

An Empirical Research to Find Relationship between Exchange Rate and Net Exports: Case of China

A. Taghipour and X. Lu

Abstract—China exchange rate is experiencing a gradual reform. However, this reform had a negative impact on China's export trade. To avoid these negative impacts, it was very important to realize the smooth transition of the RMB exchange rate regime to free floating exchange rate regime. Through empirical research, this paper studies the relationship between RMB exchange rate and China's trade balance accords with the basic theory of balance of payments. We will put forward some countermeasures and suggestions for helping decision makers in their decisions.

Index Terms—Exchange rate, export trade, RMB, trade balance.

I. INTRODUCTION

China exchange rate is experiencing a gradual reform. Since 2005, the RMB exchange rate formation mechanism has undergone two major reforms. However, these reforms of RMB exchange rate formation mechanism has not been completed yet. This problem is still a major challenge for China's monetary authorities to establish a smooth transition in the coming period of time. This paper, based on the data from China and some different trading countries, using the dynamic panel model and synthetic control method, empirically studies the impact of the reform of the exchange rate formation mechanism on the trade balance, the case of China.

II. LITERATURE REVIEW

The literature of economy shows from different points of view the impact of the reform of the exchange rate on the trade balance. Some authors believe that the reform of the exchange rate can modify the trade balance. Yaocheng *et al.* [1] have shown that exchange rate changes have a significant impact on China's trade balance. Other researchers believe that the reform has no impact or little impact on China's trade balance. Yumei [2] found that although the RMB continued to appreciate after the reform of the RMB exchange rate formation mechanism in 2005, it did not have a substantial impact on China's trade balance. Yanping *et al.* [3] used the VAR model and found that the impact of exchange rate on the trade balance is not strong.

On the basis of summarizing the existing research, this paper uses the dynamic panel model to empirically test the impact of RMB exchange rate on China's trade balance. In addition, the synthetic control method is also introduced to construct a counterfactual framework, so that the trade impact of the exchange rate reform can be presented quantitatively.

III. EMPIRICAL RESEARCH

This section will first use the dynamic panel data model to test the relationship between RMB exchange rate and China's trade balance. And then we use the synthetic analysis method to discuss the impact of the "8.11 exchange rate reform" on China's export trade. So that the two empirical results can complement each other in analyzing the impact of the reform on China's trade balance.

A. Model

In the empirical study of import and export trade, the existing studies mainly use the imperfectionist models. According to the model, domestic imports can't completely replace domestic goods, and domestic export products can't completely replace the domestic goods of other countries. It can be assumed that a country's import trade volume is a function of its gross domestic product (GDP), import price (P_m), domestic commodity price (P_d) and exchange rate (R). The export trade volume of a country is a function of the income level of the trading country (GDP'), the export price of its own goods (P_x), the export commodity price of the trading country (P_x') and the exchange rate R . The formula can be expressed as:

$$D_m = D_m(GDP, P_m, P_d, R) \quad (1)$$

$$D_x = D_x(GDP', P_x, P_x', R) \quad (2)$$

In the formula, D_m represents import demand and D_x represents export volume. In order to simplify the calculation, this paper assumes that the domestic commodity prices and the export prices of domestic goods are equal to the general price level of their own country, that is $P_d = P_x = CPI$, so as $P_m = P_x' = CPI'$. Therefore, the above expression (1) (2) can be expressed as:

$$D_m = D_m(GDP, CPI', CPI, R) \quad (3)$$

$$D_x = D_x(GDP', CPI, CPI', R) \quad (4)$$

The trade balance equation can be obtained by combining the above two formulas (3) (4). This paper constructs the following empirical model (5) with reference to the research of Qian and Guoqiang (2005), and Dingyu and Cong (2016).

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$$Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 R_{i,t} + \beta_3 GDP'_{i,t}/GDP_t + \beta_4 CPI'_{i,t}/CPI_t + \varepsilon_{i,t}$$

In order to eliminate the possible heteroscedasticity of each variable data, all the data will be taken as the natural logarithm to analyze the elasticity coefficient of the impact. With $gdp_{i,t}$ for $GDP'_{i,t}/GDP_t$, $cpi_{i,t}$ for $CPI'_{i,t}/CPI_t$. Formula (5) can be rewritten as follows (model 6):

$$\ln y_{i,t} = \beta_0 + \beta_1 \ln y_{i,t-1} + \beta_2 \ln r_{i,t} + \beta_3 \ln gdp_{i,t} + \beta_4 \ln cpi_{i,t} + \varepsilon_{i,t}$$

This paper selects the annual data of from 2002 to 2019 according to the ranking of China's foreign exports in 2019. In order to enrich the data range to cover five continents, New Zealand is selected in Oceania; Chile is selected in Latin American countries, and South Africa in Africa. These three countries together with the United States, Japan, South Korea, Germany, Australia, Vietnam, Malaysia, Brazil, the Russian

Federation, India, Singapore, Thailand, the United Kingdom, the Netherlands, Indonesia, Canada, France, Italy, the Philippines constitute a sample section of 22 countries.

