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Renminbi (RMB) Appreciation: Discussion and Analysis on China's Trade Balance, Import and Export from 2005 to 2019

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ABSTRACT

The modern mainstream in economic globalization and integration suggests that trade cooperation is being a trend that forges foreign trade generally contributes as a vital driving force to the national economic development. In particular, changes in the exchange rate due to either market forces or monetary policies have been viewed as a direct effect on a country's trade balance, industrial development, and macroeconomic growth. Since China acceded to the World Trade Organization (WTO), its economic openness has been further enhanced, and the total foreign trade volume has multiplied. However, the Renminbi (RMB) exchange rate lately has received widespread attention. This paper examines and discusses the impact, if any, of exchange rate changes under currency appreciation on China's trade balance from 2005 to 2019. For the selection of necessary variables related to trade balance, we use a set of independent variables including income, RMB exchange rate, and FDI to research the correlation between those variables by using the co-integration testing method and impulse response function. The empirical testing results suggest that RMB appreciation could affect China's trade balance, though not significantly, and most likely reduce the trade surplus. The appreciation in RMB also creates a favorable environment for domestic enterprises to trade. Further, the Chinese government should take appropriate measures to respond to the impact of RMB appreciation on China's exports.

1. Introduction

The value of the Chinese currency Renminbi (RMB) has maintained its stability and went through a modest increase in recent years. However, for decades China faces currency appreciation pressure pushed by other countries. There is also domestic reason largely due to public policies that have promoted the appreciation of Chinese currency, eventually leading to the continuous development of the Chinese economy. While the exchange rate is an important international financial element closely related to the national economy, a common consensual belief among macroeconomists is that an exchange rate appreciation or devaluation will have a major impact on a country's economy. Since 2005, the time that the Chinese government announced the new exchange rate regime, individuals and most consumers hold different perspectives for the appreciation trend. Some argue that the negative effect brought by the currency appreciation is outweighed the positive effect on the Chinese economy, while others may be overly optimistic about the appreciation. Generally, the appreciation of RMB may have affected the Chinese economy in many aspects such as the balance of international payment, foreign direct investment, inflation rate, and foreign exchange reserves. However, this paper mainly focuses on how the import and export trade sector would be affected under RMB appreciation circumstances.

The positive effect of RMB appreciation on import and export trade is twofold: promoting the expansion of import scale and promoting the optimization and upgrading of trade structure. The appreciation of the RMB has relatively reduced the import costs of enterprises, thereby promoting the expansion of import scale. At present, China's trade structure is not ideal and under strict monitor by many critics. Most firms are at a labor-intensive stage and low-tech level. The appreciation of the RMB can effectively squeeze out those with low technical content and added value and poor management in the manufacturing industry, this pattern is in line with the development direction of China's industrial structure transformation. Further, negative effects include conducive influence on the development of export enterprises, restricting the enthusiasm of foreign business partners to invest in China, and not conducive to the purpose of the country's introduction of overseas or foreign direct investment. The appreciation of the RMB has caused the prices of Chinese enterprises to rise relatively, weakening the international competitiveness noticeably on the exports and reducing the competitiveness of export enterprises. Because of these competing views, it is crucial to understand the economic consequences of foreign trade brought by the RMB appreciation. Therefore, one of the objectives of this paper is to offer a better understanding of how the RMB appreciation could affect China's import and export trade.

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Regarding trade theory, Hume (1752) put forward the price-specie-flow mechanism, which points out that the trade balance can be adjusted automatically through the function of the price mechanism. For example, if a country has a deficit balance of payment, that is, when the expenditure is greater than income, the foreign exchange reserves most likely decrease and the money supply of the local currency would decrease. Consequently, the prices of domestic commodities would drop, and the prices of imported goods would rise, which will lead to an increase in exports and a decrease in imports. Further, Hume (1752) believes that the domestic price level will continue to rise until trade surplus is eliminated. To support this view, Zhang (2008) points out that the elasticity approach is the most common approach to analyze the relationship between exchange rate changes and trade balance. The study reveals how a country's import and export trade would respond to relative price changes. To be more specific, the study investigates whether or not currency depreciation could improve the balance of trade.

In addition, utilizing the Marshall Lerner condition approach, when the sum of import price elasticity and export price elasticity is greater than 1, the devaluation of local currency is conducive to improving the trade balance. To this point, by using China's economic outcomes from 1991 to 2001, Chen (2003) analyzes the impact of RMB exchange rate fluctuation on import and export trade. The empirical results suggest that the exchange rate fluctuation has a greater impact on China's export trade. Although the import is also affected by the exchange rate fluctuation, the national import policy has a greater impact on the import. Thus, this paper considers the overall trade balance as the dependent variable, and the RMB exchange rate as the most important independent variable for research on the causal relationship between the two by using a quantitative research method.

To cope with the appreciation of RMB, the Chinese government has intervened in the foreign exchange market and adopted sterilized monetary policies to maintain the stability of the RMB exchange rate, thus this approach helped reduce the volatility in the international market brought by the rising risk of the exchange rate. Just as the Chinese government is expecting to push for the reform of RMB exchange rate stability, so too domestic firms within the import and export industry could take cautious measures to reduce the negative impact caused by currency appreciation. This leads us to offer suggestions on how the RMB appreciation could promote the development of foreign trade in China.

Therefore, this paper first reviews the extant literature on competing views of the relationship between RMB appreciation and import and export in China. Second, it demonstrates how domestic enterprises are engaged in international trade affected by an increasing exchange rate. Third, it applies an appropriate methodology of quantitative analysis on the yearly data from 2005 to 2019. Finally, it provides empirical evidence on how the changes in the RMB exchange rate could influence China's import and export sector through the method of constructing the VAR model.

2. Literature Review

2.1 The Reasons for RMB Appreciation

In July 2005, the Chinese government has announced that the exchange rate of RMB would be adjusted according to a basket currency in the market instead of pegging to the U.S. dollars. Thereafter, the Renminbi (RMB) has an obvious appreciation trend, and a study by Wang (2007) finds that, at the end of 2005, the RMB exchange rate against U.S. dollars is 8.0702, which increases 0.4932% compared to the beginning date of RMB exchange rate reform. Moreover, RMB has appreciated by 25% against U.S. dollars from the year 2005 to 2013, as indicated by Luo *et al*. (2014). Moreover, Xiang *et al*. (2011) notice that from the year 2005 to 2008, RMB appreciates by 15.8%. The exchange rate with U.S. dollars changes from 1:8.1 to 1:6.82. Guo (2017) also claims that the price elasticity has changed significantly compared to the previous years since China launched the reform of the exchange rate.

Next, Luo *et al*. (2014) claim that the RMB appreciation after 2005 for two reasons. One is due to the prosperous development of the Chinese economy; the other is a credit to the political pressure pushed by many foreign countries. As for the first reason, Wang (2007) agrees that the value of one country's currency is closely related to its economic development. From the year 1994 to 2005, over ten years, the Chinese GDP has increased steadily and continuously. The GDP in the year 2005 is about 18.2321 trillion yuan, and it is almost four times the GDP in 1994. From another perspective, the development of China's domestic economy has provided a good economic environment for the reform of the exchange rate regime. In terms of the political progressive movement, also known as law and social order in the United States, Luo (2002) points out that Masajuro Shiokawa, a former finance minister of Japan, tried to persuade six countries to put pressure on China and accelerate the process of RMB appreciation. Feenstra (1987) adds that the United States expects Chinese currency to appreciate relative to the market forces. This suggestion was reasonable because the U.S. government has blamed the American high unemployment rate in the manufacturing industry for RMB's manipulation. Moreover, Li and Dong (2005) find that the exchange rate of RMB is complicatedly affected. It not only relates to various countries but also the interest of different groups. Zhang *et al*. (2015) extend the argument and document that the reason for RMB appreciation is associated with "political games between counties."

2.2 The Impact of RMB Appreciation on Trade Balance

In terms of imports, Luo *et al*. (2014) point out that the cost of imported commodities would be reduced due to domestic currency appreciation. This observation is sustained because RMB can be afforded to buy more imported goods,

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holding everything else constant. Therefore, firms engaged in imports trading can introduce advanced technologies with lower costs from other countries. With cutting-edge technologies, productivity can be improved significantly, which helps to reverse the trade surplus situation. There are many previous studies demonstrating that domestic currency appreciation hurts exports because appreciation reduces the number of export (William and Gordon, 2010; Marquez and Schindler, 2007). To be clear, Thorbecke (2006) points out that if the exchange rate of RMB increases by 10% then the final exports most likely decrease by 13%. In addition, Mundell (2003) agrees that RMB appreciation is very harmful to China's export and, in the long run, it may lead to deflation in China. However, Yang (2004) considers that a small change of RMB appreciation would not have a significant negative impact on exports because such appreciation would cause changes in export cost and trade structure at the same time. Based on the year data from 1982 to 2007, Du *et al*. (2009) notices that the increase of RMB exchange rate only has a little negative impact on exports in the short-term by using the co-integration test. Luo (2014) has evaluated both the positive and negative effects of currency appreciation on exports. Domestic exchange rate increases lead to the increase of exports price. On one hand, higher exports price is hurting the exporting industry in China since the international demand would shrink. Thus, the increasing price of exports allows China to use fewer export products in exchange for more products in demand.

