

Study on the Impact of RMB Exchange Rate on China's Industrial Structure Adjustment

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Abstract. This paper firstly summarizes the current situation of China's current industrial structure as well as the change of exchange rate system, systematically describes the research object of this paper, and outlines its main features. After that, this paper analyzes the impact of the real effective exchange rate of RMB on China's secondary and tertiary industries for the purpose of the study, takes into full consideration the main factors affecting the industrial structure, selects a large number of control variables, and completes the empirical analysis of China's overall as well as the eastern, middle and western regions by using the panel data of the country's 30 provinces in the 16-year period from 2005 to 2020. In addition, a variety of robustness tests were conducted to fully ensure the stability and interpretability of the model. It is finally concluded that the appreciation of RMB exchange rate will significantly benefit the development of China's tertiary industry, promote the industrial structure from the secondary industry to the tertiary industry, and complete the upgrade of industrial structure. Specifically, for every 1% increase in the real effective exchange rate of RMB, the proportion of tertiary industry in the GDP of the whole country, the east, the center and the west will increase by 0.7850%, 0.7171%, 1.0186% and 0.4873% respectively. Besides, this paper also verifies the indirect impact of the exchange rate on the industrial structure through the three paths of price effect, foreign trade openness and FDI, and verifies the existence of the intermediary effect. According to the empirical results, the price effect, FDI, and the increase of foreign trade openness will promote the advanced industrial structure of China. But both FDI and foreign trade openness are negatively correlated with the exchange rate, which is the core variable of this paper.

Keywords: Exchange rate; industry structure; panel data; mediation effect; Thiel index.

1. Introduction

1.1. Research Background

Industrial structure represents the allocation of a country's resources in various industries. Generally speaking, the industrial structure of developed countries favors the tertiary industry, while the secondary industry of developing countries is usually more developed, and the transformation of industrial structure at present also refers to the transformation from the secondary industry to the tertiary industry. The reasons are as follows: firstly, tertiary industry contains many kinds of high-tech industries, and it is also an important symbol of a country's social productivity and modernized economic strength. Secondly, the continuous development of the tertiary industry will be conducive to the continuous improvement of the production efficiency of the primary and secondary industries, which will promote the enhancement of a country's comprehensive national strength.

From the perspective of global ecology, the global ecological and environmental conditions are not optimistic, extreme weather and natural disasters are frequent, sea level rise threatens major developed cities along the coasts of mankind, and the frequent occurrence of insurance claims and elevated trade risks have all had a certain impact on the normal financial order. In this context, China fully demonstrates the image of a responsible big country, takes the initiative to strive to achieve carbon peak in 2030, 2060 to achieve the goal of carbon neutrality, the introduction of a series of carbon emission reduction support tools, the development of the carbon emissions trading market, and help the development of green finance. At present, China's development in the photovoltaic industry and new energy battery industry in the world have achieved a great advantage, China needs to grasp this opportunity to complete the optimization of industrial structure as soon as possible.

1.2. Research Significance

Exchange rate and its changes have always been the core issues explored in the field of international finance, and the adjustment of industrial structure is an important concept in development economics. Many international scholars have done a lot of research on the two respectively, however, there are relatively few researches to explore the influence mechanism of exchange rate on industrial structure with the sample of China as a whole, and most of them are mainly based on the research method of time series analysis. This paper, by constructing a panel data model to explore the relationship between industrial structure and RMB exchange rate of each province in China, fills in the weak points of the current theory very well.

This paper calls the statistical yearbook data of China's provinces from 2005 to 2020, and analyzes the impact of exchange rate on industrial structure at the same time, and selects eight domestic economic indicators with practical significance as control variables, which largely ensures the rigor of the research problem and better enhances the explanatory strength of the model. Through the discussion of the status quo and empirical analysis part of this paper, we will have a very clear understanding of the distribution of the industrial structure of China's provinces and the influence of the exchange rate and other factors, so as to facilitate the government of China's provinces according to the actual situation of the release of the industrial structure transformation supportive policies to improve the efficiency of resource allocation. At the same time, through the verification of the impact mechanism in this paper, we explore the indirect impact of exchange rate more deeply, which on the one hand helps us to understand the development status of some indicators in China, and on the other hand, it also shows the impact of exchange rate on the transformation of industrial structure more comprehensively.

