effect of exchange rate fluctuations on export trade.Caporale[7] also verified a significant negative correlation between real exchange rate fluctuations and trade turnover using a GARCH model.

Studies based on the impact of exchange rate fluctuations on import and export trade have also failed to reach a unanimous result, with some scholars concluding that exchange rate fluctuations have a positive or negative impact on trade and a few concluding that exchange rate fluctuations are not a major influence on trade.Caporale[8] (2011) empirically finds that exchange rate fluctuations promote the import and export trade of most African countries, and that exchange rate fluctuations are conducive to the optimization of the commodity structure of African countries' imports and exports and the overall development of their international trade. Baek[9](2013) using industry data on bilateral trade between Japan and Korea as a sample, the study finds that Korean imports and exports are affected by exchange rate changes in the short run by means of autoregressive distribution lags, but the results show that the effect is minimal in the long run.Bahmani-Oskooee et al. (2008), by studying the impact of changes in the level of the yen-dollar exchange rate and its volatility on manufacturing-based import and export trade between Japan and the U.S., conclude that RMB exchange rate fluctuations do not have a significant impact on their major industries in the medium and long run. There is also uncertainty about the impact of RMB exchange rate fluctuations in the short run.

2.3 Impact on trade structure

Jin Zhaohui[10] (2021) first classifies 512 HS goods into technology-intensive, capital-intensive and labor-intensive products, and then builds two models to empirically analyze the impact of RMB real exchange rate changes on exports and its spatial effects. The results of the study reveal that the appreciation or depreciation of the real exchange rate of RMB will increase or decrease China's exports of technology-intensive and capital-intensive products to low-income countries, capital-intensive products to middle-income countries, and three types of products to high-income countries and countries along the "Belt and Road"; China's exports of technology-intensive and labor-intensive products to the Asian region will increase or decrease. China's exports of technology-intensive and labor-intensive products to Asian countries have a mutually suppressing neighboring trade effect.Using a GARCH model to measure daily data on exchange rates from 2008- 2016,WangTongtong[11] (2015) shows that

the empirical results indicate that the J-curve effect holds for trade in most industries, that the RMB exchange rate is an important factor explaining the trade balance, and that the exchange rate has a weak or even weak influence on labor-intensive industries and a stronger influence on technology- and capital-intensive industries.

Scholars have done abundant research on thecexchange rates and trade and have obtained fruitful research results. Through the summary of previous literature, a systematic review of exchange rate changes and trade effects, exchange rate transmission theory and the impact of exchange rate changes on trade structure have been conducted, which is very enlightening for this paper to study RMB exchange rate fluctuations on import and export trade of China-Japan-Korea commodity trade.

3 EMPIRICAL ANALYZE

3.1 Data processing

Considering that the macro data can well reflect the current import and export and exchange rate situation in China, the time series sample interval selected in this paper is 2010-2021 annual data, and there are many factors affecting China's export trade, Muwen considered from the main explanatory variables, combined with the relevant literature, the explanatory variables selected are as follows.

Table 1. Data processing

Variable	Variable Meaning	Data Source	Data Processing
JEI	Total import and export of goods between China and Japan	China's National Bureau of Statistics	
KEI	Total import and export of goods between China and Korea	China's National Bureau of Statistics	
GDP	GDP of China	China's National Bureau of Statistics	Constant price in 2010
JGDP	GDP of Japan	WB	Constant price in 2010
KGDP	GDP of Korea	WB	Constant price in 2010
CPI	CPI of China	China's National Bureau of Statistics	With 2000 as the base period
JCPI	CPI of Japan	Japan's National Bureau of Statistics	With 2000 as the base period
KCPI	CPI of Korea	Korea Statistical Office	With 2000 as the base period
JER	Nominal exchange rate of RMB to JPY	IMF	

KER	Nominal exchange rate of RMB to KRW	IMF	
JRER	Real exchange rate of RMB to JPY	Formula calculation	Formula calculation
KRER	Real exchange rate of RMB to KRW	Formula calculation	Formula calculation