Furthermore, Wei and Liu (2010) indicate that RMB appreciation leads to an increased price of labor-intense exports as well as a reduction of export scale. Li and Xu (2011) agree that with the appreciation of RMB, the price of export goods would increase, which may harm the labor-intense industry in China. As the labor cost rises relatively, the competitive advantage of the manufacturing industry is more likely to be weakened compared to those in other developing countries in Asia. Similarly, Liu and Fan (2010) posit that if the Chinese yuan appreciates, manufacturing industries in China may lose their competitiveness gradually, which may lead to a shift of manufacturing industry to other countries. However, from the scenario analysis of Zheng *et al*. (2006), Chinese exports still have the international competitiveness that no other countries can easily be replaced even in an increasing exports price situation. In general, mostly due to the business cycle, people has held two different point of view on whether or not exports could be influenced strongly by RMB appreciation. Both views are reasonably presented because the appreciation of RMB may have harmed Chinese exports in the short run, however in the long run Chinese exports would be barely influenced. Li and Xu (2011) assert that the impact of currency appreciation on export is related to domestic content, that is, the higher the domestic content, the deeper of influence it would have on exports.

Together with import and export, there is a trade balance component to be considered and addressed. Many scholars argue that RMB appreciation would reduce the trade balance because the export variable decrease and that of the import increases. The trade surplus in this situation therefore can be weakened, holding everything else constant. Frankel (2004) supports this notion, in which he notices that the competitiveness of Chinese export commodities should be weakened brought by the increase of RMB exchange rate. At the same time, the current account surplus would decrease. Hooy *et al*. (2015) find that RMB appreciation reduces trade balance because China imports tech-related products as well as components products more than before from Southeast Asian nations. In the same argument, Cheung *et al*. (2007) support that if the real exchange rate of RMB increases by 10%, the total trade balance would reduce by 46 billion dollars. In addition, Chen and Xu (2007) agree that when RMB appreciates, it has a nominal effect on the trade balance. Because they find that there is a positive correlation between the RMB real exchange rate and China's import and export trade. From their study, the imports and exports would both decline when the RMB exchange rate increases.

While Zhang and Sato (2012) argue that the appreciation of a currency would not have much impact on the trade balance because they find that, per their estimated model, the Chinese trade balance is more likely to be affected by international demand shock. Similarly, Huang (2010) used the Engle-Granger test to analyze the relationship between the RMB real exchange rate and China's import and export trade. The study concludes that in the short run, there is a negative relationship between exchange rate and import, while in the long run, China's import and export trade is affected more by the fluctuation of national income as well as the price level, and it is not sensitive to the change of exchange rate. Wang (2007) agrees that the imports and exports trade has not been affected negatively, this study compares the numbers before and after RMB exchange rate reform. Instead, the imports and exports increase steadily from the year 2005 to 2006. Additionally, within the same year, Song (2007) argues that the competitiveness of China's exports has not been weakened; based on the government statistics, the imports and exports have both increased. More importantly, the trade surplus has increased within the same period. In 2005, the Chinese export growth reaches 28.4%, and the import growth reaches 17.6%. It also happened in 2006, with export growth and import growth of 27.2% and 20% respectively. Shen and Yang (2005) conduct a study and they conclude that there is not a causal relationship between RMB real effective exchange rate and China's import and export trade.

The evidence is more profound as Zhang (2008) points out that the price elasticity of demand is insufficient in China, and that the changes of the RMB exchange rate would not have a big influence on China's import and export trade. In a more persuasive argument with empirical evidence, Wang and Cao (2008) consider independent variables such as foreign exchange reserve and CPI in a VAR model. They conclude

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that RMB appreciation most likely does not have a significant impact on China's imports and export by constructing a vector error correction model. In line with the same argument, Schindler and Marquez (2006) show that 10% of RMB appreciation will only lead to a 0.5% change in export and 0.1% change in import, which leads us to believe that the appreciation does not have a big influence on the trade balance. From McKinnon's (2005) studies, one can see that RMB appreciation is unable to reduce trade surplus in China since the internalization of finance becomes stronger gradually. Similarly, Bondkengata (2007) uses a co-integration test to examine the relationship between the RMB exchange rate and China's long-term trade surplus based on the monthly data from 1992 to 2006. The result suggests that RMB appreciation is not beneficial to the trade surplus situation.

In addition, Guo (2017) studies more specifically and extensively on the trade balance issue. The study finds that even in the same situation of currency appreciation, the trade balance is affected differently across various industries. For example, the processing trade balance would increase while the ordinary trade balance would decrease. The RMB appreciation would have a deeper influence on processing trade than ordinary trade. Since the ordinary trade balance and processing trade balance has been affected differently, it is not easy to quantify or separate each factor's change. In the same fashion, therefore, it is not feasible for Guo (2017) to evaluate the overall influence on the trade balance. Thus, this is one of the limitations of the study. Furthermore, the estimated VAR model does not account for the situation of bilateral trade. Another scholar Dees (2001) notices that the price of ordinary exports reacts more sensitively to RMB appreciation compared to processed exports, thus there is not a uniformly agreed consensus to the terms exports in general. Yet, Li and Xu (2011) agree that currency appreciation affects industries differently because each industry has its domestic content and the domestic content behaves differently across industries.

Moreover, the time lag effect analysis reveals that, in general, the trade balance changes slowly with the exchange rate. Lu and Dai (2005) use the vector auto-regression (VAR) analysis to empirically test the long-term relationship between the weighted real exchange rate fluctuation of RMB against the world's major currencies and China's import and export from 1994 to 2003. The results suggest that the impact of RMB real exchange rate fluctuation on import and export behaves like one of the J-curve effects. Li *et al.* (2007) have reason to believe that under the pressure of RMB appreciation, the current growth rate of China's import and export trade is similar to the prediction known as the J-curve effect. That reveals RMB appreciation could improve the trade balance in the short term while causing the trade balance to decline in the long term. Thus, it conforms to the J-curve effect under the currency appreciation situation. Similarly, Xu (2007) finds that the RMB real exchange rate has a remarkable effect on China's import and export trade by constructing the VAR model. Particularly, the J-curve effect exists in the short-term and the time lag is about 5 months. However, from the empirical evidence of Ye (2006), there is evidence that no causal relationship between the RMB real exchange rate and Sino-US trade balance, and there is no J-curve effect. While there are competing views on how exchange rate changes could influence trade balance, reviewing and knowing the outcomes from these studies is essential for macroeconomists and policymakers alike.

2.3 The Impact of RMB Appreciation on International Trading Enterprises

Whether by direct or indirect impact of RMB appreciation on trade, enterprises engaging in trading activities would be affected. Eichengreen and Tong (2015) indicate that firms mainly profit from exporting are prone to be negatively affected because the demand for the trading components would decrease as the relative exports price increases. Inconsistent with Tong's argument, Fung, Baggs, and Beaulieu (2011) assert that as the demand for export goods decreases, the productivity by firms would decreases. Liu and Fan (2010) add that there is a dilemma for exports firms because the increasing price caused by RMB appreciation would limit the exporting quantity. And if firms lower the exports price, their profit margin can be very low. It is assumingly that the previous impact on Chinese firms is not good. However, Tomlin (2014) argues that home currency appreciation is beneficial to firms' productivity, a study conducted by investigation on Canadian agricultural industry. The findings suggest that firms with low producing efficiency are prone to exit the market and firms with high producing efficiency would remain, leading to an overall improvement in industrial productivity. Moreover, Caglayan and Demir (2014) point out that, in general, domestic currency appreciation would lead to a decrease in firms' productivity, while export-oriented firms tend to improve their productivity.

Also, Auer and Chaney (2009) demonstrate that currency appreciation could promote domestic enterprises to upgrade exports structure. The argument is sustained because they find that firms tend to produce and export high-quality products since these products are not susceptible to exchange rate fluctuations. On the contrary, Li *et al.* (2011) disagree with Chaney's argument because Li (2011) supposes RMB appreciation has very little impact on exports structure in China. To support the above observation, Chen *et al.* (2007) agree that labor-intense firms would reduce exports prices to maintain their competitiveness, and technology-oriented firms would increase exports prices to maintain the same profitability level if the home currency appreciates. Therefore, RMB appreciation most likely not cause the improvement of exports structure in China. Zhang and Tang (2013) find that RMB appreciation could reduce the trade surplus situation in China while it may have less effect on improving the export structure. Huang (2011) finds that RMB appreciation is less likely to improve Chinese exports structure because high

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productivity firms and low productivity firms both reduce the exports by 2.05% and 1.94% respectively in an RMB appreciates 1% condition. However, Huang (2011) assumes that firms in different industries behave the same way in the export market, which is not feasible in reality.

Nevertheless, Auer and Chaney (2009) have different views on the profitability issue. They notice that firms have to add higher mark-ups if they are trying to produce superior goods, which is helpful to improve profitability. Similarly, Mann (1986) finds that from the year 1981 to 1985, export-oriented firms' profit margin has been increased in the United States under a home currency appreciation situation. More specifically, Zhang and Ouyang (2017) find that RMB appreciation is beneficial to firms' profits even when the exports factor was not included in the study. From their estimation result, a 1% real exchange rate change would lead to 2.4% of firms' exports share drop, while firms' profits would increase 0.5% as the profit ratio shows. The research by Zhang and Ouyang (2017) suggests that the improvement in firms' profitability is due to the lower price of imported raw materials and the upgrade of exports structure. However, there is limited evidence to show if the improvement of profitability is due to product enhancement. In addition, Ranciere and Rogoff (2009) document that there is a negative relationship between home currency appreciation and profitability. Dominguez and Tesar (2006) notice that exchange rate movement has little impact on firms' profitability. Furthermore, the appreciation of RMB could have an impact on foreign direct investment activities, and would therefore affect firms' value indirectly. Yang and Lam (2012) point out that foreign enterprises invested in China could increase their corporate value by the revaluation of their asset, such as equipment investment. Note that any capital gain of revaluation would come from the RMB appreciation.