2. Literature review

2.1. Studies on the correlation between exchange rate, foreign trade and industrial structure

Theoretically, whether technological innovation of enterprises has a positive relationship with high export growth depends on whether the exporting enterprises allocate the additional profits brought by high growth exports to the enhancement of the technological level of enterprises and innovation. Melitz (2003) that the appreciation of the local currency will intensify the intensity of competition between the country's export enterprises, low labor productivity enterprises are forced to withdraw from the market, those who actively through innovation or increased investment in research and development to improve the competitiveness of the enterprise level of the enterprise can continue to survive, the whole country's exports of the average quality of goods and the competitiveness of the import and export trade will also be further enhanced. At the same time, the technological innovation of export enterprises will bring economic externalities for other domestic non-export enterprises, driving the non-export sector to carry out technological innovation and R & D, and thus promote the upgrading of a country's industrial structure. Feder (1982) divided domestic enterprises into two sectors: exporting enterprises and non-exporting enterprises, and believes that because exporting enterprises tend to be more technologically innovative, their production efficiency is usually more prominent than non-exporting enterprises, so exporting enterprises will lead non-exporting enterprises to improve the technological content, which will promote the transformation and innovation of the country's overall industrial structure.

2.2. Studies on the correlation between exchange rate, FDI and industrial structure

On the one hand, when the local currency appreciates, foreign investors will be able to exchange an equivalent amount of foreign currency for domestic factors of production and other resources, which will discourage foreign capital inflows. But on the other hand, the appreciation of the local currency will also benefit the international market's expectations of the value of the local currency, and FDI inflows may increase as a result. Theoretically, the more solid a country's economic

fundamentals are, the better the international capital's expectations for the future of its market will be, and the more FDI inflows will increase. Looking back in history, we find that many Southeast Asian countries have had severe damage from currency crises domestically under specific circumstances due to shaky economic fundamentals.

Antwi S et al. (2021) analyzed the role of foreign direct investment (FDI) in boosting Ghana's economy mainly through an autoregressive distributed lag model and also analyzed the moderating effect of exchange rate fluctuations on its economy. From the findings, foreign direct investment (FDI) significantly contributes to economic growth in the short run, while exchange rate volatility shows unfavorable effects on economic growth in the long run. Moreover, FDI reduces economic growth in the long run, while exchange rate fluctuations show a dampening effect on the negative impact of FDI on the economy.

Zhang Qian et al. (2019) examined the rationality of the industrial structure of Jiangsu Province from the development status of the exchange rate and the industrial structure of Jiangsu Province, using the Thiel index, and found that exchange rate fluctuations will have a significant impact on the foreign trade and foreign direct investment FDI in Jiangsu Province, and at the same time will affect the industrial structure of Jiangsu Province through the above two conduction pathways, in which the secondary industry is affected most strongly.

3. Empirical analysis of the impact of exchange rate on industrial structure

3.1. Model Construction

This paper believes that a country's exchange rate will affect the changes of a country's industrial structure in many ways, therefore, this paper plans to take into full account the impact of the internal economy on the industrial structure on the basis of controlling for a number of indicators such as the level of regional economic development, the level of consumption of the population, the level of education per capita in the region, the volume of freight transported in the region, the level of scientific and technological development, the pressure of macro-taxes, the degree of financial development, the level of urbanization and so on, to conduct empirical tests on the core variables exchange rate empirical test on the impact of industrial structure. In addition, since this paper is based on provincial panel data, the region effect and time effect terms will be added to obtain the empirical model established in this paper, as shown below:

$$X = \ln \beta_0 + \beta_1 \ln E_t + \beta_2 \ln GDP_{it} + \beta_3 \ln C_{it} + \beta_4 \ln Edu_{it} + \beta_5 \ln Cargo_{it} + \beta_6 \ln Tech_{it} + \beta_7 \ln Fin_{it} + \beta_8 \ln City_{it} + \beta_9 \ln Tax_{it} + \alpha_i + \alpha_t + \vartheta_{it} \quad (1)$$