3.2 Model Setting

The mechanism by which exchange rate changes affect import and export trade is described in Chapter 1, followed by a mathematical and physical model to examine the impact of exchange rate fluctuations on import and export trade. This paper draws on the model construction methods of previous scholars and combines specific time series data with its own innovations to introduce third-party exchange rate variables into the equation:

$$JEI = F_1(JER,\ JGDP,\ JCPI,\ CPI)$$
$$KEI = F_2(KER,\ KGDP,\ KCPI,\ CPI)$$

In the equation, Y denotes the national income of the country and Y* denotes the national income of the trading country; PEX denotes the price of the commodity exported by the country; PEX* denotes the price of the commodity exported by the trading country; PIM denotes the price of the imported commodity; PD denotes the price of the domestic commodity; and L denotes the exchange rate under the direct markup method. In order to make the model closer to the real trade situation, it is necessary to examine the impact of the real exchange rate changes on trade, and it is necessary to add the price factor to the nominal exchange rate, so the RER is used to denote the exchange rate of RMB to EUR under the indirect markup method, and the expression is shown as follows:

$$JRER = JER \times \frac{CPI}{JCPI}$$
$$KRER = KER \times \frac{CPI}{KCPI}$$

The model is set to take the logarithm of the original data in the calculation, on the one hand, to make the data as smooth as possible, and on the other hand, to eliminate the problem of heteroskedasticity of the data as much as possible, and the results given later with the software SPSS are all calculated after taking the logarithm. The variables representing the third country effect mentioned earlier are introduced again, and here the nominal exchange rate of the third country in the mutual influence of China, Japan and Korea is added as a variable in the influence equation, and the final expression is obtained by taking logarithms for both sides as follows:

$$LnJEI = C + \alpha_1 LnJRER + \beta_1 LnJGDP + \gamma_1 LnKER + \varepsilon_1$$
$$LnKEI = C + \alpha_2 LnKRER + \beta_2 LnKGDP + \gamma_2 LnKER + \varepsilon_2$$

3.3 Unit root test

For the time series, the first step is to check its smoothness to see if these variables have the characteristic of changing over time. Therefore, the ADF test is first performed on the variables in the model, and the results are shown in Table 1. It is found that all of these variables are non-stationary time series except for the real exchange rate between China and the U.S., but the other relevant variables become stationary time series after second-order differencing

Table 2. unit root test

Variables	t	P	AIC	Threshold value			Conclusion
				1%	5%	10%	
LnJRER	-1.339	0.611	-10.915	-4.223	-3.189	-2.73	Unstable
LnJGDP	0	-1.339	0.611	-10.915	-4.223	-3.189	Unstable
LnKER	-1.339	0.611	-10.915	-4.223	-3.189	-2.73	Unstable
△LnJRER	-10.749	0.000***	-29.353	-5.354	-3.646	-2.901	stable***
△LnJGDP	2	-10.749	0.000***	-29.353	-5.354	-3.646	stable ***
△LnKER	2	-10.749	0.000***	-29.353	-5.354	-3.646	stable ***

In the table, T represents the trend term, P represents the lag term, △ represents the second-order difference, and "*", "**", and "***" denote passing at the 10%, 5%, and 1% levels, respectively test. The results of this series test show that based on the variable Ln JEI, the significance p-value is 0.000*** at the second order of difference, which presents significance at the level and rejects the original hypothesis that the series is a smooth time series.

The time series itself is not smooth, and the time series is smooth after the second-order difference. It is consistent with the J-shaped curve principle. Therefore, the logarithm of the nominal exchange rate and the logarithm of the effective exchange rate after second-order differencing are considered for the time series regression analysis in this paper.

3.4 PLSR model

Partial Least Squares Regression

(PLSR) is the latest data analysis method in multivariate statistical analysis, which combines the advantages of multiple regression analysis, principal component analysis, and typical correlation analysis. It can use the idea of information decomposition to recombine the information of independent variables and dependent variables under one algorithm, extract the composite variable with the strongest explanatory power for the explanatory variables, and remove the interfering information to output a more accurate and robust result. Partial least squares regression (PLSR) is applicable to both single and multiple dependent variables. In this paper, only the single dependent variable of real import and export trade is involved in the empirical study, and thus only the single dependent variable PLSR modelling is described.