2.4 Suggestions for Chinese Government and China's Export Trading Enterprises

In 2016, the People's Bank of China (PBOC) also known as China's central bank has declared that the Chinese government tends to maintain the stability of the RMB exchange rate and it would take significant steps to deepen the exchange rare reform as needed. From the above information, China's central bank would continue to implement prudent monetary policy as well as use various monetary tools to promote the development of social financing. Xiao and Wang (2012) declare that the attitude of the Chinese government with the RMB exchange rate has changed through time as well. For instance, it changes from accelerated appreciation at the beginning of exchange rate reform to long-term and slight appreciation. Luo *et al*. (2014) recommend that the Chinese government is better improve the exchange rate reform system gradually so that the exchange rate of RMB would fluctuate more flexibly according to the total market demand and supply. In addition, the study emphasizes that encouraging trading companies to upgrade their structure is important. To reduce the impact of RMB appreciation, enterprises are expected to develop or improve the technology so that they have bigger profit margins, leading to greater benefits for trading firms.

Next, Zhang (2008) suggests that when facing the problems of RMB appreciation, the Chinese government is better off to change its export orientation strategy into the strategy of increasing domestic demand. The argument is that the negative impact of RMB appreciation on export trade can be weakened and the Chinese economy would be developed strongly domestically. As for the export trade firms in China, most of these enterprises should devote resources to increase the added value of exports products as well as optimize the structure of exported commodities. Zhang (2008) adds that exports enterprises are able to reduce the negative effect of RMB appreciation by implementing a diversified export strategy. In this way, the revenue of these enterprises is in foreign currencies when they focus on the international market. Moreover, export enterprises can use financial derivatives to reduce risks, such as forward foreign exchange trading and foreign exchange options. From Song's (2007) suggestion for export firms, the author argues that these domestic firms should bear exchange rate risk with their customers when they sign trade contracts. In this way, exports firms can share the loss of RMB appreciation with trading partners.

3. Methodology

From the literature review, it is apparent for some people to argue that RMB appreciation would result in the reduction of trade balance (Hooy, 2015; Cheung, 2007), while other people take a different point of view and would argue that RMB appreciation should not affect the trade balance significantly (Chen and Xu, 2007; Huang, 2010; Wang, 2007). Therefore, the research question of this paper is whether or not the RMB appreciation could affect China's trade balance, and if so, in which way. Further, this study also provides information necessary to policymakers and corporate governance to take essential steps to promote the development of and improve the current policy on foreign trade. This study uses "trade balance" as the dependent variable, and "RMB exchange rate," "foreign exchange reserve," "foreign direct investment," "GDP," "average domestic wage," and "openness degree" as independent variables. We construct a vector auto-regression (VAR) model and use stationary test, co-integration and error correction model, impulse response, and variance decomposition methods. Next, we clarify the methodology and then analyze the relationship between RMB appreciation and trade balance changes.

3.1 Selection of Variables

The variables include dependent variables and independent variables. The dependent variable is China's trade balance, which is expressed in terms of China's trade imports minus trade exports, with the unit of 100 million yuan (¥), or RMB.

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Independent variables are the following: RMB exchange rate, expressed by the annual average exchange rate of RMB to US dollar over the years; foreign exchange reserve (FER) in China over the years, unit 100 million U.S. dollars; foreign direct investment, unit 100 million yuan; GDP, unit 100 million yuan; average domestic wage, unit 1,000 yuan; China's trade openness, it is expressed by the ratio of total trade volume to total export output. These variables are chosen mostly according to the literature from Bahmani (2012), whose quantitative analysis is widely accepted. Also, according to other previous studies, the selected independent variables are all variables that have a direct and mostly indirect relationship with trade balance. For example, Guo (2017) uses RMB exchange rate, foreign direct investment, domestic demand (this part transferred it into average wage) and Li (2013) uses GDP as independent variables to research whether those variables have any influence on the trade balance. The details of the variable are shown in the table below.

Table 1: Specification of the Variables

Types of Variables	Variable Identification	Abbreviation	Source of Data (2005 – 2019)
Dependent variable	Trade balance	TB	China Statistical Yearbook (2020)
Independent variables	RMB rate	REB	China Statistical Yearbook (2020)
	Foreign exchange reserve	FER	China Statistical Yearbook (2020)
	Foreign direct investment	FDI	China Statistical Yearbook (2020)
	Gross domestic product	GDP	China Statistical Yearbook (2020)
	National average wage in China	AW	China Statistical Yearbook (2020)
	Openness	OPN	China Statistical Yearbook (2020)

3.2 Source of Data and Model Construction

Since the RMB exchange rate reform was implemented after 2005, the time range of sample data is from 2005 to 2019. The data obtained is from the Ministry of Commerce, China Statistical Yearbook (2020). To prevent the logarithm of variables could be misrepresenting the interpretation of the coefficient and reduce the heteroscedasticity of the selected data, our study transformed the data into a logarithmic form for variables with large data set. The data processing method can be related to Liu's (2014) study, an analysis of the impact of RMB's exchange rate volatility on China's import and export trade. In this section, we construct the VAR model to show the dependent variable and the independent variables are having very distinct characteristics, especially for time series testing. Different from the VAR model used by Liu (2014), the variables in this study are being processed logarithmically. Therefore, this section implements logarithmic processing on the balance of trade (TB), foreign exchange reserve (FER), FDI, and GDP, and the model in this study are as follows:

$$lnTBt = \beta 0 + \beta 1REBt + \beta 2lnFERt + \beta 3lnFDIt + \beta 4lnGDPt + \beta 5AWt + \beta 6OPNt + \mu t \quad (1)$$

Note that $\beta 0$ is a constant term, and μt is a random error term.

3.3 Specifications for VAR

The research in this study is aiming to measure changes in China's trade balance from 2005 to 2019, and we use the variables for time series testing. VAR model is a common choice for time series testing, prediction, and explanation because VAR features several important characteristics, including contemporaneous correlation, granger casualty, and feedback effect. Also, VAR has the advantage of analyzing the dynamic impact on endogenous variables and future values if a standard deviation of a random disturbance term has changed, namely an impulse response function. Note that before using the VAR model for estimation, it is essential for us to check the stability of time series variables. Only when the time series variables are stable, then it is feasible to carry out further regression analysis. After ensuring that the variables are stable, the next step is to use the co-integration test to examine if a long-term equilibrium relationship exists among time series variables, and a commonly used method is Johansen co-integration test. Therefore, the error correction coefficient in the error correction model could correct the pullback speed when the long-term migration occurs. This is one of the reasons why this section of the paper implements the co-integration test and error correction model. More importantly, the impulse response function will be used to

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show the magnitude of any impact between variables, thus we could examine the impact degree of one variable relative to another variable, and variance decomposition helps explain the degree to which import and export trade has changed.

3.4 Limitations

Note that the independent variable RMB exchange rate is expressed by the annual average exchange rate of RMB to U.S. dollars, and this value may vary substantially in the sample data and ignores the exchange rate of RMB against the currencies of other countries that have ongoing trades with China. Besides, given that the sample data is annually based and when the frequency of samples was higher, thus the results would be more acceptable. The research period is from 2005 to 2019 and does not include 2020. Also, the panel data analysis method in this paper is excluded because the data found from other countries' official statistical reports are incomplete. Finally, the research mainly focuses on the impact of RMB appreciation on the overall trade balance, it does not extend to trade with different trading partners.

4. Analysis of Empirical Results

4.1 Stability Test

Before regressing the model, it is necessary to test the stationarity of time series variables. Only when the variables are stable can the time series analysis be carried out. If the variables are not stable, it is easy to cause inaccurate model measurement in the subsequent tests. If the original sequence is not stable, the first-order difference is needed for the variable. Further, if the original sequence is still not stable, the difference is continued until the variable is stable. Dickey-Fuller (DF) test and augmented Dickey-Fuller (ADF) test are commonly used to test stationarity. DF test generally exists in the case of high-order lag correlation, essentially violating the hypothesis of independent and identically distributed random interference items. Therefore, most stationary tests generally are using the ADF test.

There are several steps to prepare when using ADF in the test. First, the reasonable lag order should be determined. Second, because the critical value of the statistics is highly related to the equation form, it is vital to choose the equation form of the test. Furthermore, if the test result is to reject the original hypothesis, the original sequence does not have a unit root, which can provide evidence that the original sequence is stable. If the original hypothesis is given, then the order is instability, it is necessary to make several differences until the original hypothesis is rejected, to determine the order of sequence simplex.

The results of the ADF test on the dependent variable and independent variable are as follows:

Table 2: Augmented Dickey-Fuller (ADF) Test

Variable	ADF Value	5% Critical Value	Stability
LnTB	-2.098	-3.000	Instable
REB	-2.910	-3.000	Instable
lnFER	-5.833	-3.000	Stable
lnFDI	-1.607	-3.000	Instable
lnGDP	-4.761	-3.000	Stable
AW	0.275	-3.000	Instable
OPN	0.178	-3.000	Instable

The ADF test of the original data shows that, except for foreign exchange reserves and GDP, the other variables are not stable. While after completing the second-order difference, all of the variables are stable. The results of the ADF test of second-order difference variables are as follows:

Table 3: Second-order Difference Augmented Dickey-Fuller (ADF) Test

Variable	ADF Value	5% Critical Value	Stability
LnTB	-4.039	-3.000	Stable
REB	-5.398	-3.000	Stable
lnFER	-4.336	-3.000	Stable
lnFDI	-6.031	-3.000	Stable
lnGDP	-4.120	-3.000	Stable
AW	-6.542	-3.000	Stable
OPN	-3.431	-3.000	Stable

All the variables are now stable, allowing the co-integration test of the model (1) to perform.