Where X is an indicator representing industrial structure, i is taken as different regions of a country, t is taken as different time points in the survey time period, specifically, E_t represents the exchange rate at time point t , GDP_{it} represents the gross domestic product per capita at time point t in region i , C_{it} represents the level of consumption of the population at time point t in region i , Edu_{it} represents the level of educational attainment per capita at time point t in region i , $Cargo_{it}$ represents the level of freight transportation at time point t in region i , $Tech_{it}$ represents the level of science and technology research and development at time point t in region i , Fin_{it} represents the level of financial development at time point t in region i , $City_{it}$ represents the level of urbanization at time point t in region i , Tax_{it} represents the level of macro-tax burden at time point t in region i , α_i represents the regional effect, α_t represents the time effect, ϑ_{it} represents the random perturbation term.

In this paper, in order to study and analyze the transformation of industrial structure more directly and dynamically, the index of advanced industrial structure is chosen as the explanatory variable of this paper for regression fitting.

Regarding the advanced industrial structure, this paper draws on the treatment of Wang Wei et al (2015) and assigns weights to the share of the three major industries, defined as the variable T_{s1} , as follows:

$$T_{s1} = T_1 + 2 \times T_2 + 3 \times T_3 \quad (2)$$

Where T_i denotes the share of industry i ($i=1, 2, 3$) in regional GDP.

Besides, some literatures choose to use the ratio of value added of secondary and tertiary industries directly as the indicator of industrial structure advanced, such as Gan Chunhui (2011). This is also considered more reasonable in this paper considering the trend of transition from secondary industry to tertiary industry, so this kind of index of industrial advancement will be used later as a method in the part of robustness test. It will be defined as T_{s2} , and the specific operation is demonstrated as follows:

$$T_{s2} = T_3/T_2 \quad (3)$$

Regarding the rationalization of industrial structure, its idea is consistent with the assumption that the productivity of each industrial sector is the same when the economy of classical economics is in equilibrium, and it has no tendency to each industry, and it measures the degree of effective use of resources, and when the economy tends to be in equilibrium, the rationalization index should tend to 0.

Theil's index, also known as Theil's entropy, was first generated by Theil (Theil, 1967) by using the concept of entropy to calculate income inequality, and later widely used to measure the problem of income disparity. This paper also draws on the approach of Chunhui Gan (2011) to measure the degree of rationalization of industrial structure by using Theil's index T_L . The definition is as follows:

$$T_L = \sum_{i=1}^n \left(\frac{Y_i}{Y} \right) \ln \left(\frac{Y_i}{L_i} / \frac{Y}{L} \right) \quad (4)$$

Where Y_i denotes the value added of industry i , L_i denotes the number of people employed in industry i , and n denotes the number of industrial sectors.

Secondly, taking into account China's active participation in international economic cooperation and trade exchanges, active participation in the international division of labor, and the exchange rate system to fully take into account the basket of currencies, and then exclude the impact of inflation and prices, this paper believes that the selection of the real effective exchange rate of the RMB REER on behalf of the exchange rate of the variable is more appropriate, which also with most of the relevant topics of the current research choices consistent.

In order to exclude factors other than the exchange rate that have an impact on the industrial structure from interfering with the empirical evidence in this paper, this paper chooses eight control variables: regional economic development level, residents' consumption level, regional per capita education level, regional freight traffic, level of scientific and technological development, macro-tax pressure, degree of financial development, and level of urbanization.

Among them, the regional economic development level (*GDP*) is measured by regional per capita GDP, the consumption level (*C*) is measured by regional per capita retail consumption, the education level (*Edu*) is measured by the proportion of tertiary education in the total regional population, the regional cargo volume (*Cargo*) is measured by the total amount of regional cargo/population, and the science and technology development level (*Tech*) is measured by the total amount of patents granted. Total volume measure, macro tax pressure (*Tax*) is measured by regional general fiscal revenue/total population, financial development level (*Fin*) is measured by year-end deposit and loan balances of financial institutions/regional GDP, and urbanization level (*City*) is measured by regional urban population/total population. For the mediating variables, FDI and CPI are based on the foreign direct investment and consumer price index data of each region, respectively, while OPEN is defined as the total amount of imports and exports of each region/regional GDP.