Table 3. Factor Explanatory Variables

Potential factors	X Variance	Cumulative X variance	Y Variance	Cumulative Y variance	Adjusted R^2
1	0.56	0.56	0.441	0.441	0.385
2	0.328	0.888	0.062	0.502	0.392
3	0.112	1	0.027	0.529	0.353

The above table demonstrates the combined explanatory power of the information of the potential factors. In this case, the accumulated X variance represents the extraction of information on the independent variable, and the accumulated $Y^2(R^2)$ represents the

extraction of information on the dependent variable, which can be used to determine the maximum number of principal components of the parameter.

The results of the table of variance explained by the factors show that the first 2 potential factors alone explain 80% of the information of the dependent variable, and all potential factors do not explain 80% of the information of the dependent variable.

Table 4. factor loading coefficients

Variables	Factor 1	Factor 2	Factor 3
JRER	0.735	-0.482	-0.517
JGDP	0.463	0.849	-0.245
CNY/KRW	0.602	0.504	0.82

Table4shows a factor loading plot for partial least squares regression, through which the interrelationship between the set of independent variables and the set of dependent variables can be observed. In this figure, if the two variables are located very close to each other, they can be considered to have a strong correlation.

The table shows that total exports ~~and~~ are highly positively correlated with the real exchange rate of RMB to JPY and the nominal exchange rate of RMB to KRW. Japanese GDP also has some positive impact on merchandise exports, but it is far from playing a key role. It shows that the export industry is closely linked to the exchange rate.

Independent variable VIP

In the partial least squares regression analysis, the explanatory power of the ith variable Xi on the dependent variable Y is portrayed by the variable importance in projection (VIPi), and in economic practice

it is generally considered that when VIPi ≥ 1, the explanatory power of the variable is strong; when 0.5 ≤VIPi< 1, the explanatory power of the variable is The explanatory power of the variables is considered to be strong when VIP≥1; when 0.5≤VIPi<1, the explanatory power of the variables is considered to be weak when VIPi<0.5.

The Variable Importance in Projection (VIP) index reflects the importance of the role of each independent variable Lxj in explaining the dependent variable LY, which is calculated as:

$$VIP_j = \sqrt{\frac{p}{Rd(LY;t_1,\cdots,t_m}\sum_{k=1}^{m} Rd(LY;t_k)\,w_{kj}^2}$$

whereVIP_j denotes the jth independent variable Lx_j projection importance index, p is the number of independent variables, w_{kj} is the jth component of axis wk to measure the marginal contribution of Lx_j to the construct component t_k and for any k=1,2,· · · ·,m, there is always has$\sum_{j=1}^{p} w_{kj}^2$ = 1

Table 5. Summary table of independent variables VIP (cumulative projection importance)

Variables	Factor 1	Factor 2	Factor 3
JRER	1.42	1.338	1.319
JGDP	0.232	0.622	0.614
CNY/KRW	0.965	0.907	0.94

Table 5 shows the VIP (cumulative projection importance) which indicates the strength of the explanatory importance of X for Y when the number of components varies and can also be used for reference to the maximum number of principal components. For independent variables with a large VIP (greater than 1), it plays a relatively larger role in explaining the underlying factors (and thus in explaining the dependent variable).