The explained variables are selected as the trade balance between those countries and China, represented by Y. In order to facilitate logarithmic processing, the trade balance is calculated by dividing exports by imports. The source of data is the Chinese National Bureau of Statistics. The explanatory variables are as follows. The first-period lag value of Y, to reflect the continuity of trade. The annual average exchange rate of RMB to 22 sample countries, using the direct pricing method, expressed as R. The data source is the Bank for International Settlements. The CPI selects the consumer price index of China and trading partner countries, the data source is the World Bank database, with 2010 = 100 as the base period. The GDP selects the gross domestic product of 22 trading partners and China, the data source is the UNCTAD database, in millions of US dollars.

TABLE I: STATISTICAL DESCRIPTION OF VARIABLES AND DATA

Variable		Mean value	Standard deviation	Minimum value	Maximum value	Number of samples
Explained variable	Y	1.525569	1.547751	.3243348	8.841208	396
Explanatory variable	R	3.6907	3.853551	0.0002879	15.22272	396
Control variable	GDP	.4009878	.8489205	.0030476	7.486311	396
	CPI	.9989381	.1273745	.5638372	1.421129	396

Before the empirical test, the unit root test of the variable is carried out to ensure the validity of the results. Levin-Lin-Chu test and Fisher-ADF test are used in this paper, and the results are shown in Table II. All variables pass the significance test under 5%, means that the panel is stable.

TABLE II: VARIABLE UNIT ROOT TEST

Variable	Levin-Lin-Chu		Fisher-ADF	
	Statistical Value	P Value	Statistical Value	P Value
lny	-2.3755	0.0088	6.0848	0.0000
lnr	-4.8755	0.0000	4.8625	0.0000
lngdp	-4.4446	0.0000	3.7177	0.0001
lncpi	-1.7302	0.0418	5.9374	0.0000

Data source: Collated according to the running results of stata15

TABLE III: EMPIRICAL RESULTS OF SYS-GMM

Variable	Coefficient		P Value	
			Statistical Value	P Value
L.lny	0.909	0.000***		
lnr	0.138	0.041**	6.0848	0.0000
lngdp	0.042	0.000***	4.8625	0.0000
lncpi	0.016	0.103	3.7177	0.0001
_cons	0.115	0.079*	5.9374	0.0000

Note: *, ** and *** represent significant at 10%, 5% and 1% levels.

The results are shown in Table III. According to the empirical results, it can be concluded that:

First, the lag first-order coefficient of Y is positive, and it has passed the significance test of 1%, indicating that the international trade relations between China and its trading partners have a good continuity. It shows that the stable development of bilateral relations has a good promotion and continuity to China's economic development.

Second, the coefficient of R is significantly positive at the

confidence level of 1%, which means that if the RMB exchange rate appreciates, it will reduce China's trade balance. The empirical results show that the relative appreciation of the RMB will improve the imbalance of China's trade balance.

Third, a significant positive GDP at 1% confidence level indicates that GDP has a positive impact on the trade balance. This shows that when the market size and income level of trading partners increase, it can promote the import demand of trading partners for Chinese goods.

Fourth, the coefficient symbol of the relative price level variable is positive, indicating that when the foreign price level becomes relatively high, China's export trade volume will increase relatively. However, the variable of price level did not pass the significance test of 10%, which shows that there are obstacles to the price effect in the transmission mechanism.

B. Synthetic Method

The synthetic control method is usually used to evaluate the impact of events or the implementation effect of policies. The main purpose of this empirical study is to explore the impact of the "8.11 Exchange rate Reform" on China's foreign trade in 2015. Taking 2015 as the time point of occurrence of the policy, the scope of the selected countries follows the countries used in the previous section, but Russia, which reformed the exchange rate formation mechanism in 2014, is excluded. In order to have a better analyze of empirical results, in this section, the explained variable selected is the export trade volume, and the other control variables are exchange rate, the total imports, total import and export trade, GDP, CPI, and the proportion of exports in total trade.