Finally, in order to avoid the effect of heteroskedasticity in the data, all the variables in this paper, except the explanatory variables, are logarithmically processed.

In summary, the selection of variables in this paper is as follows:

- (1) Interpreted variable: index of industrial structure advancedization (T_{s1})
- (2) Core explanatory variables: RMB real effective exchange rate (REER)

(3) Control variables: level of economic development (GDP), level of consumption (C), level of education (Edu), level of regional freight traffic (Cargo), level of scientific and technological development (Tech), level of financial development (Fin), level of urbanization (City), macro tax pressure (Tax)

(4) Intermediary variables: foreign direct investment (FDI), the degree of openness to foreign trade (OPEN), the level of consumption of residents (CPI)

3.2. Empirical Testing

Since China implemented the reform of exchange rate system in 2005, considering the appropriate value of the sample time span, all the data in this paper are taken from the corresponding data of each province in China from 2005 to 2020. The vast majority of the macro data in this paper come from the National Bureau of Statistics of China (NBS), and the real effective exchange rate of the RMB is taken from the International Monetary Fund's (IMF's) IFS database, the 2021 Statistical Yearbook published by the statistical bureaus of each province in China, as well as the China Statistical Yearbook.

3.2.1. Panel Unit Root Test

Table 1. Panel unit root test results.

Variables	LLC Test			Fisher-ADF Test		Fisher-PP Test	
	Trend	Drift	None	Trend	Drift	Trend	Drift
T_{s1}	4.2e+15	-1.2835*	-1.9253**	1.8305**	6.7746***	1.0136	-1.1217
$LnGDP$	1.4e+15	-4.1384**	-9.9090***	5.4157***	9.6567***	-3.2010	-0.5666
LnC	3.8e+15	1.1942	-4.2893***	-2.1479	2.0644**	-3.5662	-3.5057
$LnEdu$	7.7e+15	-8.6690**	-4.8440***	0.5285	11.7843**	9.7268***	8.6357***
$LnCargo$	3.8e+15	-4.7378**	-2.1067**	3.5019**	8.9755	-2.2790**	2.7957***
$LnTech$	4.6e+15	-1.6550**	-2.1780**	2.2402**	7.7196***	-1.7790	-1.0989
$LnFin$	3.1e+15	-2.7430**	-3.9941***	-2.9257	5.1940***	8.0916***	5.7866***
$LnCity$	2.3e+15	-3.6660**	-29.3447*	22.0291***	5.7304***	6.0020***	2.4537
$LnTax$	3.5e+15	0.4827	-1.4918*	0.0269	7.8536***	-0.3245	0.1178
$LnFDI$	2.1e+15	-0.3421	0.1761	2.1867**	6.2338***	1.1372	1.8540**
$LnOPEN$	3.7e+15	-2.1249**	-5.4355***	-2.2133	5.8750***	-1.6669	-0.3027
$LnCPI$	4.4e+15	-12.1479	-15.2810*	8.2897***	11.9844**	29.4882**	24.6972**

Note: ***, **, and * denote significant at 1%, 5%, and 10% confidence levels, respectively

As can be seen from the results in the table above, all the variables of the panel data in this paper are found to be smooth under more than two tests after the LLC, Fisher-ADF, and Fisher-PP tests. Therefore, this paper will next start trying to model

3.2.2. Fixed-Effects Regression

Before modeling regression on panel data, it is generally necessary to carry out the F test, Chow test, LR test, as well as the Hausman test to make specific judgments to determine which one of the fixed effects, random effects, as well as individual, point in time is established. In this paper, the Hausman test results $\chi^2(9) = 49.69$, $\text{Prob} > \chi^2 = 0.0000$, and then take into account the core variables of this paper, the exchange rate and the year of the existence of significant multicollinearity problems, we ultimately determined that this paper will establish an individual fixed-effects model.

Table 2. Fixed-effects regression results.