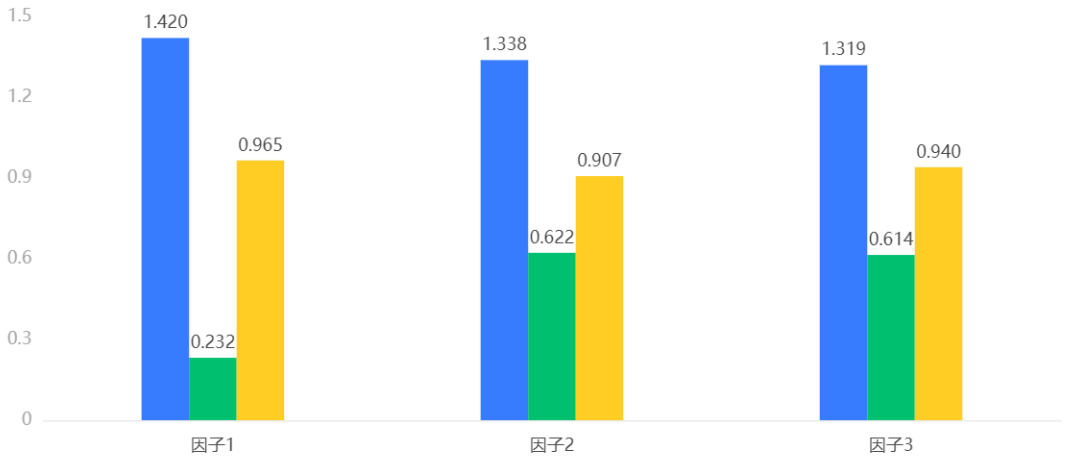

Fig. 1 VIP (cumulative projection importance) plot of independent variables

The magnitude of the combined explanatory power of each independent variable on the dependent variable can be visualized in Fig.1 The VIP value of the real exchange rate between China and Japan is the largest, ranking 1st among the 3 indicators, indicating that it plays the largest role in explaining the dependent variable. The continuous appreciation of RMB in recent years has directly increased the cost of export products and the risk of international trade, which has seriously affected the development of exports. The VIP value of the GDP of trading countries is less than 1 and ranks last, indicating that it is the least important factor affecting the development of export trade; the VIP value of the nominal exchange rate of third countries ranks second, very close to 1, indicating that the role of third countries' influence in multilateral trade cannot be ignored.

Table 6. Model coefficient structure table

	LnJEI	LnJEI (Standardization)
Constants	14.739	0
LnJRER	-0.42	-0.563
LnJGDP	0.58	0.305
LnCNY/KRW	-0.759	-0.557

Using the PLSR method, based on the extraction of the two components, we obtained the standardized equation for the regression model model of the factors influencing the real exchange rate of RMB as

$$LnJEI = 14.739 - 0.42 \times LnJRER + 0.58 \times LnJGDP - 0.759 \times LnKER$$

Analysis of Empirical Results

The output of the PLSR model shows that the exchange rate, GDP, and third-country nominal exchange rate are all positively correlated with China's commodity trade course with that country, which is consistent with the actual economic significance as well as the theoretical analysis. Among them, the impact ofthe RMB real exchange rate on merchandise trade is the most obvious, the coefficient before the variable is above 15% and the VIP value is more than 1, which fully indicates that relative to GDP and the third country exchange rate, the RMB-JPY real exchange rate has an important effect on the import and export trade volume between China and Japan. the negative coefficient in front of JRER indicates that when the exchange rate variable decreases, that is, when the RMB depreciates, it will promote the trade of import and export goods between China and Japan, which is consistent with the expected results.

5. CONCLUSION AND OUTLOOK

5.1 Conclusion

This paper uses macro annual data from 2010 to 2021 to explore the impact of RMB real effective exchange rate changes on China's import and export commodity trade with Japan and South Korea. First, based on descriptive statistics, it is found that there is a certain correlation between the change in the RMB exchange rate and China's import and export trade volume, but the changes are not perfectly consistent. Second, the unit root test reveals that the three selected independent variables are all second-order smooth, as expected from a J-curve. the cumulative importance of the VIP projection results indicates that the development of Japanese GDP has a negligible impact on Sino-Japanese merchandise trade, while the change in the exchange rate has a significant contribution to the trade promotion in contrast. Later, the impact of the real effective exchange rate of RMB on China's import and export trade volume was estimated using a partial least squares model, and it was found that the impact of the real exchange rate on the import and export trade volume between the two countries was the most sense relative to the other two variables.