4.2 Co-integration Test

The time series of the general economy is non-stationary, and its mean and variance change in the different periods. If using non-stationary time series to establish a regression model, we would not achieve one of our goals due to inaccurate regression. If the non-stationarity of time series can be eliminated, inaccurate results from regression can be avoided. The most common method to achieve non-bias regression results is the difference method, that is, through the difference of non-equilibrium variables; by using this method, the difference order is changed into a balanced sequence, and then the different variables are regressed. This method can eliminate the pseudo regression problem caused by the non-stationarity of variables, but it would not maintain the information of the long-term relationship between variables. Therefore, we utilize another method called co-integration analysis that takes an approach to avoid the loss of variable information caused by differences. To this end, we are constructing the linear combination of unstable variables as well as eliminating the instability by linear combination.

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Effectively, the variable information can be retained and the correlation relationship between variables can be established.

Moreover, we utilize the Johansen co-integration test. This test is proposed by Johansen (1988) to test the regression coefficient based on the VAR model. The basic idea is to find eigenvalues and corresponding eigenvectors based on the VAR model instead of finding maximal imaginary function. Johansen test estimates the rank of matrix and test matrix based on the idea of canonical correlation analysis. Canonical correlation is to find two pairs of linear combinations with the maximum correlation coefficient. The correlation between unbalanced variables and equilibrium variables cannot reach the maximum. Therefore, only when the two variables are balanced can the correlation coefficient reach the maximum. Consequently, if a co-integration relationship exists in unbalanced variables, then there should be a certain linear combination to maximize the correlation between the two variables.

The central idea of the Johansen co-integration test is to find a suitable linear combination vector under a specific linear combination so that the combination of specific linear combination and related time series can reach the maximum correlation coefficient, and the square of the correlation coefficient is the eigenvalue. According to the theory of linear algebra, matrix rank is equal to the number of non-zero eigenvalues. The general judgment methods are the trace test method and the maximum eigenvalue method.

Suppose the model statistic is following:

$$q_r = -T \sum_{i=r+1}^{n} \ln(1 - q_i), r = 0, 1, 2, \ldots N - 1$$

When q_0<critical value, there is no co-integration relationship;
When q_0> critical value, there is at least one co-integration relationship;
When q_1< critical value, at most, there is only one co-integration relationship;
When q_1> critical value, there are at least two co-integration relationships.
And so on until there are at most *r* co-integration relations.

The regression coefficient is used to examine the influence degree of variables, and the co-integration test can be used to test the regression coefficient. Bondkengata's (2019) method and study explain the reason why the co-integration test is constructed to examine the long-term equilibrium relationship between variables. Before that, it is necessary to do the Akaike information criterion (AIC) evaluation test for the VAR model to improve the effectiveness of the co-integration test more accurately.

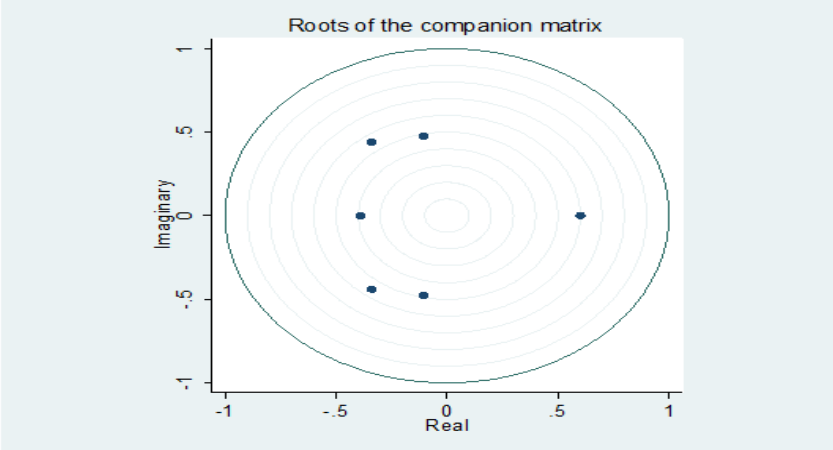
Table 4: Optimal Lag Order

Lag	LL	LR	df	P	FPE	AIC	HQIC	SBIC
0	25.6291				8.0e-11	-3.3871	-3.5467	-3.1339
1	891.093	1730.9	49	0.000	4.2e-74*	-151.835	-153.112	-149.809
2	2411.13	3040.1	49	0.000		-424.387	-426.142	-421.601
3	2517.82	213.38*	49	0.000		-443.785*	-445.54*	-440.999*

According to the determination of the optimal lag order, AIC takes stars at the third order, so the model should choose the optimal lag order as the third order.

Further, we need to make sure that all variables are within the unit circle. Once this condition is met, we then have ensured the exact measure line of the impulse response function. In the unit circle test, all variables included in this study are within the unit circle, as shown below. In the impulse response function test performed in the next section, we can see that the test results are valid, according to the stated conditions.

Chart 1: Unit Circle Test



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As shown from the unit circle test above, all the six independent variables selected in this study are lying within the circle, suggesting that the model is stable and ready for further testing.

We now further analyze the empirical results from RMB exchange rate changes on China's foreign trade. First, from the co-integration analysis, considering that some variables have intercept and trend, and there is no obvious time characteristic of trade balance and RMB exchange rate appreciation, the Johansen co-integration test is selected. The Co-integration test is one part of the error correction model. The error correction model reveals the short-term relationship, while co-integration reveals the long-term relationship. Note that the error correction model is different from a VAR model. Thus, if a VAR model chooses n-order lag, then the error correction model is equivalent to the lag n-1 order. The results of the co-integration test are as follows:

Table 5: Johansen Co-integration Test and Results

Number of co-integration equations	Trace statistic	5% critical	Max statistic	5% critical
None	336.75	136.61		48.45
At most1	195.62	104.94	463.0253	42.48
At most2	153.38	77.74	43.8237	36.41
At most3	34.07	54.64	25.0560	30.33

From Table 5, in at most three co-integration equations, the maximum eigenvalue statistic is less than 5% critical value, which indicates that at most three co-integration equations are not tenable, and there are two co-integration equations. The value of trace statistics is 34.07, which is less than the critical statistical value of 54.64, and the value of maximum eigenvalue in the third order is 25.0560, which is also less than the critical statistical value of 0.05, or 30.33. Therefore, the stated hypothesis is rejected and the co whole number of the model is 2. Further, the results show that there are at most two co-integration equations for the influence of RMB appreciation on import and export. Consequently, the co-integration equation is established as follows:

$$lnTB_t = 0.1430 - 0.2182REB_{t-1} - 1.3859lnFER_{t-1} - 0.1674lnFDI_{t-1} + 1.8870lnGDP_{t-1} + 0.0796AW_{t-1} + 0.5057OPN_{t-1} - 0.0529REB_{t-2} - 0.1547lnFER_{t-2} - 0.0050lnFDI_{t-2} + 0.3710lnGDP_{t-2} + 0.0112AW_{t-2} + 0.0771OPN_{t-2}$$

Note that $R^2 = 0.8258$, DW=1.0541

According to the results from the co-integration equation testing, is 0.8258, indicating a high degree of explanatory power, and the regression effect is significant. In addition, the first-order and second-order coefficients of the independent variables of the model are all significant, giving us reliable reason to believe that RMB appreciation can have a remarkable effect on import and export trade.

Moreover, the results suggest that RMB appreciation would have a positive impact on the trade balance. RMB appreciation leads to the reduction of trade surplus because RMB appreciation reduces exports and increases imports, holding all other variables constant. From another perspective, if the RMB appreciates, then most likely the total import increases and the total export decreases. In particular, and currently, RMB appreciation is not conducive to China's exports because export enterprises would spend more money on settlement, while imports would not, and thus foreign goods entering the Chinese market are fewer. As such the trade balance gap is getting larger and continues to grow. Nevertheless, all coefficients are significant at the 5% level.

Next, the foreign exchange reserves are negatively impacted on the trade balance. In particular, with the increase of foreign exchange reserves, the sign of trade surplus is weakening in China. High foreign exchange reserves indicate the increase in China's exports. In the current international trade landscape, the main settlement currency is the U.S. dollar, therefore the majority of China's foreign exchange reserves is the U.S. dollar. From a macroeconomics standpoint, the increase of foreign exchange reserves indicates that the export increases and the inflow of U.S. dollars to China increase. Essentially, while the number of export increases in China, the balance of trade is decreasing.

Yet, foreign direct investment is negatively affecting the import and export trade industry. The increase of foreign direct investment suggests that the investment opportunities are expanding in China. For some foreign enterprises, the increase of foreign direct investment allows firms to increase production and, among other things, obtain more funds, leveraging the opportunities for firms to export more goods and services. Therefore, China's overall export volume continues to grow, and this growth rate would narrow the trade balance as a result.

On the other hand, the impact of GDP on import and export trade is positive. The increase in GDP suggests that China's economy is improving and the average domestic wage is on an increasing trend. Therefore, the increase of average domestic wage assumingly increases the demand for imported goods, and subjectively the trade balance is strengthening. From an international trade standpoint, the degree of openness in this study also affects the import and export trade positively. Given abundant evidence from the government on policy reform and corporate governance in China, the demand for imported goods would continue to increase, and the degree of openness is on the rise. Therefore, the higher the degree of

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opening up to trade, the greater the demand for imported goods, which could lead to a stronger trade balance for China.