Variables	Regression(1)	Regression(2)
<i>LnREER</i>	0.3901*** (0.0255)	0.1556** (0.0617)
<i>LnFin</i>		0.0183* (0.0099)
<i>LnCargo</i>		-0.0488*** (0.0165)
<i>LnGDP</i>		0.0602 (0.0377)
<i>LnC</i>		-0.0232 (0.0314)
<i>LnTax</i>		-0.0313 (0.0290)
<i>LnEdu</i>		0.0186 (0.0193)
<i>LnTech</i>		0.0106 (0.0122)
<i>LnCity</i>		0.1206 (0.1104)
Intercept	0.7529*** (0.1754)	1.325205*** (0.4050)
Individual effect	controled	controled
R^2	0.2677	0.5281

Note: ***, **, and * denote significant at 1%, 5%, and 10% confidence levels, respectively, and the corresponding standard errors are in ()

Among them, regression (1) is a separate regression of industrial structure advanced index using only the core variable REER, and regression (2) is the main empirical model of this paper, which finds that there is a significant improvement in R^2 , proving that the selection of control variables has a significant explanatory relationship with industrial structure adjustment.

3.2.3. Serial Correlation and Heteroskedasticity Test and Correction

According to the test results in Table 3, we know that the original models all contain significant autocorrelation, cross-section correlation and heteroskedasticity, and we use the Feasible Generalized Least Squares (FGLS) method to correct the models. The principle of the FGLS method is to correct the model perturbation term by extracting the information of the residual in the original regression so as to make it satisfy the classical assumptions. The results are as follows:

Table 3. Fixed-effects regression modified results.

Variables	T_{s1}
<i>LnREER</i>	0.0629** (0.0253)
<i>LnFin</i>	0.0044*** (0.0014)
<i>LnCargo</i>	-0.0098*** (0.0033)
<i>LnGDP</i>	0.0139 (0.0099)
<i>LnC</i>	0.0234*** (0.0055)
<i>LnTax</i>	-0.0128* (0.0069)
<i>LnEdu</i>	0.0029 (0.0030)

<i>LnTech</i>	0.0085*** (0.0028)
<i>LnCity</i>	0.1056*** (0.0244)
Individual effect	controled
Wald Test (Autocorrelation within the group)	112.991***
Pesaran Test (Intergroup cross-section correlation)	19.383***
Friedman Test (Intergroup cross-section correlation)	107.085***
Frees'Q Test (Intergroup cross-section correlation)	6.244***
Wald Test (Heteroskedasticity)	1938.01***

Note: ***, **, and * denote significant at 1%, 5%, and 10% confidence levels, respectively, and the corresponding standard errors are in ()

The empirical results show that the rise of the effective exchange rate of RMB will be conducive to the transformation of China's industrial structure to the tertiary industry, and for every 1% increase in the real effective exchange rate of RMB, the index of China's industrial structure advancement will be increased by 0.0629%, which shows a significant positive promotion effect.

3.2.4. Robustness Testing

In this paper, we try to replace the explanatory variables with another way of defining industrial structure advancement, and back with the two indicators of industrial structure rationalization separately to verify the robustness of the model. Regarding the industrial structure advancedization, we use another way of definition of the variable selection part in the previous section to generate the new explanatory variable T_{S2} , specifically, $T_{S2}=T_{S3}/T_{S2}$. Regarding the index of industrial structure rationalization T_L , we use the definition of the Thiel index in the previous section and apply the original model to conduct the regression, and the results are shown in Table 4.

Table 4. Robustness test results of the industrial structure index.

Variables	T_{S2}	T_L
<i>LnREER</i>	0.4684*** (0.1229)	-0.1258*** (0.0448)
<i>LnFin</i>	0.0373*** (0.0063)	0.0101*** (0.0018)
<i>LnCargo</i>	-0.2817*** (0.0194)	0.0381*** (0.0061)
<i>LnGDP</i>	0.0347 (0.0547)	0.1361*** (0.0218)
<i>LnC</i>	0.2027*** (0.0383)	-0.0418*** (0.0109)
<i>LnTax</i>	-0.2593*** (0.0277)	0.0784*** (0.0098)
<i>LnEdu</i>	0.0376*** (0.0122)	-0.0273*** (0.0052)
<i>LnTech</i>	0.1037*** (0.0145)	-0.0419*** (0.0070)
<i>LnCity</i>	-0.3736*** (0.1179)	-0.4359*** (0.0389)
Individual effect	controled	controled