5.2 Suggestions

（1）Further promote the reform of the exchange rate mechanism to be flexible and nimble, and reduce the adverse impact of exchange rate fluctuations on trade. Changes in the RMB exchange rate have a significant impact on China's trade with its neighbors, and maintaining the stability of the RMB exchange rate and reducing the risks associated with the sharp fluctuations in the RMB exchange rate play an important role in maintaining the balance of international trade. Therefore, for the stability of China's economy and the sustainable and healthy development of import and export trade, we should adhere to the managed floating exchange rate policy and intervene in the foreign exchange market from time to time in accordance with the needs of the country's economic interests in order to make the exchange rate of the national currency rise and fall in the direction favorable to the country's exchange rate system. Under a managed floating exchange rate system, the exchange rate fluctuates within a range determined by the monetary authority, and once the exchange rate floats beyond a specified range, the monetary authority enters the market to buy and sell foreign exchange, controlling the fluctuation of the RMB exchange rate within a reasonable range。

（2）When the central bank makesan exchange rate adjustment, it should not only consider the impact of exchange rate fluctuation but also the time lag of policy formulation and the adjustment of other related economic policies, so that the exchange rate policy and other economic policies can work together to promote the stable development of the national economy. In addition, China's enterprises should seize the opportunity of exchange rate changes to actively attract foreign investment, the introduction of foreign advanced technology, the development and development of new products with international competitiveness, the eliminate of high energy consumption,and low-technology goods, improve the value of the commodity itself, to achieve upgrading. At the same time, Chinese enterprises should also reduce their dependence on the technology of foreign enterprises, seize their own advantages, control costs and encourage innovation, in order to improve corporate income and achieve independent and stable development. In recent years, the RMB has been gaining influence in the international market and its international status has been increasing. For this reason, we should seize the opportunity to expand the use of RMB in international trade, strengthen the value of RMB in international use, and stabilize the economic risks caused by exchange rate fluctuations.

CONSENT (WHEREEVER APPLICABLE)

Author WuHao designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author XuYongqimanaged the literature searches. All authors read and approved the final manuscript.

REFERENCES

[1] Akhtar, M. and R. Spence Hilton, ‘Effects of Exchange Rate Uncertainty on German and U.S. Trade’ [J]. Federal Reserve Bank of New York. Quarterly Review. Vol 9:7-16.

[2] SoleymaniA,Chua S Y.Effect of exchange rate volatility on industry trade flows between Malaysia and China[J]. Journal of International Trade & Economic Development, 2014,23(5-6):626-655.

[3] Bahmani-OskooeeM,Hegerty S W.Exchange-rate risk and U.S.-Japan trade:Eviden-ce from industry level data[J]. Journal of the Japanese and International Economies,2008,22(4):518-534.

[4] D Boyd ,Caporale G M, Smith R.Real Exchange Rate Effects on the Balan-ce of Trade : Cointegration and the Marshall-Lerner Condition[J].International Journal of Fin-ance& Economics,2001,6(3):187-200.

[5] Cao W, Luo JQ. The impact of RMB exchange rate changes on import trade: a study based on panel data of China's trade with countries along the "Belt and Road" by industry[J]. International Business (Journal of the University of International Business and Economics), 2020(04):64-79.

[6] CengizTunc et al. Exchange rate risk and international trade : The role of third country effect[J].Economics Letters,2018,167:152-155.

[7] Caporale T and Doroodian K., ‘Exchange rate variability and the flow of international trade’ [J]. Economics Letters, 1994, 46(1):49-54.

[8] Caporale T and Doroodian K., ‘Exchange rate variability and the flow of international trade’ [J]. Economics Letters, 1994, 46(1):49-54.

[9] JunghoBaek.Does the exchange rate matter to bilateral trade between Korea and Japan Evidence from commodity trade data[J].Economic Modelling,2013,30.

[10] Jin, ZhaoHui, ZhuMengNan. The impact of real exchange rate changes of RMB on export trade[J]. International Trade Issues,2021(05):143-160.

[11] Wang TongtongA study on the long- and short-term effects of exchange rate changes on China-US trade [D]. Southwest Jiaotong University,2018.