4.3 Error Correction Model

From the statistical results of the co-integration test performed in the earlier section of the paper on RMB appreciation and China's import and export trade, we may conclude that there is a long-term equilibrium relationship between the two variables, and this relationship is stable. Nevertheless, the existence of a long-term relationship between those two variables does not imply there is a short-term relationship, and the error correction model is utilized to test whether there is a short-term relationship exist between the variables. The error correction model was first proposed by Davidson *et al*. (1978), and this model is different from the VAR model. In essence, the error correction model aims to show the short-term relationship between time series variables, and how strong the error correction coefficient can be pulled back to the normal level when the time series model deviates in the long term. Furthermore, the Vector Error Correction Model (VECM) is different from VAR because there are co-integration constraints in VECM, but the basic framework is the same. We now examine the components of the two frameworks.

In general, the equation of long-term equilibrium is as follows:

$$y = k_0 + k_1 x$$

For error correction model, it is as follows:

$$y_t = \alpha(y_{t-1} - k_0 - k_1 x_{t-1}) + \beta \Delta x_t + \mu_t$$

Note that Error Correction Term ECM(-1) is $y_{t-1} - k_0 - k_1 x_{t-1}$, representing the short-term equilibrium deviation of y_t with respect to x_t at time t. And α is an adjustment coefficient, it is y_{t-1} toward equilibrium value $k_0 + k_1 x_{t-1}$ of adjustment speed. Thus, in the short term, the deviation degree of the system from the equilibrium state determines the fluctuation range of y value. The error correction model combines the raw data of variables with the difference to measure the degree of fluctuation deviating from the equilibrium state.

We use Stata program for regression analysis on our error correction model (1), and the results we obtained are as follows:

$$\begin{aligned} lnTB_t = {} & -4.5561 - 0.5139 ECM_{t-1} - 5.5404 REB_t \\ & - 3.8310 lnFER_t - 0.2693 lnFDI_t \\ & + 2.8736 lnGDP_t + 2.5973 AW_t \\ & + 0.6742 OPN_t \end{aligned}$$

The coefficient of error correction term is statistically significant, indicating that in the next period, the imbalance of the explained variable is adjusted proportionally. Next, the coefficient of error correction indicates that in the short term, 51.39% of trade balance will be adjusted if it deviates from the long-term equilibrium value determined by the independent variables: RMB exchange rate, foreign exchange reserve, foreign direct investment, GDP, average domestic wage and the degree of openness. In case deviation between long- and short- term happens, the error correction coefficient could *pull* and thus make appropriate adjustment of the short-term back to the long-term equilibrium with 51.39% efficiency.

4.4 Granger Causality Test

In this section, we use the Granger causality test to examine the causality between the balance of import and export trade and each of the independent variables, namely RMB appreciation, foreign exchange reserves, foreign direct investment, GDP, average domestic wage, and openness. Granger causality test reveals the mutual guiding relationship between time series. While the causality test may not give us a complete causality linkage between two variables, it best establishes the time causality. Thus, under this method, determining the direction of influence is important. Further, investigating the long-term adjustment relationship of the time series variables is crucial. Equally important, the influence of the lag factor of the time series on the explained variable in the short term is investigated. Note that if the time series is non-stationary, then we may imply that the results from the causality test are not necessarily valid. On the other hand, for stationary time series variables, the model detects long-term causality and the test results are more favorable.

We also use the Stata program to test the Granger causality between RMB appreciation and import and export trade model variables, the results are as follows:

Table 6: Granger Causality Test and Results

Equation	Excluded	Chi2	df	Prob
lnTB	REB	7.0374	1	0.008
REB	lnTB	0.4210	1	0.516
lnTB	lnFER	25.17	1	0.000
lnFER	lnTB	6.2052	1	0.013
lnTB	lnFDI	25.604	1	0.000
lnFDI	lnTB	2.643	1	0.104
lnTB	lnGDP	108.96	1	0.000
lnGDP	lnTB	0.4212	1	0.516
lnTB	AW	4.3068	1	0.038
AW	lnTB	2.0976	1	0.148
lnTB	OPN	1.2855	1	0.257
OPN	lnTB	0.0011	1	0.973

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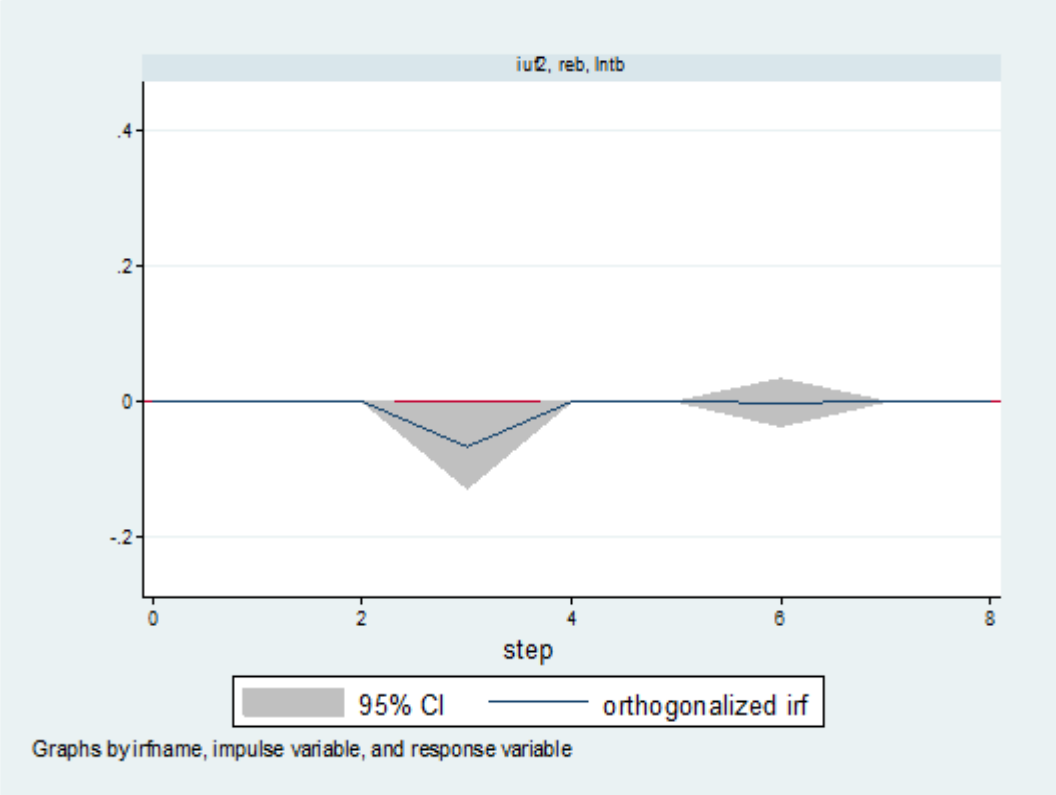
The results of the Granger causality test indicate that there is *a one-way* causal relationship between the trade balance and RMB exchange rate. In other words, the trade balance is the causal relationship of the RMB exchange rate, and the *p-value* is 0.008. While the RMB exchange rate is the causal relationship of trade balance, *the p-value* is 0.516, not causality. The import and export trade balance and foreign exchange reserve *p* values are both less than the critical value of 0.05 indicating that the two variables are causality to each other. The balance of import and export trade is also a *one-way* causal relationship with foreign direct investment, and it is also a *one-way* causal relationship with GDP and average domestic wage. The *p* values of the two variables are greater than the critical value of 0.05, suggesting that the two variables are not causally related.

4.5 Impulse Response Function

In general, we use the VAR model to analyze the dynamic impact of endogenous variables and future values when a standard deviation of a random disturbance term changes a measurement yardstick also known as the impulse response function method. This section first analyzes VAR based on the impulse response, then discusses the impulse response function of the balance of import and export trade under the impact of a standard deviation from those of RMB exchange rate, foreign exchange reserve, foreign direct investment, GDP, average domestic wage and openness lag value. The following figures Chart 2 to Chart 7 show the impulse response diagram of the model variables. The vertical axis represents the change value of the corresponding variable growth rate, and the horizontal axis represents the lag interval number of the impact variable.

Chart 2 shows the impulse response between the import and export balance (TB) and the RMB exchange rate, or REB.

Chart 2: Response of REB to lnTB



The result from Chart 2 suggests that the impact of the RMB exchange rate on trade balance reaches the minimum value in the third period, then stabilizes gradually. In addition, the RMB exchange rate has a positive impact on the balance of import and export trade, and this result is consistent with that in the previous co-integration test results. Moreover, the appreciation of RMB most likely has a positive impact on import and export trade. In particular, trade surplus-value would be reduced due to RMB appreciation. As a result, the balance of import and export trade most likely increases, and its impact is significant in the long run. Next, as RMB appreciation would cause harm to the exports industry, export enterprises are suggested to increase or acquire additional funds when conducting export trade.

Chart 3 illustrates the impulse response function of foreign exchange reserve (FER) to the balance of import and export trade (TB).