With reference to the empirical model of [4] and [5], the synthetic control method selected in this paper is basically set

as follows. Suppose there are $K+1$ observable sample of trading partners, the observation period is $t \in T$, T_0 represents the period before the reform of the exchange rate formation mechanism, and T_1 represents the observation period after the reform of the exchange rate formation mechanism, $T = T_0 + T_1$. Country 1 is China, and countries 2 to K are the control group, representing other countries that have not undergone exchange rate formation mechanism reform during 2003-2019. R_{kt} represent that in the absence of policy intervention, the export trade volume of the K th country in the t period. R_{kt}^I represents the export trade volume of the country K that has carried out the exchange rate system reform at t time point, and R_{kt}^N represents the export trade volume of the country K that has not carried out the exchange rate system reform at t time point. When $t \in T_0$, $t \in T_0$, $R_{kt}^I = R_{kt}^N$. When $t \in T_1$, the influence of exchange rate formation mechanism, reform on the export trade volume of country K at t time point can be expressed as: $Y_{kt} = R_{kt}^I - R_{kt}^N$, $t \in T_1$. So, it can be concluded that the impact of the reform of RMB exchange rate formation mechanism on China's export trade volume is $Y_{1t} = R_{1t}^I - R_{1t}^N$, $t \in T_1$. The main purpose of this section is to synthesize R_{1t}^{N*} to simulate China's export trade without the "8.11 exchange rate reform" in 2015.

Virtual China is synthesized by using the synthesis control method in stata15. Table IV below shows the country weights of the control groups that make up virtual China. The comparison of the relevant variables between the virtual China synthesized by the four countries through the synthetic control method and the actual China from 2003 to 2019 is shown in Table V. It can be seen from the table that there is a small difference between the real China data and the synthesized China data. This shows that the China synthesized by these four countries can better fit the situation of real China from 2003 to 2019.

TABLE IV: WEIGHT COMPOSITION OF SYNTHETIC VIRTUAL CHINA

Country Weight	Germany		United States	
	0.421	0.295	Statistical Value	P Value
Country	Germany	United States	6.0848	0.0000
Weight	0.421	0.295	4.8625	0.0000
Country	Germany	United States	3.7177	0.0001
Weight	0.421	0.295	5.9374	0.0000

TABLE V: VARIABLE FITTING BY SYNTHETIC CONTROL METHOD IN 2003-2019

Variable exchange rate	Real China		Synthetic China	
	1.962955	1.708215	Statistical Value	P Value
Total import volume			6.0848	0.0000
Total trade volume	13.88231		4.8625	0.0000
14.65134	13.87745		3.7177	0.0001
14.63735			5.9374	0.0000

After determining the weight of synthetic China, the trajectory of the change of export trade volume between synthetic China and real China is shown in figure I. In figure I, the vertical dotted line represents the 2015 policy node. The

left side of the vertical dotted line is before the "8.11 exchange rate reform" in 2015, and the right side is after the reform. It can be seen from figure 4 that the change trajectory of export trade volume between synthetic China and real China from 2003 to 2015 is basically the same, which shows that synthetic China better simulates the export trade level of real China. Comparing the export data from 2015 to 2019, it can be concluded that the average export value of China without the "8.11 exchange rate reform" is 1.33% higher than the actual value over the past four years.

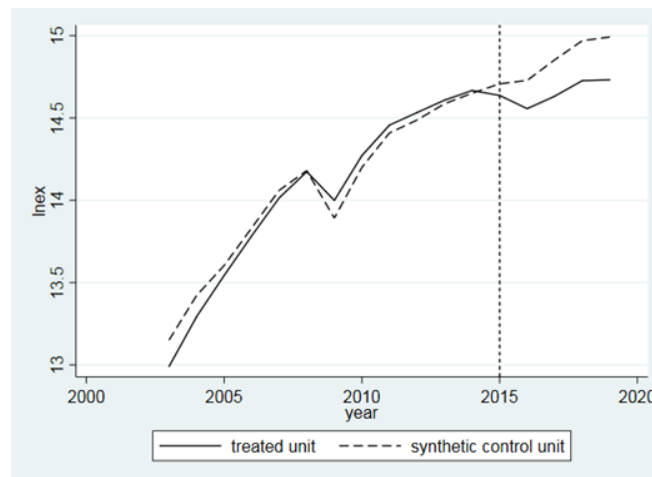


Fig. 1. China and synthetic China Export trend Chart.

IV. CONCLUSIONS

Using an empirical research, we tried to find the relationship between the exchange rate and the trade balance accords with the basic theory of balance of payments. The case of China is considered, which shows that the exchange rate reform of August 11 in 2015 had a negative impact on China's export trade. The average decline in export trade volume from 2015 to 2019 is 1.33%, and the downward trend is continuing to a certain extent. Therefore, it is very important to realize the smooth transition of the RMB exchange rate regime to free floating exchange rate regime.

In order to ensure the accuracy and robustness of the results, it is suggested to use the placebo test ([4]; [6]-[9]), which can be used to exclude the contingency of the empirical results [10].

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Atour Taghipour supervised the research; XiaoWen Lu analyzed the data and wrote the paper. All authors had approved the final version.

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