Note: ***, **, and * denote significant at 1%, 5%, and 10% confidence levels, respectively, and the corresponding standard errors are in ()

From the results of the above table, we find that both indices for the definition of advanced industrial structure are highly significant in the FGLS regression results, and the vast majority of them are significant within 99% confidence level. It is worth noting that the core variable exchange rate is negative in the regression results on T_L , and this result is not contradictory to this paper considering that the index of industrial structure rationalization is the smaller the more reasonable. The robustness of the model underlying this paper is fully verified

3.2.5. Heterogeneity Testing

The heterogeneity test, also known as the consistency test, is used to explore whether the transmission of our established model differs across samples and groups. In this section we categorize the original sample according to the National Bureau of Statistics of China, and divide China into three regions: east, central, and west by geographic location. The regressions are built according to the original model respectively, and the results are shown in Table 5.

Table 5. Results of the Heterogeneity test.

Variables	T_{s1}		
	East	Central	West
<i>LnREER</i>	0.0247* (0.0154)	0.0312* (0.0651)	0.0826*** (0.0287)
<i>LnFin</i>	0.0146*** (0.0027)	0.0050 (0.0039)	0.0150*** (0.0375)
<i>LnCargo</i>	-0.0194*** (0.0032)	-0.0207*** (0.0072)	0.0034 (0.0050)
<i>LnGDP</i>	0.1042*** (0.0099)	0.0321 (0.0234)	-0.0103 (0.0131)
<i>LnC</i>	-0.0152* (0.0088)	0.0088 (0.0153)	0.0135* (0.0082)
<i>LnTax</i>	-0.0020 (0.0072)	-0.0290* (0.0175)	-0.0076 (0.0090)
<i>LnEdu</i>	0.0099*** (0.0026)	-0.0081 (0.0070)	-0.0029 (0.0038)
<i>LnTech</i>	0.0076*** (0.0028)	-0.0162*** (0.0060)	0.0001 (0.0030)
<i>LnCity</i>	0.1160*** (0.0253)	0.4359*** (0.0487)	0.1719*** (0.0049)
Individual effect	controled	controled	controled
Sample capacity	176	128	176

Note: ***, **, and * denote significant at 1%, 5%, and 10% confidence levels, respectively, and the corresponding standard errors are in ()

According to the results of the above table, it can be seen that the core variable of the original model, the real effective exchange rate of RMB, is significant at the 10% confidence level in all the classification samples, and the impact on the index of advanced industrial structure is also consistent with the total sample base model. At the same time, we find that in the results of the above table, the regions of China appear to be characterized by differences, and there are differences in the extent of the impact of the exchange rate on different regions of China. The other control variables are also different, and some of them have the opposite direction of influence, which is greatly related to the local industrial structure focus, economic development level, geographic natural resource advantages and other factors.

3.2.6. Mediating Effect Testing

In the previous section, we have modeled the basis of the research problem in this paper, which we now simplify as follows:

$$X = \ln \beta_0 + \beta_1 \ln E_t + \sum \beta_i CV_{it} + \vartheta_{it} \tag{5}$$

Where X represents the index of advanced industrial structure, E_t represents the value of exchange rate at time point t of the core variable in this paper, CV_{it} represents the value of each control variable at time point t in region i , β_i is the corresponding coefficient of each control variable, and ϑ_{it} is the random perturbation term.

Next, we use the three-step regression method to test the establishment of the three transmission mechanisms described in the previous section, and the specific model of the three-step regression method is as follows:

$$X = \ln \alpha_0 + \alpha_1 \ln E_t + \sum \alpha_i CV_{it} + \vartheta_{it} \tag{6}$$

$$MV_{it} = \ln \beta_0 + \beta_1 \ln E_t + \sum \beta_i CV_{it} + \vartheta_{it} \tag{7}$$

$$X = \ln \gamma_0 + \gamma_1 \ln E_t + \sum \gamma_i CV_{it} + \delta_i MV_{it} + \vartheta_{it} \tag{8}$$

Where CV_{it} denotes the value of each control variable at time point t in region i , α_i and β_i are the corresponding coefficients of each control variable, MV_{it} denotes the value of mediating variable at time point t in region i , δ_i is the corresponding coefficient of mediating variable, and ϑ_{it} is the random perturbation term.