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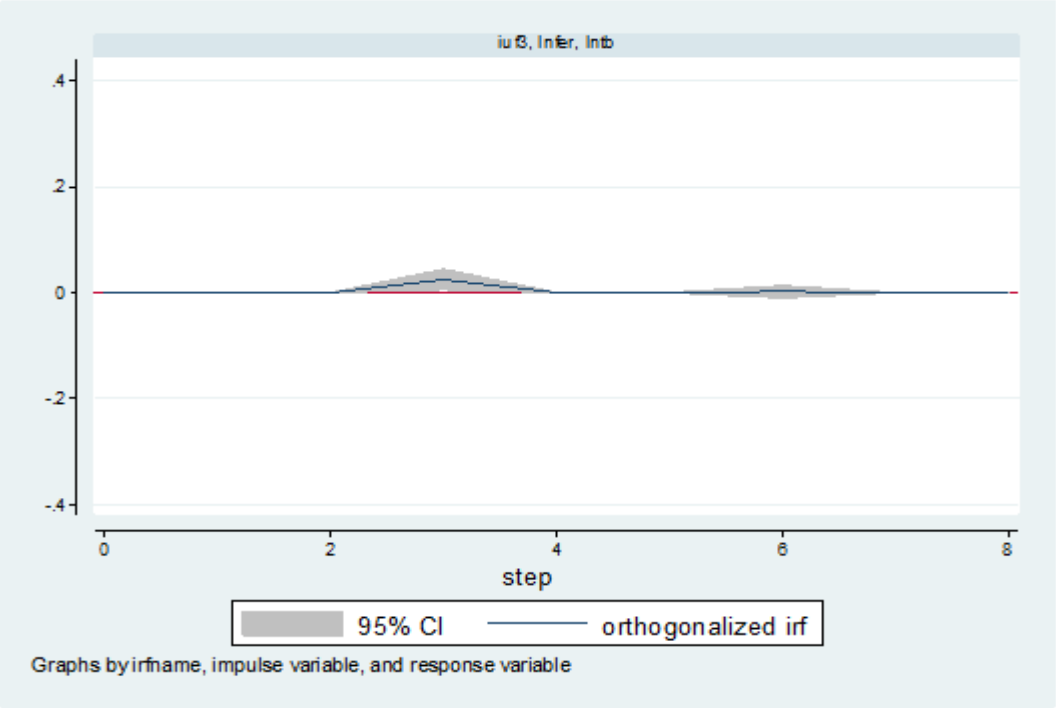
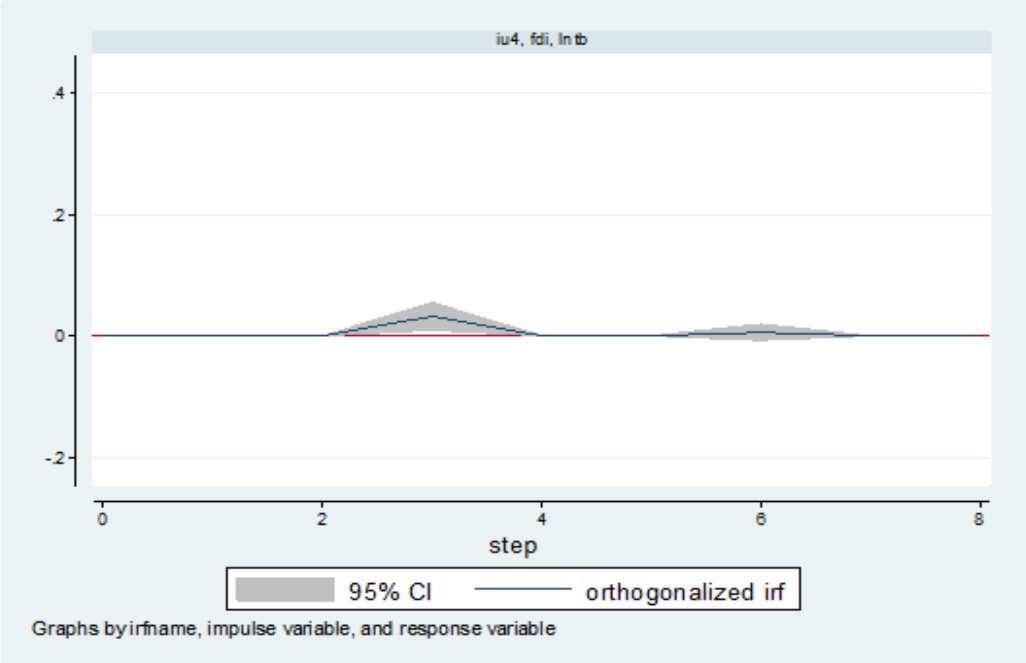
Chart 3: Response of lnFER to lnTB



The result from Chart 3 suggests that the impact of foreign exchange reserves on trade balance reaches the maximum in the third period, and then stabilizes thereafter. Also, the impact is smaller than that of RMB appreciation. Note that the impact of foreign exchange reserves on the balance of import and export trade is positive. As a country, China has a significant accumulation of foreign exchange reserves, and foreign trade is the main force of economic growth. Thus any increase in foreign exchange reserves would promote and increase trade in China, making foreign exchange reserves an important role and positive impact on China's trade sector. On a side note, China's foreign exchange reserves are settled in U.S. dollars, therefore an increase of foreign exchange reserves implies that the amount settled in U.S. dollars increases, causing the amount of foreign trade settlement to also increase.

Chart 4 depicts the impulse response function of foreign direct investment (FDI) to the balance of import and export trade (TB).

Chart 4: Response of lnFDI to lnTB



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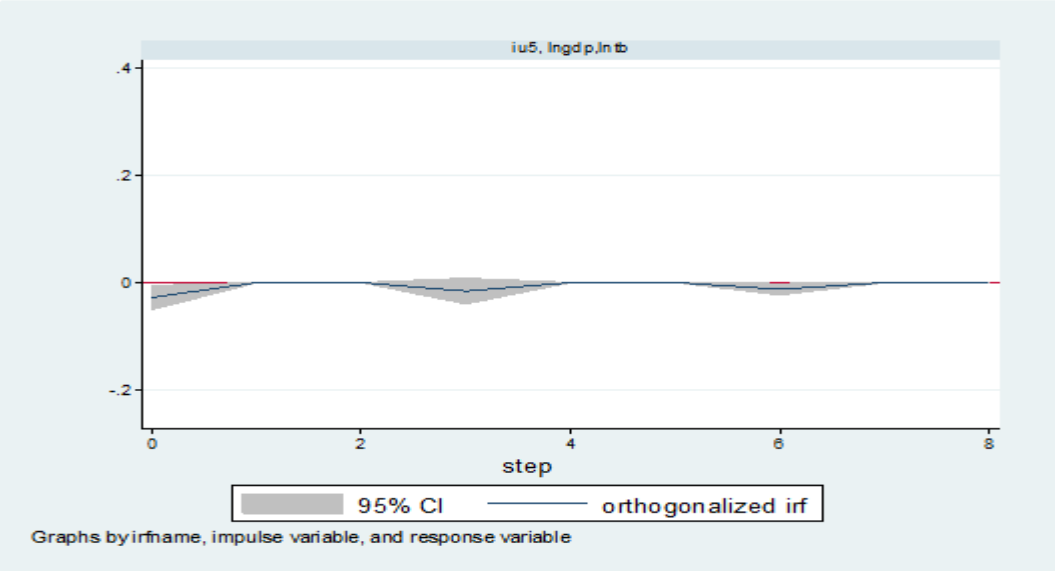
The result from Chart 4 suggests that foreign direct investment affects the balance of imports and export the same way as it does with foreign exchange reserves. For instance, the impact of foreign direct investment on trade balance reaches the maximum in the third period then stabilizes thereafter, and this impact is a positive one. Further, foreign direct investment most likely directly increases China's investments. To a greater extent, the increase in China's investment would promote import and export activities. Thus China's import and export enterprises would have to obtain additional capital and technology, leading to an increase in the production scale of import and export commodities. In addition, an increase in foreign direct investment could increase capital inflows and enhance technical knowledge. More than 85% of Chinese enterprises are import and export trade enterprises, and thus foreign direct investment would stimulate growth and increase productivity as a whole. Consequently, foreign direct investment positively affects both import and export sectors in China.

Chart 5 presents the impulse response function of gross domestic product (GDP) to the balance of import and export trade (TB).

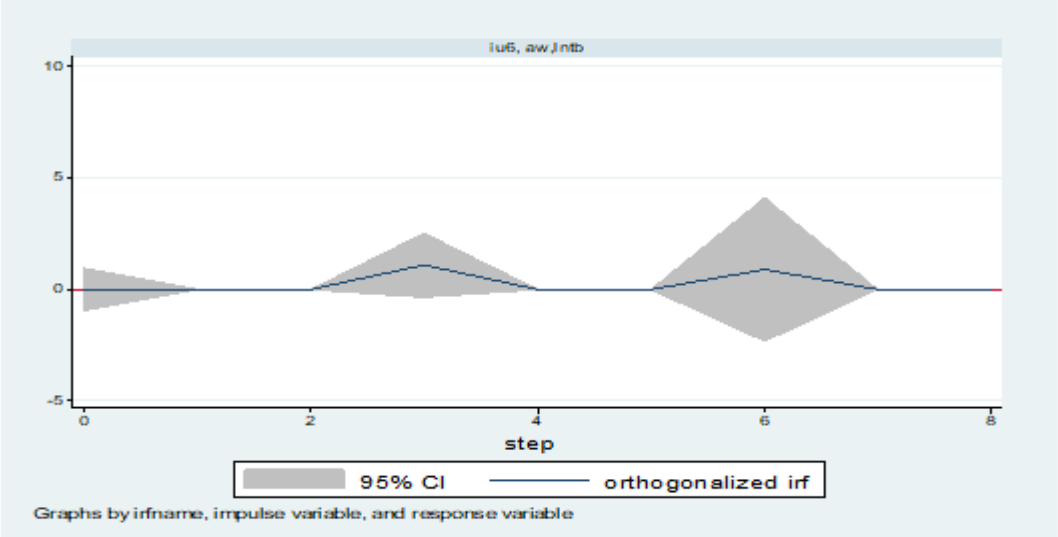
Chart 5: Response of lnGDP to lnTB



The result from Chart 5 suggests that the impact of GDP on the impulse response function of the balance of import and export trade is on the rise, reaching the minimum value in the third period, then stabilizing thereafter. Further, from the fifth to the seventh period, the impact is negative, then stabilizes after the seventh period, implying that China's economy is on a growing trend. Enterprises would sense this signal favorably and thus produce a large number of export products, prompting exports would increase while imports would stay constant or decline. As a result, GDP most likely influences import and export negatively.

Chart 6 exhibits the impulse response function of domestic average wage (AW) to the balance of import and export trade (TB).

Chart 6: Response of AW to lnTB



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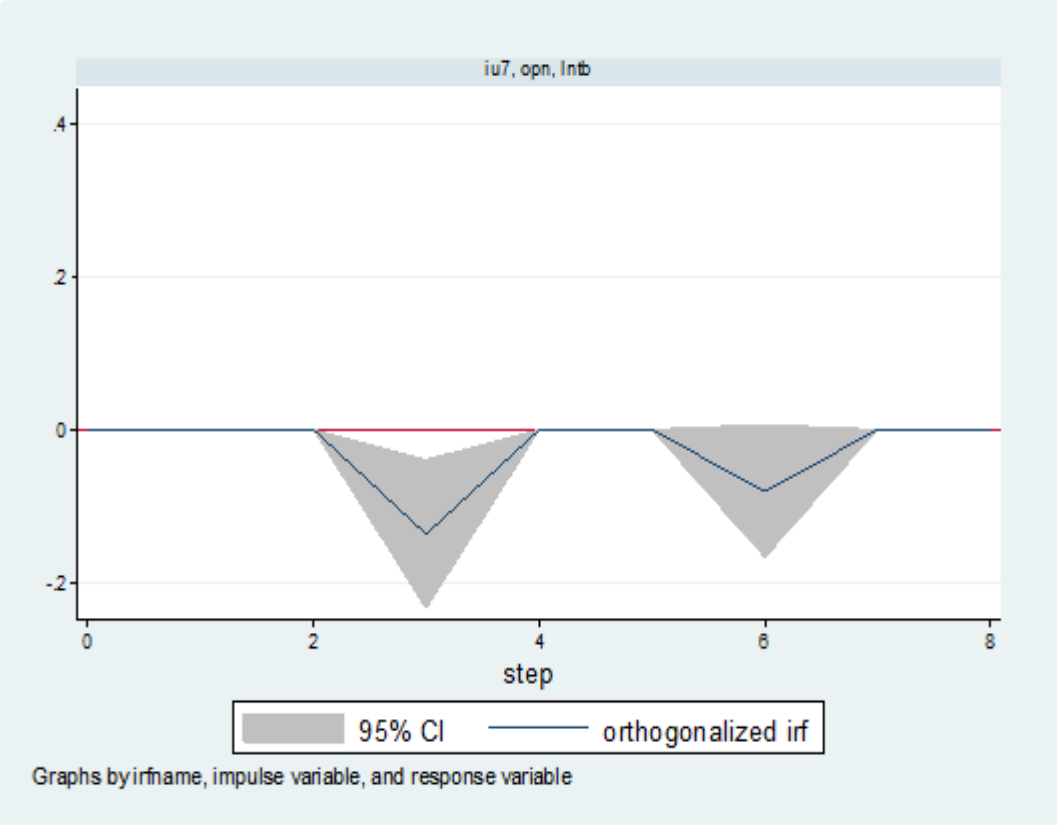
The result from Chart 6 suggests that the impact of domestic average wage on the balance of import and export trade is stable at the beginning, then increases in the second period, reaches the maximum in the third period, then declines, and stabilizes after the fourth period. Further, the response function rises in the fifth period, achieves the maximum in the sixth period, and declines thereafter. In addition, the response function is stable after the seventh period. Also, consistent with general consumer expectation characteristics, an increase of national average wage prompting more demand for imported products, yielding a positive influence on import and export trade. From a macroeconomics standpoint, an increase in average wage implies that the living standard of a typical Chinese consumer is better, and thus more purchasing power for a foreign-made good purchase. Therefore, this trend is a tie to and would improve the structure of import and export trade.

Chart 7 summarizes the impulse response function of openness (OPN) to the balance of import and export trade (TB).

Chart 7: Response of OPN to lnTB



The result from Chart 7 suggests that the impact of the degree of openness on import and export trade is negative. At first, the response function declines in the second period and achieves a minimum point in the third period, then rises and tends to be stable, however it declines after the fifth period. Next, in the sixth period, the response function exhibits a drop to the undervalued value then rises and tends to be stable, but this impact has always been negative. Thus, a larger degree of openness suggests a stronger foreign trade activity, leading to a decrease in import and export trade. Additionally, a higher degree of openness suggests that more exports of foreign goods or that the trend is on the rise. For instance, in the current market condition, import and export are both crucial for China, however, the evidence suggests that domestic consumption outweighs the rate of domestic production. Thus far, the impact of openness on import and export trade is negative for China.

4.6 Variance Decomposition

We use variance decomposition in this section to analyze the interaction between and impact of contribution endogenous variables and other endogenous variables. Through the process of variance decomposition, we could clarify the important information of random items. The idea is to decompose the fluctuation of each endogenous variable into a single component associated with the information items of each equation according to the causes so that we could understand the relative importance of each information to the endogenous variables of the model. Thus, if the errors are correlated, the results of variance decomposition are affected by the order of the variables. Recall that this paper uses the RMB exchange rate, foreign exchange reserves, foreign direct investment, GDP, average domestic wage, and degree of openness as independent variables to explain the balance of import and export trade. Hence, we use the Stata program for the said purpose, and the results are as follows:

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Table7: Variance Decomposition and Results

period	S.E.	lnTB	REB	lnFER	lnFDI	lnGDP	AW	OPN
1	5498.338	100.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	8268.807	97.5608	0.7226	0.3206	0.0114	0.1517	0.0180	1.2149
3	9179.114	92.4696	1.8090	1.1486	0.9347	0.2949	1.6308	1.7124
4	9277.195	90.1500	2.8749	1.9913	0.7030	0.5848	1.8127	1.8833
5	9371.884	87.2295	3.3074	2.1154	1.2263	1.7168	2.4499	1.9547
6	9567.669	87.3187	3.2579	1.9345	2.0778	1.1307	2.3199	1.9605
7	9609.086	86.0296	3.1703	1.8534	2.3839	1.7821	2.7104	2.0703
8	9732.627	85.8103	3.1707	1.8653	2.3827	1.2491	2.6808	2.8411
9	9733.858	83.6618	3.1937	1.8705	2.3050	1.9552	3.2514	3.7624
10	9742.324	83.5110	3.1957	1.8529	2.2709	1.9779	3.2797	3.9119

Variance decomposition explains the role of each variable resulting from the change of the balance of import and export. From the test results of variance decomposition in Table 7, we note that the reason for the change of import and export balance is the variable itself, and it is 100% in the first period then decreases in each period subsequently. However, the change is nominal and within a very small range. Next, the contribution rate of variance is at 83.5110%, meaning that more than 80% of the variance is attributed to the same variable. Furthermore, the degree of openness has great explanatory power for the balance of import and export trade, reaching 3.9119% in the 10th period. More importantly, the domestic average wage has a higher degree of explanation than other variables, accounting for 3.2797%. However, the core explanatory variable is the RMB exchange rate, yielding at 3.1957%. Whereas, the explanatory power for foreign direct investment is 2.2709%, for GDP is 1.9779%, and for foreign exchange reserves is 1.8529%.

4.7 Discussion of the Results

Most results from the study are within our expectations, and the results from various testing support our hypotheses. First, from the co-integration test results, we note that the appreciation of the RMB would have a positive effect on the trade balance. Moreover, RMB appreciation would trigger trade surplus to reverse mainly because RMB appreciation is more likely beneficial to China's imports while there is no sign that it helps China's exports. Additionally, we note that there is a long-term co-integration relationship exists between the two variables. Next, a strong relationship exists between the independent variables and the balance of import and export trade can be summarized as follows: foreign exchange reserves could affect the balance of import and export trade negatively; foreign direct investment may hurt trade balance; GDP influences trade balance positively; an increase of domestic average wage on the trade balance is positive; an increase of national wages would increase the demand for imported goods; while a higher degree of openness could affect the trade balance positively.

The empirical results overall indicate that a long-term equilibrium relationship exists between the RMB appreciation and China's trade balance, and there is also a time adjustment for the short-term deviation. Evidently, in case of a short-term deviation happens, the error correction coefficient could *pull* or make adjustments of the short-term back to the long-term equilibrium by 51.39%. Furthermore, an increase in the RMB exchange rate affects the trade balance positively, but the effect is not significant. In general, our results are consistent with those in the work of Liu (2014) and Qiao (2015), in which analyzing and offering support that currency appreciation resulting from exchange rate change would have a great impact on a nation's trade balance.