First, we test the mediating effect of price, we choose China's 2005-2020 CPI data to characterize the price effect as a mechanism, and use a three-step regression method for regression, and the results are shown in Table 6.

Table 6. Test of the transmission mechanism of the price effect.

Variables	T_{s1}	$LnCPI$	T_{s1}
$LnREER$	0.0629** (0.0253)	-0.1333*** (0.0159)	0.0208 (0.0302)
$LnCPI$			-0.1639*** (0.0442)
$LnFin$	0.0044*** (0.0014)	-0.0045*** (0.0007)	0.0002 (0.0019)
$LnCargo$	-0.0098*** (0.0033)	-0.0058*** (0.0011)	-0.0149*** (0.0034)
$LnGDP$	0.0139 (0.0099)	0.0585*** (0.0056)	0.0544*** (0.0100)
LnC	0.0234*** (0.0055)	-0.0122*** (0.0031)	0.0164** (0.0075)
$LnTax$	-0.0128* (0.0069)	0.0192*** (0.0027)	-0.0164** (0.0067)
$LnEdu$	0.0029 (0.0030)	-0.0027* (0.0015)	0.0039 (0.0034)
$LnTech$	0.0085*** (0.0028)	-0.0014* (0.0009)	0.0057** (0.0025)
$LnCity$	0.1056*** (0.0244)	-0.0526*** (0.0073)	0.0514* (0.0303)
Individual effect	controled	controled	controled

Note: ***, **, and * denote significant at 1%, 5%, and 10% confidence levels, respectively, and the corresponding standard errors are in ()

According to the results in the table, we have successfully verified that the mechanism of the indirect impact of the exchange rate via price effect on industrial structure is established, and it shows a complete mediation effect. Specifically, the degree of the exchange rate through the price effect to the industrial structure of the transmission of the impact of the exchange rate through the price effect of every 1% appreciation of the exchange rate, through the price effect will lead to the index of the advanced industrial structure increased by 0.0218%.

Secondly, we test the mediation effect on the indicator of foreign trade, we define the openness of foreign trade $OPEN = \text{China's total imports and exports} / \text{China's GDP}$, and all the data involved are

from the National Bureau of Statistics of China. The test results of the three-step regression method are shown in Table 7.

Table 7. Test of the transmission mechanism based on foreign trade.

Variables	T_{s1}	$LnOPEN$	T_{s1}
$LnREER$	0.0629** (0.0253)	-0.8606*** (0.2452)	0.0409 (0.0342)
$LnOPEN$			-0.0085** (0.0034)
$LnFin$	0.0044*** (0.0014)	0.0041 (0.0364)	0.0005 (0.0022)
$LnCargo$	-0.0098*** (0.0033)	0.1291*** (0.0346)	-0.0076* (0.0046)
$LnGDP$	0.0139 (0.0099)	0.1331 (0.1181)	0.0226* (0.0116)
LnC	0.0234*** (0.0055)	0.0644 (0.0864)	0.0219** (0.0092)
$LnTax$	-0.0128* (0.0069)	0.1546** (0.0631)	-0.0101 (0.0073)
$LnEdu$	0.0029 (0.0030)	0.0452 (0.0384)	-0.0005 (0.0038)
$LnTech$	0.0085*** (0.0028)	-0.1080*** (0.0257)	0.0076** (0.0033)
$LnCity$	0.1056*** (0.0244)	-0.3019 (0.3108)	0.1063*** (0.0307)
Individual effect	controled	controled	controled

Note: ***, **, and * denote significant at 1%, 5%, and 10% confidence levels, respectively, and the corresponding standard errors are in ()

From the regression results, it is known that the mechanism of indirect influence of exchange rate on industrial structure through foreign trade effect is established, and it manifests itself as a complete intermediary effect. Specifically, the degree of the exchange rate via foreign trade effect to the industrial structure of the degree of transmission of the impact of the exchange rate to the industrial structure, the exchange rate appreciation of 1%, via foreign trade effect will lead to the index of industrial structure of the seniority of the increase of 0.0073%.

Finally, we test for the mediating effect of FDI in a three-step regression, and the results are shown in Table 8.

Table 8. Test of the transmission mechanism based on foreign trade.

Variables	T_{s1}	$LnFDI$	T_{s1}
$LnREER$	0.0629** (0.0253)	-0.7902*** (0.2660)	0.0627** (0.0253)
$LnFDI$			-0.0008 (0.0016)
$LnFin$	0.0044*** (0.0014)	-0.1831* (0.1038)	0.0043*** (0.0015)
$LnCargo$	-0.0098*** (0.0033)	-0.1677*** (0.0530)	-0.0094*** (0.0035)
$LnGDP$	0.0139 (0.0099)	0.4015** (0.1786)	0.0131 (0.0100)
LnC	0.0234*** (0.0055)	0.1766 (0.1093)	0.0238*** (0.0056)
$LnTax$	-0.0128* (0.0069)	1.2194*** (0.1245)	-0.0131* (0.0069)

<i>LnEdu</i>	0.0029 (0.0030)	-0.0998* (0.0603)	0.0031 (0.0030)
<i>LnTech</i>	0.0085*** (0.0028)	-0.0933** (0.0464)	0.0080*** (0.0029)
<i>LnCity</i>	0.1056*** (0.0244)	1.4024*** (0.5352)	0.1117*** (0.0015)
Individual effect	controled	controled	controled

Note: ***, **, and * denote significant at 1%, 5%, and 10% confidence levels, respectively, and the corresponding standard errors are in ()

According to the results of the above table, in the three-step regression method, the most one-step mediator variable FDI is not significant at 10% confidence level, while the core variable is significant, this paper, after drawing on some of the literature [37] that the method may ignore some of the weaker mediation effect, so use Sobel test, for further verification. The test results are shown in Table 9.

Table 9. Sobel test for mediation effects.

	Coefficient	Std	Z	P>Z
Sobel	-0.0155	0.0077	-2.001	0.0454

Apparently, the Sobel test Z-statistic of -2.001 and p-value of 0.0454 proves the existence of FDI mediation effect at 5% confidence level.

From the results, the exchange rate and FDI show a negative relationship, which indicates that when the local currency appreciates, FDI will be damaged, FDI will flow out, and the transformation of the country's industrial structure will be promoted. This is due to China's foreign direct investment is mainly concentrated in the advantageous manufacturing industry, exchange rate appreciation, FDI due to bear losses, exit the market. And FDI itself is concentrated in China's manufacturing industry, FDI inflows did not support the development of China's tertiary industry, so FDI and industrial structure advanced performance is negatively correlated. On the whole, when the exchange rate of the country appreciates, FDI outflows, which ultimately leads to the promotion of industrial structure transformation, which indicates that the exchange rate through the path of FDI also shows a positive role in promoting the industrial structure.

4. Summary

According to the empirical results, this paper finds that for every 1% increase in the real effective exchange rate of RMB, the index of China's industrial structure advanced will increase by 0.0629%, and the appreciation of the RMB exchange rate will significantly promote the upgrading of China's industrial structure to a reasonable level. In addition, according to the regression results of the robustness test, this paper also similarly verifies the promotion effect of exchange rate appreciation on industrial structure transformation. The results of heterogeneity test, on the other hand, show that there are regional differences in the adjustment of China's industrial structure, and the three major regions of eastern, central and western China have different conditions of industrial structure adjustment, and there are also differences in the factors mainly affected. Finally, this paper uses the three-step regression method to verify the three indirect transmission paths of "exchange rate - price effect - industrial structure", "exchange rate - foreign trade - industrial structure", "exchange rate - FDI - industrial structure", and all three paths pass the intermediation test, which significantly proves that the exchange rate can indirectly affect the industrial structure through the three paths of price effect, foreign trade and FDI.

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