Moreover, the exchange rate adjustment, whether theoretically or in practice, is supposed to be a continuous process. Here, in this case, the exchange rate adjustment of RMB should extent to a certain degree, not boundless. Therefore, in terms of the policy-making process, it is not advisable to adjust the exchange rate completely or rapidly, given that size of currency appreciation would affect the outcomes accordingly. For example, in recent years, China's economy has been experiencing a trade surplus, and thus the country continues to draw great attention from foreign firms and organizations in terms of foreign direct investments. This component of the whole economy overall would prompt large capital inflows to China. Consequently, and eventually, any attempt to put pressure on the RMB appreciation is unlikely to consummate. To this end, it is a new and emerging issue for the Chinese government to address on how to properly handle the impact of RMB appreciation on the trade balance. That, however, is another topic to be discussed.

5. Summary and Concluding Remarks

This paper aims to examine the impact, if any, of RMB appreciation on the trade balance in China from 2005 to 2019. For testing and necessary variables related to trade balance, the authors use a series of independent variables including income, RMB exchange rate, and FDI to research the correlation between those variables by using the co-integration testing method and impulse response function. We further examine the effect of RMB exchange rate appreciation to trade balance including imports and exports, then use statistical indicators to analyze the trade structure of China within the

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same period. From various testing results, we note that RMB appreciation could affect China's trade balance, but not significantly. Fundamentally, an increase in the real effective exchange rate of a country most likely increases the exchange price of that country's exported commodities, thereby reducing the price competitiveness of the products. Applying the same logic to the case in this study, coupled with the evidence from the tests conducted, we could conclude that RMB appreciation is more than likely to reduce China's trade surplus. In addition, we have the evidence to believe that, mainly for and applicable to domestic enterprises, RMB appreciation could create a favorable environment for trade.

For most of the second haft the 20th century, notwithstanding any effect from the RMB appreciation, and largely due to monetary policies, China's economic development models and mechanisms were moving in the direction of internationalization. Within this period, China's real effective exchange rate was significantly underestimated, giving rise to a need for further reform to a more competitive RMB in the international markets. For example, under an undervalued exchange rate scenario, many Chinese industries had prosperous and gradually expanded. Lately, most firms in those industries developing into industrial clusters with a considerable scale of cluster effect. Note that those firms are state-owned enterprises and thus China is given much credit for their achievements and successful strategies. Moreover, knowing as a low labor cost economy, China has been using this competitive force for domestic productions and eventually for trade, and, according to many well-known trade models, most labor-intensive industries have achieved their goals, effectively raising the living standards in China. Note that exchange rate appreciation would not affect the competitive advantage of Chinese products, therefore this is another reason that China would take advantage of the exchange rate adjustment to effectively and actively implement industrial restructuring and push for a transition from less competitive firms to higher standards firms with trust-valued products.

Next, from the empirical test results, we note that the domestic income elasticity in terms of the trade balance is much more elastic than the actual effective exchange rate elasticity of RMB, thus we could argue that the actual national income in various countries having trade with China is playing an important role in affecting the development of China's foreign trade policy. For instance, assume there is an increase in income in foreign countries having trade with China, then a small change in the price of China's export (normal) goods would not have a significant exchange impact on China's trade balance. Thus, price elasticity is negligible in this case. Another example could be illustrated in the steel industry, where a small increase in foundry costs would not affect, let alone offset China's competitive advantage stance due to strong industrial and related facilities foundation.

One takeaway from the estimated coefficient of the co-integration test to examine the effect of RMB real effective exchange rate on the trade balance is that RMB appreciation influences imports negatively. Up until recently, demand for foreign goods is mostly rigid demand, and price changes in those goods are imposing on China's import demand. For this reason, the appreciation of the RMB would greatly increase purchasing power for domestic customers. On the other hand, RMB appreciation would cause the product price less competitive in the international market, and therefore exchange rate increase most likely impacts exports negatively. However, the negative effect of the exchange rate on exports is difficult to assess or offset the positive effect of an increase in foreign national income on China's exports, as discussed earlier. Collectively, even if the RMB exchange rate continues to increase, China's exports are more than likely to increase in tandem.

Related to the exchange rate reform issue in China, we have noted that the effect of exchange rate changes on China's trade balance is not significant, and such exchange rate changes are not a real solution to the fundamental problem of the continued international surplus. For one thing, on a macroeconomics level, there are many drawbacks to the international parity conditions, thus the rate and level in economic growth are not uniformly consistent in all countries, making market participants face increasingly uncertainties. Secondly, the systematic risk remains an obstacle for investors and speculators to overcome, therefore making government interventions in the international currency market less than predictable. Nevertheless, there are tools and options available that China could use to take on a direct and proactive approach to address and offer a solution to the issue of balance of payments and, among other things, trade surplus.

Of last, there are many factors affecting China's trade balance, and, as we have examined, the RMB exchange rate has a nominal impact. The following variables could very well be related to a change in the overall trade pattern in China, namely inflation, tax codes and obligations, labor market conditions, international economic conditions, and so forth. Therefore, in general, changes in exchange rate alone could hardly or significantly influence the overall direction in the trade balance. Taking matters into their own hands, the Chinese government should take appropriate measures to respond to the impact of RMB appreciation on China's exports. The appreciation of RMB is conducive to a stable economy in the long run, and the impact on certain industries in the short run should also be given great attention. One way is to reduce the adverse effects of large fluctuations in the RMB exchange rate on foreign trade revenues and expenditures. Another way is to improve domestic industrial structure so that domestic firms could stay competitive in the international markets.

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Appendix

1. ADF:

Dickey-Fuller test for unit root — Number of obs = 14

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-2.098	-3.750	-3.000	-2.630

MacKinnon approximate p-value for Z(t) = 0.2453

Dickey-Fuller test for unit root — Number of obs = 14

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-2.910	-3.750	-3.000	-2.630

MacKinnon approximate p-value for Z(t) = 0.0442

Dickey-Fuller test for unit root — Number of obs = 14

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-5.833	-3.750	-3.000	-2.630

MacKinnon approximate p-value for Z(t) = 0.0000

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```
Dickey-Fuller test for unit root                    Number of obs   =        14

                                 ---------- Interpolated Dickey-Fuller ----------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -1.607           -3.750            -3.000           -2.630
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.4799
```

```
Dickey-Fuller test for unit root                    Number of obs   =        14

                                 ---------- Interpolated Dickey-Fuller ----------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -4.761           -3.750            -3.000           -2.630
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0001
```

```
Dickey-Fuller test for unit root                    Number of obs   =        14

                                 ---------- Interpolated Dickey-Fuller ----------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)             0.275           -3.750            -3.000           -2.630
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.9762

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Dickey-Fuller test for unit root                    Number of obs   =        14

                                 ---------- Interpolated Dickey-Fuller ----------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)             0.178           -3.750            -3.000           -2.630
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.9710
```

2. Second-order ADF：

```
Dickey-Fuller test for unit root                    Number of obs   =        12

                                 ---------- Interpolated Dickey-Fuller ----------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -4.039           -3.750            -3.000           -2.630
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0012
```

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```
Dickey-Fuller test for unit root                   Number of obs   =        12

                                 ------------ Interpolated Dickey-Fuller ------------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -5.398           -3.750            -3.000           -2.630
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

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Dickey-Fuller test for unit root                   Number of obs   =        12

                                 ------------ Interpolated Dickey-Fuller ------------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -4.336           -3.750            -3.000           -2.630
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0004
Dickey-Fuller test for unit root                   Number of obs   =        12

                                 ------------ Interpolated Dickey-Fuller ------------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -6.031           -3.750            -3.000           -2.630
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

.
. dfuller d2.lngdp

Dickey-Fuller test for unit root                   Number of obs   =        12

                                 ------------ Interpolated Dickey-Fuller ------------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -4.120           -3.750            -3.000           -2.630
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0009
Dickey-Fuller test for unit root                   Number of obs   =        12

                                 ------------ Interpolated Dickey-Fuller ------------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -6.542           -3.750            -3.000           -2.630
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

.
. dfuller d2.opn

Dickey-Fuller test for unit root                   Number of obs   =        12

                                 ------------ Interpolated Dickey-Fuller ------------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -3.431           -3.750            -3.000           -2.630
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0100
```

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3. Optimal lag order:

Selection-order criteria
Sample: 2009 - 2019 Number of obs = 11

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	25.6291				8.0e-11	-3.38711	-3.54672	-3.13391
1	891.093	1730.9	49	0.000	4.2e-74*	-151.835	-153.112	-149.809
2	2411.13	3040.1	49	0.000	.	-424.387	-426.142	-421.601
3	2517.82	213.38*	49	0.000	.	-443.785*	-445.54*	-440.999*
4	.	.	49	.	.	.	.	.

Endogenous: lntb reb lnfer fdi lngdp aw opn
Exogenous: _cons

4. Johansen co-integration test:

maximum rank	parms	LL	eigenvalue	max statistic	5% critical value
0	14	.	.	.	48.45
1	27	.	1.00000	463.0253	42.48
2	38	.	1.00000	43.8237	36.41
3	47	.	0.95629	25.0560	30.33
4	54	.	0.83299	14.8667	23.78
5	59	.	0.65420	10.6867	16.87
6	62	.	0.53389	2.1780	3.74
7	63	.	0.14407		

5. Granger causality test:

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
lntb	reb	7.0374	1	0.008
lntb	lnfer	25.17	1	0.000
lntb	fdi	25.604	1	0.000
lntb	lngdp	108.96	1	0.000
lntb	aw	4.3068	1	0.038
lntb	opn	1.2855	1	0.257
lntb	ALL	339.03	6	0.000